Heterogeneity in Climate Risk Perception and Rights-Based Protection: A Multi-Group Analysis in the Marshall Islands and Kiribati

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This study examines how university students in the Marshall Islands and Kiribati differ in their attitudes toward climate adaptation. Multi-group confirmatory factor analysis (CFA) revealed three factors: perceived feasibility of artificial islands (F1), satisfaction with current conditions (F2), and recognition of climate threats and rights protection (F3). Measurement invariance testing supported partial scalar invariance, allowing valid cross-group comparisons. While F1 and F2 showed no differences, F3 revealed heterogeneity through three findings. First, the latent structure differed, with a weaker covariance between F2 and F3 in the Kiribati group. Second, the Kiribati group scored lower on F3 than the Marshall Islands group. Third, Permutation Feature Importance (PFI) analysis indicated distinct determinants of F3, suggesting that it may rest on different psychological foundations in each country. Although the statistical evidence was modest, these results imply that uniform policy packages may be less effective than anticipated. The findings highlight the need for adaptation and climate justice strategies tailored to the unique socio-historical contexts shaping how atoll populations perceive their right to international protection.

Keywords: Climate Adaptation, Atoll Nations, Multi-Group CFA, Latent Mean Analysis, Perception Heterogeneity

1. Introduction

1.1. Background: Climate Justice and On-the-Ground Realities

In recent years, the international legal landscape surrounding climate justice has expanded rapidly. On 23 July 2025, the International Court of Justice (ICJ) issued an advisory opinion on “States’ Obligations Regarding Climate Change,” unanimously affirming that states may incur international responsibility for failing to prevent, mitigate, or remedy (including, where appropriate, provide compensation for) climate-related harm [1]. This paper does not examine the validity of such overarching frameworks per se. Instead, it focuses on how people in atoll nations structure their perceptions, life satisfaction, and future preferences, and under what conditions these preferences translate into support for the “Right to Stay” and for international guarantees such as financial assistance, international protection, or treaty-based arrangements, from the perspective of those directly affected. For higher-level regimes to be effective, the values and priorities they assume must align with the preference structures of communities on the ground.

1.2. The Heterogeneity of Adaptation in Atoll Nations

Even among atoll nations, baseline conditions such as geography, economy, demographics, and international relations vary considerably. These differences directly shape local preferences toward the Right to Stay and climate adaptation measures, making it inappropriate to generalize from the experience of a single country. In practice, adaptation strategies have taken diverse forms. In Kiribati, the Migration with Dignity policy emphasizes overseas skills and education pathways [2]. In the Marshall Islands, the National Adaptation Plan considers coastal protection, land elevation, and settlement consolidation [3]. In the

Maldives, projects such as the construction of the artificial island Hulhumalé and the development of high sea walls are underway [4]. In Tuvalu, a bilateral agreement with Australia is creating a framework that combines mobility with domestic adaptation [5]. Accordingly, rather than treating adaptation in atoll nations as a single process, it is necessary to compare and understand the structure of preferences among those directly concerned.

1.3. Research Objectives and Hypotheses

Guided by this objective, we focus on two countries, the Republic of the Marshall Islands and Kiribati. In both nations, several major adaptation options—internal relocation, coastal protection, land elevation, artificial islands, and international migration—coexist as realistic possibilities, but artificial island projects are not yet operational. Previous research by Nakayama et al. (2025) [6] has already suggested that the underlying structures of influence on climate change perception differ significantly between these two nations, despite their surface similarities. Building on this finding, we hypothesize that the perceptual structures regarding climate adaptation will vary between the two nations, particularly in how students link climate threat recognition with support for rights-based international protection (F3). We expect these differences to manifest in three ways: (i) different mean levels of F3, (ii) different patterns of correlation between F3 and other factors, and (iii) different determinants of individual variation within F3.

In these contexts, we assess F1 (Perceived Feasibility of Artificial Island Life), F2 (Satisfaction with Current Conditions), and F3 (Recognition of Climate Threats and Rights Protection). Using a common questionnaire design, this study conducts a comparative analysis based on (i) the latent structure, including differences in inter-factor covariances, (ii) latent mean differences in a factor (F3) integrating climate risk perception and orientation toward rights-based protection, and (iii) an analysis of the qualitative differences in the determinants of F3 via Permutation Feature Importance (PFI).

To examine these hypotheses, we compare responses from university students in Kiribati (USP) and the Marshall Islands (CMI).

Our exploratory analysis suggests that in the USP group, support for the Right to Stay is only weakly connected to other specific policy items, whereas in the CMI group it tends to be consistently linked with concrete measures such as international assistance, infrastructure development, and host-country arrangements. This paper examines this hypothesis more rigorously.

1.4. Contributions and Structure of the Paper

Given the exploratory nature of this inquiry and the moderate sample sizes, this study should be understood primarily as hypothesis-generating rather than hypothesis-testing research. Our aim is not to provide definitive conclusions about cross-national differences in climate adaptation preferences, but rather to identify patterns and mechanisms that warrant further investigation. The statistical findings, while suggestive, should be interpreted with appropriate caution and viewed as a foundation for future confirmatory research with larger, more diverse samples.

The contributions of this study are threefold. First, by applying the same design across multiple groups and establishing partial scalar invariance, it identifies cross-country differences in preference structures while controlling for measurement error. Second, it reveals critical structural differences in how normative support for rights-based protection is connected to other attitudes and concerns. Through analysis of inter-factor correlations and Permutation Feature Importance (PFI), it demonstrates that support for the "Right to Stay" is embedded within different psychological frameworks in each country, identifying the distinct conditions under which it is supported as part of a broader policy package rather than as a standalone abstract value. Third, it draws practical implications from the comparative findings for operationalizing support and compensation through financial mobilization, treaty design, and domestic adaptation investment, ensuring alignment between higher-level frameworks and local preferences. Section 2 describes the survey design, measurement model, and analytical procedures. Section 3 presents results for the latent correlation structures, latent means, and PFI analysis. Section 4 interprets these findings, including differences in institutional experience between the two countries, and examines the feasibility of implementing the Right to Stay and international guarantees. Section 5 outlines priorities for the design of support and compensation in atoll nations and proposes future directions for comparative research.

2. Materials and Methods

2.1. Participants and Procedure

The College of the Marshall Islands (CMI) and The University of the South Pacific in Kiribati (USP) were selected as case institutions because they represent the highest-level educational institutions in their respective countries and serve as key venues for youth engagement and public discourse on climate change.

This study compares the structure of perceptions regarding climate change adaptation among university students from the College of the Marshall Islands (CMI; n = 99) and The University of the South Pacific in Kiribati (USP; n = 84). Data for the CMI students were drawn from a previous study, "Artificial Island Construction as an Instrument for the Right to Stay: Case of the Marshall Islands" (Nakayama et al., 2025) [7]. For students in Kiribati, new data were collected

using an identically designed questionnaire. The survey instrument, used for both groups, consisted of approximately 40 items covering various aspects of climate change adaptation (with 3–4 items per factor). The analysis proceeded in three main stages. First, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to develop and validate a measurement model applicable to both groups. Second, multi-group CFA was used to sequentially test for measurement invariance. After establishing partial scalar invariance, this framework was used to conduct two key comparisons: an examination of the latent structure (specifically, inter-factor covariances) and a comparison of latent factor means. Third, Permutation Feature Importance (PFI) was applied to visualize and interpret the structural heterogeneity of the " Recognition of Climate Threats and Rights Protection" (F3) factor by identifying its key predictive items within each group.

2.2. Measurement Model

The measurement model was developed in two stages: EFA followed by CFA.

First, to confirm the suitability of the data for factor analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were performed. Results indicated that both the CMI group (KMO = 0.659, Bartlett's $p < .001$) and the USP group (KMO = 0.621, Bartlett's $p < .001$) met the standard criteria for the application of factor analysis.

Next, to explore a common factor structure, EFA was conducted separately for each group. The number of factors was determined using parallel analysis (PA) with 500 bootstrap replications. Factors were retained when their observed eigenvalues exceeded the upper bound of the 95% confidence interval for eigenvalues generated from random data. This procedure identified a three-factor structure as the most appropriate solution for both groups (see Appendix for details).

Based on the three-factor structure identified in the EFA, and with consideration for model identification in multi-group comparison, three to four representative items were selected for each factor to construct the CFA model. The final three-factor model adopted in the analysis is summarized in **Table 1**.

When the three-factor model was tested separately for each group using CFA, the results indicated good model fit. This model was then adopted as the baseline for multi-group comparison (configural invariance model).

Table 1. Measurement Model Structure in Confirmatory Factor Analysis (CFA)

Factor Label	Factor Name (Latent Variable)	No.	Question
F1	Perceived Feasibility of Artificial Island Life	x32	Artificial islands are technically safe.
		x33	The construction of an artificial island will not adversely affect the natural environment.
		x34	The same lifestyle as today can be maintained after moving to the artificial island.
		x37	Living conditions will be better on the artificial island.
F2	Satisfaction with Current Conditions	x10	After graduation, I will be able to get a good job.
		x11	I am satisfied with the level of health care.
		x12	I am satisfied with the level of education.
F3	Recognition of Climate Threats and Rights Protection	x19	Without special measures, the atoll will be largely uninhabitable by the end of the century due to sea level rise.
		x23	International treaties and financial assistance should be provided to developing countries to ensure the "Right to Stay" for all people worldwide.
		x28	The host country should provide the same protection to the expatriate atoll people as it provides to refugees.

2.3. Analytical Strategy

To test our hypotheses, we employed a three-stage analytical strategy.

First, to establish a robust measurement model, we conducted an Exploratory Factor Analysis (EFA) separately for each group. The suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) statistic and Bartlett's test of sphericity. The number of factors to retain was determined through Parallel Analysis (PA).

Second, we performed a Multi-Group Confirmatory Factor Analysis (CFA) to examine measurement invariance and conduct cross-group comparisons. This procedure followed a standard hierarchical approach. We first tested for configural invariance (the same factor structure across groups), which was supported. We then tested for metric invariance (equal factor loadings), which was also supported. The next step was to test for scalar invariance (equal intercepts). As the full scalar model did not meet the recommended fit criteria (ΔCFI > .010), we examined modification indices and released the equality constraints on the intercepts of two items (x23 and x28), thus establishing partial scalar invariance. This final model demonstrated good fit, which permitted valid cross-group comparisons. Model fit was evaluated using the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR), with model comparisons based on ΔCFI and ΔRMSEA thresholds. With partial scalar invariance established, we proceeded with two key comparisons: first, we used chi-square difference tests to explore the equality of inter-factor covariances, and second, we estimated

latent mean differences, setting the CMI group as the reference.

Third, to investigate the internal structure of F3 in greater detail, we employed Permutation Feature Importance (PFI) analysis, which examines whether the same survey items contribute equally to F3 across groups. While factor loadings reveal overall item-factor relationships, PFI analysis identifies which specific items most strongly predict individual differences within each group. This approach moves beyond simply comparing the level of F3 (via latent means) to uncovering potential qualitative differences in its psychological foundation, revealing qualitative differences in how the same latent construct is supported by different item configurations across cultural contexts.

3. Results

This section presents the findings in the following order: (i) model fit and measurement invariance, (ii) comparison of latent structures, (iii) comparison of latent means, (iv) further exploration of structural heterogeneity through PFI analysis, and (v) a summary of results.

3.1. Measurement Invariance Testing

The results of our measurement invariance testing are presented in **Table 2**. The initial configural invariance model, which tested for a common factor structure, demonstrated an excellent fit to the data ($\chi^2(64) = 64.72$, $p = .451$; CFI = .998; RMSEA = .011). Subsequently, the metric invariance model, with all factor loadings constrained to be equal, was also fully supported (ΔCFI = +0.002), indicating that the items' relationships to the latent factors were equivalent across groups.

The test for scalar invariance, however, revealed a more nuanced picture. A model constraining all item intercepts to be equal did not meet the criteria for invariance. This suggests that for some items, the groups had different baseline levels of agreement, regardless of their underlying scores on the latent factor. To achieve an adequate model fit, it was necessary to establish partial scalar invariance. Specifically, the intercepts for items x23 (concerning the "Right to Stay" via international treaties) and x28 (concerning refugee-like protection for Marshallese) were freely estimated. This adjustment resulted in a well-fitting model (ΔCFI = -0.010 compared to the metric model). The non-invariance of x23 and x28 reveals that these items, both invoking international institutions, operate differently across groups. This likely reflects the Marshall Islands' extensive engagement with international frameworks (e.g., COFA negotiations, nuclear compensation) versus Kiribati's limited experience. For CMI students, treaty guarantees and refugee-like protections feel concrete, while for USP students, they are more abstract and less connected to everyday adaptation. Methodologically, this supports our comparative approach: differences in F3 reflect not only factor means and correlations but also the interpretation of rights-based concepts, highlighting the need for context-sensitive policy design.

This finding of partial invariance is itself a significant result, highlighting structural heterogeneity in how the two groups approach highly political and ethical questions of international protection. With partial scalar invariance established, the prerequisite for comparing latent means was met.

Table 2. Results of Measurement Invariance Testing

Stage	χ^2	df	CFI	RMSEA	ΔCFI	ΔRMSEA
1. Configural	64.7	64	0.998	0.011	–	–
2. Partial Metric[1]	70.5	71	1	0	0.002	-0.011
3. Partial Scalar[2]	79.9	76	0.99	0.024	-0.01	0.024

Note:
[1] Partial Metric model was used, where the loadings for items x23 and x28 on F3 were freely estimated across groups.
[2] Partial Scalar model was used, where the intercepts for items x23 and x28 were freely estimated across groups.

3.2. Latent Structure Comparison: Factor Loadings and Correlations

Table 3 presents the standardized factor loadings for each group. Overall, key items loaded appropriately on their respective factors in both groups, supporting the validity of the model. A notable finding was that the item "International Treaty and Aid Support for the Right to Stay" (x23), part of F3 (Recognition of Climate Threats and Rights Protection), had a high loading in the CMI group (.863) but a weaker, non-significant loading in the USP group (.361, p=.066).

Table 3. Standardized Factor Loadings (Std.all)

Factor		CMI	USP
F1	x32	0.721	0.793
Perceived Feasibility	x33	0.751	0.707
of Artificial Island Life	x34	0.570	0.566
	x37	0.768	0.715
F2	x10	0.542	0.510
Satisfaction with	x11	0.590	0.918
Current Conditions	x12	0.727	0.630
F3	x19	0.542	0.465
Recognition of Climate Threats	x23	0.863	0.361*
and Rights Protection	x28	0.407	0.404*

Note: * indicates p > .05 (x23: p = .066, x28: p = .052).

Table 4 shows the inter-factor correlations. In the CMI group, the three factors were moderately and positively correlated (.437–.512). In the USP group, however, the correlation between F2 (Satisfaction with Current Conditions) and F3 was near zero (.115). A chi-square difference test for equality of factor covariances (**Table 5**) indicated a difference in the F2–F3 relationship at the 10% level (χ^2 diff(1) = 2.92, p = .088).

Table 4. Inter-Factor Correlation Matrix by Group

CMI			
	F1	**F2**	**F3**
F1	1.000		
F2	0.512	1.000	
F3	0.437	0.509	1.000

USP			
	F1	**F2**	**F3**
F1	1.000		
F2	0.305	1.000	
F3	0.637	0.115	1.000

Table 5. X. Chi-Square Difference Tests for Equality of Inter-Factor Covariances

Covariance Tested	χ^2	df	AIC	$\Delta\chi^2$	Δdf	p-value
(Unconstrained Model)	-64.722	-64	-4721.0	-	-	-
F1 ~~ F2 Constrained	66.214	65	4720.5	1.492	1	0.222
F1 ~~ F3 Constrained	65.598	65	4719.9	0.877	1	0.349
F2 ~~ F3 Constrained	67.636	65	4722.0	2.915	1	0.088*
All Constrained	68.066	67	4718.4	3.344	3	0.342

Note: * indicates p > .05–.10

3.3. Latent Mean Comparison

Using the scalar invariance model, latent mean differences for the USP group were estimated relative to the CMI group (set to zero). As shown in **Table 6**, no statistically significant differences were observed for F1 (Perceived Feasibility of Artificial Island Life) or F2 (Satisfaction with Current Conditions). However, for F3, the USP group scored approximately 0.55 standard deviations lower than the CMI group (estimated difference = -0.550, p = .076).

Table 6. Estimated Latent Mean Differences

Factor	USP–CMI Mean Diff (SD)	SE	z	p-value	95% CI
F1: Perceived Feasibility of Artificial Island Life	–0.078	0.171	–0.455	0.649	[–0.413, 0.258]
F2: Satisfaction with Current Conditions	0.204	0.21	0.973	0.330	[–0.207, 0.615]
F3: Recognition of Climate Threats and Rights Protection	–0.550	0.31	–1.773	0.076*	[–1.159, 0.058]

Note: * indicates p > .05–.10

3.4. PFI Analysis of F3

The patterns of feature importance revealed by the Permutation Feature Importance (PFI) analysis (**Figure 1**) indicate that Factor F3 rests on markedly different psychological foundations in the CMI and USP groups. In each triplet of panels (left: CMI in blue; middle: USP in green; right: USP–CMI differences), the top row depicts x19 (sea level rise perception), the middle row x23 (International Treaty and Aid Support for the Right to Stay), and the bottom row x28 (refugee-like protection).

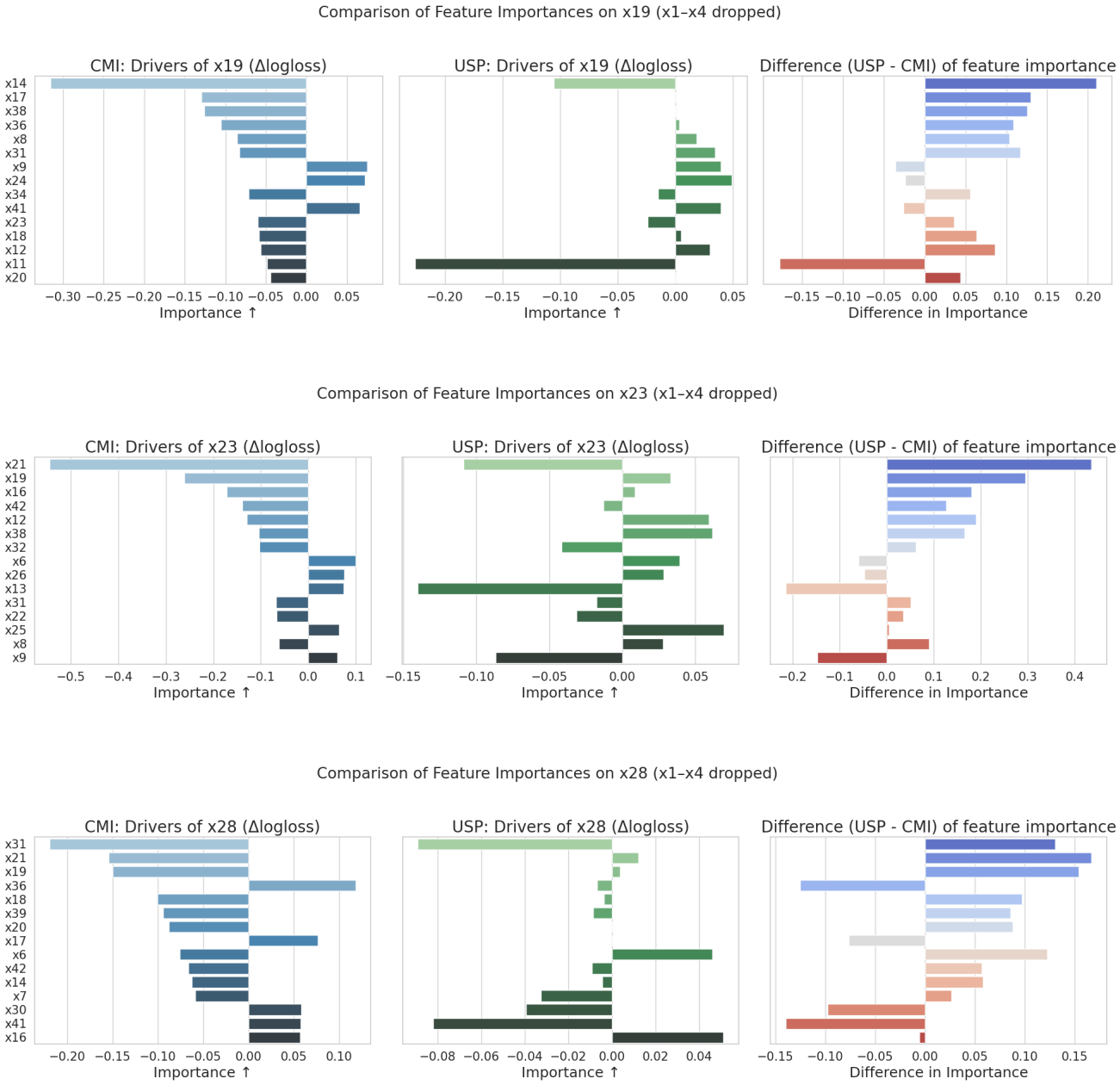
For x19 (top row), CMI scores are most strongly influenced by x14 (*belief that migrants abroad are happier*), followed by x17 (*perceived persistence of family obligations after migration*) and x36 (*expectation that prices will not rise on artificial islands*) (left panel). In contrast, in the USP group (middle panel), x11 (*satisfaction with health care*) emerges as the dominant predictor with a strong negative contribution, while other variables play a minor role. This shift is clearly visible in the right panel, where x11 shows the largest negative difference, indicating a substantial divergence in predictive importance between groups.

For x23 (middle row), CMI results indicate that x21 (*support for the Right to Stay as part of adaptation policy*) and x19 (*sea-level-rise perception*) are the most influential predictors, both showing strong negative contributions (left panel). In contrast, the USP group (middle panel) displays a distinctly different pattern: x13 (*intention to emigrate abroad*) and x16 (*belief that emigrants should prepare well in advance by learning language and society of destination countries*) become dominant predictors, with x13 showing a positive contribution and x16 a moderate negative one. The right panel highlights these contrasts, with x21 and x19 showing large positive differences (indicating weaker influence in USP) and x13 showing a negative difference (indicating stronger influence in USP).

For x28 (bottom row), the leading predictors also shift notably. In the CMI group, x31 (*willingness to move to an artificial island within Kiribati*) and x21 (*support for the Right to Stay*) exert the strongest influence, followed by x19 (*sea-level-rise perception*) and x36 (*expectation of stable prices on artificial islands*) (left panel). In USP, however, x41 (*belief that those wishing to remain should have their land raised by the government and international community*) and x16 (*preparation for emigration abroad*) emerge as dominant positive predictors, while x31 and x21 lose much of their explanatory power (middle panel). These changes are clearly captured in the right panel, where x41 and x16 exhibit large positive differences, indicating that these factors play a stronger role in shaping USP students' recognition of refugee-like protection compared to their CMI counterparts.

These systematic shifts, visible across all three variables in **Figure 1**, demonstrate that while F3 is statistically identified as the same factor, its underlying network of associations differs substantially between the two groups, underscoring the context-specific nature of rights-based climate adaptation preferences.

Figure 1. Permutation Feature Importance (PFI) for x19 (sea level rise perception), x23 (International Treaty and Aid Support for the Right to Stay), and x28 (refugee-like protection).
In each row: left panel = CMI (blue), middle panel = USP (green), right panel = USP–CMI difference.



3.5. Summary of Results

Across analyses, the perception structures of the CMI and USP groups were similar for F1 and F2 but showed marked heterogeneity for F3 (Recognition of Climate Threats and Rights Protection). This heterogeneity was supported from three angles: (i) latent mean level (USP ≈ 0.55 SD lower), (ii) latent structure (notably weaker association with F2 in USP), and (iii) determinants of individual differences (qualitative differences in top PFI items). Given the sample sizes (CMI: n = 99, USP: n = 84), these results fall near the conventional significance boundary (p ≈ .05–.10), yet they indicate substantively important differences that serve as hypothesis-generating evidence warranting further large-scale research.

4. Discussion

The results of this study reveal substantive differences between the CMI group (Marshall Islands) and the USP group (Kiribati) in both the mean and structural parameters of the latent factor (F3) that combines recognition of climate threats and rights protection. The USP group scored approximately 0.55 standard deviations lower than the CMI group (p = .076), representing a medium-to-large effect size that warrants attention despite falling just outside conventional significance thresholds. Given that both groups face similar ecological threats as atoll nations, the observed differences in F3 are likely shaped by more complex sociopolitical and institutional factors rather than by variations in physical risk perception alone. This discussion adopts an exploratory and hypothesis-generating perspective that extends prior theories on climate justice, focusing on asymmetries in "access to institutions" and "rights consciousness regarding compensation," and situates these interpretations within existing literature.

4.1. Main Findings and Their Interpretation

The higher F3 scores in the CMI group likely reflect the Marshall Islands' distinct historical and institutional experiences. The Compact of Free Association (COFA) with the United States, the legacy of nuclear testing and related compensation disputes (Bordner, 2024) [8], and the exclusion of COFA migrants from certain U.S. social programs (Lum, 2023) [9] have contributed to both a culture and practical skills for contesting structural injustices and asserting rights through international frameworks. Such accumulated experiences, from negotiating the terms of association with the U.S. (Young, 2023) [11] to confronting the limits of internal mobility as an adaptation option (Roland, 2023) [10], may have reinforced an orientation toward "international institutions" as critical arenas for securing the nation's future. Drawing on Krzesni and Brewington (2022), the fragility of "everyday infrastructure" (health, water, food) under climate stress may further heighten the inclination to seek institutional solutions [12].

4.2. Institutional Context: Marshall Islands vs. Kiribati

In the Kiribati, climate risk perception is known to be high (Allgood & McNamara, 2017 [13]; Cauchi et al., 2021 [14]), yet it does not appear to translate into similar demands for compensation through international frameworks. One possible explanation is Webber's (2013) notion of "performative vulnerability," in which national adaptation policies strategically represent vulnerability to secure aid, cultivating dependency rather than individual rights consciousness [15]. Moreover, as Klepp and Fünfgeld (2022) argue, when international aid projects fail to integrate local knowledge and participation, "epistemic injustice" may emerge [16]. These dynamics can foster a sense that "the institutions are not ours," thereby dampening grassroots engagement with global governance.

4.3. Theoretical Implications for Climate Justice

Differences in engagement with international institutions also help explain variation in F3. The Marshall Islands has actively used international platforms, notably in nuclear compensation negotiations, and more recently in Pacific-wide advocacy, such as Marshallese youth movements urging ICJ advisory opinions on climate justice (Rikimani, 2024) [17]. Such experiences may correlate with a political orientation toward treating "non-economic losses" (NELD), land, culture, and identity, as subjects for institutional redress (Handmer et al., 2024) [18]. By contrast, in Kiribati, international advocacy remains concentrated among elites, and opportunities for grassroots participation in institutional processes are limited (Morgan & Petrou, 2023) [19]. This aligns with the observed group differences in F3.

4.4. Policy Recommendations

As Siders (2022) [20] emphasizes, the realization of climate justice depends less on normative ideals than on the ability to navigate implementation dilemmas. The differences in F3 may thus reflect an asymmetry in the capacity to appeal to institutions, shaped by historical trajectories. For the CMI group, rights consciousness is tied to engagement in institutional struggles; for the USP group, exclusion from institutional design processes may have contributed to a weaker inclination to seek international guarantees.

While these interpretations remain provisional given data limitations, the findings point to important implications for both theory and practice. Addressing disparities requires more than quantifying losses and providing financial aid. It demands empowerment strategies that foster agency and institutional access, rooted in postcolonial perspectives on structural inequality. For the USP group, where rights-oriented recognition is relatively low, stepwise readiness measures, such as participatory processes and capacity

building, may be more suitable. In contrast, for the CMI group, where rights consciousness is established, more advanced implementation measures, mobilizing finance, establishing legal frameworks, may be warranted. Designing country-specific adaptation strategies that reflect latent preference structures is therefore essential for equitable policy design.

5. Conclusion

This study compared perceptions of climate change adaptation between university students in the Marshall Islands (CMI group) and Kiribati (USP group) using multi-group CFA. While no significant differences were found in the feasibility of artificial islands (F1) or satisfaction with current conditions (F2), a clear divergence emerged in the factor integrating recognition of climate threats and rights protection (F3). The USP group scored about 0.55 standard deviations lower than the CMI group ($p = .076$), indicating a moderate effect size that reflects underlying sociopolitical and institutional differences.

The study contributes to climate justice research by providing hypothesis-generating evidence that, even among atoll nations facing similar ecological risks, the cognitive structures shaping rights-oriented perceptions are heterogeneous. By combining measurement invariance testing, latent mean analysis, and permutation-based diagnostics, this study empirically tests and extends existing theoretical frameworks on climate justice and rights-based adaptation.

This study has several limitations. The relatively small sample size and the focus on university students constrain generalizability, and the cross-sectional design precludes causal inference. As an exploratory and hypothesis-generating analysis, the findings should be regarded as preliminary evidence that lays the groundwork for larger-scale, multi-site studies. Future research should build on this work through confirmatory and mixed-method approaches. Further causal examination of the observed differences and hypothesis testing on institutional and cultural mechanisms will be crucial to deepen understanding of climate justice dynamics. Ultimately, large-scale and collaborative empirical research will be essential to consolidate these findings, for which this study may serve as an initial foundation.

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Appendix A. Full List of Survey Items (Questionnaire Items and Codes)

Code	Question
x1	**Gender**
x2	**Your age.**
x3	**Place of Residence.**
x4	**I have traveled to other countries.**
x5	**I feel burdened by daily obligations imposed by my family.**
x6	**I feel burdened by daily obligations imposed by the local community.**
x7	**Local community involvement is part of growing up and being a part of my community.**
x8	**Leaving [Kiribati / the Marshall Islands] will give me more freedom than staying in [Kiribati / the Marshall Islands].**
x9	**I am satisfied with my present life.**
x10	**After graduation, I will be able to get a good job in [Kiribati / the Marshall Islands].**
x11	**I am satisfied with the level of health care in [Kiribati / the Marshall Islands].**
x12	**I am satisfied with the level of education in [Kiribati / the Marshall Islands].**
x13	**I would like to emigrate to abroad in the future.**
x14	**People from [Kiribati / the Marshall Islands] who have migrated abroad are happier than they were in their home country.**
x15	**People from [Kiribati / the Marshall Islands] have kept their own language and culture when they leave [Kiribati / the Marshall Islands].**
x16	**People from [Kiribati / the Marshall Islands] who wish to emigrate to abroad must prepare well in advance by learning the language and society of the destination country.**
x17	**Even if people from [Kiribati / the Marshall Islands] emigrate abroad, they cannot escape the obligations imposed on them by their families.**
x18	**The majority of people from [Kiribati / the Marshall Islands] who emigrate to abroad will eventually return to [Kiribati / the Marshall Islands].**
x19	**Without special measures, Atoll of [Kiribati / the Marshall Islands] will be largely uninhabitable by the end of the century due to sea level rise.**
x20	**Instead of island countries taking climate change adaptation measures on their own, developed countries should finance all necessary measures in island countries.**
x21	**“Right to Stay” should be included in climate change adaptation measures.**
x22	**I am satisfied with [Kiribati / the Marshall Islands] government's climate change adaptation measures.**
x23	**International treaties and financial assistance should be provided to developing countries to ensure the “Right to Stay” for all people worldwide.**
x24	**[Kiribati / The Marshall Islands] government should protect the Atoll with high seawalls to ensure the “Right to Stay” of the atoll’s residents.**
x25	**[Kiribati / The Marshall Islands] government should build an artificial island in one of the atolls in [the Kiribati / the Marshall Islands] Islands to ensure the “Right to Stay” of the residents in [Kiribati / the Marshall Islands].**
x26	**[Kiribati / The Marshall Islands] government should provide financial assistance to out-migrating nationals.**
x27	**[Kiribati / The Marshall Islands] government should provide vocational training for nationals who wish to emigrate to abroad.**
x28	**The host country should provide the same protection to the expatriate people from [Kiribati / the Marshall Islands] as it provides to refugees.**
x29	**I want to stay in [Kiribati / the Marshall Islands].**
x30	**I would not hesitate to move to another atoll within [Kiribati / the Marshall Islands].**
x31	**I would not hesitate to move to an artificial island to be built within [Kiribati / the Marshall Islands].**
x32	**Artificial islands are technically safe.**
x33	**The construction of an artificial island will not adversely affect the natural environment.**
x34	**The same lifestyle as today can be maintained after moving to the artificial island.**
x35	**People will be able to maintain the same relationships as they have now after moving to the artificial island.**
x36	**Prices and housing costs will not increase on the artificial island.**
x37	**Living conditions will be better on the artificial island.**
x38	**There will be more opportunities for higher income jobs on the artificial island.**
x39	**Life on the artificial island will be more convenient than it is now.**
x40	**Construction work to develop an artificial island should not be done until all parties involved agree to it.**
x41	**If there is even one person who wants to remain in the present residence, the government and the international community should raise the land owned by that person so that he or she can continue to live there.**
x42	**Construction of the artificial island in [Kiribati / the Marshall Islands] should begin as soon as possible.**

Note: Respondents in each country were presented with identical questions, with country names adjusted appropriately. The survey items x5–x42 employed a 5-point Likert response format. Items x1–x4 were excluded from the factor analysis conducted in this study.

Appendix B-1. Exploratory Factor Analysis (EFA) Results

Variable	USP-F1	USP-F2	USP-F3	CMI-F1	CMI-F2	CMI-F3
x5		0.63				
x6		0.70		0.42		
x8		0.49		0.39	–0.45	
x10			0.64			0.67
x11			0.73		0.40	
x12			0.53		0.53	
x13		0.63				
x16						0.55
x19						0.62
x21						0.64
x22			0.58			
x23						0.48
x25						0.40
x27						0.54
x28						0.50
x31				0.42	0.38	
x32	0.72			0.53		
x33	0.59			0.66		
x34				0.65		
x35	0.64			0.48		
x37	0.69			0.72		
x39	0.76			0.66		
x42	0.66				0.41	

Extraction method: Principal axis factoring
Rotation: Varimax with Kaiser normalization
KMO = 0.63, Bartlett's test $p < .001$
Note: Factor names—F1 = Artificial Island Feasibility, F2 = Satisfaction with Current Conditions, F3 = Recognition of Climate Threats and Rights Protection. Only salient loadings (>|0.40|) are shown.

Appendix C. Supplementary Parameter Estimates and Fit Indices

C.1 Standardized and Unstandardized Factor Loadings (CMI & USP)

Factor	Item	Estimate (CMI / USP)	Std. Err (CMI / USP)	z-value (CMI / USP)	p-value (CMI / USP)	Std.lv (CMI / USP)	Std.all (CMI / USP)
F1 (Perceived Feasibility of Artificial Island Life)							
	x32 – Artificial islands are technically safe.	1.000 (fixed)	–	–	–	0.696 / 0.742	0.721 / 0.793
	x33 – The construction of an artificial island will not adversely	1.077 / 1.093	0.17 / 0.19	6.35 / 5.85	< .001	0.750 / 0.811	0.751 / 0.707
	x34 – The same lifestyle as today can be maintained after moving to the artificial island.	0.808 / 0.822	0.16 / 0.17	5.02 / 4.74	< .001	0.562 / 0.610	0.570 / 0.566
	x37 – Living conditions will be better on the artificial island.	0.935 / 0.895	0.15 / 0.15	6.44 / 5.90	< .001	0.650 / 0.664	0.768 / 0.715
F2 (Satisfaction with Current Conditions)							
	x10 – After graduation, I will be able to get a good job	1.000 (fixed)	–	–	–	0.448 / 0.553	0.542 / 0.510
	x11 – I am satisfied with the level of health care.	1.462 / 1.951	0.39 / 0.55	3.76 / 3.57	< .001	0.655 / 1.078	0.590 / 0.918
	x12 – I am satisfied with the level of education.	1.409 / 1.258	0.36 / 0.31	3.92 / 4.03	< .001	0.631 / 0.696	0.727 / 0.630
F3 (Recognition of Climate Threats and Rights Protection)							
	x19 – Without special measures, the atoll will be largely uninhabitable by the end of the century due to sea level rise.	1.000 (fixed)	–	–	–	0.459 / 0.532	0.542 / 0.465
	x23 – International treaties and financial assistance should be provided to developing countries to ensure the “Right to Stay” for all people worldwide.	1.595 / 0.446	0.44 / 0.24	3.66 / 1.83	< .001 (CMI) / .066 (USP)	0.732 / 0.237	0.863 / 0.361
	x28 – The host country should provide the same protection to the expatriate atoll people as it provides to refugees.	0.797 / 0.580	0.25 / 0.30	3.19 / 1.94	.001 (CMI) / .052 (USP)	0.366 / 0.308	0.407 / 0.404

Note. CMI = Marshall Islands group; USP = Kiribati group. All estimates are derived from the partial-scalar invariance model described in Section 3.1.

C.2 Factor Correlations

Group	F1–F2	F1–F3	F2–F3
CMI	0.512	0.437	0.509
USP	0.305	0.637	0.115

Note: The F2–F3 association was weaker in USP ($p \approx .09$), indicating potential contextual heterogeneity in risk and rights perceptions.

C.3 Supplementary Fit Indices

Model	χ^2 (df)	p	CFI	TLI	RMSEA [90 % CI]	SRMR	AIC	BIC	SABIC
CMI + USP Configural	64.72 (64)	0.451	0.998	0.997	.011 [.000–.064]	0.053	4721.05	4932.88	4723.84
Partial Metric	70.50 (71)	0.482	1	0.998	.010 [.000–.060]	0.052	–	–	–
Partial Scalar	79.90 (76)	0.397	0.99	0.986	.024 [.000–.065]	0.066	–	–	–

Note: Model evaluation criteria: CFI ≥ .95, RMSEA ≤ .06, SRMR ≤ .08 for good fit.
ΔCFI ≤ .010 and ΔRMSEA ≤ .015 indicate measurement invariance (Chen, 2007).
Partial scalar invariance was achieved by freeing the intercepts of x23 and x28 across groups.