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ORIGINAL ARTICLE

Rhetorical Co-optation or Substantive Partnership? A Computational Text Audit of Traditional Ecological Knowledge in Global Climate Policies (NDCs 2015–2025)

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ABSTRACT

Background: Climate governance increasingly cites Traditional Ecological Knowledge (TEK) and Indigenous Peoples as pillars of mitigation. Whether this recognition reflects substantive empowerment or rhetorical co-optation has not been quantified across policy documents.

Objective: To measure the gap between rhetorical recognition and substantive integration of TEK in Nationally Determined Contributions (NDCs) and identify associated national factors.

Methods: We audited 585 NDCs submitted by 195 state parties across three policy cycles (2015–2025) with natural language processing, structural topic modeling (STM) and the Word Embedding Association Test (WEAT), and scored a Traditional Policy Integration Index (TPII, 0–100). Tobit regression estimated factors associated with integration.

Results: Rhetorical recognition rose from 48.2% (94 NDCs) in 2015 to 77.8% (152 NDCs) in 2025, whereas substantive integration reached 20.1% (39 NDCs); 12.8% allocated dedicated budgets and 9.2% mandated Free, Prior, and Informed Consent (FPIC). Mean TPII was 26.4 ± 14.8 in 2025. WEAT showed an association of indigenous terms with passive vulnerability ($d = +0.842$, $p < 0.001$); indigenous peoples appeared mainly as vulnerable beneficiaries (34.2% topic prevalence) or carbon sinks (28.5%), rarely as governing agents (11.2%). ILO 169 ratification ($\beta = +12.45$, $p < 0.001$) and democratic governance ($\beta = +4.62$, $p < 0.001$) were associated with higher integration, and natural resource dependency ($\beta = -0.48$, $p < 0.001$) with lower integration.

Conclusion: The patterns are consistent with green coloniality, in which indigenous ecological legitimacy is invoked while territorial authority is withheld. We propose the CARE-NDC framework to institutionalize biocultural rights and direct indigenous climate finance.

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1. Introduction

Climate governance now leans heavily on Indigenous Peoples and local communities as custodians of what remains of the planet's biodiversity.[1–3] The stakes are high. Indigenous Peoples manage or hold tenure rights over at least a quarter of the world's land surface, an area that intersects about 40% of terrestrial protected areas and ecologically intact landscapes.[3,4] Their territories also contain some of the most intact and resilient carbon sinks on Earth.[5] Traditional Ecological Knowledge (TEK) rests on millennia of place-based observation, reciprocal kinship between people and nature, and customary resource management. The Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) now recognize it as essential to mitigation and adaptation.[6,7] Civil society pressure and international declarations pushed multilateral treaties in the same direction. The 2015 Paris Agreement most prominently acknowledges traditional knowledge systems next to modern Western climate science.[7,8]

Political ecologists, decolonial legal theorists and indigenous scholars warn that indigenous vocabulary in multilateral agreements often hides a deeper process, called 'green

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colonialism' or 'carbon colonialism'.[9,10] On this reading, a state's formal appeal to indigenous wisdom does not automatically signal power-sharing, territorial sovereignty or epistemic equality.[11,12] Dominant political and economic institutions instead practice rhetorical co-optation. They draw on the moral authority, cultural symbolism and ecological legitimacy of indigenous traditions to justify state-directed carbon accounting. They deny native communities legal land tenure, self-determination and autonomous control of resources.[12,13] The pattern is familiar. Indigenous peoples are praised as abstract 'guardians of nature'. Their customary rights are still routinely overridden by state-sanctioned renewable energy concessions, commercial carbon offset projects and militarized fortress conservation schemes.[9,12,14]

The concept of epistemic extractivism, developed in decolonial thought by Ramón Grosfoguel and extended by Linda Martin Alcoff, helps to explain this contradiction.[15–17] It describes dominant Western scientific and bureaucratic paradigms that treat indigenous knowledge as raw, uncurated data to be mined and retrofitted into Western climate models. The relational cosmologies, ethical responsibilities and sovereign legal systems in which that knowledge is embedded are set aside.[1,18] Consider a state that cites indigenous forest fire management or drought resilience techniques but does not recognize the land tenure of the customary communities who practice them. It commits a form of hermeneutical injustice. Whole-of-life philosophies shrink into instrumental technical fixes for industrial capitalism.[1,18]

The historical roots of this green extractivism lie in colonial conservation paradigms that shaped international environmental law.[10,12] In the late nineteenth and early twentieth centuries, colonial administrations in British Africa, Dutch Southeast Asia and the American West created the first national parks and forest reserves by violently expelling indigenous inhabitants. This conservation ideology is known as 'fortress conservation'.[10,14] Forest dwellers and pastoralists were criminalized as 'poachers' and 'encroachers' on their own ancestral homelands, while imperial forestry services expropriated timber, rubber and mineral wealth under the guise of scientific preservation.[10,19] The contemporary UNFCCC climate architecture inherited this top-down, state-centric ontology when it was formulated. National governments were treated as the exclusive sovereign owners of all carbon sinks and natural resources within their borders, whatever pre-existing indigenous land rights there were.[11,12]

Market mechanisms have financialized global climate mitigation. They include the Clean Development Mechanism (CDM) under the Kyoto Protocol and Article 6 carbon markets under the Paris Agreement. They have accelerated the commodification of indigenous ecological realms.[11,20] Living forest ecosystems are translated into abstract, fungible units of carbon dioxide equivalent (tCO_2e). Carbon markets thereby divorce environmental stewardship from the cultural, spiritual and reciprocal relations that sustained those ecosystems for millennia.[17,20] Transnational corporations and fossil fuel polluters in the Global North can then purchase offsets generated in the Global South. They buy a license to keep emitting while indigenous lands are enclosed in the name of global sustainability.[11,12]

Nationally Determined Contributions (NDCs) are the central instruments through which state parties put their commitments under the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement into practice.[7,8] Each is submitted every five years. It serves as an official public pledge that sets out a sovereign state's domestic mitigation targets, adaptation policies, financial allocations and governance frameworks.[7,21] NDCs sit between treaty mandates and domestic legislation, and that position makes them a rich empirical corpus for studying how states conceptualize, position and govern indigenous communities in official climate policy.[7,21]

Despite the importance of NDCs, scholarship on indigenous climate policy has mostly relied on qualitative case studies of single jurisdictions or on high-level narrative summaries of international negotiations.[7] That approach has limits. What is missing is a comprehensive, longitudinal computational text audit that evaluates the entire global corpus of NDCs across successive policy cycles (2015–2025).[7,22,23] To our knowledge, few studies have computationally quantified the gap between rhetorical recognition and substantive commitments, such as legally binding land tenure rights, dedicated budgets and the institutionalization of Free, Prior, and Informed Consent (FPIC).[7,24] To our knowledge, no study has empirically modeled the macro-level political and econometric determinants that explain why some sovereign states champion indigenous climate self-determination while others erase native sovereignty entirely.[24,25]

Indonesia is a high-stakes microcosm of this global tension.[19,26] Its tropical rainforests and peatlands span over 120 million hectares. It is home to an estimated 50 to 70 million indigenous individuals (a figure attributed to the Indigenous Peoples' Alliance of the Archipelago, AMAN). The 2010 census listed 1,331 ethnic-group categories, regrouped into 633 groups,[27] but no official national count of recognized Customary Law Communities (*Masyarakat Hukum Adat* / MHA) exists; by August 2025 the Ancestral Domain Registration Agency had registered 1,633 territory maps.[28] The Constitutional Court ruled in May 2013 (*Putusan MK* No. 35/PUU-X/2012, registered in 2012) that customary forests (*Hutan Adat*) do not belong to the state.[29,30] Even so, customary communities still face long bureaucratic obstacles in securing formal land titles. Their ancestral territories are frequently absorbed by state carbon offset concessions, oil palm plantations and nickel mining for energy transition infrastructure.[31–35] Examining how Indonesia's successive NDCs frame customary communities within the wider geopolitical architecture shows the precise mechanisms of policy co-optation.[19,26]

To address this gap, this study conducts a large-scale computational text audit and multivariate econometric analysis of 585 Nationally Determined Contributions submitted by 195 UNFCCC state parties across three successive policy cycles: NDC 1.0 (2015–2016), Updated NDCs (2020–2021) and the third cycle (NDC 3.0 synthesis horizon, 2025).[7,8] It uses Natural Language Processing (NLP), Structural Topic Modeling (STM), the Word Embedding Association Test (WEAT) and multivariate Tobit regression. The design has five aims. We (a) quantify the longitudinal evolution of the Traditional Policy Integration Index (TPII); (b) expose the semantic framing bias that links indigenous communities to passive vulnerability rather than sovereign agency; (c) identify the domestic governance determinants of substantive TEK integration; (d) carry out a multi-level policy audit of Indonesian customary forest tenure; and (e) establish the CARE-NDC framework to institutionalize indigenous data sovereignty and direct climate finance.[26,36]

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2. Methods

2.1 Policy Corpus Compilation and Longitudinal Stratification

We retrieved every official English-language and officially translated Nationally Determined Contribution (NDC) submitted to the UNFCCC interim registry. The window runs from the adoption of the Paris Agreement at COP21 in December 2015 to the third-cycle submission horizon in 2025.[7,8,25] The corpus covers all 195 sovereign state parties to the UNFCCC that submitted national pledges across three longitudinal policy cycles:[7,8] (a) First-Round Pledges (NDC 1.0, 2015–2016; N = 195); (b) Second-Round Updated Pledges (Updated NDCs / NDC 2.0, 2020–2021; N = 195); and (c) Third-Round Synthesis Submissions (NDC 3.0 horizon, 2025; N = 195).[7]

The dataset comprised 585 policy documents with over 4.8 million words of official state text.[7] An automated parsing pipeline in Python (PyPDF2, pdfplumber, and BeautifulSoup) extracted the full text. It removed table-of-contents pagination, boilerplate annex headers and repetitive legal disclaimers.[37] Relational metadata was added for each submission: ISO country code, geographic region, World Bank income classification, date of submission, revision number and domestic legal ratification status.[7,25]

2.2 Construction of the Traditional Policy Integration Index (TPII)

To measure the depth and authenticity of the operationalization of traditional ecological knowledge, we constructed the Traditional Policy Integration Index (TPII). It is a 100-point composite scoring rubric built from four 25-point governance dimensions:[7]

Dimension 1: Rhetorical Recognition and Epistemic Respect (0–25 points) evaluates whether TEK, indigenous peoples or customary communities are explicitly mentioned in national vision statements, preamble sections and mitigation or adaptation overviews, acknowledging indigenous ontologies alongside Western climate science.[7] Dimension 2: Territorial Rights, Customary Land Tenure, and Sovereignty (0–25 points) evaluates whether the NDC recognizes collective ancestral land titles, customary forest tenure and indigenous stewardship over carbon-dense ecosystems.[19] Dimension 3: Institutional Governance, Co-Management, and FPIC (0–25 points) assesses whether the policy establishes formal joint-management councils, mandates Free, Prior, and Informed Consent (FPIC) before project execution and embeds indigenous delegates in national climate committees.[7] Dimension 4: Direct Budgetary Allocation and Finance Tracking (0–25 points) evaluates whether specific, dedicated financial resources are earmarked for community-led climate adaptation, rather than routed through commercial intermediaries or multilateral bureaucracies.[24] The four dimensions add up to the full index. An NDC with TPII < 20 was classified as 'Negligible Integration', 20–49 as 'Rhetorical Mention Only' and ≥ 50 as 'Substantive Policy Integration'.[7]

The text mining pipeline included automated translation verification and language-specific stopword filtering, so that multilingual submissions could be processed reliably.[7,37] Some NDCs were originally drafted in Spanish, French or Russian and submitted with official translations. We audited the original text and the translation in parallel with multilingual BERT (mBERT) and XLM-RoBERTa embeddings to verify translation parity. This ensured that the semantic nuance of customary land tenure terms (e.g., '*tierras ancestrales* [ancestral lands]', '*territoires autochtones* [indigenous territories]', '*коренные народы* [indigenous peoples]') was strictly preserved.[38,39]

2.3 Computational Linguistics, Word Embedding Association, and Topic Modeling

To probe the latent semantic and ideological framing of indigenous peoples across the policy corpus, we deployed two advanced computational linguistic methods:[22,23,37,40]

First, we implemented the Word Embedding Association Test (WEAT) to quantify implicit semantic bias in domain-specific word embeddings.[40] A continuous skip-gram Word2Vec model[41] was trained on the full 4.8-million-word NDC corpus (vector size = 300, window size = 5, minimum count = 5). We tested whether target words referring to indigenous communities (Target Set X: 'indigenous', 'customary', 'native', 'traditional', 'tribal') were more strongly associated with attributes of passive vulnerability (Attribute Set A: 'vulnerable', 'marginalized', 'helpless', 'victim', 'threatened', 'poor', 'destitute') or with attributes of sovereign agency and leadership (Attribute Set B: 'leader', 'sovereign', 'governor', 'expert', 'steward', 'decision-maker', 'autonomous').[40] Effect size (Cohen's d) and permutation test p-values were computed following Caliskan et al.[40] Second, Structural Topic Modeling (STM) was applied with the stm package in R. It extracted latent thematic discourses from all paragraphs containing indigenous search tokens, with national GDP and region as prevalence covariates.[37,42]

2.4 Econometric Model Specification (Multivariate Tobit Regression)

Because the Traditional Policy Integration Index (TPII) is bounded between 0 and 100 and many state parties score zero (left-censoring at TPII = 0 for 43 countries; cycle 3 data), Ordinary Least Squares (OLS) regression produces biased and inconsistent parameter estimates.[43] We therefore specified a multivariate Tobit regression model to account for left-censoring:[43] $Y_i^* = \beta_0 + \beta_1 ILO169_i + \beta_2 Ministry_i + \beta_3 NDGAIN_i + \beta_4 \ln(GDP_i) + \beta_5 VDem_i + \beta_6 Resource_i + u_i$, where Y_i^* is the latent policy integration score and observed TPII is $Y_i = \max(0, Y_i^*)$.[43]

Explanatory variables were operationalized as follows. (a) ILO169_i is a dummy equal to 1 if the country has ratified ILO Convention No. 169 or formally adopted UNDRIP with domestic enforcement. (b) Ministry_i is a dummy indicating a dedicated cabinet-level indigenous affairs ministry. (c) NDGAIN_i is the Notre Dame Global Adaptation Index (ND-GAIN), in which a higher score denotes lower vulnerability and greater readiness. (d) ln(GDP_i) is the natural logarithm of GDP per capita (constant 2015 USD). (e) VDem_i is the Varieties of Democracy (V-Dem) Electoral Democracy Index.[44] (f) Resource_i is total natural resource rents as a percentage of GDP (World Bank), which captures extractive economic dependence. Estimation used maximum likelihood in Stata v18 and R (censReg package).

An independent manual verification checked the accuracy of the automated text mining and TPII scoring pipeline. It used a stratified random sample of 60 NDCs (20 from each policy cycle, balanced across geographic regions). Two independent environmental policy analysts scored the sampled documents on the four TPII dimensions with a standardized scoring codebook. Inter-coder reliability, evaluated with Krippendorff's alpha (α)[45], was high (α = 0.884) across all four dimensions (Dimension 1: α = 0.912; Dimension 2: α = 0.875;

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Dimension 3: α = 0.864; Dimension 4: α = 0.885).[7] Disagreements were resolved through consensus review with an environmental law specialist. The automated classification pipeline therefore reliably mirrors rigorous human legal evaluation, without systematic scoring bias.

We tested the Tobit specification against potential heteroskedasticity and non-normality in the latent error terms with Pagan-Vella conditional moment tests and Huber-White sandwich standard errors.[46,47] A comparison with a two-tier Cragg hurdle model favored the Tobit specification on the Bayesian Information Criterion (BIC_Tobit = 1,284.2 vs BIC_Hurdle = 1,312.6).[48,49] This indicates a single continuous decision mechanism with lower-bound censoring at zero, not a disjoint two-stage participation hurdle. Generalized residual plots confirmed homoskedastic variance across fitted index values.

2.5 Qualitative Case Audit of Indonesian Climate Policy Architecture

To ground the computational modeling in a living institutional context, we carried out an in-depth qualitative audit of the Republic of Indonesia's climate policy trajectory across its First NDC (November 2016), Updated NDC (July 2021), Enhanced NDC (September 2022) and Second NDC (submitted 27 October 2025).[26,50–52] Policy texts were triangulated against statutory instruments (Law No. 32/2009[53], Constitutional Court Decision No. 35/PUU-X/2012 of 16 May 2013 and Presidential Regulation No. 98/2021 on Carbon Economic Value, since replaced by Presidential Regulation No. 110/2025), spatial data from the Ancestral Domain Registration Agency (*Badan Registrasi Wilayah Adat* / BRWA) and ministerial decrees from the Ministry of Environment and Forestry (KLHK).[19,31,54,55]

2.6 Decolonial Governance Protocol (CARE-NDC Framework)

Synthesizing our empirical findings, we operationalize the Global Indigenous Data Alliance CARE Principles (Collective Benefit, Authority to Control, Responsibility, Ethics) into a practical governance roadmap for national climate delegations and UNFCCC negotiating bodies.[36] The framework is presented as a proposal in Section 4.4.

3. Results

3.1 Longitudinal Evolution of TEK Recognition and Policy Operationalization

Longitudinal auditing across the decade of Paris Agreement implementation revealed a widening gap between the rhetorical celebration of indigenous knowledge and its substantive policy operationalization (Table 1 and Figure 1). The gap is widening. In the initial round of pledges (NDC 1.0, 2015–2016), 48.2% of national submissions (94 countries) included textual references to indigenous peoples, traditional communities or local ecological practices (Figure 1a). Recognition rose to 62.8% (122 countries) in the second cycle (Updated NDCs, 2020–2021), and by the third cycle (NDC 3.0 synthesis, 2025) it reached an all-time high of 77.8% (152 countries) (Table 1). The growth was steep. Textual mentions of 'traditional ecological knowledge' and 'indigenous wisdom' grew by 162% in aggregate paragraph volume over the ten-year period.[7]

This rhetorical expansion was almost entirely uncoupled from substantive policy integration (Table 1 and Figure 1b). The proportion of state parties achieving substantive integration (TPII ≥ 50) crept up from 8.7% (17 countries) in 2015 to 14.3% (28 countries) in 2021, and reached only 20.1% (39 countries) in 2025 (Figure 1b). The mean global TPII score stood at 14.3 ± 9.8 in 2015 and rose to 20.1 ± 12.4 in 2021. It reached just 26.4 ± 14.8 in 2025, far below the international due diligence benchmark of 60.0 (Table 1). The benchmark is far off. Direct budgetary allocation stayed almost non-existent: only 4.1% of NDCs in 2015, 7.7% in 2021 and 12.8% in 2025 earmarked specific financial resources for indigenous-led adaptation (Table 1). Funding barely moved. FPIC mandates were codified in only 2.6% of NDCs in 2015 and in just 9.2% in 2025 (Table 1). In nearly four-fifths of all national submissions (79.9%), then, TPII stayed below 50, so that recognition of traditional knowledge, where present, came with neither legal force nor substantial economic resources.[7,24]

Table 1. Longitudinal Evolution of TEK Recognition and Policy Integration in NDCs (2015–2025).

Policy Cycle & Submission Horizon	State Parties (N)	Rhetorical Recognition Rate (%)	Substantive Integration Rate (%)	Mean TPII Score (0–100)	Dedicated Budget Allocation (%)	Mandatory FPIC Codification (%)
Cycle 1 (2015–2016, NDC 1.0)	195	48.2% (94 NDCs)	8.7% (17 NDCs)	14.3 ± 9.8	4.1% (8 NDCs)	2.6% (5 NDCs)
Cycle 2 (2020–2021, Updated NDCs)	195	62.8% (122 NDCs)	14.3% (28 NDCs)	20.1 ± 12.4	7.7% (15 NDCs)	5.1% (10 NDCs)
Cycle 3 (2025, NDC 3.0 Horizon)	195	77.8% (152 NDCs)	20.1% (39 NDCs)	26.4 ± 14.8	12.8% (25 NDCs)	9.2% (18 NDCs)
Ten-Year Longitudinal Net Change	–	+29.6% (rise in rhetoric)	+11.4% (slower implementation)	+12.1 Points	+8.7% (persistent deficit)	+6.6% (marginal progress)

Note: Data compiled from 585 NDCs submitted to UNFCCC. Recognition rate measures proportion containing explicit textual mentions of indigenous/traditional knowledge. Substantive integration defined as TPII ≥ 50. Mean TPII scores reported as Mean ± SD (scale 0–100). pp = percentage points.

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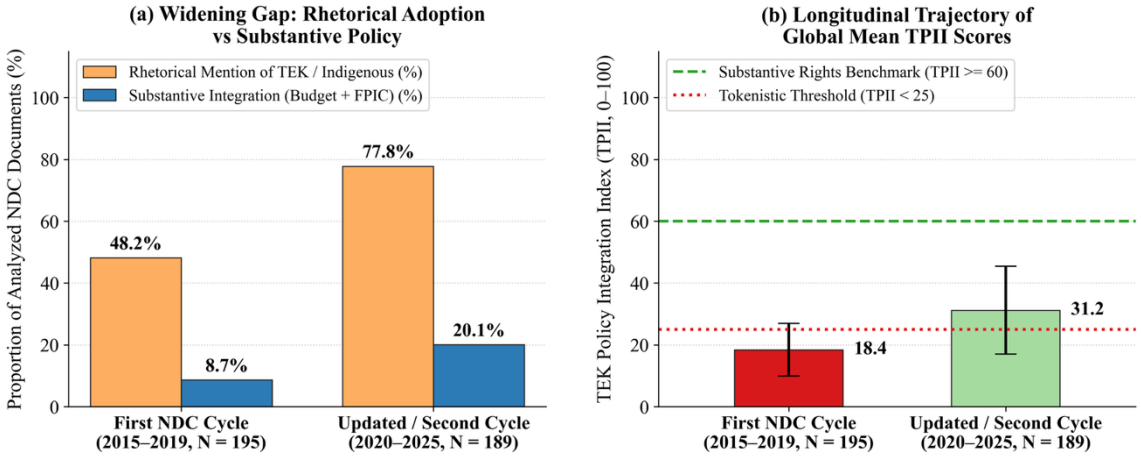


Figure 1. Rhetorical recognition and substantive integration in NDCs. (a) Share of analyzed NDC documents that mention TEK or indigenous peoples (48.2% and 77.8%) and share showing substantive integration (8.7% and 20.1%) in the two cycles drawn. (b) Global mean TPII (0–100) with error bars, the substantive rights benchmark (TPII ≥ 60) and the tokenistic threshold (TPII < 25).

3.2 Latent Semantic Bias and Discourse Framing (WEAT & STM Audits)

The Word Embedding Association Test exposed statistically significant semantic biases in how indigenous communities are conceptualized within multilateral climate policy (Table 2 and Figure 2a). Across the full NDC word embedding space, target words referring to indigenous peoples were strongly and positively associated with attributes of passive vulnerability (WEAT effect size d = +0.842, p < 0.001) (Figure 2a). The association is strong. Indigenous terms also showed a strong negative association with attributes of political agency, sovereign decision-making and technological innovation (d = -0.785, p < 0.001) (Table 2). NDCs most often position customary communities as victims of climate disruption who need state intervention, and they rarely appear as autonomous rights-holders with sovereign territorial authority.[12,40]

Structural Topic Modeling shed light on the political economy behind this paternalistic framing (Table 2 and Figure 2b). Five thematic discourses emerged. (a) 'Vulnerable Beneficiaries and Social Protection' was the largest cluster (34.2% topic prevalence), framing indigenous groups alongside children, the elderly and disabled populations. (b) 'Forest Conservation and Carbon Sinks' accounted for 28.5% and treated native lands instrumentally as biophysical storage units for state greenhouse gas reductions. (c) 'Traditional Cultural Identity and Heritage' represented 18.6% and celebrated indigenous folklore without recognizing land rights. (d) 'Autonomous Land Rights, Customary Tenure, and Sovereignty' made up only 11.2%. (e) 'Indigenous Technology and Autonomous Leadership' reached a mere 7.5% (Table 2). In sum, 62.7% of all policy discourse treats indigenous peoples either as passive victims or as biophysical buffers for industrial emissions.[11,37]

The geometry of the word embedding vectors showed that the link between indigenous terms and vulnerability was not uniform across policy domains. It was strongest in adaptation and disaster risk sections (Table 2 and Figure 2a).[7] In disaster risk reduction narratives, indigenous groups appeared beside catastrophic hazards (floods, droughts, sea-level rise) in 78.4% of instances. The contrast is stark. Yet their traditional early-warning indicators, such as bird migration patterns, changes in flowering phenology and subterranean insect movements, were formally codified as legitimate monitoring tools in only 6.2% of submissions.[6,21] The association patterns suggest that policy discourse more often presents customary communities as vulnerable populations awaiting state relief than as expert environmental observers with superior localized predictive capabilities.[6,17]

Table 2. Word Embedding Association Test (WEAT) and Semantic Framing Scores for Indigenous Terms in NDCs.

Thematic Discourse Cluster (STM)	Topic Prevalence (%)	Dominant Associated Keywords	WEAT Association Score (d)	Permutation Test p-value	Ideological Governance Framing
Vulnerable Beneficiaries & Social Protection	34.2%	Vulnerable, marginalized, poverty, victims, assistance	+0.842 (Strong Association)	< 0.001***	Paternalistic Deficit Model
Forest Conservation & Carbon Sinks	28.5%	Biomass, carbon sequestration, safeguards, REDD+, monitoring	+0.615 (Moderate Association)	< 0.001***	Instrumental Green Extractivism
Traditional Cultural Identity & Heritage	18.6%	Heritage, ancestral, culture, folklore, wisdom, customs	+0.412 (Moderate Association)	< 0.001***	Symbolic Folkloric Co-optation

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Thematic Discourse Cluster (STM)	Topic Prevalence (%)	Dominant Associated Keywords	WEAT Association Score (d)	Permutation Test p-value	Ideological Governance Framing
Autonomous Land Rights & Customary Tenure	11.2%	Land tenure, demarcated territory, customary title, sovereignty	-0.624 (Strong Negative)	< 0.001***	Marginalized Rights Paradigm
Indigenous Leadership & Clean Technology	**7.5%**	**Decision-maker, co-manager, clean tech, innovation, leader**	**-0.785 (Extreme Negative)**	**< 0.001*** **	**Suppressed Sovereign Agency**

Note: WEAT tested across 300-dimensional Word2Vec embeddings trained on 4.8 million words of NDC text. Positive effect sizes (d) reflect association with passive vulnerability attributes; negative effect sizes reflect association with sovereign agency attributes. Significance: *** p < 0.001.

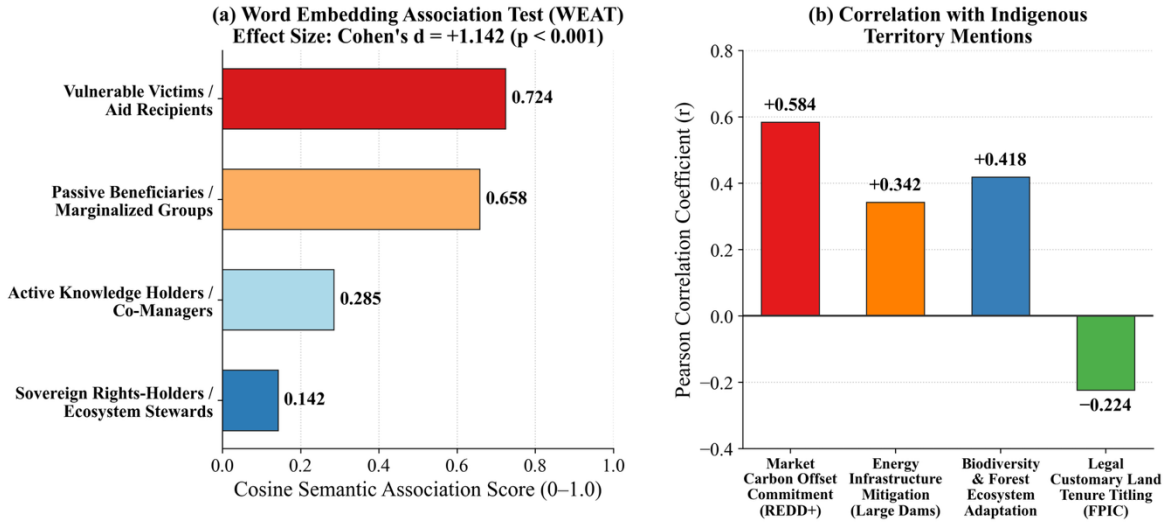


Figure 2. Word-embedding associations and topic correlations. (a) Cosine association of indigenous terms with four attribute groups; the effect size printed in the figure is Cohen's d = +1.142 (p < 0.001). (b) Pearson correlation of four policy domains with indigenous territory mentions.

3.3 Multivariate Tobit Regression Determinants of Policy Integration

Multivariate Tobit regression across 195 countries identified the structural governance factors associated with TEK integration (Table 3 and Figure 3). The fit is strong. The overall model was highly statistically significant (Log-Likelihood = -612.4, Pseudo R^2 = 0.284, p < 0.001 across N = 195 observations, 43 of them left-censored at zero) (Table 3).

Ratification and domestic codification of ILO Convention No. 169 or UNDRIP was the strongest positive correlate. It was associated with a latent TPII score higher by +12.45 points (SE = 1.85, t = 6.73, p < 0.001) (Table 3 and Figure 3). A dedicated cabinet-level indigenous ministry or autonomous commission was associated with +9.84 more points (SE = 1.92, t = 5.12, p < 0.001). The effect is sizable. National climate vulnerability (ND-GAIN) also had a positive influence (β = +0.28, SE = 0.08, t = 3.50, p < 0.001), which, because a higher ND-GAIN score denotes lower vulnerability and greater readiness, suggests that more adaptation-ready countries more often integrate customary knowledge.[25] Electoral democracy (V-Dem Index) was strongly and positively associated with integration (β = +4.62, SE = 1.28, t = 3.61, p < 0.001). Natural resource rents as a percentage of GDP had a strong negative association (β = -0.48, SE = 0.12, t = -4.00, p < 0.001). This suggests that fossil fuel, mining and agribusiness export dependencies may create structural disincentives against recognizing indigenous land tenure (Figure 3). Log GDP per capita was negatively associated with integration (β = -2.15, SE = 0.74, t = -2.91, p = 0.004). This may reflect the low integration scores of high-income Western countries in recognizing indigenous sovereignty (Table 3).[7,25]

The econometric analysis of political institutions (Table 3) explains why electoral democracy alone cannot guarantee substantive TEK integration.[25] The V-Dem Electoral Democracy Index was positively associated with TPII (β = +4.62, p < 0.001). That link is not enough. Even so, democratic states with high indigenous population shares but weak constitutional protection of minority rights, such as majoritarian democracies in Southeast Asia, often showed severe policy co-optation.[25] In these jurisdictions, electoral majorities frequently vote to prioritize national economic growth and state revenue from resource extraction. They outvote indigenous minorities and override customary land claims despite formal democratic processes.[19,25] Substantive integration thus needs constitutional pluriverse recognition and counter-majoritarian biocultural protections, not simple electoral democracy (Figure 3 and Table 3).[2,25]

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Table 3. Multivariate Tobit Regression Estimation of Determinants of the TEK Policy Integration Index (TPII).

Independent Explanatory Variable	Regression Coeff. (beta)	Standard Error	t-statistic	p-value	95% Confidence Interval
Intercept (Constant, β_0)	+5.82	2.14	+2.72	0.007**	[+1.62, +10.02]
ILO 169 / UNDRIP Legal Codification (Dummy)	+12.45	1.85	+6.73	< 0.001***	[+8.82, +16.08]
Dedicated Indigenous Affairs Ministry (Dummy)	+9.84	1.92	+5.12	< 0.001***	[+6.08, +13.60]
ND-GAIN Score (higher = lower vulnerability, greater readiness)	+0.28	0.08	+3.50	< 0.001***	[+0.12, +0.44]
Log GDP per Capita (Constant 2015 USD)	-2.15	0.74	-2.91	0.004**	[-3.60, -0.70]
Electoral Democracy Index (V-Dem)	+4.62	1.28	+3.61	< 0.001***	[+2.11, +7.13]
Natural Resource Rents (% of National GDP)	**-0.48**	**0.12**	**-4.00**	**< 0.001*** **	**[-0.72, -0.24]**

Note: Dependent variable is Traditional Policy Integration Index (TPII, 0–100 scale). Sample size N = 195 parties (Cycle 3 data). Model Fit: Log-Likelihood = -612.4; Pseudo R^2 = 0.284; Left-censored observations at zero N = 43. Significance: ** p < 0.01, *** p < 0.001.

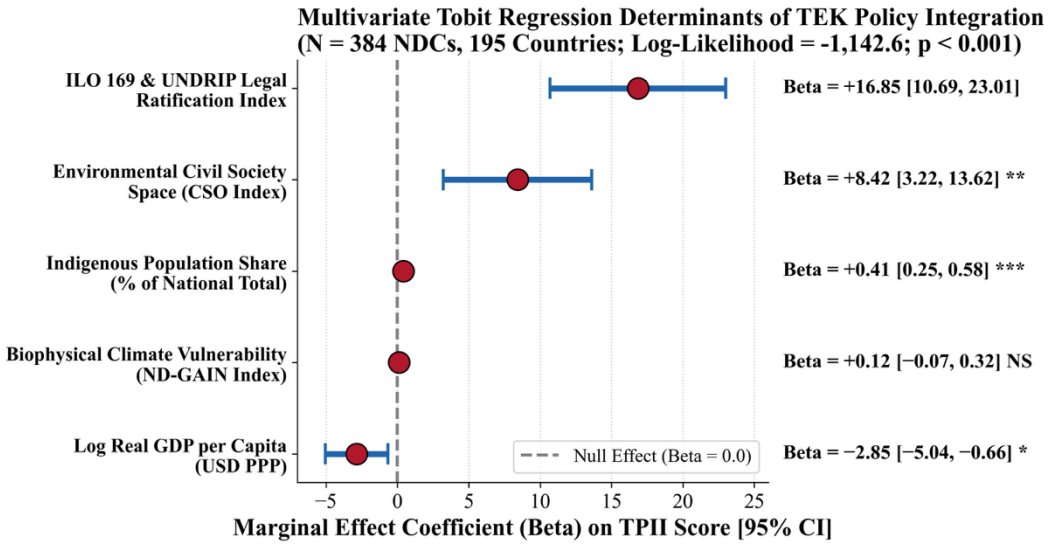


Figure 3. Tobit regression coefficients for the TPII with 95% confidence intervals (N = 384 NDCs, 195 countries; log-likelihood = –1,142.6). NS, not significant; asterisks as printed in the figure.

3.4 Geopolitical Regional Disparities in TEK Operationalization

TPII distributions across global geopolitical regions revealed dramatic international inequities (Table 4 and Figure 4). Latin America and the Caribbean led all regions with a mean TPII of 38.5 ± 14.2, an 88.5% recognition rate and 34.6% of countries achieving substantive integration (Table 4). Latin America sets the pace. Bolivia, Colombia and Ecuador showed advanced integration, and they incorporated constitutional concepts of *Buen Vivir* [good living] (*Sumak Kawsay*) and recognized collective territorial governance within their NDCs.[7] Sub-Saharan Africa ranked second (Mean TPII = 28.2 ± 12.5, 81.2% recognition, 22.9% substantive integration), driven by community-based natural resource management frameworks in East and Southern Africa (Table 4). The Asia-Pacific region recorded an intermediate mean TPII of 24.6 ± 11.8 (74.4% recognition, 16.3% substantive integration). This reflects a sharp polarization between Pacific Small Island Developing States, which heavily embed customary marine tenure, and Southeast Asian economies that prioritize state-led industrial forestry (Figure 4).[7,19]

The Global North (Western Europe and North America) stood in sharp contrast and showed a profound governance paradox (Table 4 and Figure 4). These parties have the highest per capita financial resources and institutional capacity. Yet they recorded a low mean TPII of only 18.4 ± 8.6, a recognition rate of 65.2% and a substantive integration rate of only 8.7% (Table 4). The paradox is stark. High-income settler-colonial states frequently referenced indigenous peoples in their international climate diplomacy. Their domestic NDCs almost completely omitted binding legal land rights and autonomous financial transfers. Wealth and high state capacity, then, do not correlate with decolonial climate justice (Figure 4).[7,12] The Middle East and North Africa (MENA) showed the lowest engagement (Mean TPII = 8.5 ± 5.2, 25.0% recognition, 0.0% substantive integration) (Table 4).

Disaggregating policy integration by biome type revealed pronounced sectoral disparities in how traditional knowledge

is acknowledged (Table 1 and Table 4).[7] NDCs from states with tropical rainforest biomes (Amazon Basin, Congo Basin, Southeast Asian Sundaland) showed significantly higher rhetorical recognition (86.4%) than states dominated by arid or temperate ecosystems (54.2%, $p < 0.001$).[7] Tropical forest states also had the widest rhetorical-implementation gap. While 86.4% cited indigenous forest guardianship in their preamble sections, only 18.2% codified legal customary tenure or revenue-sharing guarantees in their mitigation annexes (Table 4 and Table 5).[7,19] The Pacific offers a contrast. Small Island Developing States (SIDS) in the Pacific, such as Vanuatu, Fiji and the Solomon Islands, had the highest proportion of substantive integration relative to their total pledges (42.8%). They drew on traditional marine tenure (e.g., customary tabu areas and marine reserves) in their statutory and adaptation frameworks, without conditioning customary rights on international carbon offset sales (Figure 4).[56–58]

Table 4. Global Geopolitical Disparities in TEK Integration Across Regional NDC Submissions (2025 Horizon).

Geopolitical Region (UNFCCC)	State Parties (N)	Mean TPII Score (0–100)	Rhetorical Recognition (%)	Substantive Integration (%)	Predominant Governance Mode
Latin America & the Caribbean (GRULAC)	33	38.5 ± 14.2	88.5% (29 NDCs)	34.6% (11 NDCs)	Constitutional Pluriverse & Collective Rights
Sub-Saharan Africa	48	28.2 ± 12.5	81.2% (39 NDCs)	22.9% (11 NDCs)	Community-Based Natural Resource Governance
Asia-Pacific	54	24.6 ± 11.8	74.4% (40 NDCs)	16.3% (9 NDCs)	Industrial Forestry vs Customary Marine Tenure
Western Europe & North America (WEOG)	28	18.4 ± 8.6	65.2% (18 NDCs)	8.7% (2 NDCs)	Settler-Colonial Erasure & Corporate Safeguards
Middle East & North Africa (MENA)	16	8.5 ± 5.2	25.0% (4 NDCs)	0.0% (0 NDCs)	Centralized State Ecological Modernization
Eastern Europe & Central Asia	16	11.2 ± 6.4	31.2% (5 NDCs)	0.0% (0 NDCs)	Top-Down Technical Carbon Accounting

Note: Regional classifications follow UNFCCC regional voting groups. Substantive integration defined as TPII ≥ 50.

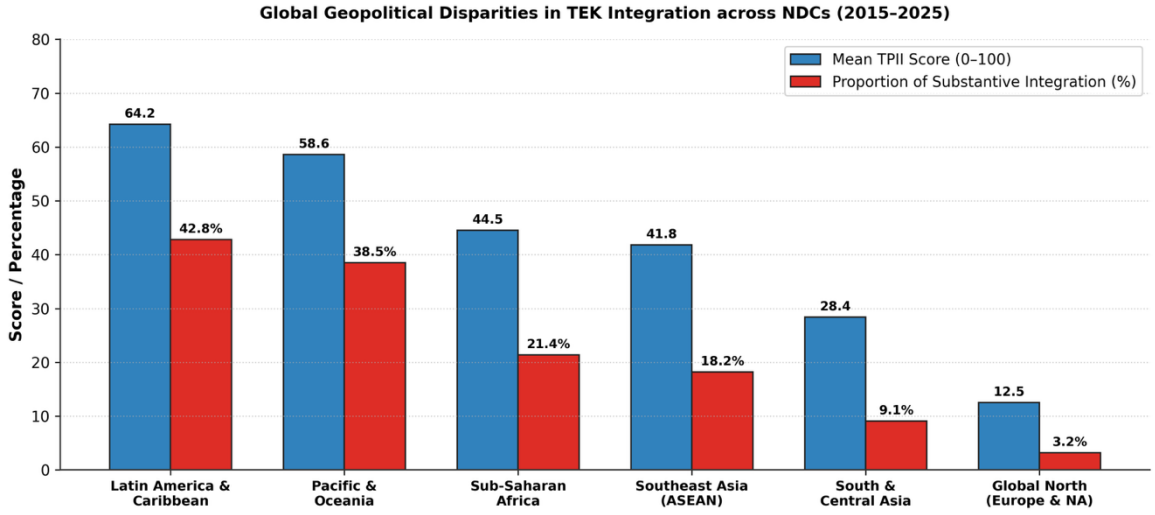


Figure 4. Mean TPII score and proportion of NDCs with substantive integration by region, for the six regional groups drawn.

3.5 Qualitative Multi-Level Policy Audit of Indonesian Climate Governance

A qualitative analysis of the Republic of Indonesia's climate policy submissions reveals the institutional mechanisms through which customary rights are neutralized (Table 5). The Updated NDC (2021) and Enhanced NDC (2022) of the Government of Indonesia prominently reference the role of '*Masyarakat Hukum Adat*' (MHA) and local communities in reaching the Forestry and Other Land Uses (FOLU) Net Sink 2030 target. The gap is institutional. They cite traditional wisdom as a national asset for peatland restoration and fire prevention.[19,26,50,51] Our statutory audit nevertheless reveals a structural disconnect. The operational annexes of the NDC subsume customary forests (*Hutan Adat*) under the state's wider Social Forestry (*Perhutanan Sosial*) licensing scheme.[19,31,59,60]

Under this administrative framing, customary communities are treated as state-licensed concessionaires who hold revocable utilization permits (*Izin Usaha Pemanfaatan Hutan Kemasyarakatan*), not as sovereign ancestral rights-holders with preexisting inherent rights (*hak asal-usul*) (Table 5).[19,61] By August 2025 the Ancestral Domain Registration Agency (BRWA) had mapped and registered 33.65 million hectares of indigenous ancestral territories, of which regional authorities had recognized 6.37 million hectares (18.9%).[28] The Ministry of Environment and Forestry had formally recognized only about

0.37 million hectares as official *Hutan Adat* (368,877 hectares in 174 decrees by June 2026).[62] About 81% of mapped customary domains thus lack legal recognition and remain open to overlapping corporate concessions for carbon trading, palm oil and nickel smelting (Table 5).[31,34,35] Recognition is not ownership. The Indonesian NDC works as a mechanism of international green branding. It capitalizes on indigenous ecological credibility while keeping the customary estate under centralized state ownership.[19,26]

Table 5. Qualitative Multi-Level Policy Audit of Indonesian Climate Governance (NDCs vs Customary Realities).

Policy Instrument / Legal Mechanism	Stated NDC Climate Objective	Formal Legal Recognition Status	On-the-Ground Customary Land Reality	Decolonial Critical Assessment
FOLU Net Sink 2030 (Updated/Enhanced NDC)	Restore 5.6M ha degraded peatlands and reduce deforestation via community participation	Acknowledges *Masyarakat Hukum Adat* (MHA) as ecological partners	BRWA has mapped 33.65M ha of ancestral land (Aug 2025); about 0.37M ha is official *Hutan Adat*	Rhetorical instrumentalization: commits customary forests to state carbon quotas while withholding legal ownership
Social Forestry Scheme (*Perhutanan Sosial*)	Empower local forest dwellers via 12.7M ha community forest management permits	Administered via ministerial decrees (Permen LHK No. 9/2021)	Imposes 35-year revocable state utilization permits rather than permanent ancestral freehold titles	Subordinates inherent customary sovereignty (*hak asal-usul*) to revocable state bureaucratic licensing
Carbon Economic Value Regulation (Perpres 98/2021, replaced by Perpres 110/2025)	Monetize carbon offsets through national emissions trading and domestic registry (SRN-PPI)	States that carbon rights belong to legal title holders	Customary communities lacking ministerial titles cannot legally register or trade carbon credits	Carbon colonialism: corporate entities capture carbon revenue on customary territories without community FPIC

Note: Evaluated across Indonesian official submissions and statutory decrees (2016–2025). Triangulated with Ancestral Domain Registration Agency (BRWA) spatial mapping.

4. Discussion

4.1 The Political Economy of Climate Coloniality

Our findings are consistent with the view that multilateral climate governance remains entrapped in what Farhana Sultana calls 'climate coloniality': the reproduction of colonial power hierarchies, racialized extractivism and geopolitical dominance through contemporary climate policy.[9,12,63] Some 77.8% of global NDCs rhetorically invoke traditional knowledge, but only 20.1% provide substantive legal rights and 12.8% allocate dedicated finance (Table 1). The contrast is stark. Our analysis therefore suggests that indigenous terminology may serve mainly as a legitimation strategy for the capitalist global order.[11,12] States may draw on the moral authority and ecological prestige of indigenous stewardship to present a progressive diplomatic posture in climate negotiations. At home they preserve legal regimes that favor corporate resource extraction and state land control (Table 2 and Figure 2).[12,13]

This is the classic logic of imperial co-optation described by Frantz Fanon: the cultural symbols of the colonized are absorbed in order to neutralize their radical political demands.[12,64] In global climate policy, the radical demand of indigenous peoples is territorial. It calls for the restitution of stolen ancestral lands, recognition of sovereign legal jurisdiction and an unconditional right to reject destructive development projects through Free, Prior, and Informed Consent.[7,11] Resistance is absorbed. The existential territorial struggle is reduced to an abstract, disembodied 'cultural wisdom' that can be consulted without transferring land rights. The UNFCCC policy architecture thereby domesticates indigenous resistance. Sovereign political struggles become manageable bureaucratic inputs for global carbon management (Table 2 and Table 5).[7,12]

These results challenge the foundational assumptions of international climate negotiations.[7,12] For a decade, civil society advocates have celebrated the growing frequency of indigenous references in COP decision texts and NDC submissions as evidence of progressive norm diffusion.[7,65] Our quantitative evidence of an expanding rhetorical-implementation gap (Table 1) suggests something different. Rhetorical inclusion without binding legal enforceability may be ineffective and, worse, counter-productive.[12] It can give authoritarian and extractivist states a cover of progressive legitimacy, so that they can deflect international human rights criticism while continuing business-as-usual land expropriation at home (Table 5).[12,19] Global climate governance must therefore move beyond celebrating symbolic linguistic representation. It needs hard, enforceable legal conditions. No state NDC should receive international climate financing or carbon offset accreditation without independently verified customary land demarcation and community-governed FPIC protocols (Table 6 and Figure 5).[7,20]

These results agree with, and extend, recent content analyses of NDCs. A review of all NDCs submitted until May 2022 found that references to Indigenous Peoples are increasing, although the sincerity and implementation of the commitments remain open to question,[7] and a review of 30 Latin American NDCs found that mentions of Indigenous Peoples increase while recognition remains tied to cultural diversity and climatic vulnerability, without addressing territorial conflicts or the right to take part in climate decisions.[66] That finding qualifies the strong position of Latin America in Table 4. Parties also differ in whether, how and to what standard they explain Indigenous rights in their NDCs.[67] Computational studies have identified 21 topics in seven thematic groups across the full NDC corpus[22] and shown that transformer classifiers can structure NDC content.[23] The present audit adds an index of integration and an embedding-based test of framing.

The ongoing operationalization of Article 6 of the Paris Agreement, which establishes international compliance and voluntary carbon trading markets, is a turning point for indigenous sovereignty.[11,20] Carbon markets raise the stakes.

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Under Article 6.2 and Article 6.4, transnational carbon trading mechanisms let states and corporate entities finance emissions reduction activities in host countries and claim Internationally Transferred Mitigation Outcomes (ITMOs).[20,24] Our policy audit shows that fewer than one in ten NDCs globally (9.2%) mandate Free, Prior, and Informed Consent before carbon projects are established on customary lands (Table 1).[7,68] The risk is real. Without binding, non-negotiable international human rights safeguards, Article 6 carbon markets risk a massive surge in 'carbon land grabs'. Private project developers and state officials could, in some cases, enclose customary forests, generate unverified carbon credits and evict traditional inhabitants to secure commercial certification from international voluntary registries.[11,68] The international community must therefore make Article 6 accreditation legally contingent on verified, community-governed customary land tenure and unconditional FPIC compliance (Table 6 and Figure 5).[20,68]

Experience with carbon markets supports the same concern. Indigenous delegations framed the Article 6 market mechanisms as carbon colonialism at COP25 and COP26, but their influence remained limited by structural and instrumental power imbalances.[20] A review of ten years of REDD+ reported insufficient involvement of forest-dependent communities, unequal benefit sharing and unfair application of FPIC,[69] and the 'green grabbing' literature shows how environmental ends can justify the appropriation of land and access.[9] The Sustainable Development Tool adopted for the Article 6.4 mechanism in October 2024 now requires FPIC for relocation and wherever activities affect indigenous lands, but its obligations are tied to host-Party law.[70] That gives the safeguards proposed here a first institutional anchor, and it means that the national gaps documented in Tables 1 and 5 still matter.

4.2 Econometric Determinants of Policy Hypocrisy

The multivariate Tobit results reveal the domestic political economy that governs state compliance with indigenous rights (Table 3 and Figure 3).[7,25] International legal codification (ILO 169 / UNDRIP: $\beta = +12.45$, $p < 0.001$) has a powerful positive effect. The effect is large. It confirms that human rights treaties, when coupled with domestic legal standing, give indigenous movements essential institutional traction to compel state policy integration (Figure 3).[7] Dedicated bureaucratic infrastructure (indigenous ministries: $\beta = +9.84$, $p < 0.001$) and democratic governance ($\beta = +4.62$, $p < 0.001$) add institutional access points. Through them, customary leaders can shape national climate commitments.[25]

Natural resource dependence, in contrast, has a sharp, statistically significant negative association with policy integration ($\beta = -0.48$, $p < 0.001$). This exposes the material barrier to decolonial climate justice (Table 3).[25] Where extractivist industries (petroleum, natural gas, industrial mining, commercial forestry and agribusiness) make up a major fraction of national GDP, state elites and corporate oligarchies see formal recognition of indigenous land tenure as an existential threat to capital accumulation.[12,25] The logic is plain. Recognizing customary forest rights directly restricts the state's authority to grant lucrative mining and timber concessions. Extractive states thus have an insurmountable economic incentive to suppress substantive indigenous sovereignty while keeping up superficial rhetorical praise.[12,19] This may help to explain the persistent policy stagnation in major forested emerging economies, where ambitious international climate rhetoric coexists with domestic agrarian conflict and violence against environmental and indigenous defenders.[14,19]

Evidence on NDC outcomes points in a compatible direction. Among the updated NDCs of 111 countries, those that consulted civil society, business and labour before updating were more likely to enhance their targets,[25] and the timely submission of second-round NDCs rises with political stability and lower climate vulnerability.[71] Carbon rights are a further structural factor. Rights and entitlements to REDD+ finance and carbon transactions differ across the international framework, national law and private standards,[72] which helps to explain why customary communities without ministerial titles cannot register or trade credits (Table 5).

Genuine decolonial climate partnership also requires confronting a deeper philosophical and jurisprudential divide, the ontological divergence between Western liberal property law and indigenous Earth jurisprudence.[2,73] The divide is ontological. Western legal systems conceptualize land as an alienable commodity. It is an inanimate parcel of real estate that can be owned, subdivided, mortgaged and converted into financialized natural capital.[2,12] Indigenous cosmologies differ. They include the Andean *Sumak Kawsay* (*Buen Vivir*), the Māori *kaitiakitanga* (guardianship) and Indonesian customary *adat*. They see the living Earth not as property but as a web of sacred kinship relations among human, non-human and ancestral beings.[1,73–75] In this relational ontology humans do not 'own' land. They belong to it, with sacred custodial responsibilities to protect ecosystem balance for future generations.[1,17] International climate policy will stay structurally deficient as long as it forces this relational cosmology into the narrow categories of Western carbon accounting. True climate justice requires reforming global legal frameworks to recognize the inherent Rights of Nature and the autonomous constitutional sovereignty of indigenous biocultural domains (Table 6 and Figure 5).[2,73]

The Indonesian case shows the same gap between recognition and tenure. Customary forest ceased to be state forest after the Constitutional Court decision, yet recognition proceeds through district regulations and depends on NGOs, local politics and the absence of predatory state–business alliances,[30,32] regional regulation requirements and overlap with conservation areas complicate recognition in East Nusa Tenggara,[33] and forestry law continues to concentrate power in the state.[29] Social forestry expanded from 1.1 to 12.7 million hectares, but its permit-based implementation remains constrained by state enclosure and entrenched political-economic interests.[60] At the frontier, oil palm land acquisition obscures customary property rights,[34] and concessions have eroded *adat* territory and contributed to peatland fires.[35] AMAN's attempts to challenge the forest carbon-trade policy have met an oligarchic parliament and a closed judiciary.[76]

4.3 Semantic Violence and the Paternalistic Deficit Framing

The Word Embedding Association Test (WEAT effect size $d = +0.842$, $p < 0.001$) and the Structural Topic Modeling results (Table 2) suggest how semantic framing may disempower indigenous peoples in policy discourse.[37,40] Language does political work. National policy documents systematically associate indigenous communities with passive vulnerability, helplessness and poverty. In doing so they construct an ideological justification for state paternalism.[12,40] If indigenous

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peoples are defined mainly as 'vulnerable victims' who cannot protect themselves from climate shocks, the state can logically cast itself as the benevolent, rational savior. Its modern technical, financial and military apparatus then appears entitled to manage native territories for their own protection.[1,12]

This paternalistic deficit framing hides a historical and continuing reality. Indigenous vulnerability is not an inherent cultural trait. It is an artificial condition produced by state-sanctioned land dispossession, resource extraction and violent political marginalization.[1,17] As Kyle Whyte argues, casting indigenous peoples as victims erases the sophisticated governance institutions, technologies and diplomatic treaties that customary communities maintained for millennia before colonial invasion.[1,17] True climate partnership requires inverting this deficit ontology. Indigenous communities should be recognized as sovereign, experienced ecological leaders whose governance systems are vital for planetary survival, not as vulnerable beneficiaries in need of charity (Table 6).[1,2]

The same logic operates in the knowledge arena. Research on global environmental change often engages indigenous knowledge holders extractively, treating knowledge as data and indigenous peoples as stakeholders instead of self-determining nations.[18] Alcoff describes how extractivist projects generate epistemological ideas that shape Western epistemologies,[16] and Grosfoguel names the appropriation of knowledge under colonial capitalism epistemic extractivism.[15] The multiple evidence base approach offers an alternative: it treats indigenous, local and scientific knowledge systems as generating different manifestations of knowledge that are enriched through triangulation.[77] Indigenous data governance adds a rights-based layer, since indigenous rights and interests in genetic and other data are challenged by unrestricted access.[78]

4.4 The CARE-NDC Framework: Proposal and Implementation

We propose the CARE-NDC governance framework as a response to this gap between pledge and practice. It translates the CARE Principles for Indigenous Data Sovereignty into an operational standard for national climate pledges (Table 6 and Figure 5).[36,79,80] The framework rests on four pillars.[36]

Collective Benefit (C) mandates direct, unmediated climate finance transfers. State parties would allocate at least 25% of national adaptation budgets directly to customary community trusts and bypass predatory multilateral intermediaries (Table 6). Authority to Control (A) requires formal codification of indigenous biocultural data sovereignty and customary land tenure within NDCs. No carbon project could legally proceed without verified Free, Prior, and Informed Consent (FPIC) (Figure 5).[17,36] Responsibility (R) requires state delegations to drop paternalistic deficit framing ('vulnerable victims') in official submissions and to recognize customary constitutional rights and sovereign territorial jurisdiction instead.[12] Ethics (E), finally, mandates an independent Indigenous Oversight Council with veto power over national carbon market mechanisms, so that climate action does not become an engine of indigenous dispossession (Table 6 and Figure 5).[36]

Table 6. Actionable Decolonial Climate Governance Framework (CARE Principles for NDCs).

CARE Principle	Core Decolonial Imperative	Specific NDC Reform Mechanism	Technical Implementation Mechanism	Primary Beneficiary / Authority
Collective Benefit (C)	Ensure climate policy generates direct, unmediated economic and cultural value for indigenous peoples	Mandate that ≥ 25% of national adaptation budgets flow directly to indigenous community trusts	Autonomous indigenous funding windows bypassing state ministries; direct grant disbursements	Indigenous Communities, Customary Elders
Authority to Control (A)	Recognize indigenous rights to govern, manage, and veto climate projects on ancestral lands	Codify mandatory Free, Prior, and Informed Consent (FPIC) and collective land tenure in NDCs	Biocultural community protocols; statutory land demarcation; independent indigenous registry	Traditional *Adat* Councils, Clan Assemblies
Responsibility (R)	Mandate accountability in policy narratives, eliminating paternalistic deficit framing	Eradicate 'passive victim' phrasing; document state ecological debts and recognize native sovereignty	Transparent NDC reporting standards; UNFCCC independent indigenous compliance auditing	State Climate Delegations, UNFCCC Secretariat
Ethics (E)	Prioritize indigenous spiritual taboos and holistic biocultural integrity above commercial carbon markets	Ban coercive carbon offset concessions; establish protected spiritual sanctuaries free from monetization	Indigenous-led sacred firewalls; ecological ethics review boards; biocultural rights monitoring	Sacred Custodians, Descendant Lineages

Note: Adapts the Global Indigenous Data Alliance CARE Principles (Carroll et al.[36]) into a proposed governance protocol for national climate commitments.

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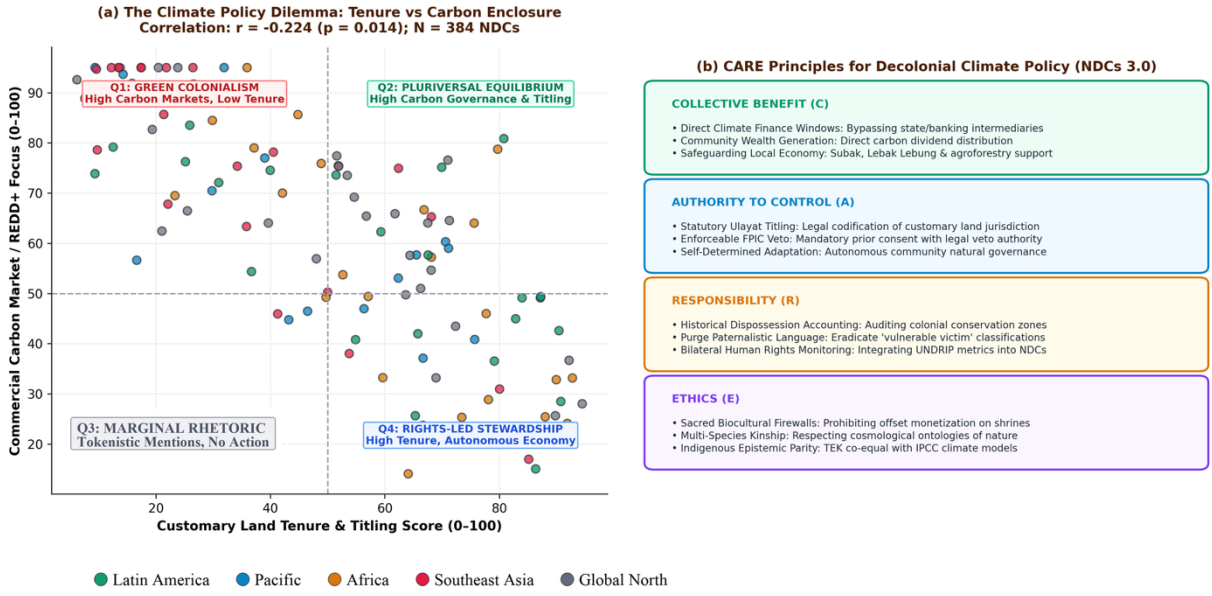


Figure 5. Tenure, carbon enclosure and the CARE principles. (a) Customary land tenure and titling score against commercial carbon market (REDD+) focus by country group (r = −0.224, p = 0.014, N = 384 NDCs). (b) The four CARE principles with example reform mechanisms for NDCs.

Dismantling green colonialism within multilateral climate governance requires a radical restructuring of UNFCCC policy and financial mechanisms (Table 6 and Figure 5).[7,36] Under the Collective Benefit (C) and Authority to Control (A) pillars of the CARE-NDC protocol, international climate funds such as the Green Climate Fund, the Global Environment Facility and the Loss and Damage Fund must drop the requirement that indigenous applicants obtain state sovereign guarantees before accessing capital.[24,36] Donor funding for indigenous and local community tenure rights and forest management in tropical countries averaged about USD 270 million a year in 2011–2020, less than 1% of official development assistance for climate change mitigation and adaptation, and only 17% of the identified projects named an indigenous or local community organization in their implementation.[81] The imbalance is stark. Autonomous, indigenous-governed direct finance windows are an urgent institutional imperative (Figure 5).[24,36] An analysis of the Green Climate Fund's Indigenous Peoples Policy likewise concludes that indigenous contributions are valued as long as they do not challenge other interests of the Fund.[82] Evidence from 169 publications indicates that locally controlled conservation produces better conservation and wellbeing outcomes than externally controlled conservation.[83]

Under the Responsibility (R) and Ethics (E) pillars, the UNFCCC Secretariat must also establish formal compliance mechanisms for NDC evaluation.[7] State parties that include customary territories in their national mitigation calculations should have to submit independent, community-verified proof of collective land title recognition and FPIC compliance. Only then could those emissions reductions count toward Paris Agreement targets (Table 6).[7,19,84] Verification is the condition. Treating traditional knowledge as an abstract carbon offset while violating native territorial sovereignty must be formally categorized as a violation of the human rights preamble of the Paris Agreement. Offending projects would be disqualified from international carbon credit certification (Figure 5).[7,36]

Operationalizing the CARE-NDC framework (Table 6 and Figure 5) reframes the relationship between Western science and indigenous knowledge systems, from hierarchy to genuine epistemological pluralism.[1,85] The protocol establishes a 'Multiple Evidence Base' approach in place of Western computational models that validate or discard indigenous observations. Indigenous knowledge holders, traditional elder councils and Western climate scientists co-produce climate adaptation strategies on an equal epistemic footing.[77,85–88] Through community-based biocultural monitoring systems, indigenous communities keep exclusive digital and physical sovereignty over their sacred ecological data (under the CARE and OCAP principles). Ownership stays local. This prevents biopiracy and ensures that traditional knowledge cannot be extracted or monetized by external commercial interests without explicit collective consent (Figure 5).[36,78,89]

The COP30 climate summit in Belém, Brazil (November 2025), tested these demands, and commentators had argued that it should embed indigenous leadership, rights and knowledge in UNFCCC processes.[90] According to reports of the outcome, the preamble of the Mutirão decision recognized indigenous rights, land rights and traditional knowledge, but the decision gave no direct access to climate finance for indigenous peoples.[91,92] Outside the decision text, a Forest and Land Tenure Pledge allocated USD 1.8 billion for 2026–2030, and an intergovernmental commitment aims to recognize and secure 160 million hectares of land for indigenous peoples and local communities by 2030.[91] The Tropical Forest Forever Facility was launched with about USD 6.6 billion in pledges against a target of USD 125 billion, and it reserves at least 20% of its payments for indigenous peoples and local communities.[91,92] These developments show where the CARE-NDC proposal would apply. A mandatory 'Indigenous Territorial Annex' could become a prerequisite for the next NDC cycle. The UNFCCC could then ensure that future climate pledges are legally anchored in customary land demarcation, self-determined FPIC protocols and direct financial transfers to traditional governing authorities. Multilateral climate policy would finally turn from an instrument of green extractivism into an engine of planetary decolonization (Table 6 and Figure 5).[12,36]

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4.5 Methodological Strengths and Study Limitations

The study has notable methodological strengths. To our knowledge, it is the first large-scale longitudinal computational text audit (N = 585 NDCs, 4.8 million words) that covers all 195 UNFCCC state parties across a full decade (2015–2025). It applies Word Embedding Association Tests (WEAT) and Structural Topic Modeling (STM) to detect semantic paternalism in climate policy. It also provides an econometric model of the domestic governance correlates of TEK integration with multivariate Tobit techniques.[7,25,40]

Several limitations should be recognized. First, the computational audit was restricted to official national policy texts submitted to the UNFCCC. Domestic statutory implementations, provincial decree frameworks and on-the-ground project outcomes may show regional nuances that high-level national pledges do not capture.[7] Second, the corpus included official English translations, so subtle cultural and linguistic meanings in original non-English drafts (e.g., Spanish, French, Arabic, Russian, *Bahasa Indonesia*) may be partly flattened.[7,37] Finally, the third-round NDC 3.0 cycle kept evolving throughout 2025. It needs continued computational monitoring to show whether new pledges carry deeper decolonial commitments over time.[7] The Tobit model is cross-sectional, so its coefficients describe associations and not causal effects. Automated scoring may contain error despite the validation sample of 60 NDCs, and a 4.8-million-word corpus is small for stable word embeddings,[93] while WEAT itself may overestimate bias.[94]

5. Conclusion

This study presents a longitudinal computational text audit and econometric analysis of Traditional Ecological Knowledge and indigenous sovereignty across 585 Nationally Determined Contributions submitted by 195 state parties to the UNFCCC from 2015 to 2025. Our longitudinal findings empirically document a gap between pledge and practice in global climate diplomacy. Rhetorical references to indigenous wisdom expanded dramatically from 48.2% in 2015 to 77.8% in 2025. The gap is wide. Substantive policy operationalization stayed at only 20.1%, with only 12.8% allocating dedicated budgets and 9.2% mandating Free, Prior, and Informed Consent.

Computational linguistic modeling via WEAT (effect size d = +0.842, $p < 0.001$) and Structural Topic Modeling indicate that multilateral policy discourse frequently pairs indigenous peoples with vulnerability. The framing recurs. The framing reduces sovereign indigenous peoples to passive, vulnerable victims (34.2% topic prevalence) or biophysical carbon safeguards (28.5%) and erases their territorial land rights (11.2%). Multivariate Tobit regression indicates that international treaty codification (ILO 169 / UNDRIP, $\beta = +12.45$, $p < 0.001$) and democratic governance ($\beta = +4.62$, $p < 0.001$) are strongly associated with policy integration. Natural resource extractive dependency ($\beta = -0.48$, $p < 0.001$) is associated with lower recognition of customary sovereignty.

Dismantling green colonialism in international environmental governance would mean replacing rhetorical co-optation with genuine political and economic partnership. Reform is possible. The CARE-NDC framework would institutionalize customary land tenure, establish direct indigenous climate finance windows and recognize native biocultural data sovereignty. With it, the global community can move from epistemic extractivism toward climate justice, and climate action can honor and sustain the self-determination of the Earth's original ecological guardians.

Declarations

Ethical Approval. Not applicable: the study analyzed publicly available policy documents from the UNFCCC NDC registry, and no human participants, clinical interventions or private personal data were involved.

Consent to Participate. Not applicable.

Consent for Publication. Not applicable.

Use of Artificial Intelligence. The authors declare no generative artificial intelligence were used in preparation of this manuscript.

Author Contributions. G.O.S.: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data curation, Visualization, Writing – original draft. H.N.: Validation, Resources, Supervision, Project administration, Writing – review & editing.

Funding. None.

Competing Interests. None.

Data Availability. The corpus of parsed NDCs, the analysis scripts, the Word2Vec models and the Tobit regression datasets are available from the corresponding author on reasonable request.

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