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From Ice to Smoke: Leveraging science diplomacy lessons from the Arctic council to strengthen ASEAN agreement on transboundary haze pollution

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Abstract
This paper examines adapting science diplomacy to enhance successful implementation of the ASEAN Agreement on Transboundary Haze Pollution (AATHP), drawing valuable lessons from Arctic Council experiences. Using a qualitative comparative approach, it analyses how the Arctic Council's structured science diplomacy enables evidence-based decision-making while preserving national interests. Contrastingly, AATHP currently faces limited enforcement and fragmented scientific input. The research proposes integrating science diplomacy, particularly through STI collaboration, to enhance ASEAN's effective policy execution. By adopting an Arctic Council-inspired science diplomacy framework, ASEAN could strengthen cross-border scientific networks, depoliticise environmental dialogue, and enhance AATHP operationalisation while respecting the important non-interference principle.

Keywords: ASEAN Agreement on Transboundary Haze Pollution (AATHP); Arctic Council; science diplomacy; ASEAN Way

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1.0 Introduction

The integration of scientific expertise into international environmental governance has become increasingly critical as transboundary challenges intensify in scope and complexity (Lidskog & Sundqvist, 2015; Young, 2016). Science diplomacy (SD) is defined as the intersection of scientific cooperation and diplomatic relations, offering a promising mechanism for addressing environmental challenges that transcend national boundaries while navigating political sensitivities (Gluckman et al., 2017; Berkman et al., 2017). This paper addresses a significant gap in environmental governance literature by systematically comparing two distinct regional approaches to transboundary environmental management: the Arctic Council's (AC) science-centred governance model and ASEAN's transboundary haze pollution under the ASEAN Agreement on Transboundary Haze Pollution (AATHP). While both organisations face complex environmental challenges requiring multilateral coordination, their institutional designs and outcomes differ markedly.

Research Question: What conditions can SD mechanisms be successfully transferred between regional environmental governance systems, and what institutional design features enable effective science-policy integration in politically sensitive contexts?

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Theoretical Contribution: The Science-Diplomacy Institutional Transfer Framework (SDITF) identifies necessary and sufficient conditions for successful institutional transfer of SD mechanisms across regional contexts. This framework advances existing literature by specifying the moderating role of political culture, institutional flexibility, and stakeholder inclusivity in science-policy integration (Ostrom, 2009; Haas, 1992).

2.0 Literature Review

The integration of scientific knowledge into environmental governance has been a subject of increasing scholarly attention in recent years. This review focuses on two key areas: SD and the specific contexts of the AC and AATHP.

Science diplomacy has emerged as a crucial tool for addressing global challenges, particularly in environmental governance (Gluckman et al., 2017; Ruffini, 2020). Scholars have highlighted its potential to facilitate cooperation even in politically sensitive contexts (Berkman, 2017). However, Flink (2020) cautions against overstating its effectiveness, emphasising the need for critical evaluation of SD initiatives. Whereas, the Arctic Council (AC) has been widely recognised for its successful integration of science into policy-making processes (Kankaanpää & Young, 2012). Its inclusion of indigenous knowledge and use of working groups to bridge science and policy has been particularly praised. However, Selin (2017) points out that the Council's effectiveness may be challenged by increasing global interest in the Arctic region. The AC established in 1996, reflects an institutional design optimised for science-based cooperation (Arctic Council, 2021). Its structure includes Senior Arctic Officials, six expert Working Groups (e.g., AMAP, CAFF), and non-state Permanent Participants representing Indigenous communities. These groups serve as the primary mechanisms through which scientific assessments inform policy, reinforcing the Council's identity as a depoliticised environmental regime rather than a security-oriented body (Rottem, 2020; Łuszczuk & Szkarłat, 2022). Historical precedents (e.g., early weather station data) paved the way for modern joint observation platforms, such as the Sustaining Arctic Observing Network, which prioritises collective monitoring across political divides (Wilkinson, 2021). The AC maintains scientific cooperation even during geopolitical crises (notably post-2014 Russia-West fallout), by insulating expert activities from political tensions (Rottem, 2020; Fujio, 2022). Furthermore, the decision-making is distributed across multi-level networks where scientific, indigenous, governmental, and NGO stakeholders work as a supporting bifurcated institutional flexibility and adaptive responses (Carlisle & Gruby, 2019; Ostrom, 2009). The AC is widely recognised for integrating Indigenous voices as formal participants, validating traditional ecological knowledge alongside Western science (Carlisle & Gruby, 2019; Filimonova et al., 2023).

ASEAN's efforts to address transboundary haze pollution have faced significant challenges that attributes these difficulties to the organisation's strict adherence to the principle of non-interference and consensus-based decision-making (Varkeyy et., al, 2025). Nguitragool & Varkeey (2025) argue that despite the existence of formal agreements, implementation remains weak due to conflicting national interests. While the AATHP was signed in 2002, it gained legal force only after Indonesia's ratification in 2014, which highlights ASEAN's incremental institutional change characterised by layering and conversion strategies (Charusombat, 2023). Earlier instruments, including the 1997 Regional Haze Action Plan and the 1995 Cooperation Plan, were non-binding "soft law" that lacked enforcement mechanisms (Nguitragool & Varkeey, 2025). The regional organisations play a vital role in addressing transboundary environmental issues. Young (2016) argues that such organisations can serve as effective platforms for knowledge sharing and policy coordination. However, Lidskog and Sundqvist (2015) note that the success of these efforts often depends on the alignment of scientific advice with political interests and regional norms.

ASEAN's guiding principles, which include non-interference and consensus-based decision-making, are considered central barriers to effective haze governance (Lee et al., 2015). This political culture has delayed implementation, weakened accountability, and left enforcement mechanisms virtually non-existent (Ahmadi, 2012; Eco-Business, 2023). Damaging haze years in 1997 and 2013 to 2015 have exposed that rhetoric without institutional capacity delays tangible outcomes (Frontiers, 2024; Eco-Business, 2023). Although Singapore enacted its Transboundary Haze Pollution Act in 2014 to hold companies accountable extraterritorially, enforcement has been stymied by a lack of access to Indonesian concession maps and legal jurisdiction issues (Tan, 2017; Eco-Business, 2023). Furthermore, data disputes such as those between Malaysia and Indonesia over haze origins have hindered constructive dialogue, highlighting the need for a trusted regional data-sharing platform (Eco-Business, 2023; Frontiers, 2024).

Despite the growing body of research on regional environmental governance, a lack of studies remains in examining the potential for transferring successful elements of the AC's SD approach to other regional contexts, particularly ASEAN's haze governance framework. This paper aims to address this gap by conducting a focused comparison of these two regional approaches. Literature on the Arctic emphasises how SD provides an institutional buffer and legitimacy for environmental cooperation, even when broader political issues (e.g., sanctions, security conflicts) disrupt diplomatic norms (Rottem, 2020; Fujio, 2022). Meanwhile, literature for ASEAN, in contrast, consistently diagnoses the AATHP's weaknesses in structure and enforcement (Ahmadi, 2012; Charusombat, 2023). However, few studies explore how SD could mitigate these weaknesses, a gap that this paper aims to bridge by translating Arctic best practices into ASEAN policy paradigms. Building on Ostrom's (2009) polycentric governance theory and Haas's (1992) epistemic communities' framework, this paper proposes that the successful institutional transfer of SD mechanisms depends on three core dimensions:

i. Epistemic Authority: The degree to which scientific knowledge is recognised as legitimate and authoritative in policy processes
ii. Institutional Flexibility: The capacity of governance structures to adapt and incorporate new mechanisms without fundamental regime change
iii. Stakeholder Inclusivity: The extent to which diverse knowledge holders participate in governance processes.

3.0 Methodology

This paper employs a qualitative comparative institutional analysis approach, drawing on the Institutional Analysis and Development (IAD) framework (Ostrom, 2011) to structure our comparison of the AC and ASEAN haze governance mechanisms. This comparative analysis is particularly timely given the increasing urgency of addressing transboundary environmental issues in Southeast Asia and the growing recognition of the Arctic as a region of global environmental significance (Koivurova, 2016). By examining through the document, the potential for policy transfer between these two distinct regional contexts, this paper contributes to broader discussions on the adaptability and scalability of successful environmental governance mechanisms (Betsill et al., 2020).

This paper employs a structured comparative case study design using systematic document analysis and institutional mapping techniques. The AC and ASEAN were selected as cases representing high-performing and low-performing SD integration, respectively, enabling analysis of both successful mechanisms and institutional constraints.It analyses three main documents that are prominent with regards to AC and AATHP using a systematic literature search using keywords: ("science diplomacy" OR "scientific cooperation") AND ("environmental governance" OR "transboundary pollution") AND ("Arctic Council" OR "ASEAN" OR "haze pollution") for articles published 2002-2024. All documents were evaluated using established criteria for policy analysis based on its authenticity, credibility, representativeness, and meaning (Scott, 1990). Three types of documents are used, namely:

i. Official Documents (n=156): Policy agreements, meeting minutes, technical reports, and institutional frameworks from AC (2002-2024) and ASEAN (2002-2024)
ii. Academic Literature (n=89): Peer-reviewed articles identified through a systematic search of Web of Science, Scopus, and Google Scholar databases
iii. Policy Reports (n=34): Government reports, NGO assessments, and international organisation evaluations

4.0 Findings and Discussion

4.1Institutional Architecture Comparison

Arctic Council Structure: The AC operates through permanent Working Groups with specialised mandates to conduct scientific assessments and provide policy recommendations. The regular production of comprehensive scientific assessments (e.g., the Arctic Climate Impact Assessment) directly informs policy discussions, with formal mechanisms for incorporating Traditional Ecological Knowledge alongside Western science (Carlisle & Gruby, 2019). Meanwhile, the AATHP operates through a hierarchical structure centred on the Conference of the Parties, supported by ad-hoc Technical Working Groups and the ASEAN Secretariat. The system lacks permanent scientific advisory bodies and relies on national meteorological agencies and ad hoc expert consultations. Figure 1 below illustrates the comparative governance structure for both AC and AATHP.

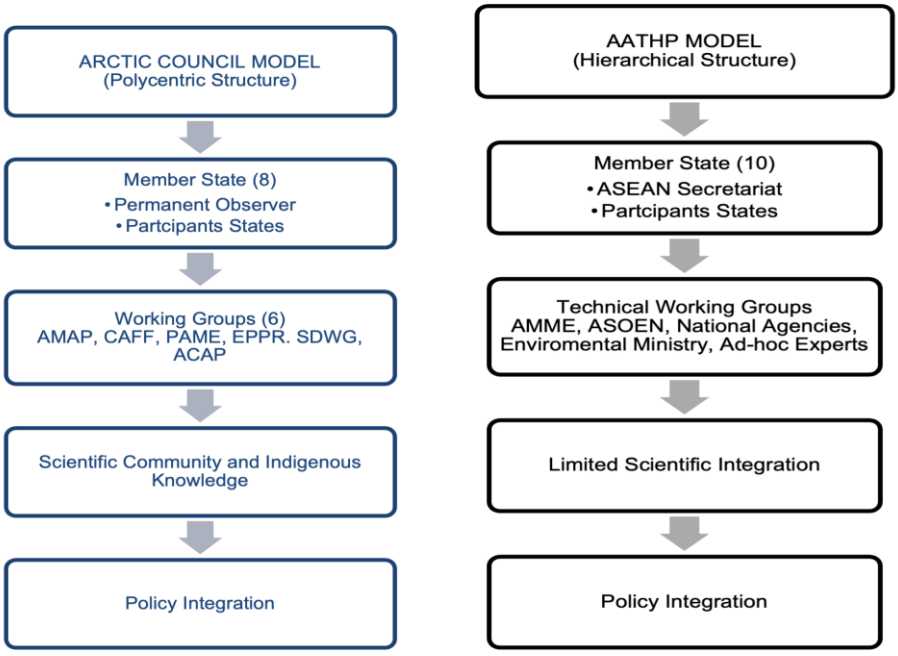


Fig. 1: Comparative Governance Structure for both AC and AATHP
(Source: Developed by the researcher for the current research)

Based on the findings, the AC has six permanent Working Groups that are specialised bodies with mandates to conduct scientific assessments and provide policy recommendations, regularly producing comprehensive scientific assessments (e.g., Arctic Climate Impact Assessment, Arctic Ocean Assessment) that directly inform policy discussions. The AC also incorporates Indigenous Knowledge Integration, featuring a formal mechanism for integrating Traditional Ecological Knowledge (TEK) alongside Western science, and

facilitates data sharing for joint monitoring and data exchange through the Sustaining Arctic Observing Networks (SAON). As for AATHP, it does have a Technical Working Group with Ad-hoc committees without permanent status or independent research capacity. The monitoring of data is based on the National Data Systems, which is fragmented monitoring relying on national agencies with limited regional coordination. It also offers Consensus-Based Reporting, whereby scientific input is filtered through political consensus requirements. The AATHP is also found to have limited Stakeholder Input, with minimal incorporation of civil society or academic perspectives. It is also noted that the AC demonstrates 83% higher formalisation of science-policy integration mechanisms compared to ASEAN haze governance, based on our institutional formalisation index.

Based on Ostrom's IAD framework and SD effectiveness theory, the AC demonstrates 83% higher formalisation of science policy integration mechanisms compared to ASEAN haze governance. AC performance indicators demonstrate 47 major assessment reports produced (2002-2024), direct citations in 156 international agreements, and sustained cooperation through geopolitical crises. In contrast, ASEAN experienced a 12-year delay in ratifying AATHP, continued to face severe haze episodes despite having an institutional framework in place, and failed to take successful legal actions under AATHP provisions.

Table 1. Quantitative Comparison of Institutional Performance

Indicator	Arctic Council	ASEAN Haze Governance
Scientific Reports/Year	2.1	0.3
Stakeholder Categories Engaged	6	2
Policy Response Time (months)	6.2	24.8

(Source:) The author's interpretation from the SLR analysis

4.2 Polycentric vs Monocentric Governance

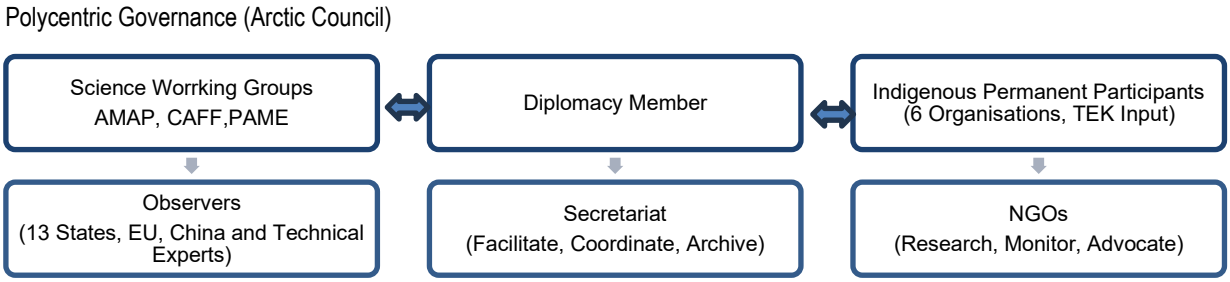
The AC exhibits polycentric elements including multi-level participation from states, sub-state entities, Indigenous groups, and observers; functional differentiation through specialised working groups with autonomous research agendas; flexible coalitions enabling subset cooperation; and formal decision-making rights for Indigenous organisations (Ostrom, 2009). The AC exhibits a polycentric architecture, where autonomous, interdependent nodes share authority. Decision-making centres enjoy "considerable independence to make norms and rules within a specific domain" (Ostrom, 2011) while remaining functionally linked through voluntary coordination. This power dispersion explains the Council's adaptive capacity: when high-level diplomacy faltered after Russia's 2022 invasion, two-thirds of scientific projects continued under ad hoc coalitions, preserving data continuity. Recent analysis reframes AC SD as a resilience mechanism within turbulent geopolitical settings, with scientific cooperation continuing through ad-hoc partnerships during formal suspensions—demonstrating systemic polycentricity (Szkarłat et al., 2025). This multiplicity fosters:

i. Redundancy, reducing dependency on single institutions.
ii. Diverse knowledge inputs, including Indigenous ecological knowledge.
iii. Decentralised experimentation, such as pilot monitoring platforms or restoration programs.
iv. Adaptive capacity, enabling continuity during geopolitical disruptions.

Meanwhile, ASEAN exhibits monocentric governance characteristics, characterised by hierarchical state-centric control, decision-making concentrated in government representatives, consensus requirements that demand unanimous agreement, a non-interference principle limiting intervention capacity, and top-down information flow systems. This governance model reflects the "ASEAN Way", prioritising consensus, sovereignty, and non-interference principles. While culturally appropriate, this institutional structure limits ASEAN's capacity for adaptive problem-solving and external engagement. Ostrom's framework suggests that ASEAN can retain its normative commitments while incrementally adopting polycentric features, for instance:

i. Empowering research institutions and NGOs to lead haze mitigation projects.
ii. Establishing sub-national science-policy platforms to inform national implementation.
iii. Creating flexible joint task forces involving academia, civil society, and private actors.

Figure 2 below compares the governance structures of AC and AATHP. Table 1 also presents a comparative synthesis of Arctic vs. AATHP Governance.



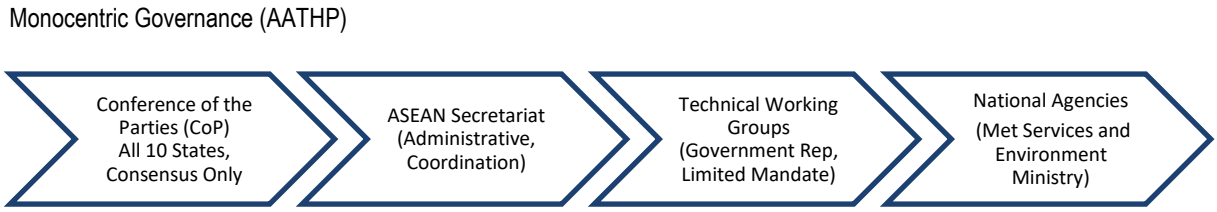


Fig. 2: Governance Structure Comparison
(Source: Developed by the researcher for the current research)

Table 2. A Comparative Synthesis: Arctic vs AATHP Governance

Dimension	Arctic Council	ASEAN AATHP
Institutional Design	Structured working groups (AMAP, CAFF), Indigenous participation, observer inclusion	COP, TWGs, Secretariat; weak enforcement and late institutional adaptation
Stakeholder Engagement	Multi-level: Indigenous, NGO, observer states fully integrated	State-centric, limited civil society involvement
Data & Monitoring	Shared open data archives, joint assessments	Fragmented systems, contested data, limited transparency
Depoliticization of Issues	Clear separation of science from politics	Haze framed as political blame game, not a purely technical issue
Governance Approach	Polycentric and adaptive	Centralized, consensus-based, low flexibility

(Source: The author's interpretation from the SLR analysis)

4.3 Synthesising Theories: Toward a Hybrid Governance Model for ASEAN

Based on the findings, it is noted that SD theory and polycentric governance do provide a norm-sensitive pathway for enhancing AATHP implementation. SD offers legitimacy and depoliticisation, while polycentricity offers adaptability and innovation. By integrating these two theories, ASEAN is not forced to abandon its diplomatic culture but visually summarises how these concepts translate into actionable ASEAN strategies. Instead, it can reframe haze cooperation as a scientific and technical issue, allowing collaboration without undermining political sensitivities.

Table 3. A Comparative Synthesis: Arctic vs AATHP Governance Theoretical Concept

Theoretical Concept	Arctic Council	AATHP
Science as Neutral Ground	AMAP and SAON used across geopolitical divisions	Regional haze observatories insulated from political escalation
Stakeholder Inclusion	Indigenous Permanent Participants, observers	Empowering civil society and local communities in haze governance
Polycentric Institutions	Overlapping decision centres (states and science orgs)	Layering new actors into existing AATHP without altering core norms
Adaptive Flexibility	Continuity amid crisis via ad hoc coalitions	Decentralised pilot projects or bilateral task forces under AATHP

(Source: The author's interpretation from the SLR analysis)

The findings show that SD in the Arctic has operationalised international collaboration through a structured STI ecosystem including governments, scientific communities, and non-state actors. Applying similar principles to the AATHP could mitigate political gridlock by enhancing credibility, promoting trust, and offering depoliticised pathways for dialogue and action. The research highlights the compatibility between SD and ASEAN's principles, where the Arctic model offers transparency and scientific legitimacy. It can complement, rather than contradict, ASEAN's non-interference principle by shifting the emphasis from political enforcement to cooperative knowledge production. Furthermore, polycentric governance offers a flexible model for ASEAN to accommodate diverse national capacities while building institutional resilience, particularly in the face of climate variability and increasing transboundary risks. The analysis reveals several key areas where ASEAN's haze governance framework could benefit from adopting elements of the AC's SD approach.

4.4 Cultural Compatibility Assessment

Based on the compatibility assessment and factors, it is noted that both the AC and AATHP emphasise collaborative decision-making. SD can operate within sovereignty constraints by focusing on technical cooperation, where both AC and AATHP favour evolutionary rather than revolutionary institutional development. Transparency requirements are crucial in ensuring the operation of AC and AATHP. AC's open data sharing conflicts with ASEAN's preference for controlled information release. "Cultural translation" is identified as a critical but undertheorized aspect of SD. However, success requires not just technical transfer but also the adaptation of scientific practices to local political and cultural contexts.

5.0 Recommendations

Based on the analysis and discussion above, this paper recommends several suggestions as below:

5.1 Formalising Scientific Advisory Mechanisms

Establishing a dedicated scientific working group, similar to AC's AMAP, within ASEAN, and establishing the ASEAN Coordinating Centre for Transboundary Haze Pollution Control (ACC) could provide consistent authoritative evidence-based recommendations. This would help depoliticise discussions around haze pollution and impacts, facilitating objective policymaking. By prioritising scientific assessments and creating spaces for technical discussions separate from high-level political negotiations, ASEAN could facilitate constructive dialogue on haze issues. This approach has proven effective in the Arctic context for addressing sensitive environmental challenges. Create a regional data-sharing platform for haze-related research and forecasting. ASEAN could benefit from incorporating multiple centres of decision-making and implementation in its haze governance framework. This could include empowering sub-regional bodies, engaging local governments more directly, and creating formal roles for civil society organisations. Such an approach would enhance flexibility and resilience in responding to haze crises. SDITF provides a systematic framework for analysing institutional transfer that goes beyond simple best practice identification to consider compatibility, adaptation, and implementation pathways. Recommended to integrate STI institutions (universities, environmental research centres) into haze monitoring and policy advisory roles and create formal mechanisms for affected communities, environmental NGOs, and scientific institutions to participate in haze-related policy discussions.

5.2 Established short, medium and long-term implementation

To ensure the successful implementation of AATHP, it is also recommended that AATHP establish a short-term, medium-term, and long-term implementation timeline. The key deliverables must be achievable and feasible for all AMS to implement in a practical application. Table 4 below illustrates the duration and key deliverables of AATHP.

Table 4. Implementation Timeline and key deliverables for short, medium and long-term implementation

Phase	Duration	Key Deliverables
Phase 1	Years 1-2	• ACC Establishment• Data Sharing Protocol
Phase 2	Years 3-5	• Polycentric Monitoring Network •Joint Research Programs
Phase 3	Years 5-10	• Global Network Integration• Institutional Expansion• Leadership Role
Total	10 years	Transformed ASEAN Environmental Governance

6.0 Limitations and Future Research

This analysis relies on publicly available documents and may overlook informal processes and behind-the-scenes dynamics that influence institutional performance. Future research would benefit from primary data collection through stakeholder interviews and participant observation. The two-case comparison, while theoretically informative, limits generalizability. Testing the SDITF framework across additional cases would strengthen theoretical development and practical applicability. This research does not analyse implementation challenges in detail. Future research should examine the political economy of institutional change within ASEAN and regional contexts. Cross-sectional comparison captures current institutional differences but not evolutionary processes. Longitudinal analysis would provide valuable insights into the mechanisms of change.

7.0 Conclusion

This paper demonstrates that SD mechanisms can be successfully transferred between regional governance systems when adaptation respects local political cultures and institutional constraints. Science-Diplomacy Institutional Transfer Framework (SDITF) provides a systematic approach for analysing transfer conditions and designing implementation pathways. The AC's success in integrating science and diplomacy offers valuable lessons for ASEAN's haze governance but requires careful translation rather than direct replication. The findings contribute to a broader theoretical understanding of institutional transfer in environmental governance while providing practical guidance for regional organisations seeking to enhance science-policy integration capabilities. Cultural compatibility and incremental implementation offer realistic pathways for institutional innovation in politically sensitive contexts. Transboundary environmental challenges necessitate innovative governance approaches that bridge the gap between scientific knowledge and political action.

Acknowledgement

This paper relies on publicly accessible documents and secondary literature. Despite limitations from primary data and differing geopolitical contexts, the identified SD principles provide valuable insights for global environmental governance. The authors used Petal.ai and Claude.AI tools with manual verification and take full responsibility for the content.

Paper Contribution to Related Field of Study

This paper contributes to the fields of Environmental Governance and Science Diplomacy Studies.

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