

ORIGINAL ARTICLE



SCIENCE DIPLOMACY AS A CONCEPTUAL BRIDGE: A FRAMEWORK FOR ENHANCING THE IMPLEMENTATION OF THE ASEAN AGREEMENT ON TRANSBOUNDARY HAZE POLLUTION

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Abstract

Despite two decades of multilateral effort, the ASEAN Agreement on Transboundary Haze Pollution (AATHP) has failed to produce the tangible outcomes its architects envisioned. The persistent failure to operationalise the ASEAN Coordinating Centre for Transboundary Haze Pollution Control (ACCTHPC) reveals a deeper problem that legal text alone cannot resolve: the collision between regional environmental governance and entrenched norms of national sovereignty. This paper presents a conceptual framework that underpins a qualitative study through document analysis, investigating three interrelated problems: the political factors shaping AATHP negotiations, the barriers ASEAN Member States (AMS) face in using scientific knowledge, and the potential of science diplomacy as a governing logic for future deliberations. Drawing on two theoretical traditions, neorealism and regionalism, the framework situates the AATHP within the structural tensions of ASEAN's consensus-based and non-interference architecture. This paper then suggests science diplomacy as a conceptual bridge to reconcile those tensions by embedding scientific expertise in the diplomatic process. Evidence from the Arctic Council, the European Union's S4D4C programme, and national science diplomacy strategies in the United States, United Kingdom, Japan, and Germany is examined to substantiate the feasibility of this approach. The paper concludes by outlining how the proposed framework could yield a practical guideline for integrating science diplomacy into AATHP negotiations, thereby contributing to both international relations theory and regional environmental governance practice.

Keywords: AATHP, science diplomacy, transboundary haze pollution, neorealism, regionalism, environmental governance.

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Introduction

Every third quarter of the year, satellite imagery over Kalimantan and Sumatra tells roughly the same story: dense clusters of hotspots, drifting smoke, and air quality indices trigger school closures and airport delays across several neighbouring countries. The imagery is almost routine by now, which is precisely the problem. The ASEAN Agreement on Transboundary Haze Pollution (AATHP) was signed in 2002, ratified by all ten ASEAN Member States by 2014, and has been accompanied by a detailed implementation roadmap since 2016. A second roadmap covering the period 2023 to 2030 was launched in February 2024, signalling that the first roadmap's targets remain substantially unmet (CIFOR-ICRAF, 2025). However, as of the latest Conference of the Parties review, the single most critical institutional mechanism the first roadmap prescribed, namely the ACCTHPC, remains unestablished, stuck in a cycle of deliberation that has produced a completion score somewhere between 'moderate' and 'in progress' for over six consecutive years (ASEAN Secretariat, 2022).

The obvious question is why. The less obvious answer is that the stagnation reflects not a failure of political will in the simple sense, but a structural collision between the ASEAN Way's foundational commitments to non-interference and sovereign equality, on the one hand, and the increasingly technical and cross-border character of environmental governance, on the other. Haze monitoring, hotspot verification, and emergency response coordination all require data sharing, joint assessment protocols, and institutional authority that no single member state can unilaterally provide. They require, in other words, exactly the kind of supranational coordination the ASEAN Way was designed to avoid. Recent empirical analysis covering 2014 to 2024 confirms that ASEAN's inability to adopt enforcing pronouncements and mediate the blame game between member states remains the core governance failure driving the persistence of haze (Putra, 2025). This deadlock persists into the present decade: Article 27 of the AATHP still provides only for consultation and negotiation rather than any binding dispute-settlement mechanism, a gap starkly exposed by the renewed Indonesia-Malaysia-Singapore haze dispute of 2025 (Setianingrum & Muamanah, 2026).

Despite this substantial body of scholarship on why the AATHP has underperformed, the political and scientific dimensions of the stalemate have largely been analysed in isolation from one another: one strand of literature explains the impasse through ASEAN's institutional norms, while a separate strand documents the region's fragmented monitoring capacity, but the two are rarely brought into a single explanatory framework. This is the specific gap the present paper addresses: no existing account explains how sovereignty-driven political constraints and the practical absence of a shared scientific infrastructure interact to produce the ACCTHPC deadlock, or what a workable alternative pathway would look like. The objective of this paper is accordingly twofold which to explain, through neorealist and regionalist theory, why the AATHP's institutional mechanisms have stalled, and to develop a conceptual framework in which science diplomacy is adapted, rather than merely imported, to ASEAN's non-interference norm. The study's originality lies in this synthesis: pairing international relations theory on ASEAN's regionalism with the comparative science diplomacy literature is a combination not yet attempted in haze governance scholarship, and it is this combination that the paper contributes.

This paper presents the conceptual framework that takes that structural tension seriously and investigates whether science diplomacy offers a credible path forward. Science diplomacy is not a new idea, but its application in Southeast Asian environmental governance is strikingly underdeveloped. It has been used to navigate politically sensitive nuclear research programmes, to sustain collaboration between adversarial states in the Arctic, and to institutionalise research partnerships across the European Union. There is no obvious reason why the same logic cannot inform AATHP negotiations, and there are some compelling theoretical reasons to think it can.

This is precisely where the gap identified above becomes actionable: because the AATHP's stagnation is a gap in mechanism rather than in political will alone, science diplomacy is proposed here not as a general solution but as the specific mechanism through which technical evidence could be channelled into negotiations without requiring any AMS to cede the sovereign authority the ASEAN Way is built to protect. The link is deliberate rather than incidental: the framework treats science diplomacy as the missing institutional bridge between what the political-economy literature says ASEAN cannot do and what the ACCTHPC was designed to require it to do.

The conceptual framework developed here has three interlocking components. First, it grounds the study in two complementary international relations theories, neorealism and regionalism, which together explain why the AATHP has performed below expectations and what structural forces any reform strategy must contend with. Second, it maps the specific challenges that AMS face in translating scientific knowledge into negotiating positions. Third, it draws on comparative evidence from successful science diplomacy initiatives to articulate a model for integrating science into the AATHP's deliberative architecture. What follows is a structured account of how those three components fit together and why the resulting framework is analytically coherent and practically applicable.

The Research Problem in Context

Transboundary haze pollution in Southeast Asia is not primarily a scientific mystery. The mechanics are well understood: seasonal land clearing by open burning, predominantly on peatlands in Kalimantan and Sumatra, generates particulate matter that is carried by weather systems across international borders (Nazeer & Furuoka, 2017; Varkkey, 2012; Boonprong et al., 2026). The economic and public health costs are similarly well documented. Recent literature situates this recurring crisis within a broader climate-development feedback loop, in which anthropogenic climate change intensifies drought-driven fire risk while the resulting emissions accelerate warming in turn, undermining progress on multiple Sustainable Development Goals simultaneously (Syed Azhar et al., 2026). What remains contested, year after year, is the appropriate institutional and political response.

The AATHP's implementation roadmap, endorsed at the Conference of the Parties in 2016, outlined eight strategies for achieving a haze-free ASEAN by 2020. Strategy 1 mandated the physical establishment and full operationalisation of the ACCTHPC as the first and enabling step. The ACCTHPC was conceived as a neutral coordinating body responsible for monitoring, joint emergency response, and data arbitration among member states. Without it, the seven remaining strategies lack a credible institutional backbone (NRES, 2023; ASEAN Secretariat, 2022; Peteru et al., 2025). Importantly, the final review of the first roadmap did not close that gap. A revised roadmap extending to 2030 was subsequently launched, reflecting official acknowledgement that the original targets had not been achieved (CIFOR-ICRAF, 2025).

The delay in establishing the ACCTHPC is not simply an administrative matter. It reflects a genuine and recurring disagreement among AMS over the scope of the Centre's authority, its administrative arrangements, and the sovereignty implications of granting a regional body the power to verify data generated by individual member states within their own territories. Indonesia's 13-year delay in ratifying the AATHP itself was shaped by parliamentary concern that the agreement could be used to penalise Indonesia for domestic fire management failures. Fikri (2022) demonstrates, through legalisation theory, that the AATHP's non-interference framing deliberately weakened its binding obligations, thereby giving Indonesia latitude to advance national interests that ran contrary to the agreement's goals. This concern illustrates exactly how deeply sovereignty considerations penetrate even foundational matters of regional environmental cooperation (Hurley et al., 2020; Syahrullah Barca, 2024; Periani & Iskatrinah, 2025).

At the same time, the scientific dimension of AATHP implementation is chronically underutilised. AMS differ substantially in their satellite monitoring capacities, their technical expertise in fire risk assessment, and their institutional channels for translating research outputs into negotiating briefs. The absence of a shared scientific infrastructure means that data from hotspot monitoring, the most empirically accessible input to haze management decisions, remains fragmented across national systems that are not always interoperable (Sunchindah, 2015; Nguitragool, 2011; Varkkey, 2021; Bose, 2026). The result is a governance system in which political factors consistently override scientific evidence, not because decision-makers are indifferent to evidence, but because the institutional architecture does not provide a credible mechanism for incorporating it. Monitoring by the ASEAN Specialised Meteorological Centre confirms that hotspot counts in Kalimantan alone exceeded 1,000 in 2019 and that the region registered 4,315 hotspots between 2020 and 2023, with no substantial reduction in the underlying institutional failure (ASMC, 2023). The pattern recurred as recently as July 2025, when ASMC data again recorded dense hotspot clusters in West and Central Kalimantan and Riau, with prevailing winds pushing haze toward Sarawak, Brunei Darussalam, and southern Peninsular Malaysia (Jaes et al., 2026).

Three research questions follow from this diagnosis. First, how do political factors, particularly sovereignty norms and the ASEAN Way, affect the negotiation process for implementing AATHP, especially in establishing the ACCTHPC? Second, what specific obstacles do AMS face in utilising scientific knowledge during AATHP deliberations? Third, how might ASEAN, as a regional organisation, improve the implementation of AATHP by institutionalising science diplomacy within its deliberative architecture? The conceptual framework presented in this paper is designed to provide a structured analytical response to all three. These three questions map directly onto the gap and the twofold objective set out above: the first two questions establish the political and scientific dimensions of the gap separately, and the third asks how science diplomacy can close it, which is the paper's specific contribution to the literature.

Theoretical Foundations

Neorealism and the Sovereignty Trap

Neorealism, as systematised by Waltz (1979) and developed by subsequent structural realists, provides the most parsimonious account of why multilateral environmental cooperation is structurally difficult. The theory posits that states operate within an anarchic system in which no overarching authority can compel compliance or guarantee security. In that environment, states

prioritise relative gains over absolute ones, guard their autonomy jealously, and treat any institutional arrangement that might constrain their sovereign decision-making with deep suspicion. Meibauer (2023) argues that while neorealism's structural determinism remains analytically valuable, neoclassical variants that incorporate domestic-level variables offer a more nuanced explanatory toolkit, particularly for understanding why states deviate from what systemic pressures alone would predict. This insight is directly applicable to AATHP, where Indonesia's behaviour has frequently defied structural predictions about what a state in its position should rationally do.

The four foundational principles Waltz identifies are anarchy, self-help, balance of power, and the security dilemma. These translate directly into observable behaviour in AATHP negotiations. Anarchy manifests in the absence of any supranational body with the authority to enforce the agreement's provisions. Self-help appears in member states' preference for national legislation, such as Singapore's Transboundary Haze Pollution Act or Malaysia's proposed parallel measure, over collective enforcement mechanisms. The balance-of-power dynamic shapes how smaller AMS respond to Indonesia's dominant role as both the primary source of haze and the largest member of the grouping. The security dilemma arises when states interpret requests for data transparency as a potential source of penalisation rather than as a contribution to shared governance.

More specifically, neorealism helps explain the ASEAN Way as a rational institutional response to structural constraints rather than simply a cultural preference. The non-interference norm, consensus-based decision-making, and the deliberate avoidance of binding enforcement mechanisms are not diplomatic courtesies. They are the terms on which sovereign states with divergent economic interests and historical sensitivities agreed to cooperate at all (Narine, 2002; Varkkey, 2012). Cerioli (2024) further demonstrates that realist theoretical frameworks, when applied to Global South contexts, must account for socioeconomic asymmetries and hierarchical power structures that classical neorealism tends to underweight. In the ASEAN context, this means recognising that sensitivity to sovereignty is not a uniform preference across AMS but is unevenly distributed in relation to each state's economic exposure and its dependence on land-use practices that generate haze.

Neorealism is less useful in explaining the conditions under which states can transcend these structural constraints. The theory, by design, emphasises constraint over agency and tends to treat cooperation as a precarious equilibrium rather than a transformative possibility. Science diplomacy addresses this specific limitation: by routing cooperation through technical, ostensibly depoliticised epistemic channels rather than through binding legal commitments, it allows states to exchange information and update their assessment of relative gains without the sovereignty concessions that neorealism predicts they will resist, offering a plausible mechanism for movement that structural constraint alone cannot generate. This is where regionalism becomes analytically necessary.

Regionalism and the Limits of Institutional Architecture

Regionalism as a theoretical tradition, particularly in its post-Cold War articulations, draws attention to the ways in which regional institutions can generate cooperative outcomes that pure self-interest calculations would deem unlikely (Hurrell, 1995; Fawcett, 2004). The establishment of ASEAN itself, the progressive expansion of its institutional mandate, and the negotiation of

agreements like the AATHP are all evidence that regional frameworks can shift the incentive structure within which member states operate.

For this study, the key contribution of regionalism lies in its focus on how norms, identities, and institutional capacity interact to shape regional governance outcomes. Umar (2023) identifies both the positive and negative dimensions of ASEAN regionalism in the context of haze governance. On the positive side, ASEAN's institutional architecture created the forum within which the AATHP could be negotiated and provides the recurring CoP process through which implementation is reviewed. These are non-trivial achievements. On the negative side, the same institutional logic that enabled the AATHP, namely consensus, non-interference, and pragmatic flexibility, also explains why enforcement remains weak and why the ACCTHPC has not been established.

Varkkey's (2011) characterisation of ASEAN as a 'thin community' is particularly instructive here. A thin community is a looser form of association in which member states retain substantial autonomy over their domestic priorities and commitments. In a thin community, regional norms can influence state behaviour at the margins but cannot override deep national interests. The AATHP operates within a thin community architecture, meaning its implementation depends heavily on voluntary alignment with national priorities rather than on any credible sanctioning mechanism. Salazar (2023) provides recent empirical support for this characterisation by demonstrating that even transnational governance networks in ASEAN, which might be expected to inject civil society perspectives and scientific knowledge into regional processes, remain structurally constrained by the organisation's top-down, state-centric architecture. Non-state actors engage through shared practices but cannot contest policy, which is precisely the limitation that science diplomacy must navigate.

The environmental dimension of regionalism adds a further layer. Elliott (2011), Watson and Chandra (2015) and Balsiger and VanDeveer (2012) note that environmental regionalism often requires coordination between state and non-state actors, and that the technical complexity of environmental issues creates pressure to include scientific expertise in governance processes. This pressure is precisely what the AATHP's current architecture struggles to accommodate. A recent analysis of ASEAN's network governance architecture confirms that resource disparities and institutional asymmetries among member states remain the central obstacles to bridging the governance gap in multilateral environmental contexts (Frontiers in Political Science, 2025; Karim, 2025; Hashemi Rafsanjani et al., 2026). The scientific dimension of haze management is acknowledged in the agreement's text but not institutionalised in its deliberative processes. Closing that gap is what science diplomacy, as a conceptual tool, is designed to do. Read alongside the neorealist account in Section 3.1, the two theories jointly define the space science diplomacy must occupy: neorealism explains why AMS will resist any mechanism that looks like ceded sovereignty, while regionalism's 'thin community' concept explains why the existing institutional architecture cannot compel scientific input even where it is technically available. Science diplomacy is positioned in this paper as the mechanism that satisfies both constraints simultaneously, operating through technical, non-binding epistemic channels that neither require AMS to accept enforceable obligations, which neorealism predicts they will resist, nor demand a thicker regional community than the thin-community architecture regionalism describes ASEAN as being.

Science Diplomacy as a Conceptual Tool

Conceptual Foundations

Science diplomacy is broadly understood as the intersection of scientific collaboration and international diplomatic practice. As Flink and Schreiterer (2010) and Turekian et al. (2015) established in the foundational literature, science diplomacy operates in three overlapping modes: science in diplomacy, where scientific advice informs foreign policy; diplomacy for science, where diplomatic channels facilitate international research collaboration; and science for diplomacy, where scientific partnerships are used to build trust and advance diplomatic relations between states. Figure 1 illustrates how these three modes apply specifically within the AATHP governance context.

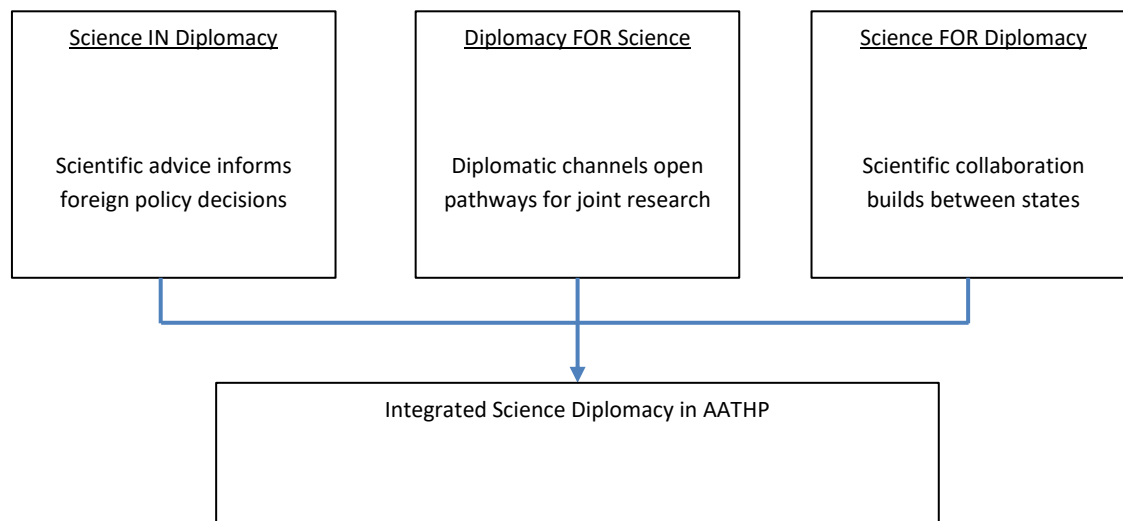


Figure 1. Three Modes of Science Diplomacy and Their Application in AATHP.

Source: Adapted from Flink and Schreiterer (2010) and Turekian et al. (2015); developed by the researcher for the current research

What makes science diplomacy particularly relevant to the AATHP context is its explicit attention to the interface between technical expertise and political decision-making. Environmental issues are, by their nature, scientifically complex. Effective governance of transboundary haze requires satellite monitoring data, fire risk modelling, land-use mapping, and atmospheric dispersion analysis, none of which is straightforwardly political in the conventional sense, but all of which carry profound political implications depending on how they are generated, shared, and interpreted (Haas, 1992; O'Neill, 2017; Varkkey, 2021). Science diplomacy provides a framework for managing that interface: it creates institutional roles for scientists within diplomatic processes and, conversely, provides scientists with the political context they need to make their findings actionable.

Krasnyak and Ruffini (2020) identify three core elements that make science diplomacy effective: international scientific cooperation through formal partnerships and joint research initiatives; science-informed policymaking through the systematic integration of research evidence

into foreign policy decision cycles; and science as a tool for building soft power and diplomatic trust. All three elements are relevant to AATHP implementation. The ACCTHPC, if properly constituted, could serve as the institutional vehicle for all three, functioning as a body that commissions joint scientific assessments, translates those assessments into negotiating briefs, and builds the kind of evidence-based trust that might eventually enable the enforcement mechanisms the agreement currently lacks.

Evidence from Comparative Cases

The theoretical case for science diplomacy in AATHP implementation is supported by substantial comparative evidence. The most directly relevant case is the Arctic Council, established in 1996 to manage environmental governance across eight Arctic states whose political relationships range from collegial to deeply adversarial. The Arctic Council's success in sustaining scientific collaboration even during periods of acute geopolitical tension, including between Western members and Russia, illustrates that science can serve as a domain of cooperation partially insulated from political friction (Arctic Council, 1996 & 2020; Berkman, 2020 & 2023; Berkman & Young, 2009).

The mechanism through which this insulation operates is institutional: the Arctic Council's six working groups, including the Arctic Monitoring and Assessment Programme (AMAP), create formal spaces for scientists from member states to collaborate on joint assessments that then feed into ministerial-level negotiations. This is precisely the kind of architecture the AATHP lacks. The ASEAN Specialised Meteorological Centre (ASMC) performs some analogous functions, but without the formal status and deliberative integration that would make its outputs authoritative inputs into CoP negotiations.

At the regional level, the European Union's S4D4C project (Using Science for/in Diplomacy for Addressing Global Challenges), funded under Horizon 2020, provides a more recent and methodologically sophisticated example. The S4D4C initiative developed governance frameworks for science diplomacy across EU member states and produced training programmes for science diplomats, a professional cadre that most diplomatic services, including ASEAN member state foreign ministries, do not yet formally recognise (European Commission, 2024; Aukes et al., 2019). The establishment of the EU Science Diplomacy Alliance, a product of this initiative, signals that science diplomacy is transitioning from a conceptual framework to an institutional reality at the regional level.

National-level cases provide further evidence that science diplomacy is a practical governance tool rather than an aspirational concept. The United States has maintained a Science and Technology Adviser to the Secretary of State since 1999 and deploys science envoys in bilateral contexts where diplomatic relations are sensitive or where scientific collaboration can build bridges that conventional diplomacy cannot (Fedoroff, 2009; US Department of State, 2023). The United Kingdom's Science and Innovation Networks, operating under the Foreign and Commonwealth Office, perform a similar function, with an explicit mandate to support post-Brexit international scientific partnerships (Government of the UK, 2021). Japan's 4th Science and Technology Basic Plan and subsequent Sixth Basic Plan explicitly frame science and technology diplomacy as a national strategic priority, with science advisers deployed in strategically important partner countries (Council for Science, Technology and Innovation, 2021; López-Aranguren, 2023). Germany's Federal Ministry of Education and Research has maintained an international

science cooperation strategy since 2008, using science diplomacy instruments to advance both research partnerships and broader foreign policy goals (Fähnrich, 2015).

A further parallel, emerging outside the European and Arctic contexts more conventionally examined in this literature, is the concept of ‘smog diplomacy’ recently articulated for South Asia. Naz and Irfan (2025) propose addressing transboundary smog over the Indo-Gangetic Plain through a green-theory-informed diplomatic framework that can transcend India and Pakistan's longstanding political tensions, arguing that shared environmental vulnerability can motivate cooperative air-quality governance even between historically adversarial neighbours. The case is instructive for AATHP precisely because it shows that environment-led diplomacy is not confined to consensual regional blocs such as the Arctic Council or the EU: it has also been proposed as a bridging mechanism where formal political trust is comparatively low, a condition closer to the sovereignty-sensitive dynamics among some AMS than either of the other cases reviewed here.

Taken together, these cases point to a consistent pattern: effective science diplomacy requires dedicated institutional infrastructure, formal mechanisms for integrating scientific evidence into diplomatic processes, and a shared understanding among both scientists and diplomats of what each group needs from the other. None of these elements currently exists in a systematic form within AATHP's governance architecture. Table 1 summarises the key lessons each case offers for AATHP reform.

Table 1

Comparative Science Diplomacy Models and Their Applicability to AATHP.

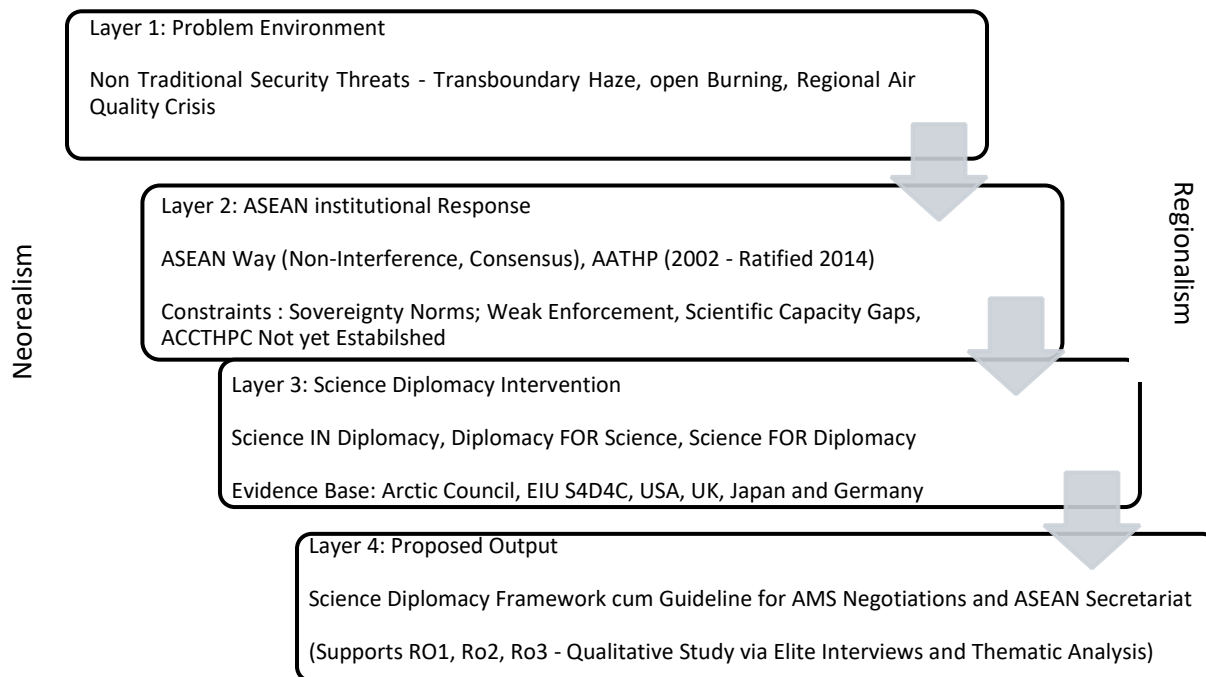
Case/ Model	Key mechanism	Sovereignty Design	Lesson for AATHP
Arctic Council (International Org)	Scientific Working Groups (AMAP)	Science separated from politics; member equality preserved	ASEAN scientific working group within CoP structure
EU S4D4C (Regional Org)	Governance framework; Science Diplomat training programme	Value-based and interest-based motives combined	Train ASEAN science diplomats and establish ASEAN Science Diplomacy Alliance
USA/ UK (National Level)	Science Adviser to State; Science and Innovation Networks	Science as soft power; national interest advanced via S&T	AMS foreign ministries deploy science attachés in ASEAN haze-affected capitals
Japan/ Germany (National Level)	National S&T Basic Plans; BMBF-strategy; S&T as diplomacy	Explicit state commitment to S&T diplomacy as strategic foreign policy	AMS formally embed science diplomacy in national foreign policy strategies

Source: Developed by the researcher for the current research

The Conceptual Framework

Framework Architecture

The conceptual framework developed in this study comprises four interdependent layers, each corresponding to a distinct level of analysis and a set of research questions. Figure 2 provides a schematic representation of the full framework; the following subsections unpack the logic connecting each layer.



Source: Developed by the researcher for the current research

Figure 2. Four-Layer Conceptual Framework for Integrating Science Diplomacy into AATHP Implementation.

The first layer is the problem environment: non-traditional security threats, specifically environmental challenges such as haze, smoke, and open-fire burning, that create regional interdependencies that individual states cannot manage in isolation. This layer establishes the rationale for regional governance and frames haze pollution as a security issue in the expanded and non-traditional sense, one that is relevant to both neorealist security concerns and regionalist cooperation frameworks.

The second layer is ASEAN's existing institutional response, encompassing the ASEAN Way as a governing philosophy and the AATHP as the primary institutional expression of regional haze governance. This is the layer where the structural tensions identified by neorealism and regionalism become most visible. The ASEAN Way provides the normative architecture within which the AATHP operates; that architecture both enables the agreement's negotiation and

constrains its implementation. The four factors that literature consistently identifies as contributing to AATHP's underperformance, namely sovereignty and non-interference norms, Indonesia's delayed ratification, weak enforcement mechanisms, and disparities in scientific knowledge and technology across AMS, all operate at this level. The launch of a second roadmap in 2024 reflects official acknowledgement that these factors have not been overcome (CIFOR-ICRAF, 2025).

The third layer is the science diplomacy intervention: the conceptual and institutional resources that could be introduced into AATHP's deliberative processes to address the failures identified in the second layer. This layer draws on the comparative evidence reviewed in Section 4, translating the lessons of the Arctic Council, the EU's S4D4C initiative, and national science diplomacy programmes into design principles for AATHP's governance architecture. The core proposition is that science diplomacy, by creating formal roles for scientific evidence in diplomatic negotiations, can partially decouple environmental governance decisions from the sovereignty dynamics that currently stall the establishment of the ACCTHPC.

The fourth layer is the proposed output, a framework cum guideline that provides AMS negotiators, scientific advisers, and Industry players with a structured approach to integrating science diplomacy into AATHP deliberations. This output directly addresses the research gap identified in the literature, specifically not merely the absence of science diplomacy in AATHP negotiations, but also the lack of formal guidelines to guide the practitioners on how to introduce it.

Theoretical Integration

The framework's theoretical coherence derives from the way neorealism and regionalism are deployed together rather than in opposition. Neorealism explains the problem: sovereignty norms, self-help behaviour, and the absence of supranational enforcement authority create structural conditions under which ambitious environmental cooperation agreements systematically underperform. Regionalism explains both the partial solution that ASEAN's institutional architecture already provides and the specific form of the remaining gap: thin community dynamics limit enforcement but do not preclude norm evolution and institutional innovation.

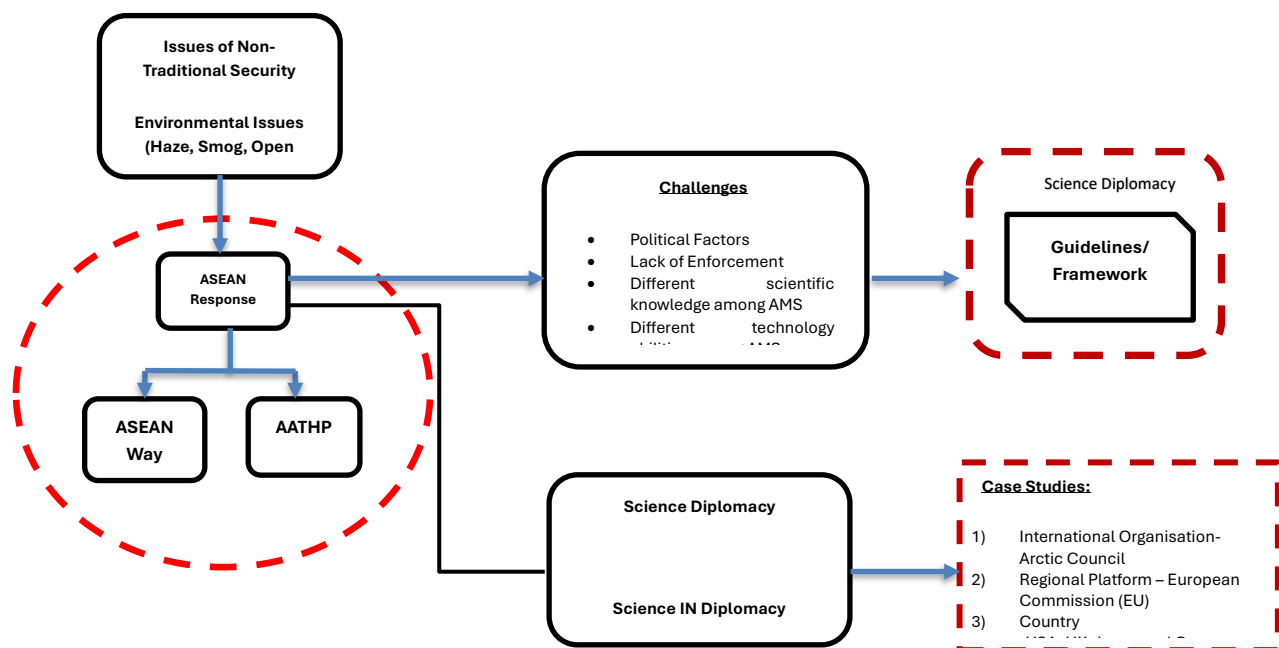
Science diplomacy enters as what might be called a norm-compatible reform mechanism. Unlike proposals that would require AMS to surrender sovereignty over environmental enforcement, proposals that neorealism predicts they will resist and that the historical record confirms they do resist, science diplomacy works within the sovereignty framework rather than against it. It proposes not that states cede decision-making authority to a regional body, but that they agree to base their decisions on jointly produced, scientifically verified evidence. This is a more modest ask, and one that has proven achievable in analogous regional contexts. Putra (2025) specifically recommends that ASEAN adopt a code of conduct that elevates domestic transboundary haze regulations while explicitly aligning with the ASEAN Way's principles of sovereignty and non-interference, which is precisely the logic that a science diplomacy approach operationalises.

The framework also integrates the epistemic dimension of AATHP governance. Haas's (1992) concept of epistemic communities, which are networks of experts who share normative commitments and causal beliefs, is relevant here. One of the recurring findings in the AATHP literature is that AMS do not share a common understanding of either the scientific evidence on

haze causation and spread or the appropriate policy responses. Building an epistemic community around haze science, through joint monitoring programmes, shared data protocols, and formal scientific advisory roles within CoP processes, is precisely what the science diplomacy framework proposes. The Arctic AMAP working group provides a concrete institutional model; the challenge is to design an ASEAN equivalent that is compatible with the region's institutional culture.

Beyond its function in this study, the framework carries analytical utility for future research on transboundary environmental governance more broadly. It is built around structural conditions rather than a single fixed causal mechanism, it isn't tied to the specifics of the AATHP case. It can be adapted to other multilateral environmental agreements where political constraints, rather than technical or scientific gaps, are the primary barrier to implementation. Researchers examining other instances of science diplomacy seeking to shift entrenched political dynamics, whether in fisheries governance, transboundary water disputes, or regional climate agreements, set against the broader thirty-year trajectory of global climate governance from Rio to Glasgow (Zou, 2026), could apply the same structural logic without needing to replicate this study's findings. In that sense, the framework works less as a conclusion specific to AATHP and more as an analytical template, a way of asking where political constraints sit and where science diplomacy might realistically step in, that carries across cases.

Based on the previous research, the conceptual framework adopted in this study is derived as portrayed in Figure 3 as follows:



Source: Developed by the researcher for the current research

Figure 3. Conceptual Framework Derived from the Problem Statement.

Literature Gap and Research Contribution

Three distinctive gaps in the existing literature justify this research and give the conceptual framework its theoretical stakes. The first gap is the near-absence of research examining how political factors shape the specific negotiating processes within AATHP implementation. The literature on AATHPs' ineffectiveness is substantial and covers the four main factors identified in Section 2: sovereignty norms, Indonesia's delayed ratification, enforcement weakness, and scientific capacity disparities. Recent empirical work by Fikri (2022) applies legalisation theory to demonstrate how non-interference softened the AATHP's binding character, and Putra (2025) confirms that spikes in haze since 2023 have not been accompanied by any meaningful shift in ASEAN's institutional capacity for response. What is largely missing is research examining how these factors interact within the actual negotiating dynamics of CoP meetings, ASEAN Senior Officials on the Environment (ASOEN) sessions, and ASEAN Ministerial Meeting on Environment (AMME) discussions. Understanding ACCTHPC's non-establishment requires understanding the politics of deliberation, not just the structural conditions that make agreement difficult.

The second gap is the lack of research that connects science diplomacy specifically to AATHP governance. The literature on science diplomacy in environmental contexts is growing (Ruland et al., 2023; Rüffin, 2020; Turekian et al., 2015; Krasnyak & Ruffini, 2020) but remains almost entirely focused on global climate negotiations, the Arctic, or bilateral research partnerships. Southeast Asian environmental governance, and AATHP in particular, represents an underexplored application domain in which the concept is clearly relevant but has not been analytically developed (Ng & Mohd Zabidi, 2023).

The third gap is practical: there is no existing framework or guideline for how scientists, diplomats, and ASEAN Secretariat staff should interact during AATHP negotiations. The Arctic Council's working group model, the S4D4C's training framework for science diplomats, and the various national science adviser models reviewed in this paper all address analogous coordination problems in different contexts. Translating these models into a form compatible with ASEAN's institutional culture and the specific governance challenges of transboundary haze constitutes the practical contribution this research aims to make. This is consistent with the broader public-administration finding that institutional fragmentation, rather than the absence of any single policy instrument, is the primary barrier to effective governance in comparable multi-level environmental and health systems (Mayusa et al., 2026).

Together, these gaps suggest that the research makes contributions at three levels. Theoretically, it extends the application of neorealism and regionalism to a domain, namely non-traditional environmental security in Southeast Asia, where both theories have explanatory power but have not been systematically integrated with science diplomacy frameworks. Empirically, it generates primary data on AATHP negotiation dynamics that are not currently available in the academic literature. In practice, it produces a framework document that, if adopted, could materially improve the deliberative architecture within which AATHP implementation decisions are made.

Discussion

The conceptual framework presented here rests on a proposition worth stating plainly: science diplomacy can do what legal text and political goodwill alone have not managed in ASEAN's haze governance for over twenty years. That proposition is reasonable but not guaranteed, and it depends on the three conditions set out below. Science diplomacy is treated here as both an institutional mechanism and a political process, not a normative aspiration extended by diplomats to scientists. As a mechanism, it needs a real organisational form to function: chief science advisers, joint working groups, scientific attachés (Ruffini, 2017). As a process, it runs through the same bargaining and coalition-building that structures ordinary interstate diplomacy, rather than sitting in some depoliticised space set apart from it (Legrand & Stone, 2018). Gluckman et al. (2017) add that scientific input is easily marginalised once it lacks a defined institutional channel into foreign policy, however sound the underlying evidence may be. Read through Hall and Taylor's (1996) institutionalist distinctions, the argument here is historical institutionalist rather than rational choice. A body such as the ACCTHPC matters not merely as a coordination device that lowers transaction costs, but as a durable allocation of who gets to define reliable haze science, which is exactly why AMS negotiate its design so cautiously. Measured against Baldwin's (1985) benchmark for statecraft, knowledge counts only once AMS actually deploy it in bargaining. A verified hotspot count cited in a CoP negotiation counts; background information presented alongside the talks does not. By that benchmark, the ASMC's existing outputs remain pre-statecraft, technically available but not yet put to use.

The first condition is that science diplomacy has to be introduced as sovereignty-compatible rather than sovereignty-threatening. The Arctic Council's working-group model is instructive here. It sustained genuine scientific integration (Russia's participation in Arctic assessments continued even through periods of severe diplomatic strain) by keeping scientific collaboration procedurally separate from political negotiation while still connecting the two substantively. AATHP's version of this problem is harder, though. Haze-generating land use in Kalimantan and Sumatra is tangled with agribusiness patronage networks that shape whether fire and land-use data are disclosed, contested, or suppressed in the first place (Varkkey, 2012). Sovereignty compatibility here has to be secured on two fronts, not one. AMS governments need reassurance that scientific integration won't be used to penalise them internationally, which the Arctic template addresses; the science itself also needs insulation from domestic capture by commercial actors with a direct stake in how monitoring data is verified and reported, which the Arctic case never had to solve. Any ASEAN equivalent of the AMAP model would need a data-verification and independent-audit layer that the Arctic Council simply does not require. Singapore's Transboundary Haze Pollution Act illustrates the limits of unilateral legal remedies for exactly this reason: its extraterritorial liability provisions face substantial jurisdictional, choice-of-law, and enforcement obstacles when applied against agribusiness actors operating across borders, underscoring why a diplomatic rather than purely legal solution is needed (Chong & Schacherer, 2025).

The second condition is that scientific capacity disparities among AMS need to be addressed directly, not assumed away. Member states differ substantially in their technical capacities for monitoring, analysis, and scientific advice (Sunchindah, 2015; Heilmann, 2015), compounded by weak law enforcement, underinvestment, and practices such as slash-and-burn farming (CIFOR-ICRAF, 2025). Recent evidence confirms that policy effectiveness in this domain tracks national commitment and financial accessibility rather than any single policy instrument,

meaning regulatory design alone cannot close capacity disparities (Bang et al., 2026). Capacity building, joint training, shared monitoring infrastructure, and regional data-sharing protocols all have to be designed alongside the diplomatic innovation, not bolted on afterwards.

The third condition is institutional buy-in from both the scientific and diplomatic communities. The EU's S4D4C experience shows that effective science diplomacy needs practitioners fluent in both the culture of research and the culture of negotiation, which are not the same culture, and that building this bridge takes a deliberate government decision to treat science diplomacy as a foreign policy function rather than just a training exercise (Aukes et al., 2019; López de San Román & Schunz, 2018). Japan's dedicated science and technology diplomacy strategy shows what that decision looks like in practice.

Taken together, these conditions support treating science diplomacy not as one option among several but as the most credible way forward for AATHP implementation. Two decades of binding-obligation attempts have already tested the alternative that neorealism predicts will stall (Fikri, 2022; Putra, 2025), and waiting for AMS to converge voluntarily on shared scientific standards looks equally unpromising given the capacity disparities documented above. As Sections 3.1 and 3.2 establish, science diplomacy is the one governance logic here that neither requires AMS to surrender the sovereignty protections neorealism predicts they will defend, nor leaves unaddressed the scientific gap that regionalism's thin-community architecture cannot close on its own. The Arctic Council's AMAP and the EU's S4D4C both demonstrate that this fit is workable in practice (Putra, 2025; Salazar, 2023).

These conditions are demanding but not utopian. The ASEAN Secretariat already coordinates AATHP deliberations, and the ASMC already performs the scientific monitoring that feeds CoP discussions, so the infrastructure exists in rudimentary form already. What remains is to formalise it so scientific evidence carries genuine authority within the political negotiation process. Whether that formalisation is achievable within ASEAN's thin-community architecture is the empirical question this research sets out to answer, tracing how science diplomacy would have to operate both as an institutional mechanism (embedded in specific bodies, budgets, and reporting lines) and as a political process (contested and bargained over by AMS with unequal capacities and interests) before haze science can be said to be translated into statecraft rather than merely presented alongside it.

Conclusion

The AATHP's persistent implementation gaps are not primarily a technical failure. They are a governance incompetence, rooted in the structural tension between the scientific complexity of transboundary haze management and ASEAN's sovereignty-preserving decision-making architecture. The conceptual framework presented in this paper addresses that tension by drawing on neorealism to explain its existence, on regionalism to identify what ASEAN's institutional architecture can and cannot deliver, and on science diplomacy to propose a reform pathway compatible with the political constraints that have blocked previous approaches.

The framework's central proposition is that embedding scientific expertise within AATHP's deliberative processes, through formal advisory roles, joint monitoring working groups, shared data protocols, and trained science diplomats, can partially decouple environmental governance from the sovereignty dynamics that currently prevent the ACCTHPC from being

established and operational. This is not a proposal to override the ASEAN Way; it is a proposal to work through it more effectively by giving scientific evidence the institutional status it currently lacks.

The comparative evidence reviewed in this paper, from the Arctic Council, the EU's S4D4C initiative, and national science diplomacy programmes in the United States, the United Kingdom, Japan, and Germany, provides substantial support for the proposition that this kind of institutional innovation is achievable. The specific form it should take within ASEAN's governance architecture is the empirical question this framework-supported research is designed to answer.

The launch of the second ASEAN Haze-Free Roadmap covering 2023 to 2030 is a timely prompt (CIFOR-ICRAF, 2025). It signals that ASEAN member states recognise the first roadmap fell short but have yet to identify a fundamentally different approach. Science diplomacy, as conceptualised and justified in this paper, is that different approach: a governance logic that accepts the sovereignty constraints ASEAN operates under while providing a mechanism to introduce scientific rigour into the political processes that have, until now, kept the ACCTHPC on hold and the haze in the air.

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Paper Contribution to Related Field of Study

This paper contributes to the fields of environmental governance and science diplomacy studies.

References:

- Arctic Council. (1996). *Declaration on the establishment of the Arctic Council*: Ottawa declaration.
- Arctic Council. (2020). *Arctic Council working groups*. <https://arctic-council.org>
- ASEAN Secretariat. (2022). *Final review of the roadmap on ASEAN cooperation towards transboundary haze pollution control*.
- ASEAN Specialised Meteorological Centre. (2023). *Hotspot monitoring report 2020–2023*. ASEAN Secretariat.
- Aukes, E., et al. (2019). Making the case for science diplomacy [Policy brief]. *S4D4C*.
- Baldwin, D. A. (1985). *Economic statecraft*. Princeton University Press.
- Balsiger, J., & VanDeveer, S. D. (2012). Navigating regional environmental governance. *Global Environmental Politics*, 12(3), 1–17.
- Bang, Y., Ha, E., Oh, J., Hong, Y.-C., Lim, Y.-H., & Kim, H. (2026). Effectiveness of air pollution reduction policies and financial accessibility in ASEAN countries. *Environmental Research Communications*, 8, Article 015027. <https://doi.org/10.1088/2515-7620/ae322a>

- Berkman, P. (2020). Science diplomacy and its engine of informed decision-making: Operating through our global pandemic with humanity. *The Hague Journal of Diplomacy*, 15, 435–450. <https://doi.org/10.1163/1871191X-BJA10034>
- Berkman, P. (2023). Science diplomacy with diplomatic relations to facilitate common interest building. https://doi.org/10.1007/978-3-031-10971-3_33
- Berkman, P. A., & Young, O. R. (2009). Governance and environmental change in the Arctic Ocean. *Science*, 324(5925), 339–340.
- Boonprong, S., Satapanajaru, T., Khantachawana, A., Zhang, W., Varnakovida, P., & Rattana-amornpirom, O. (2026). Long-term cross-border PM2.5 transport coupling in Southeast Asia, 2003–2024. *Atmosphere*, 17(6), Article 587. <https://doi.org/10.3390/atmos17060587>
- Bose, S. K. (2026). Environmental federalism and multi-level governance coordination in Southeast Asia: A comparative empirical analysis of five ASEAN economies. *International Journal of Business and Management*, 5(1), 1170–1186. <https://doi.org/10.56879/ijbm.v5i1.61>
- Cerioni, L. (2024). Neoclassical realism, global international relations, and the unheard echoes of realist practices from the South. *The British Journal of Politics and International Relations*, 27(1), 369–386. <https://doi.org/10.1177/13691481241230858>
- Chong, A., & Schacherer, S. (2025). Extra-territorial liability and enforcement: Finding ways to tackle haze pollution in Southeast Asia. *Chinese Journal of Transnational Law*, 2(2), 198–220. <https://doi.org/10.1177/2753412X251350527>
- CIFOR-ICRAF. (2023). *Peatlands and fires in Southeast Asia: A stocktake of knowledge products*. Center for International Forestry Research and World Agroforestry. <https://www.landscapealliance.org/knowledge/publication/31222/>
- Council for Science, Technology and Innovation. (2021). *The 6th science and technology basic plan*. Government of Japan.
- Elliott, L. (2011). ASEAN and environmental governance: Rethinking networked regionalism in Southeast Asia. *Procedia – Social and Behavioral Sciences*, 14, 61–64. <https://doi.org/10.1016/j.sbspro.2011.03.023>
- European Commission. (2024). *Science diplomacy*. <https://ec.europa.eu>
- Fährnich, B. (2017). Science diplomacy: Investigating the perspective of scholars on politics–science collaboration in international affairs. *Public Understanding of Science*, 26(6), 688–703.
- Fawcett, L. (2004). Exploring regional domains: A comparative history of regionalism. *International Affairs*, 80(3), 429–446. <https://doi.org/10.1111/j.1468-2346.2004.00391.x>
- Fedoroff, N. (2009). Science diplomacy in the 21st century. *Cell*, 136(1), 9–11.
- Fikri, M. (2022). Environmental agreement under the non-interference principle: The case of ASEAN Agreement on Transboundary Haze Pollution. *International Environmental Agreements: Politics, Law and Economics*, 22(1), 139–155.
- Flink, T., & Rüffin, N. (2019). The current state of the art of science diplomacy. In D. Simon, S. Kuhlmann, W. Canzler, & J. Stamm (Eds.), *Handbook on science and public policy* (pp. 104–121). Edward Elgar Publishing.
- Flink, T., & Schreiterer, U. (2010). Science diplomacy at the intersection of S&T policies and foreign affairs. *Science and Public Policy*, 37(9), 665–676.
- Frontiers in Political Science. (2025). *Network governance in ASEAN: Fostering regional cooperation and integration*. <https://doi.org/10.3389/fpos.2025.1434595>
- Gluckman, P. D., Turekian, V., Grimes, R. W., & Kishi, T. (2017). Science diplomacy: A pragmatic perspective from the inside. *Science & Diplomacy*, 6(4).

- Government of the UK. (2021). *UK science and innovation networks*. Department for Business, Energy and Industrial Strategy.
- Haas, P. M. (1992). Introduction: Epistemic communities and international policy coordination. *International Organization*, 46(1), 1–35.
- Hall, P. A., & Taylor, R. C. R. (1996). Political science and the three new institutionalisms. *Political Studies*, 44(5), 936–957.
- Hashemi Rafsanjani, W. A., Risma Saragih, H. J., Saputro, G. E., & Simbolon, L. (2026). Crafting regional identity and peace through the ASEAN Way in diplomacy (Version 2). *F1000Research*, 15, Article 621. <https://doi.org/10.12688/f1000research.179376.2>
- Heilmann, D. (2015). After Indonesia's ratification: The ASEAN Agreement on Transboundary Haze Pollution and its effectiveness as a regional environmental governance tool. *Journal of Current Southeast Asian Affairs*, 34(3), 95–121.
- Hurley, A., & Lee, T. (2020). Delayed ratification in environmental regimes: Indonesia's ratification of the ASEAN Agreement on Transboundary Haze Pollution. *The Pacific Review*, 34(1), 1–30. <https://doi.org/10.1080/09512748.2020.1801816>
- Hurrell, A. (1995). Explaining the resurgence of regionalism in world politics. *Review of International Studies*, 21(4), 331–358.
- Jaes, L., Rahman, R., Syamsuadi, A., & Safitri, K. I. (2026). Transglobal leadership as a framework for environmental policy diplomacy in addressing transboundary forest fire impacts: Evidence from Malaysia and Indonesia. *Journal of Social Transformation and Regional Development*, 8(1), 40–61. <https://doi.org/10.30880/jstard.2026.08.01.004>
- Karim, M. (2025). Regionalism in international politics: A comparative analysis of ASEAN and the European Union. *American Journal of Political Science and Leadership Studies*, 2(3), 10–20.
- Krasnyak, O., & Ruffini, P.-B. (2020). *Science diplomacy*. Oxford Bibliographies. <https://doi.org/10.1093/obo/9780199743292-0277>
- Legrand, T., & Stone, D. (2018). Science diplomacy and transnational governance impact. *British Politics*, 13, 392–408. <https://doi.org/10.1057/s41293-018-0082-z>
- López de San Román, A., & Schunz, S. (2018). Understanding European Union science diplomacy. *Journal of Common Market Studies*, 56(2), 247–266.
- López-Aranguren, J.-L. (2023). Japan's science and technology diplomacy: Society 5.0 and its international projection. *Communication & Society*, 36(2), 225–239. <https://doi.org/10.15581/003.36.2.225-239>
- Mayusa, A., Salingkat, S. P., & Molano, U. C. (2026). Environmental policy and public health: A systematic literature review in public administration perspective. *Journal of Social Interactions and Humanities*, 5(2), 159–178. <https://doi.org/10.55927/jsih.v5i2.11>
- Meibauer, G. (2023). Neorealism, neoclassical realism and the problem(s) of history. *International Relations*, 37(2), 348–369. <https://doi.org/10.1177/00471178211033943>
- Ministry of Natural Resources and Environmental Sustainability (NRES), Malaysia. (2023). *AATHP status report*. Government of Malaysia.
- Narine, S. (2002). *Explaining ASEAN: Regionalism in Southeast Asia*. Lynne Rienner.
- Naz, U., & Irfan, M. (2025). Smog diplomacy: Strengthening Pakistan-India cooperation for transboundary air pollution. *Journal of Climate and Community Development*, 4(1), 55–65.
- Nazeer, N., & Furuoka, F. (2017). Overview of ASEAN environment, transboundary haze pollution agreement and public health. *International Journal of Asia-Pacific Studies*, 13(1), 73–94.

- Ng, B. K., & Mohd Zabidi, M. Z. (2023). Science diplomacy in Malaysia. *Asian Research Policy*, 14(1), 77–84.
- Nguitragool, P. (2011). *Environmental cooperation in Southeast Asia: ASEAN's regime for transboundary haze pollution*. Routledge.
- O'Neill, K. (2017). *The environment and international relations*. Cambridge University Press.
- Periani, A., & Iskatinah. (2025). Asap lintas batas dan kebakaran hutan: Pertanggungjawaban negara di hadapan ASEAN Agreement on Transboundary Haze Pollution [Transboundary haze and forest fires: State accountability under the ASEAN Agreement on Transboundary Haze Pollution]. *Cakrawala Hukum*, 27(1), 48–53.
- Peteru, S., Dermawan, A., Silviana, S. H., & Brady, M. A. (2025). Revisiting the ASEAN response strategy to fire, smoke and haze (Infobrief No. 419). *CIFOR-ICRAF*. <https://doi.org/10.17528/cifor-icraf/009359>
- Putra, B. A. (2025). The politics of environmental policy: Haze pollution, ASEAN, and the way forward. *Frontiers in Sustainable Cities*, 6, Article 1417746. <https://doi.org/10.3389/frsc.2024.1417746>
- Rüffin, N. (2020). EU science diplomacy in a contested space of multi-level governance: Ambitions, constraints and options for action. *Research Policy*, 49(1), Article 103903.
- Ruffini, P.-B. (2017). *Science and diplomacy: A new dimension of international relations*. Springer International Publishing.
- Rüland, A.-L., Rüffin, N., Cramer, K., Ngabonziza, P., Saxena, M., & Skupien, S. (2023). Science diplomacy from the Global South: The case of intergovernmental science organizations. *Science and Public Policy*, 1–12. <https://doi.org/10.1093/scipol/scad024>
- Salazar, V. (2023). From practices to praxis: ASEAN's transnational climate governance networks as communities of practice. *Journal of Current Southeast Asian Affairs*, 42(2), 190–215. <https://doi.org/10.1177/18681034231167443>
- Setianingrum, E., & Muamanah. (2026). Efektivitas ASEAN Agreement on Transboundary Haze Pollution (AATHP) dalam penyelesaian sengketa kabut asap antara Indonesia, Malaysia dan Singapura tahun 2025 [The effectiveness of the ASEAN Agreement on Transboundary Haze Pollution (AATHP) as a dispute settlement mechanism in the 2025 transboundary haze case between Indonesia, Malaysia and Singapore]. *Rewang Rencang: Jurnal Hukum Lex Generalis*, 7(1), 1–17.
- Sunchindah, A. (2015). *Transboundary haze pollution problem in Southeast Asia: Reframing ASEAN's response* (ERIA Discussion Paper No. DP-2015-82). Economic Research Institute for ASEAN and East Asia.
- Syahrullah Barca, M. R. (2024). ASEAN Agreement on Transboundary Haze Pollution (AATHP) sebagai upaya pengentasan kabut asap di Asia Tenggara: A literature review. *World Journal of Advanced Research and Reviews*, 21(3), 1910–1913.
- Syed Azhar, S. N. F., Abdul Razak, I. A., & Ng, T. F. (2026). At the nexus of climate change and sustainable development: A review of high particulate events in Southeast Asia's agrarian heartland. *Sustainability and Climate Change*, 19(2), 92–98. <https://doi.org/10.1177/26922932261439215>
- Turekian, V. C., et al. (2015). Evolving institutions for twenty-first century (science) diplomacy. *Science & Diplomacy*, 4(2).
- Umar, A. R. M. (2023). Beyond regionalism: The politics of the transboundary haze pollution in Southeast Asia. *Global South Review*, 3(1), 7–20. <https://doi.org/10.22146/globalsouth.67324>
- US Department of State. (2023). *Science diplomacy*. <https://www.state.gov>

- Varkkey, H. (2011). ASEAN states as a thin community. *Contemporary Southeast Asia*, 33(2), 209–233.
- Varkkey, H. (2012). Patronage politics, plantation fires and transboundary haze. *Environmental Hazards*, 11(3), 200–217.
- Varkkey, H. (2021). New forms of scientific data sharing and border-spanning hazards. *Political Geography*, 84, Article 102284.
- Waltz, K. N. (1979). *Theory of international politics*. Addison-Wesley.
- Watson, I., & Pandey, C. (2015). *Environmental security in the Asia-Pacific*. Palgrave Macmillan.
<https://doi.org/10.1057/9781137494122>
- Zou, X. (2026). *Thirty years of global climate governance: From Rio to Glasgow*. Springer.
<https://doi.org/10.1007/978-981-95-8457-4>