

Perspective

Regime Type and Environmental Adaptation: A Theoretical Examination of Political Constraints on Ecological Governance

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2026, volume 7, issue 2

doi:10.21926/aeer.2602014

Received: February 28, 2026**Accepted:** June 11, 2026**Published:** June 22, 2026

Abstract

This Perspective revises the Regime-Constraint-Adaptation (RCA) framework to clarify that environmental adaptation is not explained by regime labels alone, nor by a normative comparison between democracy and autocracy. Governance is treated more narrowly as the selection, calibration, implementation, and correction of policy instruments in relation to legally defined ecological objectives and observed ecological outcomes. The revised argument integrates RCA with the Technology-Organization-Environment (TOE) framework: monitoring and disclosure technologies shape signal quality; organizational capacity and stakeholder structures shape implementation; and the wider institutional environment, including regime constraints, policy mandates, and social-cultural motives, shapes whether instruments become ecologically effective. The article also introduces configurational reasoning inspired by fuzzy-set qualitative comparative analysis (fsQCA), because high adaptation may arise through different combinations of transparency, decision centralization, technology, capacity, legal accountability, and behavioral alignment. The contribution is therefore conceptual and diagnostic. It does not claim to present empirical testing. Still, it refines testable propositions, operational indicators, boundary conditions, and short illustrative cases from China, Europe, and Southeast Asia to show how the framework can guide future comparative research.



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Keywords

Environmental adaptation; regime constraints; RCA-TOE framework; policy instruments; fsQCA; adaptive governance; behavioral motives; non-Western environmental governance; climate governance; ecological effectiveness

1. Introduction

In this text, “regime type” is treated as an institutional package comprising components such as the degree of institutionalization of political competition, horizontal and vertical constraints on the executive, protection of freedom of expression and association, and transparency of public information flow, beyond the labels of democracy or autocracy [1]. The package approach shifts the regime debate from a question of character to one of process: which mechanism detects the signal of environmental risk earlier, which drowns this signal in noise, and which can turn the error into an institutional correction?

A clarification is necessary at the outset. This article now uses governance primarily in an instrumental policy sense: governance concerns how public authority, administrative capacity, legal mandates, and implementation systems select and operate policy instruments, and how their ecological effectiveness is assessed against binding environmental objectives. For biodiversity governance, Article 1 of the Convention on Biological Diversity provides a useful example of such an objective by linking conservation, sustainable use, and fair and equitable benefit sharing [2]. The RCA framework does not replace the policy-instrument debate; it asks which political and institutional conditions make policy instruments visible, enforceable, adjustable, and ecologically consequential [3].

This question becomes even more pressing in an era in which climate and biodiversity crises are no longer “exceptions” but governance conditions. Growing scientific synthesis on climate risks, impact chains, and adaptation capacity reveals that adaptation is not merely a technical adjustment but a matter of institutions learning under uncertainty [4]. Similarly, global assessments of biodiversity loss show that the links between ecosystem services and social welfare are shaped by political decisions and that the costs of delay accumulate [5].

International regimes also codify this transformation: while the UNFCCC establishes climate change as a governance area within a framework of common but differentiated responsibilities [6], the Paris Agreement elevates adaptation from a mere side theme to a core element of its decision-making architecture [7]. The Kunming-Montreal Global Biodiversity Framework effectively acknowledges that implementation will remain at the “target” level without transparency, monitoring, and accountability [8]. The Sendai Framework for Disaster Risk Reduction also builds an institutional bridge between climate adaptation and risk governance, making early warning and resilience part of the public policy discipline [9].

In this broad governance area, procedural regimes such as public access, participation, and access to justice raise the bar for the “how” of environmental policy. While the Aarhus Convention defines access to environmental information and participation in decision-making processes as rights [10], the Escazú Agreement provides a regional framework for institutionalizing these rights in Latin America and the Caribbean [11].

Climate politics is also becoming increasingly judicialized: the ruling in *Verein KlimaSeniorinnen v. Switzerland* is seen as a threshold that strengthens the debate on climate inaction in the human rights sphere [12]. The public and political resonance of this ruling shows that the legitimacy crisis is being produced not only in the streets but also in courtrooms [13].

This backdrop reopens the classic question in environmental policy literature: does democracy protect the environment better? While some studies argue that democratic institutions are negatively correlated with environmental degradation or can produce better outcomes for certain types of pollution [14, 15], other findings show that this relationship varies by issue, measurement, and historical institutional legacy [16]. Approaches that break down the regime into its components make the debate more nuanced by emphasizing that elements such as elections and civil liberties operate through different channels on environmental policy [17, 18]. Findings on the heterogeneity of the authoritarian field show that the label “autocracy” does not imply uniform performance, but rather that subtypes diverge [19]. Meanwhile, the “authoritarian environmentalism” debate reminds us that some regimes can be quick to produce policy outputs, but that the disconnect between output and outcome can simultaneously grow [20].

The revised framing also narrows the role of the democracy-autocracy debate. Democracy and autocracy are not treated here as moral categories to be ranked. They are used only as coarse labels for institutional configurations that may differ in openness of information, veto structure, legal accountability, administrative command, and social feedback. The article therefore moves away from a normative regime debate and toward the practical question of instrument effectiveness under different institutional constraints.

The theoretical key to this debate lies in moving beyond explanations that reduce environmental governance failures solely to capacity deficits or weak social awareness. Institutionalist approaches show that institutions are not merely sets of rules but transform into structures that narrow actors’ horizons and redistribute costs, thereby locking policy change into a temporal logic [21-26].

The very nature of environmental adaptation necessitates this theoretical reading: stability in socio-ecological systems is often a dynamic tension, and “resilience” is not a fixed equilibrium but a capacity reproduced through feedback loops [27, 28]. Discussions of common-pool resources and sustainability show that the multi-actor and multi-scale nature of governance sharpens the institutional design problem [29, 30]. The adaptive capacity and learning literature emphasizes that adaptation can easily be delayed or misdirected when not considered alongside knowledge production and institutional learning processes [31-34].

The aim of this Perspective is not to place the regime type within a normative hierarchy; rather, it is to make visible, at the level of mechanisms, how the regime package produces friction in adaptive governance cycles. As discussions focused on evaluation published in *AEER* also indicate, sustainable transitions and environmental policy design depend not only on setting targets but also on activating feedback and evaluation mechanisms [35].

This clarification changes the explanatory target. The question is not whether democratic or autocratic systems are normatively preferable, but whether a given configuration can hear ecological risk signals, select suitable policy instruments, motivate real behavioral change, implement decisions across administrative levels, and correct errors before maladaptation becomes locked in.

2. Materials and Methods

2.1 Study Design: Critical-Conceptual Synthesis

This Perspective derives “data” not from the field but from texts and concepts; the method is therefore less a measurement protocol and more a discipline of delineating concepts and establishing mechanisms. The approach to conceptual framework construction explicitly follows the steps of definition, dimensioning, establishing relationships, and specifying boundary conditions [36]. By making the minimum conditions for theoretical contribution (what is being explained, how it is being explained, under what conditions) visible, the text aims to make the “open to interpretation” “diagnosable” [37].

This design is not a systematic review; the aim is not to extract the average of the literature, but to reestablish the regime-adaptation link left ambiguous in the literature. It is positioned within the interpretive/critical line of review typologies [38] and embraces the logic of the critical interpretive synthesis tradition, which combines concepts from different disciplines through productive tensions [39].

2.2 Analytical Architecture: Typology and Mechanism Logic

The backbone of the framework is mechanism logic, not correlation. Typologies are not mere embellishments in such conceptual work, but rather a discipline of measurement and conceptualization: when properly established, they regulate both boundary conditions and possible failure modes [40]. The mechanism approach, in turn, allows us to describe how the processes in between work, rather than offering short-circuit explanations such as “regime → outcome” [41].

The analysis of texts is based on the document analysis approach recommended in qualitative policy research: the authenticity, context, production purpose, and target audience of the text are taken into account; a comparative reading is conducted using conceptual categories [42, 43]. Content analysis is conducted in line with the basic principles of the content analysis tradition to capture the consistency of concepts and the visible/hidden assumptions in the texts [44].

In response to the need for greater multi-dimensional integration, the analytical architecture is extended through the Technology-Organization-Environment (TOE) framework [45]. In this article, the technology dimension refers to environmental monitoring, climate-adaptation technologies, digital disclosure platforms, and data verification tools. The organization dimension refers to implementation structures, administrative capacity, inter-agency coordination, and multi-stakeholder organization. The environment dimension refers to regime institutions, policy-instrument constraints, legal objectives, and social-cultural conditions. RCA remains the mechanism logic, while TOE provides the dimensional map within which those mechanisms operate.

The framework is also revised to accommodate configurational reasoning rather than a strictly linear causal model. Fuzzy-set qualitative comparative analysis (fsQCA) treats outcomes as potentially produced by different combinations of conditions, allows for equifinality, and distinguishes between necessary and sufficient configurations [46, 47]. The present article does not conduct fsQCA, but it reformulates the propositions so that future studies can test whether high environmental adaptation follows, for example, from open-information/high-capacity configurations, centralized/high-technology/high-verification configurations, or rights-based accountability configurations. This extension follows the logic of recent TOE-fsQCA work on carbon-

reduction pathways in China's rural production and household sectors, which shows that carbon outcomes can be shaped by multiple interacting technological, organizational, and environmental conditions rather than by a single institutional variable [48].

2.3 RCA Logic and Maladaptation Brake

The RCA framework defines adaptation as a feedback-driven process: signal detection, interpretation, decision-making, implementation, and learning. This definition incorporates the warning that adaptation can turn into maladaptation even with good intentions as a methodological brake [49]. Thus, the disconnect between "quick output" and "lasting results" is made conceptually visible.

The temporal dimension of the regime package is incorporated into the framework through discussions of historical institutionalism's critical junctures and path dependency: institutions can harden or change direction at certain moments, which explains why adaptation sometimes stalls [50, 51]. The politics of time allows institutional change to be read not only as a choice but also as the product of accumulated costs and increasing returns [52].

2.4 Boundary Conditions: Capacity, Problem Structure, and Scale

This Perspective does not present regime type as the sole determining factor. Policy capacity is the ability to coordinate and sustain implementation beyond mere analysis; the same regime package can produce different outcomes at different capacity levels [53].

The boundary conditions are therefore specified more explicitly. RCA-TOE is most applicable to ecological problems where feedback cycles, implementation chains, and behavioral responses matter: climate adaptation, pollution control, biodiversity protection, disaster risk reduction, and carbon emissions reduction. It is less suitable for explaining one-off emergency decisions without monitoring or learning cycles. Development level, policy capacity, technological infrastructure, fiscal resources, and the maturity of civil society or stakeholder organization moderate the framework. In lower-capacity contexts, technology transfer and stakeholder organization may partly substitute for weak state capacity; in higher-capacity contexts, veto structures and indicator gaming may become the more salient constraints.

The link between capacity and action in climate adaptation is not always straightforward; it is shaped by perceptions, institutional priorities, and political costs, as a well-established warning in the adaptation literature [54]. Furthermore, scale and polycentricity can create opportunities for experimentation and learning, but they can also generate fragmentation costs; therefore, polycentric governance is considered both an opportunity and a risk in the framework [55].

2.5 Literature Support: Adaptive Governance and Environmental Governance

The adaptive governance literature emphasizes learning, multi-scale coordination, and institutional flexibility in socio-ecological systems [56]. Studies in the field of water governance show that adaptive (co-management) prescriptions need to be tested from a governance perspective and that the research agenda opens up here [57]. Discussions on the transformation of water governance also reinforce that institutional change is not only a technical but also a political process [58].

The environmental governance literature theoretically frames how relationships between actors, institutions, and scales shape environmental outcomes [59]. The resilience approach positions adaptation as a capacity that addresses social and ecological dynamics together [60].

3. Results

3.1 RCA Framework: From Regime Type to Institutional Friction

The “result” of this section is an explanatory architecture linking regime type to the functioning of environmental adaptation: the Regime-Constraint-Adaptation (RCA) framework. The starting point of RCA is this: Regime type, rather than being a direct performance seal on environmental governance, accelerates, slows down, disrupts, or makes feedback channels enabling adaptation work in one direction.

RCA operationalizes the regime package through three theoretical keys. The first is the veto architecture: how many gates the decision passes through, which actors have the power to apply the brakes, and when this brake produces stability or gridlock [61]. The second is the logic of power survival: who the leader must rely on and how they weigh public goods against selective benefits [62]. The third is informational governance: some regimes survive by managing the circulation of information and selecting what is visible rather than through crude coercion [63].

The revised model therefore treats regime type as one part of a broader RCA-TOE configuration. Political institutions shape feedback, but they do not act alone. Technologies determine how ecological risk is monitored and disclosed; organizational structures determine whether policy outputs become field-level implementation; and environmental conditions, including law, culture, economic development, and behavioral motives, determine whether instruments can change real ecological outcomes. Figure 1 summarizes this integrated logic.

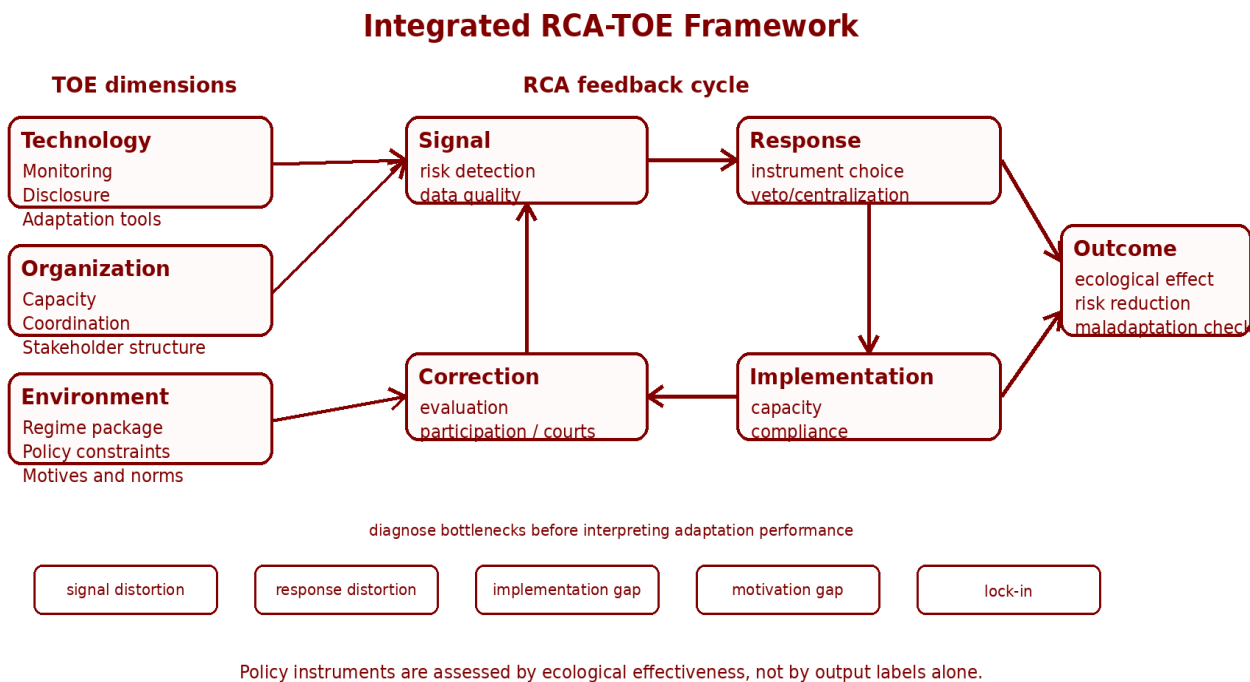


Figure 1 Integrated RCA-TOE framework for diagnosing environmental adaptation.

3.2 Taxonomy of Political Constraints: Bottlenecks that Drive Adaptation

RCA now treats the regime package as affecting adaptation through several interacting bottlenecks. These bottlenecks are not mutually exclusive; the same regime package can produce both advantages and vulnerabilities simultaneously, and the revised framework adds policy-instrument effectiveness and motivation-behavior alignment to the original institutional friction logic.

A sixth, cross-cutting bottleneck is added to address the policy-instrument debate more directly: the instrument-effectiveness bottleneck. Environmental governance is not exhausted by whether a policy exists; it depends on whether the selected instrument can plausibly affect the targeted ecological process. Command-and-control regulation, disclosure instruments, subsidies, taxes, planning obligations, and participatory procedures differ in informational demands, enforcement costs, distributional burdens, and vulnerability to gaming. RCA-TOE therefore asks not only whether a regime can act quickly, but whether it can select instruments suited to the ecological problem, monitor their effects, and adjust them when measured outputs diverge from ecological outcomes [3].

The epistemic bottleneck relates to risk visibility, the first condition for adaptation. Findings pointing to the link between democracy and transparency reveal the relationship between information disclosure and institutional design [64]. In authoritarian contexts, strategic censorship selectively cuts the signal; early warnings are often shifted to “safe” areas [65].

At this point, measurement itself becomes a political tool. Practices of governing by numbers do not merely measure performance; they shape performance and sometimes narrow reality [66]. Control rituals and verification mechanisms can accelerate learning as much as they can encourage report production [67]. Transparency itself is not innocent; visibility can serve the production of a “manageable image” as much as accountability [68].

Indicators can function as channels of social pressure and reputation at the international and national levels; however, they can simultaneously produce false compliance by locking behavior into the logic of the indicator [69]. The global circulation of human rights and governance indicators strengthens the power of measurement regimes; numbers can capture reality as much as they can replace it [70].

Information disclosure mechanisms can be effective regulatory tools: the community right-to-know approach has been shown to deter pollution [71]. However, if disclosure is poorly designed, contextualized, or controlled, transparency policy can become selective disclosure (see also [72]).

The commitment-veto bottleneck is the tension between speed and stability. The veto players approach explains that institutional brakes make policy change difficult but can also create commitment credibility by limiting sudden swings [61].

The coalition-incentive bottleneck highlights the relationship between the broad-public-good-production nature of environmental adaptation and the distributional conflict over costs. Selectorate logic shows why selective benefit distribution becomes dominant in narrow coalition structures and why this can increase the output-outcome disconnect in the environmental sphere [62]. This incentive structure is linked to a deeper institutional order, as well as to the form of regulation of violence and coercion [73].

A motivation-behavior bottleneck is also added. The ecological effectiveness of policy instruments depends on the real motives behind human behavior, not on the assumption that legal

rules automatically produce compliance. Environmental behavior may be shaped by material incentives, habit, perceived behavioral control, trust in authorities, social norms, identity, fear of loss, moral commitment, and skepticism toward expert knowledge [3, 74-77]. This matters for regime analysis because closed systems may secure visible compliance without revealing whether motives have changed. In contrast, open systems may generate contestation that is politically noisy but behaviorally informative. Instruments therefore need to be evaluated by whether they alter opportunity structures and motives, not merely by whether they announce a target.

The capacity-implementation gap is the distance between policy and practice. State capacity emphasizes institutional construction in property rights, taxation, and public goods production; if capacity is weak, environmental policy discourse increases, but field impact remains limited [78]. The classic warning of implementation literature shows how high expectations are dampened in the field [79]. It is precisely at this point that policy learning approaches explain why feedback and evaluation mechanisms are critical for “change” [80-82].

Centralization seeks to make the world readable to manage the environment; however, readability often simplifies the world and dismisses local knowledge as noise [83]. Therefore, while centralization produces coordination advantages, it also carries epistemic risks. The “environmental authoritarianism” debate reminds us that speed and coordination come with legitimacy and learning costs [84].

The rights-judicialization bottleneck concerns the institutional form of channels for objection. Analyses of the wave of climate lawsuits show that the judiciary sometimes opens regulatory space and sometimes exposes the executive’s inaction [85, 86]. The recognition of the right to a clean, healthy, and sustainable environment at the UN level normatively strengthens this channel [87, 88].

Finally, the lock-in bottleneck refers to the narrowing of the set of options for carbon-intensive investments and infrastructure choices over time. Carbon lock-in becomes more persistent if feedback channels are weak; adaptation often serves as a belated corrective measure [89].

Recent adaptation research reinforces this configurational view. Institutional contexts can create delayed, abrupt, and unjust adaptation limits even where plausible adaptation pathways exist [90]. Local government studies from Mexico City show that horizontal and vertical collaboration can mobilize capacity amid urgency and scarcity [91]. At the same time, recent work on Ethiopian urban climate governance identifies human resources, policy enforcement, political commitment, finance, coordination, and data management as distinct but interacting institutional constraints [92]. These studies support the revised claim that regime constraints must be examined together with technology, organization, and social context.

3.3 Typology: Information Openness and Decision Centralization

The practical purpose of RCA is to discuss regimes not as “labels” but as constraint profiles. Two axes are sufficient to make this visible: information transparency (monitoring, scientific autonomy, and media and civil society’s capacity to convey information) and decision centralization (coordination concentrated in a single center or distributed in a multi-centered manner). These two axes produce four ideal types; each type has a promise and a cost for adaptation.

In an open and multi-centered system, signal diversity is high; experimentation and public dissent at different scales fuel adaptation. However, coordination costs increase, and decision-making often slows. In an open and centralized system, the center can provide rapid coordination to the extent

that data and criticism channels function; but the risk of local information loss and single-point failure may increase. In a closed and centralized system, short-term output may appear impressive; but if the epistemic bottleneck is severe, the system cannot hear its own mistakes. In a closed and multi-centered system, both signal channels are weak, and coordination is fragmented; adaptation itself may become trapped in local patronage mechanisms.

3.4 Operational Propositions and Configurational Testability

The revised propositions are formulated as measurable claims rather than abstract statements. They are intended to be falsifiable in future large-N, comparative-case, or fsQCA designs. Table 1 identifies the mechanism, possible operational indicators, data sources, and the condition under which each proposition would be weakened or rejected.

Table 1 Revised operational propositions for future empirical testing.

Proposition	Mechanism	Indicative measures	Possible data sources	Falsification logic
P1	Higher information transparency and independent monitoring reduce signal distortion.	Environmental data openness; media/civil-society freedom; scientific autonomy; disclosure frequency	V-Dem indicators; Environmental Democracy Index; official monitoring portals; satellite or third-party datasets	High transparency is not associated with lower data discrepancy or earlier risk detection.
P2	Strategic censorship and indicator control increase maladaptation risk.	Censorship events; restrictions on environmental NGOs; mismatch between reported output and ecological outcome	V-Dem; Freedom House; pollution/biodiversity outcome data; media-event datasets	Closed information systems still show timely correction and low outcome discrepancy.
P3	Centralization improves rapid coordination only when monitoring technology and verification are strong.	Decision centralization; environmental monitoring coverage; verification independence; implementation speed	National adaptation plans; audit reports; remote sensing; administrative datasets	Centralization alone predicts high adaptation without technology or verification.
P4	Veto structures slow short-term change but may improve commitment reliability when legal accountability is high.	Number of veto actors; judicial independence; policy continuity; reversals in climate/adaptation plans	Constitutional datasets; climate litigation databases; policy-tracking datasets	Veto-rich systems produce neither continuity nor accountability gains.
P5	Implementation capacity and stakeholder organization reduce the policy-implementation gap.	Budget execution; staffing; inter-agency coordination; stakeholder platforms; local implementation records	Government budgets; OECD/World Bank capacity indicators; project evaluations; interviews	Formal capacity does not reduce output-outcome discrepancy.
P6	Policy instruments are more ecologically effective when they align incentives, social	Compliance behavior; trust; perceived fairness; behavioral intention; observed environmental practice	Surveys; experiments; enforcement records; household or firm behavior datasets	Information-only or coercive instruments outperform behaviorally aligned

	norms, trust, and perceived control.			instruments under similar conditions.
P7	Rights-based participation and judicial review operate as error-correction channels when information and capacity are sufficient.	Access to justice; participation rights; litigation outcomes; implementation after judgments	Aarhus/Escazu reports; legal databases; policy implementation records	Legal channels exist but never alter implementation or correction.
P8	High adaptation is configurational: different RCA-TOE condition sets can produce similar outcomes.	Set membership in transparency, centralization, technology, capacity, legal accountability, and behavioral alignment	fsQCA calibration using mixed administrative, legal, and outcome indicators	Only a single condition explains adaptation across cases.

3.5 Configurational RCA-TOE Pathways and Short Illustrative Cases

The configurational implication is that high adaptation can emerge through multiple pathways. An open-capacity pathway may combine high information transparency, strong local organization, independent monitoring, and moderate veto constraints. A centralized-technological pathway may combine high decision centralization, robust monitoring technology, executive capacity, and external verification, but it becomes fragile when information is politically filtered. A rights-accountability pathway may combine legal objectives, public participation, judicial review, and sufficient administrative capacity. A developmental-substitution pathway may combine technology transfer, donor or multilevel finance, local stakeholder organization, and targeted capacity building where state capacity is weaker. These are not empirical findings; they are proposed configurations for future fsQCA or comparative case testing.

Illustrative cases help clarify the scope. China is relevant not because it represents all autocracies, but because its carbon-reduction and environmental-governance experience shows how technological monitoring, administrative command, and organizational capacity can produce rapid outputs while also raising questions about information filtering, local incentives, and outcome verification; recent TOE-fsQCA research on China's rural production and household sectors is directly useful for specifying such configurations [48]. European countries illustrate a different configuration: relatively open information channels, legal participation rights, and climate litigation can strengthen error correction, but multi-level vetoes and implementation gaps may slow adaptation. Southeast Asian urban adaptation, including flood-risk work in Ho Chi Minh City, shows that local adaptation technologies and spatial risk assessment are meaningful only when administrative coordination, financing, and stakeholder uptake are in place [93]. Mexico City and Bahir Dar further show that non-Western and developing-country cases require attention to collaboration networks, financial scarcity, data management, human resources, and policy enforcement rather than simple regime labels [91, 92].

4. Discussion

The RCA framework's proposal is not a simple claim but a discipline of reading: diagnosing the regime type through the institutional friction it produces in the adaptation cycle, without reducing it to a "good-bad" ranking. This approach aims to break two common abbreviations in environmental management and policy literature: the labeling of regime types and the loss of adaptation between output and outcome.

This revision also addresses the concern that the original manuscript seemed overly aligned with the normative democracy-autocracy debate. The framework now treats regime labels as insufficient. Its analytical object is the ecological effectiveness of policy instruments under institutional, technological, organizational, and motivational constraints. This means that a formally democratic system can fail when vetoes, short electoral time horizons, weak capacity, or indicator gaming block adaptation; and a formally authoritarian system can fail when information control, fear, local reporting incentives, or weak error-correction channels conceal maladaptation.

Discussions of transformation and governance published in AEER show that in complex environmental problems, neither the state nor networks alone is sufficient; public and network governance must be considered together [94]. This is consistent with the logic of RCA typology:

decision centralization alone is not the solution; while the center produces coordination advantages, it can also stifle learning channels.

The transparency architecture of the Paris regime aims to add external pressure to feedback channels that are blocked in domestic politics. The transparency framework, concretized in the Katowice package, aims to require parties to report their actions and supporting information in specific formats and open them to technical scrutiny [95]. However, the impact of this external feedback is limited by the information and control architecture within the regime package: reporting can encourage learning, but it can also shift toward performance production.

The political body of feedback is not established solely through reporting; channels of dissent and representation are part of institutions' capacity for error correction. Hirschman's exit-voice-loyalty framework remains useful for conceptualizing feedback channels for organizations and states: if voice is silenced, exit increases; loyalty often becomes the name for silence [96]. Environmental adaptation is particularly sensitive to the closure of these channels, as risk signals are often "disturbing".

Measurement and target regimes create a critical dilemma at this point. Targets and performance indicators can foster accountability; however, "managing the measured" can become a game in which what should be managed cannot be measured [97]. Therefore, output measurement approaches developed to monitor and compare adaptation represent methodological progress but also risk reproducing the output-outcome disconnect [98].

Studies on intergovernmental adaptation tracking identify the gap between monitoring progress and achieving progress as the fundamental problem; the Paris Agreement's adaptation agenda still requires criteria to bridge this gap [99]. A systematic review of large-n comparative adaptation studies also shows that data and conceptual issues produce a structural limit in this field [100]. RCA does not deny this limit; rather, it seeks to diagnose under which constraint profiles measurement regimes are more likely to turn into performance theater.

This diagnosis also reframes the legitimacy debate. Scharpf's distinction between input and output legitimacy reveals the tension between speed and participation in environmental adaptation [101]. Schmidt's emphasis on throughput legitimacy, meanwhile, reminds us that processes (transparency, accountability, inclusiveness) indirectly but powerfully determine the outcomes of environmental policy [102]. RCA's claim here is sharp: the political success of adaptation lies not only in the content of the decision, but in the existence of processes that can hear the error.

At the design level, this means that environmental adaptation must be integrated with network and public governance. Network governance literature shows that different forms of network governance (shared governance, leader organization, network administrative organization) yield varying levels of effectiveness depending on the conditions [103]. The regime package also carries constraints that determine which network form will be sustainable; therefore, lists of "best practices" easily fall flat without regime sensitivity.

The TOE extension sharpens this design implication. Technological monitoring without organizational implementation capacity can produce data without correction. Organizational capacity without open information can produce administrative output without ecological learning. A strong legal objective without behavioral alignment can produce formal compliance but weak field-level change. Future empirical work should therefore test configurations rather than isolated variables, using fsQCA, comparative process tracing, or mixed-method designs calibrated around both policy outputs and ecological outcomes.

Finally, the adaptation cycle cannot be closed without institutionalizing the interface between science and politics. In Lee's words, the compass (science) can point the way; but the gyroscope of governance (politics) constantly spins under other forces. This tension can be made productive through design; left undesigned, either technocracy or rhetoric wins [104].

5. Conclusions

The main move proposed by this revised Perspective is to remove regime type from the role of a normative label and to treat it as one element within an RCA-TOE configuration of policy instruments, monitoring technologies, implementation structures, legal mandates, and behavioral motives. The central question is therefore not which regime type is morally superior, but which configuration can detect ecological risk, select effective instruments, motivate compliance and behavioral change, implement across administrative levels, and correct errors before maladaptation becomes durable.

The RCA framework keeps the power of measurement and targets as a warning: poorly designed targets can mask progress rather than represent it [97]. When informational management logic dominates, speed and coordination advantages can come with signal distortion and error concealment [63]. Carbon lock-ins, meanwhile, narrow the set of options, turning adaptation into delayed correction [89].

This text still does not claim empirical testing. Its revised contribution is to make future testing more feasible: it identifies boundary conditions, specifies indicators, proposes falsifiable propositions, and clarifies how fsQCA or comparative case designs could evaluate alternative RCA-TOE configurations. The framework is most useful where ecological objectives are legally or politically defined, where policy instruments have observable outputs and outcomes, and where adaptation depends on feedback between technology, organization, institutions, and human behavior.

Author Contributions

Mehmet Recai Uygur was responsible for conceptualization, theoretical framework development, writing - original draft, and final manuscript preparation. Fatma Sever contributed to literature review, critical revision, reference checking, and editing. Both authors reviewed and approved the final manuscript.

Competing Interests

The authors have declared that no competing interests exist.

AI-Assisted Technologies Statement

AI-assisted tools were used only for language polishing, grammar correction, formatting support, and checking the internal consistency of terminology and references. They were not used to generate research data, conduct analysis, create or alter images, or make substantive scientific decisions. The authors reviewed and edited all AI-assisted outputs for accuracy and integrity and accept full responsibility for the content of the manuscript.

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