



## The GREEN-GRID Governance: A Holistic and Adaptive Environmental Policy Framework

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### Abstract

Climate change, biodiversity loss, and developmental pressures demand environmental policies capable of responding to socio-ecological complexity and regulatory fluctuations. This article introduces GREEN-GRID Governance, a holistic model for environmental management and protection that integrates political ecology, multi-level governance, ecological economics, responsive law, risk society theory, and common-pool resource (CPR) management. The model is structured around four operational pillars (ecological, socio-participatory, economic-incentive, and regulatory-institutional) centred within the framework of Adaptive Environmental Governance. A qualitative-descriptive analysis, employing case studies of environmental policy in Indonesia, demonstrates that the model enhances adaptive policy capacity, strengthens participatory legitimacy, and improves feedback mechanisms between scientific evidence and policymaking. Recommendations emphasise harmonisation of policies across levels of government, development of integrated ecological–social–economic performance indicators, and targeted green financing. This study offers practical contributions for policymakers and sets a research agenda to examine the operationalisation of the model in developing country contexts.

**Keywords: GREEN-GRID Governance; Holistic Approach; Adaptive Governance; Multi-level Governance**

### A. INTRODUCTION

Climate change and environmental degradation constitute one of the greatest challenges to contemporary governance. The *Intergovernmental Panel on Climate Change* (IPCC, 2023) reports an accelerated rise in global temperatures, intensification of extreme weather events, and a systematic decline in ecosystem functions. Pressures on biodiversity and hydrological cycles are compounded by the rapid extraction of resources that exceed the regenerative capacity of ecosystems (Nile et al., 2025; Nimma et al., 2025; Yang et al., 2021). The *World Wide Fund for Nature* (WWF, 2022), in its *Living Planet Report: Building a Nature-Positive Society*, documents a decline of more than 69 per cent in the average global vertebrate population since 1970. These trends underscore the urgency of policy approaches that account for the complex interplay between ecological, social, economic, and institutional factors.

Policy responses across many countries, however, remain constrained by sectoral orientations, overlapping regulations, and rigid institutional designs (Breuer et al., 2023; M. Pelengkahu & Pratama, 2024; M. R. Pelengkahu & Satria, 2023; Saguin & Howlett, 2022; Sudirman et al., 2023). Lemos and Agrawal (2006:25) emphasise that fragmented environmental governance tends to produce policies that fail to keep pace with ecological dynamics. Similar conditions are observed in comparative studies of coastal policy in Southeast Asia (Noor & Maulud, 2022), which reveal that developing countries' responses to ecological change are hindered by unstable cross-agency coordination, limited adaptive capacity, and reliance on static planning instruments. Policy challenges become even more complex when political, economic, and power relations are embedded in resource management. Robbins (2020), through the lens of political ecology, asserts that environmental management is invariably shaped by power relations and benefit distribution, with inequitable access exacerbating ecological impacts.

Global economic developments add further pressure. Development financing schemes and intensive investment expansion frequently drive high levels of resource exploitation (Berawi et al., 2021; Indrawati et al., 2023; Topaloglu et al., 2025). UNCTAD (2024) reports that although green financial instruments have grown rapidly, global financial flows remain significantly directed towards carbon-intensive sectors. This situation highlights the imbalance between sustainability rhetoric and actual economic practice (UNCTAD, 2024b). The paradox is reinforced by findings from the *Rainforest Action Network* et al, which show that fossil fuel industries continue to receive substantial funding from several major global banks (Rainforest Action Network et al., 2024). The gap between commitments and policy implementation underscores the need for integrative, evidence-based policy frameworks.

Contemporary theoretical contributions provide a strong foundation for more holistic approaches. Daly's (1996) framework of ecological economics and Elkington's (1998) concept of the triple bottom line emphasise that development must align with ecological limits and social well-being. Beck (1992), through the perspective of the risk society, highlights the rise of modern ecological risks that are no longer localised, requiring policies responsive to scientific uncertainty. Ostrom

(1990) offers robust empirical evidence that the governance of common-pool resources necessitates collective rules, community monitoring, and adaptive institutional structures. These perspectives converge on the urgency of public participation and collaborative mechanisms in policy formulation. Furthermore, the tradition of responsive law introduced by Nonet and Selznick (2017) provides critical insights into shaping legal frameworks that adapt to evolving socio-ecological systems.

Taken together, this body of literature demonstrates the necessity of environmental policy frameworks that can adapt to ecological dynamics while bridging social, economic, and political interests. The evolution of adaptive governance approaches reinforces the urgency of policy transformation that can respond to emerging scientific data, enable substantive participation, and allow institutional structures to evolve in line with field conditions (Chaffin et al., 2014). The complexity of global environmental challenges underscores that policy strengthening must rest upon cross-sectoral integration, multilevel coordination, and the utilisation of increasingly precise environmental monitoring technologies.

Against this backdrop, this article formulates and examines a holistic governance model that integrates ecological dynamics, social relations, institutional design, and economic instruments within a single adaptive framework. This model, termed GREEN-GRID Governance, is designed to address the need for environmental policy capable of responding to uncertainty, preventing ecological risks, and reinforcing public legitimacy in decision-making processes. The approach aims to provide a conceptual foundation that can be extended for policy analysis, particularly in the context of developing countries facing intense ecological and regulatory pressures

## **B. RESEARCH METHOD**

This article employs a qualitative-descriptive approach, focusing on the development of a conceptual framework and policy analysis. This method was selected because the issues under examination concern the design of environmental governance, which is inherently complex, multidimensional, and influenced by diverse social, political, and ecological factors. A qualitative approach provides scope to explore relationships among non-quantitative variables through literature synthesis, conceptual mapping, and interpretation of empirical findings across relevant contexts. The research process was conducted in three main stages. The first stage involved a

systematic literature review of key theories forming the foundation of adaptive governance frameworks, including political ecology (Robbins, 2020), *adaptive governance* (Chaffin et al., 2014; Lemos & Agrawal, 2006), *ecological economics* (Daly, 1996), *the triple bottom line* (Elkington, 1998), *common-pool resource management* (Ostrom, 1990), and *risk society theory* (Beck, 1992). Supplementary literature, such as international reports (IPCC, 2023; UNCTAD, 2024b, 2024a; WWF, 2022) was used to reinforce the ecological and economic dynamics that reflect the need for more responsive governance. The literature screening process followed the principle of substantive relevance and theoretical contribution to the construction of a holistic framework.

The second stage comprised thematic-conceptual analysis. This phase mapped core concepts in environmental governance, such as adaptiveness, multilevel governance, community participation, economic incentives, ecological boundaries, and institutional capacity. Each concept was analysed to identify causal relationships, complementary elements, and potential integration. This process followed thematic coding techniques as outlined in environmental policy studies by Lemos and Agrawal (2006). The results of the thematic analysis provided the basis for formulating the pillars of the GREEN-GRID Governance model. The third stage involved comparative-contextual policy analysis. This was conducted through critical examination of policy practices in various developing countries, including Indonesia, which face ecological pressures and regulatory uncertainty. International case studies on forest management, carbon market systems, coastal governance, and climate change policies served as references to assess the coherence and operational feasibility of the model. This combined methodology produced a holistic conceptual framework designed to bridge theory and practice. By integrating theoretical synthesis with policy analysis, the approach enables the development of a governance model that is not confined to a single discipline and is capable of accommodating the evolving socio-ecological complexities.

## C. RESULTS AND DISCUSSION

### 1. Challenges of Sectoral Approaches and Governance Gaps

The structure of environmental policy in many developing countries reveals patterns of regulatory fragmentation and weak cross-agency coordination (Biermann

et al., 2020; Skovgaard et al., 2023). found that single-sector governance designs tend to neglect ecological interactions that transcend administrative boundaries. A similar study by Noor and Maulud (2022) in Southeast Asian coastal regions demonstrated that non-integrated policies trigger adaptive vulnerabilities, particularly when environmental pressures intensify simultaneously with developmental pressures (see also, Sudirman et al., 2023). These conditions arise from several factors: overlapping mandates; policy formulation processes that prioritise administrative efficiency over ecosystem integrity; development paradigms still oriented towards extractivism; and budgetary dependence on short-term financing.

Robbins (2020) argues that hierarchical power structures reinforce policy biases towards dominant actors' interests, while local communities often remain in subordinate positions. UNCTAD (2024a:3) further notes that the growth of green financing instruments has not been accompanied by systemic alignment between financial markets and global sustainability goals. This misalignment hampers the creation of economic incentives that support cross-sectoral policies. Such imbalances justify the need for a holistic policy model that unites ecological, social, and economic dimensions within a single adaptive governance framework.

## 2. Theoretical Synthesis for Building a Holistic Model

To construct the GREEN-GRID Governance model, theoretical foundations from diverse disciplines are synthesised into a single conceptual structure. The following table presents the synthesis of theories, their conceptual functions, and contributions to the holistic model.

**Table 1. Theoretical Synthesis and Contribution to GREEN-GRID Governance Model**

Theory/Thinker	Key Idea	Contribution to the Model
Political Ecology (Robbins, 2020)	Power relations, access, and benefit distribution shape environmental degradation	Explains socio-economic and political dynamics underpinning policy; ensures distributive justice as a core element
Adaptive Governance (Chaffin et al., 2014; Lemos & Agrawal, 2006)	Policy flexibility, continuous learning, and ecological feedback mechanisms	Provides the principal framework for shaping policy cycles responsive to scientific data and environmental change
Ecological Economics (Daly, 1996)	Ecological limits, carrying capacity, and material-energy balance	Establishes environmental boundaries as policy parameters and offers sustainability evaluation criteria
Triple Bottom Line (Elkington, 1998)	Integration of social, economic, and environmental dimensions	Serves as an evaluative structure guiding simultaneous mapping of policy impacts
Risk Society (Beck, 1992)	Modern ecological risks are global and non-localised	Highlights the urgency of risk mitigation in policy design and the

CPR Governance (Ostrom, 1990)	Collective rules, community participation, and local monitoring	need for institutional vigilance Provides institutional foundations for community-based resource management and local rule adaptation
Responsive Law (Nonet & Selznick, 2017)	Law sensitive to social context and substantive goals.	Strengthens institutional and regulatory dimensions to support adaptive policy design

Sources: author analysis, 2025.

The synthesis presented in table 1 demonstrates that each theoretical approach addresses distinct gaps in environmental governance practice. Political ecology is relevant for examining how structural inequalities shape policy implementation. Ecological economics provides biophysical boundaries that must be incorporated into policy, while the triple bottom line directs evaluation across three dimensions simultaneously. Risk society theory illustrates that policies reliant on stable predictions are vulnerable to uncertainty, thereby underscoring the importance of adaptiveness within the model. Ostrom's insights on CPR governance introduce corrective mechanisms when top-down approaches fail to address local community needs. Collectively, these theories converge complementarily into the structure of GREEN-GRID Governance.

### 3. Model GREEN-GRID Governance

Following the theoretical synthesis, four pillars of the model emerge: ecological, social, economic, and institutional. This section outlines how each pillar functions and interacts:

#### a. Ecological Pillar (*Sustainability Science-Based Policy*)

The ecological pillar places scientific indicators at the core of decision-making. According to the IPCC (2023), adaptation and mitigation policies must rely on precise measurement of temperature trends, biodiversity dynamics, and ecosystem function indicators. Remote sensing systems, spatial modelling, and multisource data integration provide information that strengthens the accuracy of regulatory decisions. Within this model, ecological indicators are grouped into three categories:

- 1) Condition indicators (e.g. biodiversity indices);
- 2) Pressure indicators (e.g. land degradation, carbon emissions);
- 3) Response indicators (e.g. restoration effectiveness).

This framework ensures that decisions are driven not by short-term political agendas but by measurable biophysical realities.

**b. Social-Participative Pillar (*Community-Based and Stakeholder Engagement*)**

Ostrom (1990) demonstrates that successful resource management depends on flexible local rules, community monitoring mechanisms, and collective decision-making processes. Substantive participation enhances policy legitimacy and reduces the likelihood of conflict. The social-participative pillar in this model is built through three mechanisms:

- 1) Strengthening village- or area-based governance forums;
- 2) Recognition of customary structures as monitoring units;
- 3) Formulation of access rules through local deliberation.

This participatory approach also serves as a corrective to power asymmetries revealed by political ecology.

**c. Economics-Incentive Pillar (*Circular Economy*)**

UNCTAD (2024) reports significant growth in sustainable financing instruments, including green bonds, green sukuk, voluntary carbon markets, and results-based finance mechanisms. Nevertheless, a substantial share of global investment flows continues to target carbon-intensive industries. This necessitates the design of economic instruments that redirect investment towards environmentally friendly activities.

The economic-incentive pillar emphasises:

- 1) Environmental tax schemes oriented towards reducing ecological pressures;
- 2) Integration of green–blue economy and circular economy principles;
- 3) Development of transparent carbon markets and technological innovation;
- 4) Application of ecosystem service payments for biodiversity priority areas;
- 5) Alignment of public investment with national climate targets.

Daly's (1996) ecological economics provides biophysical boundaries as reference points, ensuring that economic instruments do not merely pursue financial efficiency.

**d. Regulation and Institutions Pillar (*Legal and Institutional Framework*)**

Nonet and Selznick (2017) argue that law must evolve from a repressive form towards a responsive one. The regulatory pillar operationalises this concept through:

- 1) Harmonisation of cross-sectoral regulations;
- 2) Evidence-based policy evaluation mechanisms;
- 3) Establishment of inter-ministerial environmental coordination councils;
- 4) Incentives for local institutional innovation.

This approach responds to Chaffin et al. (2014), who highlight that adaptive institutions are better equipped. The model does not end with the four pillars. Three operational mechanisms bind them into a single adaptive governance cycle.

#### **4. Operational Mechanisms of GREEN-GRID**

The model does not end with the four pillars. Three operational mechanisms bind them into a single adaptive governance cycle:

##### **a. Adaptive Management Mechanism**

Adaptive management emphasises learning by doing, periodic policy renewal, and strategic shifts based on the latest data. Adaptation literature shows that such cycles effectively reduce ecological losses because decisions are not final but remain open to correction (Folke et al., 2005; Puig et al., 2025; Walker et al., 2004).

##### **b. Multi-level Integration Mechanism**

Multilevel integration ensures that decision flows between national and local levels are two-way, creating dialogue among central government, regional authorities, and communities, thereby making policies more adaptive and relevant. Lemos and Agrawal (2006) underline that policies failing to facilitate vertical integration often neglect local knowledge. This mechanism enables alignment of regional development plans with national environmental targets.

##### **c. Evidence-based Policy Instruments Mechanism**

Policy instruments must be grounded in measurable indicators. The *Environmental Performance Index (EPI)* provides an evaluative framework that can be adopted. This approach strengthens transparency and accountability, particularly in green financing instruments.

#### **5. Indonesian Case Study: Lessons and Opportunities**

The GREEN-GRID Governance model demonstrates strong relevance to the Indonesian context. Two strategic sectors are selected as illustrations: palm oil landscape management and the national carbon market:

##### **a. Palm Oil Landscape Management**

Palm oil governance is often influenced by conflicts of interest among local governments, corporations, and communities (Berenschot & Dhialuq, 2023; Purwanto et al., 2020). Spatial planning inconsistencies, weak law enforcement, and the absence of in-depth ecological assessments frequently exacerbate landscape degradation (Austin et al., 2019).

The model offers solutions through:

- a. Ecological carrying capacity-based zoning;
- b. Socio-ecological contracts between villages and corporations;
- c. Ecosystem service payments to safeguard biodiversity corridors.

This approach aligns with Ostrom's principles of CPR governance.

#### **b. National Carbon Market**

Indonesia is developing a carbon market supported by the *Paris Agreement* framework (M. Pelengkahu & Pratama, 2024). Its main challenges are verification, transparency, and the risk of greenwashing (M. Pelengkahu & Pratama, 2024; PwC Indonesia, 2024; Suryani, 2025). Global trends show that certain carbon markets fail to achieve their promised ecological impacts (UNCTAD, 2024a; West et al., 2020).

The GREEN-GRID Governance model offers corrective measures through:

- a. Standardisation of emission calculation methodologies;
- b. Establishment of independent verification institutions;
- c. Prioritisation of financing for restoration and adaptation activities

## **6. Theoretical and Practical Implications**

The synthesis of the GREEN-GRID Governance model affirms that environmental governance requires an integrative framework grounded in scientific data, adaptive institutional structures, and economic incentives aligned with ecological boundaries. This section formulates key policy implications for the design of national and subnational strategies. First, governments must develop a standardised framework of environmental performance indicators as the basis for policy evaluation. The IPCC (2023) emphasises that mitigation and adaptation decisions require consistent metrics to monitor ecosystem change. Aligning national indicators with global frameworks such as the *Environmental Performance Index* fosters harmonisation of planning and facilitates interregional comparison.

Strengthening monitoring systems through spatial scanning and sensor-based technologies also enhances the accuracy of field data.

Second, a priority agenda for governments is to reinforce the design of economic incentives and green financing instruments. UNCTAD (2024a) notes the rapid growth of sustainable financial instruments, yet green transactions in many countries continue to face risks of transparency and *greenwashing*. Regulations establishing independent verification criteria and standardised environmental reporting help ensure that financial flows generate genuine ecological impacts. Integrating carbon markets with ecosystem restoration mechanisms further increases the effectiveness of financing distribution. Third, responsive legal frameworks must be strengthened through regulatory reforms that facilitate policy adaptiveness. Nonet and Selznick (2017:73-75) provide a normative foundation for shaping law capable of transforming in line with social and scientific developments. Implementation of this principle involves periodic regulatory review, elimination of overlapping regulations, and formulation of new rules based on evidence-driven evaluation.

Fourth, governments should expand spaces for public and local community participation in policy formulation and oversight. Ostrom (1990) demonstrates that community-based governance produces stronger compliance and more effective monitoring. Strengthening indigenous rights, village forums, and joint monitoring mechanisms are elements that advance policy legitimacy. Fifth, relations across levels of government must be structured through mechanisms of multi-level coordination. Lemos and Agrawal (2006) underline that successful environmental governance is determined by consistent interaction between central government, local authorities, and communities. Cross-level coordination mechanisms enrich data flows, reduce implementation gaps, and strengthen policy coherence.

Future research directions should focus on empirical testing of this model in specific policy contexts, such as sustainable agricultural landscapes, protected area management, and carbon market implementation. Further studies may assess the effectiveness of integrating ecological–social–economic indicators and explore how economic disincentives can be applied to accelerate transformation towards low-carbon development systems.

## D. CONCLUSION

This article formulates GREEN-GRID Governance as a model of environmental governance that integrates ecological, socio-participatory, economic-incentive, and regulatory-institutional pillars within a single adaptive framework. The synthesis of theory and global scientific findings demonstrates that contemporary environmental challenges cannot be addressed through sectoral policies alone. The dynamics of global ecological risks demand institutions that are open to continuous learning and consistent feedback mechanisms. The model offers a conceptual structure that unites ecological indicators, community participation, green financial instruments, and evidence-based regulatory adjustments. Its four pillars and three operational mechanisms provide a systematic foundation for designing policies that are sensitive to socio-ecological complexity. Application of the model in the Indonesian context illustrates its practical potential for strategic sectors such as palm oil management and carbon markets. The principal contribution of this article lies in its cross-disciplinary integration and the formulation of an adaptive governance framework applicable to developing countries. Further research is required to test the operational effectiveness of the model, measure its impact on local ecosystems, and assess institutional capacity in implementing sustained policy adaptation.

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