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Article

Multilevel governance for climate compatible development: A case study of mangrove governance in Indonesia

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Abstract: Climate Compatible Development (CCD), which aims to mitigate greenhouse gas emissions and promote economic growth while adjusting to the effects of climate change, necessitates integrated policy approaches across several sectors. However, little attention has been given to the types of institutional structures collaborating and competing in conceptualizing CCD and understanding its functioning. This paper develops and applies a qualitative analysis to determine the compatibility of national and local policies and multi-stakeholder roles with the aims of the three dimensions of CCD (development, climate adaptation, and climate mitigation) using the mangrove governance case. Results indicate that mangrove governance policies currently support shifts towards CCD, especially by national governments. The existence of Ministry of Development National Planning that play roles in formulating climate change policy and development planning in Indonesia proved beneficial for CCD attainment. However, several regulations showed that political intervention and sectoral interests were present in multilevel governance toward CCD. Institutional challenges in this context were described, particularly in the existence of a hierarchy of statutory powers in Indonesia.

Keywords: climate compatible development; multilevel mangrove governance

1. Introduction

The climate crisis is recognized as one of the world's most serious concerns, posing a threat to environmental, social, and economic growth (van den Bergh, 2023). The global response to climate change is changing over time, historically distinguishing between adaptation and mitigation efforts (Werners et al., 2021). Early international policy predominantly described climate change mitigation, led by initiatives under the United Nations Framework Convention on Climate Change (UNFCCC) (Sanderson and Islam, 2007). A significant turning point occurred with the UNFCCC's 2001 Marrakesh Accords and the Bonn Agreements, marking an enhanced recognition that both adaptation and mitigation are important components in addressing future climate change (IPCC, 2007).

At the same time, scientific evidence showing trade-offs between adaptation, mitigation, and development partial actions has been extensively documented (Castells-Quintana, et al, 2018; Munasinghe and Swart, 2005; Thornton and Comberti, 2017; Sharifi, 2020; van den Bergh, 2023).

These trade-offs cause significant challenges for policymakers in the aspect of climate and development governance (Ayers and Dodman, 2010; Bretschger, 2017;

Gnansounou et al., 2024; Sanderson and Islam, 2007). The growing public and political attention to climate change in recent decades has elevated its significance in development planning (Bernauer and Schaffer, 2012) and making it an important consideration (Amara and Qiao, 2023; Tan et al., 2020; Wang, 2018).

Navigating climate governance and development requires new methods that address the complex interactions between climate change actions and development goals. Climate Compatible Development (CCD) is a specific method in policy formulation for countries aiming to balance adaptation, mitigation, and development objectives (Mitchell and Maxwell, 2010). Commonly referred to as "triple wins" for achieving three benefits through one strategy, this concept serves as a compelling tool for proposing solutions to interconnected climate-development challenges. Scholars and policymakers find "triple-wins" reasoning persuasive, as it promises synergistic effects across mitigation, adaptation, and development with a single intervention (Denton et al., 2015; Thornton and Comberti, 2017; Werners et al., 2021).

Even though many studies have analyzed local-level implementations of triple-wins (Huxham et al., 2015; Næss et al., 2023; Ryan-Collins et al., 2011a; Tilahun et al., 2023; Wood et al., 2016) there is limited investigation on how institutional structures collaborate and compete in achieving triple-wins. In order to critically analyze CCD, we must not only ask what kinds of problems currently exemplify its multi-sector and multi-stakeholder elements but also whether new institutional processes are beginning to emerge that reflect the convergence of development and triple-win thinking with climate adaptation and mitigation.

This study aims to investigate the current governance structures associated with CCD and explore developing institutional mechanisms in line with the shift towards triple-wins thinking. The focus is on showing how multilevel institutional governance facilitates CCD, using the case of managing mangrove conservation and planting in Indonesia. It crucial to be aware that the selection of the mangrove case is consistent with the principles of the CCD concept.

Numerous risks to ecosystems, biodiversity, and human life are presented by climate change. One of the most important natural remedies for addressing climate change and its effects while offering socio-economic benefits is mangrove forests. Several national and municipal governments are considering mangrove rehabilitation as a natural protection against these risks due to the rising frequency of extreme weather occurrences. Knowledge about the role of mangroves for achieving triple wins have been reported by many scholars, Mangrove ecosystems play an important role in protection and conservation, offering substantial economic potential and emission reduction (Amalia, 2023; Eyzaguirre et al., 2023; Sunkur et al., 2023; Triyanti et al., 2017).

Indonesia is the world's largest mangrove cover, comprising half of Asia's mangrove area (BAPPENAS, 2022). The total mangrove area in the country spans 3.3 million hectares (Wahyudi et al., 2019). Concerns of sustainable development in mangrove regions have gained more attention since 1991. In pursuit of enhanced mangrove governance, Indonesia has implemented novel policy and initiatives, resulting in a large-scale mangrove protection and restoration program. This program aims to achieve multiple objectives, including emission reduction (Arifanti, 2020; BAPPENAS, 2022).

The contribution of this study is filling the lack of critical engagement among scales of state governance, scales of decision-making and local participation on CCD or triple wins research. This study has described the potential and the challenge of multilevel mangrove governance towards CCD.

2. Literature review

2.1. Multilevel governance

The concept of multilevel governance originated in the 1990s to explain evolving decision-making dynamics in the European Union (EU), describing distributed policy-making processes including numerous state and non-state actors across different territorial level (Hirschhorn, 2021; Sun and Baker, 2021). For example, Hooghe et al. (2019) proposed multilevel governance typology, incorporating both hierarchical (vertical) and polycentric (horizontal) methods. The hierarchical model examines the distribution of resources, tasks, and power among government levels, while the polycentric model incorporates multiple, or interconnected areas of authority. Multi-level governance is a new conceptual framework for examining the policies' creation, application, efficacy, and accountability. It rejects the notions that the national government is the primary body responsible for enacting policy and that a hierarchical structure of levels of government—international, national, regional, sub-regional, and local—is used to make policy (Marquardt, 2014; Zhang and Mora, 2023).

Literature on polycentric and multilevel governance shows the significance of inter-level relationships in managing complex socio-ecological systems (Bisaro et al., 2020; Di Gregorio et al., 2019; Gallemore et al., 2015; Kim et al., 2020; Pietrapertosa et al., 2021). Practical benefits in facing multilevel challenges arise from effective communication and information exchange among various groups participating in government projects (Liu and Lo, 2021; Westman et al., 2019).

Multi-Level Governance as an approach also has emerged to discuss the state-level mandates distribute to local in China (Zhang and Mora, 2023), to plan and to address climate change issues (Osei et al., 2024), transcend national borders and organizational silos in areas like biodiversity preservation and climate change (Sheng et al., 2023), to creates a conceptual framework for China's urban low-carbon governance and execution (Sun and Baker, 2021b), to examine the function of national assistance programs by connecting them to important elements that are necessary for the creation of successful projects (Mladenovič et al., 2022) and to analyze the stages and types of actors and processes involved reveals of the local project (Rocle et al., 2021).

Multilevel on Climate governance literature suggests a shift from the state having absolute authority to overcome the complexity of climate problems (Bulkeley and Kern, 2006; Lazaro et al., 2022). Effectiveness of Multi-Level Governance depends on maintaining the attention of national governments to local projects (Liu and Lo, 2021b; Mickwitz et al., 2009; Westman et al., 2019). This understanding directs development of multilevel governance studies, exploring authority distribution vertically and horizontally and power imbalances in multilevel governance network of climate change policymaking (Di Gregorio et al., 2019a). Furthermore, climate governance, marked by complexity and uncertainty, necessitates a consensus-building

method considering different actors and their bounded rationalities (Okereke et al., 2009; Termeer et al., 2016). Climate change governance incorporates various level of government and actors, widely considered a multi-level problem (McNaught, 2024)

2.2. Climate compatible development

Climate Compatible Development is defined as development minimizing harm from climate change impacts by maximizing low-emission and climate-resilient development (Mitchell and Maxwell, 2010). Commonly referred to as "triple wins" describes the interrelated nature of adaptation, mitigation, and development, where progress in one component has implications for and depends on progress in the other two components (Anton et al., 2014; England et al., 2018; Huxham et al., 2015). Climate compatible development (CCD) is gaining traction as a conceptual framework for mainstreaming climate change mitigation and adaptation within development efforts. The success of triple-wins heavily relies on planning policy and the roles played by the concerned institutions (Dyer et al., 2013; England et al., 2018; Nunan, 2017). The concept of triple wins has inspired debates due to perceived institutional challenges and political interventions (Ficklin et al., 2017; Rodríguez and Carril, 2024).

Achieving CCD or triple-wins necessitates cross-sector and cross-level coordination, collaboration (Wood, et al., 2018), and a consideration of social complexity (Ellis and Tschakert, 2019).

As in **Figure 1**, the Mitchel and Maxwel (2010) diagram shows the difference between the CCD concept and the concepts of Low Carbon Development, Climate Resilient Development and Co-benefit.

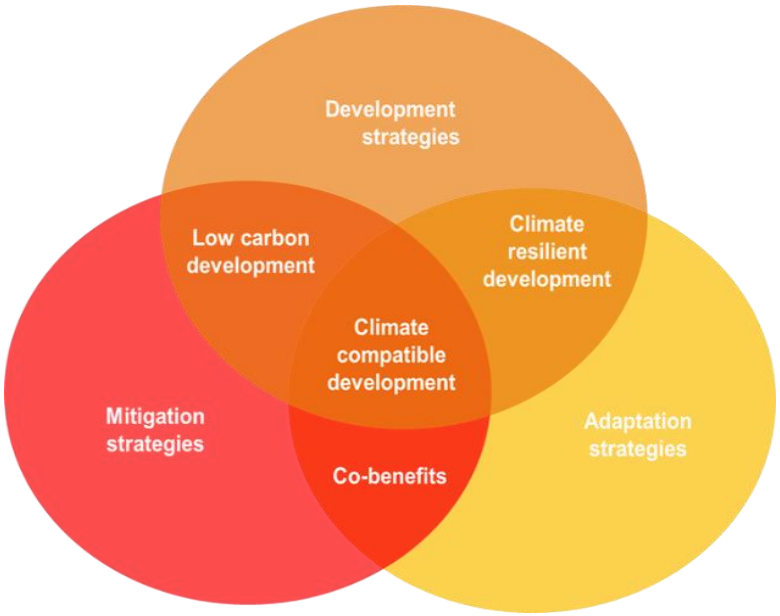


Figure 1. Climate compatible development diagram (Mitchel and Maxwel, 2010).

"Triple-wins" have become a potent rhetorical tool for provoking solutions to interconnected climate-development problems (Bickersteth, 2012; Ellis and Tschakert, 2019). Triple-win reasoning has gained much traction among academics and policymakers because it promises to produce synergistic mitigation-adaptation-development results with only one intervention. Numerous research has examined the

triple-win data on mangrove governance at the local level. Mangrove restoration as a natural approach to the Paris Agreement, SDGs, and the global objectives for disaster risk reduction and the shift to low-carbon and climate-resilient economies (Luom et al., 2021; Agaton and Collera, 2022). Reducing Emissions from Deforestation and Forest Degradation (REDD+), mangrove restoration, and Integrated Multi-Trophic Aquaculture (IMTA) are a few adaptation measures that might aid in lowering Indonesia's blue carbon emissions. (Ahmed et al., 2017).

In addition to providing food and wood, mangroves act as blue carbon and are gaining popularity as a natural climate solution for human wellbeing. They also provide habitats for commercial fish species and biodiversity, regulate floods, storms, and erosion, offer recreational opportunities, and sequester atmospheric carbon, all of which have an increasing impact on climate change (Cameron et al., 2021; Friess, 2023; Huxham et al., 2015; Orchard et al., 2015; Ruslan et al., 2022; Rakotomahazo et al., 2023; Singh and Chudasama, 2021; Sudharmma Vishwanathan et al., 2023).

In the developing world, programs that combine development, adaptation, and mitigation through community-based approaches—community-based CCD—are operationalizing climate-compatible development (Tilahun et al., 2023). These initiatives are positioned as being more effective, efficient, and sustainable than "top-down" climate and development solutions since they take into account the concerns of the local population (Ryan-Collins et al., 2011b; Wood, et al., 2018).

2.3. Multilevel governance towards climate compatible development

The Paris Climate Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) acknowledges the critical role that local and subnational areas play in fulfilling global obligations related to mitigation and adaptation. The significant contribution made by global networks of cities and regions to climate planning at the local and regional levels (Pietrapertosa et al., 2021). The governance systems based on several levels of government, ranging from local or municipal administrations to state or provincial administrations and finally national governments, are referred to as the "governance scale" in this context. Although we concentrate on governments in our discussion, this word recognizes other players who play within these many tiers. Coordination between actors—such as local and national government—is necessary to achieve this alignment across scales. The intricate and multifaceted nature of climate action and mangrove governance makes coordination across several levels of government an inherently intricate and non-linear process (Hermawan et al., 2023).

Multilevel governance towards CCD becomes increasingly complex, adding new benefits, particularly economic development in climate change adaptation and mitigation action (Anton et al, 2014; Ficklin et al, 2018; Stringer et al, 2017).

The transition from partial climate action and development to CCD. The new strategy involves the interaction of central governments with other public and private actors to develop and carry out policies at all levels of government, from the national to the local, horizontally in networks spanning sectors, regions, and stakeholders, and vertically across levels of government.

The multilayer dependencies on the vertical axis suggest that national

governments need strong collaboration with regional and local governments as change agents to execute national climate policy. Regional and municipal land use, urban planning, and transportation strategies are similarly limited; they can only be implemented if they do not align with national development objectives, technical standards, budgets, and financial priorities.

3. Study design and methods

3.1. Study area

As shown in **Figure 2**, The study was conducted on the coast of Semarang City, the capital of Central Java Province. The coastal area of Semarang City covered approximately 5039.17 hectares, constituting around 0.02 percent of the city's total area (37,366,838 hectares). Spanning about 25 kilometers, it extended across Tugu District for 3.5 km, North Semarang for 5.56 km, West Semarang for 8.94 km, and Genuk for 7 km.

Semarang was selected as the location due to its potential as a case study for CCD governance. The Semarang City Government managed the coast, necessitating a balance between adaptation, mitigation, and development. Situated at a central point along the North Coast of Java Island, Semarang was a strategic city with a coastline stretching 36.63 kilometers. Furthermore, it rapidly developed as a hub for industrial, trade, and service activities. The city's coast demanded special attention for climate change adaptation due to its vulnerability to floods and tidal disasters. Contour analysis, assuming an average sea-level rise of 8 mm/year, predicted the submersion of several areas in Semarang City's coastal regions. Semarang City experienced approximately 10.31 m/year of abrasion and 20.95 m/year of accretion from 2001 to 2021. In 2041, abrasion and accretion are anticipated to decrease marginally to roughly 10.15 m/year and 19.69 m/year, respectively (Amalia, 2023).

With mangrove forest covering 93.56 hectares, the coastal city held significant potential for absorbing greenhouse gases, contributing to climate change mitigation.

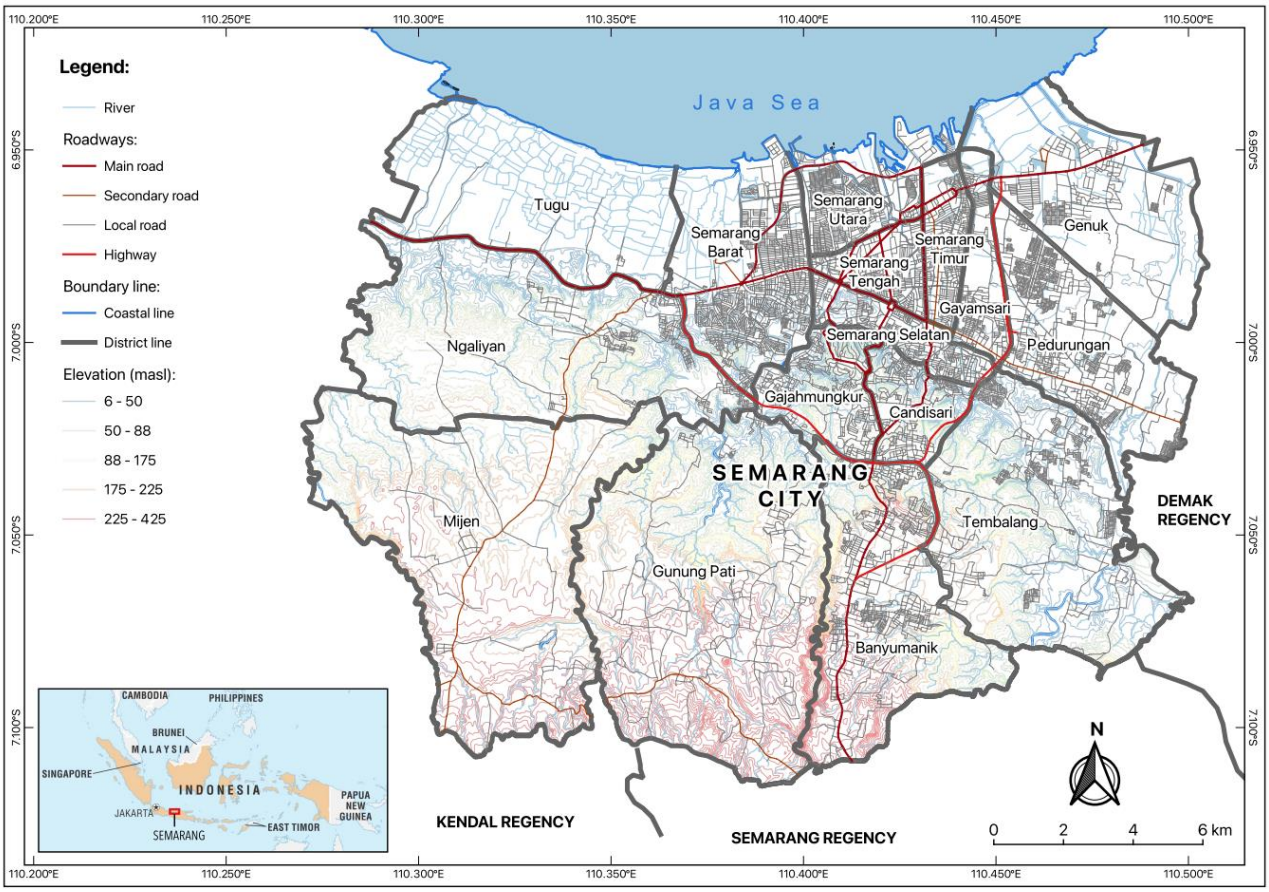


Figure 2. Map of the study area.

The study was structured in two stages, namely (1) identifying stakeholders related to mangrove conservation and planting and (2) describing the transformation of governance institutions towards CCD.

First Stage: Identifying stakeholders related to mangrove conservation and planting.

Stakeholder analysis aimed to identify institutions included in coastal governance in Semarang City. Government institutions' roles were discerned through the examination of published documents on the Internet, while non-governmental institutions were identified through direct surveys and field interviews. The study of actors' roles in coastal area governance comprised interviews with all identified institutions and actors. The stakeholders interviewed were stated in **Table 1**.

To identify policies related to mangrove conservation and planting, only secondary data was required. Secondary data could be obtained from the official government website or by directly requesting it from the relevant office. The regulations and policy identified were those that were currently in effect. The planning documents included national development policy documents and policy of ministries and institutions related to coastal area development.

Table 1. Stakeholders in Mangrove Governance.

No	Institution/Organization	Category
1.	Provincial Maritime Affairs and Fisheries Service	Government
2.	Development Planning Agency at Sub-National	Government
3.	Spatial Planning Department	Government
4.	Public Works Department	Government
5,	Environmental Service	Government
6.	Tugu, Genuk, Main Semarang and West Semarang Districts	Government
7.	City Spatial Planning Department	Government
8.	Diponegoro University	Academic/Research center
9.	Bintari Foundation and Kemem Foundation	NGO
10.	Prenjak, Sido Rukun and Bina Tapak	Community group

Krippendorf (2004) defined content analysis as a method for inferring the meaning of texts through procedures that are reliable, replicable, or applicable in different contexts. Using qualitative content analysis consisted of analyzing the visible text and understanding the meaning and context behind the words (Neuman, 2011).

Second Stage: Transformation of governance institutions towards CCD.

From the information obtained in the first and second stages, it could be formulated how the network and structure between institutions and policy would lead to CCD governance.

4. Results and discussion

Indonesia had an institutional architecture based on four level of government, namely national, provincial, city, and sub-district. Responsibility and authority were distributed between those levels of government based on regional autonomy regulations since 2014. Institutional arrangements, policy rules, and clear mandates in the distribution of rights and responsibilities between stakeholders were important in achieving CCD. Mangrove governance towards CCD was a complex topic requiring cross-sectoral and multi-stakeholder collaboration. To promote mangrove management, it is essential to understand the level of collaboration among stakeholders. In Indonesia, cooperation between parties involved in mangrove co-management still needs to be developed despite solid regulations. The mangrove management networks in the coastal provinces varied, particularly in terms of the number of participants.

4.1. Stakeholders and multilevel policies framework for mangrove governance

The stakeholders referred to in this section included all actors, such as institutions, community groups, and individuals who were directly included in mangrove ecosystem management and those who indirectly influenced the management in the coastal areas. There were at least five leading groups in mangrove management issues, namely the government, university/research institution, non-governmental organizations, the private sector, and the community. In multilevel governance method,

vertically, the management consisted of the government from the national to local level, and horizontally (polycentric), as well as various government and non-government organization.

Policy referred to in this section were related to the management of coastal areas, impacting mangrove ecosystem at the national level, and at the regional government level related to the management of the coastal areas. Local policy studies described how local commitments were linked to regional and national policy and priorities. Consequently, the documents analyzed were at different scales, from the national to the local level. Stakeholders and policies found in the field can be seen in **Figure 3**. The policy content related to mangrove governance is described in the Appendix tables.

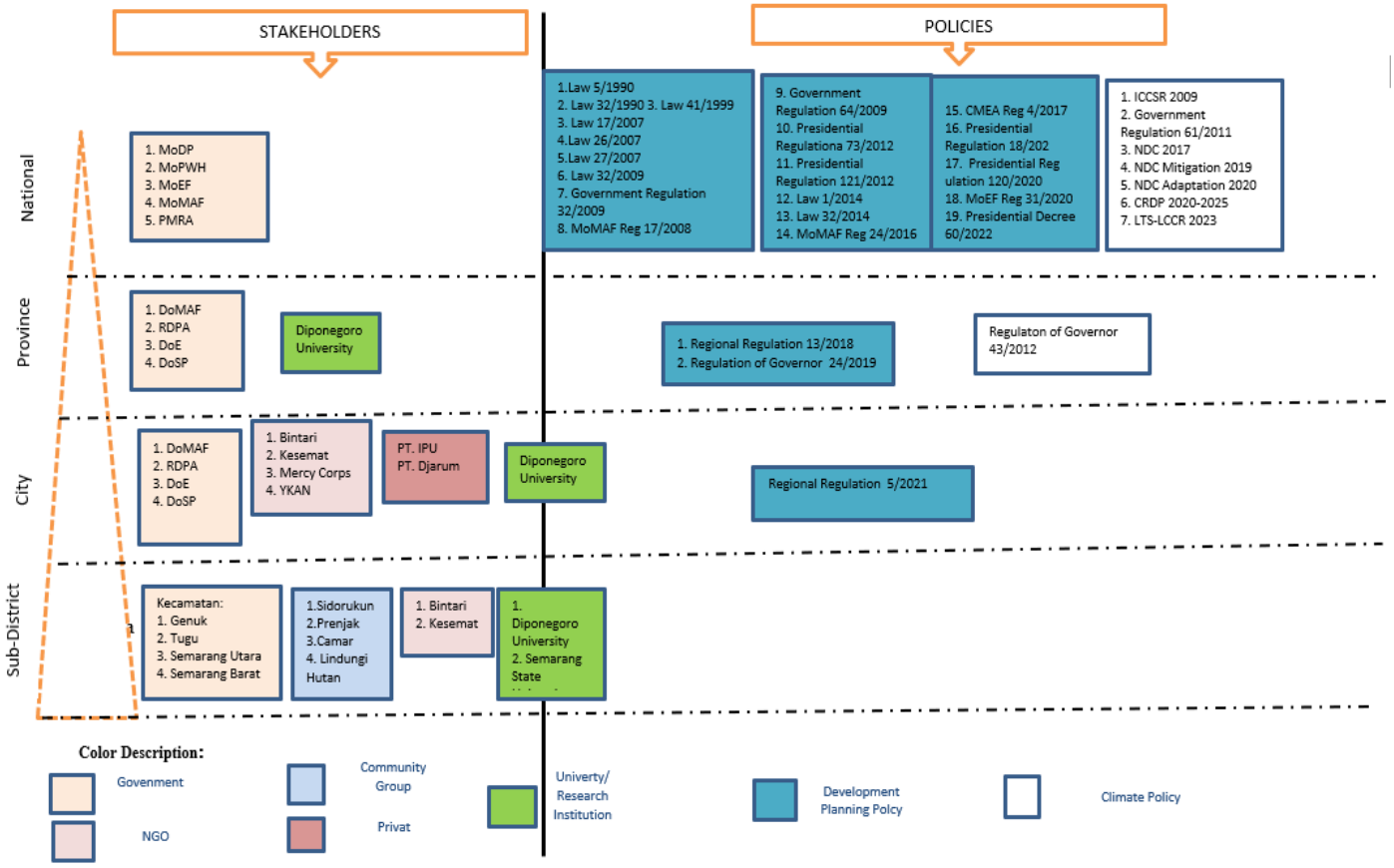


Figure 3. Stakeholders and policies in multilevel mangrove governance of Semarang.

A. National

At the national level, the government played a greater role in passing laws, setting national targets, and developing action plans according to the mandate and duties of each sector. Presidential Regulation No 82/2020 mandated the Ministry of Environment and Forestry (MoEF) and the Ministry of Maritime Affairs and Fisheries (MoMAF) as the main government institutions tasked with mangrove management. The Ministry of Maritime Affairs and Fisheries had authority outside Forest Areas (APL). According to the National Mangrove Map, the area of mangrove forests in APL was 702,798 ha in 2021. Additionally, the ministry collaborated with local governments and communities to carry out management and conservation activities aimed at protecting marine ecosystems, sustaining their function, and increasing the

sustainable use of marine resources. Consequently, a Strategic Plan 2020–2024 was established to protect marine areas, with a conservation target of 26.9 million hectares by 2024.

In early 2021, the Peat and Mangrove Restoration Agency (PMRA) was formed. PMRA was specifically tasked with coordinating with central government agencies concerned with implementing peatland and mangrove restoration to accelerate mangrove rehabilitation with a target area of 600,000 ha by 2024.

The Ministry of National Development Planning (MoDP) had a mandate to prepare Indonesia's development plans but was also an active stakeholder in climate change policy discussions. One of the coastal restoration programs was to fulfill the objectives of the National Medium-Term Development Plan (RPJMN). In the 2020–2024 RPJMN, National Priority 6th, Building the Environment, Increasing Disaster Resilience, and Climate Change. Management of coastal and marine areas and peat restoration were mainstreamed into the 2020–2024 Medium-Term Development Planning document or RPJMN.

B. Province

The decentralization policy, Law 23/2014, granted greater authority to regional governments, which were at the forefront of implementing policy with a direct impact at the regional level. The management of the sea area 0–12 miles outside oil and gas fell under the authority of the Provincial Government.

Stakeholders and policy at the national level exerted influence on the management of mangrove ecosystems at the provincial, city, and sub-district level. The implementation of climate change policy and national development plans at the local level required multi-level coordination between provincial and municipal governments. Subnational actors, such as provinces, cities, and sub-districts, played a critical role in achieving national goals. Cross-government coordination was needed in policy formulation and the implementation of national programs. Besides the government, educational institutions, particularly Diponegoro University, contributed significantly to mangrove conservation in the city of Semarang. The university conducted numerous studies, launched programs, and established communication forums for mangrove management, aiming at climate change adaptation and coastal economic empowerment.

C. City

Law No. 23/2014 stipulates that city governments do not have authority over coastal areas. At the city level, the government plays a greater role in implementing programs launched at the national and provincial level. The national government does not have direct authority to implement national programs at the regional level but needed to collaborate with regional governments to implement national programs.

City governments played an important role in promoting the protection and conservation of mangroves in non-forest areas. This included spatial planning, establishing clear protection and conservation zones, and adjusting these efforts with Strategic Environmental Assessment (SEA) implementation, in accordance with central government policy. The City Government operated at a level with high opportunities for direct coordination with local communities, NGOs, the private sector, and educational institutions.

D. Subdistrict

Sub-districts mainly facilitated and directed community participation in coastal management programs initiated by the central, provincial, and city governments (Wang et al., 2024). The barriers to mangrove restoration and their solutions cross several disciplinary domains and need consultation and interaction with local stakeholders (Friess et al., 2022).

In the last two decades, mangrove rehabilitation and conservation management schemes in Indonesia prioritized community participation as the primary method.

Locals value mangroves for their ability to safeguard the shore and other local protective functions, but they also value wider-reaching benefits like biodiversity and carbon sequestration. Residents' preferences for different ecosystem services vary depending on how near they live to the ocean and mangroves (Jadin and Rousseau, 2022).

Ecological environments have suffered, and the means of subsistence for populations have changed due to anthropogenic activity, overuse of resources, and the degradation of coastal ecosystems. The qualities they have in common the most include being transparent and accountable in decision-making and having the capacity to identify, discover, and sustainably utilize high-energy regions. In order to accomplish sustainable goals, coastal communities, local government, and the academic sector must collaborate due to the complexity and multiple causes of this issue (Afonso et al., 2022; Peña-Puch et al., 2023).

4.2. From Conversion to CCD: Transformation of mangrove governance policy discourse in Indonesia and Semarang City

Achieving CCD necessitated a shift towards a mindset that consisted of triple wins. This transformation could manifest through development of policy and program activities. **Figure 4** showed the evolution of mangrove ecosystem governance, indicating its potential to yield adaptation, mitigation, and economic development benefits.

A. National

In 1984, Pond Intensification, a government program, expanded pond cultivation land across Indonesia, allocating 860,000 hectares of mangrove forest for conversion into pond cultivation land (approximately 25% of Indonesia's mangrove forests). For 30 years, this program resulted in the loss of nearly 800,000 hectares of mangrove forest, causing significant detrimental impacts in coastal areas. Consequently, several policies were made to anticipate ecosystem degradation and promote long-term management goals.

Since 1990, the government mangrove forests as natural resources requiring protection (Law No.5/1990, Presidential Decree No.32/1990). This was followed by regulations supporting the sustainability of ecosystem management, such as Law 41/1999 and Law 32/2009, showing the need to protect mangrove ecosystems. Law No. 26/2007 concerning Spatial Planning designated mangrove forested coastal areas as national protected areas, while the ecosystem along riverbanks was regulated as a river green belt. Recognizing the benefits of mangrove forests for coastal protection and disaster mitigation, Minister of Maritime Affairs and Fisheries Regulation No.

2/2009, PP 64/2010, and presidential decree 121/2012 stated that the forested coastal areas were marine coastal areas, serving as natural habitats for forests providing protection for coastal and marine life.

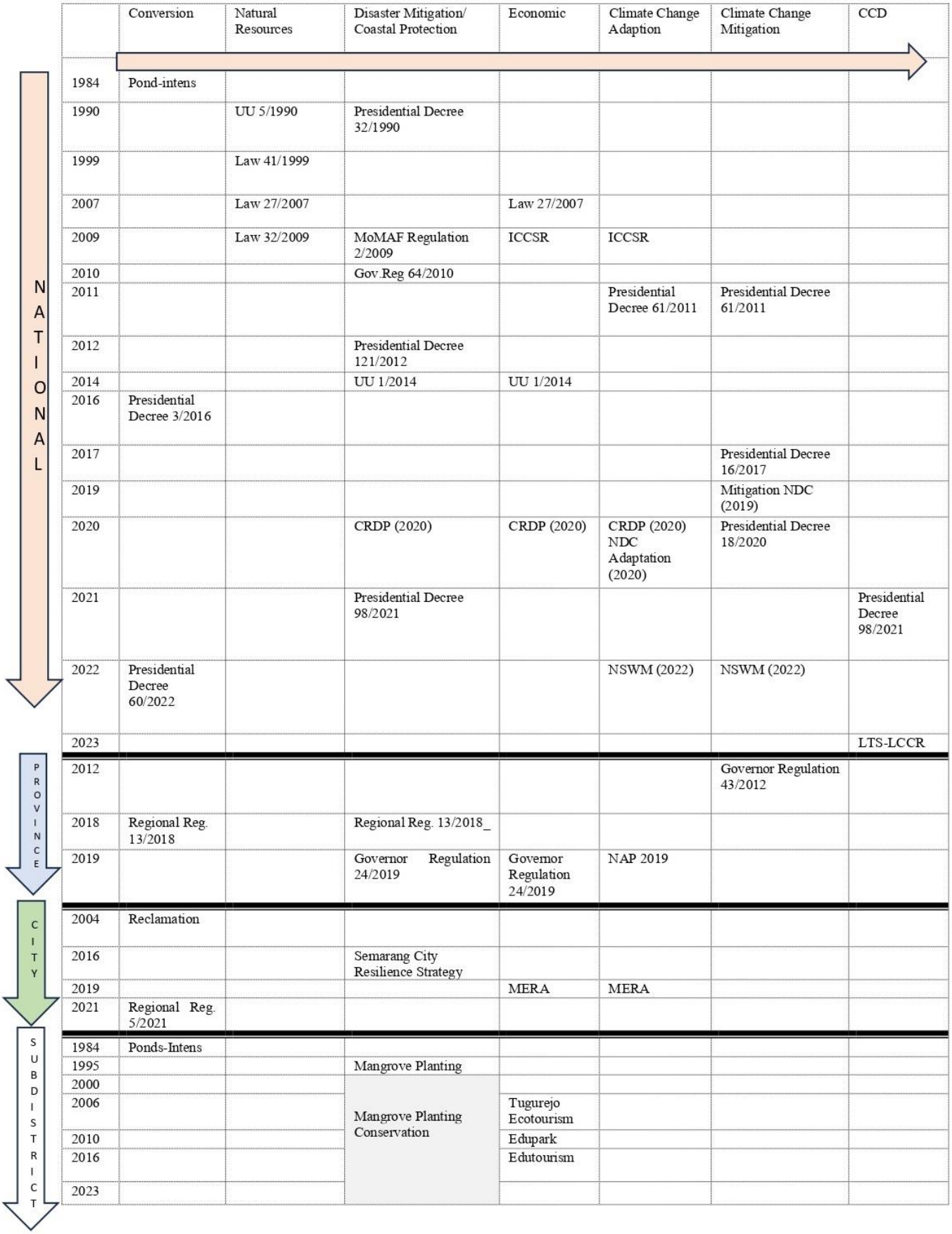
The function of mangrove ecosystem for climate change adaptation and economic improvement began to surface in the 2001 ICCSR document published by MoNDP. Since 2007, climate change had been a significant political issue in Indonesia, garnering stronger political support. Climate change considerations were now integral to government programs, comprising various ministries, institutions, and local governments.

Presidential Decree 61/2011, outlining The National Action Plan for Reducing Greenhouse Gas Emissions, represented the first policy acknowledging role of mangrove in climate change mitigation. This regulation showed climate change as a cross-sectoral issue. In 2020, MoNDP also published a Resilient Development document focusing on managing resilient ecosystems, improving the economy and adapting to climate change. MoNDP aimed to integrate climate change action into development planning through low-carbon development programs.

Presidential Decree 18/2020, addressing the National Medium-Term Development Plan (RPJMN) 2020–2024, prioritized the management of coastal and marine areas and mangrove restoration. In the 2020–2024 RPJMN, the government set a rehabilitation target of 50,000 hectares under the Low Carbon Development policy.

To reinforce climate change mitigation actions from mangrove ecosystem, MoNDP published the National Strategy for Wetland Management in 2022. This strategy targeted the rehabilitation of 245,087 hectares by 2045, focusing on priority locations determined by the coastal vulnerability index. By 2045, the aim was to decrease emission intensity from the ecosystem management by 93% from the Business as Usual (BAU) scenario (972 tonnes CO_2-eq/billion rupiah) to 68.26 tonnes CO_2-eq/billion rupiah.

Coordinating Minister for Economic Affairs Regulation No. 4 of 2017, addressing Policy, Strategies, Programs, and Performance Indicators for National Mangrove Ecosystem Management, denoting the significant ecological value of mangrove as high carbon stores in both vegetation and substrates. Presidential Regulation No. 98 of 2021, addressing the Economic Value of Carbon and regulating the carbon market, supported forest conservation and rehabilitation, including mangrove ecosystems. This aimed to achieve targets for reducing greenhouse gas (GHG) emissions, improving the economy, and adapting to climate change. Through the LTS-LCCR document, Indonesia committed to achieving Net-Zero Emissions by 2060. Nearly 60% of the total emission reduction target from all sectors would depend on the forestry and land use (FOLU) sector, including mangrove ecosystem.



		Conversion	Natural Resources	Disaster Mitigation/ Coastal Protection	Economic	Climate Change Adaption	Climate Change Mitigation	CCD
NATIONAL	1984	Pond-intens						
	1990		UU 5/1990	Presidential Decree 32/1990				
	1999		Law 41/1999					
	2007		Law 27/2007		Law 27/2007			
	2009		Law 32/2009	MoMAF Regulation 2/2009	ICCSR	ICCSR		
	2010			Gov.Reg 64/2010				
	2011					Presidential Decree 61/2011	Presidential Decree 61/2011	
	2012			Presidential Decree 121/2012				
	2014			UU 1/2014	UU 1/2014			
	2016	Presidential Decree 3/2016						
	2017						Presidential Decree 16/2017	
	2019						Mitigation NDC (2019)	
	2020			CRDP (2020)	CRDP (2020)	CRDP (2020) NDC Adaptation (2020)	Presidential Decree 18/2020	
	2021			Presidential Decree 98/2021				Presidential Decree 98/2021
	2022	Presidential Decree 60/2022				NSWM (2022)	NSWM (2022)	
	2023							LTS-LCCR
PROVINCE	2012						Governor Regulation 43/2012	
	2018	Regional Reg. 13/2018		Regional Reg. 13/2018_				
	2019			Governor Regulation 24/2019	Governor Regulation 24/2019	NAP 2019		
CITY	2004	Reclamation						
	2016			Semarang City Resilience Strategy				
	2019				MERA	MERA		
	2021	Regional Reg. 5/2021						
SUBDISTRICT	1984	Ponds-Intens						
	1995			Mangrove Planting				
	2000			Mangrove Planting Conservation				
	2006				Tugurejo Ecotourism			
	2010				Edupark			
	2016				Edutourism			
	2023							

Figure 4. A timeline of the different mangrove policy and program representations in Indonesia.

The narrative of mangrove ecosystem governance at the national level denoted a shift in thinking toward triple wins for economic development, adaptation, and climate change mitigation benefits. Institutions such as MoNDP, responsible for climate change action and development planning, actively promoted CCD effectiveness. Additionally, robust coordination and cooperation between MoNDP, MoEF (National Vocal Point for Indonesia's climate change action), and MoMAF (with specific tasks in coastal management) presented a significant opportunity to implement CCD method. Challenges in achieving CCD in mangrove ecosystem governance persisted in Indonesia. A major point of contention revolved around the potential occurrence of political conflicts among interested sectors (Ficklin et al., 2017; Stringer et al., 2014; England et al., 2018b). This manifested as sector egos between institutions responsible for climate change adaptation, climate change mitigation, and development, prioritizing the interests of their respective sectors (Ficklin et al., 2017).

The introduction of Presidential Decree 3/2016, focusing on the acceleration of the national strategy, and Presidential Decree 60 of 2022, addressing the National Strategic Area Spatial Plan for the Kendal Urban Area (Demak, Ungaran, Salatiga, Semarang, and Purwodadi—Kedung Sepur), led to planning for the construction of the 27 KM Semarang Demak sea embankment toll road. However, this development project resulted in the degradation of 46 hectares of mangrove ecosystem.

B. Province

Local governments played an important role in integrating climate change adaptation into development planning. National-level stakeholders and policy influenced mangrove ecosystem management at the provincial, city, and sub-district level. The implementation of climate change policy and national development plans at the local level necessitated multi-level coordination among provincial and municipal governments. Regulation of the Governor of Central Java Number 43/2012, focusing on the Regional Action Plan for Reducing Greenhouse Gas Emissions in Central Java Province for 2010–2020, was developed to fulfill the mandate of Presidential Decree 61/2011. This document explicitly recognized the role of mangrove ecosystem in mitigating climate change, incorporating it into the forestry sector to reduce emissions by 10.82 tons of CO_2-equivalent.

Regional Regulation 13/2018 was policy crafted to implement Law No. 27 of 2007, mandating Regional Governments to formulate Zoning Plans for Coastal Areas and Small Islands (RZWP-3-K) for Provinces and Districts. Regional Regulation 13/2018 described the function of mangrove forests as coastal protection. Central Java Governor Regulation Number 24 of 2019 concerning Mangrove Ecosystem Management Policy and Strategies for Central Java Province directed the management of the ecosystems to preserve their ecological and socio-economic functions.

Upon close examination of climate change policy documents and development planning in Central Java Province, no specific document stipulated the triple wins benefits for the ecosystem. However, separate documents addressing mangrove ecosystems for economic development, adaptation, and climate change already existed. The opportunities for managing the ecosystems toward CCD with the existence of these documents were significant because the stakeholders participating in implementing this policy was coordinated by the Provincial.

During the exploration of this research, the Development Planning Agency at the Sub-National Level (DPA) prepared a low-carbon development planning document, which included mangrove ecosystem's function to achieve the triple wins target (CCD).

C. City

The city government policy that led to the conversion of mangrove ecosystem in 1987 was the issuance of a permit for the Marina Beach reclamation carried out by PT. IPU, covering a planning area of 200 hectares. This reclamation continued in line with Regional Regulation Number 8 of 2004 concerning Semarang City Spatial Planning, designating the Marina area for a building zone supporting housing functions. Based on informant interviews, this reclamation caused abrasion and damage to mangrove in the surrounding area. Although the exact extent of mangrove degradation is unknown, the loss of this mangrove ecosystem significantly impacted the economic activities of coastal communities.

The importance of mangrove ecosystem in disaster resilience and improving the coastal economy was described in the Semarang City Resilience Strategy document (2016). Being a member of the 100 Resilient Cities, Semarang promoted an ecosystem-based community economy through Ecotourism and Edu tourism. Another influential program on mangrove ecosystem restoration was Mangrove Ecosystem Restoration Alliance (MERA) in 2019, focusing on ecosystem-based climate change adaptation initiated by the Nusantara Nature Conservation Foundation (YKAN) and PT. Djarum. This program also improved economic development through processing mangrove products and developing ecotourism and Edu tourism.

In 2021, city government policy was identified as causing land conversion to mangrove ecosystems. Regional Regulation No. 5 of 2021 concerning Semarang City RTRW allocated space for the Semarang Demak toll road and Harbor toll road. This regulation was issued to support Presidential Decree No. 3 of 2016, necessitating changes to the spatial and regional plans for the city of Semarang to accommodate toll road construction. The toll road construction project required relocating 46 hectares of mangrove land.

Climate change policy was infrequently found at the Semarang city level, but climate change adaptation and mitigation actions were evident in the city. Currently, the City of Semarang referred to the Regional Action Plan for Climate Change Adaptation and climate change mitigation documents issued by the Provincial Government. The government played a more substantial role in implementing programs launched at the national and provincial level since the national government lacked direct authority to implement national programs at the regional level. Consequently, the potential for governance towards CCD found at the national level was achieved through implementation and regulation at the city government level.

D. Subdistrict

The most extensive conversion of mangrove forest land in the city of Semarang took place in 1984 with the launch of the National Pond Intensification (INTAM) program. By 2009, the beaches along the Central Java coast had suffered erosion, affecting an area of 5600 hectares (16%). In the early 1990s, the conversion of mangrove forest land led to various environmental and social problems. This issue prompted vulnerable and affected community groups to independently carry out

mangrove planting and rehabilitation activities since the late 1990s. These grassroots efforts resulted in numerous community groups increasingly committed to mangrove conservation. The aim was to prevent damage to fishponds caused by sea level rise and abrasion. In 2006, local NGOs Bintari and Mercy Corps initiated an eco-based tourism program in mangrove ecosystem to boost the economy and simultaneously protect mangrove ecosystem in Tugurejo sub-district. This program was replicated in other sub-districts with similar concepts, such as Edupark in Tambakrejo Village in 2010 and Mangunharjo Village edutourism in 2016.

Mangrove conservation, planting, and ecotourism activities persisted at that time, both independently by community groups and in collaboration with government stakeholders, NGOs, the private sector, and educational institutions. The initiative for mangrove planting began with Mr. Sururi as an individual in 1999 in Tugu District. These efforts led to numerous community groups increasingly dedicated to the conservation of the ecosystems. In 2003, the Sido Rukun and Group was formed, followed by Youth Concerned with the Tapak Environment (PRENJAK) in 2006, the Tourism Awareness Group (Pokdarwis) Bina Tapak Lestari, and in 2017, Pokdarwis "Ngebruk Jaya Beach". These groups generally consisted of fishermen, environmentalists, pond farmers, and mangrove product processors. The community groups were actively included in planting activities, managing ecotourism, overseeing Mangrove Edupark Tourism, and processing mangrove products. Mangrove ecosystem's economic improvement through an ecotourism program was initially initiated by a community group and later supported by the local NGO Bintari in 2010.

Some studies showed that the continuous goal of conserving and planting mangrove was to increase resilience to natural disasters and improve the economy. However, there was still limited understanding regarding adaptation, mitigation, and climate change among community groups. At the sub-district level, community groups were important stakeholders in achieving climate change adaptation and mitigation targets set by the government. Indonesia's national climate change policy encouraged regional and local projects to advance development, mitigation, and adaptation that could facilitate CCD.

4.3. Challenges to deliver climate compatible development

We have found that mangrove conservation greatly benefits society, such as fisheries provision, coastal protection, and climate change mitigation via blue carbon sequestration (Thompson and Rog, 2019). However, our findings also showed institutional challenges towards CCD. Presidential Decree 68/2022 led to planning to construct the 27 KM Semarang Demak Sea embankment toll road. However, this development project resulted in the degradation of 46 hectares of mangrove ecosystem. Construction seawall tolls have negative implications for CCD. This regulation contradicts the Indonesian blue carbon target in other climate policies, such as LTS-LCCR and Presidential Decree 98/2021. This fact implied that government ministries and departments often operate in relative isolation, characterized by a lack of communication, information sharing, and collaboration.

Regional Regulation No. 5 of 2021 was issued to support Presidential Decree No. 3 of 2016, necessitating changes to the Semarang's spatial and regional plans to

accommodate toll road construction and requiring relocating 46 hectares of mangrove land. This issue also implied that power imbalances across governance levels in decentralized government systems were also found to be governance challenges toward CCD.

Similar results were obtained from the mangrove governance research conducted by a few academics. The policy is the primary obstacle to Indonesian mangrove conservation and restoration (Gallemore et al., 2015; Quevedo et al., 2023). In many nations, a significant cause of local initiative failure is ineffective coordination between the various governmental levels (Pietrapertosa et al., 2021; Wood et al., 2016b). Diverse governmental establishments possess differing ideologies and developmental agendas about the sustainable management and preservation of mangrove ecosystems (Mursyid et al., 2021; Nijamdeen et al., 2023).

5. Conclusion

The potential for CCD success increased significantly when climate change evolved into a cross-sectoral and inter-ministerial discussion in Indonesia. Furthermore, the introduction of the blue carbon paradigm in the country promoted commitment among related sectors in mangrove ecosystem management plan, aiming to maximize the benefits of CCD. The results showed the critical role of the national government in establishing regulations, particularly important for the success of multilevel governance in achieving CCD in a decentralized government model. In the context of mangrove ecosystem governance, national-level regulations were transformed towards CCD, particularly with the development of LTS-LCCR policy. The success of policy implementation set by the National Government towards CCD was significantly influenced by the active participation of local governments and stakeholders.

This study also showed that in multilevel governance, instances of political intervention and sectoral interests were evident. Institutional challenges towards CCD were described, particularly the existence of a hierarchy of statutory powers.

6. Research limitation

In our study, we acknowledge certain limitation that may have influenced the results and their applicability. The study was conducted on one case mangrove governance to describe the evidence of CCD governance model. Meanwhile, CCD governance model for other sector case might be different. By acknowledging this limitation, we encourage further research to address these concerns and expand the many sector cases to describe the CCD governance model.

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Appendix

Table A1. Multilevel policies related to mangrove governance.

Year	Policy	Mangrove Issues
I. National		
1990	Law No. 5 of 1990 concerning Natural Resources Conservation	Describes mangrove conservation as a natural resource, and ensure the sustainability of its supply while maintaining and improving the quality, diversity, and value.
1990	Presidential Decree No. 32 of 1990 concerning the Management of Protected Areas	Mangrove area is a natural habitat protecting coastal and ocean life.
1999	Law Number 41 of 1999 concerning Forestry	Mangrove forest protection as a data source.
2007	Law No.17 of 2007 concerning the National Long-Term Development Plan 2005–2025	Prioritize the management of coastal and marine areas and mangrove restoration.
2007	Law No. 26 of 2007 concerning Spatial Planning.	Mangrove area is a national protected area for the protection of coastal life.
2007	Law No. 27/2007 on Coastal Zone and Small Islands Management	Mangrove ecosystem conversion must take into account the sustainability of coastal ecological functions.
2008	Government Regulation No. 26/2008 on National Spatial Planning	Prohibiting the use of mangrove wood and activities that can change the area and/or pollute mangrove ecosystem in mangrove zoning.
2008	Minister of Maritime Affairs and Fisheries Regulation No. 17 of 2008 concerning Coastal Areas and Small Islands Conservation Areas	Location permits cannot be granted in core zones in conservation areas, sea lanes, port areas, and public beaches.
2009	Law no. 32/2009 concerning Environmental Protection and Management	Describes the standard criteria for mangrove ecosystem deterioration.
2009	Indonesia Climate Change Sectoral Roadmap (ICCSR)	The ICCSR document for the fisheries and marine sector has included mangrove conservation as an action for adapting to climate change.
2010	Government Regulation No. 64 of 2010 concerning Disaster Mitigation in Coastal Areas and Small Islands.	Creating coastal vegetation using mangrove plants can function as mitigation against types of coastal erosion disasters, tsunami disasters, and extreme waves.
2011	Presidential Regulation no. 61 of 2011 concerning the National Action Plan – Greenhouse Gases (NAP-Mitigation).	The document has considered the blue carbon ecosystem which plays a role in storing carbon to mitigate climate change.
2012	Presidential Regulation Number 73 of 2012 concerning the National Strategy for Mangrove Ecosystem Management	Policy and programs to realize sustainable mangrove ecosystem management and sustainable prosperous communities based on available resources as an integral part of the national development planning system.
2012	Presidential Regulation no. 121 of 2012 concerning Rehabilitation of Coastal Areas and Small Islands	Specifically, regulates the rehabilitation of mangrove and seagrass ecosystems in coastal areas and small islands.
2014	Law Number 1 of 2014 concerning Amendments to Law No. 27 of 2007 concerning Management of Coastal Areas and Small Islands	The use of small islands and surrounding waters is prioritized for conservation, education and training, study and development, mariculture, and tourism.
2014	Law Number 23 of 2014 concerning Regional Government	Coastal management authority is in accordance with level of government.
2014	Law Number 32 of 2014 concerning Maritime Affairs	Protect, conserve, rehabilitate, use, and enrich coastal and small island resources and their ecological systems in a sustainable manner.

Table A1. (*Continued*).

Year	Policy	Mangrove Issues
I. National		
2016	Ministerial Regulation of the Ministry of Maritime Affairs and Fisheries Number 24 of 2016 concerning Procedures for Rehabilitation of Coastal Areas and Small Islands	Beach vegetation rehabilitation for coastal protection.
2017	Regulation of the Coordinating Minister for Economic Affairs Number 4 of 2017 concerning Policy, Strategies, Programs and Performance Indicators for National Mangrove Ecosystem Management	Explain the strategy and performance indicators for mangrove ecosystem management where mangrove rehabilitation target is set at 1.82 million ha in 2045.
2017	NDC implementation strategy	Land, coastal, and marine ecosystems in climate change adaptation and mitigation efforts.
2019	Nationally Determined Contribution Mitigation Implementation Roadmap	This document does not include mangrove forests in the calculation of Reducing Emissions from Deforestation and Forest Degradation. However, mangrove have been included in essential ecosystems as providers of services including carbon storage.
2020	Presidential Regulation No. 18/2020 on Medium-Term National Development Planning (RPJMN) 2020–2024	Mangrove rehabilitation target is 50,000 hectares under the umbrella of the LCDI policy.
2020	Presidential Regulation No. 120/2020 on Peatland and Mangrove Restoration Agency	Mandate to accelerate mangrove rehabilitation with a target of 600,000 hectares in 9 provinces.
2020	Minister of Environment and Forestry Regulation Number 31 of 2020 concerning Management of Conservation Areas	Mangrove forest conservation as a provider of environmental services.
2020	Roadmap for Nationally Determined Contribution to Climate Change Adaptation in 2020	Contains ecosystem-based protection of coastal zones including mangrove ecosystems in increasing resilience to climate change.
2020	Climate Resilient Development Policy (CRDP) 2020–2045	The Maritime and Coastal, Water, Agriculture, and Health sectors are some of the priority sectors for climate resilience.
2022	Presidential Decree No 60 of 2022 concerning the National Strategic Area Spatial Plan for the Kendal Urban Area. Demak, Ungaran, Salatiga, Semarang, and Purwodadi (Kedung Sepur).	Reference to the National Strategy Project for the construction of the 27 km Semarang Demak Sea embankment toll which has an impact on mangrove ecosystem.
2022	National Strategy for Wetland Management (NSWM)	Targeting a reduction in emissions from mangrove ecosystem management of 68.26 tons of CO_2-eq through mangrove rehabilitation covering an area of 245,087 Ha by 2045.
2023	Long Term Strategy-Low Carbon Climate Resilient (LTS-LCCR)	This document contains the Indonesia FOLU Net Sink 2030 agenda which will be achieved through reducing deforestation, conservation and sustainable forest management, protection and restoration of peat and mangrove.
II. Province		
2012	Regulation of the Governor of Central Java Number 43 of 2012 concerning Regional Action Plans for Reducing Greenhouse Gas Emissions in Central Java Province for 2010 - 2020	The document includes Forest and Land Rehabilitation Planning including Mangrove Forests in the forestry sector to reduce emissions of 10.82 tons of CO_2e with an area of 320 ha 148,350 trees (PJ Forestry Service and Environmental Agency).
2019	Central Java Governor Regulation Number 24 of 2019 concerning Mangrove Ecosystem Management Policy and Strategies for Central Java Province	Each district/city in Central Java is to develop a regional strategy for managing mangrove ecosystems to preserve ecological, socio-economic, and carbon storage functions.
2018	Regional Regulation No. 13 of 2018_RZWP3K_Central_Java	Restoring the function of mangrove forests as coastal protectors and establishing mangrove forest zone plan covering an area of 8,707,718 Ha throughout Central Java Province.
III. City		
2021	Regional Regulation No. 5 of 2021 concerning Semarang City RTRW	Allocation of space for the construction of the 27 km Semarang-Demak toll road which resulted in the relocation of 46 ha of mangrove.