Integrating Indigenous Governance into Nature-Based Solutions for Climate and Biodiversity Resilience

Rismawati Nur[1*], *Retno* Meilani[1], *Alfin* Dwi Novemyanto[1]

[1]Faculty of Law, Universitas Gadjah Mada, Yogyakarta, Indonesia

Abstract. The accelerating climate crisis underscores the limitations of state-centric and technocratic approaches to environmental governance. Although Nature-Based Solutions (NbS) are increasingly promoted as strategies for climate adaptation and biodiversity conservation, prevailing frameworks often neglect Indigenous governance systems that have long sustained ecosystems through customary law, ecological knowledge, and cultural values. This article positions Indigenous governance as a pivotal dimension of NbS, emphasizing its capacity to integrate ecological stewardship with social justice and intergenerational equity. Drawing on the case of the Ammatoa Kajang community in South Sulawesi, Indonesia, the study illustrates how Indigenous forest classifications and customary norms safeguard ecological balance while reinforcing cultural resilience. Employing a mixed-methods approach, combining ethnography, geospatial analysis, and reflective narrative. The research demonstrates that Indigenous-led governance provides legitimacy and inclusivity frequently absent in state-driven conservation initiatives. The findings highlight the importance of legal pluralism and co-management models that recognize Indigenous rights, thereby advancing NbS that are ecologically robust, socially just, and culturally sustainable.

1 Introduction

Climate change is one of the most serious challenges facing humanity in this century. Scientific evidence consistently shows a significant increase in global temperatures over time. The latest data shows that in 2024, the global land average annual temperature anomaly reached more than 2.0 °C compared to the normal period of 1951–1980, making it the highest record since temperature records began in 1880 [1]. Figure 1 shows the trend in annual and seasonal temperature changes, which have increased almost linearly since the mid-1980s.

* Corresponding author : rismawatinur@mail.ugm.ac.id

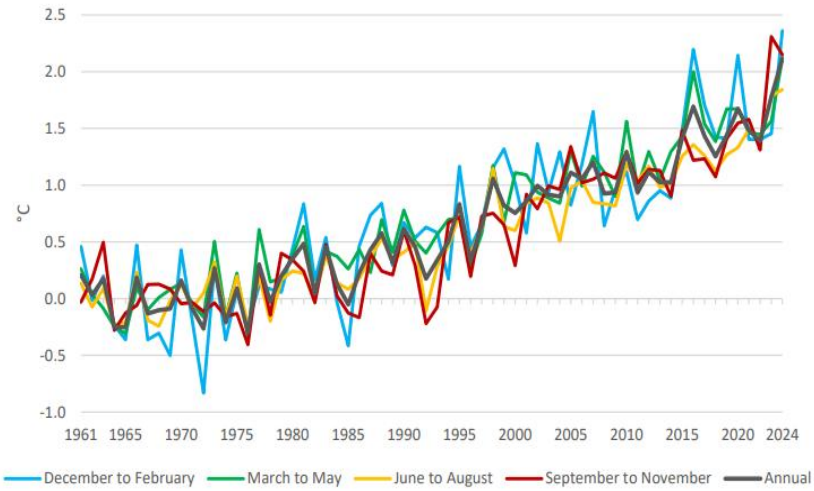

Fig. 1. Mean annual and seasonal temperature change on land

The data shows that the last ten years have been the hottest period in history, with an average increase of around 1.5 °C. This threshold is a critical point set in the *Paris Agreement* to prevent catastrophic climate impacts. Several seasons have recorded temperature anomalies above 2.0 °C, indicating an accelerating climate crisis with direct impacts on ecosystems and human life. Figure 2 shows that while almost no population lived in countries exceeding 1.5 °C before 1980, this figure has risen sharply since the early 2000s, reaching more than 60% of the world's population by 2024. This data reinforces the fact that climate change is not a future threat, but a reality that is now being felt by most of the global community.

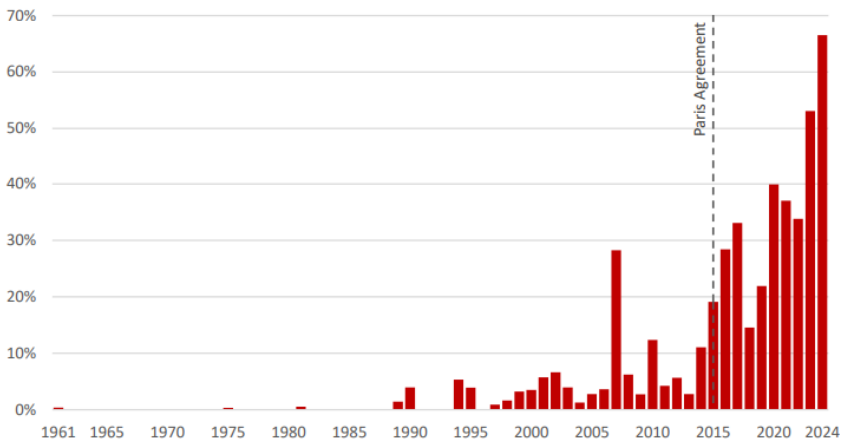

Fig. 2. Share of population living in countries with warming above 1.5 °C in world population

Floods, droughts, storms, and shifts in extreme weather patterns are occurring more frequently and with greater intensity. These changes increase socio-economic vulnerability, threaten food security, and increase the risk of livelihood loss, especially for vulnerable communities such as indigenous peoples who depend directly on nature for their livelihoods.

Thus, climate impacts must be viewed not only as ecological problems but as multidimensional challenges requiring integrated solutions. In response, sustainability-oriented approaches are increasingly emphasized in global climate policy, with Nature-based Solutions (NbS) emerging as a prominent strategy.[2-3]. NbS is characterized by its ecosystem-based approach, including biodiversity protection, improved water management, and strengthened social cohesion [4].

The success of NbS is highly dependent on a supportive social context and governance. Without the involvement of local communities, NbS risks becoming a technocratic program that ignores the needs of communities in the field. Active community participation, transparency in decision-making, and the principle of justice are key prerequisites for NbS to be truly inclusive. Thus, NbS should be understood not only as an ecological strategy, but also as a social process that requires cross-actor collaboration. In this context, indigenous peoples have a very strategic role to play. For centuries, they have developed management systems based on local wisdom that have proven capable of maintaining ecological balance. Previous studies have demonstrated the ability of indigenous peoples to adapt to socio-ecological changes. The participation of indigenous peoples in conservation has proven to promote a more effective and equitable ecological restoration process.

These dynamics indicate that customary governance should be positioned on an equal footing with modern scientific approaches. International recognition of Indigenous peoples is reflected in legal instruments such as the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), which affirms their rights to land, territories, and resources, as well as their participation in decision-making processes. Moreover, Local and Indigenous Knowledge Systems (LINKS) provide important insights for ecosystem management and restoration. Through their longstanding relationship with forests and land, Indigenous communities have developed tradition-based management mechanisms that remain effective in sustaining ecological balance [5]. Indigenous peoples' contributions remain largely overlooked in modern conservation. Many conservation areas, including national parks and biosphere reserves, restrict their access to ancestral lands, despite evidence that Indigenous communities have long maintained ecosystem sustainability. These contradictions create social tensions and weaken conservation outcomes. Research also shows that Indigenous peoples continue to organize and defend their rights against external development pressures that threaten their territories. [6].

In addition to recognition issues, the implementation of NbS also faces technical and structural obstacles. Various case studies show that the application of NbS is often hampered by limited funding, weak institutional capacity, and a lack of policy support [2]. Unplanned urbanization and uncontrolled land exploitation further degrade ecosystems, undermining NbS implementation. This confirms that NbS should not be viewed solely as a technical approach but rather requires participatory governance transformation. Within this framework, indigenous community governance can be understood as a concrete manifestation of NbS. This system not only ensures the sustainability of resource management but also brings about social justice and cultural resilience. By placing indigenous knowledge as its foundation, NbS has the potential to produce more inclusive and sustainable solutions as a climate change mitigation effort that does not sacrifice the rights of communities.

Based on the above description, this paper will explain that indigenous governance is a crucial element of nature-based solutions for climate mitigation and ecosystem resilience. By examining the relationship between indigenous governance, NbS, and global policies, this article offers a comprehensive perspective on how local knowledge can be integrated into climate strategies. Specifically, this study uses the Kajang indigenous community in South Sulawesi, Indonesia, as a case study to explore how traditional governance systems contribute to ecosystem conservation and climate resilience. This approach is expected to encourage

synergy between modern science, international policy, and local knowledge systems to produce effective and equitable climate solutions.

2 Research Method

This study uses a mixed-method approach by integrating three complementary methodological components. First, ethnographic observations were conducted in conjunction with in-depth interviews with key informants, particularly traditional leaders, community members, and relevant policy makers, to gain a contextual understanding of indigenous community governance. Second, this study utilizes qualitative analysis of geospatial data, including maps of indigenous territories and changes in land cover, to assess the role of indigenous-based governance in preserving ecosystems. Third, a reflective approach is used through first-person narratives [7], which reconstructs the researcher's empirical experiences and enriches the interpretation of the interaction between customary norms and *Nature-based Solutions* strategies. The integration of these three methods allows for a more comprehensive analysis of the potential of indigenous community governance as a nature-based solution in climate change mitigation and ecosystem resilience strengthening.

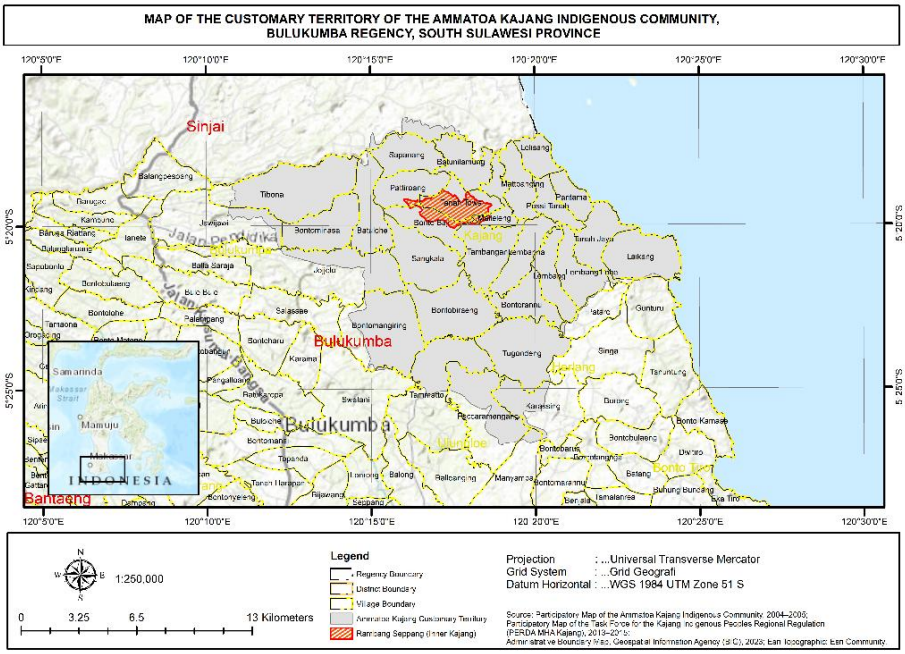

Fig. 3. Map of the Customary Territory of the Ammatoa Kajang Indigenous Community, Bulukumba Regency, South Sulawesi Province.

This study examines the governance of customary forests within the Ammatoa Kajang Indigenous Community in Bulukumba Regency, South Sulawesi. The community occupies a traditionally recognized territory with clearly defined boundaries, as illustrated in Fig. 3, which provides essential spatial context for understanding the jurisdictional framework that shapes land-use governance and customary authority. The analysis integrates data from ethnographic observations and in-depth interviews with traditional leaders, community members, and policymakers, complemented by spatial analysis using maps of customary areas and land-cover change. These findings are further reinforced by the researcher's

narrative reflections to provide a holistic understanding of how customary norms interact with Nature-based Solutions strategies.

3 Discussion

3.1 Indigenous-led Governance as a Pathway to Biodiversity Conservation

At the global level, Indigenous peoples are increasingly recognized for their effective management of the environment and natural resources, as well as their significant contribution to biodiversity conservation. Although they comprise only about 5% of the world's population, they help protect nearly 80% of global biodiversity, while their customary territories account for roughly 24% of global land and include most of the world's remaining intact forests. These figures indicate that Indigenous-led environmental governance goes beyond ecosystem preservation, integrating cultural, spiritual, and social values into conservation practices. From this holistic perspective, conservation is understood not only as an ecological effort but also as part of collective identity and intergenerational responsibility [8–10].

Indigenous knowledge-based environmental management has great potential to create an ethical space, which is a space for dialogue that allows for the equalization of traditional knowledge and modern science. This interaction not only broadens the perspective of conservation, but also produces more inclusive, fair, and sustainable strategies in responding to contemporary ecological challenges [10]. Therefore, customary governance should not be viewed merely as an alternative model, but as the main foundation for efforts to preserve biodiversity and strengthen ecosystem sustainability, whether at the local, national, or global level.

3.2 Indigenous Governance in Climate Change Mitigation and Ecosystem Resilience

Indigenous governance plays a strategic role in climate change mitigation and ecosystem resilience. Indigenous forests worldwide, including those in the Amazon, function as major carbon sinks and help maintain ecosystem balance. Global estimates show that Indigenous peoples and local communities manage about 24% of all above-ground carbon stored in tropical forests, amounting to more than 54 billion metric tons of carbon [11]. This confirms that the continuity of customary governance not only has implications for the preservation of the local environment but is also a key factor in achieving global carbon emission reduction targets. Without recognition and protection of the management rights of indigenous peoples, climate mitigation efforts risk losing their most important ecological foundation.

Traditional ecological knowledge passed down across generations reinforces this contribution. The practice of cultural burning in North America, for example, has been shown to reduce the risk of large fires while increasing ecosystem diversity. Similarly, indigenous agroforestry systems in Asia not only maintain soil productivity and food sources but also play a role in carbon sequestration and reducing vulnerability to climate change. With a value-based approach, indigenous peoples view ecosystems as an integral part of their social and spiritual lives, not merely as economic resources. The recognition of rights, collective responsibilities, and ecological wisdom inherent in indigenous societies are fundamental factors that make Nature-based Solutions (NbS) more effective because they strengthen socio-ecological resilience while promoting environmental justice.

3.3 Towards Inclusive Forest Management by the Kajang Indigenous Community in Indonesia

Forest management by the indigenous Kajang tribe of South Sulawesi demonstrates the existence of inclusive forest management by indigenous peoples. The system of classifying forests into various levels, namely *Borong Karamaka*, *Borong Batasayya*, and *Borong Luarayya*, not only describes the community's concrete practices in distinguishing between sacred, communal, and subsistence functions, but also demonstrates a structured ecological rationality. This can be seen in the following Table 1.

Table 1. Classification of the Ammatoa Kajang Indigenous Forest Areas

Types of Forests	Function
Borong Karamaka	*Borong Karamaka* is a forest area designated as a habitat for the flora and fauna of the customary area, so it cannot be touched by anyone for human activities. This forest is the place where *Tu Rie A'ra'na* (the indigenous people's belief in God) descends, so it is highly sacred. The only activities that can be carried out in the *Borong Karamaka* area are traditional rituals.
Borong Batasayya	This area is designated as a forest area, the proceeds of which are used to develop public facilities if timber is available and with the permission of Ammatoa as the traditional leader.
Borong Luarayya	This area is a forest area that can be managed by indigenous peoples to meet their daily needs, but such management must be based on the contents of the *Pasang Ri Kajang*, considering the balance of nature.

Source: author, 2025

As shown in Table 1, the institutional arrangement preserves a balance between conservation objectives and subsistence needs by embedding local practices within broader strategies for biodiversity protection and climate change mitigation. Governance inclusivity emerges through collective compliance with customary rules, the authority exercised by the Ammatoa, and the shared communal responsibility for safeguarding forest resources. Customary sanctions and cultural norms transmit ecological values across generations, illustrating that sustainability is sustained not only by formal regulatory frameworks but also by robust socio-cultural institutions. These dynamics foster a degree of social legitimacy that state regulatory mechanisms alone often fail to achieve. Furthermore, the Kajang community applies a mandatory regeneration principle that requires every harvested tree to be replaced and obliges individuals to plant trees prior to cutting, thereby ensuring continuous forest renewal and long-term ecological stability.

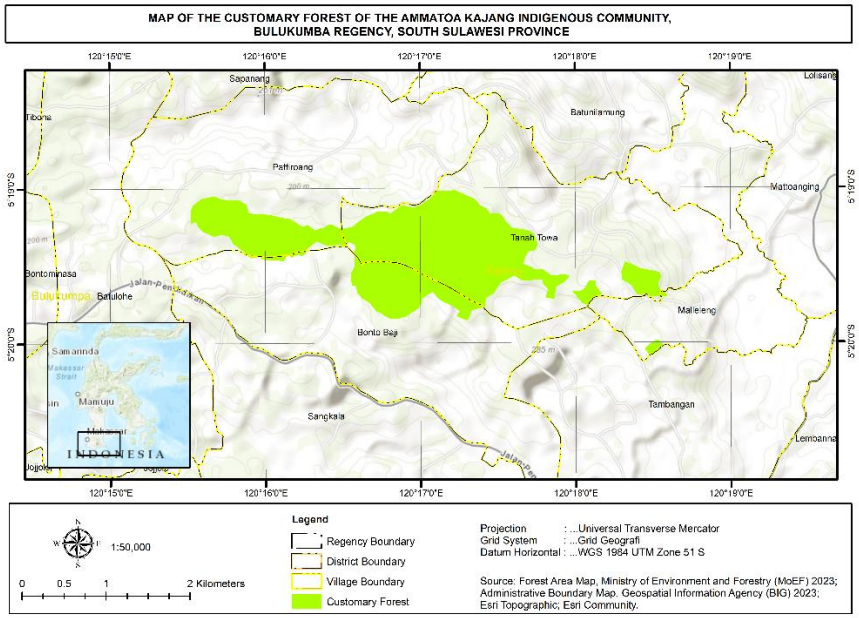

Fig. 4. Spatial distribution of the Ammatoa Kajang customary forest area.

The spatial distribution and ecological configuration of the Ammatoa Kajang customary forest, as illustrated in Fig. 4, provides a clear visual representation of the forest zones that underpin the community's governance system and resource-use regulations. Forest management by the Ammatoa Kajang Indigenous Community emphasizes the importance of the principle of environmental justice. With recognition of land and resource rights, communities can maintain authority in decision-making. This reality shows that customary governance is not subordinate but can coexist with and even complement national conservation policies. The Kajang Indigenous People provide a concrete example of a co-management model in which customary authorities, the state, and civil society can interact on an equal footing.

The experience of the Kajang indigenous community proves that inclusive customary governance can strengthen Nature-Based Solutions (NbS). By embedding ecological management into social institutions and cultural identity, this form of governance not only contributes to biodiversity conservation and carbon sequestration but also strengthens ecosystem resilience while preserving cultural sustainability. These findings critique and enrich the technocratic tendencies in NbS practices that often neglect social and cultural dimensions. Therefore, inclusivity in the case of the Kajang tribe is not only interpreted as participatory involvement, but also as the recognition and institutionalization of customary leadership as the center of environmental governance.

This study shows that customary ecological governance is not merely an alternative, but rather the main foundation for Nature-Based Solutions. While the NbS framework promoted by various international organizations often emphasizes technical interventions, such as reforestation or ecosystem restoration, customary governance emphasizes the social, cultural, and spiritual dimensions of ecological management. By embedding ecological responsibility into customary law and collective identity, this system can overcome the main weaknesses of state governance, namely low legitimacy and limited land ownership by communities.

One important insight from the case of the Kajang Indigenous People is the capacity of customary governance to integrate ecological resilience with cultural sustainability. This dual role is often overlooked in the dominant NbS discourse. The Kajang Indigenous Community

shows that preserving ecosystems cannot be separated from protecting the rights and cultural integrity of indigenous peoples. Thus, customary governance promotes not only ecological outcomes but also social justice and intergenerational justice.

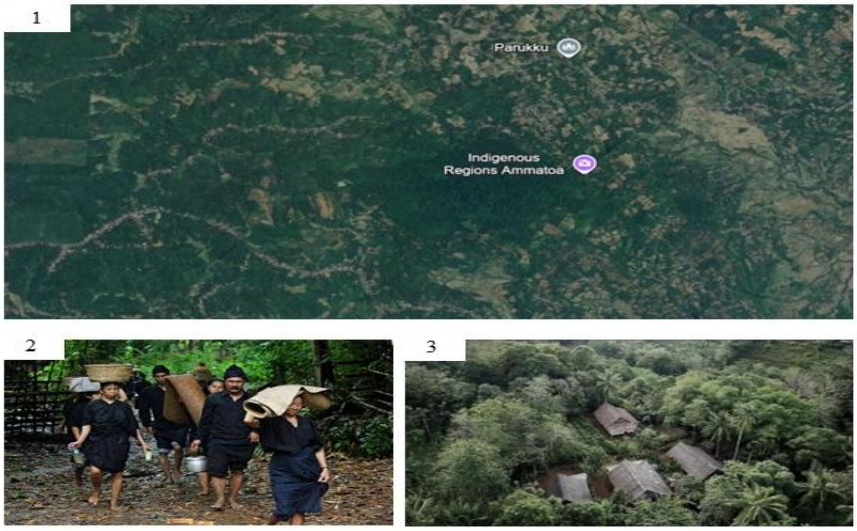

Fig. 5. (1-3)-1. Satellite map showing the Indigenous Regions of Ammatoa Kajang in Bulukumba, South Sulawesi; 2. Members of the Ammatoa Kajang community in traditional black attire during daily activities; 3. Traditional Ammatoa Kajang settlements surrounded by forest.

The spatial context and everyday interaction between the Kajang community and their forest environment, as illustrated in Fig. 5, provide an empirical foundation for understanding how customary norms shape environmental governance. For the indigenous Kajang tribe, rules regarding the division of forest areas are regulated in the Pasang ri Kajang. One of the tribal precept's states, "*Anjo natahang ri boronga karena pasang. Rettopi tanayya rettoi*," which means that the preservation of the forest is guaranteed because of tribal protection. If the forest is damaged, then the tribal order will also be disrupted. The Kajang tribe clearly demonstrates that humans, customs, and nature are inseparable entities. If nature is degraded, the survival of the community and the integrity of customary norms are likewise threatened. Conversely, if the rules are broken, nature will be destroyed, which will also have an impact on human survival.

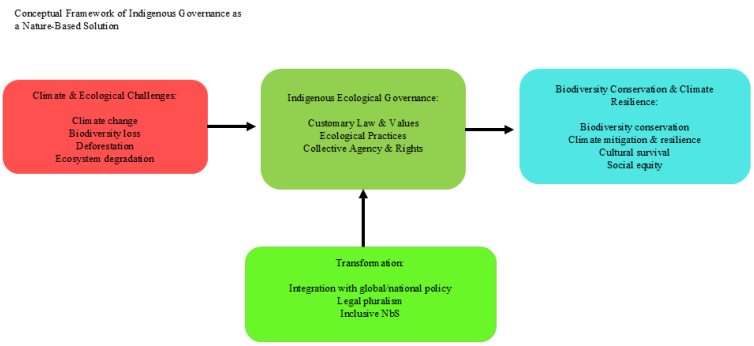

Fig. 6. Conceptual Framework of Indigenous Governance as a Nature-Based Solution

Figure 6 presents a conceptual framework that positions customary governance as a core component of NbS and linking ecological challenges with social outcomes. Processes of

change, such as legal pluralism, the incorporation of customary rules into policy, and the recognition of indigenous peoples' rights, strengthen governance systems. This ultimately results in biodiversity conservation, reduced climate change impacts, and ecosystem resilience. Thus, this framework shows a recurring and mutually reinforcing relationship between governance, ecological sustainability, and cultural continuity. However, challenges remain. National development agendas and the expansion of extractive industries often reduce the living space of indigenous peoples, thereby weakening ecological and cultural resilience. Policy frameworks in Indonesia and other countries tend to place customary governance under positive state law. Without recognition of legal pluralism, the transformative potential of customary governance as a NbS will remain limited.

A comparative perspective reinforces the global implications of these findings. Research in the Amazon shows that legally recognized indigenous territories have lower rates of deforestation than surrounding areas. Similarly, Maori ecological governance in Aotearoa New Zealand has successfully integrated cultural values into the country's legal framework and offers a model for co-management. These cases demonstrate that incorporating indigenous governance into climate policy, both nationally and globally, is not only important but necessary to ensure the effectiveness of NbS.

4 Conclusions and Recommendations

This study concludes that indigenous peoples' ecological governance is not merely an alternative, but rather the main foundation of Nature-Based Solutions (NbS) in climate change mitigation, biodiversity conservation, and ecosystem resilience strengthening. The experience of the Kajang indigenous community in South Sulawesi shows how customary law, cultural values, and ecological knowledge are integrated into daily practices that ensure environmental sustainability and intergenerational justice. Unlike state-centric or technocratic approaches, customary governance embeds ecological responsibility into social and cultural institutions, giving it stronger legitimacy, inclusiveness, and sustainability. However, recognition of customary governance in national and international policy frameworks remains limited, often placed under state law and development agendas. Therefore, strengthening indigenous peoples' ecological governance is key to achieving biodiversity conservation that is fair, sustainable, and resilient to climate change.

Based on these findings, several recommendations can be proposed:

1) Recognition and Integration of Customary Governance in Policy
   Governments need to provide strong legal recognition of indigenous peoples' rights to land, territories, and resources, and integrate indigenous ecological knowledge into national and global strategies related to climate and biodiversity.
2) Strengthening Co-Management Models and Community Capacity
   An inclusive co-management framework between the state, indigenous peoples, and civil society is needed, accompanied by funding support and capacity-building programs to strengthen indigenous institutions and ecological management practices.
3) Global Recognition and Knowledge Exchange
   International organizations and climate governance regimes must prioritize indigenous governance in global policy, while facilitating knowledge exchange among indigenous communities worldwide to strengthen ecosystem resilience and environmental justice.

Thus, indigenous peoples' ecological governance can be positioned as a transformative pathway, so that biodiversity conservation and climate change mitigation are not only based on ecological aspects, but also on social justice and cultural sustainability.

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