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Regulatory Innovation in Micro-Disaster Governance: Linking Civil Administration to Ecological Mitigation in Rural Indonesia

Ulfiah Syukri
ulfiah24001@mail.unpad.ac.id
Padjadjaran University
Ida Widianingsih
Padjadjaran University
Nandang Alamsah Deliarnoor
Padjadjaran University
Dede Sri Kartini
Padjadjaran University

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Regulatory Innovation in Micro-Disaster Governance: Linking Civil Administration to Ecological Mitigation in Rural Indonesia

Ulfiah Syukri (*Corresponding authors*)[12*],
[1]Doktoral Program in Department of Government Science, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia. Dago, Coblong, Kota Bandung, Jawa Barat 40135
[2]Center for Decentralization & Participatory Development Research, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia. Dago, Coblong, Kota Bandung, Jawa Barat 40135
Email: ulfiah24001@mail.unpad.ac.id, Orcid : (https://orcid.org/0000-0002-2075-5588)

Ida Widianingsih[13]
[2]Center for Decentralization & Participatory Development Research, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia. Dago, Coblong, Kota Bandung, Jawa Barat 40135
[3]Department of Public Administration, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia Dago, Coblong, Kota Bandung, Jawa Barat 40135
Email: ida.widianingsih@unpad.ac.id, Orcid : (https://orcid.org/0000-0003-2472- 5236)

Nandang Alamsah Deliarnoor[4],
[4]Department of Government Science, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia Dago, Coblong, Kota Bandung, Jawa Barat 40135
Email: nandang.alamsah@unpad.ac.id, Orcid : (https://orcid.org/0000-0002-3145-0069)

Dede Sri Kartini[4],
[4]Department of Government Science, Faculty of Social and Political Sciences, Universitas Padjadjaran, Bandung, Indonesia Dago, Coblong, Kota Bandung, Jawa Barat 40135
Email: dede.sri.kartini@unpad.ac.id, Orcid : (https://orcid.org/0000-0002-2707-5083)

Abstract

Motivation, Conventional disaster mitigation often relies on costly technocratic approaches that may not foster sustained community stewardship of critical watersheds.

Purpose, This study examines how local governance innovation uses non-conventional regulation for disaster risk reduction through Tarumajaya Village Head Regulation No. 2/2022, which mandates avocado planting for civil administrative services.

Approach and methods, Using a qualitative case study, data were collected through interviews, focus group discussions, field observations, and document analysis, and analyzed using NVivo 14.

Findings, The regulation links ecological restoration with household economic interests through productive conservation, while *RT*/*RW* actors facilitate community compliance. However, severe land-tenure inequality, with state and commercial entities controlling over 90% of local land, constrains implementation.

Policy implications, Administrative compliance should be complemented by technical assistance, secure access to productive land, planting inputs, and livelihood support to sustain community stewardship and strengthen watershed-based disaster risk reduction.

Keyword: Disaster Mitigation; Government Innovation; Local Government; Tarumajaya Village; Indonesia

1. Introduction

In a global context, increasing disaster risks are increasingly understood as a direct consequence of climate change, environmental degradation, and structural development inequalities, particularly in countries of the Global South (Achour et al., 2015; Alcayna et al., 2016; Oliver-Smith, 2014; Thomalla et al., 2018). Countries in the Global South face higher vulnerability to disasters due to limited institutional capacity, dependence on natural resource-based sectors, and weak integration between disaster mitigation policies and the sustainable development agenda (Briggs, 2023; Chirambo, 2020). Within this framework, disaster mitigation is no longer positioned as a purely technical issue, but rather as part of the global development agenda that is intertwined with the objectives of the Sustainable Development Goals (SDGs), especially SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 16 (Strong Institutions) (Dany & Lebel, 2020; Hwang et al., 2021).

In line with these global dynamics, scholarly and policy attention has shifted toward the level of government closest to the community namely village governments as key actors in building local disaster resilience across the Global South (Mortimer et al., 2023; Swaris et al., 2024; Yumarni et al., 2021). Existing studies demonstrate that village-level innovations, such as strengthening local institutions, fostering community-based governance, and leveraging indigenous knowledge, play an essential role in bridging national policy frameworks with local vulnerabilities (Ahmed et al., 2016; Sam-Mbomah et al., 2025; Wong, 2025). In Southern contexts, village governance innovations are deeply embedded within local social systems, including established norms, social networks, and collective mechanisms (Abdillah et al., 2022; Arizkha et al., 2023). Consequently, strengthening village governance is not merely an administrative delegation of power, but an institutionalization of local capacities into broader disaster risk reduction and climate adaptation strategies.

In Indonesia, the increasing frequency and severity of hydrometeorological disasters over the last decade highlight that disaster mitigation is fundamentally a governance challenge directly confronted at the grass-roots level (Aeni & Khoirul Anwar, 2024; Hermawan et al., 2024; Syukri et al., 2025; Tierney, 2012). Villages serve as the primary arena where national disaster policies are tested for their practical relevance and operational effectiveness (Aspinall et al., 2021; Barua et al., 2021). Rather than acting merely as passive implementers of top-down directives (Purwanto et al., 2025), village governments are increasingly challenged to act as policy entrepreneurs (Barua et al., 2021;

Lara et al., 2021) by utilizing their discretionary authority to formulate contextualized, proactive risk management solutions (Hayu Nawang et al., 2024; Uddin et al., 2020).

Within public governance scholarship, innovation is not confined to digital adoption or technocratic tools, but encompasses updates in institutional design, regulatory instruments, decision-making processes, and state-society interactions (Noch et al., 2023). In local disaster management, one key manifestation of governance innovation is the enactment of local regulatory instruments, such as Village Regulations (*Peraturan Desa* / PERDES) or Village Head Regulations (*Peraturan Kepala Desa* / PERKADES) (Prasetyo & Ainita, 2021; Sunarto et al., 2025). While formal regulations serve as administrative legal frameworks, they also act as mechanisms for institutionalizing local policy innovations, granting formal legitimacy to community-based practices, and embedding risk reduction agendas into routine governance (Atmojo et al., 2018; Azad et al., 2019; Yumarni et al., 2021; Zurita et al., 2015).

Located at the foot of Mount Wayang and the upstream basin of the Citarum River, Tarumajaya Village in West Java Province represents a critical empirical case of local disaster vulnerability (Widianingsih et al., 2024; Wirawan et al., 2026). According to the Bandung Regency disaster risk map (see figure 1), nearly 70% of this village's area is located on slopes with a gradient greater than 30°, which, according to the BPBD classification, is considered high-risk for landslides. This became even more apparent following the 2024 earthquake that struck the village of Tarumajaya; the earthquake affected 2,996 people and caused damage to 888 public facilities and residential buildings (see table 1).

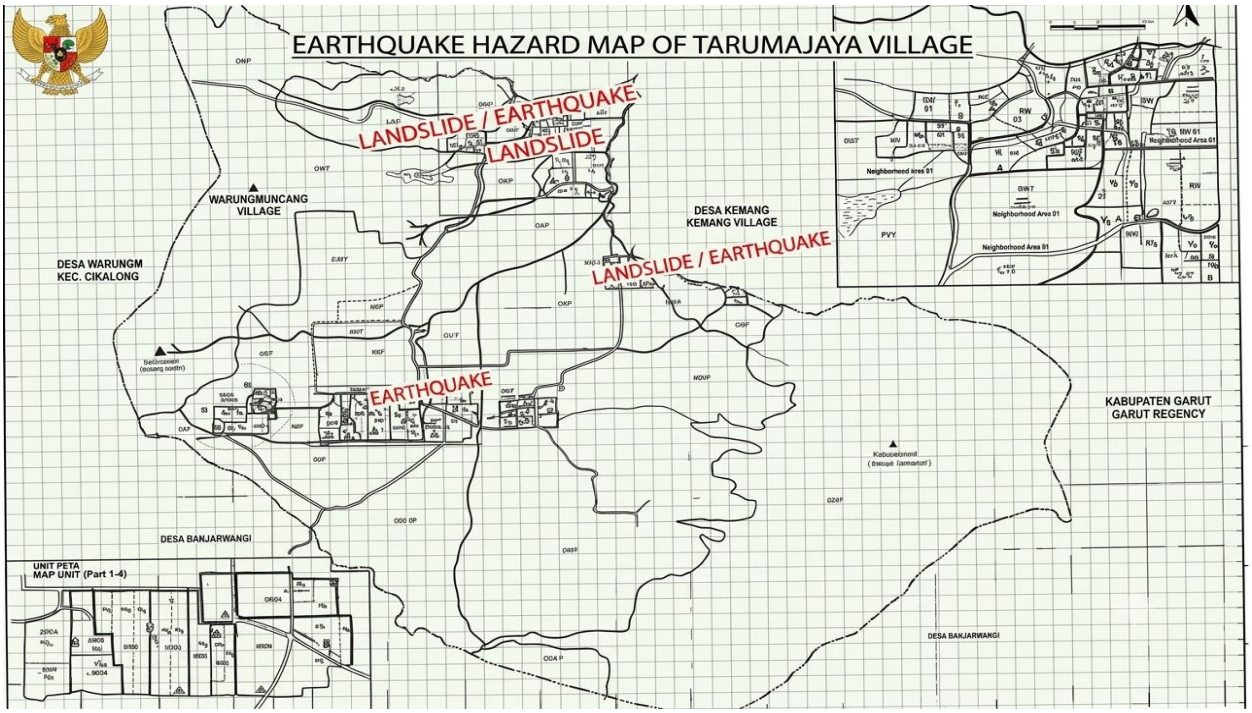


Figure 1. Disaster Risk Map of Tarumajaya Village
Source: Field Documentation, 2026.

Table 1. Disaster Data Matrix for Villages in Kertasari Subdistrict[1]

Village	Types of disasters	Damage	Fatalities	It Appeears that
Cibeureum	Earthquake	1.784 unit	None	6,920
Cihawuk	Earthquake	450 unit	None	770
Cikembang	Earthquake	436 unit	1 person	2323
Neglawangi	Earthquake	60 unit	None	Not available yet
Resmi Tingal	Mild earthquake	38 unit	None	Not available yet
Santosa	Mild earthquake	5 unit	None	44
Tarumajaya	Earthquakes and landslides	888 unit	None	2996
Sukapura	Earthquake	79 unit	None	132

Sumber: created by team, 2026.

[1] Data kejadian bencana berdasarkan data dari tiap desa, 2024.

To address these ecological threats, the village government introduced an unconventional regulatory mechanism: Tarumajaya Village Head Regulation No. 2 of 2022, which mandates tree planting (specifically avocado trees) as an administrative requirement for issuing marriage certificates and updating Family Cards (*Kartu Keluarga*) for newborns. This policy integrates ecological conservation directly into everyday population administration services. Despite growing interest in village disaster management, a critical research gap remains in current literature. Existing studies predominantly focus on technocratic disaster response, voluntary community participation, or conventional disaster management bylaws (Azad et al., 2019; Prasetyo & Ainita, 2021). Limited scholarly attention has been paid to how local governments employ regulatory innovations that link routine administrative rights to compulsory ecological duties as a means to shape long-term community behavior. To fill this gap, this study investigates how non-conventional regulatory instruments operate as governance innovations in local disaster mitigation. Specifically, this paper examines:

1. The structural drivers and socio-ecological rationale behind embedding mandatory avocado tree planting into civil administration services in Tarumajaya Village.
2. The collaborative mechanisms and implementation challenges involved in translating legal mandates into socially accepted community practices.

By analyzing this case, this study contributes to disaster governance literature by proposing a hybrid governance perspective. It demonstrates how micro-administrative mechanisms at the village level can bridge formal regulatory authority with local social practices, transforming administratively induced compliance into sustainable disaster mitigation

2. Methods

Research Design: Source and Collection Data

This research uses a qualitative case study approach with an intensive and contextual data collection strategy (Baxter & Jack, 2015). Researchers use two data sources (see figure 2), namely primary data and secondary data with four different categories of data collection techniques, namely interviews, Forum Group Discussions, Observation (for Primary Data), and Regulation, Social Media, Research (for secondary data):



Figure 2. Collection Data Category
Source: Authors' field documentation, 2026.

Data Analysis

To compile patterns from field findings, a thematic coding strategy was used based on constructivist grounded theory with the help of NVivo 14 software (Ghorbanzadeh et al., 2025) . Through this approach, local practices are read as expressions of contextual governance, not anomalies to be "fixed." It is precisely from this locality that nature-based solutions gain social legitimacy and political vitality.

3. Findings

Drivers of Village Government Innovation

Tarumajaya Village is strategically situated at the headwaters of the Citarum River, carrying profound historical and ecological significance for the sustainability of the entire hydrological system. Historically, the landscape was anchored by production forests that supplied paper mills, serving as vital ecological buffers and natural water regulators. However, extensive logging stripped away permanent vegetation cover, severely weakening water absorption capacities and escalating local vulnerability to soil erosion, landslides, and hydrometeorological hazards. Because environmental degradation at the river's source exerts a systemic downstream impact, local village development must be

firmly directed toward environmental conservation as a historical and ecological responsibility.

At the same time, the Village Head faced pressing socio-economic challenges, including rapid population growth within a restricted territory alongside persistent local poverty. To address these dual environmental and socio-economic pressures, the village administration declared Tarumajaya a conservation area through an innovative regulatory policy. This strategy was institutionalized by linking mandatory avocado tree planting directly to routine civil administration services, such as prerequisites for marriage registration and updating Family Cards for newborns. The selection of avocado trees as a core conservation tool rests on mutually reinforcing historical, economic, and ecological considerations. Historically, perennial avocado trees help restore landscape functions by approximating the protective vegetation cover of the past. From an economic perspective, avocados provide tangible financial incentives to the community, where a single tree yields an average of Rp1.5 million per harvest season, boundary row planting (*dibiring*) can generate up to Rp9 million annually, and tree transaction values can reach approximately Rp4 million depending on quality. Ecologically, avocado trees feature deep root networks and dense canopy coverage that enhance water infiltration, reduce surface runoff, and curb soil erosion. As highlighted by a key informant:

> *"This village actually needs large shade trees. But not all large trees can grow here. Take jackfruit, for example. It can grow in other areas, but not here. So we looked for a tree that could grow in all areas of the village, and that is the avocado. And why fruit trees, not just conservation trees? Because the hope is that when they bear fruit, the trees can be sold. So the residents not only plant them, but also take care of them, because there is economic value in them."* (Gym interview, 12 September 2025).

This narrative confirms that the selection of avocados bridges ecological restoration with economic viability, encouraging long-term community stewardship. Despite the formalization of the regulation, several operational and structural challenges persist. Public understanding of the policy's broader conservation substance remains relatively low, with many residents viewing the regulation as a routine administrative hurdle rather than a guiding principle for daily life. For instance, citizens often interact directly with village midwives for socio-administrative needs, engaging with the village office only when formal administrative signatures are strictly necessary. Furthermore, post-planting sustainability remains vulnerable because residents frequently treat planting as a one-time obligation without acquiring sufficient technical knowledge regarding pruning, fertilization, pest control, and harvest management.

A major structural barrier is the severe limitation of land access. Land tenure in Tarumajaya Village is heavily dominated by commercial plantations and state controls, with PTPN VIII holding 1,113 hectares (29.9%), state forest areas covering 1,059 hectares (28.5%), BKSDA nature reserves spanning 660 hectares (17.8%), and PT Lonsum controlling 627 hectares (16.9%). In stark contrast, privately owned property rights (*Hak*

Milik) account for only 97 hectares (2.6%) of the total 3,717 hectares, while village treasury land comprises a mere 11 hectares (0.3%). Because local households possess extremely limited land titles, many lack sufficient spatial capacity to plant avocado trees at standard conservation densities, creating inequalities in program participation and benefits. Addressing these hurdles requires expanding social capacity, technical training, and resource access alongside legal enforcement.

Challenges of Village Government Innovation in Tarumajaya Village

Although Village Regulations (*Peraturan Desa* / *Perdes*) have been formally established as key policy instruments, their practical execution faces significant operational and structural hurdles. Field research reveals that public understanding regarding the true substance and long-term objectives of these regulations remains relatively low. In daily practice, most residents do not view the *Perdes* as a primary reference for their routines, continuing instead to rely on informal mechanisms and long-established social patterns. For example, in socio-administrative matters such as reporting new family members, community members frequently deal directly with village midwives, interacting with the village administration only when an official signature from the Village Head is strictly required for formal procedures like marriage licensing. This behavior demonstrates a clear gap between the formal existence of local regulations and their actual internalization and social acceptance among the community.

A further operational challenge involves the long-term sustainability of the avocado planting program beyond the initial execution stage. Many residents perceive the policy merely as a one-time planting requirement to fulfill administrative obligations, lacking crucial technical knowledge regarding subsequent cultivation stages such as tree maintenance, pruning, fertilization, pest management, and post-harvest operations. Without sufficient technical capacity, planting practices risk becoming symbolic gestures that fail to generate meaningful ecological or economic benefits over time. Consequently, productive conservation is still widely perceived as a temporary administrative duty rather than a continuous, sustainable process. Beyond capacity and knowledge gaps, limited land access presents a severe structural constraint. As shown in Table 2, land ownership in Tarumajaya Village is heavily concentrated under large corporate plantations and state authorities, leaving local residents with minimal property rights.

Tabel 2 Land Tenure Distribution in Tarumajaya Village

Land status	Area (HA)	Percent
HGU PTPN VIII	1.113	29,9
Lahan Negara/Eks HGU	150	4,0
HGU PT. Lonsum	627	16,9
BKSDA / CAGAR ALAM	660	17,8
Forest Area	1.059	28,5
Village Secretary	11	0,3
Property Rights	97	2,6
Area	3.717	

Source: Adapted from Tarumajaya Village Profile, 2026.

The data illustrates that commercial plantations hold the largest share of land, with PTPN VIII controlling 1,113 hectares (29.9%) and PT Lonsum managing 627 hectares (16.9%) under Cultivation Rights (*HGU*). State forest areas and nature reserves account for an additional 46.3% of the total 3,717 hectares. In contrast, land directly owned by residents under private property rights (*Hak Milik*) covers a mere 97 hectares (2.6%), while village-owned treasury land (*Kas Desa*) stands at just 11 hectares (0.3%). This skewed land tenure system severely restricts community land use and limits economic opportunities. Because many households lack sufficient private space to plant avocado trees in ideal quantities or at spacing intervals that meet conservation standards, equitable community participation is heavily constrained, threatening to exacerbate benefit inequalities across the village. Ultimately, the primary challenges in implementing the village regulation on avocado planting extend far beyond legal formulation; they depend heavily on enhancing social capacity, technical expertise, and resource availability, which collectively dictate the long-term viability of conservation policies in Tarumajaya Village.

Collaborative Processes and Community Participation

The collaborative framework driving the avocado tree planting policy in Tarumajaya Village was established not through rigid formal partnerships, but through an embedded network of local governance actors tied into everyday community life. Vertical and horizontal interactions tie village authorities directly to residents, with Neighborhood Associations (*RT/RW*) serving as critical links between official regulations and daily social practices. During the initial policy formulation stage, the Village Head collaborated with local institutional structures, particularly the Village Consultative Body (*BPD*). Because the drafting process relied on representative mechanisms, the resulting regulation emerged as a broader institutional consensus rather than an arbitrary executive decree, even though direct citizen participation at this phase remained indirect and mediated through formal structures.

During the implementation phase, multi-stakeholder collaboration expanded substantially. Neighborhood Associations (*RT/RW*) and Hamlet Heads (*Kepala Dusun*) act as key frontline executors and verifiers who inspect tree-planting sites and assess household social conditions, grounding policy enforcement in social proximity and trust rather than technocratic surveillance. Cross-sectoral collaboration also emerged through functional partnerships with external public entities, such as the Office of Religious Affairs (*KUA*) and the Assistant Marriage Registrar (*P3N*), ensuring that mandatory planting prerequisites are verified prior to issuing marriage licenses. Interactions with village midwives were also established to track birth registrations; however,

administrative misalignments persist between healthcare services and village administrative channels, creating operational gaps in policy execution.

Public participation within this system operates through complex socio-administrative dynamics. Because tree planting is tied directly to essential public services, citizen involvement is initially driven by practical necessity rather than intrinsic environmental awareness—a condition village authorities strategically leverage to broaden participation. Community responses vary significantly: while many residents adhere strictly to the established rules, others attempt to bypass requirements by using low-quality or inappropriate seedlings. In response, village officials utilize informal communication, dialogue, and social persuasion to encourage genuine compliance. Furthermore, institutional support mechanisms remain underdeveloped. The involvement of the Village-Owned Enterprise (*BUMDes Wahyang Tarumajaya*) in managing seedling supply chains has not been fully institutionalized, leaving seed procurement heavily dependent on individual household capabilities and causing variations in seedling quality. The actor typology of this governance network is illustrated in Figure 3, which categorizes key stakeholders into policy makers (*BPD*), policy legitimators (the Village Head and Government), key executors (*RT/RW* and Hamlet Heads), implementation subjects (local residents), cross-sector partners (*KUA*, *P3N*, and midwives), and potential supporting actors (*BUMDes*)

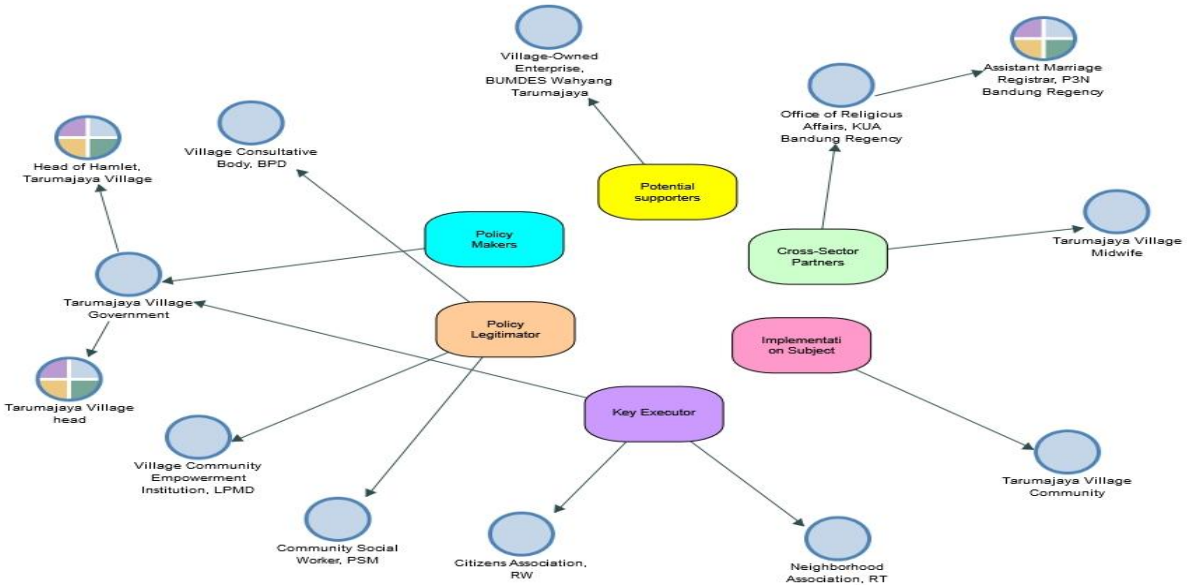


Figure 3. Actor Typologi Summary
Source: Authors' in nvivo field documentation, 2026[2].

[2] Create by Nvivo 12 Plus 2025 of Author Team.

This dynamic illustrates a community-based governance model in which the village government provides strategic political direction, *RT/RW* officers serve as social mediators, and residents act as primary implementers. Community involvement is not entirely voluntary; rather, it is shaped by a hybrid combination of administrative obligations, social proximity, and gradual habituation in daily practice. Ultimately, these findings confirm that village-level disaster mitigation works through hybrid mechanisms that bridge formal legal structures, local social ties, and everyday economic rationality.

Village Regulation as a Form of Regulatory Innovation

Tarumajaya Village Head Regulation (*Perkades*) No. 2 of 2022 exemplifies regulatory innovation by turning civil administration services into active instruments for ecological conservation and micro-disaster risk governance. Rather than treating tree planting as a voluntary or separate initiative, the regulation formalizes avocado cultivation by linking it directly to key population administration milestones, such as registering marriages and updating Family Cards (*Kartu Keluarga*) for newborns. This legislation recognizes avocado trees as both an ecological buffer and an economic asset, delineating responsibilities for land care among local institutions, neighborhood authorities, and individual citizens. By embedding environmental obligations into mandatory civil procedures, the village government successfully integrates ecological stewardship into the daily socio-administrative life of its residents..



Figure 4. Avocado Planting by a couple from Tarumajaya village
Source: documentation from Tarumajaya Village's Government, 2025[3].

[3] Tarumajaya Village Government. (2024). *Documentation of avocado planting program* [Photograph]. Unpublished internal document.

As illustrated in Figure 4, a betrothed couple is required to plant an avocado tree as a documented prerequisite prior to receiving marriage administrative approval from the village office. Similarly, Figure 5 depicts a mother planting an avocado seedling accompanied by her children, a mandatory step for updating the Family Card to issue birth certificates for new family members. These administrative workflows ensure that the fulfillment of basic civil rights is coupled with a tangible contribution to local watershed conservation.



Figure 5. Avocado planting by a mother at Tarumajaya village
Source: documentation from Tarumajaya Village's Government, 2025[4].

Far from being a top-down administrative decree forced upon the public, the regulation was formulated through inclusive local processes involving the Village Consultative Body (*BPD*), Neighborhood Associations (*RT/RW*), and key community representatives. This participatory drafting process granted the policy strong social legitimacy and fostered collective agreement regarding local environmental rules, land-use boundaries, and social accountability mechanisms. Beyond establishing immediate legal compliance, this regulatory instrument provides long-term institutional stability that safeguards environmental policies against local political turnover. As highlighted by a key local informant during interviews:

> *"If it's not included in the village regulation, this program will only last while we're in office. With a village regulation, whoever the village head is, they must still implement it, because it's already a village regulation and a collective agreement with the community."*

[4] Tarumajaya Village Government. (2024). *Documentation of avocado planting program* [Photograph]. Unpublished internal document.

This perspective demonstrates that local residents view formal regulations as a structural anchor for long-term policy innovation. The regulation prevents vital ecological initiatives from being abandoned or altered when village leadership changes. Consequently, local regulations in Tarumajaya transcend traditional bureaucratic governance; they represent a novel, adaptive regulatory approach that maintains policy continuity, reinforces community resilience, and embeds local ecological wisdom into the formal state administrative framework.

4. Discussion

Village regulations (Peraturan Desa / Perdes) operate far beyond their conventional definition as static legal-administrative documents; they function as dynamic institutional mechanisms that actively reshape the structural relationship between rural governance, everyday civic practices, and landscape conservation. In the specific empirical setting of Tarumajaya Village positioned at the ecologically sensitive headwaters of the Citarum Riverthe enactment of the avocado planting regulation serves as a critical integrative node. It bridges previously fragmented agendas, connecting disaster risk reduction, hydrological landscape restoration, and household economic survival into a unified local policy framework. A primary theoretical contribution of this study to the literature on local disaster governance lies in conceptualizing village regulations as behavior-shaping regulatory innovations. By strategically embedding ecological obligations into essential civil administration services such as prerequisites for issuing marriage approvals and updating Family Cards for birth registrations the village government constructs a hybrid governance mechanism that leverages legal-administrative necessity to generate environmental participation.

This mechanism extends theoretical insights on institutional trust and compliance behavior, which have traditionally been explored within formal fiscal or tax compliance frameworks (Mishi & Tshabalala, 2023), into the realm of community-based micro-disaster management. It demonstrates that top-down administrative conditions, when designed with local social proximity, can serve as a functional gateway toward habituating sustainable civic practices and long-term ecological stewardship. However, this study also exposes a significant theoretical and practical friction between legal policy adoption and deep social internalization. The empirical evidence reveals a clear operational gap: while residents comply with tree-planting mandates to obtain administrative documents, many continue to view the regulation as a temporary bureaucratic hurdle rather than an internalized principle for daily life. This is reflected in public health-seeking behaviors, where residents interact directly with village midwives for population services and engage with formal village authorities only when an executive signature is legally indispensable. As (Peña, 2018) argues, the transformative capacity of local regulations is not determined solely by their normative legal power, but

by the degree to which formal rules resonate with, adapt to, and embed within established informal social customs.

Consequently, village regulations operate within a continuous space of negotiation where formal legal mandates must constantly interact with embedded local habits and administrative shortcuts. From the analytical lens of village political ecology, this research advances the conceptualization of productive conservation by illustrating how local disaster mitigation policies depend on aligning ecological imperatives with household economic rationality (Mantey & Teye, 2021; Yang & Lu, 2018). Selecting avocado trees rather than non-economic shade trees represents a pragmatic policy compromise. Avocados satisfy ecological restoration demands by establishing deep root networks and dense canopy cover that enhance soil stability and water infiltration in an erosion-prone upstream watershed. Concurrently, they offer tangible, high-value financial returns that incentivize local maintenance, thereby transforming resource-constrained citizens from passive subjects into active custodians of environmental assets. Despite these strengths, the empirical findings contribute a critical nuance to existing productive conservation models by demonstrating that economic incentives alone cannot overcome deep structural barriers, specifically regarding technical capacity and land tenure access (Abdillah et al., 2024).

The sustainability of post-planting conservation remains highly vulnerable when residents view planting as an isolated administrative event and lack technical training in tree maintenance, pruning, fertilization, and pest control. Without continuous technical empowerment, ecological policies risk devolving into symbolic compliance that yields negligible long-term conservation or economic value. Furthermore, skewed land distribution introduces a major structural constraint on equitable policy implementation. In Tarumajaya Village, land control is heavily concentrated among state entities and commercial plantation corporations, which together manage over 90% of the total 3,717-hectare landscape. In stark contrast, private property rights (Hak Milik) held by local residents cover a mere 2.6% (97 hectares), while village treasury land comprises only 0.3% (11 hectares). This severe spatial restriction prevents many resource-poor households from planting trees at standard conservation densities, creating systemic inequalities in program participation and economic benefit distribution.

Ultimately, these findings confirm that local disaster risk reduction and environmental conservation are not linear, technocratic tasks, but rather relational, multi-layered governance ecosystems. The regulatory innovation in Tarumajaya Village succeeds not simply because of its formal legal authority, but because of its ability to connect landscape history, local economic survival, and regional watershed protection. In this framework, intermediary actors specifically Neighborhood Associations (RT/RW) and local community leaders play an essential translation role. They bridge the gap between abstract state regulations and everyday community practices, resolving disputes and guiding informal compliance. This study concludes that village-level regulatory

innovations achieve true sustainability only when understood as comprehensive governance ecosystems where formal legal authority, social proximity, continuous technical empowerment, and equitable resource access are harmonized rather than as isolated legal mandates.

5. Conclusion

This study demonstrates that local disaster mitigation and micro-environmental governance can emerge as dynamic policy innovations rooted in regulatory mechanisms, rather than relying exclusively on high-cost technological solutions or top-down, externally driven development programs. The empirical case of Tarumajaya Village illustrates how local regulations specifically Village Head Regulation No. 2 of 2022—can institutionalize long-term disaster risk reduction by embedding ecological duties into the routine operations of civil administration. By strategically conditioning essential population services (such as marriage approvals and Family Card updates) upon mandatory tree planting, the village administration successfully converted static legal mandates into active, behavior-shaping governance instruments that gradually transform compliance into habituated social norms.

A central conceptual contribution of this research to the broader disaster governance literature lies in challenging the conventional assumption that effective community participation must be strictly voluntary. The findings reveal that administratively induced or conditional participation can serve as a highly functional, pragmatic entry point for building collective environmental responsibility, particularly in resource-constrained rural contexts facing acute hydrometeorological hazards. Furthermore, this study advances the concept of hybrid disaster governance by illustrating how micro-regulatory authority, social proximity, and household economic rationality interact within a unified policy arena. In this framework, intermediary actors—most notably Neighborhood Associations (RT/RW) play a vital operational role in translating legal mandates into socially acceptable local practices, thereby safeguarding policy legitimacy while maintaining long-term implementation momentum.

Practically, these insights emphasize that village governments should not be viewed merely as passive implementers of higher-level directives, but as proactive policy entrepreneurs capable of designing contextualized, self-sustaining regulatory instruments for micro-disaster mitigation. Despite these contributions, this study acknowledges several methodological and empirical limitations. First, because this research relied on a single-case study design focused on Tarumajaya Village, the specific socio-ecological dynamics such as its unique status as the Citarum River headwaters and its distinct local leadership style may limit the direct generalizability of the findings to other rural contexts with differing institutional capacities or land-tenure conditions. Second, while the study captured the immediate behavioral and administrative changes

brought about by the policy, it did not evaluate long-term ecological metrics, such as tree survival rates, actual groundwater infiltration increases, or quantifiable reductions in soil erosion over extended temporal scales. To address these limitations, future research should pursue longitudinal, comparative studies across diverse ecological settings to evaluate the long-term sustainability of administratively induced conservation. Subsequent investigations would benefit from integrating ecological modeling with socio-political analysis to measure the precise environmental impact of productive conservation policies over time. Additionally, exploring alternative institutional mechanisms such as formal land-sharing schemes between village communities and state or corporate landholders could provide valuable insights into overcoming structural spatial constraints in rural disaster governance.

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Data availability
The results of this study are shown in the figure attached to the article. The data set used to support the findings of this study is available from the appropriate authors upon request.

Competing Interests
The authors declare no competing interests.

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