Rehabilitating Critical Land in the Watersheds of North Sulawesi Province, Indonesian: Strategies and Community-Based Implementation

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ABSTRACT

The degradation of watersheds (DAS) due to critical land is a primary environmental challenge in North Sulawesi, Indonesia, leading to increased flooding, erosion, sedimentation, and disruption of water resources. This study aims to describe the strategy and implementation of Forest and Land Rehabilitation (RHL) programs in the province, with a focus on the priority Tondano Watershed. Using a descriptive qualitative methodology based on secondary data from government reports and relevant literature, this research outlines the comprehensive framework for RHL, from long-term planning (RURHL-DAS) to annual operational plans (RTnRHL). Key activities include professional seedling procurement, extensive community socialization, and on-ground rehabilitation through community forests (hutan rakyat). Implementation data for 2024-2025 shows the rehabilitation of 217.12 hectares, combining seedling provision (37.12 ha) and community forests (180 ha). The findings highlight that a synergistic approach, integrating ecological restoration with socio-economic benefits through agroforestry and community empowerment, is crucial for the success and sustainability of rehabilitation efforts. The study concludes that effective RHL in North Sulawesi requires strong cross-sectoral coordination, systematic planning, and active local community involvement to restore ecological functions and enhance community resilience.

***Keyword** : critical land, watershed rehabilitation, North Sulawesi, Tondano watershed, community empowerment*

1. INTRODUCTION

Watershed (DAS) ecosystem degradation remains a pressing issue in Indonesia, driven largely by land-use changes that disrupt hydrological systems (Saroinsong et al., 2007; Pangemanan et al., 2025). This is evidenced by an increased frequency of floods, landslides, and irrigation damage due to erosion and sedimentation (Pandeirot et al., 2018;. Saroinsong, 2022). In North Sulawesi Province, conflicts of interest and a lack of integration between sectors and regions exacerbate this damage. De facto, forest areas continue to deteriorate despite de jure established boundaries.

Critical land is defined as land where the biophysical condition is so degraded that it can no longer function effectively as a medium for production or water regulation (Badan Pusat Statistik, 2018). The Forest and Land Rehabilitation (Rehabilitasi Hutan dan Lahan, RHL) program is thus essential to restore, maintain, and enhance the function of forests and land, ensuring their carrying capacity, productivity, and role in supporting life-support systems. This paper examines the conceptual framework, implementation strategies, and outcomes of RHL activities in the critical watersheds of North Sulawesi, providing a model for similar regions facing ecological degradation.

2. METHODS

This study employs a descriptive qualitative approach, analyzing secondary data from official documents of the North Sulawesi Provincial Forestry Service and the Tondano River Basin Management Office (BPDAS Tondano). The data includes policy documents, implementation reports for 2024-2025, and maps of critical land and watershed management units. A literature review of academic publications was also conducted to contextualize the findings within the broader discourse on watershed management and land rehabilitation. The analysis focuses on the planning concepts, implementation mechanisms, and the socio-ecological benefits derived from the rehabilitation activities.

3. RESULTS AND DISCUSSION

Implementation of Rehabilitation Activities

The implementation of RHL in North Sulawesi is executed through three main pillars:

1. Seedling Procurement: The government ensures a supply of quality seedlings, including Multipurpose Tree Species (MPTS), from three permanent nurseries (e.g., Likupang Batuputih Modern Nursery). This is critical for ensuring the right species are planted for ecological restoration and community benefit (Aulia, Irundu, & Idris, 2023). In addition to centralized production, local community nurseries are encouraged to participate in seedling propagation to promote ownership and reduce transportation costs. The integration of local genetic resources is also prioritized to maintain ecological suitability and resilience to local environmental stresses. Furthermore, collaboration between forestry agencies, research institutions, and local farmer groups facilitates the identification of high-performing native species suited to different microhabitats within the watershed. Continuous monitoring of seedling quality, including germination rates, root health, and adaptability, ensures that planting materials meet restoration objectives and long-term sustainability targets.
2. Community Socialization: A two-stage socialization process is conducted. General Socialization introduces the program's goals and benefits to build community support. Technical Socialization provides hands-on training in planting techniques, spacing, and maintenance, directly involving farmer groups (Sanaky & Siwa, 2024). This participatory approach is essential for ensuring that local communities not only understand the ecological objectives but also recognize the socioeconomic advantages of rehabilitation activities. During the process, local leaders, women's groups, and youth organizations are engaged to foster inclusivity and collective responsibility. Practical demonstrations and field schools are organized to enhance local technical capacity and promote peer learning among farmers. Moreover, continuous feedback mechanisms allow communities to express challenges and propose context-specific solutions, which strengthens local ownership and sustainability of the rehabilitation efforts. The two-stage socialization process thus bridges scientific knowledge and traditional ecological practices, ensuring long-term behavioral change and stewardship of restored landscapes.
3. On-Ground Rehabilitation: Activities are implemented through two schemes:
   a. Seedling Provision: Distributing seedlings for planting on critical land. This program targets degraded slopes, riparian zones, and former agricultural lands to enhance vegetation cover and soil stability. The selection of species is based on ecological suitability, local livelihood potential, and long-term restoration goals. Regular field supervision ensures proper planting density, survival monitoring, and adaptive management to improve success rates over time.
   b. Community Forests (Hutan Rakyat): Involving communities in planting and maintaining a mix of forestry and productive plants on their land. This scheme promotes an agroforestry-based approach, combining timber, fruit, and multipurpose tree species to optimize both ecological and economic outcomes. Through this participatory model, local farmers gain additional income sources while contributing to watershed protection and biodiversity restoration. Community institutions play a key role in coordinating maintenance activities, monitoring plant

growth, and ensuring compliance with sustainable management practices.

4. The realized rehabilitation area for 2024-2025 is summarized below:

Year	Seedling Provision (ha)	Community Forest (ha)	**Total (ha)**
2024	19.27	100.00	**119.27**
2025	17.85	80.00	**97.85**
Total	**37.12**	**180.00**	**217.12**

The RHL Framework and Priority Watershed

The RHL program in North Sulawesi is guided by a structured, long-term plan (RURHL-DAS) and detailed annual plans (RTnRHL). The province has 23 Watershed Management Units (SWP DAS) covering 1,423,047 hectares. The Tondano Watershed is identified as a strategic priority due to its critical state and vital role. It supports Lake Tondano, a key source of clean water, hydropower, irrigation, and local livelihoods. However, it suffers from severe degradation caused by deforestation, land conversion, and unsustainable agriculture, leading to high erosion and sedimentation rates (Karouw, Liando, & Waleleng, 2023). Forest and Land Rehabilitation has gained global prominence as a multifaceted approach addressing the critical challenges of deforestation, soil degradation, and biodiversity loss, necessitating a thorough review of existing frameworks and methodologies (Löhr et al., 2024) (César et al., 2020). Despite the widely acknowledged importance of integrating social and ecological dimensions, many restoration projects tend to emphasize ecological aspects, often overlooking the critical social perspectives required for sustainable outcomes (Löhr et al., 2024). This oversight can lead to unsuccessful restoration initiatives within Forest Landscape Restoration endeavors, particularly given the United Nations' declaration of 2021-2030 as the Decade of Ecosystem Restoration (Maniraho et al., 2023). Consequently, an integrated approach that balances both social and ecological considerations is essential for achieving long-term success in restoration efforts (Löhr et al., 2024).

Critical land represents a state of severe land degradation where the biophysical properties of the soil are so diminished that the land can no longer perform its ecological and productive functions effectively. This degradation is characterized by deteriorated soil structure, loss of fertility, reduced water infiltration capacity, and increased vulnerability to erosion and mass wasting (Tiagas & Lateheru, 2024). The primary drivers are often anthropogenic, including deforestation, unsustainable agricultural practices on slopes, and land conversion that exceeds the land's carrying capacity, exacerbated by natural factors like high rainfall and steep topography.

The impacts of critical land are multifaceted and pernicious. Ecologically, it disrupts hydrological cycles, leading to decreased water retention in the dry season and increased surface runoff and flooding in the wet season. Severe erosion leads to the sedimentation of rivers and reservoirs, impairing water quality and reducing the lifespan of hydraulic infrastructure. From a socio-economic perspective, critical land threatens food security by reducing agricultural productivity, undermines livelihoods, and increases the risk of environmental disasters such as landslides, thereby perpetuating a cycle of poverty and vulnerability (Badan Pusat Statistik, 2018).

Therefore, rehabilitating critical land is not merely a technical exercise but a vital imperative for sustainable development (Pangemanan et al., 2025;. Forest and Land Rehabilitation (RHL) is defined as a systematic effort to restore, maintain, and enhance the functions of forest and land to reinstate their carrying capacity, productivity, and role in supporting life-support systems (Hamidah, Adhya, Hendrayana, & Supartono, 2024). Effective rehabilitation employs an integrated approach, combining vegetative methods (e.g., reforestation, agroforestry using Multipurpose Tree Species) with civil engineering

techniques (e.g., terracing, check dams) (Suparwata, 2017). Crucially, contemporary best practices emphasize that successful, sustainable rehabilitation must be participatory, integrating socio-economic benefits for local communities through empowerment and agroforestry systems to ensure long-term commitment and success (Saroinsong et al., 2021; Talif et al., 2023). This holistic approach is essential for rebuilding ecosystem resilience, mitigating climate change, and securing human well-being (Saroinsong, 2022).

Socio-Ecological Benefits and Synergies

The RHL program delivers significant benefits. Ecologically, it restores hydrological functions, prevents erosion, enhances carbon sequestration, and conserves biodiversity. Socio-economically, it creates employment and strengthens local economies through agroforestry systems, producing timber, fruit, and other non-timber forest products (Talif, Hasanuddin, Abdullah, Hajawa, & Mukti, 2023). The involvement of communities in "hutan rakyat" fosters a sense of ownership, which is crucial for the long-term maintenance and success of the rehabilitated areas (Rombang et al., 2017; Talif et al., 2023; Pangemanan et al., 2025). This participatory model effectively converts local communities from passive beneficiaries into active stewards of the land. Their direct engagement in activities—from seedling distribution and planting to maintenance and monitoring—ensures that rehabilitation efforts are not only ecologically appropriate but also socially embedded. This empowerment leads to higher survival rates for planted seedlings and fosters sustainable land management practices that persist long after the initial project phase, thereby securing the long-term resilience of the watershed ecosystem. The rehabilitation of critical lands within watershed systems presents a multifaceted approach to mitigating environmental degradation and enhancing socio-ecological resilience. Initially, such efforts focused predominantly on physical interventions like reforestation and soil conservation, primarily aimed at improving climate resilience and sustaining crucial ecosystem services (Naji et al., 2024; Nurmawan et al., 2025). However, contemporary understanding recognizes that neglecting social perspectives in these initiatives can lead to suboptimal or even unsuccessful restoration outcomes within Forest Landscape Restoration (Maniraho et al., 2023). This oversight often stems from a failure to integrate the human dimension, including local communities' needs, knowledge, and participation, into the planning and implementation phases of restoration projects (Shelton et al., 2024) (Maniraho et al., 2023).

4. CONCLUSION

The rehabilitation of critical land in North Sulawesi's watersheds is a complex but essential endeavor. The success of the RHL program hinges on a multi-faceted strategy that includes systematic planning, professional seedling supply, comprehensive community engagement, and the implementation of synergistic models like community forests. The case of the Tondano Watershed demonstrates that integrating ecological goals with socio-economic incentives through community empowerment is key to achieving sustainable outcomes. For future success, continued cross-sectoral collaboration, adequate funding, and consistent monitoring and evaluation are recommended. This approach not only restores degraded ecosystems but also builds community resilience, offering a replicable model for watershed rehabilitation in other tropical regions.

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