National Greening Program in the Philippines: A Thematic Review of Policy Frameworks, Implementation Practices and Measured Outcomes

.

ABSTRACT

|  |
| --- |
| The Philippine government launched the National Greening Program (NGP) in 2011 to reforest 1.5 million ha of degraded land, later expanding its target to 7.1 million ha by 2028. This review covers literature published between 2014 and 2024 in Scopus-indexed journals, supported by relevant policy and technical documents, to evaluate scholarly engagement with the NGP. A total of 22 peer-reviewed studies forming the core evidence base were analyzed and grouped into four thematic areas: remote sensing and monitoring, policy and governance, community participation and socioeconomic impact, and species selection and biodiversity. Findings reveal notable advances in geospatial monitoring and regulatory reforms, which have improved oversight and policy integration. However, persistent implementation challenges, such as fragmented planning, weak community involvement, and poor ecological matching, continue to limit the program’s effectiveness. While some socioeconomic benefits have been observed, the literature indicates that the NGP often falls short in delivering sustained livelihood improvements due to limited tenure security and post-planting support. This review underscores the need to shift from purely quantitative planting targets toward quality-driven, site-specific, and inclusive restoration strategies. Key recommendations include integrating biodiversity-sensitive practices, enhancing community-led planning, strengthening governance mechanisms, and institutionalizing the use of ecologically appropriate planting materials. As the NGP approaches its 2028 target, evidence-based, participatory approaches will be critical to ensuring the program’s long-term ecological and social success. |

*Keywords:* Community participation, Environmental governance, Forest restoration, Remote sensing, Reforestation, Sustainable land management

**1. INTRODUCTION**

The Philippines has experienced significant forest loss and degradation over the past century. Forest cover declined from approximately 17 million hectares in 1930 to just 5.8 million hectares by 2000 (Dolom, 2003), posing a critical threat to the country’s rich biodiversity (Verburg et al., 2006). The main drivers of deforestation include commercial logging, illegal forest activities, agricultural expansion, and shifting cultivation, locally known as kaingin (Verburg et al., 2006; Mukul et al., 2016). According to the most recent report by the Forest Management Bureau (FMB), forest cover had modestly increased to 7.2 million hectares by 2020 (FMB, 2024).

Forest degradation has far-reaching ecological and socio-economic consequences. It reduces the capacity of ecosystems to provide essential services such as carbon sequestration, wood production, and biodiversity conservation (Thompson et al., 2013). Moreover, deforestation exacerbates the severity of environmental hazards, including flooding and landslides (Nistor, 2021). These challenges are compounded by the Philippines’ high vulnerability to climate anomalies, which threaten national economic growth and the well-being of millions, particularly marginalized and poor communities (Fuentes & Conception, 2007).

In response to these environmental and socio-economic threats, the Philippine government launched the National Greening Program (NGP) in 2011 through Executive Order No. 26. Initially covering the period 2011–2016, the program aimed to plant 1.5 billion trees across 1.5 million hectares of denuded and degraded lands. This was later expanded under Executive Order No. 193 in 2015, with an extended target of 7.1 million hectares by 2028 (Aquino, 2015; Fontanoza, Jr. & Navarra, 2020; Goltiano et al., 2021; von Kleist et al., 2021). The NGP pursues multiple objectives: poverty reduction, food security, biodiversity conservation, and climate change mitigation (Cagalanan, 2016; Goltiano et al., 2021).

Led by the Department of Environment and Natural Resources (DENR), the NGP is implemented in partnership with Local Government Units (LGUs), civil society organizations, and grassroots communities. LGUs are mandated to contribute by planting and maintaining trees in public spaces such as parks and urban forests (Fontanoza, Jr. & Navarra, 2020). A central strategy of the NGP is the involvement of farmers and local residents, who receive training and labor-based incentives to promote sustainable reforestation (Goltiano et al., 2021).

Despite its ambitious scope and planting achievements, the program’s effectiveness in delivering long-term biodiversity and livelihood outcomes remains contested. While some gains have been noted in knowledge and technical capacity, immediate socioeconomic benefits to participants were found to be limited and inconsistently distributed (Goltiano et al., 2021). The NGP has also been criticized for prioritizing quantitative targets over ecological integrity, often neglecting biodiversity-sensitive practices and community-based forestry principles (von Kleist et al., 2021).

Further constraints arise from issues of poor governance, inadequate planning, and regulatory gaps. Satellite-based assessments show that although forest cover initially increased, deforestation resurged between 2016 and 2018, resulting in minimal net forest gain (Perez et al., 2020). The FMB (2024) reported only a 3% increase in forest cover from 2015 to 2020, underscoring the limited progress in reversing deforestation trends. These persistent challenges highlight the need for improved program design, stronger stakeholder participation, and more robust monitoring frameworks. Scholars advocate for deeper community engagement, clearer policy alignment, and the use of advanced remote sensing technologies to evaluate ecological and social outcomes (Diwa et al., 2024; von Kleist et al., 2021; Goltiano et al., 2021).

More than a decade after its launch, the NGP remains one of the most ambitious environmental and development initiatives in Philippine history. Its multi-dimensional goals, ranging from ecosystem restoration to poverty alleviation, make it a complex undertaking with broad implications for sustainability, governance, and rural development. As implementation continues toward its 2028 targets, there is an urgent need to critically assess how the program has been studied, understood, and evaluated by the academic and policy communities.

Although several studies have explored specific components of the NGP, such as planting performance, livelihood effects, and governance dynamics, no comprehensive synthesis has been undertaken to consolidate the scope, direction, and findings of these works. The existing literature remains fragmented by theme, scale, and methodology, limiting the ability to derive integrated insights about the program’s strengths, weaknesses, and future potential. Moreover, questions remain regarding the balance between environmental and social outcomes, the effectiveness of monitoring mechanisms, and the extent of meaningful community participation in implementation.

Given these gaps, a systematic review of research conducted on the NGP from 2011 to 2025 is both timely and necessary. This paper aims to provide a holistic overview of peer-reviewed and policy-relevant literature that has examined the program since its inception. By identifying dominant research themes, geographic and institutional coverage, methodological approaches, and evidence-based insights, this review seeks to highlight both the achievements and limitations of current knowledge.

Anchored on the overarching goal of assessing scholarly engagement with the NGP, this paper seeks to achieve the following specific objectives:

1. Determine the extent and thematic focus of peer-reviewed research on the NGP published between 2011 and 2025;

2. Analyze the contributions of these studies to the understanding, evaluation, and improvement of the program’s implementation, outcomes, and impacts; and

3. Identify key research gaps and recommend future research thrusts and directions that can enhance the program’s refinement, sustainability, and long-term success.

By addressing these objectives, this review aims to deliver a synthesized and critical account of how the NGP has been represented in the literature, offering insights that are relevant for both academic inquiry and policy advancement.

**2**. **SCOPE AND METHOD OF LITERATURE REVIEW**

To address the identified research gaps and meet the objectives of this review, a literature analysis was conducted focusing on Scopus-indexed publications relevant to the NGP. The review specifically covers documents published from 2014 to 2024, aligning with the years following the official implementation of the program in 2011.

A systematic search was carried out using the Scopus database, applying the keywords “National Greening Program” AND “Philippines” to the title, abstract, and keyword fields. This search yielded a total of 22 documents, which were subjected to detailed metadata analysis. Each document was reviewed for information, including publication year, document type, citation count, subject area, and source title. The documents were then categorized into four major subject areas based on their central thematic focus (Table 1).

Table 1. Scopus-indexed studies related to the National Greening Program in the Philippines (2014–2024).

|  |  |  |
| --- | --- | --- |
| **Author(s)** | **Year** | **Major subject area** |
| **Garcia and Principe** | **2024** | **Remote Sensing, GIS, and Landscape Change Monitoring** |
| **Diwa et al.** | **2024** |
| **Pansit and Parilla** | **2024** |
| **Israel and Bantayan** | **2021** |
| **Fontanoza, Jr. and Navarra** | **2020** |
| **Perez et al.** | **2020** |
| **Arellano et al.** | **2019** |
| **Jardeleza et al.** | **2019** |
| **Estoque et al.** | **2018** |
| **Pada et al.** | **2016** |
| **von Kleist et al.** | **2021** | **Policy and Environmental Governance** |
| **Cruz** | **2018** |
| **Navarrete et al.** | **2018** |
| **Gregorio et al.** | **2017** |
| **Baynes et al.** | **2016** |
| **Cagalanan** | **2016** |
| **Wiset et al.** | **2023** | **Community Participation and Socioeconomic Impact** |
| **Goltiano et al.** | **2021** |
| **Cororaton et al.** | **2016** |
| **Le et al.** | **2014** |
| **Nabua et al.** | **2023** | **Species Selection, Biodiversity, and Tree Improvement** |
| **Engay-Gutierrez et al.** | **2022** |
|  |  |  |

In terms of document type, 15 were journal articles, five were conference papers, and two were book chapters (Figure 1). These were published across 18 distinct sources, with the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences (ISPRS Archives)* contributing the largest number (n = 3). As of June 2025, 18 of the 22 documents had been cited at least once, with a total citation count of 277. The resulting h-index for this dataset is six, indicating that six documents have received at least six citations each.

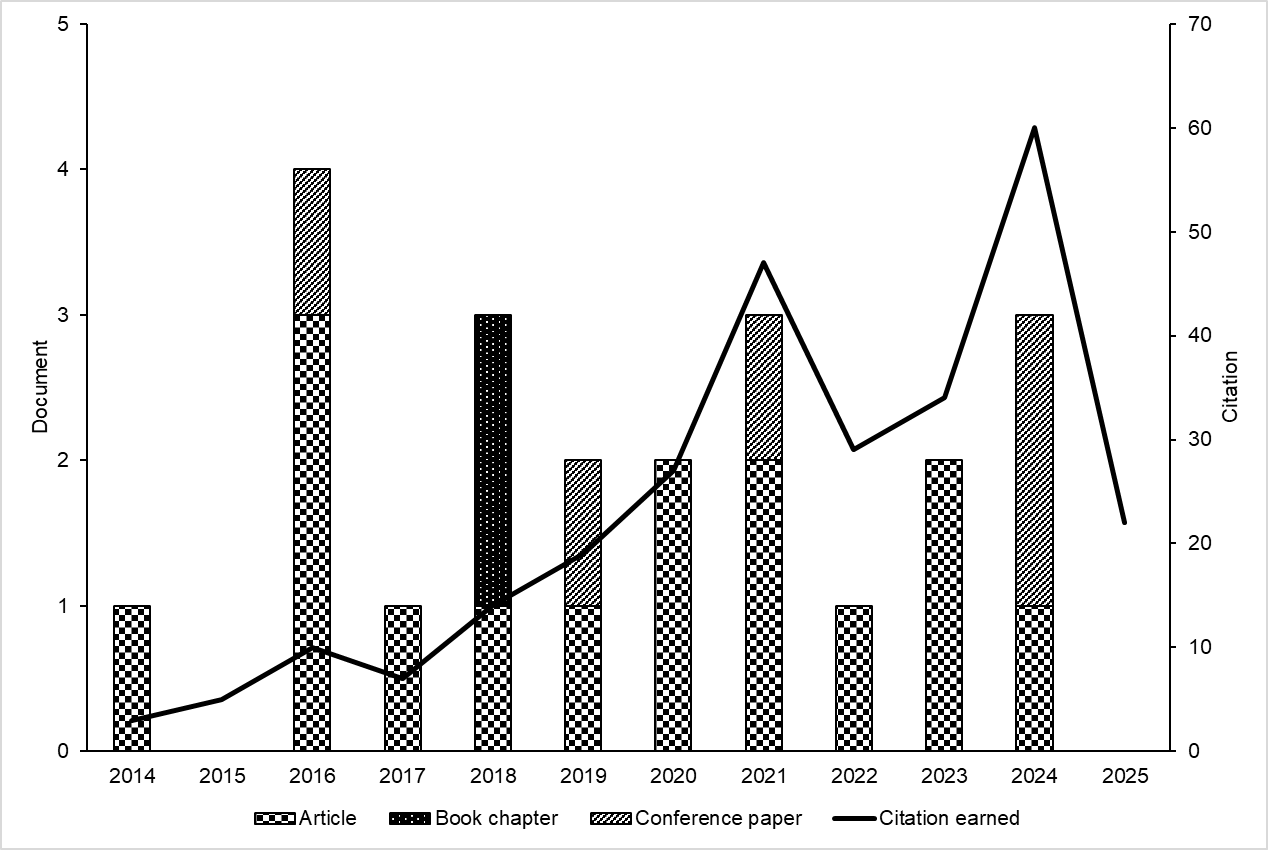


Fig. 1. Year of publication, document type and citation count of Scopus-indexed studies on the National Greening Program in the Philippines.

All reviewed documents were written in English and formed the core dataset for identifying research trends, thematic concentrations, and gaps in the literature. To provide a broader and more nuanced discussion, this review also incorporated additional sources, such as government reports and recent technical publications, where appropriate.

**3.** **REMOTE SENSING, GIS, AND LANDSCAPE CHANGE MONITORING**

This section highlights the use of geospatial tools in monitoring forest conditions, land cover change, and NGP outcomes. Technologies such as Normalized Difference Vegetation Index (NDVI) analysis, radar imaging, and mangrove suitability mapping have supported forest disturbance detection and spatial policy assessments (Estoque et al., 2018; Arellano et al., 2019; Jardeleza et al., 2019; Fontanoza and Navarra, 2020; Perez et al., 2020). These methods have also revealed spatial mismatches in site selection, landscape-scale forest dynamics, and varying impacts of reforestation across regions (Israel and Bantayan, 2021; Pada et al., 2016; Garcia and Principe, 2024; Pansit and Parilla, 2024; Diwa et al., 2024).

Several studies have confirmed that remote sensing platforms, particularly the use of NDVI, SAR backscatter, and Google Earth Engine, offer scalable, near-real-time tools for evaluating vegetation trends under the NGP. Radar backscatter analysis has also been employed to differentiate forest structural conditions. Arellano et al. (2019) used Sentinel-1A SAR data to assess dense versus sparse forest growth in Zamboanga Sibugay and Bohol, demonstrating the utility of radar imagery for structural characterization in cloud-prone regions. Their findings revealed that radar backscatter values could effectively distinguish varying biomass densities and canopy structures, providing an objective measure of forest condition. This is significant for the NGP as it enhances the capacity to monitor forest development over time, particularly in areas where frequent cloud cover hinders the use of optical satellite imagery. The study supports the integration of advanced geospatial technologies into national reforestation efforts, offering a more accurate and consistent means of evaluating project outcomes and informing adaptive management strategies.

Diwa et al. (2024) have developed a methodology using both optical (Sentinel-2 and MODIS) and radar (Sentinel-1 SAR) satellite imagery to assess reforestation efforts in Zambales. Their approach utilized indices such as NDVI, RVI (Radar Vegetation Index), and RFDI (Radar Forest Degradation Index), and applied advanced techniques like Random Forest classification via Google Earth Engine. The results showed consistent increases in vegetation cover from 2016 to 2022, indicating successful greening efforts in the area. These findings were validated with field data, highlighting the reliability of combining remote sensing with on-the-ground verification. On the other hand, Israel and Bantayan (2021) found that countrywide NDVI mosaics indicated a positive trend in vegetation cover from 2011 to 2018, especially in protected areas and ancestral domains, suggesting that the NGP had a measurable impact in areas with stronger institutional stewardship.

Moreover, monitoring forest fragmentation and urban greening efforts has also featured prominently. Fontanoza and Navarra (2020) applied mean patch size as a spatial metric to evaluate the effectiveness of Quezon City’s urban reforestation under the NGP, finding increased patch cohesion and vegetation density in key urban parks. Furthermore, Casisirano et al. (2024) applied remote sensing and GIS in their study on tree planting prioritization in the National Capital Region, Philippines, using remote sensing, analytic hierarchy process, and GIS to aid local government agencies and environmental organizations in evaluating and recalibrating their local greening programs. Meanwhile, Estoque et al. (2018) conducted a multi-temporal landscape analysis in the La Mesa Watershed, concluding that while tree cover had improved from 2002 to 2016, urban encroachment remained a threat, and forest fragmentation continued at the peripheries. These findings underscore the potential of remote sensing not only to assess gains but also to identify persistent pressures on forest systems.

Furthermore, the Philippine Space Agency (PhilSA) (2023), in partnership with the DENR, launched a national initiative in 2023 to institutionalize geospatial monitoring for the NGP. This program involves the monthly generation of vegetation and forest-cover maps through satellite data, complemented by DENR's own field and policy data. The integration aims to enhance the DENR’s capacity to assess the performance of the NGP and detect forest disturbances more efficiently. A geospatial database system has been developed under this initiative, and DENR staff are being trained to operate and interpret satellite data using platforms like Google Earth Engine. These efforts ensure that the remote sensing outputs directly reflect the realities on the ground and conform to official DENR records and standards (PhilSA, 2023). Overall, both the Diwa et al. (2024) study and the DENR–PhilSA collaboration highlight the growing potential of GIS and remote sensing to provide accurate, up-to-date, and policy-relevant data for evaluating the progress of the NGP.

Despite these technological advances, other studies have observed limited or uneven gains in forest cover. Pansit and Parilla (2024) reported minimal positive NDVI changes in Central Visayas between 2013 and 2019, with only modest vegetation recovery in Negros Oriental. Cebu, on the other hand, experienced vegetation loss due to low seedling survival, agricultural conversion, and unregulated tourism. Similarly, Perez et al. (2020) demonstrated that despite large-scale planting campaigns in Northern Luzon, satellite data did not reflect meaningful forest recovery due to ongoing deforestation driven by subsistence activities and logging.

Forest disturbance monitoring and land use modeling have also formed critical components of recent assessments. Garcia and Principe (2024) used the Normalized Difference Moisture Index (NDMI) to detect changes in the Kaliwa River Forest Reserve, where forest loss was significantly driven by kaingin practices and illegal logging, although reforestation initiatives had slowed the rate of disturbance. Jardeleza et al. (2019) utilized land cover change models to simulate deforestation trends nationwide and projected future forest loss under different policy scenarios. Their study emphasized that unless forest governance is strengthened, NGP’s reforestation gains may be eroded by continued land conversion.

In terms of site suitability assessment, Pada et al. (2016) conducted a GIS-based evaluation of mangrove planting sites in Kabankalan, Negros Occidental. The study revealed that many reforestation efforts had failed due to species-site mismatches. By analyzing pH, salinity, soil type, and elevation, the authors provided a detailed suitability map that could guide future mangrove restoration. Their work reinforces the argument that ecological diagnostics must precede planting activities to ensure survival and success.

A related issue in upland reforestation was identified by Emam and Lubos (2021), who reported that many NGP sites in upland areas of Bukidnon experienced high seedling mortality due to mismatches between soil characteristics and the species planted. Emam and Lubos (2021) further stressed that planners often bypassed soil testing, slope analysis, and rainfall assessment, resulting in the planting of fast-growing exotic species in degraded or poorly suited environments. This study signifies one of the factors affecting the implementation of the largest reforestation activity in the country.

While the NGP is a significant project aimed at improving forest cover in the Philippines, and the DENR is advancing its ability to measure and monitor the program, the initiative was reported to be slow in its implementation. A report from the Philippine Institute for Development Studies (PIDS) (2015) indicated that in its first three years, the NGP planted only 398 million seedlings out of a planned 600 million, with an average survival rate of 61%, which falls short of the 85% target. In 2019, a Commission on Audit (COA) performance audit revealed that the NGP fell far short of its 1.5 million ha target, achieving only about 177,000 ha, or 12% of its goal. The audit cited rushed planning, untenured sites without maintenance, and the planting of largely agroforestry species that did not contribute to true forest cover (COA, 2019).

These studies underscore that while the Philippines has made progress in remote monitoring of reforestation, the overall outcomes of the NGP remain uneven. Technological tools have enhanced the ability to measure vegetation change and forest disturbance, yet implementation challenges, including poor site-species matching, continuing deforestation, and urban expansion, remain unresolved. Remote sensing can identify where forest gains are occurring and where they are not, but translating these insights into adaptive management strategies remains a critical gap in NGP governance. These monitoring gaps highlight the importance of examining how institutional frameworks and policy designs can better respond to the on-the-ground realities revealed by geospatial tools.

**4.** **POLICY AND ENVIRONMENTAL GOVERNANCE**

This section highlights the institutional and regulatory frameworks of the NGP, focusing on integrated policy design, seedling standards, science-based planning, and governance reforms to support biodiversity and productivity goals (Baynes et al., 2016; Cagalanan, 2016; Gregorio et al., 2017; Cruz, 2018; Navarrete et al., 2018). It also addresses persistent issues such as fragmented planning, weak coordination, limited community inclusion, and implementation gaps, including poor site matching and top-down decision-making (von Kleist et al., 2021).

Cruz (2018) positioned the NGP as a strategic policy tool within the broader context of water and land management in the Philippines. He argued that aligning reforestation efforts with watershed rehabilitation and climate change mitigation strategies could significantly enhance long-term environmental security. By restoring forests, the NGP not only improves biodiversity and ecosystem services but also serves as a natural carbon sink, helping mitigate climate change. In terms of adaptation, the program’s efforts to reforest watersheds and coastal areas, such as mangrove restoration, enhance resilience to extreme weather events, flooding, and coastal erosion, issues exacerbated by climate change. However, institutional fragmentation and weak sectoral alignment have hindered the program’s effectiveness. To address these, the Philippine government introduced key policies, notably the Philippine Master Plan for Climate Resilient Forestry Development 2022–2030, which aims to harmonize approaches across forestry, water, and land-use planning (DENR, 2022). Despite these efforts, field-level fragmentation persists.

Israel (2017) noted that although the NGP has mobilized financial and institutional resources, its operational coherence has been undermined by ambiguities in the roles of national agencies and LGUs, as well as overlapping mandates within the DENR. He suggested integrating reforestation into broader watershed management frameworks to improve institutional accountability. This concern was partially addressed through DENR Administrative Order No. 2021-18, which mandates site-specific, science-based planning that considers topographic, hydrological, and ecological suitability (DENR, 2021b). While this policy lays the foundation for better governance, implementation challenges in upland municipalities continue.

Luna (2016) critiqued the NGP’s siloed governance, where administrative targets, such as the number of trees planted, often overshadowed the need for integrated landscape management. He advocated for incorporating climate adaptation, disaster risk reduction, and land-use harmonization into reforestation planning. Reforms such as Executive Order No. 193 of 2015 and DAO 2021-11 have begun shifting the program towards landscape-level approaches and ecological integrity (DENR, 2021a). However, program success is still largely measured by output-oriented indicators like planting targets, rather than by ecosystem services, highlighting a disconnect between policy and practice.

Gregorio et al. (2017) pointed to issues in nursery accreditation and seedling quality control, where procurement practices prioritized cost-efficiency over biological quality, contributing to high seedling mortality. DAO 2021-11 addressed these concerns by establishing stricter nursery accreditation procedures, third-party audits, and mandatory seedling performance monitoring (DENR, 2021a). These measures represent progress in strengthening the technical foundation of forest restoration.

Navarrete et al. (2018) emphasized the absence of soil-based considerations in NGP planning, which led to ecological mismatches and lower seedling survival rates. They recommended integrating soil diagnostics, land classification, and agroecological zoning into program protocols. DAO 2021-18 responded by requiring soil data collection and application during site assessments (DENR, 2021b). However, uneven technical capacity and limited access to soil data remain barriers to effective implementation.

Cagalanan (2016) provided evidence of the positive outcomes of public-private partnerships (PPPs) in reforestation, citing a successful case in Negros Occidental, where collaboration between a geothermal company and local communities improved both ecological and social results. While current DENR policies and the Master Plan for Climate Resilient Forestry Development recognize the value of PPPs, institutional incentives for long-term private sector engagement are still underdeveloped, limiting the scalability of these models (DENR, 2022).

von Kleist et al. (2021) offered a governance critique, identifying factors that hinder biodiversity outcomes in the NGP: prioritizing planting volume over ecological suitability, marginalizing community-based forestry systems, and inadequate implementation planning. Attempts to recalibrate the NGP through the Master Plan and DAO 2021-18 stress the importance of biodiversity-oriented and participatory strategies (DENR, 2022; DENR, 2021b). However, entrenched institutional norms and centralized decision-making continue to impede significant reforms.

Baynes et al. (2016) examined governance limitations, revealing how inequitable power dynamics within community forestry groups fostered exclusion and resistance. Their findings underscored the limitations of devolving authority without ensuring participatory structures and equitable benefit-sharing. Although recent policies emphasize stakeholder engagement and participatory governance, actual implementation often remains top-down, creating a gap between policy ideals and field realities (DENR, 2022).

Collectively, the reviewed studies illustrate both progress and persistent challenges in the institutional and governance aspects of the NGP. While policy reforms signify a shift toward more integrated, science-based, and participatory approaches, unresolved issues include inconsistencies in local implementation, limited institutional capacity, and an ongoing focus on quantitative metrics over ecological and social outcomes. Addressing these gaps requires not only technical improvements but also systemic reforms that prioritize coherence, inclusivity, and long-term ecological sustainability in forest governance. These governance reforms are crucial for translating policies into meaningful community participation and socioeconomic benefits at the grassroots level.

**5.** **COMMUNITY PARTICIPATION AND SOCIOECONOMIC IMPACT**

This section reviews the engagement of local communities in the NGP and its associated socioeconomic impacts, focusing on community-led forest restoration, the lived experiences of smallholders, and the broader economic potential of reforestation in reducing poverty and enhancing livelihood resilience in the Philippines (Le et al., 2014; Cororaton et al., 2016; Goltiano et al., 2021; Wiset et al., 2023).

Since its launch in 2011, the NGP has planted over 2 million hectares of forests, produced more than 1.8 billion seedlings, and created over 5.3 million jobs across the country. These accomplishments represent significant progress in restoring degraded forestlands, enhancing ecosystem services, and contributing to rural employment and poverty reduction (FMB, 2024).

Wiset et al. (2023) examined community engagement in reforestation initiatives under the NGP in Leyte and Biliran. Their study focused on the role of People’s Organizations (POs) in restoring degraded forest landscapes. While the program mobilized collective action, it often failed to involve communities in meaningful decision-making. Local actors were typically limited to fulfilling labor contracts, with little input in species selection, site design, or monitoring frameworks. This limited engagement reduced the sense of ownership and long-term commitment to forest maintenance. Wiset et al. (2023) emphasized that the success of large-scale reforestation depends not just on technical execution but on securing tenure, empowering communities, and fostering a bottom-up governance model. This pattern reflects common challenges in Philippine reforestation, where top-down delivery mechanisms often overlook the needs of upland communities (Pulhin et al., 2024). Baynes et al. (2016) echoed these concerns, noting that community forestry efforts in Southeast Asia often struggle due to weak participatory structures and a lack of local autonomy.

Goltiano et al. (2021) further explored the socioeconomic outcomes of NGP implementation among smallholder farmers in Caibiran, Biliran. Their research revealed a disconnect between measured improvements and participants’ perceptions of change. While quantitative indicators suggested increased income and skills development among farmers, respondents were skeptical about any real improvement in their quality of life. The perceived shortcomings were mainly linked to the lack of post-planting livelihood support, limited market access, and exclusion from planning and monitoring roles. The study concluded that without sustained engagement, capacity-building, and integrated support services, the economic benefits of NGP remain short-lived. Chechina et al. (2018) highlighted similar issues, noting that forest-dependent communities in the Philippines achieved better outcomes when local livelihoods, such as non-timber forest products, were integrated into conservation planning.

At the national level, Cororaton et al. (2016) conducted an economic modeling study to assess the potential of the NGP in improving rural livelihoods and reducing poverty. Their findings indicated that full implementation of the NGP could increase agricultural productivity, lower food prices, and improve household welfare, particularly for the poorest segments of the population. However, they cautioned that these outcomes depend on program continuity, effective governance, and the integration of NGP objectives into broader rural development strategies. This reflects a common challenge in Philippine development programs: strong short-term implementation with weak long-term institutional integration. The World Bank (2021) echoed this point, emphasizing that natural capital investment alone is insufficient without strong institutions and consistent policy support.

Le et al. (2014) examined 43 reforestation projects in Leyte and identified key success drivers, including revegetation methods, funding sources, education campaigns, forest protection mechanisms, infrastructure, and community dependence on forest resources. Successful projects often combined mixed-species plantations with marketable trees, allowing communities to meet both conservation and livelihood needs. Education campaigns improved local stewardship, and road conditions, surprisingly, influenced seedling transport and market access. Forest protection mechanisms, such as grazing control and fire prevention, were critical for maintaining planted areas.

Le et al. (2014) emphasized that reforestation success depends on the interaction of technical, institutional, and social factors. When communities are empowered through inclusive planning, appropriate incentives, diversified livelihood options like agroforestry and non-timber forest products, and strong partnerships with government and NGOs, projects are more likely to achieve ecological restoration and sustainable development goals. Börner et al. (2020) reinforced this idea, emphasizing that secure tenure, community participation, and robust incentives are essential for effective and lasting forest restoration. Their global review highlighted the need for integrated strategies that combine technical interventions with social investment, infrastructure development, and sustained capacity-building for local stakeholders.

These studies demonstrate that while the NGP has created temporary employment and introduced forest restoration practices at the community level, it has not yet fully realized its potential as a poverty reduction and social development program. Many community members involved in NGP projects still face land tenure insecurity and unstable incomes, despite their contributions to forest rehabilitation. Structural limitations in participation, livelihood integration, and follow-through have prevented communities from fully benefiting from the program. To become an effective driver for inclusive growth, the NGP must adopt a systems-based approach that strengthens socio-economic incentives, encourages community leadership, and supports enabling conditions such as road infrastructure, market access, and multi-actor partnerships. In future iterations, integrating long-term livelihood strategies, adaptive management practices, and grassroots-driven monitoring systems could improve the program's ecological and social outcomes. Such inclusive approaches are vital when considering biodiversity and tree improvement strategies that must align with both ecological objectives and community needs.

**6. SPECIES SELECTION, BIODIVERSITY, AND TREE IMPROVEMENT**

This section examines the ecological contributions of the NGP, focusing on the use of native tree species, biodiversity-centered reforestation strategies, and appropriate species-site matching, particularly in mangrove ecosystems (Engay-Gutierrez et al., 2022; Nabua et al., 2023).

Engay-Gutierrez et al. (2022) conducted a tree improvement assessment in Mt. Banahaw de Lucban, Quezon, in Southern Luzon, identifying 22 superior individual trees across 12 native forest tree families. Using phenotypic selection criteria such as height, diameter, and canopy structure, the study identified vigorous trees predominantly found at mid-elevations (700–900 m above sea level). These individuals demonstrated strong site adaptability, making them valuable genetic resources for future reforestation efforts. This approach aligns with tree improvement programs, which focus on selecting genetically superior traits to enhance forest regeneration, wood quality, and resilience under changing environmental conditions (Commission on Genetic Resources for Food, 2014). The authors emphasized the importance of documenting and conserving these trees through biodiversity registers, while implementing protective measures against environmental threats. Their findings suggest that both genetic quality and ecological suitability should guide NGP implementation.

This position aligns with existing national policy frameworks. Specifically, DENR Administrative Order No. 2010-11 outlines protocols for identifying, registering, and utilizing plus trees as official seed sources for reforestation programs (DENR, 2010). Additionally, DENR Memorandum Order No. 2023-03 mandates the exclusive use of quality planting materials from individual plus trees (IPTs), Seed Production Areas (SPAs), or accredited nurseries for NGP activities to ensure the biological integrity and field performance of seedlings (DENR, 2023). Institutionalizing tree improvement and integrating forest genetic resource management into restoration planning will enhance the long-term ecological sustainability of reforestation efforts, in line with internationally recognized best practices (ITTO, 2009).

From a coastal perspective, Nabua et al. (2023) examined mangrove ecosystems in Panguil Bay, where the NGP has led to notable mangrove cover expansion. At the national level, mangrove rehabilitation became a key component of the broader reforestation agenda. By 2016, the NGP reported planting over 1.8 billion seedlings across 2.17 million hectares, a significant portion of which were allocated to mangrove areas (DENR, 2016). In the Malampaya Sound Protected Landscape and Seascape in Palawan, 136 ha of mangroves were established between 2011 and 2013, increasing the area from 2,513 ha in 2005 to 3,064 ha by 2016 (FMB, 2016). In Bohol, reforestation efforts from 2011 to 2017 resulted in approximately 2,090 ha of mangroves, with Nasingin Island contributing 250 ha (Gerona-Daga & Salmo, 2022). These initiatives significantly contributed to the national mangrove inventory, which stood at 303,373 ha as of 2015 (FMB, 2015).

Despite these quantitative accomplishments, ecological challenges persist in mangrove restoration under the NGP. Many efforts have involved the indiscriminate planting of *Rhizophora* species, often without considering site-specific biophysical conditions. While convenient administratively, this monoculture approach has led to several ecological drawbacks, including reduced species diversity, heightened vulnerability to pests and diseases, and poor survival rates in mismatched sites. These issues mirror global critiques of monoculture reforestation, which caution against ecological simplification and its impact on coastal resilience (Primavera & Esteban, 2008).

The NGP's approach to monitoring and restoration is aligned with global initiatives like the Bonn Challenge, which aims to restore 350 million hectares of degraded land by 2030 (Bonn Challenge, 2021). Similar global efforts emphasize the importance of accurate, real-time monitoring to assess progress and ensure the success of restoration initiatives. By adopting best practices from such initiatives, the NGP can continue to evolve and contribute to global efforts in combating land degradation and deforestation. In response, Nabua et al. (2023) recommend a more ecologically grounded approach to mangrove restoration. They suggest strategies such as species diversification, using native taxa suited to local salinity, substrate, and tidal regimes, developing community-based mangrove nurseries, and participatory species-site matching. These strategies aim to improve seedling survival, ecological functionality, and local stewardship, promoting social sustainability (Gerona-Daga & Salmo, 2022).

These studies highlight both the successes and ecological limitations of the NGP. While the program has made significant progress in expanding forest cover and rehabilitating mangrove ecosystems, it is crucial to consider the quality, sustainability, and ecological integrity of restoration practices. The selection of plus trees in upland areas underscores the importance of integrating genetic improvement and biodiversity into reforestation strategies. Similarly, mangrove rehabilitation experiences emphasize the risks of monocultures and the neglect of species-site matching. These insights point to a central lesson: ecological restoration must be context-specific, scientifically grounded, and socially inclusive.

For the NGP to become a resilient and ecologically responsible program, it must move beyond a numbers-driven approach and embrace quality-based restoration. This includes using high-quality, site-appropriate planting materials, institutionalizing tree improvement programs, diversifying species, and involving communities in decision-making processes. Only through this holistic approach can the NGP achieve long-term ecological resilience, biodiversity conservation, and sustainable benefits for future generations. This highlights the need for future NGP assessments to adopt interdisciplinary approaches that integrate ecological, social, and institutional dimensions of reforestation success.

7. Conclusion

Over a decade since its launch, the NGP remains the Philippines' most ambitious reforestation initiative, with far-reaching implications for ecological restoration, rural development, and climate change mitigation. This thematic review of Scopus-indexed literature from 2014 to 2024 reveals that while substantial progress has been made in documenting and evaluating the NGP’s implementation, critical challenges persist in its design, governance, and on-the-ground outcomes.

The literature points to notable advances in remote sensing applications, which have enhanced the monitoring of vegetation recovery and forest disturbance. Policy and governance research has highlighted important regulatory reforms aimed at improving seedling quality, ecological planning, and inter-agency coordination. Studies on community participation have emphasized the need for genuine engagement beyond labor contracts, pointing to the importance of tenure security, livelihood integration, and participatory governance. Meanwhile, ecological studies underscore the necessity of using genetically diverse, site-suitable species and avoiding monoculture planting practices, especially in mangrove rehabilitation.

Despite these efforts, the review underscores that the NGP continues to face implementation bottlenecks, including weak institutional alignment, limited community empowerment, and a persistent focus on planting targets rather than long-term ecological and social outcomes. Research reveals gaps in integrating biodiversity-sensitive practices, adaptive management, and livelihood support, which are essential for achieving both environmental and developmental goals.

To move forward, future research must support a paradigm shift from a numbers-driven to a quality- and outcomes-based restoration model. This includes:

* Strengthening multi-level governance and accountability mechanisms;
* Institutionalizing site-species matching protocols and forest genetic resource management;
* Embedding community-led approaches with tenure security and capacity-building; and
* Applying remote sensing innovations to guide adaptive, evidence-based interventions.

The NGP’s long-term success depends on reconciling its ecological ambitions with inclusive, science-informed, and socially responsive strategies. As the program enters its final years toward the 2028 target, research and policy must converge to transform the NGP from a tree-planting campaign into a resilient, equitable, and biodiversity-rich forest restoration movement.

**Disclaimer (Artificial intelligence)**

The authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript. All work presented is entirely the original effort of the authors.

References

Aquino, B. S. III. (2015). Executive Order No. 193: Expanding the coverage of the National Greening Program. Official Gazette of the Republic of the Philippines. <https://www.officialgazette.gov.ph/2015/11/12/executive-order-no-193-s-2015/>

Arellano, C. M., Maralit, A. A., Paringit, E. C., Sarmiento, C. J., Faelga, R. A., Tandoc, F. A., ... & Pamittan, F. J. (2019). Multi-temporal analysis of dense and sparse forests’ radar backscatter using SENTINEL-1A collection in Google Earth Engine. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 42, 23-30. https://doi.org/10.5194/isprs-archives-XLII-4-W19-23-2019

Balanta, J. A. (2023). Land distribution, National Greening Program (NGP) status using GIS mapping in Camarines Norte: Basis for LGU action plan preparation. International Journal of Innovative Science and Research Technology, 8(4), 3174–3222. https://doi.org/10.5281/zenodo.8282780

Baynes, J., Herbohn, J., Smith, C., Fisher, R., & Bray, D. (2016). Key factors which influence the success of community forestry in developing countries. Global Environmental Change, 35, 226-238. https://doi.org/10.1016/j.gloenvcha.2015.09.011

Bonn Challenge. (2021). Global effort to restore 350 million hectares of degraded and deforested land by 2030. Global Landscapes Forum. <https://www.bonnchallenge.org/>

Börner, J., Schulz, D., Wunder, S., & Pfaff, A. (2020). The effectiveness of forest conservation policies and programs. Annual Review of Resource Economics, 12(1), 45-64. https://doi.org/10.1146/annurev-resource-110119-025703

Cagalanan, D. (2016). Public-private partnerships for improved reforestation outcomes in the Philippines. World Development Perspectives, 3, 32-34. https://doi.org/10.1016/j.wdp.2016.11.004

Casisirano, J., Tuminting, M., Ramos, R. V., & Medina, J. M. (2024). Tree planting prioritization in National Capital Region, Philippines using Remote Sensing, Analytic Hierarchy Process and GIS. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 48, 121-127.

Commission on Genetic Resources for Food. (2014). The State of the World's Forest Genetic Resources. Food & Agriculture Organization of the UN (FAO).

Commission on Audit. (2019, December 18). National Greening Program (PAO‑2019‑01). Performance Audit Office, Commission on Audit. <https://www.coa.gov.ph/wp-content/uploads/2019/12/National-Greening-Program-PAO-2019-01.pdf>

Cororaton, C.B., Inocencio, A.B., Tiongco, M., & Manalang, A.B.S. (2016). Assessing the potential economic and poverty effects of the National Greening Program. DLSU Business & Economics Review, 26(1), 1136-157.

Chechina, M., Neveux, Y., Parkins, J. R., & Hamann, A. (2018). Balancing conservation and livelihoods: A study of forest-dependent communities in the Philippines. Conservation and Society, 16(4), 420-430. https://doi.org/10.4103/cs.cs\_16\_182

Cruz, R. V. O. (2018). Sustaining water resources with environmental protection. Water Policy in the Philippines: Issues, Initiatives, and Prospects, 185-208.

Department of Environment and Natural Resources. (2010). DENR Administrative Order No. 2010-11: Revised regulations governing forest tree seed and seedling production, collection and disposition. Quezon City, Philippines: Department of Environment and Natural Resources.

Department of Environment and Natural Resources. (2016). NGP accomplishment report 2011–2016. Forest Management Bureau, DENR Central Office, Quezon City, Philippines.

Department of Environment and Natural Resources. (2020). NGP Monitoring and Evaluation Manual. Forest Management Bureau, DENR Central Office, Quezon City, Philippines.

Department of Environment and Natural Resources. (2021a). DAO 2021-11: Guidelines in the accreditation of private and government nurseries for the Enhanced National Greening Program (ENGP). Quezon City, Philippines: Department of Environment and Natural Resources.

Department of Environment and Natural Resources. (2021b). DAO 2021-18: Enhanced guidelines on the implementation of the Enhanced National Greening Program (ENGP). Quezon City, Philippines: Department of Environment and Natural Resources.

Department of Environment and Natural Resources. (2022). Philippine Master Plan for Climate Resilient Forestry Development (2022–2030). Forest Management Bureau, DENR Central Office, Quezon City, Philippines.

Department of Environment and Natural Resources. (2023). DENR Memorandum Order No. 2023-03: Supplemental guidelines on the production of quality planting materials for the National Greening Program. Quezon City, Philippines: Department of Environment and Natural Resources.

Diwa, R. R., Borlongan, N. J. B., Tabardillo, J. I. A., Sabuito, A. J. C., Candido, C. G., de la Cruz, R. M., & Blanco, A. C. (2024). Development of methodology for monitoring and assessing the National Greening Program using Optical and SAR data. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 48, 175-181. https://doi.org/10.5194/isprs-archives-XLVIII-4-W8-2023-175-2024Fdenr

Dolom P.C. (2003). Criteria and indicators for assessing the sustainability of a community-based forest management project in the Philippines. Unasylva, 54, 22-26.

Emam, A. A. G., & Lubos, L. C. (2021). Implementation of the National Greening Program in the Province of Bukidnon: Basis for Interventions. Liceo Journal of Higher Education Research, 17(2).

Engay-Gutierrez, K., Dimailig, E., & Yacon, J. (2022). Plus, and Mother Trees in Mt. Banahaw de Lucban, Quezon, Philippines. Journal of Environmental Science and Management, 25(2). https://doi.org/10.47125/jesam/2022\_2/05

Estoque, R. C., Murayama, Y., Lasco, R. D., Myint, S. W., Pulhin, F. B., Wang, C., ... & Hijioka, Y. (2018). Changes in the landscape pattern of the La Mesa Watershed–The last ecological frontier of Metro Manila, Philippines. Forest Ecology and Management, 430, 280-290. https://doi.org/10.1016/j.foreco.2018.08.023

Fontanoza Jr, F., & Navarra, N. L. (2020). Using mean patch size as a landscape metric to determine the effectiveness of the national green policy in Quezon City, Manila. Alam Cipta: International Journal on Sustainable Tropical Design Research & Practice, 13(1).

Forest Management Bureau. (2015). Philippine Forestry Statistics 2015. Department of Environment and Natural Resources.

Forest Management Bureau. (2016). Protected Area Management Board report: Malampaya Sound Protected Landscape and Seascape. Department of Environment and Natural Resources.

Forest Management Bureau. (2024). Philippine forests at a glance: 2024 Edition. https://forestry.denr.gov.ph/fmb\_web/about-fmb/publicationses/

Fuentes R.U., & Concepcion R. (2007). Implementation of initiatives for addressing climate change and land degradation: A look at the Philippine context. Environmental Science and Engineering, 448-467.

Garcia, M. A. R., & Principe, J. A. (2024). Assessment of forest disturbances using remote sensing: case of Kaliwa River Forest Reserve (KRFR), Philippines. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 48, 273-278. https://doi.org/10.5194/isprs-archives-XLVIII-4-W8-2023-273-2024

Gerona-Daga, M. E. B., & Salmo III, S. G. (2022). A systematic review of mangrove restoration studies in Southeast Asia: Challenges and opportunities for the United Nation’s Decade on Ecosystem Restoration. Frontiers in Marine Science, 9, 987737. https://doi.org/10.3389/fmars.2022.987737

Goltiano, H., Gregorio, N., Pasa, A., Herbohn, J., Tripoli, R., & Valenzona, J. (2021). The effect of the implementation of the National Greening Program on the socioeconomic status of smallholders in Caibiran, Biliran, Philippines. Small-scale Forestry, 20(4), 585-604. https://doi.org/10.1007/s11842-021-09482-9

Gregorio, N., Herbohn, J., Harrison, S., Pasa, A., & Ferraren, A. (2017). Regulating the quality of seedlings for forest restoration: Lessons from the National Greening Program in the Philippines. Small-scale forestry, 16, 83-102. https://doi.org/10.1007/s11842-016-9344-z

Israel, D. C. (2017). Taking stock of the National Greening Program six years hence. Philippine Institute for Development Studies Policy Notes No. 2017-12.

Israel, D. C., & Arbo, M. D. G**.** (2015). The National Greening Program: Hope for our balding forests [Study Summary]. Philippine Institute for Development Studies. Retrieved from BusinessMirror website

Israel, K. P. R., & Bantayan, N. C. (2021). Analysis of cloud‑based NDVI trends of a country‑wide forest restoration program. Paper presented at the 42nd Asian Conference on Remote Sensing (ACRS2021), Can Tho, Vietnam. <https://acrs-aars.org/proceeding/ACRS2021/8%20Remote%20sensing%20_%20Maping/ACRS21_196.pdf>

ITTO (2009). ITTO/IUCN guidelines for the conservation and sustainable use of biodiversity in tropical timber production forests. ITTO Policy Development Series, 17(120).

Jardeleza, J. M., Gotangco, C. K., & Leah Guzman, M. A. (2019). Simulating national-scale deforestation in the Philippines using Land Cover Change Models. Philippine Journal of Science, 148(4).

Le, H. D., Smith, C., & Herbohn, J. (2014). What drives the success of reforestation projects in tropical developing countries? The case of the Philippines. Global Environmental Change, 24, 334-348. https://doi.org/10.1016/j.gloenvcha.2013.09.010

Luna, M. P. G. (2016). Impact assessment of the National Greening Program of the DENR: Scoping or Process Evaluation Phase-Institutional Component (No. 2016-29). PIDS Discussion Paper Series.

Mukul S.A., Herbohn J., & Firn J. (2016). Tropical secondary forests regenerating after shifting cultivation in the Philippines uplands are important carbon sinks. Scientific Reports, 6(22483). https://doi.org/10.1038/srep22483

Nabua, W. C., Roxas, A. T., & Uy, W. H. (2023). The status of mangroves in Panguil Bay, Philippines. Aquaculture, Aquarium, Conservation & Legislation, 16(6), 3079-3092.

Navarrete, I. A., Peque, D. P., & Macabuhay, M. D. (2018). Soil information as a reforestation decision-making tool and its implication for forest management in the Philippines. Environmental Resources Use and Challenges in Contemporary Southeast Asia: Tropical Ecosystems in Transition, 97-116. https://doi.org/10.1007/978-981-10-8881-0\_5

Nistor, M. (2021). Outlook: Advantages and disadvantages of studies of the impact of climate change and land use on natural and artificial systems. Climate and land use impacts on natural and artificial systems: Mitigation and adaptation, 319-327. https://doi.org/10.1016/B978-0-12-822184-6.00018-1

Pada, A. V. S., Cabanlit, M. A. A., Bernales, A. M. J., Mangaporo, W. C., Leyva, J. V. M., Regalado, D. J. D., Cenit, R. L., Silapan, J. R., & Edullantes, B. (2016). Mangrove forest suitability analysis in the City of Kabankalan, Negros Occidental, Philippines. University of the Philippines Cebu. <https://www.studocu.com/ph/document/university-of-negros-occidental-recoletos/agriculture/ab-0451-can-help-student-for-research/63845843>

Pansit, N. R., & Parilla, R. B. (2024). Detecting vegetation cover change in reforestation sites from 2013 to 2019 in Central Visayas, Philippines using remotely sensed data. Mindanao Journal of Science and Technology, 22(1). https://doi.org/10.61310/mjst.v22i1.1961

Perez, G. J., Comiso, J. C., Aragones, L. V., Merida, H. C., & Ong, P. S. (2020). Reforestation and deforestation in Northern Luzon, Philippines: Critical issues as observed from space. Forests, 11(10), 1071. https://doi.org/10.3390/f11101071

Philippine Space Agency (PhilSA). (2023). PhilSA and DENR partner for geospatial monitoring of National Greening Program. <https://philsa.gov.ph/news/philgems-ngp-denr>

Primavera, J. H., & Esteban, J. M. A. (2008). A review of mangrove rehabilitation in the Philippines: successes, failures and future prospects. Wetlands Ecology and Management, 16, 345-358. https://doi.org/10.1007/s11273-008-9101-y

Pulhin, J. M., Ramirez, M. A. M., Garcia, J. E., Pangilinan, M. J. Q., Evaristo, M. B. S., Catudio, M. L. R. O., ... & Mariano, B. J. S. (2024). Contextualizing sustainable forest management and social justice in community-based forest management (CBFM) program in the Philippines. Trees, Forests and People, 16, 100589. https://doi.org/10.1016/j.tfp.2024.100589

Thompson I.D., Guariguata M.R., Okabe K., Bahamondez C., Nasi R., Heymell V., & Sabogal C. (2013). An operational framework for defining and monitoring forest degradation. Ecology and Society, 18(2).

Verburg P.H., Overmars K.P., Huigen M.G.A., de Groot W.T., & Veldkamp A. (2006). Analysis of the effects of land use change on protected areas in the Philippines. Applied Geography, 26(2): 153-73. https://doi.org/10.1016/j.apgeog.2005.11.005

von Kleist K., Herbohn J., Baynes J., & Gregorio N. (2021). How improved governance can help achieve the biodiversity conservation goals of the Philippine National Greening Program. Land Use Policy, 104, 104312. https://doi.org/10.1016/j.landusepol.2019.104312

Weltbank. (2021). The changing wealth of nations 2021: Managing assets for the future. World Bank.

Wiset, K., Gregorio, N., Fisher, R., Mangaoang, E., & Herbohn, J. (2023). Assessing the effectiveness of the engagement of local people in restoring degraded forest landscapes in Leyte and Biliran Provinces, the Philippines. Environmental Science & Policy, 148, 103545. https://doi.org/10.1016/j.envsci.2023.07.005