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Contrasting Biodiversity Monitoring Methods in Two NIPAS Sites in Luzon, Philippines: A Mini-Review

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Abstract— *Protected areas under the National Integrated Protected Areas System (NIPAS) in the Philippines serve as critical habitats for biodiversity conservation. This mini-review compares two biodiversity monitoring approaches used in NIPAS-declared areas of Luzon remote sensing in Mt. Pulag National Park and field-based rapid biodiversity assessment in Bataan National Park. The Mt. Pulag study employed Synthetic Aperture Radar (SAR) to detect forest disturbance, while the Bataan study conducted species-level surveys to document biological richness. The review highlights key differences in data type, scale, and application: remote sensing allows for broad-scale, time-series habitat monitoring, while ground-based surveys offer direct ecological insights but are limited by time and area. The review concludes that combining these approaches can create a more effective and adaptive biodiversity monitoring system, aligned with the objectives of the NIPAS framework. An integrated method linking technology, field data, and local participation will better support conservation decision-making in protected areas.*

Keywords— ***biodiversity monitoring, community-based monitoring, field assessment, remote sensing, protected area***

I. INTRODUCTION

Biodiversity monitoring is an essential component of conservation science, providing the empirical basis for understanding ecological dynamics, assessing threats, and guiding the sustainable management of natural resources. In the Philippines a recognized global biodiversity hotspot with over 52,000 documented species, more than half of which are endemic the need for robust monitoring systems is especially urgent due to escalating pressures such as habitat degradation, land-use conversion, and climate change (Aurellado et al., 2021).

To institutionalize the protection and assessment of biologically significant areas, the Philippine government enacted the National Integrated Protected Areas System (NIPAS) Act of 1992 (Republic Act No. 7586), which was subsequently enhanced through the Expanded NIPAS Act of 2018 (Republic Act No. 11038). These legislative frameworks mandate systematic identification, management, and regular evaluation of protected areas, with a strong emphasis on ecological integrity and biodiversity conservation.

The NIPAS framework promotes a decentralized and participatory approach to protected area governance. It mandates the conduct of Biological and Socioeconomic Assessment and Monitoring (BSAM) activities as foundational components of site management (DENR Administrative Order No. 25, 1992). Despite this mandate, implementation challenges persist, including limited technical capacity, methodological inconsistencies, and insufficient integration of local ecological knowledge (Custodio and Molinyawe, 2001). Addressing these systemic constraints is critical for ensuring the long-term effectiveness of biodiversity conservation efforts within the NIPAS system.

Luzon, the largest and most biologically diverse island in the Philippines, hosts several nationally designated protected areas, including Mt. Pulag National Park and Bataan National Park. These sites are ecologically

significant yet face varying levels of anthropogenic pressure and differences in monitoring practice (Llave et al., 2018; Daipan, 2021). This mini-review examines two recent case studies from these NIPAS sites one utilizing remote sensing technology, the other employing field-based rapid biodiversity assessment. Through comparative analysis of these methodologies and their respective outcomes, this review aims to contribute to ongoing discourse on strengthening biodiversity monitoring systems within the NIPAS framework.

II. SUMMARY OF REVIEWED ARTICLES

2.1 Biodiversity Monitoring through Remote Sensing in Mt. Pulag National Park

Daipan (2021) utilized Sentinel-1 Synthetic Aperture Radar (SAR) time series to detect forest disturbances within Mt. Pulag National Park. The study focused on monitoring temporal and spatial changes in forest cover to serve as indicators of human disturbance or ecological stress. By analyzing backscatter changes in radar data, the study identified zones of possible degradation, particularly in areas near human settlements and agricultural encroachment.

The remote sensing approach allowed long-term observation and non-intrusive assessment of land cover changes. However, it did not generate direct species-level data. Instead, the information served as a habitat-based proxy for monitoring ecological pressure, making it useful for tracking trends but limited in documenting actual biodiversity composition.

2.2 Field-Based Rapid Biodiversity Assessment in Bataan National Park

Llave et al. (2018) conducted a rapid biodiversity assessment (RBA) in the buffer zone of Bataan National Park using ground sampling methods such as quadrats, transects, and opportunistic species observations. Their work produced a detailed inventory of flora and fauna, including species richness, endemism, and conservation status.

The study revealed a biologically diverse landscape under threat from human activity, including kaingin farming, poaching, and habitat fragmentation. Unlike the Mt. Pulag study, this assessment produced specific ecological data highlighting key species of conservation interest but lacked the ability to monitor temporal trends or cover large areas.

III. COMPARATIVE ANALYSIS

The two studies offer contrasting strengths and limitations, providing a useful basis for evaluating biodiversity monitoring strategies in protected areas (Table 1).

Table 1. Comparative summary of biodiversity monitoring methods in Luzon NIPAS sites

Feature	Mt. Pulag (Daipan 2021)	Bataan NP (Llave et al. 2018)
Method	Remote sensing (SAR)	Field-based biodiversity survey
Scale	Landscape-scale	Site-specific
Data Type	Habitat condition (proxy)	Species richness, endemism
Strengths	Long-term, broad-scale detection; good for inaccessible areas	Detailed, species-level data; identifies specific threats
Limitations	No direct biodiversity data; cannot identify species	Limited in spatial coverage; one-time data only

Mt. Pulag's approach is excellent for monitoring habitat disturbances over time but does not assess species' diversity directly. In contrast, Bataan's RBA delivers rich biological data but lacks long-term monitoring capacity. Together, they represent two sides of biodiversity assessment habitat trend analysis versus species documentation.

This conceptual framework illustrates the integration of remote sensing, field-based assessments, and local stakeholder participation within the NIPAS monitoring system to inform conservation decisions (Figure 1).

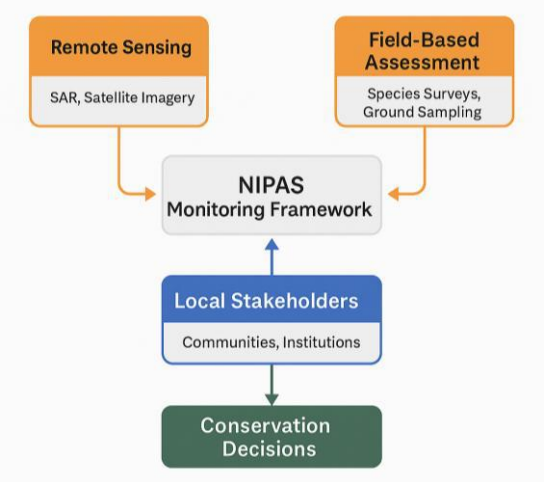

Fig.1. Integrated biodiversity monitoring framework for NIPAS areas in Luzon.

IV. REFLECTIONS AND IMPLICATIONS

The reviewed studies illustrate how biodiversity monitoring in NIPAS areas can benefit from method integration. Remote sensing tools such as SAR enable wide-scale, long-term monitoring of land cover changes, making them ideal for early warning systems and policy enforcement. On the other hand, field-based assessments provide granular data on species presence, richness, and threats crucial for ecological understanding and conservation prioritization.

However, neither approach alone provides a complete picture. Remote sensing lacks biological specificity, while field assessments may be logistically demanding and time limited. To address this gap, an integrated monitoring framework is recommended one that combines remote sensing technology with periodic, standardized field biodiversity assessments. An integrated framework is proposed (Figure 1) to align monitoring efforts with policy goals and management needs. This approach echoes global best practices; the FAO, for instance, emphasizes the use of complementary indicator tools to effectively track biodiversity changes across scales (FAO, 2020; CBD, 2011).

More importantly, effective monitoring should not be viewed solely as a scientific activity but as a participatory governance process. Local communities, indigenous peoples, and academic institutions play a critical role in sustaining monitoring efforts through knowledge sharing, logistical support, and stewardship a model aligning with community-based monitoring principles. This also aligns with the frameworks outlined under NIPAS, which include Biological and Socioeconomic Assessment and Monitoring activities as part of protected area management plans. However, recent reviews of NIPAS implementation highlight persistent gaps such as fragmented monitoring, limited technical capacity, and low integration of community inputs (DENR-BMB, 2018). Addressing these limitations through better protocols, stakeholder engagement, and capacity-building will be essential in enhancing biodiversity conservation outcomes.

V. CONCLUSION

This mini-review highlights the contrasting but complementary roles of remote sensing and field-based approaches in biodiversity monitoring within NIPAS-declared areas in Luzon. The Mt. Pulag study showcases how technology can reveal forest disturbance patterns across time, while the Bataan National Park assessment demonstrates the value of direct species-level data for conservation insight. Each method has distinct advantages and limitations, but together, they offer a more holistic framework for understanding ecological change.

Effective biodiversity monitoring under the NIPAS system should therefore not rely on a single tool but adopt an integrated, adaptive approach. Strengthening this capacity through funding, training, and collaboration will be essential in safeguarding the Philippines' rich but increasingly threatened biodiversity. As biodiversity pressures intensify, investing in science-based, locally grounded monitoring frameworks will be essential to uphold the long-term integrity of the country's protected areas.

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