

# Seeing through Satellites, Streets and Stories: Assessing Nature-Based Solutions in the Santa Rosa-Silang Watershed, Philippines

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## Abstract:

The effectiveness of Nature-Based Solutions (NBS) in rapidly urbanizing cities in the Global South remains underexplored (Puskás et al., 2021; Wolff et al., 2022), particularly in emerging cities where unchecked growth, fragmented governance, and limited institutional capacity exacerbate vulnerability to climate risks and environmental degradation (Adelina et al., 2021; Yasmin et al., 2023). NBS can mitigate flooding, water scarcity and heat island effects, while also providing critical ecological benefits like habitat restoration, pollution reduction, and enhanced biodiversity - when implemented with careful attention to local contexts. Yet, in many Global South contexts effective NBS planning is complicated when external climate finance and expertise overshadows local priorities and, as a consequence, may exacerbate inequalities (Sharma et al., 2016; Escobedo et al., 2019; Eakin et al., 2022; Goodwin et al., 2023). Currently, there is limited understanding of how to effectively align NBS goals across scales and this challenge is most acute within informal settlements (Dovey, 2013; Diep et al., 2022) where traditional planning approaches often fail to address rapid, unregulated growth, urban poverty, and low resources for adaptive capacity (Gulati & Scholtz, 2020; Mabon & Shih, 2021).

This research leverages the tools of cartography to advance our understanding of how to align NBS goals across scales in order to more effectively address social and ecological needs. It uses a mixed-methods approach that integrates satellite imagery, street-level observations, and community-generated narratives to visualize and assess the spatial distribution and governance of NBS in the Santa Rosa–Silang watershed, Philippines. In general, the focus is on expressing the socio-ecological dynamics that shape NBS interventions in the Santa Rosa-Silang watershed. In a context where official data is often scarce, outdated, or exclusionary, this method enables the co-production of maps that surface socio-spatial inequalities and centre multiple knowledge systems. By blending remote sensing with qualitative methods, this research offers a spatially grounded methodological approach that maps not only ecological conditions and climate risks but also power, knowledge, and exclusion in the design and implementation of urban NBS.

Findings show that NBS projects in ecologically sensitive, flood-prone areas do reduce environmental risks, but their benefits are unevenly distributed. Local governments struggle to scale up NBS initiatives due to limited public land, constrained budgets, and lack of technical expertise. Wealthier, less vulnerable neighbourhoods—such as newly built 'eco-city' developments—benefit from privately implemented NBS embedded in exclusive residential and commercial design, while informal settlements, often located in the most climate-sensitive and flood-prone areas, remain excluded from formal NBS projects despite their heightened vulnerability. Community-driven ecological interventions, though promising, frequently lack the institutional support necessary to sustain them, often exacerbating existing inequalities rather than alleviating them.

To develop these findings, the study overcomes the challenges of fragmented data and governance by combining satellite-based geospatial analysis with on-the-ground observations and community-driven data collection. These three modes—satellites, streets, and stories—are complementary and integrative, enabling a cartographic synthesis of ecological patterns and lived experiences. Together, they inform a multi-modal cartographic output: an interactive, web-based exploratory map allowing users to engage with geospatial and narrative data layers, and a composite synthesis map for print and policy use, visualizing the ecological and social dimensions of urban NBS implementation across the watershed.

"Seeing through satellites"—using openly accessible satellite imagery, climate data and remote sensing techniques—provided insights into the geographic and ecological conditions of the watershed, including land cover, vegetation health, and climate risks such as flooding and urban heat islands. The geospatial analysis provided insight into the spatial distribution and ecological impacts of existing NBS interventions, to identify how current NBS efforts align with—or overlook—areas of heightened vulnerability, including informal settlements and ecologically sensitive zones.

"Seeing through streets" refers to on-the-ground observations and walking interviews with local stakeholders, including government representatives, environmental organizations, and community members. This ground-level fieldwork was essential for contextualizing the satellite data and gaining a deeper understanding of how NBS are perceived and experienced by those directly affected. Site visits with environmental activists revealed critical insights into the ecological value and limitations of various NBS interventions. Some initiatives relied on monocultures (e.g., bamboo plantations) or suffered poor timing (e.g., saplings lost to typhoons shortly after planting), while others effectively restored habitat using native species and promoted biodiversity through diverse vegetation. Top-down interventions in vulnerable settlements were often implemented as one-off projects with little community involvement or long-term planning. As a result, maintenance was often lacking, leading to failed outcomes due to factors such as invasive species, lack of watering, flooding, grazing animals, or accumulated waste. Photographs and sketches from these visits complement satellite-derived maps by offering visual detail of site conditions and ecological outcomes. This ground-level material adds critical resolution to watershed-scale mapping of land use, income disparities, flood-prone zones, and pollution gradients.

"Seeing through stories" allowed the research to engage with the lived experiences of local residents through participatory mapping workshops, community discussions, and video submissions. These activities reveal local perceptions of climate risk and resilience, identify overlooked green spaces, and document grassroots efforts such as drone-based monitoring and geotagged video storytelling. The resident stories were developed through participatory mapping sessions, which contributed to co-produced maps that illuminate community and neighbourhood-level priorities in relation to planned NBS interventions by local governments and private developers. As well, these maps are augmented with participatory videos in which residents narrate their changing relationship to the landscape, such as how recurrent flooding has intensified over their lifetime. Embedded in the map interface, these video stories anchor lived experience to specific sites.

Together, these methods offer a nuanced account of NBS implementation in a data-scarce, rapidly urbanizing environment. The resulting layered maps combine satellite-derived indices (e.g., NDVI, land use classifications), geotagged field observations, and spatially referenced community narratives. These maps reveal spatial disparities in NBS distribution and illuminate areas of high social vulnerability not captured in formal planning data. In Santa Rosa, the combination of satellite data, street-level observations, and community-driven stories has proven essential for capturing the full complexity of urban NBS in a data-scarce environment, providing both ecological insights and social context. The findings from the Santa Rosa-Silang watershed contribute to the growing body of knowledge on NBS in the Global South, offering insights into how urban resilience strategies can be more effectively and equitably informed by holistic, participatory and context-specific approaches. By addressing the challenges of fragmented governance and incorporating local knowledge, this research offers practical insights for policymakers and planners seeking to integrate NBS into climate adaptation strategies, particularly in cities where rapid urbanization poses both challenges and opportunities for anticipatory planning.

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