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EXECUTIVE SUMMARY

Redefining Urban Riparian Zones in Bangung:

Integrating Ecosystem Services Approach and Suitable Vegetation Identification to Flook Risk Reduction

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Executive Summary

Overview

Floods have become one of the most destructive hydrometeorological disasters, increasingly intensified by climate change, urbanization, and environmental degradation. Riparian zones in urban areas, as natural buffers that regulate water flow, trap sediments, and reduce flood risks, are increasingly threatened due to settlement expansion, particularly in low- and middle-income countries with low law enforcement and unintegrated spatial planning. To address this problem, not only ecological restoration but also the analysis of vulnerable communities residing in riparian slum areas is needed. The Ecosystem Services Approach, as a holistic framework that integrates the environmental and social dimensions, is crucial to be implemented to enhance resilience and sustainability in managing urban ecosystems.

This study focuses on Bandung City, Indonesia, an economically dynamic urban center and the third most populous city in the country. Rapid urbanization and settlement growth in Bandung have severely encroached upon riparian areas, diminishing their ecological function and increasing flood risks. With multiple rivers traversing the city and frequent flood events recorded in recent years, Bandung represents a critical case for exploring sustainable riparian management through ecosystem-based planning.

The research employs an integrated methodology combining geospatial analysis, ecological assessment, and social inquiry. Key methods include the identification of flood-prone riparian and slum areas, flood hazard modeling using the Geomorphic Flood Index (GFI), and the evaluation of ecosystem services related to flood protection, biodiversity, and water regulation. The study adapts the Ministry of Environment and Forestry's ecosystem service assessment framework and enhances it through expert consultation, ensuring that flood protection is explicitly addressed. By integrating physical, ecological, and socio-economic factors, this study aims to redefine riparian zone recommendations comprehensively and socially inclusive for sustainable urban flood management.

Main objectives

This study has two primary aims:

1. The first is to develop riparian zoning in Bandung City by integrating ecosystem services assessment with socio-economic conditions, particularly those represented by slum areas, to reduce flood risk and enhance urban resilience.
2. The second is to provide evidence-based recommendations for suitable plant species in each designated riparian zone. This vegetation suitability assessment aims to support sustainable flood mitigation efforts while maintaining ecological functions and enhancing the overall quality of the urban environment.

Key findings

This section distills the most decision-relevant evidence linking hydrologic hazard, socio-economic exposure, and ecosystem-service (ES) capacity along Bandung's riparian corridors.

1. Flood hazard is extensive and relatively uniform in depth. A DEM-based model estimates that 7,130.05 ha (42.7%) of Bandung's area is flood-affected, concentrated in Gedebage, Arcamanik, Babakan Ciparay, and Bojongloa Kidul; the average flood depth is ~1.0–1.2 m across districts, indicating consistent hazard severity.

2. Slum exposure concentrates in river buffers. A merged slum map totals approximately 3,447.248 ha (approximately 20.7% of the city); approximately 681.084 ha (approximately 19.8% of all slums) lie within river-buffer zones, compounding exposure to flooding and service deficits.
3. Water-regulation capacity is broadly low. Over 75% (16,738 ha total modelled) of the city falls in Low/Very Low water-regulation ES, with High/Very High <1.5%—a pattern consistent with vegetation loss and impervious cover.
4. River buffers are especially weak in ES. Nearly the entire mapped buffer network rates Very Low–Low for water regulation; flood hotspots (e.g., Gedebage, Batununggal, Bandung Kidul) align with these low-ES stretches.
5. Fieldwork and vegetation condition corroborate deficits. The plan focuses on riparian-vegetation suitability and field validation to ground recommendations, confirming sparse, poorly adapted vegetation in many segments.

Recommendations

The package below integrates zoning, ecological rehabilitation, and social upgrading, ensuring that actions are both hydraulically effective and socially inclusive.

1. Redefine riparian zoning by risk and ES, not distance alone. Classify reaches into Protection (high hazard & high ecological value), Rehabilitation (degraded ES or moderate risk), and Management (lower risk with GI requirements); use flood hazard, ES indices, and slum sensitivity as criteria.
2. Rehabilitation nature-based flood buffering with native plants. Select species by hydrological niche (bank, lower bank, terrace) to stabilize banks, slow flows, and increase infiltration; pair deep-rooted trees/shrubs with groundcovers.
3. Retrofit green-blue infrastructure in hotspot districts. Deploy bioretention cells, permeable pavements, and vegetated swales and connect them to riparian green belts, prioritizing Gedebage, Batununggal, and Bandung Kidul.
4. Integrate slum upgrading with ecological rehabilitation. Couple housing/drainage improvements with riparian replanting and community-managed buffers in river-adjacent neighbourhoods identified by the overlap analysis.
5. Align institutions and plans with ES evidence. Utilize ES layers in RDTR/RTRW updates; establish an inter-agency riparian working group and incorporate field-validation loops into the implementation.

Implications

These implications highlight the changes that would occur if Bandung were to adopt the integrated approach.

1. Urban planning. ES indicators make flood management preventive and place-specific, guiding land-use controls and GI standards in river corridors.
2. Climate adaptation. Nature-based solutions complement grey works with lower lifecycle costs and co-benefits (biodiversity, water quality, urban cooling).
3. Equity and governance. Linking slum upgrading to riparian restoration reframes riverbanks as inclusive socio-ecological assets, improving safety and livelihoods in high-risk neighbourhoods.
4. Replication. The hazard–social–ES–vegetation workflow provides a transferable template for other Indonesian urban basins using readily available geospatial inputs.