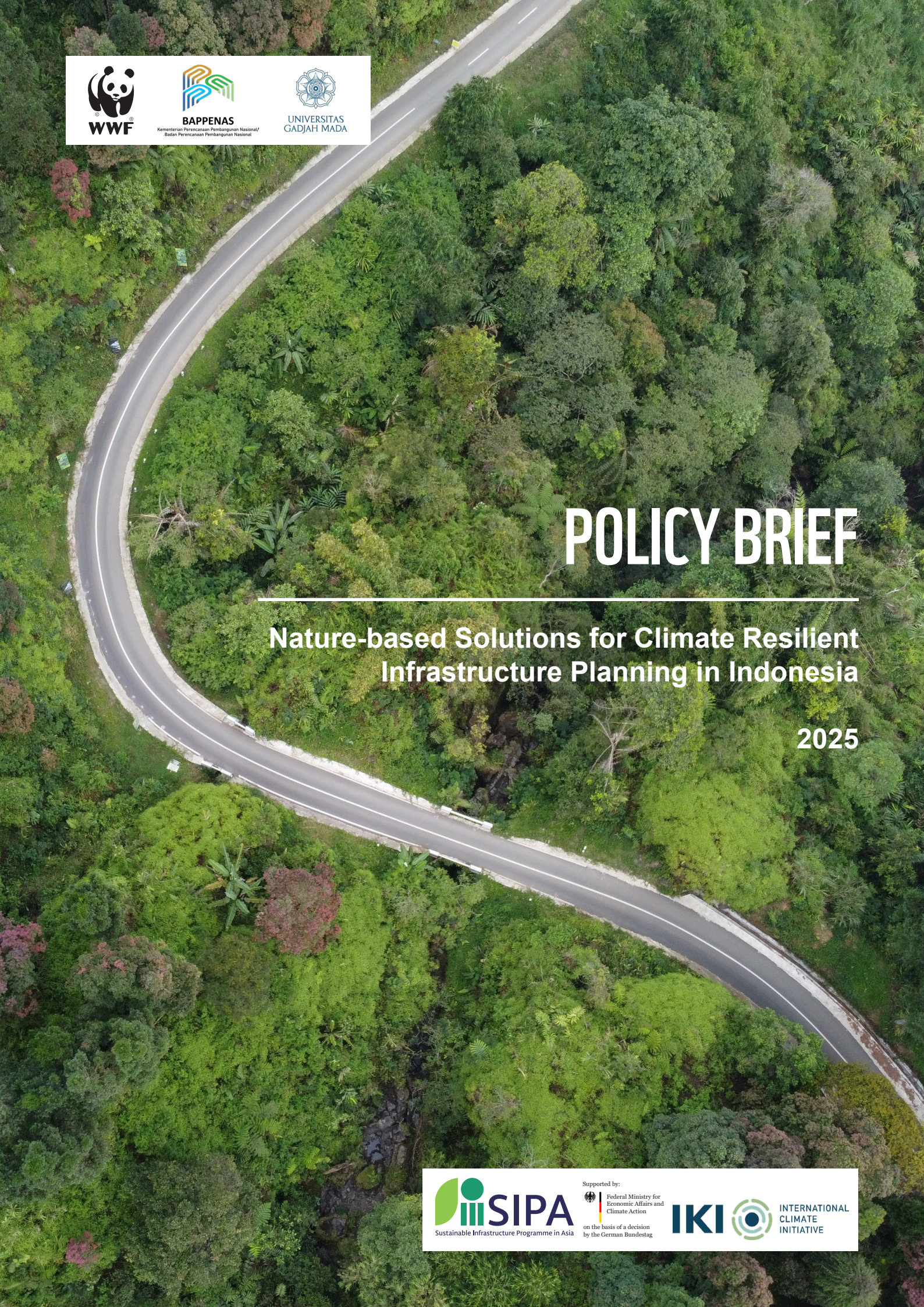

WWF

BAPPENAS
Kementerian Perencanaan Pembangunan Nasional/
Badan Perencanaan Pembangunan Nasional

UNIVERSITAS
GADJAH MADA

POLICY BRIEF

Nature-based Solutions for Climate Resilient Infrastructure Planning in Indonesia

2025

SIPA
Sustainable Infrastructure Programme in Asia

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

IKI INTERNATIONAL CLIMATE INITIATIVE

KEY FINDINGS

- Ecosystems most impacted by road infrastructure and settlement development provide significant benefits, supporting climate resilience for nearly half the population, 147 million people, and 68% of the road network, on just 16% of Indonesia's lands.
- Evaluating all intact ecosystems nationwide that could support NbS benefits, conserving priority areas on just 18% of Indonesia's land area supports climate resilience for 113 million people and 44% of the road network.
- Restoring degraded forests found on just 11% of the country provides the best opportunities to invest in multiple NbS to enhance climate resilience, benefiting roughly half the population, 143 million people, and a little over half, 47,000 km or 53% of the road network.
- Most of these priority areas are outside the protected area network, necessitating new regulatory approaches or land use management schemes for successful conservation or restoration efforts.
- There are, however, also immediate "win-win" opportunities for NbS investments under conservation or restoration inside protected areas and Key Biodiversity Areas that would simultaneously support climate resilience for people and infrastructure and biodiversity outcomes.
- These analyses can serve as valuable inputs to support NbS mainstreaming to achieve climate and biodiversity goals in national and subnational policies and their implementation, including in the Medium and Long-Term Development Plans and associated processes.
- Achieving this requires investments in training and capacity building programs at all levels across these ministries and key departments in how to assess and integrate NbS in infrastructure planning. WWF and the University of Gadjah Mada (UGM) have developed such training materials for this purpose under the SIPA project.
- To ensure maximum utility for planners across departments and ministries, maps and associated data should be integrated into existing key ministry and departmental web platforms and centralized national data and mapping platforms.

SUMMARY

This brief summarizes the results of modeling analysis to determine potential priority areas for Nature-based Solutions (NbS) for climate resilience for people and infrastructure in Indonesia. Four key benefits provided by nature were assessed: sediment retention (erosion control), flood risk reduction, water recharge (for supply), and coastal protection (of people and infrastructure). It closes with recommendations for how to integrate these analyses in infrastructure development, climate adaptation, and conservation planning moving forward. The analysis provides useful information for planners within Ministry of National Development Planning (Bappenas), Ministry of Agrarian Affairs and Spatial Planning / National Land Agency (ATR/BPN), Ministry of Public Works, Ministry of Environment, Ministry of Forestry, Geospatial Information Agency (BIG), National Research and Innovation Agency (BRIN), the Peat and Mangrove Restoration Agency (BRGM), local government units, and other relevant government departments at the national and subnational levels in guiding infrastructure planning and siting decisions.

CONTEXT

Indonesia is among the top third of countries at high risk of climate disasters.

In the face of intensifying climate change and biodiversity loss, Indonesia must balance trade-offs between increasing economic development, preserving large biodiversity hotspots, and addressing infrastructure service gaps that still affect millions. Over the last two decades the country has seen significant degradation and deforestation, losing 104,000 hectares in 2021-22 alone, mainly due to logging and land conversion for timber and palm oil.[1,2] Recent policies have slowed deforestation; however, a surge in infrastructure development, particularly roads and railway corridors aimed at boosting the economy risks a return to previous trends without careful strategic and spatial planning beyond individual project EIA/AMDAL processes. A recent study underscores this, showing that new roads and settlements in Borneo affect biodiversity up to 50 km and 250 km deep into sensitive ecosystems and animal habitats.[3] Estimates suggest there are three to six times more roads in forests than previously accounted for, exacerbating forest loss.[4]

These impacts are intensified due to climate change. Indonesia is among the top third of countries at high risk of climate disasters like flooding, extreme heat, droughts, and coastal risks from sea level rise. Around 180 million Indonesians are vulnerable to sea level rise, and about 40% of the population

Integrating sustainability into these projects provides a crucial opportunity to avoid and mitigate significant climate risks.

faces multiple hazards, including droughts, flooding, and landslides.[5,6] These climate impacts will affect various sectors and regions, potentially costing the country between 2.5 – 7% of its GDP.[7]

Indonesia's 2025 infrastructure budget, though a slight 5% decrease from the highest number in five years in 2024, remains high, with a significant portion of the funds allocated for the development of new linear infrastructure such as toll roads and the construction of the new capital.[8] Integrating sustainability into these projects during the preparation and approval stages provides a crucial opportunity to avoid and mitigate significant climate risks. Doing so is also critical to meeting its global climate and biodiversity commitments under the Paris and Montreal-Kunming agreements. Effectively balancing these trade-offs at the project level requires a supportive policy enabling environment that Bappenas is rigorously developing with the Medium-Term Development Plan (RPJMN) process and the recently launched Long-term (RPJPN) Development Plan. Prioritizing the NbS outlined in this brief offers a chance to develop climate-resilient infrastructure with significant co-benefits for nature and wildlife.

Under the Sustainable Infrastructure Programme in Asia (SIPA), WWF is working to mainstream NbS into infrastructure planning in Indonesia, in alignment with national strategies to meet global climate and biodiversity commitments.

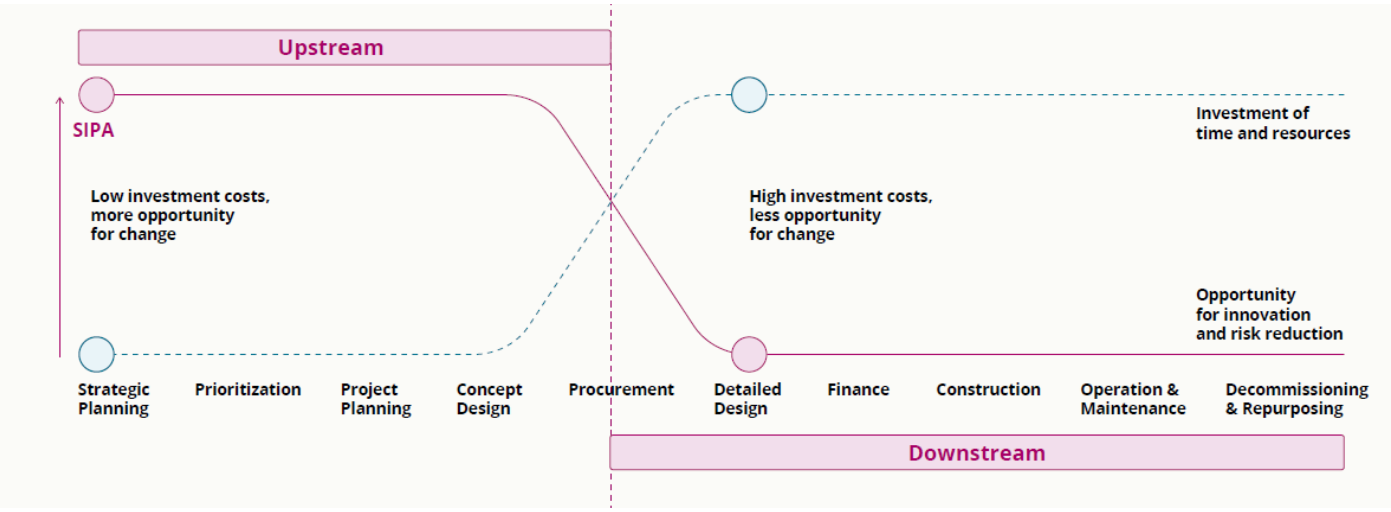

Figure 1. The benefits of considering nature-based solutions opportunities in the earliest stages of infrastructure planning.

METHODOLOGY

The results focus on areas that provide at least one key service, offering maximum benefits to communities or infrastructure (roads) under three scenarios: two for conservation and one for restoration. Only areas in the top 10% for both current and future climate conditions were selected as "climate-robust" priorities for conservation and restoration. Constructing conservation scenarios requires a counterfactual of what could occur without conservation, represented through land-use conversion mapping. The three scenarios are:

1. **Unconstrained Conservation**: we modeled the loss of ecosystem services by converting all relatively intact forest areas nationwide into agriculture. By evaluating this loss from deforestation, we estimate the marginal value of the service on each pixel, which helps to identify the most critical areas for conservation that provide climate resilience benefits for people and roads downstream and along coastlines (e.g., sediment retention, water filtration, coastal protection).

2. **Infrastructure Impact Conservation**: this scenario focuses on forests within 25 km of roads near urban areas and 15 km in rural areas. It estimates the degradation of biophysical service value due to roads within the buffer, highlighting priority areas around current infrastructure that are most important to maintain to not lose resilience benefits for roads and people.

3. **Restoration**: all agricultural and barren lands are reclassified as "secondary forest", which is beneficial but not as high-quality as primary forest. We then run biophysical models to compare this restored land cover to the current one and assess the changes in ecosystem service supply. This value, combined with the number of people or kilometers of roads benefiting, provides the full added value of the service for restoration to show which areas are most important to restore to enhance climate resilience.

The analysis evaluated four ecosystem services nationally in Indonesia:

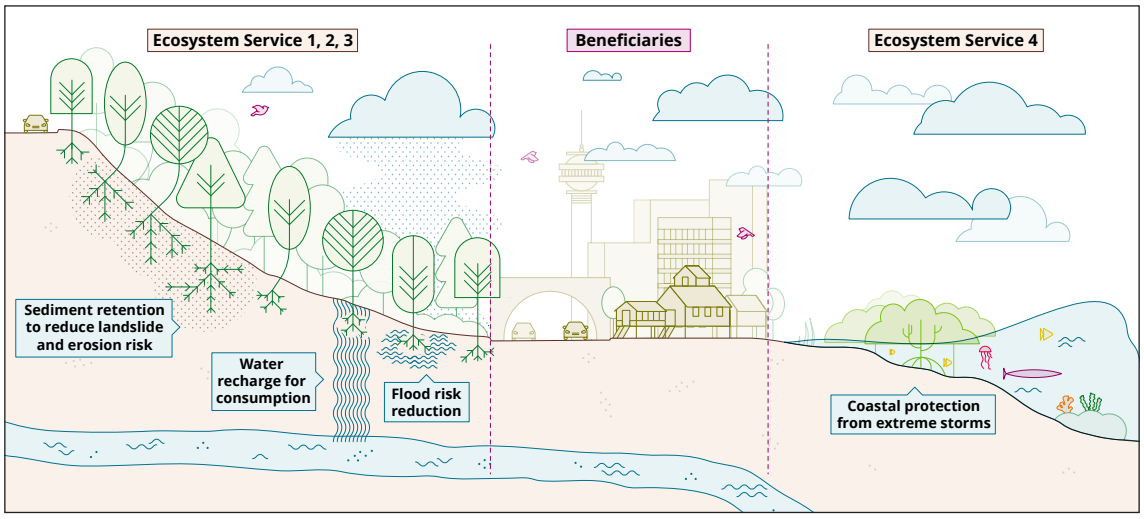

Figure 2. The four ecosystem services that act as nature-based solutions for climate resilience.

KEY RESULTS FROM THE ANALYSIS

The analysis pinpoints the locations and magnitude of benefits—measured in total kilometers of roads and millions of people—where conservation and restoration efforts (NbS) should be prioritized. These efforts aim to maintain and enhance climate resilience by providing services such as sediment retention, flood risk reduction, water recharge, and coastal protection. This section highlights key results and findings for each of three scenarios:

Scenario 1: Unconstrained conservation areas

Our findings reveal that ecosystems covering 18% of total land area of the country (34.5 million hectares) play a critical role in supporting climate resilience by providing more than one service to people and infrastructure. Predominantly located in the provinces of Papua, Kalimantan Barat and Tengah, Sumatra Selatan, and Sulewasi Selatan, only 44% of this total area lies within the Protected Area (PA) network (56% outside it), with 13% intersecting with Key Biodiversity Areas (KBAs). Implementing conservation measures in these identified areas would afford greater protection to residents and both existing and future infrastructure assets from climate extremes like worsening flooding, drought, and coastal storms. In total, nearly 40% of the total population, or 113 million people and 44% of roads (38,980 km) downstream and in low-lying coastal areas could potentially benefit from these areas. These results show that there are regions distant from existing settlements and current or planned roads—beyond the 15-25km buffer—that provide benefit for people and roads downstream and along coastlines.

Scenario 2: Infrastructure impact conservation areas

In this scenario, 16% of the country's total land area (30 million hectares) within the 15-25km buffer surrounding roads and settlements plays a critical role in supporting climate resilience by providing multiple benefits: retaining sediments and soil, preventing erosion and potential landslides, buffering shorelines against coastal storms, and capturing excess water from heavy precipitation events to reduce flood risk and recharge groundwater supplies. Given the proximity to roads, not surprisingly only 27% of this area lies within the Protected Area (PA) network, with 7% intersecting with Key Biodiversity Areas (KBAs), indicating that nearly 73% of priority areas are outside Protected Areas. The climate resilience of approximately 147 million people, more than half the population, and roughly 70% of the nation's roads depends on conserving the priority areas most impacted by infrastructure and development (within the 15-25 km buffer). Simply stated the impacts to people and roads from worsening climate hazards like floods, droughts, erosion, and coastal storms will be worse if these areas are deforested or degraded.

Scenario 3: Restoration Areas

Our results highlight significant opportunities to enhance adaptive capacity for people and improve road resilience through restoration NbS. Key provinces such as Kalimantan Barat, Sulawesi Utara and Selatan, and Sumatra Barat show potential for large-scale restoration strategies to be integrated into infrastructure planning and implementation cycles to improve resilience. Restoring degraded forests on just 11% of the country's land area would benefit millions of people and thousands of kilometers of roads. Nearly 88% of these areas are outside Protected Areas (PAs) and 95% are outside Key Biodiversity Areas (KBAs). Restoration in these areas would enhance resilience for 143 million people and protect 53% of the national road network. The restoration scenario demonstrates the effectiveness of PAs and KBAs, with most priority areas found outside of them. However, some priority areas within PAs and KBAs, particularly in Kalimantan Barat, present the easiest opportunities to create mutual benefits for both biodiversity and climate resilience for people and infrastructure given that they are already classified as conservation areas.

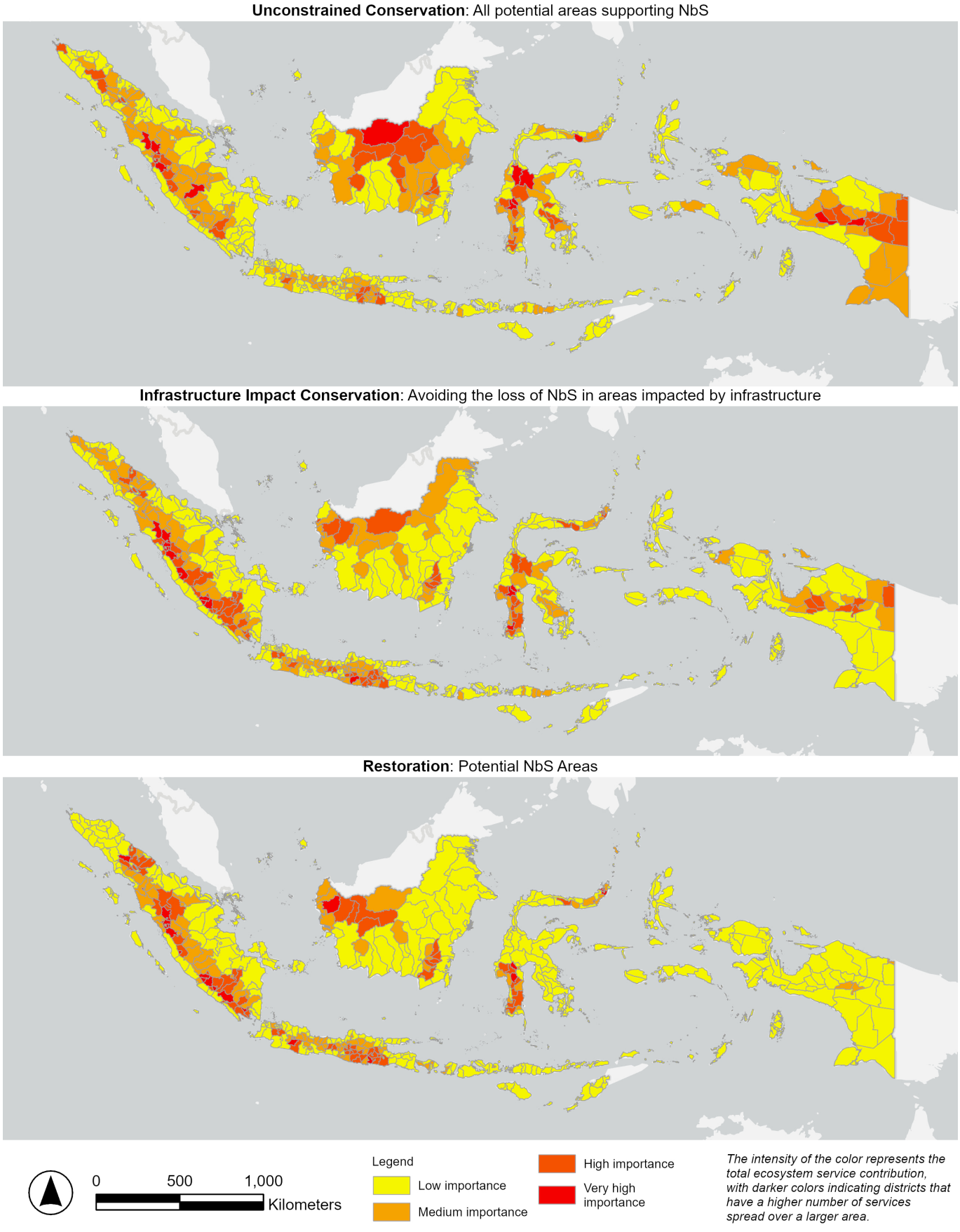

Figure 3. Conservation and restoration hotspot maps illustrating the total ecosystem service contribution per hectare for each district. (Top to bottom) 1) map showing key districts critical for unconstrained conservation areas, 2) map showing key districts critical for the Infrastructure Impact Conservation scenario 3) districts important for restoration.

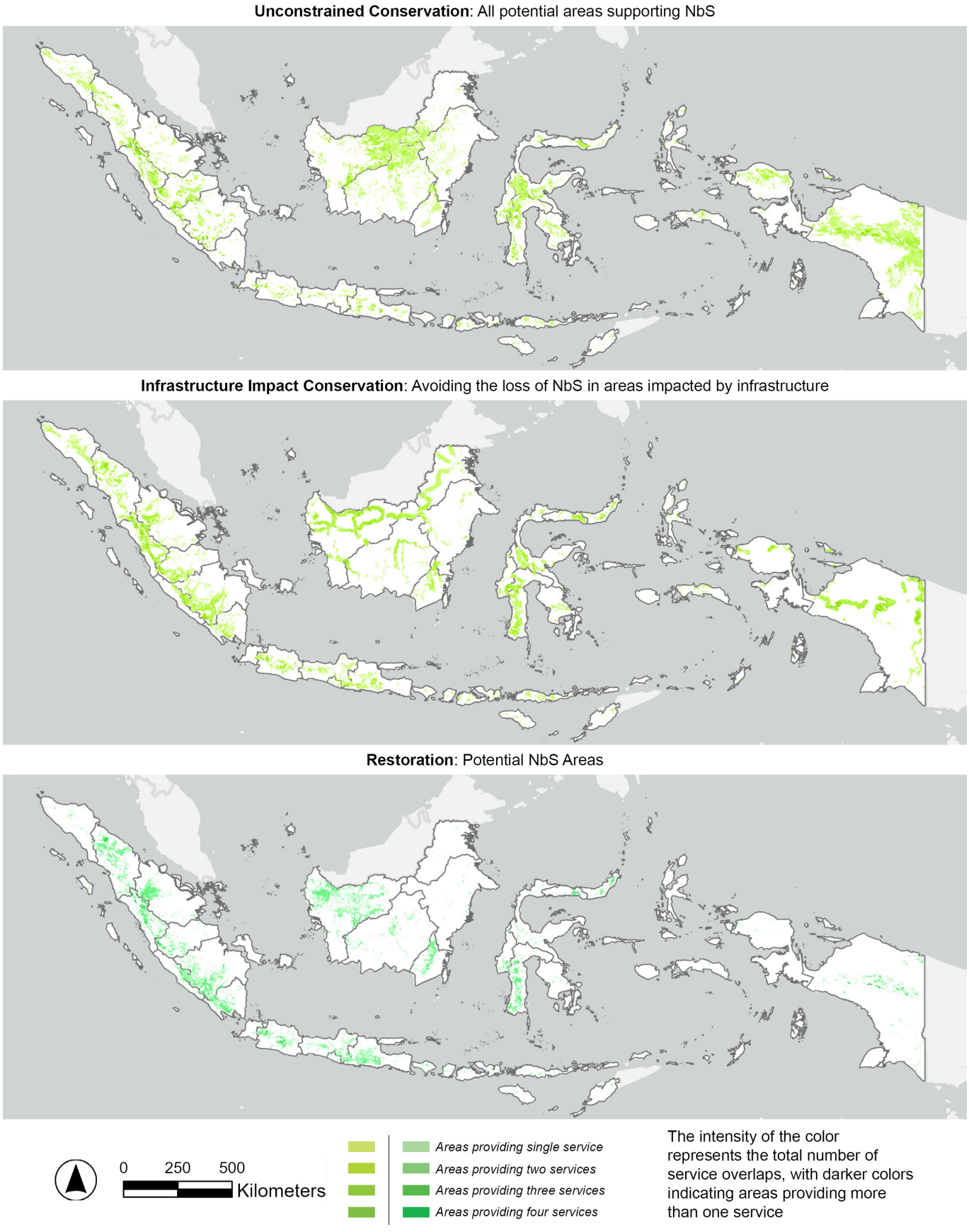

Figure 4. Conservation and restoration service overlap maps illustrating the total number of ecosystem service overlaps. (Top to bottom) 1) map showing key districts critical for unconstrained conservation areas, 2) map showing key districts critical for the Infrastructure Impact Conservation scenario 3) districts important for restoration.

RECOMMENDATIONS

For technical staff and decision-makers involved in infrastructure planning, conservation, and climate change resilience in Indonesia, we recommend the following to leverage these analyses to enhance NbS implementation and uptake nationwide in line with the country's sustainable development, climate adaptation and mitigation, and biodiversity goals, as outlined in the Medium- and Long-Term Development plans (RPJMN, RPJPN) and "Asta Cita" priorities of the new administration.

1. **Leverage these analyses to support resilience, biodiversity, and sustainability goals in the design and implementation of key national and subnational planning processes.** The RPJMN, RPJPN, and RTRW plans offer multiple entry points to integrate environmental and sustainability considerations with transportation and infrastructure development. This includes Ecological Resilience Policy areas supporting the RPJPN, such as Quality Living Environment, Disaster and Climate Change Resilience, and Energy, Water, and Food Independence. Spatial planning, geospatial information, and disaster mitigation are all priorities targeted for strengthening to accelerate regional development. These analyses can also support sustainable land management targets under Priority Program 11, Ensure Environmental Preservation; and are aligned with focus areas of the Asta Cita goals of the new administration, including on green economy, infrastructure development, and strengthening the natural environment.

2. **Encourage Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) to promote and integrate NbS into spatial planning processes, including the RTRW.** Analysis of NbS potential like in this brief (and longer technical report) should be applied comprehensively across all levels of planning, starting from the national level down to provincial and to district levels. WWF and partners at the University of Gadjah Mada have developed training materials that could be used to train ATR/BPN staff and subnational regional staff now in the process of developing regional spatial plans. You can find the materials here.

3. **Incorporate NbS areas to avoid and restore in the 2020-2040 Road Network General Plan.** To align with the Ministry of Public Works' road infrastructure development targets (15,404.05 km of toll roads and 12,807.16 km of new roads), the identified NbS areas could be incorporated into the 2020-2040 Road Network General Plan and specific road planning processes. This would support identifying areas to avoid or restoration opportunities to enhance the resilience of roads and downstream and coastal populations. The Ministry of Public Works could coordinate with the Ministry of Environment and Ministry of Forestry to identify optimal conservation and restoration areas and approaches and standards for implementation.

4. **Integrate spatial assessment of NbS in the prioritization and screening criteria of national priority infrastructure projects (PSN).** Bappenas P3IPN staff should work with colleagues across ministries to integrate Nature-Based Solutions (NbS) into its project selection and prioritization processes. It should revise the selection and screening criteria to incorporate hotspots identified through this analysis to guide citing decisions around go and no-go areas for PSN. This will inform the selection of projects that either avoid or mitigate impacts on these crucial conservation and restoration areas.

5. **Build capacity to mainstream NbS in subnational infrastructure planning through trainings and guidance materials developed under SIPA to evaluate and plan for NbS.** Under SIPA, WWF has worked with Gadjah Mada University to develop training modules for technical and policy staff at the national and subnational levels that can be used to train additional staff across regions in Indonesia.

6. **Facilitate coordination between private sector, local associations (e.g., environmental associations, land owner associations) and local governments to address barriers related to land rights and acquisitions in areas for new NbS investments, either to maintain existing habitats or restore new areas.** Such coordination could contribute to better incentivize the private sector to maintain existing habitats or implement NbS if associations participate in the maintenance of the land. Similarly, local governments can guide private sector investments in NbS through urban planning, or fiscal incentives.

7. **Encourage the Ministry of Finance to mandate the implementation of NbS within Environmental, Social, and Governance (ESG) frameworks in government support and facilities for infrastructure financing.** Indonesia could integrate NbS in the selection and prioritization guidelines for public private partnerships (PPPs) for major road investments. The private sector finance for infrastructure-focused Guarantee and Infrastructure (PT PII) organization and the Knowledge Management Unit (IIGF) could update environmental and social safeguards policies to strengthen the project guarantees process, not just mandating project developers to avoid and minimize environmental harm, but also identifying potential conservation and restoration opportunities to strengthen projects (as outlined herein).

8. **Integrate maps and associated data into existing centralized national data and mapping platforms to mainstream NbS in planning at national and subnational levels.** In collaboration with Ministry of Agrarian Affairs and Spatial Planning / National Land Agency (ATR/BPN) and Geospatial Information Agency (BIG), BAPPENAS should upload these maps and background data and resulting analyses to the World Bank funded One Map and other relevant national and subnational platforms used by key agencies.

9. **Include NbS in the infrastructure planning criteria of key national and subnational projects to increase efficiency in the management and delivery of public investment.** In Sumatra and Riau, the Indonesia Infrastructure and Finance Compact's The Advancing Transport and Logistics Accessibility (ATLAS) Project is a perfect opportunity to prioritize identifying conservation and restoration measures for key ecosystems, while simultaneously enhancing the infrastructure planning capabilities of subnational agencies across five non-Java provinces through. The Public Investment Management Guidelines (PIMG) and Project Preparation and Delivery Facility (PPDF) can integrate nature-based solutions into the planning of subnational and regional infrastructure projects. PPDF's technical assistance should include ecosystem services training, such as SIPA modules, for transport specialists before and during the Environmental and Social Impact Assessment (ESIA) process.

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