

Strengthening Upstream Forest Conservation Policies to Achieve Sustainable Development Goals



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ABSTRACT

Existing studies on watershed and forest conservation in the upstream Bengawan Solo region have largely focused on ecological degradation, technical conservation strategies, or regulatory shortcomings. However, there remains a significant gap in understanding how an ecoregion based approach can be systematically integrated with local wisdom to produce a comprehensive and context specific conservation policy. The study investigates the role of local wisdom in upstream forest management, the existence of gaps in legal protection for watershed conservation, and the impact of integrating local wisdom with legal frameworks on policy effectiveness. An empirical method with a qualitative approach was employed, drawing on primary data obtained through field observations in four regencies, namely Wonogiri, Sukoharjo, Surakarta, and Karanganyar. The results of this study reveal three principal findings. First, sustainable conservation in the upstream Bengawan Solo watershed requires a synergistic model that integrates ecological considerations with community based knowledge systems. Second, fragmented regional regulations and weak legal coordination continue to obstruct effective watershed governance, resulting in inconsistent conservation practices across administrative boundaries. Third, the study highlights the need for comprehensive policy reform through the establishment of interregional cooperation mechanisms supported by a Memorandum of Understanding, which can strengthen institutional governance, harmonize conservation strategies, and enhance long term ecological resilience within the watershed area.



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1. Introduction

Indonesia possesses extensive biodiversity and diverse ecological landscapes that form a vital foundation for national sustainability. The upstream area of the Bengawan Solo watershed represents one of these important natural regions, serving as a strategic zone with significant ecological, social, and economic functions.¹ This region plays a central role in maintaining environmental stability,

¹ Ahmad Dhiaulhaq and others, 'Joined-up Governance and Sustainable Finance for Inclusive Ridge-to-Reef Conservation in Southwest Papua, Indonesia', *Environmental Development*, 57 (2026), 101360 <https://doi.org/https://doi.org/10.1016/j.envdev.2025.101360>

supporting local livelihoods, and sustaining various economic activities on Java Island. Its conservation is therefore essential to ensuring long term ecological resilience and community well being.² The upstream section of the Bengawan Solo, the longest river in Java, plays a critical role in maintaining the hydrological cycle by regulating water flow, reducing flood risks, and supplying natural resources essential to local communities. Over the past two decades, forest degradation in this region has intensified. Accelerating deforestation, the conversion of forest land into residential areas and intensive agricultural zones, and the limited involvement of local communities in environmental decision making have collectively disrupted the ecological functions of the upstream watershed. These pressures indicate a significant decline in the region's environmental stability and long term sustainability.³

This phenomenon indicates that the conservation policies implemented to date remain ineffective in addressing the complex conditions occurring in the upstream watershed. The prevailing technocratic and sectoral approaches frequently overlook the biophysical characteristics of the region, including its ecoregion profile, and disregard local values that have long been preserved and practiced by customary and local communities. Such limitations persist even though ecological and cultural perspectives constitute two fundamental and inseparable pillars in natural resource governance and environmental protection. The absence of these considerations contributes to policy shortcomings and weakens conservation outcomes in the Bengawan Solo upstream area.⁴

In several villages located in the upstream Bengawan Solo region, particularly in the Wonogiri and Sukoharjo areas, local communities have long practiced conservation measures rooted in local wisdom. These practices include prohibitions on cutting specific tree species, customary rules governing land clearing, and traditional forms of agroforestry. Such practices illustrate how communities cultivate a balanced and mutually beneficial relationship with forest ecosystems. Unfortunately, these forms of local wisdom have not been adequately incorporated into formal conservation policies at either the regency or provincial

² Absori Absori and others, 'Analysis of the Issues on Bengawan Solo River Basin Management Policies', *WSEAS Transactions on Environment and Development*, 19.November 2022 (2023), 25–32 <https://doi.org/10.37394/232015.2023.19.3>

³ Setiawan Hari Harjanto and others, 'Chapter 16 - Geographic Information System-Based Statistical Mapping of Socioeconomic Vulnerability in the Upper Citarum River, West Java Province, Indonesia', in *Applications of Geospatial Technology and Modeling for River Basin Management*, ed. by Subodh Chandra Pal, Uday Chatterjee, and Rabin Chakraborty, *Modern Cartography Series* (Academic Press, 2024), XII, 413–38 <https://doi.org/https://doi.org/10.1016/B978-0-443-23890-1.00016-5>

⁴ Abdulkadir Rahardjanto and others, 'Ecocultural Practices in East Java, Indonesia: A Hermeneutic Phenomenological Study on "Reresik Kali" as Local Wisdom for River Conservation', *Social Sciences & Humanities Open*, 12 (2025), 102176 <https://doi.org/https://doi.org/10.1016/j.ssaho.2025.102176>

levels. Instead of reinforcing community initiatives, policy frameworks often marginalize local participation and replace culturally embedded practices with legalistic approaches that fail to reflect local sociological and ecological realities. In principle, community practices represent the embodiment of local wisdom, and in many contexts, legal effectiveness increases when regulatory approaches integrate these local values. Restorative justice constitutes one example of a local wisdom-oriented approach; however, this principle has yet to be recognized or applied within the field of environmental law.⁵

In reality, the conservation crisis which occurs in the upstream area of the Bengawan Solo watershed does not only regard the physical degradation of the environment, as it also regards the failure in developing a synergy between society, scientific knowledge, and public policies.⁶ Therefore, there is a need for a new paradigm in the formulation of legal policies on conservation, namely by making the ecoregion approach a scientific basis and making local wisdom an ethical-sociological basis. It is hoped that this approach may yield policies that are not only effective in preserving the environment but also economically and socially just as well as sustainable in the long term. The ecoregion approach has the function to analyze the protection of the endemic ecosystem and carry out the mapping of ecosystems that are threatened by changes in the functions of land, rivers, and forests.^{7v}

Seeing the conditions overseas, some countries have succeeded in applying a collaborative approach that integrates local and ecological perspectives into river watershed conservation policies. For instance, in Costa Rica, the community-based conservation approach was successfully applied through the Payment for Environmental Services (PES) scheme, which gives local communities incentives to preserve forests and water resources.⁸ Not only does this program increase forest coverage, it also strengthens the local capacity to sustainably manage their

⁵ Rustinsyah Rustinsyah, Ratna Azis Prasetyo and Muhammad Adib, 'Social Capital for Flood Disaster Management: Case Study of Flooding in a Village of Bengawan Solo Riverbank, Tuban, East Java Province', *International Journal of Disaster Risk Reduction*, 52 (2021), 101963 <https://doi.org/https://doi.org/10.1016/j.ijdrr.2020.101963>

⁶ Dandy Ramadan and Rahayu Subekti, 'Legal Examination of Military Court Decisions on the Criminal Actions of Indonesian Navy Members in Selling Illegal Timber', *Jurnal Jurisprudence*, 15.1 (2025), 67-82, <https://doi.org/10.23917/jurisprudence.v15i1.10001>

⁷ Arief L Hakim and others, 'Protected Spring and Sacred Forest Institutions at the Instrumental — Relational Value Interface', *Current Opinion in Environmental Sustainability*, 62 (2023), 101292 <https://doi.org/https://doi.org/10.1016/j.cosust.2023.101292>

⁸ Nguyen Tuan Anh and others, 'Influences of Key Factors on River Water Quality in Urban and Rural Areas: A Review', *Case Studies in Chemical and Environmental Engineering*, 8.July (2023), 100424 <https://doi.org/10.1016/j.cscee.2023.100424>

areas. The main principle of this program is acknowledging society's contribution in maintaining the ecosystem's services that bring value to the public.⁹

Meanwhile, in Brazil, the conservation of the Amazon river basin area shows the importance of a co-management model between the state and local communities.¹⁰ In several areas, the federal government encourages the mutual management of conservation areas with customary communities through a community-based area protection scheme (extractive reserves). This model allows for a combination of the ecoregion scientific framework and local knowledge to design spatial planning that is according to local cultures and ecologies. Not only does this method succeed in decreasing deforestation, it also strengthens society's rights and identities in their living space.¹¹

Some of these practices in foreign countries strengthen the importance of building a policy framework that is based on the ecoregion and local wisdom approaches. These two approaches have complementary strength. The ecoregion approach emphasizes the importance of paying attention to ecological integrity in designing the space and managing the area. This is so that the formulated policies are in line with the environmental carrying capacity.¹² Meanwhile, the local wisdom approach emphasizes socio-cultural values, which have been proven to be adaptive and sustainable in collectively managing natural resources. When the two are combined, not only does this policy formulation become legally and scientifically valid, but it is also valid in the social and cultural sense.¹³

In the context of Indonesia, various national policies have actually opened room for the acknowledgement of local wisdom and ecoregion principles. For instance, Law No. 32 of 2009 on Environmental Protection and Management has explicitly acknowledged the importance of a community and region-based approach in

⁹ Rodd Myers, 'What the Indonesian Rattan Export Ban Means for Domestic and International Markets, Forests, and the Livelihoods of Rattan Collectors', *Forest Policy and Economics*, 50 (2015), 210–19 <https://doi.org/https://doi.org/10.1016/j.forpol.2014.07.009>

¹⁰ Priscila F.M. Lopes Raphael Ocelli Pinheiro, Ludwig Triest, 'Cultural Ecosystem Services: Linking Landscape and Social Attributes to Ecotourism in Protected Areas', *Ecosystem Services*, 50 (2021) <https://doi.org/https://doi.org/10.1016/j.ecoser.2021.101340>

¹¹ Phidju Marrin Sagala, Rupesh K Bhomia and Daniel Murdiyarso, 'Assessment of Coastal Vulnerability to Support Mangrove Restoration in the Northern Coast of Java, Indonesia', *Regional Studies in Marine Science*, 70 (2024), 103383 <https://doi.org/https://doi.org/10.1016/j.rsma.2024.103383>

¹² María de Lourdes Gultemirian Edgardo Javier Ignacio Pero, Sergio Miguel Georgieff and Eduardo Domínguez Fátima Romero, Guillermo Eduardo Hankel, 'Physicochemical, or a Combination of All: Which Criteria Are the Best to Define River Types Based on Abiotic Variables and Macroinvertebrates in Neotropical Rivers?', *Science of The Total Environment*, 738 (2020) <https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.140303>

¹³ Elizabeth MacAfee, Edwin de Jong and Ansje J. Lohr, 'Leveraging Local Knowledge for Landslide Disaster Risk Reduction in an Urban Informal Settlement in Manado, Indonesia', *International Journal of Disaster Risk Reduction*, 111.March (2024), 104710 <https://doi.org/10.1016/j.ijdr.2024.104710>

environmental management. However, at the regional level, especially at the city/regency levels, the formulation of conservation policies is often still fragmented. It has not made local policies into a source of inspiration for creating regulations. In this case, the regional government has a highly strategic role, especially in formulating regional legal policies that specifically govern forest conservation according to local characteristics.¹⁴

Previous research strongly supports the need for robust upstream forest-conservation policies that align with Sustainable Development Goals. Narendra, Siregar, Dharmawan, Sukmana, Pratiwi, Pramono, Basuki, Nugroho, and Supangat (2021) provide a national review in Sustainability that highlights major institutional challenges in Indonesian watershed governance, such as asynchronous regulations, weak stakeholder coordination, and limited community participation.¹⁵ Basuki also emphasize in Sustainability the need to integrate culture, local wisdom, and traditional knowledge into integrated watershed management (IWM) to support both mitigation and adaptation to climate change.¹⁶ Abdul Kadir Jaelani develop a theoretical-empirical framework in Sustainability for incorporating traditional knowledge into science-based sociotechnical measures in upstream watershed management, showing that participatory and bottom-up approaches are essential for sustainability. Indonesia's watershed policies for their sectoral fragmentation and inadequate coordination, and argues for a more integrated, multi-stakeholder governance model.¹⁷

There is an increasingly urgent need for regional regulations that govern forest conservation in the upstream Bengawan Solo watershed,¹⁸ not only due to the increasing environmental damage but also due to the existence of great potential in the form of local values and a basis of regional ecology that may be used as references. It is hoped that such regional regulations may answer the issues of deforestation, increase community participation, and provide a sustainable legal basis for the management of the regions. This research aims to formulate a forest conservation policy for the upstream Bengawan Solo watershed by grounding the

¹⁴ Yanto Rochmayanto and others, 'Devolution of Forest Management to Local Communities and Its Impacts on Livelihoods and Deforestation in Berau, Indonesia', *Heliyon*, 9.5 (2023), e16115 <https://doi.org/10.1016/j.heliyon.2023.e16115>

¹⁵ Budi Hadi Narendra and others, 'A Review on Sustainability of Watershed Management in Indonesia', *Sustainability*, 13.19 (2021), 11125 <https://doi.org/10.3390/su131911125>

¹⁶ Hunggul Yudono Setio Hadi Nugroho and others, 'Forty Years of Soil and Water Conservation Policy, Implementation, Research and Development in Indonesia: A Review', *Sustainability*, 14.5 (2022), 2972 <https://doi.org/10.3390/su14052972>

¹⁷ M. Jamin and others, 'Legal Protection of Indigenous Community in Protected Forest Areas Based Forest City', *Bestuur*, 10.2 (2022), 198–212 <https://doi.org/10.20961/bestuur.v10i2.66090>

¹⁸ Trias Hernanda and others, 'The Impact of Environmental Regulation Implementation: A Meta-Analysis', *International Journal of Sustainable Development and Planning*, 18.10 (2023), 3235–3242 <https://doi.org/10.18280/ijstdp.181023>

analysis in an ecoregion-based approach and the integration of local wisdom. Using primary data obtained through interviews and field observations, the study identifies the local values embedded in community practices, examines the ecological and social characteristics of the region, and develops a policy framework that can serve as a reference in drafting regional regulations. The expected outcome is to contribute not only to the development of more contextual and regionally appropriate conservation policies, but also to the reinforcement of local cultural practices as a key foundation for environmental stewardship. This research therefore examines how local wisdom supports forest management in the upstream watershed, evaluates the presence of legal protection gaps in conservation regulations, and assesses the implications of integrating local knowledge with formal legal mechanisms in shaping effective watershed conservation policies.

2. Research Method

The method used in this research was the empirical method with a qualitative approach.¹⁹ The primary source of data originated from field observation in four regencies, Wonogiri, Sukoharjo, Surakarta, and Karangnyar. Apart from conducting observation, the authors also interviewed some key figures²⁰ who were linked to the management of the Bengawan Solo watershed using the in-depth interview method. Apart from the primary source of data, this research also utilized secondary sources of data originating from constitutional documents, articles, and case studies. In carrying out data analysis, the authors used Miles and Huberman's technique, consisting of data collection, data reduction, and conclusion drawing.²¹

3. Results and Discussion

Strengthening Upstream Forest Conservation Policies in Bengawan Solo

The nature in Indonesia has truly experienced damage. Environmental destruction has a causality relationship,²² as it represents the illegal actions of certain parties among communities or corporations that carried out their profit-oriented activities without calculating the impacts that may happen. In Indonesia, environmental crimes have made the state and its people suffer from losses.

¹⁹ A. K. Jaelani, A. Rabbani and M. J. Hayat, 'Land Reform Policy in Determining Abandoned Land for Halal Tourism Destination Management Based on Fiqh Siyasah', *El Mashlahah*, 14.1 (2024), 211–238 <https://doi.org/10.23971/el-mashlahah.v14i1.8051>

²⁰ K. Wardiono, 'Prophetic: An Epistemological Offer for Legal Studies', *Journal of Law and Justice*, 1.1 (2019), 17–41 <https://doi.org/10.23917/jtl.v1i1.8797>

²¹ Sunardi, 'Environmental Protection Based on Islamic Law and Epistemology in Indonesia', *Law and Justice*, 8.1 (2023) <https://doi.org/10.23917/laj.v8i1.635>

²² Rizky Aulia Rahman, Benedict White and Chunbo Ma, 'The Effect of Growth, Deforestation, Forest Fires, and Volcanoes on Indonesian Regional Air Quality', *Journal of Cleaner Production*, 457.November 2023 (2024), 142311 <https://doi.org/10.1016/j.jclepro.2024.142311>

Natural disasters and financial losses are the real proof. According to Sri Mulyani, environmental destruction due to environmental crimes is categorized into the three global criminal actions whose transaction value reaches hundreds of millions of dollars.²³ Then, the impacts of environmental destruction encompasses natural destruction with a wide category, namely land destruction due to illegal mines, the destruction of water resources due to river or watershed pollution, spatial planning patterns that only prioritizes development without considering environmental protection, the legalization of illegal residential areas, money laundering of profits from illegal mines, and tax evasion.²⁴

Environmental destruction is the symbolization of the environmental law's ineffective enforcement as well as the environmental protection that is not seriously carried out²⁵. On the other hand, the environmental protection pattern that is adopted from local wisdom shows a positive trend. In the protection of the upstream area of the Bengawan Solo watershed, community groups carry out some efforts to preserve the Wonogiri forest area, reaching the source of the spring. One of the actors of forest area preservation in Wonogiri is Sadiman, who planted an abundant number of trees, bringing positive and sustainable impacts to the upstream area of the Bengawan Solo watershed. According to Teguh, one of the environmental activists in Wonogiri, Mr. Sadiman's activities have a great role in maintaining the forest conservation area in the Wonogiri region. Teguh explained that Mr. Sadiman's pattern of environmental preservation is by planting as many trees as possible in the forest areas around his house, as he believes that the forest has the function of preserving the water spring and is home to some living creatures. Teguh's statement is strengthened by the statement from Hyronimus Rhiti, who stated that natural and environmental destruction can decrease the quality of human life in the current and future eras.²⁶ v

Local wisdom and environmental protection are two terms that have a close link. Indonesia is a country with varied biodiversity. Some of this biodiversity is still protected and preserved by the activities of local communities whose lives

²³ Felix Aglen Ndaru, 'Limitasi Tindak Pidana Di Bidang Sumber Daya Alam Sebagai Tindak Pidana Asal Pencucian Uang Di Indonesia', *Jurnal Hukum Lingkungan Indonesia*, 9.2 (2024), 239–78 <https://doi.org/10.38011/jhli.v9i2.532>

²⁴ Chuqi Long and others, 'Mapping Mangrove Forests in the Red River Delta, Vietnam', *Forest Ecology and Management*, 483 (2021), 118910 <https://doi.org/https://doi.org/10.1016/j.foreco.2020.118910>

²⁵ Luca Tacconi, Rafael J. Rodrigues and Ahmad Maryudi, 'Law Enforcement and Deforestation: Lessons for Indonesia from Brazil', *Forest Policy and Economics*, 108.May (2019), 101943 <https://doi.org/10.1016/j.forpol.2019.05.029>

²⁶ Moh Sholichin and others, 'Assessing Landslide Susceptibility and Formulating Adaptation Strategies in the Konto Watershed, East Java, Indonesia', *International Journal of Disaster Risk Reduction*, 113 (2024), 104797 <https://doi.org/https://doi.org/10.1016/j.ijdrr.2024.104797>

depend on nature.²⁷ Law No. 32 of 2009 on the Environment also gives a place for environmental protection with a local wisdom concept. There is a point in Article 1 which explains the meaning of local wisdom. It also contains some Articles that explain the role of local wisdom in supporting the protection of environmental law. Article 2 places local wisdom as one of the legal principles. Then, Article 10 places local wisdom as one of the substances that must be inserted in the document of Environmental Protection and Management Plans. Next, Article 63 explains the acknowledgement of customary communities and local wisdom.²⁸

The legal protection of the Bengawan Solo's watershed area at the regional level, it is a fact that no such regulations exist. This is due to the limitation of authority from the central government and regional governments regarding the zoning of water areas. This impacts the determination of regional specificity. History reveals that the Bengawan Solo watershed has a relationship with local wisdom. From the prehistoric era, the kingdom era, the colonial era, and up to the independence era, people around the upstream area of the Bengawan Solo watershed have had value systems and ecological practices that have been passed down from generation to generation.²⁹ These systems develop into forms of local wisdom that not only become guidelines to behavior but are also a form of legal protection that lives in the community. Therefore, the forest management in the upstream area of the watershed, including the Donoloyo Forest in Wonogiri Regency, requires a legal approach that is not only normative-positivistic but also accommodates local values and community participation.³⁰

The collaboration between local legal protection and local wisdom becomes an urgent need³¹ in managing the upstream area of the Bengawan Solo watershed. The state law may have a role in determining the boundaries, sanctions, as well as administrative authority. Meanwhile, local wisdom becomes an ethical and operational basis that is proven to be effective in maintaining environmental preservation. In this framework, the state should not position local communities as

²⁷ Tim C Jennerjahn, Erwin Riyanto Ardli, and others, '7 - Mangrove Ecosystems under Threat in Indonesia: The Segara Anakan Lagoon, Java, and Other Examples', in *Science for the Protection of Indonesian Coastal Ecosystems (SPICE)*, ed. by Tim C Jennerjahn and others (Elsevier, 2022), pp. 251–84 <https://doi.org/https://doi.org/10.1016/B978-0-12-815050-4.00004-3>

²⁸ Karlina Triana and others, 'An Integrated Satellite Characterization and Hydrodynamic Study in Assessing Coastal Dynamics in Cirebon, West Java', *Regional Studies in Marine Science*, 65 (2023), 103107 <https://doi.org/https://doi.org/10.1016/j.rsma.2023.103107>

²⁹ Bayu B Hanggara and others, 'Effects of Diverse Mangrove Management Practices on Forest Structure, Carbon Dynamics and Sedimentation in North Sumatra, Indonesia', *Estuarine, Coastal and Shelf Science*, 259 (2021), 107467 <https://doi.org/https://doi.org/10.1016/j.ecss.2021.107467>

³⁰ Alexandra Zieritz and others, 'Prioritising Challenges and Actions for Freshwater Conservation in a Tropical Biodiversity Hotspot', *Biological Conservation*, 299 (2024), 110839 <https://doi.org/https://doi.org/10.1016/j.biocon.2024.110839>

³¹ Arief Budiono and others, 'The Anglo-Saxon System of Common Law and the Development of the Legal System in Indonesia', *WSEAS Transactions on Systems*, 22 (2023), 207–13 <https://doi.org/10.37394/23202.2023.22.21>

mere legal objects but rather place them as active subjects who contribute towards conservation. The first step of this collaboration is the development of legal protection mechanisms that not only have a top-down characteristic but are also participative and adaptive to local conditions. This may be manifested through an inclusive regional legislation process, where the formulation of regulations not only involves the government and academicians but also local communities, customary figures, and environmental preservation actors.³² An example that deserves to become a role model is the Donoloyo Forest area of Wonogiri Regency. This area reflects successful environmental preservation based on local wisdom that has been carried out in an independent and sustainable manner. Apart from the Donoloyo Prohibited Forest, another effort that is carried out by uplifting local wisdom practices is also applied in Sukoharjo by creating a local wisdom and nature-based tourism village, namely the Janggalan Village.³³

Communities in Donoloyo and Janggalan Villages actively implement conservation practices by planting trees, enforcing customary prohibitions on the destruction of water springs, and applying spiritual values to sustain forest ecosystems and protect the Bengawan Solo River area. These community-driven initiatives have successfully restored zones previously prone to drought. The efforts of individuals such as Sadiman demonstrate that environmental stewardship can originate from personal action and subsequently develop into collective movements capable of generating substantial ecological benefits. The achievements of Donoloyo Forest and Janggalan Village therefore provide empirical models for designing community-based and local wisdom-oriented environmental protection policies at the regency, provincial, and national levels.³⁴

Therefore, there needs to be the formulation of regional legal policies that acknowledge and integrate local values in strategies to conserve the upstream area of watersheds. This legal policy must give room for legal acknowledgement of the local management system as well as provide protection and incentives to the people who are actively involved in environmental preservation. At the village level, Village Regulations may be formulated to strengthen community-based environmental management. The synergy between Regional Regulations and

³² Novitasari Novitasari and others, 'A Correlation of Infiltration Rates and Land Use Changes in Government Office Area in South Kalimantan Province, Indonesia', *AIP Conference Proceedings Conference Paper*, 3317.1 (2025) <https://doi.org/10.1063/5.0279331>

³³ Larissa Dsikowitzky and others, 'Chapter 21 - Java Island, Indonesia', in *World Seas: An Environmental Evaluation (Second Edition)*, ed. by Charles Sheppard, Second Edition (Academic Press, 2019), pp. 459–90 <https://doi.org/https://doi.org/10.1016/B978-0-08-100853-9.00029-4>

³⁴ Louis Tanguay and Stéphane Bernard, 'Ecoagricultural Landscapes in the Dieng Mountains of Central Java; A Study of Their Evolution and Dynamics', *Journal of Rural Studies*, 77 (2020), 169–84 <https://doi.org/https://doi.org/10.1016/j.jrurstud.2020.05.001>

Village Regulations will create a legal network that strengthens each other and is strongly rooted in society's socio-ecological reality.³⁵

The application of an ecoregion-based approach to managing upstream watershed areas is particularly relevant, as it facilitates governance that transcends administrative boundaries and is grounded in ecological integrity and local cultural systems. In the upstream section of the Bengawan Solo watershed, this approach is essential because the region spans multiple regencies with distinct social and geographical characteristics that are nevertheless interconnected within a single hydrological system. Positioning the Donoloyo Forest as an example of successful local wisdom demonstrates to policymakers that environmental protection is not merely a developmental or governmental initiative but a community-embedded practice sustained through lived cultural values. These locally rooted principles must be accommodated within the legal framework as a substantive source of legitimacy rather than treated as supplementary considerations. As noted by Teguh, the Donoloyo Forest plays a critical role in shaping the future ecological stability of the Bengawan Solo watershed.³⁶

Regional legal institutions must begin to incorporate and institutionalize locally embedded values into formal legal norms through regulatory instruments, development planning, and environmental protection programs. Strengthening environmental conservation in the upstream Bengawan Solo watershed therefore requires a collaborative legal framework that aligns state regulations with local wisdom and ensures active community participation. The experiences of Donoloyo Forest and Janggalan Village demonstrate that effective environmental stewardship can originate at the community level and, with appropriate legal support, evolve into broader ecological policies rooted in principles of justice and sustainability.³⁷

Legal Protection of the Watershed Upstream Area Conservation

Legal protection of the upstream area of watersheds is a crucial aspect in manifesting sustainable development and natural resource management in a just and preserved manner.³⁸ As an area with strategic eco-hydrological functions, the

³⁵ Niyati Naudiyal and others, 'Potential Distribution of Abies, Picea, and Juniperus Species in the Sub-Alpine Forest of Minjiang Headwater Region under Current and Future Climate Scenarios and Its Implications on Ecosystem Services Supply', *Ecological Indicators*, 121 (2021), 107131 <https://doi.org/https://doi.org/10.1016/j.ecolind.2020.107131>

³⁶ Jose Alan A Castillo and others, 'Tree Biomass Quantity, Carbon Stock and Canopy Correlates in Mangrove Forest and Land Uses That Replaced Mangroves in Honda Bay, Philippines', *Regional Studies in Marine Science*, 24 (2018), 174–83 <https://doi.org/https://doi.org/10.1016/j.rsma.2018.08.006>

³⁷ Benazir and others, 'Vegetation-Based Approached for Tsunami Risk Reduction: Insights and Challenges', *Progress in Disaster Science*, 23 (2024), 100352 <https://doi.org/https://doi.org/10.1016/j.pdisas.2024.100352>

³⁸ Nevi May Risnawati and Ambar Kusumandari, 'Stakeholder Analysis in Opak and Bengawan Solo Watersheds Based on Coordination, Integration, Synchronization, and Synergy (CISS) Index Calculations', *BIO Web of Conferences*, 167 (2025) <https://doi.org/10.1051/bioconf/202516703012>

upstream area of watersheds plays a vital role in maintaining environmental stability, water resilience and sustainability of the ecological system at the downstream areas. However, some research and facts in the field show that there is currently a significant gap in the legal protection of the upstream area of watersheds, especially in the upstream area of the Bengawan Solo River watershed, Central Java.³⁹

The legal protection may be understood as a lack of alignment between formally applicable legal norms and the needs, real conditions, and values that exist in society. On one hand, Indonesia has enacted various legal instruments to govern the conservation of natural resources and the environment, such as Law No. 32 of 2009 on Environmental Protection and Management, Law No. 41 of 1999 on Forestry, and the Governmental Regulation No. 37 of 2012 on the Management of River Basins. However, in practice, these legal instruments have not been fully implemented in an effective and contextual manner in the upstream area of watersheds. Apart from that, there are regulatory conflicts and legal voids at the regional regulation level.⁴⁰

The main cause of this gap is the sectoral approach in formulating and implementing these regulations. Regions are not given the opportunity to participate in creating legal bases for the Bengawan Solo watershed. Legal regulations are often formulated in a top-down manner without considering the local socio-ecological characteristics and traditional knowledge systems that have long regulated the relationship between society and nature. This approach creates policy fragmentation and an overlap of authority between institutions, both at the central and regional levels. As a consequence, the protection towards the upstream area of watersheds is implemented in a partial and uncoordinated manner. This makes it vulnerable to exploitation and environmental destruction.⁴¹

The condition of the upstream region of the Bengawan Solo River watershed illustrates this structural problem. Although the protected forest area such as the Donoloyo Forest in Wonogiri Regency holds a vital ecological function as a water-retention zone, its conservation and governance have not yet received adequate protection through effective regional legal instruments. To date, the management of this area still relies heavily on community-based local wisdom, including

³⁹ Y. Priyana and others, 'Environmental Carrying Capacity Assessment For Crops In Bengawan Solo Watershed, Indonesia: A Spatial Approach', *Journal of Sustainability Science and Management*, 19.2 (2024) <https://doi.org/10.46754/jssm.2024.02.001>

⁴⁰ A. Fariza, J. A. N. Hasim and H. Rahadiano, 'Flood Risk Mapping of Bengawan Solo River in East Java Using the Analytic Hierarchy Process and Head/Tails Break Classification', in *International Conference on Science in Information Technology: Big Data Spectrum for Future Information Economy, ICSI Tech* (ICSI Tech, 2016), pp. 331–36 <https://doi.org/10.1109/ICSITech.2015.7407827>

⁴¹ H. Marhaento, M. J. Booi and N. Ahmed, 'Quantifying Relative Contribution of Land Use Change and Climate Change to Streamflow Alteration in the Bengawan Solo River, Indonesia', *Hydrological Sciences Journal*, 66.6 (2021), 1059–68 <https://doi.org/10.1080/02626667.2021.1921182>

traditional systems for determining planting seasons, prohibitions on tree felling around water springs, and customary rituals that function as socio-ecological control mechanisms. However, these forms of local ecological knowledge have not been formally integrated into regional or national legal frameworks. As a result, they remain vulnerable to pressures driven by economic interests, particularly plantation expansion and land-use conversion.⁴²

On the other hand, the law's lax presence in accommodating local practices and values also contributes to the weak social participation in the process of formulating and implementing conservation policies. Local communities are often positioned only as developmental objects rather than subjects who have rights, knowledge, and interests that must be protected. This violates the principles of good environmental governance, which emphasizes the importance of transparency, participation, and justice in the management of natural resources. The sustainability of the natural environment has actually been guaranteed by the government, as stipulated in governmental articles.⁴³

Further, the ecoregion approach that should become the basis of territorial management based on the biophysical, social, and cultural characteristics of the local area has not been fully integrated in the regional policies and legal planning. The ecoregion concept emphasizes that environmental management cannot be carried out in a uniform manner. However, it must be adapted to the ecosystem unity and the social interactions that are attached to a certain area.⁴⁴ In the context of the Bengawan Solo River basin upstream, this approach should be used to formulate regional policies with specific and adaptive characteristics based on local knowledge. Nevertheless, no regional regulation has been formulated to specifically govern upstream watershed conservation by integrating both the ecoregion approach and local wisdom. This regulatory absence weakens the normative foundation needed for regional governments to develop holistic and coherent environmental protection policies. In addition, public awareness of the role of watershed forums, whose functions involve cooperation across sectors and across regions, remains limited. This lack of societal engagement further exacerbates existing problems and hampers coordinated watershed governance.⁴⁵

⁴² Issa Dyah Utami and others, 'A Food Resilience Model Integrating Local Wisdom and Sociotechnical Dynamic Systems: Case Study Flood-Affected Communities in the Bengawan Solo Area', *Progress in Disaster Science*, 26 (2025), 1–9 <https://doi.org/10.1016/j.pdisas.2025.100413>

⁴³ Erina Pane and Adam Muhammad Yanis, 'Reconstruction of Mining Policies on Justice in Lampung Province', *Bestuur*, 8.2 (2020), 139–51 <https://doi.org/10.20961/bestuur.v8i2.42830>

⁴⁴ Abuzer Çelekli, Ömer Lekesiz and Tolga Çetin, 'Eco-Assessment of Streams of Konya Closed River Basin (Turkey) Using Various Ecoregional Diatom Indices', *Environmental Science and Pollution Research*, 30.13 (2023), 36143–59 <https://doi.org/10.1007/s11356-022-24747-2>

⁴⁵ D. R. Indrawati and others, 'Community Participation in Soil and Water Conservation as a Disaster Mitigation Effort', *Iop Conference Series Earth and Environmental Science*, 1109.1 (2022) <https://doi.org/10.1088/1755-1315/1109/1/012030>

From the aspect of law enforcement, the gap can also be seen in the weak sanctions against violations in the upstream area of the watershed. Some cases of forest encroachment, forest fires, and the shift in the function of protected areas cannot be legally resolved or end in administrative sanctions that do not create a deterrent effect.⁴⁶ This reflects the weak function of monitoring and the low introduction of regulations that have the capacity as the substance of law enforcement. Therefore, there needs to be strategic steps to close the gap in law protection through the reformulation of conservation policies based on the integration of positive law and local law. The acknowledgement of local wisdom should not stop at the declarative step, but it must also be manifested in the form of legal norms with binding power. This can be carried out by formulating regional regulations on the conservation of the upstream area of river basins, which explicitly regulate participative management, community-based institutionalization, as well as an incentive system for traditional preservers of the environment.⁴⁷

Intersectoral harmonization requires strengthening through the establishment of a Bengawan Solo River Basin Forum. This forum must involve a wide range of regional stakeholders, including the environmental office, the forestry office, the Bengawan Solo River Basin Center, academic experts, and civil society organizations. Through this mechanism, regional actors can coordinate more effectively, formulate integrated policies, and conduct periodic evaluations of ongoing conservation programs. Such collaborative governance aligns with the principles of decentralization and regional autonomy, which encourage innovation and contextual policy development at the local level. The management practices in the Donoloyo Forest and Janggalan Village in Sukoharjo Regency demonstrate how local wisdom can be institutionalized into formal legal systems. Values such as the prohibition against cutting old trees, the belief in spiritual guardians of the forest, and the implementation of the sedekah bumi ceremony by the communities of Ngroto and Kepyar Villages in Wonogiri Regency illustrate socio ecological norms that continue to guide environmental stewardship. These living traditions may be incorporated as normative material within regional regulations. In doing so, the law functions not merely as a state instrument for

⁴⁶ Tim C Jennerjahn, Antje Baum, and others, '3 - Human Interventions in Rivers and Estuaries of Java and Sumatra', in *Science for the Protection of Indonesian Coastal Ecosystems (SPICE)*, ed. by Tim C Jennerjahn and others (Elsevier, 2022), pp. 45–82 <https://doi.org/https://doi.org/10.1016/B978-0-12-815050-4.00002-X>

⁴⁷ Arum Puspaningtyas Manto and Prasetyo Nugroho, 'Clustering Residents' Intention and Behavior Toward Forest Rehabilitation Initiative: A Case Study in the Upstream of Central Java, Indonesia', *Jurnal Manajemen Hutan Tropika*, 28.3 (2022), 232–40 <https://doi.org/10.7226/jtfm.28.3.232>

controlling society, but as a reflection of community values that serve as empirical foundations for legal development.⁴⁸

Sustainable development aims to strengthen the legal protection at the upstream area of the watershed. It is not only a matter of technical regulations but is also an effort to strive for ecological and social justice. When the law is able to protect the forest, water, and land as society's source of life, then the law truly has carried out its ethical function and functionality. On the contrary, if the law only takes the side of economic interests and neglects local values, what happens is not only environmental damage but destruction to the social and cultural orders of customary societies, such as the plan for the weakening of environmental permits during the era of President Joko Widodo. Therefore, closing the legal protection gap in the conservation of the watershed's upstream area is a basic step to build an adaptive, just, and sustainable environmental legal system. This strategy must be used as a priority in the agenda to formulate regional and national policies, so that conservation does not only become an administrative symbol but also becomes a real practice that is rooted in the earth and takes the side of the environment.⁴⁹

Strengthening Upstream Forest Conservation Policies to Achieve Sustainable Development Goals

Legal protection of upstream watershed areas constitutes an essential component in realizing sustainable development and ensuring the just and preserved management of natural resources. As regions with strategic ecohydrological functions, upstream watershed zones play a decisive role in maintaining environmental stability, strengthening water resilience, and supporting the long term sustainability of ecological systems in downstream areas.⁵⁰ However, various research and data in the field show that up to now there is still a significant gap in the legal protection of the upstream area in watersheds, especially in the upstream of Bengawan Solo River watershed, Central Java. The gap in this legal protection can be understood as a mismatch between applicable formal legal regulations and the needs, real conditions, and local values that exist in society.⁵¹

⁴⁸ Herry Purnomo and others, 'Reducing Forest and Land Fires through Good Palm Oil Value Chain Governance', *Forest Policy and Economics*, 91 (2018), 94–106 <https://doi.org/https://doi.org/10.1016/j.forpol.2017.12.014>

⁴⁹ L A Bruijnzeel, 'Hydrological Functions of Tropical Forests: Not Seeing the Soil for the Trees?', *Agriculture, Ecosystems & Environment*, 104.1 (2004), 185–228 <https://doi.org/https://doi.org/10.1016/j.agee.2004.01.015>

⁵⁰ Budi Dharmawan, Michael Böcher and Max Krott, 'Failure of Science-Based Win-Win Solution in Fishery Management: Learnings from Segara Anakan Waters, Central Java, Indonesia', *Ocean & Coastal Management*, 141 (2017), 82–89 <https://doi.org/https://doi.org/10.1016/j.ocecoaman.2017.03.014>

⁵¹ Sandra Costa-Böddeker and others, 'Ecological Risk Assessment of a Coastal Zone in Southern Vietnam: Spatial Distribution and Content of Heavy Metals in Water and Surface Sediments of the

The conservation of the Bengawan Solo River watershed constitutes not only a technical dimension of environmental management but also a social process that implicates the rights and livelihoods of communities dependent on natural resources. In the upstream region of the Bengawan Solo watershed, covering Wonogiri, Sukoharjo, and surrounding areas, local communities have long implemented environmental management practices rooted in inherited traditions and intergenerational knowledge. Although this local wisdom has demonstrated measurable effectiveness in sustaining ecosystem stability, it remains largely overlooked within formal regulatory frameworks that prioritize technocratic and sectoral approaches to watershed governance. As a result, a substantive gap emerges between the ecological conservation needs of the region and the rigid, non-contextual policy instruments currently in force.⁵²

In this context, local wisdom denotes forms of traditional knowledge whose effectiveness and continuity have been proven in the management of natural resources. Agroforestry systems, selective land-clearing practices, and prohibitions on tree felling at specific ecological points, as implemented by communities in the upstream area of the Bengawan Solo River, provide concrete evidence of how local societies construct a balanced relationship with their surrounding environment. Nevertheless, these practices have not been fully incorporated into the prevailing conservation policy framework at either the regional or national level. Existing conservation regulations still tend to position local communities as passive recipients of environmental management and development interventions, rather than as rights-bearing actors with the knowledge and capacity to participate meaningfully in the conservation process.⁵³

Legal protection towards the upstream area of the Bengawan Solo watershed should not only be based on positive law but also accommodate local wisdom that has been proven to protect environmental preservation. The state has enacted some regulations that govern the protection and management of watersheds, such as Law No. 32 of 2009 on Environmental Protection and Management and Law No. 41 of 1999 on Forestry. Even so, in practice, conservation policies at the regional level are often hindered by the sectoral approach that lacks consideration for local characteristics. For instance, many policies are formulated with the top-down approach, without considering local cultural and social conditions. This leads to the fragmentation of policies, where one policy contradicts others and a

Thi Vai Estuary and Can Gio Mangrove Forest', *Marine Pollution Bulletin*, 114.2 (2017), 1141–51
<https://doi.org/https://doi.org/10.1016/j.marpolbul.2016.10.046>

⁵² J de Graaff and others, 'The Development of Soil and Water Conservation Policies and Practices in Five Selected Countries from 1960 to 2010', *Land Use Policy*, 32 (2013), 165–74
<https://doi.org/https://doi.org/10.1016/j.landusepol.2012.10.018>

⁵³ R. Rustinsyah, 'The Power and Interest Indicators of the Stakeholders of a Water User Association around Bengawan Solo River, Indonesia', *Data in Brief*, 19 (2018), 2398–2403
<https://doi.org/10.1016/j.dib.2018.07.030>

lack of coordination in the watershed management. As a result, the protection of the watershed's upstream area becomes very weak and vulnerable towards exploitation and threats of illegal hazardous waste disposal, which brings real negative effects to the environment.⁵⁴

The sectoral and technocratic approach in the management of river basins often neglects conservation practices that have long been applied by local communities. In the upstream area of the Bengawan Solo river basin, such as in the Donoloyo Forest of Wonogiri Regency, the forest management that depends on local wisdom has been proven to be more effective in preserving the ecosystem.⁵⁵ The planting season determination system, the prohibition of felling trees around water springs, as well as customary rituals to protect the forest, are real proofs of how local communities actively participate in environmental law protection. However, even though the applicable regulations do not accommodate such local values, the continuity of such practices is vulnerable to disturbances due to economic interests, and the violation of legal permits, such as a shift in land function or the expansion of plantations.⁵⁶

Ecoregion-based approaches are highly relevant to be applied in legal regulations that are based on the conservation of the upstream area of the Bengawan Solo river basin. Such an approach regards the upstream area of the river basin as a part of a wider ecological system, where forests, rivers, and all elements of the ecosystem are interconnected. Therefore, conservation policies at the watershed area must not only see that area as a separate entity, but also as part of a greater ecosystem that requires an integrated management that is based on holistic ecological understanding.⁵⁷

Through this approach, policymakers can design conservation instruments for the upstream area of the Bengawan Solo River basin by giving systematic attention to the biophysical, social, and cultural characteristics of the local region. The upstream segment of the Bengawan Solo River traverses several regencies that possess distinct geographic and social conditions, making a uniform policy

⁵⁴ Reshma Sunkur and others, 'Modelling Mangrove Dynamics in Mauritius: Implications for Conservation and Climate Resilience', *Journal for Nature Conservation*, 85 (2025), 126864 <https://doi.org/https://doi.org/10.1016/j.jnc.2025.126864>

⁵⁵ Mohammad Basyuni and others, 'Mangrove Aboveground Biomass Estimation Using UAV Imagery and a Constructed Height Model in Budeng-Perancak, Bali, Indonesia', *Ecological Informatics*, 86 (2025), 103037 <https://doi.org/https://doi.org/10.1016/j.ecoinf.2025.103037>

⁵⁶ Desty Pratiwi and others, 'Effect of Land Use Type on Macroinvertebrates Assemblages, Distribution, and Functional Guild in Upstream Citarum River', *Ecological Indicators*, 160 (2024), 111849 <https://doi.org/https://doi.org/10.1016/j.ecolind.2024.111849>

⁵⁷ Scott Moore, 'Toward Effective River Basin Management (RBM): The Politics of Cooperation, Sustainability, and Collaboration in the Delaware River Basin', *Journal of Environmental Management*, 298, August (2021), 113421 <https://doi.org/10.1016/j.jenvman.2021.113421>

approach inadequate.⁵⁸ The ecoregion framework enables conservation measures to be aligned with these diverse local conditions while integrating ecological knowledge and long-standing local wisdom embedded in community practices. Consequently, the resulting policies will not only strengthen environmental preservation but also promote social and cultural justice for the communities that depend on the watershed.⁵⁹

The integration of local wisdom in conservation policies of the upstream area of the Bengawan Solo river basin requires acknowledgement towards the rights of local communities to manage their natural resources.⁶⁰ One of the concrete steps that may be carried out is by building an environmental law protection mechanism that not only has a top-down characteristic, but also involves the active participation of society in formulating and implementing the conservation policy. This will give room for local communities to have a role as subjects in the watershed management, rather than only having the role as policy objects.⁶¹

It is crucial to strengthen the Bengawan Solo river basin forum, which involves various sectors in the conservation policy. This forum may give room to regional governments, civil society institutions, academicians, and local communities that will cooperate to formulate policies and evaluate conservation programs in a sustainable manner. With this method, the approaches of ecoregion and local wisdom will strengthen each other, creating policies that are more comprehensive and responsive towards the challenges faced by the Bengawan Solo river basin. According to Rahmat, the Bengawan Solo river basin forum has long been formed and takes the role in encouraging the birth of policies that support the protection of the Bengawan Solo river basin. Further, according to Teguh, without the Bengawan Solo river basin forum, one will not have the vessel to carry out their deeds in participating to protect the Bengawan Solo River.⁶²

The legal protection of the upstream area of the Bengawan Solo River basin, policymakers must reformulate conservation policies by integrating positive law

⁵⁸ Derek Vollmer and others, 'Examining Demand for Urban River Rehabilitation in Indonesia: Insights from a Spatially Explicit Discrete Choice Experiment', *Land Use Policy*, 57 (2016), 514–25 <https://doi.org/https://doi.org/10.1016/j.landusepol.2016.06.017>

⁵⁹ T. B. Prayogo and others, 'Mitigating Flood Vulnerabilities through Retarding Basin Systems: A Case Study in Bengawan Solo River, Indonesia', *International Journal of Disaster Risk Reduction*, 126 (2025) <https://doi.org/10.1016/j.ijdrr.2025.105629>

⁶⁰ A. Nurhakim and others, 'Rainfall Trend Analysis to the Change of Flood Discharge Estimation in Bengawan Solo River', *IOP Conference Series: Earth and Environmental Science*, 1311.1 (2024) <https://doi.org/10.1088/1755-1315/1311/1/012037>

⁶¹ I Made Geria and others, 'Built Environment from the Ancient Bali: The Balinese Heritage for Sustainable Water Management', *Heliyon*, 9.11 (2023), e21248 <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e21248>

⁶² Natasha Mannion and others, 'Chapter 32 - Biodiversity, Function, and Change of the Tropical Rainforests of Borneo', in *Terrestrial Biomes*, ed. by Germano Leaño Demolin-Leite (Academic Press, 2025), pp. 457–81 <https://doi.org/https://doi.org/10.1016/B978-0-443-36569-0.00032-X>

with locally developed norms. Without such reformulation, gaps in the national legal framework on environmental protection will persist. The recognition of local wisdom within the legal system must be translated into binding regulatory instruments. Policy provisions that emphasize ecoregion-based management and local wisdom in the conservation of the Bengawan Solo River basin will provide communities with a strong legal foundation to participate in environmental protection while ensuring that their rights remain safeguarded. Clear and enforceable legal rules will also strengthen legal certainty and reduce the potential for environmental violations.⁶³

The institutional strengthening at the regional level is essential to secure the continuity of conservation efforts. Regional governments must collaborate with multiple stakeholders to establish an inclusive watershed management system that reflects local ecological and sociocultural conditions. Through this approach, the resulting policies will not only enhance the protection of the watershed ecosystem but also support sustainable development grounded in legal justice and directed toward ecological justice.⁶⁴ The integration of local wisdom and legal protection in conservation policies of the Bengawan Solo river basin's upstream is crucial to create sustainable river basin management. Local wisdom that has been proven to be effective in maintaining the preservation of the ecosystem must be accommodated in conservation policies by giving legal protection and acknowledgement towards society's rights in protecting their natural resources. The ecoregion-based approach will make sure that conservation policies not only consider the ecological aspect but also the social and cultural ones. Through a synergy between formal policies and local wisdom, the conservation policy of the Bengawan Solo river basin's upstream will bring long-term benefits to the sustainability of the ecosystem, social welfare, and people's economies that depend on such natural resources.⁶⁵

Therefore, the reformulation of conservation policies for the Bengawan Solo River basin that integrates local wisdom with legal protection will reinforce environmental sustainability, reduce ecological degradation, and promote development grounded in ecological and social justice.⁶⁶ This reformulation will establish a natural resource management system that is more equitable, inclusive,

⁶³ Budi Dharmawan, Michael Böcher and Max Krott, 'The Failure of the Mangrove Conservation Plan in Indonesia: Weak Research and an Ignorance of Grassroots Politics', *Ocean & Coastal Management*, 130 (2016), 250–59 <https://doi.org/10.1016/j.ocecoaman.2016.06.019>

⁶⁴ Richard Dutu, 'Challenges and Policies in Indonesia's Energy Sector', *Energy Policy*, 98 (2016), 513–19 <https://doi.org/10.1016/j.enpol.2016.09.009>

⁶⁵ Santosh Kumar Sarkar, 'Chapter 1 - Resource Conservation and Management', in *Sundarban Mangrove Wetland (a UNESCO World Heritage Site)*, ed. by Santosh Kumar Sarkar (Elsevier, 2022), pp. 1–118 <https://doi.org/10.1016/B978-0-12-817094-6.00002-X>

⁶⁶ Muthu Ponmani and others, 'Vulnerability of Mangrove Ecosystems to Anthropogenic Marine Litter along the Southeast Coast of India', *Science of The Total Environment*, 956 (2024), 177224 <https://doi.org/10.1016/j.scitotenv.2024.177224>

and sustainable, enabling it to serve as a model for conservation policy in other regions of Indonesia. The reformulation takes the form of a Memorandum of Understanding (MoU) between regions included within the Bengawan Solo watershed. This MoU is strengthened by substantive recommendations reviewed by the Bengawan Solo River Basin Forum. The MoU provides a coordinated pathway to address regulatory conflicts at both national and regional levels.⁶⁷ Its role becomes essential because overlapping institutional authority has created confusion in the management of the Bengawan Solo River basin, where regency governments bear the burden of environmental failures but lack authority to undertake enforcement actions.⁶⁸ The MoU's substantive content will regulate cooperative management from upstream to downstream areas and reinforce basin protection based on each region's local wisdom. This mechanism reflects the ecoregion approach, which classifies ecosystems based on their characteristics, potentials, and impacts, thereby ensuring that conservation strategies remain contextually grounded and scientifically informed.⁶⁹

4. Conclusion

This study concludes that the First, this study demonstrates that effective conservation of the upstream area of the Bengawan Solo River basin requires the integration of an ecoregion based approach with the formal recognition of local wisdom. Local communities have long practiced traditional conservation methods such as agroforestry, selective land management, and customary protection of water springs. These practices have contributed significantly to ecological stability, yet they remain insufficiently accommodated within existing conservation policies that rely heavily on technocratic approaches and provide limited space for community participation. Second, the study identifies persistent regulatory fragmentation and institutional weaknesses that hinder effective watershed management. Conservation policies at the regional and national levels often fail to align with local ecological conditions and community based knowledge systems. This misalignment results in policies that lack contextual relevance and do not adequately address the socio ecological complexities of the upstream watershed area. Strengthening the legal position of local wisdom within the regulatory framework is therefore essential to ensuring long term environmental sustainability. Third, the research concludes that policy reformulation is necessary through the establishment of an interregional cooperation mechanism supported

⁶⁷ Jennifer Merten and others, 'Climate Change Mitigation on Tropical Peatlands: A Triple Burden for Smallholder Farmers in Indonesia', *Global Environmental Change*, 71 (2021), 102388 <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2021.102388>

⁶⁸ Dodik Ridho Nurrochmat and others, 'Indonesia's Options in Becoming a High-Income Country: Accelerating the Turning Point in Deforestation?', *Forest Policy and Economics*, 148 (2023), 102905 <https://doi.org/https://doi.org/10.1016/j.forpol.2022.102905>

⁶⁹ Atikah Mardhiya Rohmy, Hartiwiningsih and I Gusti Ayu Ketut Rachmi Handayani, 'Judicial Mafia and Ecological In-Justice: Obstacles to Policy Enforcement in Indonesian Forest Management and Protection', *Trees, Forests and People*, 17 (2024), 100613 <https://doi.org/10.1016/j.tfp.2024.100613>

by a Memorandum of Understanding. This Memorandum of Understanding should regulate integrated upstream to downstream watershed management, incorporate ecological and socio cultural characteristics of each region, and institutionalize local wisdom as a legitimate foundation for conservation. The adoption of an ecoregion based approach will enable policymakers to classify ecological units more accurately, identify environmental potentials and risks, and formulate conservation strategies that are more effective and just. The cooperative framework is expected to strengthen governance, enhance legal certainty, and promote sustainable and inclusive environmental management that can serve as a model for watershed conservation in other regions of Indonesia.

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