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Strengthening Water Governance and Regulatory Effectiveness for Equitable Access in Indonesia

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Abstract: Water resource management in Indonesia represents a paradox of abundance and scarcity. Despite the country's vast hydrological potential, approximately 15% of Indonesians still lack reliable access to clean water, with stark inequalities persisting between urban and rural regions. Prior research has primarily emphasized technical and infrastructural dimensions, leaving a research gap in understanding how regulatory frameworks intersect with socio-economic and environmental realities. The urgency of this study stems from persistent disparities in water accessibility, escalating climate change pressures, and weak enforcement of existing laws such as Law No. 17 of 2019 on Water Resources. This study aims to evaluate the effectiveness of regulatory instruments in expanding water accessibility, identify determinants shaping implementation, and assess broader sustainability implications. Employing a qualitative descriptive method with case studies in West Java, East Nusa Tenggara, and South Kalimantan, data were collected through document analysis, in-depth interviews, and field observations. The findings indicate that regulatory effectiveness is heavily influenced by geographic and institutional contexts, with challenges ranging from infrastructural deficits to pollution and climate-induced scarcity. The study recommends adaptive, region-specific regulations, strengthened institutional capacity, and participatory governance to ensure equitable and sustainable water access.

INTRODUCTION

Water resources constitute a fundamental element that sustains human life, ecological integrity, and economic development (Singh & Goyal, 2025; Maria, 2021). As the world's largest archipelagic state, Indonesia possesses abundant hydrological potential embedded within thousands of river basins (DAS) across the archipelago (Umami et al., 2022; Fulazzaky, 2014). Ideally, this vast endowment should guarantee universal access to clean water for its population (Astriani, 2016). Nevertheless, the country continues to confront multifaceted governance and distributional challenges.

Approximately 15% of Indonesians remain without reliable access to potable water (BPS, 2024a). Stark inequalities persist between urban and rural areas, with communities in eastern provinces such as East Nusa Tenggara and Papua still dependent on rivers and shallow wells that often fail to meet health standards. In upland catchments, erosion and sedimentation exacerbate environmental degradation (Pambudi et al., 2023; World Bank, 2021). Urban centers, by contrast, grapple with declining water quality caused by industrial effluents and domestic pollution (Bappenas, 2020).

These vulnerabilities are further compounded by climate change, which intensifies rainfall variability, flooding, and drought events. Rapid population growth and accelerated

urbanization also amplify stress on existing water supplies (Damanhuri & Amini, 2021; Fadli & Wahyu, 2021; Maheshwari et al., 2016). In response, the Indonesian government enacted Law No. 17 of 2019 on Water Resources, seeking to institutionalize equitable and sustainable access (Pemerintah Indonesia, 2019). Yet, the law's effectiveness remains questionable due to weak implementation, inadequate inter-agency coordination, and limited societal participation. This constellation of issues underscores the urgent necessity of adopting sustainable water resource governance that integrates ecological resilience, social equity, and institutional effectiveness.

The central challenge lies in designing regulatory frameworks capable of ensuring equitable, efficient, and sustainable access to water resources. This issue is further complicated by the multiplicity of stakeholders involved, ranging from national and local governments to private sectors and local communities (Pambudi, 2024; Fatanen, 2021). Governance misalignments frequently trigger conflicts of interest, leading to inequitable access and unsustainable exploitation. Beyond being a basic human necessity, sustainable access to water is recognized globally as a fundamental human right. Within the framework of the Sustainable Development Goals (SDGs), particularly Goal 6, the provision of clean water and adequate sanitation is a core priority. As a committed signatory, Indonesia bears a significant responsibility to guarantee fair and universal access to clean water (Annaifah, 2024; Leontinus, 2022).

Table 1. Mapping of Regulatory Articles on Water Accessibility in Indonesia

Regulation	Core Provisions	Level of Authority	Implementation Notes
Law No. 17/2019 on Water Resources (Arts. 6–9, 45–47)	The state guarantees citizens' rights to water; governance of public water supply systems (SPAM).	Central Government (norm-setting and rights protection) + Local Governments (implementation through PDAMs and SPAM systems).	Persistent distribution inequities, especially in remote and rural areas.
Government Regulation No. 122/2015 on SPAM (Arts. 4–7, 48–50)	Obligations of local governments to prepare SPAM master plans and regulate tariffs.	Local Governments (provincial/district/municipal).	Many local governments have yet to prepare master plans; high tariffs remain in peripheral regions.
Government Regulation No. 38/2011 on Irrigation (Arts. 5–10, 46–47)	Rights and obligations in irrigation water use; role of Water User Farmers' Associations (P3A).	Central Government (technical norms), Local Governments (infrastructure provision), Village/Community Level (P3A managing local distribution).	Irrigation infrastructure remains inadequate; P3A capacity highly uneven across regions.
Ministerial Regulation of PUPR No. 27/2016 on SPAM (Arts. 14–18)	Minimum service standards for drinking water (quality, quantity, continuity).	Local Governments (service delivery via PDAMs) under Central Government regulatory oversight.	Standards applied inconsistently in practice.
Law No. 1/2014 on Coastal and Small Islands	Rights of local communities to freshwater in coastal	Village/Community Level (local rights), facilitated by Local Governments.	Coastal populations continue to face limited freshwater access.

Regulation	Core Provisions	Level of Authority	Implementation Notes
Management (Arts. 23–24)	zones and small islands.		
Law No. 32/2009 on Environmental Protection and Management (Art. 65)	Right to a healthy environment, including access to unpolluted water.	Central Government (normative guarantees), Local Governments (implementation), Communities (environmental rights).	Industrial river pollution remains widespread and insufficiently controlled.

Sustainable water resource management is a critical component in achieving the Sustainable Development Goals (SDGs), particularly SDG 6, which emphasizes the availability and sustainable management of clean water and sanitation for all (BPS, 2024b). Beyond this, effective water governance contributes substantially to broader development outcomes. Adequate water availability, for instance, plays a pivotal role in poverty reduction by improving public health and sustaining livelihoods that depend heavily on water resources (Gleick, 2018). Furthermore, universal access to clean water is essential in preventing waterborne diseases, thereby enhancing overall community well-being.

In urban contexts, sufficient water infrastructure helps mitigate the adverse impacts of hydrometeorological disasters, such as floods, while reinforcing the resilience of cities and settlements (Bappenas, 2022). Adaptive water management strategies are equally vital in addressing the challenges posed by climate change, particularly in responding to the increasing risks of droughts and floods caused by shifting global weather patterns (Pambudi & Kusumanto, 2023). Consequently, sustainable water management is not only integral to environmental resilience but also to inclusive socio-economic development.

In Indonesia, the realization of SDG 6 continues to face significant hurdles. National clean water access currently stands at approximately 89%, with marked disparities between urban and rural areas (Bappenas, 2020). These inequalities underscore the necessity of comprehensive evaluation of existing regulations and policy implementation in the water sector. Moreover, global climate pressures—manifested in unpredictable rainfall, prolonged droughts, and intensified flooding—further exacerbate water availability challenges (Sari, 2024; Malihah, 2022). Therefore, water security must be positioned as a strategic priority within Indonesia's national development agenda, extending toward the vision for 2045.

Table 2. Data and Projections of Surface Water Availability in Indonesia, 2020–2045 (m^3/capita/year)

Year	Sumatera	Jawa	Bali	Kalimantan	Sulawesi	Maluku	Papua
2020	9195,15	630,26	1920,31	46412,35	10316,67	31194,01	179889,10
2021	9061,89	621,26	1898,83	45757,75	10175,85	30800,75	177474,05
2022	8931,01	612,37	1877,53	45111,95	10036,92	30411,88	175090,31
2023	8802,40	603,62	1856,47	44477,80	9897,39	30027,14	172743,30
2024	8675,48	595,08	1835,57	43854,74	9760,36	29646,92	170430,09
2030	7950,12	546,52	1713,35	40305,76	8956,95	27451,80	157197,03
2035	7393,86	509,97	1616,98	37595,86	8364,89	25715,61	146992,25
2040	6875,53	476,62	1526,69	35079,64	7808,14	24079,94	137474,19
2045	6392,18	445,82	1443,74	32741,38	7293,24	22550,18	128568,84

Source: Bappenas, 2020

Climate change has significantly intensified pressures on water availability across Indonesia, particularly in drought-prone regions such as East Nusa Tenggara (NTT) and parts of South Sulawesi. National regulations, including Law No. 17 of 2019 on Water Resources and Government Regulation No. 30 of 2024 on Water Resources Management, normatively affirm both the public's right to water and the state's responsibility to ensure its availability. Nevertheless, practical implementation remains constrained by limited infrastructure and weak institutional capacity at the local level. In several villages in NTT, communities continue to rely on shallow wells and springs that frequently dry up during the dry season (Umami et al., 2022). Meanwhile, regional water utilities (PDAMs) in urban areas struggle to maintain supply continuity due to groundwater depletion and sedimentation of water sources (Pambudi, 2024).

Emerging community-driven initiatives—such as rainwater harvesting systems and collaborations with the state electricity company (PLN) to develop solar-powered water distribution—illustrate adaptive responses, yet these remain inadequately supported by regulatory incentive frameworks. Consequently, the effectiveness of existing regulations is contingent upon adaptive flexibility, climate risk–based budget allocations, and active community participation in water governance. Effective regulation should not only emphasize legal certainty but also integrate social, economic, and environmental dimensions over the long term. Sustainable development requires regulatory strategies that balance societal needs, economic efficiency, and natural resource conservation. Hence, a comprehensive approach is essential to strengthen water resource governance in Indonesia, encompassing inclusive planning, effective implementation, and rigorous oversight mechanisms.

This study aims to examine the influence of regulatory frameworks on sustainable water resource accessibility in Indonesia. Specifically, it pursues three core objectives: first, to evaluate the effectiveness of existing regulations in expanding access to clean water across diverse regions; second, to identify key factors shaping regulatory implementation; and third, to assess the implications of regulation for water resource sustainability from environmental, social, and economic perspectives. In addition, the study seeks to formulate strategic recommendations to strengthen future water governance. The findings are expected to make a substantial contribution to improving water management practices in Indonesia while providing evidence-based insights for policymakers in designing more adaptive and sustainable regulations.

Sustainable water access in Indonesia extends beyond mere physical availability, encompassing social justice dimensions such as equitable distribution, affordability, and the inclusion of vulnerable groups. Persistent disparities between urban and rural areas remain a critical issue, with rural communities frequently relying on unsafe water sources. High water tariffs in several regions further constrain poor households from accessing this essential service. Moreover, women, who traditionally bear primary domestic responsibility for water, have not been fully integrated into sustainable water governance planning. Therefore, water policy must be designed with stronger commitments to equity and inclusiveness.

RESEARCH METHODS

This study adopts a qualitative-descriptive approach through a case study design, conducted in three provinces—West Java, East Nusa Tenggara, and South Kalimantan—selected to represent diverse geographical and social contexts (Sugiyono, 2020). Such diversity enables a comprehensive understanding of how water resource regulations are translated from policy design to practical implementation at the local level. The approach thus provides a robust framework for analyzing how policies are formulated, executed, and adapted to region-specific conditions.

The research commenced with an extensive literature review. Document analysis was carried out on regulatory frameworks such as the Water Resources Law, government regulations, and local bylaws to assess their normative foundations and identify gaps between design and field implementation (Creswell, 2014). This was supplemented with academic reports, prior research findings, and official policy documents, offering both theoretical and empirical grounding. The

literature review ensured that the study was anchored in established scholarship while remaining responsive to current policy challenges in Indonesia.

To broaden perspectives, in-depth interviews were undertaken with 30 respondents drawn from a wide spectrum of stakeholders. These included officials from provincial and district water resource agencies, local government representatives, managers of regional water utilities (PDAMs), farmer water user associations (P3A), academics, researchers, environmental NGOs, and industrial actors (Santoso, 2023). The inclusion of such a diverse respondent base allowed the study to capture a multiplicity of views on administrative, social, and economic challenges in water governance. This diversity also provided valuable insights into the wider societal and ecological implications of regulatory implementation.

Complementing the interviews, field observations were conducted to examine the physical condition of water infrastructure and patterns of community accessibility. Direct observation facilitated the collection of empirical data on water availability, infrastructure quality, and usage practices. These findings were compared with regulatory provisions to detect discrepancies between policy objectives and real-world conditions. Data were then analyzed through content analysis, systematically examining documents, interview transcripts, and observational records to identify recurring themes and structural patterns (Bowen, 2009).

The study integrates both qualitative and quantitative data. Qualitative data were derived from interviews, field notes, and observations, while quantitative secondary data were drawn from official statistics, such as clean water access rates published by BPS (2024a) and projections of surface water availability provided by Bappenas (2020). This methodological integration ensured a balanced approach, enabling the study to combine normative, empirical, and statistical perspectives in evaluating regulatory effectiveness.

In terms of data types, primary data comprised in-depth interviews, field observations, and documentation of infrastructure conditions and community access. Secondary data consisted of regulatory documents (e.g., Law No. 17/2019, Government Regulation No. 122/2015, and Government Regulation No. 38/2011), government reports, academic publications, and statistical data related to clean water access and regional disparities. Data sources included the central government (regulations, Bappenas reports, and KLHS RPJMN), local governments (bylaws and RISPAM documents), research institutions and academics (journal articles, research reports, and policy briefs), and field-level observations from the three case study provinces.

Data validity was ensured through several strategies. Source triangulation was employed by cross-referencing interviews, official documents, and field observations. Methodological triangulation combined document analysis, interviews, and direct observations to guarantee consistency. Content analysis was used to systematically interpret transcripts and regulatory texts, while cross-checking among informants reduced bias by comparing the perspectives of government officials, civil society, communities, and private actors. Through these strategies, the study generated a comprehensive understanding of Indonesia's water governance, highlighting the effectiveness and limitations of regulatory frameworks. The integration of diverse data and rigorous validity testing not only reinforced the reliability of the findings but also provided practical insights and recommendations to enhance the effectiveness, equity, and sustainability of water governance in Indonesia.

RESULTS AND DISCUSSION

Policy optimization to expand regional clean water access

The regulatory framework governing water resource management in Indonesia plays a pivotal role in ensuring equitable access to clean water nationwide. According to data from the Central Bureau of Statistics (BPS, 2023), approximately 89% of the population has access to clean water, yet disparities remain evident, particularly in rural areas and eastern regions. This gap underscores that while regulations exist, their implementation has not been uniformly effective across diverse geographic and social contexts. The effectiveness of such regulations cannot be assessed solely by the existence of legal provisions, but rather by how well they are operationalized in practice.

Table 3. General Analysis of the Impact of Water Management and Accessibility (Previous Case Studies)

No	Scenario / Situation	Key Actors	Roles of State / Private Sector / Citizens	Conflict / Collaboration
1	Rural drought-prone areas (e.g., East Nusa Tenggara)	Local government, village residents, NGOs	State: provider of infrastructure and water subsidies; Private sector: minimal involvement; Citizens: primary users and local stewards	Collaboration between villagers and NGOs is relatively strong; however, conflict arises when water aid is unevenly distributed or when projects fail to reach intended beneficiaries (Umami et al., 2022).
2	Major cities with high water demand (e.g., Jakarta)	PDAM (regional water utilities), private water suppliers, urban residents	State: regulator and PDAM owner; Private sector: bottled/privatized water suppliers; Citizens: consumers	Conflict occurs when water distribution is unequal and tariffs increase; collaboration emerges through customer forums and public complaint mechanisms (Pambudi, 2024).
3	Industrial zones near watersheds (e.g., Citarum River)	Industries, Ministry of Environment and Forestry (KLHK), local communities	State: environmental regulator; Private sector: water users and polluters; Citizens: affected communities	High levels of conflict due to industrial pollution; emerging collaboration through government-led river revitalization programs such as Citarum Harum (Sari, 2024; Malihah, 2022).

This study employs a qualitative-descriptive approach through case studies in three provinces—West Java, East Nusa Tenggara, and South Kalimantan. The research sites were selected based on distinct geographical and socioeconomic conditions, providing a comprehensive overview of regulatory effectiveness in enhancing clean water access. Sustainable water management requires safeguarding ecosystem rights to maintain their natural functions, including the provision of minimum flows to preserve biodiversity. In this context, the protection of watersheds (DAS) is crucial, as they regulate hydrological cycles. However, deforestation and sedimentation exacerbate water scarcity and heighten hydrometeorological risks.

Discussions with key stakeholders revealed region-specific challenges. West Java, with its high urbanization levels, struggles with increasing water demand and pollution from industrial and household activities. East Nusa Tenggara faces limited water availability due to arid climates and prolonged droughts, while South Kalimantan, despite abundant water resources, suffers from poor quality caused by peatland conditions and mining-related pollution. These findings highlight the necessity of adaptive strategies—such as critical land conservation, rainwater harvesting, and wetland restoration—to strengthen water resilience with environmental sustainability as its core foundation.

Table 4. Analysis of Regulatory Effectiveness in the Study Areas

No	Province	Regulatory Effectiveness
1	West Java	Provincial-level regulations have adopted national policies such as Law No. 17 of 2019 on Water Resources and Government Regulation No. 122 of 2015 on Drinking Water Supply Systems (SPAM). However, the effectiveness of these policies largely depends on the availability of infrastructure and the coordination between local governments and Regional Water Utilities (PDAM). One of the main obstacles in West Java is the limited capacity of PDAMs to provide clean water services across the entire province, especially in peripheral and rural areas, where communities still rely on wells and river water of inconsistent quality.

No	Province	Regulatory Effectiveness
2	East Nusa Tenggara	Regulations have been introduced to expand access to clean water, including the construction of bore wells and piped water systems. Nevertheless, these measures have not yet reached all communities evenly. In several rural areas, households continue to depend on traditional sources such as shallow wells and rain-fed water, facing acute shortages during the dry season. Government efforts to promote community-based water supply systems have been implemented, but infrastructure development and maintenance remain limited. In addition, budgetary constraints and geographical challenges further hinder the effectiveness of these regulations in improving clean water access in East Nusa Tenggara.
3	South Kalimantan	Regulations implemented in this province emphasize water quality management and capacity building for drinking water infrastructure. However, their effectiveness is still hampered by weak monitoring and enforcement mechanisms. One major issue in South Kalimantan is the limited access to clean water in remote rural areas, where distribution networks are inadequate. Many villages still rely on rivers and shallow wells, the water quality of which has been compromised by pollution from mining activities and palm oil plantations. Although government programs to improve infrastructure and service quality have been initiated, progress remains slow and uneven.

Source: Interview Result, 2025

An analysis of the three study regions reveals that the effectiveness of regulatory frameworks in expanding access to clean water is strongly influenced by geographical, socio-economic, and infrastructural factors. In West Java, although infrastructure is relatively advanced, major obstacles include water pollution and the limited capacity of local water utilities (PDAM) to serve the entire population. Conversely, East Nusa Tenggara (NTT) faces severe scarcity of water resources due to its arid geographical conditions. Meanwhile, South Kalimantan struggles primarily with deteriorating water quality resulting from intensive industrial and mining activities.

The implementation of regional regulations (Perda) plays a critical role in bridging national policies with local needs. For instance, West Java Provincial Regulation No. 2 of 2014 on Water Resource Management emphasizes conservation principles and equitable distribution. However, its enforcement encounters persistent challenges related to urban water pollution and inadequate PDAM capacity. In NTT, community-based water supply regulations remain constrained by limited budgets and weak post-project infrastructure management. Similarly, in South Kalimantan, insufficient monitoring of industrial activities further exacerbates water quality issues despite the existence of regulations that prioritize watershed protection and environmental quality.

Overall, the effectiveness of regulations on clean water access depends largely on their adaptability to local conditions and their practical implementation at the regional level. This calls for a more flexible policy design that strengthens inter-agency coordination, enhances human resource capacity, and enforces transparent monitoring and evaluation mechanisms. Furthermore, integrating community participation and incorporating climate change mitigation and adaptation strategies are crucial to ensuring that water resource governance becomes more effective, sustainable, and inclusive.

Determinants shaping water resource accessibility regulation implementation

The successful implementation of regulations aimed at improving water resource accessibility is shaped by a constellation of interrelated structural, socio-economic, and environmental factors. Frequently, regulations formulated at both national and local levels are not accompanied by adequate readiness for field-level execution, thereby creating substantial barriers in practice. This study employs a qualitative-descriptive approach with case studies conducted in three provinces—West Java, East Nusa Tenggara, and South Kalimantan. These provinces were

deliberately chosen due to their distinctive geographic and social characteristics, allowing for a more comprehensive exploration of the challenges inherent in regulatory implementation surrounding water accessibility across Indonesia.

West Java, with its high population density and rapid urbanization, is under severe pressure to manage escalating demand for water resources. While urban water supply infrastructure is relatively advanced, disparities remain pronounced in rural areas. Local governments struggle to balance limited supply against rising demand amid cumbersome bureaucratic procedures and overlapping regulations between central and regional authorities, which delay the execution of clean water policies. In contrast, East Nusa Tenggara contends with an altogether different reality—scarcity of water resources themselves. Prolonged droughts, insufficient infrastructure investment, and limited community awareness of water conservation undermine the effectiveness of regulatory frameworks. Socio-economic constraints further exacerbate the situation, as low household incomes restrict the ability of many communities to afford public water utility (PDAM) services.

South Kalimantan presents yet another dimension of complexity, where environmental degradation driven by mining and deforestation has severely impaired watershed ecosystems. These activities reduce both the quality and quantity of available water. Although environmental regulations exist, enforcement remains weak, and coordination between regional governments and private actors is inadequate, resulting in diminished policy effectiveness. Structural challenges—particularly regulatory inconsistencies between national and regional levels—create further confusion. National policies, such as standardized water tariffs, often fail to reflect the purchasing power of rural and marginalized communities, thereby perpetuating inequities in clean water access.

Institutional capacity deficits constitute an additional obstacle. Monitoring and oversight mechanisms for water resource governance remain insufficient, resulting in frequent delays and failures in clean water projects. Transparency issues in budget management for water infrastructure further undermine service delivery. For example, in South Kalimantan, nearly 40% of water provision projects faced delays or failed to meet planned targets due to administrative inefficiencies. Socio-economic factors similarly hinder progress. Public awareness of water conservation remains limited, particularly in regions with lower education levels. In East Nusa Tenggara, reliance on unmanaged traditional wells and springs increases risks of waterborne diseases.

Climate change further amplifies these vulnerabilities. In West Java, erratic rainfall patterns and flooding disrupt water supply stability, while East Nusa Tenggara experiences extended dry seasons leading to significant declines in groundwater and spring discharge. Findings indicate that strengthening the role of local governments is crucial for aligning national regulations with region-specific needs. Enhancing institutional capacity for monitoring and evaluation is equally vital to ensure effective implementation.

Innovative financing models, including public-private partnerships and community-based funding schemes, are also imperative. Community-led water management initiatives, such as Water User Associations (WUAs), demonstrate considerable potential in expanding clean water access in remote regions. Regulatory frameworks must therefore evolve to accommodate dynamic social and environmental realities. Policies that remain narrowly technical without integrating socio-economic contexts risk ineffective application.

In sum, a holistic strategy is required to improve the effectiveness of water accessibility regulations. This must combine regulatory reinforcement, institutional strengthening, innovative financing, and community empowerment. Only through such an integrated approach can clean water regulations be implemented effectively, sustainably, and equitably across Indonesia's diverse regions.

Regulatory impacts on water sustainability across sectors

Regulations governing water resource management exert extensive and multidimensional impacts across social, economic, and environmental domains. The sustainability of water

resources is not solely concerned with the immediate availability of clean water, but equally with the capacity to ensure sufficient supply for future generations. Consequently, the effectiveness of regulation must be assessed in terms of how existing policies are capable of maintaining equilibrium between utilization, conservation, and the fair distribution of water resources in a sustainable manner.

From an economic standpoint, water regulation plays a pivotal role since adequate water availability underpins the continuity of strategic sectors such as industry, agriculture, and energy. Properly designed and implemented regulations can foster efficiency in water utilization, reduce production costs, and enhance the overall economic well-being of communities whose livelihoods are heavily dependent on water resources.

In agriculture, water functions as a critical production factor that directly determines productivity. In regions with low rainfall, such as East Nusa Tenggara, regulatory frameworks that promote efficient irrigation management become indispensable. Suboptimal irrigation systems frequently trigger crop failure and decreased yields. The implementation of Government Regulation No. 38 of 2011 on Irrigation was intended to guarantee proper management of irrigation systems. However, limited investment in irrigation infrastructure and weak coordination among stakeholders have perpetuated inefficiencies in water distribution.

In the industrial sphere, regulatory frameworks on water conservation and wastewater management significantly influence business sustainability. In West Java, where the textile and manufacturing industries are heavily reliant on water, policies regulating industrial water use and waste treatment have been introduced. Nevertheless, insufficient enforcement has led to severe pollution in major rivers, most notably the Citarum. Such degradation not only undermines the quality of water for domestic purposes but also raises treatment costs for other industries that rely on the same water sources. This underscores the need for more stringent regulation to ensure that industrial water consumption does not compromise environmental integrity or harm other sectors.

Water pricing policies also hold substantial implications for community welfare. Excessively high tariffs often create barriers for low-income households. In South Kalimantan, for example, rural populations without access to municipal water networks are compelled to pay higher prices for water supplied by private vendors. This condition highlights the necessity of adjusting water tariffs to align with household purchasing power in order to prevent further economic disparities.

The social implications of water regulation are closely tied to welfare, public health, and equitable access. Clean water is a fundamental human right and an essential determinant of quality of life. Regulations intended to ensure equitable access should reduce social inequality between urban and rural communities. Yet, in rural East Nusa Tenggara, significant challenges persist. Many villages still lack adequate water infrastructure, forcing residents to walk long distances to fetch water. This not only increases the burden, particularly for women and children, but also negatively affects health outcomes. Although community-based water infrastructure initiatives have been promoted, their implementation remains constrained by limited financial and technical support.

Similarly, sanitation-related regulations directly influence public health. Waterborne diseases such as diarrhea and cholera continue to pose significant health risks in areas with inadequate access to clean water. In South Kalimantan, water pollution caused by mining activities has intensified health risks among local populations. Although regulatory standards on water quality and industrial waste management exist, weak enforcement continues to allow environmental degradation.

From the perspective of social conflict, unfair implementation of regulation may provoke tensions among stakeholders. Disputes over water rights frequently emerge between farmers, industries, and local communities. Inequitable allocation fosters unhealthy competition and can escalate into broader conflicts. Hence, regulatory design must incorporate principles of social justice to prevent exacerbating inequalities in water access.

Environmentally, water regulation is closely intertwined with ecosystem conservation, resource protection, and climate change adaptation. In West Java, rapid urbanization and industrial expansion have heightened pressure on water resources. Regulatory frameworks on

watershed management should safeguard both water quality and quantity, yet implementation hurdles remain substantial. The Citarum River, a crucial source of water for millions, has suffered acute degradation due to domestic and industrial pollution. Government initiatives such as the Citarum Harum program have achieved some improvements, though their long-term success hinges on consistent regulation and robust monitoring.

In East Nusa Tenggara, climate change has intensified water scarcity. Regulations supporting adaptation measures, such as reservoir construction and rainwater harvesting systems, are increasingly critical for securing future water availability. Nonetheless, inadequate investment and technological support hinder progress. In South Kalimantan, peatland ecosystems—vital to the hydrological cycle—have been severely degraded by mining and palm oil expansion. Although regulatory frameworks for peatland conservation exist, lax enforcement perpetuates ecological damage, reducing the capacity of ecosystems to store water and diminishing groundwater availability during dry seasons.

Indonesia's water governance faces region-specific challenges. In Kalimantan, peatland degradation from mining and palm oil disrupts hydrology, weakening groundwater resilience. Sumatra suffers from deforestation and industrial pollution, burdening river basins and biodiversity. Sulawesi's urban growth strains infrastructure, prompting unsustainable groundwater use and coastal intrusion. Papua, though rich in water resources, struggles with access due to infrastructural and institutional gaps. These cases reveal a complex landscape: scarcity in arid zones, ecological damage in extractive regions, and urban stress in coastal cities. Effective solutions demand adaptive, ecologically grounded, and inclusive policies tailored to Indonesia's diverse hydrological and socio-political contexts.

Table 5. Comparative Table of Water Governance Conditions Across Indonesian Regions

Region	Key Conditions	Challenges	Policy Implications	References
East Nusa Tenggara (NTT)	Semi-arid climate with low rainfall; high dependency on traditional sources (shallow wells, springs)	Severe droughts induced by climate change, limited infrastructure investment, and insufficient adaptive technologies	Expansion of reservoirs and rainwater harvesting systems, adaptive investment incentives, and critical land conservation programs	Umami et al. (2022); World Bank (2021)
Kalimantan	Extensive peatlands, wetlands, and major river systems (Kapuas, Barito, Mahakam)	Peatland degradation from mining and palm oil expansion; river pollution; weak enforcement of conservation regulations	Strict law enforcement against illegal mining, peatland rehabilitation, and eco-regional governance frameworks	Pambudi & Kusumanto (2023); Fulazzaky (2014)
Sumatra	Large watersheds (Musi, Batanghari) with high rates of deforestation for palm oil and industrial plantations	Sedimentation, recurrent flooding, industrial pollution, and biodiversity loss	Integrated watershed–forest management, stronger industrial regulation, and upstream ecosystem restoration	Razali et al. (2018); Bappenas (2020)
Sulawesi	Rapid coastal urban expansion (Makassar, Manado); reliance on PDAM utilities and groundwater	Over-extraction of groundwater, saltwater intrusion, limited PDAM service coverage in peri-urban areas	Integrated coastal–watershed management, restrictions on groundwater exploitation, and expanded investment in municipal water utilities	World Bank (2021); Umami et al. (2022)
Papua	Abundant water resources with	Limited infrastructure access; indigenous	Environmentally friendly infrastructure expansion,	Pambudi & Kusumanto (2023);

Region	Key Conditions	Challenges	Policy Implications	References
	relatively intact ecosystems	communities dependent on rivers and rain-fed sources	empowerment of indigenous communities, and improved logistical water distribution	Bappenas (2020)

A comprehensive analysis across economic, social, and environmental dimensions demonstrates that current water resource regulations in Indonesia continue to face significant implementation challenges. For regulation to be genuinely effective, it must achieve a balanced alignment of economic interests, social welfare, and environmental preservation, thereby ensuring the sustainable governance of water resources.

CONCLUSSION

The findings of this study reveal that regulatory frameworks governing water resources in Indonesia remain only partially effective in ensuring equitable access, sustainable management, and environmental protection. Although national regulations, such as Law No. 17 of 2019 on Water Resources, affirm the right to clean water, their implementation across diverse regions demonstrates significant disparities. In West Java, relatively advanced infrastructure is undermined by pollution and the limited capacity of local water utilities to meet increasing demand. East Nusa Tenggara faces structural water scarcity due to arid climatic conditions, inadequate infrastructure, and budgetary limitations, resulting in communities' reliance on unsafe traditional sources. South Kalimantan, while endowed with abundant water, suffers from declining water quality caused by mining and palm oil activities, coupled with weak enforcement and oversight. These cases underscore that the effectiveness of regulation is contingent upon local adaptation, robust institutional capacity, and participatory governance. Overall, sustainable water governance requires regulatory integration across social, economic, and environmental dimensions to achieve universal access, protect ecosystems, and strengthen community resilience.

In light of these findings, several recommendations emerge for strengthening Indonesia's water resource governance. First, regulatory design should be adaptive, aligning national frameworks with region-specific conditions, particularly in drought-prone provinces such as East Nusa Tenggara. This requires targeted investment in climate-resilient infrastructure, including reservoirs, rainwater harvesting, and solar-powered distribution systems. Second, institutional capacity must be enhanced through improved coordination between central and local governments, stronger enforcement of industrial wastewater regulations, and the empowerment of Regional Water Utilities (PDAMs) to expand equitable services. Third, regulatory incentives should encourage community-based water initiatives by providing technical assistance, financing schemes, and capacity-building for Water User Associations (WUAs) to strengthen local stewardship. Fourth, water pricing policies must reflect affordability principles to avoid burdening low-income households, particularly in rural and remote areas. Finally, transparency and accountability mechanisms—such as participatory monitoring and open budget systems—are essential to ensure fair distribution, prevent corruption, and build trust among stakeholders. By adopting these measures, Indonesia can move closer to achieving SDG 6 while fostering resilience, inclusiveness, and sustainability in water resource governance.

The study highlights important insights into Indonesia's water governance but remains limited in several respects. The research sites (West Java, East Nusa Tenggara, and South Kalimantan) capture regional diversity yet leave out equally critical contexts in Sumatra, Sulawesi, and Papua, where deforestation, coastal urbanization, and access gaps persist. Methodologically, reliance on qualitative case studies offers depth but constrains generalizability, while regulatory analysis could be strengthened with longitudinal data. For future research, broader geographic coverage, integration of mixed methods, and comparative policy evaluation are recommended. Sustained inquiry should also explore adaptive financing

models, gender inclusion, and community-driven innovation to ensure continuous advancement of equitable and sustainable water governance in Indonesia.

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