

# Water Resource Management Strategies in the Citarum River Basin

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## ABSTRACT

The Citarum River Basin is one of Indonesia's most vital water sources, yet it faces severe degradation due to pollution, rapid industrialization, and unsustainable practices. This study explores water resource management strategies in the Citarum River Basin using a qualitative approach. Data were collected through in-depth interviews with three key informants: a government representative, a community leader, and an environmental activist. The findings reveal that effective water management requires integrated efforts involving regulatory enforcement, community participation, and environmental advocacy. While government programs such as the Citarum Harum Program provide a framework for restoration, weak law enforcement and limited stakeholder coordination hinder progress. Communities demonstrate willingness to participate but face resource and knowledge constraints, whereas civil society organizations play a vital role in advocacy and awareness-raising. The study concludes that sustainable management of the Citarum River demands multi-stakeholder collaboration, strong governance, and inclusive participation to balance ecological, social, and economic needs.

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## 1. INTRODUCTION

Water is a fundamental natural resource that supports human life, economic development, and ecological balance. In Indonesia, rivers are crucial for clean water, agriculture, energy, and transportation, with the Citarum River Basin in West Java serving as one of the most important catchment areas for household, agricultural, industrial, and hydroelectric needs. The river sustains millions of people and contributes significantly to national development, yet faces challenges such as environmental degradation, pollution, and climate change

that threaten its long-term viability. Deforestation, land use changes, and sedimentation reduce water supply and hydropower efficiency, making sustainable land management like reforestation and sediment control essential [1]. Industrial waste pollution also persists despite government cleanup efforts under the SDGs 2030 initiative, hindered by non-compliance from some industries [2]. The watershed supplies about 7,650 million cubic meters of water annually—78% for irrigation, 14% for industry and electricity, and 8% for domestic use—yet water deficits remain, particularly downstream, and are worsened by climate

change [3]. Upstream land use changes further degrade water quality and quantity, highlighting the urgency of better spatial planning [4]. To mitigate these issues, economic policies such as subsidies for sewerage maintenance and septic tank installation are being pursued to balance economic growth with water conservation and pollution control [5].

Despite its importance, the Citarum River has long been identified as one of the most polluted rivers in the world, with rapid industrialization, urban expansion, agricultural runoff, and poor waste management severely degrading its water quality. Industrial wastewater, domestic sewage, and plastic waste are the dominant contributors, causing ecological damage and health risks for riverbank communities, thereby drawing attention from both the Indonesian government and international organizations concerned with sustainable water management. Domestic sources contribute about 83.5% of the pollution load, requiring a reduction target of 81.8% to improve water quality [6], while industrial effluents, particularly from the textile industry in Majalaya District, frequently exceed permissible limits [7], and agricultural runoff, as non-point sources, accounts for 85% of the load [6]. Water quality assessments reveal high levels of E-coli, BOD, and COD, with turbidity far surpassing clean water thresholds, rendering the river unsuitable for drinking water [8], and spatial analyses show distinct pollution clusters that demand targeted interventions [9]. To address these challenges, strategies such as implementing Total Maximum Daily Load (TMDL) frameworks and adopting IoT-based real-time monitoring have been proposed [6], alongside community engagement and awareness campaigns that emphasize environmental hygiene as essential components of sustainable river management [10].

The challenges in managing the Citarum River are complex, spanning environmental, social, and institutional dimensions, and although government

initiatives such as the Citarum Harum Program have sought to restore water quality through stricter regulations, infrastructure development, and community empowerment, implementation continues to face obstacles including weak law enforcement, limited stakeholder collaboration, and low public awareness. Sustainable water resource management in the basin thus requires not only technical solutions but also inclusive governance, active community participation, and integrated policy frameworks. Collaborative governance, emphasized in the Citarum Harum Program, involves coordination among government bodies, academia, the private sector, and local communities to ensure sustainability [11], with evidence of improvements shown by the Satgas Sektor 6 team, which built trust, commitment, and shared understanding among stakeholders [12]. Nonetheless, weak law enforcement, poor coordination, and persistent pollution from industrial sectors and domestic waste remain key limitations [11], [13]. To address these challenges, innovative approaches such as the Citarum Living Lab have been introduced, offering a transdisciplinary platform where diverse stakeholders co-develop and test solutions in real-world settings, integrating community experiences and institutional frameworks to tackle complex environmental problems [14].

Given this context, it becomes crucial to examine strategies for water resource management that can address the multidimensional challenges of the Citarum River Basin. This study applies a qualitative approach by engaging three key informants: a government representative, a community leader, and an environmental activist. Their perspectives provide valuable insights into the existing management practices, the gaps in implementation, and the opportunities for more sustainable solutions.

The objective of this research is to analyze the strategies applied in managing water resources within the Citarum River Basin and to identify the roles and contributions of different stakeholders. By

understanding the interplay between policy, community action, and environmental advocacy, this study seeks to contribute to the discourse on integrated water resource management (IWRM) in Indonesia. Ultimately, the findings are expected to provide recommendations for strengthening governance, enhancing community engagement, and promoting environmentally friendly practices that ensure the long-term sustainability of the Citarum River.

## 2. LITERATURE REVIEW

### 2.1 Water Resource Management

Sustainable water resource management in developing countries requires a multifaceted approach that integrates ecological, social, and economic dimensions to address challenges from rapid population growth, industrialization, and weak institutional capacities. Effective management involves not only technical solutions but also robust governance, community participation, and strong policy enforcement to ensure equitable access, efficient use, and long-term sustainability of water resources, which are vital for achieving water security and sustainable development goals. Integrated Water Resources Management (IWRM) is a widely recognized paradigm that promotes coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising ecosystem sustainability [15], while also emphasizing interdisciplinary research and policy innovation to tackle complexities in water distribution, quality, and conservation [16]. Strong governance structures supported by stakeholder participation and decision-making tools are critical [17], and community involvement is essential to foster resilience and adaptability by integrating local needs and knowledge into strategies [16]. Moreover, socio-political dynamics such as economic disparities and institutional failures exacerbate water scarcity [18], requiring strategies that ensure equitable distribution and prevent disputes over water bodies [18]. These challenges are particularly acute in

developing countries, where rapid industrialization and weak institutional capacities further complicate management efforts, making comprehensive planning and integrated development strategies indispensable [18].

### 2.2 Integrated Water Resource Management (IWRM)

Integrated Water Resource Management (IWRM) is a comprehensive framework for sustainable water governance that promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising ecosystem sustainability. It emphasizes stakeholder participation, cross-sectoral policy alignment, and adaptive governance, fostering collaboration among governments, civil society, and private sectors, though its success depends on political will, institutional arrangements, and public awareness. The principles of IWRM highlight participatory approaches involving users, planners, and policymakers [19], policy integration across sectors that recognize water's economic and socio-developmental value [20], and adaptive governance that responds to changing conditions and scientific insights [21]. Challenges in implementation include the need for strong political commitment to enforce sustainable water policies [22], robust institutional arrangements to coordinate across sectors and regions [21], and efforts to raise public awareness and stakeholder support [19]. Case studies such as the Sava River Basin illustrate how coordinated management can balance social, economic, and environmental interests effectively [22], while global IWRM research projects provide lessons from diverse contexts and approaches, underscoring the adaptability and relevance of IWRM worldwide [21].

### 2.3 Water Pollution and Its Impacts

Pollution in river basins such as the Citarum River is a multifaceted issue involving industrial discharges, agricultural runoff, and domestic waste that significantly degrade water quality and threaten both ecosystems and human health. The Citarum

River is heavily polluted with heavy metals, plastics, and untreated sewage, directly affecting communities relying on it for drinking water and irrigation. Heavy metal contamination is severe, with mercury, zinc, cadmium, chromium, manganese, and iron detected in excess of standard limits in some tributaries, endangering aquatic life and human health [23], [24], while downstream areas show elevated cadmium and zinc levels that increase risks of poisoning [24]. The river's water quality has declined drastically, with 47.1% of the Citarum Hulu classified as heavily polluted, reducing its capacity to support fisheries and agriculture [23], [25], and high biochemical oxygen demand (BOD) levels have lowered dissolved oxygen (DO), harming fish populations and biodiversity [26]. Industrial activities driven by population growth and land use changes further contribute to pollution, with first-order streams heavily polluted compared to second-order streams [27], while agricultural runoff exacerbates water quality deterioration and ecosystem stress [26].

#### ***2.4 Stakeholder Participation in River Basin Management***

Stakeholder participation is a critical factor in the success of river basin management as it enhances decision-making, aligns interventions with local needs, and fosters sustainable practices. The involvement of government agencies, industries, local communities, and NGOs not only improves resource management but also strengthens democratic processes by enabling equal stakeholder engagement [28]. In Indonesia, community-based programs highlight the importance of grassroots participation, such as river clean-up movements that emphasize local ownership and accountability [29]. Participation supports enhanced decision-making through deliberation and consensus-building [28], ensures local ownership and cultural alignment for sustainability [29], and builds capacity, as shown in the Saba River Basin project where multistakeholder meetings improved resource management and development planning [30]. However, challenges persist, including managing

conflicts, addressing power asymmetries, ensuring perceived benefits [28], and harmonizing institutional relationships to prevent overlapping programs [29]. Case studies such as the Wae Batu Merah Watershed demonstrate the importance of mapping stakeholder influence and interests [31], while the Saba River Basin shows how participatory approaches and community forums can lead to more effective management outcomes [30].

#### ***2.5 Research Gap***

Although existing studies have examined the environmental and technical dimensions of the Citarum River crisis, there is limited qualitative research that explores the perspectives of diverse stakeholders in shaping water management strategies. Understanding the viewpoints of government actors, community leaders, and environmental activists is crucial for designing integrated solutions. This study addresses that gap by analyzing informant insights to propose more effective strategies for sustainable water resource management in the Citarum River Basin.

### **3. METHODS**

#### ***3.1 Research Approach***

This study employs a qualitative research approach to explore strategies for water resource management in the Citarum River Basin. Qualitative methods are considered appropriate because they allow an in-depth understanding of complex social and environmental issues, particularly those related to governance, community participation, and environmental advocacy. Instead of focusing on numerical data, this study emphasizes descriptive insights derived from stakeholder experiences and perceptions.

#### ***3.2 Research Design***

The research adopts a case study design centered on the Citarum River Basin. The case study approach is suitable as it provides a comprehensive and contextual analysis of water management challenges in a specific geographical and socio-political setting. By focusing on this case, the study

captures the unique dynamics of government programs, community initiatives, and civil society interventions.

### **3.3 Informants**

Data were collected from three key informants selected through purposive sampling based on their expertise and involvement in water management issues within the Citarum River Basin. The informants included a government representative who provided insights into policy frameworks, regulatory enforcement, and institutional challenges; a community leader who shared perspectives on local participation, awareness, and socio-cultural aspects of river conservation; and an environmental activist who contributed critical reflections on advocacy efforts, environmental education, and monitoring of industrial compliance. Together, these informants were considered representative of the main stakeholders directly involved in or affected by water management strategies.

### **3.4 Data Collection Techniques**

Data were gathered through in-depth semi-structured interviews. This technique allowed flexibility in asking questions while ensuring coverage of key themes related to water resource management. Interviews were conducted face-to-face and lasted between 45 to 60 minutes per informant. Additional supporting data were obtained from secondary sources such as government reports, academic studies, and media articles related to the Citarum River.

### **3.5 Data Analysis**

The data analysis employed the thematic analysis method proposed by Braun and Clarke (2006), which involved repeated reading of interview transcripts for familiarization, coding relevant text segments related to water management strategies, challenges, and opportunities, and developing themes by grouping these codes into broader categories such as governance, community participation, pollution control, and multi-stakeholder collaboration. The final step was interpreting the findings to connect stakeholder perspectives with existing theories and frameworks of integrated water

resource management (IWRM), ensuring that the results were systematically derived and firmly grounded in the empirical data collected.

## **4. RESULTS AND DISCUSSION**

### **4.1 Governance and Policy Implementation**

The government representative emphasized that the Citarum Harum Program, initiated in 2018, serves as the cornerstone of river restoration efforts. The program focuses on pollution control, waste management, reforestation, and infrastructure improvement. However, challenges remain in terms of weak law enforcement, lack of coordination among agencies, and limited financial resources.

Despite the existence of regulations, industrial compliance in the Citarum Basin remains partial, with some companies continuing to discharge untreated waste into the river, prompting informants to stress the need for stricter monitoring and sanctions. This finding is consistent with studies showing that law enforcement against river pollution is generally ineffective, as seen in the Taluduyunu River case where increased coordination and stronger sanctions were recommended [32], and in Bandung where, despite a comprehensive legal framework, challenges in clarity and enforcement persist [33]. The ineffectiveness of administrative sanctions in deterring violations by textile companies underscores the urgency of more robust penalties and better supervision [34], while the case of PT. Kahatex in West Java illustrates how economic considerations often impede strict enforcement [35]. Furthermore, fragmented institutional arrangements and weak coordination among government agencies exacerbate the problem, hindering effective law enforcement and environmental protection in the Citarum Basin, alongside significant gaps in hazardous waste management regulations that demand greater corporate awareness and compliance [36].

### **4.2 Community Participation and Awareness**

The community leader highlighted that local residents are increasingly aware of the pollution crisis but often lack sufficient

resources and knowledge to take sustained action. Community-based River clean-up initiatives and waste management programs have been implemented in several villages, but participation is inconsistent.

Cultural practices and economic limitations significantly influence community behavior, as households near the riverbanks often dispose of domestic waste into the river due to inadequate waste collection services, with local leaders emphasizing that raising public awareness and providing practical alternatives are crucial for long-term behavior change. This aligns with evidence from the Sungai Bulan program, where the Asset-Based Community Development (ABCD) method fostered high community engagement and enthusiasm, demonstrating the effectiveness of participatory approaches [37]. Community responsibility in environmental protection requires understanding, awareness, and active participation to achieve sustainable development [38], supported by practical alternatives such as producing paving blocks from recycled plastic that encourage involvement [37]. Education also plays a pivotal role in promoting climate sustainability by equipping communities with knowledge to address environmental challenges through informed actions and climate literacy [39]. Ultimately, the integration of awareness, education, and tangible solutions fosters a culture of sustainability, enhancing ownership and ensuring long-term community participation in environmental initiatives [38], [39].

#### **4.3 Environmental Advocacy and Civil Society Involvement**

The environmental activist stressed the role of civil society organizations in pressuring industries and the government to improve environmental practices. NGOs have been active in monitoring water quality, advocating for stricter regulations, and conducting educational campaigns.

According to the activist, advocacy has been instrumental in bringing international attention to the Citarum crisis, thereby increasing pressure on the

government to take action, although challenges such as limited funding, political resistance, and hostility from stakeholders prioritizing economic interests remain. These findings align with the view that advocacy is essential for raising public awareness of river ecosystems and their threats, which can drive public support and conservation actions [40]. Effective advocacy also has the potential to influence policy changes and strengthen legal frameworks for better ecosystem protection (- et al., 2024), while mobilizing resources through advocacy is critical for securing funding and support from governments, NGOs, and international donors (- et al., 2024). Community involvement further enhances advocacy's success, as it encourages local populations to adopt sustainable practices and actively participate in conservation [41], [42], with educational campaigns fostering behavioral change to protect water sources and reduce pollution [41]. Moreover, advocacy efforts increasingly adopt an ecosystem-based approach, highlighting the interconnectedness of species conservation and ecosystem health [40], [43], and emphasizing the protection of entire ecosystems and their sustaining processes rather than focusing solely on individual species [43], thereby sustaining momentum for long-term river conservation.

#### **4.4 Multi-Stakeholder Collaboration**

All three informants agreed that collaboration among stakeholders is key to effective water management. The government cannot manage the river alone without active support from communities and civil society. Similarly, advocacy efforts need government backing to ensure policy enforcement, while community initiatives require technical and financial support from both government and NGOs.

The findings suggest that integrated water resource management (IWRM) principles are highly relevant to the Citarum context, as multi-stakeholder platforms can enhance communication, reduce conflicts, and align objectives. This resonates with arguments that collaborative governance is crucial to overcome fragmented management

in the Citarum watershed, where conflicts among stakeholders have hindered effectiveness, and an interdependent model of collaboration is recommended [44]. The Citarum Harum program demonstrates the value of integrated cooperation among government, private sector, academia, and communities, emphasizing a holistic and inclusive approach [11]. Multi-Stakeholder Platforms (MSPs) are particularly vital in the Citarum context, where overlapping roles and functions have been problematic, as they enable joint efforts among public, private, and civil society sectors [45] and foster communication and shared governance essential for IWRM implementation [46]. Nonetheless, challenges such as the absence of a leading institution and poorly structured inter-organizational relationships persist, underscoring the need for reorganizing core tasks and functions to strengthen collaboration [44], while the Citarum case also illustrates that clear communication and outreach strategies are vital for effective IWRM [47], supporting the view that collaborative governance increases resilience in complex river systems.

#### 4.5 Discussion

The results highlight that managing the Citarum River Basin is not merely a technical challenge but a governance issue that demands inclusive participation and strong institutional frameworks. Insights from the three informants show that, although government programs have brought some progress, weak regulatory enforcement and limited community resources continue to undermine long-term success. This underscores the need for solutions that go beyond infrastructure and technology, addressing the social and institutional barriers that shape water governance.

A key insight is that effective strategies must integrate stronger regulatory frameworks and enforcement to ensure industrial compliance, community empowerment programs to build capacity for waste management and river stewardship, sustained advocacy and awareness

campaigns to keep water issues on the policy agenda, and collaborative governance mechanisms that align government, community, and civil society efforts. These findings enrich the broader literature on Integrated Water Resource Management (IWRM), showing that successful river basin management in Indonesia requires balancing top-down policies with bottom-up participation. The Citarum case thus illustrates the critical importance of synergy between state actors, local communities, and NGOs in achieving sustainable water management.

## 5. CONCLUSION

The findings of this study underscore that managing the Citarum River Basin is a complex challenge that goes beyond technical interventions. While the government has established programs such as Citarum Harum, their effectiveness is constrained by weak law enforcement, fragmented institutional coordination, and limited financial resources. Community efforts, although promising, are hindered by inadequate infrastructure and low levels of environmental awareness. At the same time, environmental activists and civil society organizations play a crucial role in pushing for accountability and fostering education, but they also face resource and political challenges.

To achieve sustainable water resource management, it is essential to adopt a multi-stakeholder approach. Stronger regulatory frameworks, consistent monitoring, and stricter industrial compliance must be combined with grassroots empowerment and environmental education. Collaborative governance platforms should be strengthened to align efforts among government agencies, local communities, and NGOs. Ultimately, the sustainability of the Citarum River Basin depends on the shared responsibility of all stakeholders to integrate ecological preservation with social well-being and economic development.

## REFERENCES

- [1] B. Pranoto *et al.*, "Assessing the sustainability of small hydropower sites in the Citarum Watershed, Indonesia employing CA-Markov and SWAT models," *Water Supply*, vol. 24, no. 9, pp. 3253–3268, 2024.
- [2] H. D. Fridayani, "The Government's Role in Facing SDGs 2030 Citarum River Clean-up Program, Indonesia: An Analysis," *J. Gov. Public Policy*, vol. 7, no. 1, pp. 41–50, 2020.
- [3] R. Boer, B. D. Dasanto, Perdinan, and D. Marthinus, "Hydrologic balance of Citarum watershed under current and future climate," in *Climate Change and the Sustainable Use of Water Resources*, Springer, 2011, pp. 43–59.
- [4] Mukhoriyah, S. Arifin, D. Kushardono, M. Ardha, and F. Yulianto, "Analysis of land use and spatial planning in the Upstream Citarum watershed of West Java based on remote sensing data," 2023.
- [5] R. Yokosawa and T. Mizunoya, "Improving water quality in the Citarum River through economic policy approaches," *Sustainability*, vol. 14, no. 9, p. 5038, 2022.
- [6] M. R. Djuwita, D. M. Hartono, S. S. Mursidik, and T. E. B. Soesilo, "Pollution load allocation on water pollution control in the Citarum River," *J. Eng. Technol. Sci.*, vol. 53, no. 1, p. 210112, 2021.
- [7] F. Fitriana, D. Yudianto, S. Sanjaya, A. F. V Roy, and Y. C. Seo, "The assessment of Citarum river water quality in Majalaya District, Bandung regency," *Rekayasa Sipil*, vol. 17, no. 1, pp. 37–46, 2023.
- [8] M. Sholeh, P. Pranoto, S. Budiastuti, and S. Sutarno, "Analysis of Citarum River pollution indicator using chemical, physical, and bacteriological methods," in *AIP Conference Proceedings*, AIP Publishing LLC, 2018, p. 20068.
- [9] A. Musnansyah, A. KAMIL, L. Marlina, E. Widayati, and Z. Zulfakriza, "Assessment of spatial water quality observation of Citarum River Bandung Regency using multivariate statistical methods," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 11, no. 1, 2021.
- [10] T. M. Basuki *et al.*, "Water Pollution of Some Major Rivers in Indonesia: The Status, Institution, Regulation, and Recommendation for Its Mitigation," *Polish J. Environ. Stud.*, vol. 33, no. 4, 2024.
- [11] A. Abdillah, I. Widianingsih, R. A. Buchari, and H. Nurasa, "Collaborative strategies for sustainable management of the Citarum Watershed in Indonesia: a Quintuple Helix approach," *Discov. Sustain.*, vol. 5, no. 1, p. 347, 2024.
- [12] A. Prayoga, "Studi collaborative governance Program Citarum Harum dalam perbaikan kualitas air sungai Citarum," *J. Ilm. Ilmu Pemerintah. MODERAT*, vol. 8, no. 3, 2022.
- [13] K. van Ginkel, "Water quality in the Upper Citarum River Basin: towards a better understanding of a heavily polluted catchment," *Student Undergrad. Res. E-journal!*, vol. 2, 2016.
- [14] P. Hadfield *et al.*, "Citarum Living Lab: Co-creating visions for sustainable river revitalisation," *PLOS Water*, vol. 3, no. 8, p. e0000200, 2024.
- [15] A. Agarwal *et al.*, "Integrated water resources management," 2000.
- [16] N. Azmi, S. F. Ahmed, and Z. A. Syed, "Sustainable Water Management; Understanding a Theoretical perspective," *Environ. Reports; an Int. J.*, 2024.
- [17] Y. Liu, H. Gupta, E. Springer, and T. Wagener, "Linking science with environmental decision making: Experiences from an integrated modeling approach to supporting sustainable water resources management," *Environ. Model. Softw.*, vol. 23, no. 7, pp. 846–858, 2008.
- [18] J. G. Hering and K. M. Ingold, "Water resources management: what should be integrated?," *Science (80- )*, vol. 336, no. 6086, pp. 1234–1235, 2012.
- [19] T. Jönch-Clausen, "Integrated water resources management (IWRM) and water efficiency plans by 2005: Why, what and how," *Why, what how*, pp. 4–5, 2004.
- [20] W. B. Snellen and A. Schrevel, "IWRM: for sustainable use of water 50 years of international experience with the concept of integrated water management," in *Proceedings of the FAO/Netherlands Conference on Water for Food and Ecosystems, Wageningen, The Netherlands*, Citeseer, 2004.
- [21] R. B. Ibsch, J. J. Bogardi, and D. Borchardt, "Integrated water resources management: concept, research and implementation," *Integr. water Resour. Manag. concept, Res. Implement.*, pp. 3–32, 2016.
- [22] D. Komatina, "Integrated Water Resources Management as a Basis for Sustainable Development–The Case of the Sava River Basin," in *Current Issues of Water Management*, IntechOpen, 2011.
- [23] E. Wardani, "Identifikasi pencemaran logam berat raksa di sungai citarum hulu Jawa Barat," *J. Tek. Kim. Indones.*, vol. 8, no. 1, pp. 17–23, 2009.
- [24] S. Shara, S. S. Moersidik, and T. E. B. Soesilo, "Potential health risks of heavy metals pollution in the downstream of Citarum River," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2021, p. 12061.
- [25] A. S. U. Mudjiardjo, S. S. Moersidik, and L. Darmajanti, "Analysis of water pollution using the STORET method in the Upper Citarum Watershed," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2021, p. 12012.
- [26] Y. Astuti and P. Lismining, "Respon Oksigen Terlarut Terhadap Pencemaran dan Pengaruhnya Terhadap Keberadaan Sumber Daya Ikan di Sungai Citarum Dissolved Oxygen Response Against Pollution and The Influence of Fish Resources Existence in Citarum River," *J. Teknol. Lingkungan*, vol. 19, no. 2, p. 203, 2018.
- [27] T. L. Indra, "Pemetaan Wilayah Dampak Lingkungan Terkena Limbah Industri pada DAS Citarum Hulu," *J. Teknol. Pengelolaan Limbah*, vol. 16, no. 3, 2014.
- [28] G. Carr, "Stakeholder and public participation in river basin management—an introduction," *Wiley Interdiscip. Rev. Water*, vol. 2, no. 4, pp. 393–405, 2015.
- [29] B. Syahputra and B. Fajar, "Community participation in river basin management," in *River Basin Management-Under a Changing Climate*, IntechOpen, 2022.
- [30] I. W. Budiasa and H. Kato, "A Participatory Approach to Enhance Multistakeholders' Participation in the Saba River



- Basin," in *Sustainable Water Management: New Perspectives, Design, and Practices*, Springer, 2016, pp. 67–80.
- [31] R. Haulussy, B. Latuamury, and I. Iskar, "ANALISIS PEMANGKU KEPENTINGAN (STAKEHOLDER) TERHADAP PENGELOLAAN SUMBERDAYA AIR DAS WAE BATU MERAH KOTA AMBON," *MAKILA*, vol. 18, no. 1, pp. 52–67, 2024.
- [32] P. R. Datunsolang, F. Puluhulawa, and A. Ahmad, "Penegakan Hukum Terhadap Sungai Taluduyunu Akibat Pencemaran Limbah Pertambangan," *Terang J. Kaji. Ilmu Sos. Polit. Dan Huk.*, vol. 1, pp. 179–200.
- [33] L. Judijanto, R. Madah, K. Harsya, and Y. Priyana, "Implementasi Hukum Lingkungan dalam Penegakan Hukum terhadap Pencemaran Sungai di Bandung," *J. Huk. dan HAM Wara Sains*, vol. 2, no. 12, pp. 1201–1209, 2023.
- [34] S. Stella and Y. Prianto, "Efektivitas Sanksi Administrasi Dalam Mencegah Pencemaran Sungai," *J. USM Law Rev.*, vol. 7, no. 3, pp. 1394–1407, 2024.
- [35] A. K. Sihombing, "Penegakan hukum terhadap pencemaran lingkungan di Sungai Cikijing, Jawa Barat akibat aktivitas industri tekstil PT. Kahatex," *J. Huk. Lingkung. Indones.*, vol. 7, no. 1, pp. 98–117, 2020.
- [36] M. Andriansyah and E. Rosnawati, "Pengelolaan Limbah B3 yang Tidak Efektif di Indonesia Memacu Perlunya Penegakan Hukum yang Lebih Ketat," *J. Cust. Law*, vol. 1, no. 3, p. 9, 2024.
- [37] D. S. N. Anggraeni *et al.*, "Community participation to enhance environmental awareness in Sungai Bulan sub-district, North Singkawang," *Transform. J. Pengabd. Masy.*, vol. 20, no. 1, pp. 64–76, 2024.
- [38] R. Mina, F. Fality, M. Miranda, and R. A. Imani, "Communities for Environmental Protection: Fostering Responsibility and Sustainability," *J. Judic. Rev.*, vol. 26, no. 2, pp. 227–244, 2024.
- [39] K. C. R. Kumar, M. S. Bexci, A. Bhaumik, and S. K. Ojha, "Educating and promoting climate sustainability," in *Community Resilience and Climate Change Challenges: Pursuit of Sustainable Development Goals (SDGs)*, IGI Global Scientific Publishing, 2025, pp. 183–202.
- [40] K. J. Coyle, "The new advocacy for aquatic species conservation," *J. North Am. Benthol. Soc.*, vol. 12, no. 2, pp. 185–188, 1993.
- [41] N. W. Chan, A. L. Abdullah, A. L. Ibrahim, and S. Ghazali, "River pollution and restoration towards sustainable water resources management in Malaysia," *Soc. Sp. Environ. a Glob. World Prospect. Challenges*, pp. 208–219, 2003.
- [42] I. Alviya, E. Y. Suryandari, R. Maryani, and Z. Muttaqin, "Meningkatkan peran pemangku kepentingan dalam pengelolaan wilayah hulu daerah aliran sungai Ciliwung," *J. Penelit. Sos. dan Ekon. Kehutan.*, vol. 13, no. 2, pp. 121–134, 2016.
- [43] S. Sabater and A. ELOSEGI, "Balancing conservation needs with uses of river ecosystems," *Acta Biológica Colomb.*, vol. 19, no. 1, pp. 3–10, 2014.
- [44] S. J. Raharja, "Pendekatan Kolaboratif Dalam Pengelolaan Daerah Aliran Sungai Citarum," *J. Bumi Lestari*, vol. 10, no. 2, pp. 222–235, 2010.
- [45] B. Mitchell, "Integrated catchment management and MSPs: Pulling in different directions?," in *Multi-stakeholder platforms for integrated water management*, Routledge, 2016, pp. 49–68.
- [46] N. S. Grigg, "Water as a connector among societal needs," in *Integrated Water Resource Management: An Interdisciplinary Approach*, Springer, 2016, pp. 1–18.
- [47] C. R. Samekto, "Collaboration Dynamics in Integrated Water Resources Management," 2016.