

ECOLOGICAL JUSTICE IN RIVER WATER POLLUTION CONTROL POLICY IN JAKARTA THROUGH DPSIR ANALYSIS

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Abstract: River water pollution in Jakarta is a national and international concern that requires serious attention. Therefore, environmental information, including ecological vulnerability maps, environmental status, and other relevant data, is crucial for effective environmental management. A regional environmental analysis and policy evaluation in 2024, using the DPSIR method, identified the environmental impact of river water conditions in real-time through water status measurements and aquatic ecological indicators. From the periodic analysis of Main Pollutant Parameters (MPP) during 2018-2024, eight parameters, such as fecal coliform, total coliform, free chlorine (Cl₂), hydrogen sulfide (H₂S), BOD, phenol, and ammonia (NH₃), were classified as river MPPs. Specifically, fecal coliform, total coliform, and ammonia (NH₃) have consistently been river MPPs in Jakarta during the 2018-2024 monitoring period, requiring primary attention due to their high and continuous pollution levels.

Keywords: ecological Justice, Control Policy, River Water Pollution, Jakarta, DPSIR

1 Introduction

Clean water and good sanitation are human rights and are included in one of the essential goals of sustainable development (SDGs), especially in Goal 6. Obtaining potable water and adequate sanitation facilities is key to ensuring people's health and quality of life locally and internationally. However, the reality is that many hurdles still need to be overcome to achieve this goal, given that there are still millions of people around the world who do not have adequate access to clean water and sanitation (Syahbil et al., 2022).

One of the significant obstacles is water pollution, which is a serious global problem. This pollution comes from various sources, such as industrial waste, household waste, and agricultural waste, which contain harmful substances. The effects of water pollution not only endanger human health through the spread of water-related diseases, but also damage aquatic ecosystems that have an essential role in maintaining the balance of nature. Pollution can result in mass mortality of marine organisms and reduce biodiversity, which

is vital for ecosystem sustainability. As one of the primary water sources, rivers have an essential role in providing water for human needs, function as a transportation route, and are part of a natural ecosystem supporting diverse flora and fauna. Therefore, maintaining the sustainability of the river is very important so that its ecological and social functions are maintained. Damage or pollution in rivers will endanger the distribution of clean water. It can cause widespread environmental damage and disrupt the lives of people who depend on the river.

Sustainable water and sanitation management are key focus areas in the Sustainable Development Goals, emphasizing the WaSH concept, which includes providing safe, clean water, good sanitation infrastructure, and correct hygiene practices. The government and all parties need to actively address water pollution through effective waste management, public education, and strict enforcement of regulations to ensure equitable access to clean water and proper sanitation. As a developing country, Indonesia faces significant water resource management challenges due to

rapid economic and population growth. With a population of around 270 million and a population growth rate of about 1.2% per year, the demand for clean water increases dramatically yearly. Although Indonesia is one of the countries with the most significant water reserves in the world, uneven water distribution and complicated geographical conditions are substantial challenges in meeting these needs. In addition, rapid urbanization, especially on the island of Java, puts pressure on the availability of clean water and waste management. The issue of water pollution in Indonesia is very worrying. Waste from industry is one of the leading causes of deterioration in water quality. Many factories produce hazardous waste that is not managed correctly, thus polluting rivers and other water sources. In addition, household waste is often discharged directly into water bodies without adequate treatment, which causes more widespread pollution in urban and rural areas. Unsustainable agricultural practices also exacerbate the problem of water pollution in Indonesia. Excessive use of chemical fertilizers and pesticides contributes to groundwater and surface pollution. Runoff from farmland carries these chemicals into water systems, damaging water quality and harming aquatic ecosystems and public health. Changes in land use for agriculture and settlements without proper management also reduce the ability of watersheds to store and filter water, thereby increasing the risk of flooding and drought. In addition to the pollution issue, climate change is further worsening the water resources management in Indonesia. Unstable rainfall patterns lead to longer dry seasons and high rainfall at times. This disrupts the availability of clean water and triggers floods and landslides that damage water infrastructure and the surrounding environment. Lack of investment in clean water management systems and inadequate infrastructure exacerbate this situation, especially in rural areas.

This situation is getting worse due to the situation in big cities, including Jakarta. As a very dense government, economic, and population center in Indonesia, Jakarta has a crucial position. As the country's capital, Jakarta plays a strategic role in implementing government, serving as a center of national political activities and a place for various economic and business activities crucial for Indonesia. The city also serves as a center for trade, financial services, education, and culture, thus serving as a major driver of the national economy with millions of residents and highly dynamic activities. Jakarta has many rivers that are the source of life for the people and the city's ecosystem. These

rivers have a role as water sources, channels for rainwater, traditional means of transportation, and habitats for various flora and fauna. However, Jakarta's rivers function ecologically and become vital elements in water management and flood control, given Jakarta's flat topography and propensity to flooding. Unfortunately, the rivers in Jakarta have been seriously polluted due to various human activities. Waste from households and industries is often directly dumped into the river without adequate treatment. In addition, waste from densely populated residential areas and trade activities worsens the state of the river water. This pollution causes rivers in Jakarta to be filled with plastic waste, harmful chemicals, and organic waste that threaten the aquatic ecosystem and the health of residents, especially in the rainy season when river flows cannot regulate runoff properly. Various factors, such as rapid urbanization, high population density, and lack of effective environmental management, further exacerbate river pollution in Jakarta. Despite the normalization of rivers and the construction of flood control infrastructure, many rivers are still experiencing siltation and declining water quality. This situation is exacerbated by climate change and increased rainfall, which increases the risk of flooding and water pollution in the city.

Some primary sources of river pollution in Jakarta include domestic, industrial, and agricultural waste. Domestic waste, especially wastewater from washing, bathing, and household waste activities, is the leading cause of pollution because most of it is directly discharged into the river without treatment. The latest data shows that the level of untreated greywater waste is very high, reaching 95% in the Ciliwung River, with similar figures of 91% in the Cipinang River, 87% in Sunter, 62% in Cideng, and 80% in Grogol. Waste from the industrial sector is also a significant cause of pollution because hazardous waste is disposed of without adequate treatment processes. In addition, agricultural waste, which consists of pesticides and fertilizers dissolved in runoff water, also worsens river water quality. However, this issue is more common in the suburbs of Jakarta ([Adiansyah, 2025](#)). Data on water quality in Jakarta's rivers from 2021 to 2024 show that 36% to 71% of observation sites show highly polluted conditions. Despite a decline from heavy pollution to moderate pollution in 2024, most rivers remain within the category of heavy pollution. Some parameters that often exceed the quality standard are fecal coliform and total coliform, ammonia, H₂S, and free chlorine, which indicate high microbiological and chemical con-

tamination levels. Overall, the observations show that rivers in Jakarta are still very vulnerable to household and industrial waste pollution. The impact of this river pollution on public health is very real. River water contaminated by harmful bacteria such as fecal coliforms can result in diseases such as diarrhea, cholera, typhus, and skin infections for those who use the water, directly or with poor water treatment and sanitation. In addition to threatening health, water pollution also increases the economic burden on the community through health care costs and disease control. This is even worse in densely populated and slum areas with limited household waste management access (Dinas Lingkungan Hidup Provinsi Jakarta, 2025b).

The negative impact on nature is also huge. River pollution damages freshwater ecological systems by reducing the number of species and destroying habitats for different types of aquatic plants and animals. The accumulation of plastic waste, hazardous chemicals, and organic waste disrupts the balance of ecosystems. It reduces the ability of rivers to provide environmental services, such as flood absorption and natural filtration. Jakarta's main rivers, such as Cideng, have been continuously reported to be heavily polluted over the past three years, reflecting an unresolved environmental crisis. From an economic point of view, river pollution causes a significant cost burden for the government and the community. These costs include expenses for treating diseases caused by polluted water, river cleanup programs, construction and maintenance of sewage treatment systems, and losses due to disrupting economic activities that depend on the river. In addition, Jakarta's incomprehensible waste management requires investment in more complex technology and management, leading to rising costs for clean water and sanitation services. Therefore, the application of ecological justice is relevant to overcoming this problem. Ecological justice is a principle that emphasizes the importance of a fair distribution of environmental benefits and burdens within a socio-ecological system. This concept prioritizes a balance between the use of natural resources and environmental sustainability, so no community group experiences disproportionately negative impacts due to natural exploitation. In the context of ecological justice, the environment is not only considered as an object, but as an entity that has the right to fair treatment, and this includes talking about human welfare and ecosystem sustainability (Pengurus Pusat Perhimpunan Mahasiswa Katolik Republik Indonesia, 2021).

River pollution in Jakarta raises significant ecolog-

ical justice issues. The impact of pollution is often uneven, burdening economically and socially vulnerable groups, especially those living around rivers. Poor people frequently face health problems and a decline in quality of life due to pollution, while more affluent groups may be spared from these direct impacts. This inequality in the distribution of environmental burdens is the center of attention in the context of ecological justice. The government has issued various policies to control pollution, including waste management regulations, law enforcement, river rehabilitation programs, and improved access to clean water. However, the success of such policies depends on their ability to distribute benefits and burdens fairly to all levels of society. The main challenge in implementing water pollution control policies in Jakarta lies in the equitable distribution of benefits and burdens. Ensuring poor people's access to clean water and protecting them from the harmful impacts of pollution is crucial. Policies must be designed with ecological justice in mind, not to exacerbate social and environmental inequalities. To comprehensively analyze this problem, the Driving Force-Pressure-State-Impact-Response (DPSIR) approach can be used to identify the driving factors, pressures, conditions, impacts, and responses to river pollution in Jakarta. The DPSIR analysis is expected to provide a comprehensive picture of the complexity of the problem and identify points of effective policy intervention. Based on the description above, the formulation of this research problem is:

1. How does DPSIR's approach describe the factors contributing to river pollution in Jakarta and their impact on ecological justice?
2. What technical policy recommendations result from the DPSIR analysis to improve the river water quality in Jakarta and ensure ecological justice?

This study aims to analyze ecological justice in river water pollution control policies in Jakarta using the DPSIR framework. The research results are expected to provide valuable input for the government and stakeholders in formulating fairer, more effective policies addressing river pollution and ensuring inclusive, sustainable development.

2 Research Methods

This research method is normative juridical, using primary and secondary data. The legal approach is used by elaborating on the drivers, pressures, states, im-

pact, and responses (DPSIR) approach method. This method is an approach used to analyze problems related to the environment.

3 Research Results

3.1 The DPSIR approach describes the factors contributing to river pollution in Jakarta and their impact on ecological justice.

The DPSIR approach, created by the European Environment Agency, is an analytical framework consisting of five main elements: Driving Force, Pressure, State, Impact, and Response. This framework is used to organize information and data about the state of the environment in a structured manner and to help understand the causal relationship in an environmental issue. This approach identifies the driving force that causes pressure on the environment, resulting in changes in environmental conditions (State). These changes can impact ecosystems and humans, which encourages a response from the community or government to solve these problems. Thus, this approach provides a comprehensive view of the interaction between human systems and the environment, as well as how policies can be regulated in response to the impacts that occur on the environment (Hendriarianti et al., 2022). DPSIR is very effective as an analytical tool for decision-making and planning in environmental management because it allows for precise mapping between human activities and their ecological impacts. This provides an opportunity to evaluate the effect and design an appropriate response strategy. This approach is flexible and can be used for a wide range of environmental issues and geographical areas, from water quality to land-use change, with the primary goal of helping policymakers understand and address ecological problems in a more structured and cross-disciplinary manner.

Thus, DPSIR offers a theoretical framework in understanding environmental problems and serves as a practical basis for finding the main factors that cause river pollution in Jakarta, such as rapid population growth, industrialization processes, and urbanization. The increase in population contributes to the rise in domestic waste dumped into rivers without adequate treatment. The rapidly growing industrial sector also releases hazardous liquid waste, often dumped directly into waterways without treatment. In addition, rapid urbanization accelerates land-use change and adds to the burden on existing waste management systems, ultimately worsening water quality in rivers (Beta Pra-

mesti Asia, 2024). Specific pressures that affect the quality of river water in Jakarta involve household waste (such as wastewater from washing, bathing, and cooking), industrial waste, agricultural waste, and garbage littered into the river. Research shows that five major rivers in Jakarta, including Ciliwung (95%), Cipinang (91%), Sunter (87%), Cideng (62%), and Grogol (80%) experience severe levels of pollution due to untreated household waste, with wastewater treatment still very minimal (e.g., 87-95% of household waste is not processed before disposal). Waste from industries originating from micro, small, and medium enterprises also contributes significantly to pollution (Dinas Lingkungan Hidup Provinsi Jakarta, 2025a).

The current condition of rivers in Jakarta illustrates the existence of various levels of pollution, but in general, it is still classified as moderate to severe pollution. Water quality parameters that often exceed the threshold include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and high numbers of coliform bacteria due to household waste. For example, the Ciliwung River is one of the most polluted, with domestic and industrial waste as the main culprit. Pollution index data shows that many major rivers in Jakarta are still experiencing heavy pollution conditions at various monitoring points. The impact of river pollution in Jakarta significantly affects health, the environment, and the economy. In terms of health, this pollution increases the risk of developing water-related diseases, such as diarrhea and skin infections, leading to increased treatment costs for the community. From an environmental point of view, river ecosystems are damaged, biodiversity is reduced, and habitats for various types of fish are disturbed. Economically, this pollution causes a decrease in property values around the river and disrupts fishery activities that are a source of livelihood for some local communities. Responses to river pollution in Jakarta include regulations governing waste management, river cleanup programs such as the Bebasah and Grebek Lumpur programs, the development of infrastructure for domestic and industrial waste treatment, such as Wastewater Treatment Plants (WWTP), and increased supervision of business actors, especially small businesses, to meet waste treatment standards. Although there has been some progress, the effectiveness of this effort is still limited because waste treatment infrastructure has not been evenly distributed, and public awareness and business actors regarding waste management still need

to be improved.

However, river pollution in Jakarta violates the principle of ecological justice because it damages water ecosystems, which are an essential part of the environment and a source of life for humans and other living things. This pollution results in damage to freshwater habitats, fish deaths, and water quality degradation, which has an impact on reduced biodiversity and natural balance. As a consequence, rivers can no longer function as providers of clean water and sustainable natural resources, which violates the principle of ecological justice that requires the protection of ecosystem rights and justice for present and future generations (Agatha et al., 2024). The groups of people most negatively affected by river pollution in Jakarta are those who live around rivers and depend on the river for daily activities, such as bathing, washing, cooking, and livelihoods from agriculture and fisheries. They face a high risk of direct exposure to water contaminated by harmful chemicals, heavy metals, and pathogenic microorganisms that can cause various diseases such as diarrhea, cholera, and long-term health problems. In addition, those with limited access to clean water and good sanitation, especially in underprivileged residential areas, increasingly feel this pollution's negative health and socio-economic impacts. The existing response to river pollution in Jakarta does not seem to have fully paid attention to environmental justice. Much of the effort is focused on technical management and cleanup without addressing the root cause and paying attention to the most affected groups. Environmental justice requires fair and sustainable ecological management and protection of the rights of directly affected communities, including their involvement in decision-making and equitable distribution of resources. However, socio-economic impacts such as declining agricultural yields, fisheries, loss of livelihoods, and water access conflicts indicate that a more comprehensive and inclusive approach is needed.

Furthermore, pollution management must incorporate the principles of environmental justice by considering the unequal access to clean water, sanitation facilities, and public health, especially experienced by poor and marginalized communities around rivers. Efforts to increase community participation and collaboration between governments, the private sector, and civil society groups must be strengthened to ensure that actions are sustainable and equitable. An approach that emphasizes environmental justice allows for environmental protection that is not only techni-

cally oriented but also includes social, economic, and cultural aspects for all affected parties.

3.2 Technical policy recommendations resulting from the DPSIR analysis to improve river water quality in Jakarta and ensure ecological justice

The main factors in the DPSIR analysis that have been identified include the Driving Force. Social, demographic, and economic growth elements trigger changes in people's production patterns, consumption, and way of life. Furthermore, Pressure is the direct impact of human activities on the environment, such as land use change, pollution, and exploitation of natural resources. The state explained the current environmental conditions, such as water quality, biodiversity, and ongoing ecosystem status. The effects that arise from these pressures are called Impact, which includes damage to ecosystems, deterioration of environmental quality, and negative socioeconomic impacts. Finally, Response is the measures or policies taken to reduce or address those impacts, including spatial planning, nature conservation, and developing environmentally friendly technologies. Within the framework of DPSIR, all of these factors are causally and dynamically interrelated, so this analysis provides a comprehensive picture of the cause-and-effect relationship between human activities and environmental conditions. This allows for accurately assessing the interventions needed to improve or maintain the desired environmental conditions. Thus, the proposed policy recommendations are based on an in-depth understanding of the most effective points of influence to control the pressure on the environment and minimize their impacts, while maximizing a positive and sustainable response (Pradana et al., 2023). The DPSIR approach supports policymaking that is not only reactive to addressing impacts, but also proactively targeting the sources of pressure and driving factors underlying environmental change. The policy formulated must consider the complexity of social, economic, and ecological relations for the solutions to be effective and sustainable. Therefore, the DPSIR analysis provides a strong logical framework for designing adaptive and inclusive environmental management strategies involving various stakeholders.

Therefore, an effective and sustainable environmental management strategy, as recommended by the DPSIR approach, must pay attention to efforts to control the driving factors, such as Driving Forces in ecological management, especially those related to popula-

tion growth and urbanization, demand policies that can control population growth and unplanned urbanization so that the pressure on the environment and resources can be minimized. One of the essential policies is the development of satellite cities with adequate facilities to reduce the burden and pressure on large city centers such as Jakarta. These satellite cities should be designed to provide sufficient infrastructure, public services, and employment to be a viable residential alternative and reduce excess migration to major cities. In addition, effective and equitable family planning programs are the main policy in controlling the population growth rate. This program reduces the birth rate and raises awareness of the importance of regulating the number of children for a better quality of family life and environment. The Government of Indonesia has implemented intensive family planning programs with various contraceptive and education methods, which have been proven to slow population growth and help with population equity through transmigration and planned urbanization arrangements (Gilang, 2023).

Meanwhile, to encourage sustainable industrialization, policies must include incentives for industries that utilize environmentally friendly technologies and good waste management. These incentives can be tax reductions, funding support for research and development technologies that support the environment, and training for human resources. It is also essential to strictly supervise industrial waste disposal so that industrial activities do not damage the environment and endanger public health. Such policies should be integrated into a comprehensive environmental management system, where strict technical measures and ecological regulations control driving factors such as population growth and industrialization. The development of satellite cities, family planning programs, and incentives and supervision for environmentally friendly industries are strategic steps that align with the DPSIR framework in addressing environmental pressures sustainably.

To achieve the goal of reducing pressure and impact on the environment as described earlier, a comprehensive strategy is needed that includes: First, to reduce domestic waste, a vital policy that needs to be implemented is to improve the coverage and service quality of domestic wastewater treatment plants. The government requires every home and building to treat domestic wastewater before it is discharged into the environment through installations that meet established quality standards. In addition, community edu-

cation programs on waste management and sanitation are also carried out to increase public awareness and participation in domestic waste management with the 3R principle (reduce, reuse, recycle). Second, strict law enforcement against violations of standards in industrial waste is essential to reduce industrial waste. Industries that are proven to pollute the environment, such as rivers, will be subject to severe sanctions to increase compliance levels. This supervision must be carried out regularly and transparently, involving environmental supervisors and the community. Heavy sanctions are intended to provide a deterrent effect to avoid pollution caused by industrial waste that can damage ecosystems and public health. Third, policies that support organic farming practices and the judicious use of fertilizers are the main strategies for agricultural waste. Supervision of the use of pesticides and herbicides is also enforced so that excessive use and harm to the environment, especially aquatic ecosystems, do not occur. These policies encourage sustainable agriculture that reduces the risk of chemical pollution and supports soil and water conservation. Fourth, to improve the quality of the environment, the river water quality restoration program is carried out through regular river cleaning and ecosystem restoration by planting riverside vegetation that stabilizes the river bank and filters pollutants before entering the water body. In addition, developing an integrated and real-time river water quality monitoring system is essential for detecting pollution quickly and accurately. Increased laboratory capacity is also needed for more thorough analysis. Fifth, to reduce the health impacts of river pollution, policies focus on improving public access to clean water and proper sanitation, especially for vulnerable groups. Water-related disease prevention and control programs, such as those for diarrhea and skin diseases, are also implemented to reduce the public health burden related to water pollution. Sixth, a sustainable river-based tourism sector is developed to minimize the economic impact of river pollution. This tourism must prioritize environmental preservation and empower local communities. In addition, the compensation policy for communities affected by pollution is a form of social responsibility and socioeconomic rehabilitation efforts (Sy et al., 2024). Environmental justice should be the primary basis in designing policy recommendations related to environmental management, especially regarding river management and pollution issues. Policies should not only focus on technically improving ecological conditions, but also ensure that the rights and well-being of vulner-

able communities, such as people with low incomes and people living along rivers, are protected from the adverse effects of pollution. This is important so that the environmental measures do not exacerbate existing social and economic inequalities.

In addition to protecting vulnerable communities, active community involvement in decision-making is critical to achieving ecological justice. Individuals who feel the immediate impact should be involved from the beginning of planning to policy implementation, so that their opinions are heard and their needs are considered. This community-involved approach strengthens government accountability and increases the success of policy implementation with the support of strong social commitment. Environmental justice also requires an equitable allocation of ecological benefits and burdens for all segments of society. For example, access to clean water resources and sanitation services must be guaranteed for more developed urban areas, suburban areas, and remote regions. In addition, pollution and health risks due to industrial and domestic waste must be minimized, especially in locations that have been frequently exposed. By incorporating elements of ecological justice into environmental policies, the resulting solutions will be sustainable from an ecological aspect while also covering social elements. This approach supports the formation of a healthy, productive, and resilient society, as well as maintaining the sustainability of the river ecosystem as a source of life and welfare for all parties. Therefore, policy recommendations must be designed with transparency, inclusiveness, and justice to achieve true ecological justice.

4 Conclusion

1. DPSIR's analysis of river pollution in Jakarta shows that the main driving factors (Driving Force) are rapid population growth, industrialization, and urbanization. The pressure produced is in the form of domestic and industrial waste dumped into the river without adequate treatment. The river (State) is consequently heavily polluted, characterized by high levels of BOD, COD, TSS, and coliform bacteria. The impact caused is very significant, including damage to ecosystems, diseases in the community, and economic losses. The government's response in the form of regulations, cleaning programs, and WWTP construction is still limited in effectiveness because the infrastructure is uneven, and public awareness

is still low. The DPSIR approach is essential because it exposes the complexity of this problem while highlighting the need for more comprehensive solutions and attention to ecological justice, especially for the most affected communities. Countermeasures must integrate technical, social, economic, and cultural aspects to achieve environmental sustainability and justice.

2. The DPSIR analysis revealed the driving forces of river pollution, including social, economic, and demographic factors that affect production and consumption patterns. Pressure in the form of pollution, land use, and exploitation of natural resources reduces the quality of the environment (State), impacts ecosystem damage, and causes economic and social losses. Responses include population growth control policies (e.g., family planning programs and satellite city development), green industry incentives, environmental law enforcement, WWTP upgrades, and river ecosystem restoration programs. A practical and sustainable policy must integrate technical, social, and economic aspects, emphasizing ecological justice and community participation to achieve inclusive and equitable solutions.

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