

## Conservation and Rehabilitation of River Aquatic Resources Affected by Municipal Waste

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### Abstract

Urban activities are one of the main factors that put significant pressure on river ecosystems through the disposal of domestic waste, industrial waste, and surface runoff that carry various types of pollutants, along with population growth, increased economic activity, and uncontrolled land-use changes. These conditions have an impact on the decline in water quality which is characterized by an increase in the load of organic matter, nutrients, and harmful substances, thereby triggering the degradation of river habitats in the form of excessive sedimentation, damage to riparian vegetation, and changes in the physical structure of river channels, which ultimately lead to a decrease in aquatic biodiversity, both in terms of number and species composition. Many aquatic organisms, such as fish and macrozoobentos, are becoming increasingly vulnerable to pollution and habitat loss, resulting in population declines and even local extinctions. Based on these conditions, this article aims to examine the concept of conservation and rehabilitation of river aquatic resources affected by urban waste through a national literature review approach. The method used is a literature study of Indonesian scientific journals, reference books, and official government documents related to environmental and water resources management. The results of the study show that urban river conservation and rehabilitation efforts require an integrated approach that includes pollution control through effective waste management, restoration of river and riparian habitats, and sustainable management of watersheds, supported by strong environmental policies, consistent law enforcement, and active community participation to ensure the sustainability of the ecological function of rivers.

**Keywords:** aquatic resources; conservation; rehabilitation; rivers; waste

### Abstrak

Aktivitas perkotaan merupakan salah satu faktor utama yang memberikan tekanan signifikan terhadap ekosistem sungai melalui pembuangan limbah domestik, limbah industri, serta limpasan permukaan yang membawa berbagai jenis polutan, seiring dengan pertumbuhan penduduk, peningkatan aktivitas ekonomi, dan perubahan tata guna lahan yang tidak terkendali. Kondisi tersebut berdampak pada penurunan kualitas air yang ditandai oleh meningkatnya beban bahan organik, nutrisi, dan zat berbahaya, sehingga memicu degradasi habitat sungai berupa sedimentasi berlebih, rusaknya vegetasi riparian, serta perubahan struktur fisik alur sungai, yang pada akhirnya menyebabkan penurunan keanekaragaman hayati akuatik, baik dari segi jumlah maupun komposisi spesies. Banyak organisme air, seperti ikan dan makrozoobentos, menjadi semakin rentan terhadap pencemaran dan kehilangan habitat, sehingga mengalami penurunan populasi bahkan kepunahan lokal. Berdasarkan kondisi tersebut, artikel ini bertujuan untuk mengkaji konsep pelestarian dan rehabilitasi sumber daya akuatik sungai yang terdampak limbah perkotaan melalui pendekatan kajian pustaka nasional. Metode yang digunakan adalah studi literatur terhadap jurnal ilmiah Indonesia, buku referensi, serta dokumen resmi pemerintah yang berkaitan dengan pengelolaan lingkungan dan sumber daya air. Hasil kajian menunjukkan bahwa upaya pelestarian dan rehabilitasi sungai perkotaan memerlukan pendekatan terpadu yang mencakup pengendalian pencemaran melalui pengelolaan limbah yang efektif, restorasi habitat sungai dan kawasan riparian, serta pengelolaan daerah aliran sungai (DAS) secara berkelanjutan, yang didukung oleh kebijakan lingkungan yang kuat, penegakan hukum yang konsisten, dan partisipasi aktif masyarakat guna menjamin keberlanjutan fungsi ekologis sungai.

**Kata Kunci:** limbah; pelestarian; rehabilitasi; sumberdaya akuatik; Sungai

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## INTRODUCTION

Rivers are natural resources that have ecological, social, and economic functions that are very important for the Indonesian people (Kodoatie & Sjarief, 2010). Rivers play a very important role in human life, especially as a source of water for domestic, agricultural, and industrial needs (Ubaidillah et al., 2023). However, due to uncontrolled human activities, many rivers have experienced a decline in water quality. Household, industrial, and agricultural waste that is discharged directly into rivers without going through adequate treatment processes is a major factor in this pollution (Sianturi et al., 2025). The existence of a healthy river ecosystem greatly determines the stability of biodiversity and the quality of the surrounding aquatic environment. From the social and economic aspects, rivers are used as a source of raw water for household, agricultural, and industrial needs, as well as a means of supporting urban activities such as transportation, irrigation, and flood control (Kodoatie & Sjarief, 2010).

However, the rapid development of urban areas in Indonesia has increased the pressure on the sustainability of river ecosystems. Population growth, expansion of residential areas, and increased industrial activities contribute to the increasing volume of domestic and industrial waste dumped into river bodies without adequate treatment (Widodo, 2018). Urban waste generally contains organic matter, nutrients, detergents, and other harmful substances that can reduce the physical, chemical, and biological quality of river water (Effendi, 2003). Long-term accumulation of pollutants leads to increased BOD and COD values, decreased dissolved oxygen levels, and disruption of aquatic organisms' lives.

The Ministry of Environment and Forestry (MoEF, 2020) reported that most rivers in Indonesia's urban areas are in a state of light to severe pollution due to the dominance of domestic waste and human activities along the riverbanks. This condition not only has an impact on declining water quality, but also causes habitat degradation, reduced biodiversity, and decreased function of river ecosystems as a buffer for the urban environment. Therefore, efforts to preserve and rehabilitate river aquatic resources are an urgent need in urban environmental management. An integrated approach to conservation and rehabilitation is expected to be able to restore the ecological function of the river while ensuring the sustainability of its use for current and future generations (Kodoatie & Sjarief, 2010).

## METHOD

The method used in writing this article is a literature study, which is by systematically examining various relevant and credible literature sources. Secondary data sources were obtained from accredited national scientific journals and reputable international journals, reference books that discuss water resources and river ecosystem management, as well as official government documents related to environmental quality and river management in Indonesia (Central Statistics Agency, 2022; Ministry of Environment and Forestry, 2021; OECD, 2019). The literature review process is carried out through the stages of collection, grouping, and critical analysis of research results and policy reports that discuss the impact of urban waste on river ecosystems, both from physical, chemical, and biological aspects (Effendi et al., 2018; Hidayat & Sutrisno, 2020; Paul & Meyer, 2021). The selected literature is focused on publications for the 2018–2024 period to ensure the relevance and up-to-date of information,



especially related to the dynamics of urban river pollution, water quality degradation, and anthropogenic pressures due to population growth and industrial activities (UNEP, 2023). Furthermore, the information obtained is analyzed comparatively and synthesized to produce a comprehensive picture of existing conditions, main problems, and strategies for managing and rehabilitating aquatic resources of rivers in urban areas. This literature synthesis is used to identify common patterns, management gaps, and best practices in efforts to preserve sustainable river ecosystems (Damanik et al., 2022; World Bank, 2020).

## RESULT AND DISCUSSION

### The Impact of Municipal Sewage on River Aquatic Resources

Municipal waste generally consists of domestic liquid waste, industrial waste, and surface runoff from built-up areas that carry various pollutants to the river body (Effendi, 2003). Domestic waste comes from household activities such as bathing, washing, and sanitation, which generally contain organic matter, detergents, and pathogenic microorganisms. Meanwhile, industrial waste can contain harmful chemical compounds, heavy metals, and other toxic substances that have the potential to pollute river waters if not treated adequately before being disposed of (Effendi, 2003). Surface runoff from urban areas also contributes to bringing sediments, oils, and chemical residues into river systems, especially during periods of high rainfall.

Excessive input of organic matter and nutrients into river bodies can increase the value of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), which reflects the high need for oxygen for the decomposition process of pollutants (Sutrisno et., al 2025). Increased BOD and COD lead to a decrease in dissolved oxygen levels, thus creating unfavorable conditions for aquatic organisms. Under certain conditions, oxygen deficiency can trigger mass fish deaths and disrupt the balance of river aquatic ecosystems.

The decline in river water quality has a direct impact on aquatic biota, especially organisms that are sensitive to changes in the physical and chemical conditions of the waters, such as fish and macrozoobentos (Widodo, 2018). These indicators are often used to assess the level of pollution of rivers due to their rapid response to environmental changes. In addition, chronic pollution can lead to degradation of river habitats, such as the closure of the bottom substrate by sediment and the loss of riparian vegetation, which ultimately reduces freshwater biodiversity (MoEF, 2020). This condition shows that municipal sewage pollution not only affects water quality, but also disrupts the structure and function of the river ecosystem.

### Conservation of River Aquatic Resources

The conservation of river aquatic resources aims to prevent further environmental damage through efforts to protect water quality, natural habitats, and the ecological function of rivers (Kodoatie & Sjarief, 2010). River conservation is an important preventive step, especially in urban areas that experience high pressure due to human activities. Conservation efforts are carried out by controlling pollutant sources from upstream, improving domestic and industrial waste treatment systems, and implementing sustainable environmental management policies (KLHK, 2020). Effective pollution control is expected to suppress the entry of harmful materials into the river body and maintain the quality of the waters so that they still meet environmental quality standards.

In addition to pollution control, the protection of river border areas is an important part of the aquatic resource conservation strategy. The river border area functions as a buffer



zone that can reduce surface runoff, retain sediment, and filter pollutants before entering the river body (KLHK, 2020). The existence of riparian vegetation at the river border has an important role in maintaining the stability of riverbanks, preventing erosion, and maintaining the physical structure of the river to remain natural (Sutrisno & Hamdani, 2019). In addition, riparian vegetation also provides habitat, food sources, and shelter for a variety of aquatic and semiaquatic organisms.

River conservation does not only depend on technical and policy efforts, but it also requires the active involvement of the communities living along the river. Community participation in maintaining river cleanliness, reducing waste disposal, and maintaining river border areas plays an important role in maintaining the sustainability of the river's ecological function (Widodo, 2018). Therefore, increasing public environmental awareness and education is the main supporting factor in the success of the conservation of river aquatic resources in urban areas.

### **Rehabilitation of Rivers Affected by City Waste**

River rehabilitation is an effort to restore river conditions that have been degraded due to pollution, physical changes in river flows, and long-term pressure on human activities (Kodoatie & Sjarief, 2010). Rehabilitation not only focuses on improving water quality, but also aims to restore the ecological function of the river as a aquatic ecosystem capable of supporting aquatic organisms and providing environmental services in a sustainable manner. Therefore, river rehabilitation is seen as a corrective step that complements efforts to preserve the aquatic environment.

River rehabilitation activities include various technical and ecological actions, including normalization or rearrangement of river channels that have undergone siltation or narrowing, reducing pollutant loads through improving sewage treatment systems, and restoration of aquatic habitats damaged by sedimentation and pollution (Sutrisno & Hamdani, 2019). Habitat restoration is carried out by improving the physical structure of rivers, replanting riparian vegetation, and creating water conditions that support the recovery of aquatic biota. These efforts aim to improve water quality and gradually improve the balance of river ecosystems.

In Indonesia, river rehabilitation programs are generally implemented through an integrated watershed management approach, which considers the linkages between upstream, middle, and downstream areas of rivers (KLHK, 2020). This approach emphasizes the importance of cross-sectoral coordination and the involvement of various stakeholders, including governments, communities, and the private sector, in the planning and implementation of river rehabilitation. Rehabilitation carried out in a sustainable and integrated manner has been proven to be able to improve water quality, improve habitat conditions, and gradually restore the ecological function of the river, so that the river can be used safely and sustainably by the community (Widodo, 2018).

### **CONCLUSION**

Urban waste has been shown to have a significant impact on the decline of water quality and the ecological function of rivers in urban areas of Indonesia, both from domestic, industrial, and urban surface runoff that increases the burden of pollutants such as organic matter, heavy metals, sediments, and oils. These conditions are reflected in the increase in BOD and COD values as well as a decrease in dissolved oxygen levels which directly interfere with the sustainability of aquatic biota and damage river habitats. Therefore, the preservation and rehabilitation of river aquatic resources is a strategic and urgent step to restore the quality of the aquatic environment. An integrated approach through pollution



control with waste treatment systems, protection of river boundaries through riparian vegetation, increased community participation, and physical and ecological rehabilitation of rivers through normalization, habitat restoration, and sustainable management of watersheds are key to maintaining the sustainability of urban river ecosystems and supporting long-term environmental quality.

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