Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 12 (December) (2025)

Comparative Analysis of River Pollution Control Frameworks in Pakistan and the European Union

Dr. Muhammad Saqlain Haider (Corresponding Author)
Ph.D. (Law), Universiti Utara, Malaysia. Assistant Professor, Department of Law, The University of Faisalabad Email: saqlainhaider.law@tuf.edu.pk

Sanawar Balam
LLM (Scholar), Department of Law, The University of Faisalabad.
Email: sanawarbalam@gamil.com

Muqaddas Ayub
LLM (Scholar), Department of Law, The University of Faisalabad.
Email: muqaddasayub6@gamil.com

ABSTRACT
Pakistan is facing severe challenges to human health, agricultural productivity, and aquatic ecosystems due to escalating water pollution. Rapid industrialization, unchecked population growth, and urban expansion have resulted in the continuous discharge of untreated industrial effluents, domestic sewage, and agricultural runoff containing pesticides and fertilizers into rivers, lakes, and groundwater sources. These practices have significantly degraded water quality and pose serious public health risks. The situation is further exacerbated by weak regulatory enforcement, inadequate wastewater treatment infrastructure, limited institutional capacity, and low levels of public awareness. This study aims to examine the current status and major causes of water pollution in Pakistan and to critically assess existing control measures through a comparative analysis with the policies and regulatory frameworks of developed regions, particularly the European Union. The findings indicate that concentrations of heavy metals and other hazardous substances in Pakistani water bodies frequently exceed the permissible limits prescribed by the World Health Organization (WHO). The study concludes that achieving sustainable water quality in Pakistan requires stricter implementation of environmental laws, institutional reforms, enhanced public participation, and the adoption of advanced and integrated wastewater management approaches, such as basin-wide management techniques successfully implemented in the European Union.

Keywords: Water Pollution, Pakistan, European Union, Wastewater Management, Environmental Regulation.

INTRODUCTION

Water is one of the most essential natural resource for attaining life, supporting economic activities, and maintaining ecological balance. Especially Rivers are vital for providing freshwater for agriculture, industries, and domestic use. However, increasing industrialization, population growth, and urbanization have led to severe decadence of river water quality across the world or especially in developing or under developed countries. According to the United Nations World Water Development Report **(UNESCO, 2023),** more than **80%** of wastewater globally is discharged into the

Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 12 (December) (2025)

environment without adequate treatment, leading to widespread decay of freshwater Developing countries, including **Pakistan,** face a growing crisis of river pollution that threatens Human life, health and environmental integrity.

In **Pakistan,** the problem of river pollution has become increasingly severe over the past few years. Major rivers such as the Indus, Ravi, Chenab and Sindh have been heavily contaminated due to the continuous discharge of untreated industrial materials , domestic sewage, and agricultural runoff. Studies have shown that high concentrations of heavy metals, pesticides, and microbial pathogens exceed World Health Organization (WHO) safety limits in many regions **(Farooqi et al., 2019; Khan et al., 2022)**. The rapid expansion of urban settlements, combined with weak wastewater management systems, has increased the level of pollution. Industrial clusters in cities like **Faisalabad, Lahore, and Karachi** release large volumes of toxic wastewater into nearby rivers without treatment, and cause serious threats to aquatic life and water usability (**WWF-Pakistan, 2021**).

The government of Pakistan has introduced several environmental policies, such as the **Pakistan Environmental Protection Act (PEPA) of 19**97 and **the National Water Policy** of 2018, aiming to regulate industrial discharge and improve water governance. However, weak institutional enforcement**, lack of modern wastewater treatmen**t facilities, and insufficient monitoring mechanisms have limited their effectiveness **(Rasheed et al., 2020**). Furthermore, fragmented water management responsibilities across different federal and provincial departments have led to poor control and ineffective policy implementation. As a result, despite the existence of environmental legislation, water pollution in rivers remains a critical and unresolved issue that continues to affect both rural and urban communities. Main reason behind it is weak or zero enforcement on level of governmental organizations

In contrast, the European Union (EU) has established a robust and integrated framework for water protection and pollution control.EU has introduced several laws and policies to control or to address the problem of water pollution. The EU Water Framework Directive (WFD) of 2000 is a cornerstone policy that promotes sustainable water use, integrated **river basin management**, and pollution prevention (European Commission, 2020). Complementary directives, such as the Urban Wastewater Treatment Directive (1991) and the Nitrates Directive (1991), further ensure that industrial and agricultural pollutants are managed through strict monitoring, treatment standards, and enforcement mechanisms. The EU's approach emphasizes not only the regulation of pollutants but also ecological restoration and stakeholder participation in water management. As a result, the quality of many European rivers, including the Danube, Rhine, and Thames, has significantly improved over the last two deceades.

This research aims to analyze and compare river pollution control measures in Pakistan and the European Union to identify gaps, challenges, and opportunities for improvement. The comparative approach will provide us a vision how Pakistan can strengthen its water governance and environmental enforcement by adopting successful elements from the EU framework. The study seeks to highlight the importance of policy implementations, technological investment in wastewater treatment, and public awareness for achieving sustainable river management.

LITERATURE REVIEW

Long term impact of basin wide wastewater Management on faecal pollution levels along the entire Danube River

A **basin-wide technique** to control water pollution refers to managing water quality and pollution **across an entire river basin or watershed**, rather than just at specific sites.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 12 (December) (2025)

This approach recognizes that all water bodies within a basin (rivers, lakes, groundwater, wetlands, etc.) are **hydro logically connected.** A basin-wide technique involves **planning, managing, and implementing pollution control measures** throughout the entire drainage basin (catchment area) to **prevent, reduce, and control water pollution** from all sources — domestic, industrial, and agricultural.

In the **Indus River Basin (Pakistan)** or **Danube River Basin (Europe)**, basin-wide management plans are implemented through cooperation among regions and countries to control pollutants such as agricultural runoff, sewage discharge, and industrial effluents that affect the entire basin's water quality.

In this research paper **Kirschner et al** discussed technique of basin wide also called watershed to remove all pollutant from water sources. The **Danube River**, Europe's second longest and the world's most international river, has long faced fecal pollution from untreated and treated municipal wastewater. Over the last two decades, **EU Member States in the Danube River Basin (DRB)** have made major investments in wastewater infrastructure, leading to significant improvements: the share of biologically treated wastewater rose from 69% to over 85%, and tertiary treatment from 46% to 73%. In contrast, **non-EU countries** in the middle and lower Danube still discharge large amounts of untreated wastewater.

Monitoring through the **Joint Danube Surveys (2001–2019)** revealed consistent patterns: low fecal pollution in the upper Danube, but high levels and hotspots in the middle and lower sections, especially around **Central Serbia** where no major improvements occurred. Overall, fecal pollution decreased significantly across the river (72–86% reduction), except in Serbia's untreated zones.

Future improvements depend on further EU-driven investments, upgrading plants with advanced treatment in the upper Danube, reducing sewer overflows, and extending EU accession benefits to Western Balkan states. Ongoing river-wide monitoring is essential for tracking progress.

The Danube River, Europe's second longest, has seen major improvements in water quality over the past two decades due to EU investments in wastewater treatment. Treated wastewater coverage rose sharply, leading to a 72–86% reduction in faecal pollution between 2001 and 2019. However, pollution remains high in non-EU countries, particularly Central Serbia, where untreated discharges continue. Further progress depends on infrastructure upgrades, reducing sewer overflows, and extending EU standards to Western Balkan states. Regular basin-wide monitoring remains essential.

A comprehensive review on water pollution South Asia region ; Pakistan

Noor et al in this article reviewed that Pakistan is among the most water-polluted countries in South Asia, with widespread contamination of drinking water by microbes and toxic metals. Over 80–90% of the country's water sources fail to meet **WHO quality standards**, exposing communities to serious health risks such as diarrhea, typhoid, gastroenteritis, and long-term metal toxicity.

The main sources of water pollution are **urbanization, industrial discharge, agricultural runoff, poor wastewater management, and groundwater depletion**. River and groundwater contamination has worsened between 2000–2020, with major pollutants including arsenic, cadmium, lead, chromium, and fecal coliforms. Urban centers such as Lahore, Faisalabad, Karachi, and Rawalpindi are key pollution hotspots.

Water scarcity further intensifies the crisis: declining precipitation, over-extraction of groundwater, and lack of infrastructure have left millions dependent on unsafe water. Bottled water is not a reliable alternative, as many sources remain unregulated.

Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 12 (December) (2025)

The situation calls for **urgent interventions**, including:
Strengthening water quality monitoring and enforcement of WHO standards
Investment in wastewater treatment and safe drinking water infrastructure
Policy reforms targeting pollution control in agriculture, industry, and urban centers.
Raising awareness and engaging communities in water conservation.
Without immediate action, Pakistan faces escalating health crises, ecosystem degradation, and severe water scarcity in the coming decades.

Water Resources And Their Management In Pakistan: A Critical Analysis On Challenges And Implications

Shakeel Ahmed et al discussed that Water is a critical resource for Pakistan, supporting human life, agriculture, industry, and the environment, but the country is among the most water-stressed in the world. The Indus Basin Irrigation System is the backbone of food production and the economy, yet water availability has declined drastically from 5,600 m^3 per capita in 1947 to below 1,000 m^3 today, which is the threshold of water scarcity. A systematic review of 93 research publications published between 2000 and 2023 highlights Pakistan's major challenges in managing water resources, focusing on governance, policy, infrastructure, socio-economic and technical aspects, and climate change impacts.

Pakistan's water supply comes from rivers, glaciers, rainfall, reservoirs, and groundwater, with the country being the **fourth largest groundwater** user globally. However, rapid population growth, urbanization, and poor infrastructure have led to scarcity and widespread wastage. Almost 60% of water is lost through inefficient irrigation practices and canal leakages. Pollution is another severe problem: about **79%** of drinking water is unsafe due to microbial contamination, arsenic, nitrates, and heavy metals, while nearly all industrial and domestic wastewater is discharged untreated into rivers and canals.

Governance weaknesses remain a major barrier to effective management. The National Water Policy introduced in 2018 provides a framework, but enforcement is poor and institutions at federal and provincial levels often overlap or conflict. Industries continue to discharge untreated wastewater due to lack of regulatory pressure, while monitoring of groundwater extraction and overall water consumption is almost absent. Inequities between provinces fuel disputes over water distribution, particularly between Punjab and Sindh. Moreover, water management has not been properly integrated with agriculture, urban development, and industrial growth, and climate change considerations are largely missing from planning.

Socio-economic factors add more strain. Millions of people, especially in rural areas, lack access to safe drinking water, while rapid population growth and industrialization have increased demand. Waterborne diseases such as diarrhea, cholera, hepatitis, and typhoid account for nearly 40% of the national disease burden Poverty and weak institutional capacity limit communities' ability to respond to water challenges.

Technical shortcomings further aggravate the issue.

Pakistan urgently needs to expand its water storage capacity through new dams and reservoirs, modernize its canal networks, and promote efficient irrigation methods such as drip and sprinkler systems. Wastewater treatment plants and recycling systems are necessary to reduce pollution. Real-time monitoring and digital data systems should be established to track water flows, groundwater levels, and quality.

A sustainable framework for water management requires coordinated action across multiple areas. Stronger governance is essential, with clear institutional responsibilities,

ISSN Online: 3007-3154
ISSN Print: 3007-3146

stricter enforcement of laws, and equitable distribution across provinces. Infrastructure development must focus on increasing storage capacity and reducing irrigation losses. Technological innovation should promote efficient water use and data-driven decision-making. Climate change adaptation strategies are needed to prepare for floods and droughts, monitor glaciers, and shift towards climate-resilient crops. Community participation, public awareness, and education campaigns can help build water conservation habits. Adopting international best practices, such as **the OECD Water Governance Principles**, will improve transparency, accountability, and participation. Regional cooperation on shared rivers is also necessary.

Pakistan faces severe water scarcity, pollution, and mismanagement, threatening its food security, economy, and public health. Without urgent reforms, the country risks reaching absolute water scarcity within the next decade The most important steps include stricter implementation of laws and policies, investment in storage and treatment infrastructure, adoption of water-saving technologies, climate adaptation measures, and greater involvement of both the private sector and local communities.

CAUSES OF RIVER POLLUTION

Industrial Wastewater

Industrialization in cities like Karachi, Lahore, Faisalabad, and Sialkot has greatly contributed to river pollution. Large amounts of untreated chemical waste are discharged directly into rivers. Factories release toxic chemicals, dyes, acids, oils, and heavy metals such as lead, mercury, and chromium. These substances make river water highly contaminated. Since environmental laws are weakly enforced in Pakistan, many industries avoid installing treatment plants, allowing harmful waste to freely enter rivers.

Domestic sewage

Another major cause of river pollution is the discharge of untreated sewage from households in large cities. Domestic sewage contains organic waste, detergents, plastics, and harmful bacteria and viruses. When this sewage enters rivers, it lowers the oxygen level in water and makes it unsafe for human use. As a result, people who consume or use this water often suffer from diseases such as cholera, diarrhea, hepatitis, and skin infections

Agricultural Runoff

Pakistan’s agricultural sector relies heavily on fertilizers, herbicides, and pesticides to increase crop yields. During rainfall and irrigation, these chemicals are washed away into rivers. This leads to nutrient pollution, mainly due to nitrogen and phosphorus, and causes eutrophication, which is the excessive growth of algae. Eutrophication blocks sunlight, reduces oxygen in water, and results in the death of fish and aquatic plants.

Solid Waste Duping

In many parts of Pakistan, people dispose of solid waste directly into rivers. This includes plastic bags, bottles, wrappers, animal remains, and household garbage. Such dumping makes the water dirty, clogs its natural flow, and endangers aquatic life

Oil Spills and Industrial Effluents

Oil pollution is another growing problem. Oil refineries, transport vehicles, and ship-breaking industries release oil and petroleum products into rivers. Oil spills form a thin layer on the water’s surface that prevents oxygen from mixing with water. This

Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 12 (December) (2025)

suffocates fish and other aquatic organisms. When oil mixes with industrial effluents, the pollution becomes even more toxic and endanger.

RESEARCH OBJECTIVES

To **compare** the legal, institutional, and policy frameworks for river pollution control in Pakistan and the European Union, focusing on enforcement mechanisms and governance structures.

To **evaluate** the environmental effectiveness of pollution control efforts in both regions by analyzing trends in river water quality and key sources of pollution over the past two decades.

To **assess** the role of public participation, education, and civil society in promoting compliance and awareness regarding river pollution control laws in Pakistan and the EU.

To **identify** key challenges and best practices, including lessons from the EU's Water Framework Directive that can inform improved river pollution management and policy development in Pakistan.

RESEARCH QUESTIONS

How do regulatory frameworks and enforcement mechanisms for river pollution differ between Pakistan and EU Member States, and how do these differences affect water quality?

What is the effectiveness of urban wastewater treatment (centralized vs. decentralized) in reducing key contaminants (BOD, nitrates, fecal coliforms, heavy metals) in rivers in Pakistan compared with EU best-practice regions?

How does industrial compliance (textile, tannery, and agrochemical) with effluent standards influence river pollution hotspots in Pakistan, and which EU regulatory or market instruments (e.g., EPR, BREFs) could be adapted to improve compliance?

What role do community-based river governance and stakeholder participation play in successful river restoration in the EU, and how transferable are these models to Pakistan's social and institutional context?

METHODOLOGY

This research adopts a qualitative research methodology to critically examine the legal, institutional, and policy framework governing river pollution control in Pakistan. A qualitative approach is particularly suitable for this study as it allows for an in-depth understanding of regulatory structures, governance challenges, and implementation gaps that cannot be adequately captured through quantitative analysis alone. The methodology integrates doctrinal legal analysis, policy review, and empirical insights drawn from secondary literature and field-based perceptions, thereby ensuring a comprehensive assessment of both environmental and institutional dimensions of river pollution control.

The primary sources of this research consist of statutory instruments, regulatory frameworks, and official documents that form the legal basis of environmental governance in Pakistan. These include, inter alia, the Pakistan Environmental Protection Act (PEPA), 1997, provincial environmental protection laws, rules and regulations framed thereunder, and relevant regulations of the Water and Sanitation Agencies (WASA). Judicial precedents and policy instruments such as the National Environmental Policy, National Water Policy, and river basin management guidelines were also examined to understand the scope, intent, and enforceability of existing legal provisions. Doctrinal legal analysis was employed to evaluate the adequacy of these laws in addressing river pollution, with particular attention paid to regulatory standards, enforcement mechanisms, penalties, and institutional coordination.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 12 (December) (2025)

In addition to primary legal sources, this study relies extensively on secondary sources, including peer-reviewed research articles, reports published by governmental and non-governmental organizations, international agencies, and academic institutions. These sources were used to assess the extent and causes of river pollution in Pakistan, identify key pollutants, and examine the socio-economic and environmental impacts of water contamination. Comparative literature relating to the European Union's river pollution control mechanisms—particularly the EU Water Framework Directive and basin-wide management approaches—was reviewed to draw lessons and best practices applicable to the Pakistani context.

To supplement the doctrinal and policy analysis, the research incorporates qualitative empirical inputs derived from public surveys and informal assessments of communities residing near riverbanks. These inputs provide valuable insights into local perceptions of river pollution, sources of contamination, health impacts, and the effectiveness of existing control measures. While the study does not employ statistically representative sampling, purposive sampling was used to engage individuals and communities directly affected by river pollution. This approach enabled the collection of context-specific information regarding enforcement failures, institutional responsiveness, and public awareness at the grassroots level.

Furthermore, policy documents and existing river management frameworks were systematically reviewed to evaluate the effectiveness of current pollution control measures. This involved analyzing institutional arrangements, inter-agency coordination, monitoring mechanisms, and compliance strategies. Special emphasis was placed on identifying gaps between law and practice, including deficiencies in monitoring, lack of technical capacity, insufficient wastewater treatment facilities, and weak accountability mechanisms.

The integrated methodology adopted in this research allows for triangulation of data from legal texts, policy documents, academic literature, and community-level observations. This approach enhances the reliability and depth of the analysis by capturing multiple perspectives on river pollution control. By combining doctrinal legal analysis with policy evaluation and qualitative empirical insights, the study develops a holistic understanding of river pollution control in Pakistan and provides a sound basis for proposing legal and institutional reforms aligned with international best practices.

REFERENCES

European Commission (2020) The EU Water Framework Directive – 20 years of water policy. Brussels: European Union.

Farooqi, A., Masuda, H. and Firdous, N. (2019) 'Toxic contaminants in drinking water and their human health risks in Pakistan', Environmental Monitoring and Assessment, 191(5), p. 289.

Khan, S., Ahmad, W. and Shakoor, A. (2022) 'Assessment of surface water pollution in the Indus Basin', Environmental Science and Pollution Research, 29(10), pp. 15234–15248.

Rasheed, H., Saeed, A. and Ashraf, A. (2020) 'Challenges in implementing water pollution control policies in Pakistan', Journal of Environmental Management, 270, p. 110913.

UNESCO (2023) UN World Water Development Report 2023: Partnerships and Cooperation for Water. Paris: UNESCO.

WWF-Pakistan (2021) River pollution and environmental degradation in Pakistan. Lahore: World Wide Fund for nature

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 12 (December) (2025)

Kirschner, A.K.T., Schachner-Groehs, I., Kavka, G., Hoedl, E., Kovacs, A. and Farnleitner, A.H., 2024. [Title of the article]. **Environmental Science and Pollution Research**, DOI: 10.1007/s11356-024-34190-

Noor, R., Maqsood, A., Baig, A., Pande, C.B., Zahra, S.M., Saad, A., Anwar, M. and Singh, S.K., 2023. A comprehensive review on water pollution, South Asia Region: Pakistan. **Urban Climate**, 48, p.101413. https://doi.org/10.1016/j.uclim.2023.101413.

Ahmad, S., Jia, H., Ashraf, A., Yin, D., Chen, Z., Xu, C., Chenyang, W., Jia, Q., Xiaoyue, Z., Israr, M. & Ahmed, R., [year]. Water resources and their management in Pakistan: A critical analysis on challenges and implications. **Water-Energy Nexus**, volume, pp.137-150. Received 22 June 2023.