trends IN PEACE & SUSTAINABILITY
A SCHOLARLY PLATFORM FOR NEW PERSPECTIVES AND CRITICAL INSIGHTS ON PEACE AND SUSTAINABILITY
PUBLISHED BY NERPS, HIROSHIMA UNIVERSITY

From River to Sea

The Chao Phraya's Imprint on Thailand's Marine Ecosystems

Abstract

Every year, the Chao Phraya River carries thousands of tons of plastic waste, nutrient runoff, and microbial contaminants on its journey from the northern highlands to the Gulf of Thailand. This steady flow of land-based pollution demonstrates how a single river can amplify human pressures on water quality. A spatial assessment of water quality and plastic waste management reveals how pollutants accumulate across the watershed and intensify downstream, ultimately shaping the Gulf's ecological health. These trends have direct consequences for coastal communities, local fisheries, and the marine ecosystems that support them. By following the river's path from source to sea, this article illustrates how plastic leakage, inadequate wastewater treatment, and diffuse land-based pollution interact through multiple interconnected pathways. Safeguarding the Gulf of Thailand marine ecosystems requires reducing upstream plastic leakage, strengthening wastewater treatment, and addressing the cumulative pollution burden that travels with the Chao Phraya.

Keywords: *Chao Phraya River, marine plastic pollution, land-based sources, watershed management, water quality*

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Long before it reaches the Gulf of Thailand, the Chao Phraya River carries a large amount of pollution along its 372-kilometer journey. This pollution comes from urban, industrial, and agricultural sources throughout the river's watershed.

Among the various pollutants entering the river system, plastics represent one of the most pervasive and persistent threats. Plastics account for about 80% of all marine litter and threaten marine ecosystems, wildlife, and biodiversity through entanglement, ingestion, habitat loss, and the release of harmful substances (Wilcox et al., 2016). Since plastics are made from petroleum-based chemicals, they can remain in the environment for hundreds or even thousands of years, leading to long-term ecological problems. As larger plastic items break down, they form microplastics (MPs), which are particles smaller than 5 mm and add to the pollution challenge. These MPs have now been found throughout the world's oceans, from surface waters to deep-sea sediments (Katija et al., 2017).

Along these waterways, rivers become conveyors of local failures, transforming inland waste into coastal and oceanic pollution.

The Gulf of Thailand, one of the world's 66 Large Marine Ecosystems (LMEs), is particularly vulnerable to this form of pollution due to its semi-enclosed morphology. The inner Gulf receives significant freshwater discharges from major river systems, including the Chao Phraya, Mae Klong, Tha Chin, and Bang Pakong rivers, which collectively act as conduits for land-based contaminants (Figure 1). The Chao Phraya River alone is estimated to transport about 4,000 tonnes of plastic waste to the Gulf of Thailand each year (The Ocean Cleanup, 2025), highlighting its disproportionate role in shaping coastal pollution patterns. In light of these concerns, this article therefore examines how water quality and waste-related pressures overlap across Thailand, focusing on the Chao Phraya–Gulf of Thailand system.

Figure 1. Aerial Image of the Chao Phraya River in Bangkok City. Image from Freepik: https://www.freepik.com/free-photo/aerial-view-bangkok-city-chao-phraya-river-with-morning-fog-

Plastic pollution reaches the Gulf along with other contaminants, including chemical, nutrient, and microbial pollutants. These pollutants combine to worsen water quality and put more stress on the Gulf's ecosystems. In the Chao Phraya River estuary aquaculture zone, microplastics contaminated with toxic heavy metals (Cr, Cu, Ni, Pb, Cd, and Zn) have been found (Ta & Babel, 2020), raising concerns about bioaccumulation and trophic transfer that directly affect seafood safety and human health.

Nutrient enrichment further compounds these impacts. The Chao Phraya River has been reported to contain nitrogen concentrations approximately ten times higher than recommended levels, with a decade of measurements indicating a chronic condition rather than a transient pollution event, and average concentrations of 3.12 mg/L recorded between 2008 and 2017 (Chaysiri & Sukruay, 2021). These elevated nutrient loads are largely attributed to rapid urbanization, agricultural runoff, and insufficient wastewater treatment infrastructure.

Microbial contamination represents another major concern within the Chao Phraya River system. The lower Chao Phraya River has been reported to contain high concentrations of both general and antimicrobial-resistant *Escherichia coli*, particularly in densely populated urban areas (Sweattatut et al., 2022). This pervasive microbial pollution not only reflects inadequate wastewater management but also poses direct public health risks for coastal communities that depend on these waters for fishing, aquaculture, and recreation.

Cumulative pollution pressures can lead to the decline of fish stocks and raise concerns over contaminated catches, increasing the potential for human exposure to pollutants through seafood consumption.

To understand the broader context of these anthropogenic pressures, a spatial assessment of water quality and plastic waste management, including collection, mismanagement, and leakage, was conducted using data from the Pollution Control Department (PCD, 2018) and International Union for Conservation of Nature (IUCN, 2020). This analysis provides a nationwide view of how waste management efficiency relates to water quality degradation.

Mapping water quality across Thailand reveals a striking imbalance. While 42% of surveyed provinces fall within the "good" category (WQI = 71–90) and another 45% are classified as "fair" (WQI = 61–70), not a single province achieves an "excellent" rating. More concerning, eight provinces, most of them clustered in the country's central region, have poor water quality (WQI = 31–60). At the center of this pattern lies Bangkok. Despite collecting 91% of its municipal waste and having low rates of mismanaged waste (12%) and leakage (1%), it still has the lowest Water Quality Index in the country (WQI = 35).

These disparities reveal a critical reality of river-based pollution: even strong local waste management cannot shield downstream cities from upstream failures. The Chao Phraya River, Bangkok's primary water source, carries the accumulated burden of plastic debris, untreated wastewater, nutrients, and industrial effluents from hundreds of kilometers upstream. By the time the river reaches the city, it reflects not only Bangkok's own pressures but also the combined impacts of urban expansion, agriculture, and inadequate wastewater treatment across the entire basin. Evidence of this cumulative contamination is already visible, with microplastics detected in both Bangkok's freshwater sources and tap water, showing that plastic pollution remains despite high collection rates (Chanpiwat & Damrongsiri, 2021).

Across Thailand's major river systems, a consistent pattern becomes evident. Provinces intersected by river systems or along the coast, like Sing Buri, Lop Buri, Chachoengsao, and Samut Songkhram (Figure 2), often have trouble managing waste. In these areas, 83% to 87% of waste is mismanaged and leakage rates are as high as 8-10%. This is not a coincidence. As Jambeck et al. (2015) note, mismanaged land-based waste is a dominant pathway for plastics to enter rivers, travel downstream, and ultimately accumulate in marine environments. Along these waterways, rivers become conveyors of local failures, turning inland waste into coastal and oceanic pollution.

At first glance, it seems logical that provinces with strong waste collection systems would have cleaner waterways. Yet the data tells a different story. Provinces such as Bangkok, where waste collection reaches 91%, along with Nonthaburi (82%) and Samut Prakan (79%), continue to experience poor water quality. This disconnect reveals a deeper, systemic problem: waste collection mainly addresses visible solid waste, while rivers continue to carry a broader mix of pollutants from upstream, including solid waste, wastewater-derived pollutants, and nutrient enrichment. As these pollutants accumulate downstream, they undermine local waste management efforts and expose the limits of solutions that focus solely on collection. Therefore, implementing targeted strategies to reduce mismanaged waste and minimize leakage, particularly in upstream catchments, is critical for improving water quality and mitigating pollution impacts in the Gulf of Thailand (Gómez-Sanabria & Lindl, 2024).

The Chao Phraya River is a vital lifeline for Thailand, and its journey from source to sea underscores a critical reality: improving waste collection alone is insufficient to restore river water quality or protect the Gulf of Thailand. Pollution is transported downstream, where the cumulative load of contaminants intensifies pressure on aquatic ecosystems and the communities that rely on them.

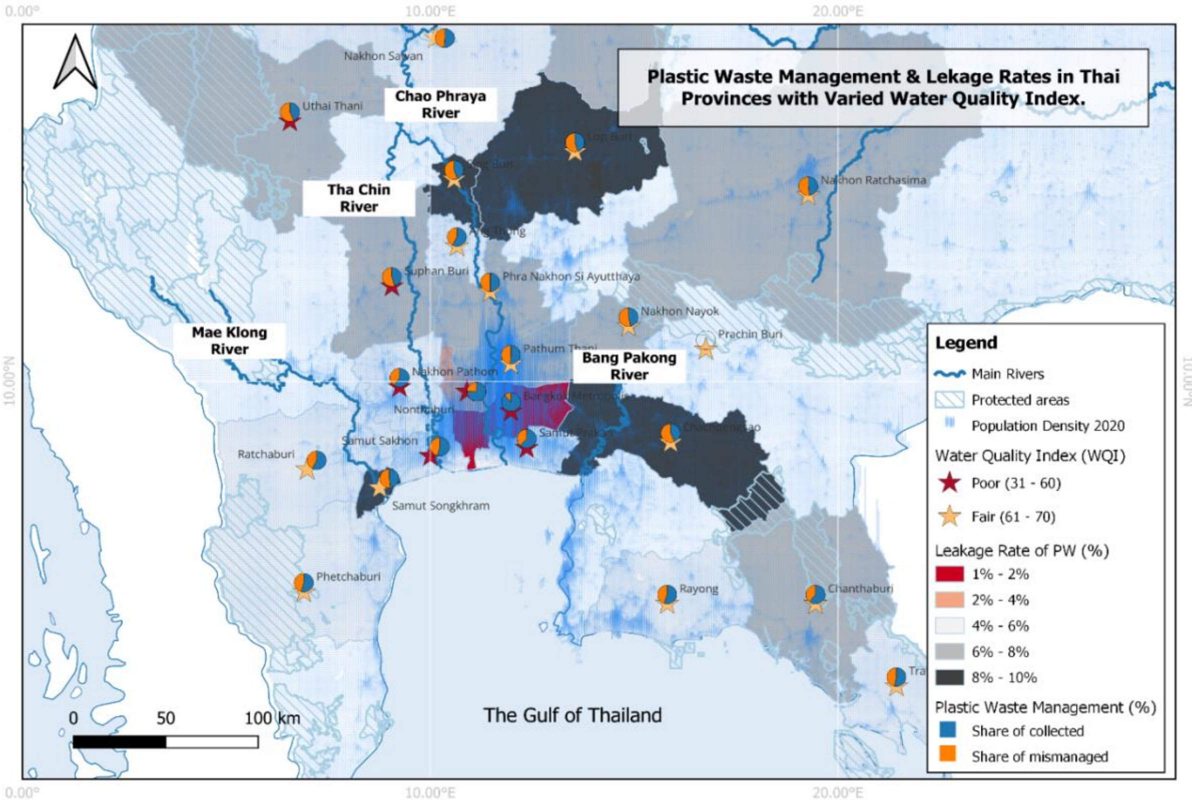

Figure 2. Plastic waste management and leakage rates in Thai provinces with varied water quality (GIS map created by author).

For coastal fishers, this environmental degradation results in declining catches and increased concerns regarding contaminated seafood, while for households, it raises ongoing questions about water safety and long-term health risks. For the Gulf, cumulative pollution threatens the resilience of an ecosystem that supports livelihoods, food security, and biodiversity.

Addressing this challenge requires looking beyond collection rates and considering the whole watershed. It is essential to reduce mismanaged waste and plastic leakage upstream, improve wastewater treatment infrastructure, and control pollution from industry, farming, and cities. When such measures are coordinated across provinces and interconnected river basins, they can disrupt the flow of pollution before it reaches coastal waters. The fate of the Gulf of Thailand depends on recognizing that rivers connect us all and that protecting marine ecosystems must begin far inland, long before river water meets the sea.

About the Author

Khouloud Jaffel is an alumna of the Asian Institute of Technology (Thailand), where she completed a Master's Program in Marine Plastic Abatement (MPA) with funding from the Government of Japan. Her research focuses on the sources and impacts of marine plastic debris in aquatic ecosystems. She is passionate about environmental sustainability and aims to pursue further research in this field. In 2022, Khouloud also participated in the Ocha Summer Program for Global Leaders in Tokyo, and her commitment to addressing environmental challenges and promoting a sustainable ocean remains steadfast. [Website]

Suggested citation

Jaffel, Khouloud (2026, January). "From River to Sea: The Chao Phraya's Imprint on Thailand's Marine Ecosystems." *Trends in Peace and Sustainability* 3(1): 1–5. <URL> Access date.

References

Chanpiwat, P., & Damrongsiri, S. (2021). Abundance and characteristics of microplastics in freshwater and treated tap water in Bangkok, Thailand. *Environmental Monitoring and Assessment, 193*(5), 258. https://doi.org/10.1007/s10661-021-09012-2.

Chaysiri, R., & Sukruay, J. (2021). Sustainability Analysis for the Lower Chao Phraya River Using System Dynamics. *Research Unit on Science, Technology and Environment for Learning, 12*(1), 105-121.

Gómez-Sanabria, A., & Lindl, F. (2024). The crucial role of circular waste management systems in cutting waste leakage into aquatic environments. *Nature Communications, 15*(5443). https://doi.org/10.1038/s41467-024-49555-9

Jambeck, J., Geyer, R., Wilcox, C., Siegler, T., Perryman, M., Andrady, A., & Narayan, R. (2015). Plastic waste inputs from land into the ocean. *Science, 347*(6223), 768-771. https://doi.org/10.1126/science.1260352

Katija, K., Choy, C., Sherlock, R., Sherman, A., & Robison, B. (2017). From the surface to the seafloor: How giant larvaceans transport microplastics into the deep sea. *Science Advances, 3*(8). https://doi.org/10.1126/sciadv.1700715

Sweattatut, R., Boontanon, S., Piyaviriyakul, P., Harada, H., & Fujii, S. (2022). Antimicrobial Resistant Escherichia coli Distribution along the Lower Part of the Chao Phraya River, Thailand. *IOP Conference Series: Earth and Environmental Science, 973*(1), 012005. https://doi.org/10.1088/1755-1315/973/1/012005

Ta, A., & Babel, S. (2020). Microplastics pollution with heavy metals in the aquaculture zone of the Chao Phraya River Estuary, Thailand. *Marine Pollution Bulletin, 161*, 111747. https://doi.org/10.1016/j.marpolbul.2020.111747.

The Ocean Cleanup. (2025). Retrieved December 2025, from River Plastic Pollution Sources: https://theoceancleanup.com/sources/?id=1456

Wilcox, C., Mallos, N., Leonard, G., Rodriguez, A., & Hardesty, B. (2016). Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife. *Marine Policy, 65*, 107-114. https://doi.org/10.1016/J.MARPOL.2015.10.014.