Jurnal Riset Kualitatif dan Promosi Kesehatan
E-ISSN: 2775-4944
Volume. 3, Issue 2, July 2024
Page No: 98-112

Microplastic Pollution in Urban Water Systems, Environmental and Public Health Implications: A Narrative Review

Pitriani[1]
[1]**Universitas Muhammadiyah Palu, Indonesia**
Correspondent: pitriani@untad.ac.id[1]

Received : June 18, 2024
Accepted : July 22, 2024
Published : July 31, 2024

Citation: Pitriani., (2024). Microplastic Pollution in Urban Water Systems, Environmental and Public Health Implications: A Narrative Review. Jurnal Riset Kualitatif dan Promosi Kesehatan, 3(2), 98-112.

https://doi.org/10.61194/jrkpk.v3i2.664

ABSTRACT: Microplastic contamination in urban water systems is a growing concern due to its ecological and health impacts. This review explores the sources, transport mechanisms, and public health implications of microplastics in urban water systems. A systematic review was conducted using PubMed, Scopus, and Google Scholar, targeting peer reviewed articles from the last decade. Selection criteria emphasized studies linking plastic pollution to water quality and human health. Microplastics are prevalent in urban rivers, lakes, and wastewater treatment plants, with concentrations varying by region and waste management practices. Key sources include single use plastics, urban runoff, and ineffective filtration in treatment plants. Human exposure occurs through drinking water and food consumption, with potential risks such as endocrine disruption and toxic bioaccumulation.Effective mitigation requires integrated approaches including advanced treatment technologies, stricter regulations, and public engagement. Further research should address detection standardization and long term health risks.

Keywords: Microplastics, Plastic Pollution, Urban Water Quality, Wastewater Treatment, Public Health, Environmental Contamination, Mitigation Strategies.

This is an open access article under the CC-BY 4.0 license

INTRODUCTION

Plastic waste contamination has become a pervasive environmental issue, significantly impacting urban water systems worldwide. The increasing production and consumption of plastic materials, coupled with inefficient waste management systems, have led to the widespread presence of plastic debris in freshwater ecosystems. Urban areas, characterized by high population densities and industrial activities, serve as primary contributors to this pollution crisis (Flores-Munguía et al., 2023; Sánchez et al., 2014). Microplastics, defined as plastic particles smaller than 5 mm, have been detected in various urban water bodies, raising concerns regarding their environmental and public health implications. Studies have shown that wastewater treatment plants (WWTPs) are major conduits for microplastic discharge into rivers and lakes, as conventional filtration processes often fail to effectively remove these contaminants (Dris, Gaspéri, et al., 2015; Vaid et al., 2024).

Urban drainage systems also play a significant role in the transportation of plastic waste from land to water bodies. Rainfall and surface runoff contribute to the mobilization of plastic debris, exacerbating pollution levels in urban rivers and lakes (Axelsson & Sebille, 2017; Tibbetts et al., 2018). The infiltration of microplastics through stormwater runoff has been extensively documented, with studies indicating that urbanization directly influences the magnitude of plastic contamination in aquatic environments (Townsend et al., 2019; Zhao et al., 2015). Moreover, the indiscriminate disposal of single use plastics in urban environments accelerates the fragmentation of macroplastics into microplastic particles, which persist in water systems and pose potential health risks to aquatic organisms and humans (Liu et al., 2023).

The human health implications of microplastic contamination are an emerging concern. Recent studies indicate that microplastics can infiltrate drinking water supplies, leading to potential adverse health effects (S. Li et al., 2024; Pratesi et al., 2021). Research has confirmed the presence of microplastic fragments in all sampled drinking water sources, raising alarms regarding their ingestion and bioaccumulation within human biological systems. These particles not only serve as physical pollutants but also act as vectors for hazardous substances, including endocrine disrupting chemicals, pathogens, and heavy metals (Xu et al., 2020; Zhu et al., 2024). Chronic exposure to microplastics has been linked to inflammatory responses, cardiovascular issues, and potential carcinogenic effects, highlighting the urgency of addressing this environmental challenge (Abedin et al., 2022; Narwal & Katyal, 2024)

Microplastics' pervasiveness extends beyond drinking water, infiltrating the human food chain through seafood consumption. Several studies have demonstrated that aquatic organisms, including fish and shellfish, bioaccumulate microplastics, leading to human exposure through dietary intake (Zhang et al., 2015; Zhu et al., 2024). The ingestion of microplastics by marine life raises concerns about potential trophic transfer and biomagnification, necessitating stringent monitoring and regulatory measures to mitigate their impact (Raffik et al., 2022; Sangkham et al., 2023). Despite growing awareness, the long term health effects of microplastic consumption remain poorly understood, warranting further investigation into their toxicological implications.

One of the most pressing challenges in addressing plastic waste contamination in urban water systems is the inadequate filtration efficiency of existing wastewater treatment technologies. While WWTPs play a crucial role in removing contaminants from municipal wastewater, studies suggest that current filtration methods are insufficient in capturing microplastic particles (Kumayon et al., 2023; Townsend et al., 2019). Consequently, untreated microplastics are continuously released into aquatic environments, contributing to the escalating pollution crisis. Enhancing WWTP capabilities through advanced filtration techniques is imperative to reducing the influx of microplastics into urban water bodies.

The variability of plastic waste accumulation across different geographic regions further complicates mitigation efforts. Socioeconomic factors play a crucial role in determining the effectiveness of plastic waste management strategies. In developing nations such as Mexico, inadequate waste management infrastructure exacerbates plastic pollution, resulting in substantial environmental degradation (Flores-Munguía et al., 2023). Conversely, wealthier regions with robust regulatory frameworks, such as parts of Europe, have implemented stringent waste management policies that mitigate plastic contamination in urban waterways (Xu et al., 2020; Zhao et al., 2015). Addressing these disparities requires context specific approaches that consider local socioeconomic conditions and infrastructure capabilities.

Microplastic exposure has been linked to endocrine disruption, gastrointestinal inflammation, and toxic chemical bioaccumulation, yet knowledge about long term health outcomes remains limited (Kosuth et al., 2018; Wibowo et al., 2021). Moreover, despite increasing attention, gaps remain in understanding the cumulative health effects of chronic exposure and the systemic inefficiencies in urban waste governance (Rochman et al., 2022).

Therefore, this review aims to:

- Identify the major sources and pathways of microplastic pollution in urban water systems,
- Analyze potential health risks associated with microplastic exposure, and
- Evaluate existing mitigation strategies, including technological, behavioral, and policy interventions.

The scope of this review encompasses a global perspective, with a particular focus on urban environments where plastic waste contamination is most pronounced. While research efforts have primarily centered on highly industrialized regions, this study also considers developing areas where plastic waste management remains a significant challenge. By examining the interplay between socioeconomic factors, regulatory frameworks, and technological innovations, this review seeks to provide a comprehensive understanding of plastic waste pollution and its broader implications for environmental sustainability and public health.

METHOD

This study employs a systematic review approach to examine the impact of plastic waste on water quality and public health in urban environments. A comprehensive literature search was conducted using major academic databases, including PubMed, Scopus, and Google Scholar, targeting peer reviewed studies published within the last ten years. The search strategy combined predefined keywords with Boolean operators to ensure precision and completeness. Keywords included "microplastics," "water quality," "public health," "urban contamination," "plastic waste," and "health impacts." Boolean search techniques, such as AND/OR operators, nesting, phrase searches, and wildcard characters, were applied to refine the search results and enhance specificity.

Selection criteria were established to include systematic reviews, meta analyses, and empirical studies that analyze the environmental and health implications of plastic waste in urban water systems. Studies were required to focus on plastic pollution's impact on water quality and public health, particularly in urban settings. Observational studies assessing microplastic concentrations in water supplies or their correlation with human health outcomes were prioritized. Research published in English or with accessible English translations was included to maintain consistency in analysis. Conversely, studies lacking empirical evidence, those centered on economic rather than biological or health outcomes, and research focusing solely on non urban areas without significant urban implications were excluded. Additionally, studies published over a decade ago were scrutinized for relevance, given the evolving understanding of microplastic pollution and its health consequences.

A multi stage screening process was employed to enhance reliability. Four independent reviewers assessed the studies, initially screening titles and abstracts before conducting full text evaluations to ensure methodological rigor and relevance. Key themes were synthesized to identify recurring patterns in the pathways of plastic contamination, its interactions with water quality, and associated health risks. The findings provide insights into the systemic factors driving plastic pollution in urban water systems and its broader public health implications.

RESULT AND DISCUSSION

The reviewed studies consistently identify urban rivers, lakes, and wastewater treatment plants (WWTPs) as hotspots for microplastic accumulation. Concentrations ranged widely, from hundreds to tens of thousands of particles per cubic meter, influenced by land use intensity, population density, and stormwater infrastructure (Riya et al., 2024; Tibbetts et al., 2018). Sediment samples from urban lakes further support this trend, showing consistent presence of synthetic fibers and fragmented plastics (Conard et al., 2023; Vaughan et al., 2017).

WWTPs are repeatedly highlighted as both a barrier and a contributor to pollution, depending on the technology in use. Studies confirm that advanced filtration methods significantly reduce microplastic effluents, yet many facilities continue to release hundreds of particles per liter due to conventional treatment limitations (Elkhatib & Oyanedel-Craver, 2020; Pratesi et al., 2021). Similarly, land use patterns, particularly in densely populated and industrialized zones, were correlated with higher contamination levels, aligning with findings from Conard et al. (2023) and Vidal et al. (2021) (Conard et al., 2023; Vidal et al., 2021).

The health risks associated with microplastic exposure are increasingly documented. The ingestion of microplastics through drinking water and food sources such as fish and shellfish has been observed across multiple regions (Kosuth et al., 2018; Wibowo et al., 2021). Beyond physical accumulation, microplastics have been shown to act as vectors for harmful contaminants including endocrine disrupting chemicals, persistent organic pollutants, and heavy metals (Z. Li et al., 2020; Rochman et al., 2022). These findings highlight a multidimensional threat that intersects environmental, technological, and biomedical domains.

Reported Concentrations of Microplastics in Urban Water Systems

Studies indicate that microplastic concentrations in urban rivers and lakes can reach alarmingly high levels. Research on urban river environments has found microplastic concentrations ranging from several hundred to tens of thousands of particles per cubic meter. For instance, Tibbetts et al. (2018) reported that peak contamination events led to concentrations exceeding 10,000 particles per cubic meter in certain sites(Tibbetts et al., 2018). Similarly, Riya et al. (2024) documented over

2,500 microplastics per cubic meter in rivers flowing through urban areas, with higher concentrations linked to increased urban runoff and poor waste management(Riya et al., 2024).

Urban lakes also exhibit significant microplastic contamination. Vaughan et al. (2017) found that sediment samples from urban lakes contained microplastic concentrations ranging from 500 to over 2,500 particles per liter, primarily composed of fragmented plastics and synthetic fibers(Vaughan et al., 2017). Conard et al. (2023) studied microplastic pollution in the Lake Ontario watershed, revealing high levels in surface waters and wastewater treatment discharges, emphasizing the need for continuous monitoring(Conard et al., 2023).

WWTPs also contribute significantly to microplastic pollution. Pratesi et al. (2021) found that urban tap water samples contained an average of 219 microplastic particles per 500 mL(Pratesi et al., 2021). Studies have shown that effluents from WWTPs contain 10 to 90 microplastic particles per liter, depending on treatment processes and influent concentrations (Flores-Munguía et al., 2023; Neves et al., 2023). These findings highlight the inefficiency of current wastewater treatment technologies in fully removing microplastics, underscoring the need for improved filtration systems.

Wastewater Treatment Plants and Plastic Waste Contamination

WWTPs play a dual role in urban microplastic contamination. While these facilities are intended to remove contaminants from wastewater, their inability to effectively filter microplastics has been well documented. Elkhatib and Oyanedel Craver (2020) found that although advanced treatment methods can remove a significant proportion of microplastics, many conventional filtration systems lack the capacity to target smaller particles(Elkhatib & Oyanedel-Craver, 2020). Consequently, large volumes of microplastics pass through and enter urban water systems (P. Li et al., 2022).

The type of treatment process employed at a WWTP influences the extent of microplastic release. Dris et al. (2015) found that over 50% of microplastics in WWTP influents remained in the sludge post treatment, highlighting the risk of further environmental contamination through sludge disposal(Dris, Imhof, et al., 2015). Additionally, stormwater events can overwhelm treatment plants, leading to direct discharges of untreated wastewater, including microplastics, into surrounding water bodies (Lorenzo et al., 2023).

Innovative filtration techniques and stricter regulations on wastewater discharge have been proposed as solutions to reduce microplastic contamination from WWTPs. Advanced membrane filtration, bioremediation techniques, and polymer degradation methods have shown promise in reducing microplastic loads in treated effluents (Leslie et al., 2017; Tiyanun et al., 2022). Effective implementation of these technologies is essential for mitigating the impact of microplastics on urban water systems.

Sources and Transport Mechanisms of Plastic Waste

Understanding the sources and transport mechanisms of plastic waste is essential for devising mitigation strategies. Several factors contribute to the widespread contamination of urban water systems with microplastics.

Sources of Plastic Pollution in Urban Environments

One of the most significant contributors to plastic pollution in urban settings is single use plastics. These include plastic bags, bottles, and packaging materials that frequently enter urban waterways due to improper disposal (Rochman et al., 2022). Poor waste management infrastructure exacerbates the problem, particularly in low income urban areas where recycling and collection systems are inefficient (Tadsuwan & Babel, 2021). Additionally, industrial processes and textile manufacturing contribute to microplastic pollution through the release of synthetic fibers and plastic particles (Abedin et al., 2022).

Stormwater runoff is another critical transport mechanism for microplastics. Rainfall events mobilize plastic debris from urban surfaces, directing it into drainage systems and ultimately into rivers and lakes (Vidal et al., 2021). The extent of microplastic transport via runoff is influenced by land use patterns, with densely populated commercial and residential zones contributing disproportionately higher loads of plastic waste (Tadsuwan & Babel, 2021).

Influence of Urban Land Use Patterns on Plastic Waste Accumulation

Urban land use patterns play a pivotal role in determining the accumulation and distribution of plastic waste. Highly populated areas with extensive commercial activity tend to generate significant amounts of plastic litter. Conard et al. (2023) found a strong correlation between urban land use intensity and microplastic concentrations in riverine systems, indicating that denser urban environments contribute significantly to microplastic pollution(Conard et al., 2023).

Conversely, urban green spaces and parks can mitigate plastic pollution by providing natural barriers that reduce runoff. However, research suggests that even these areas are susceptible to microplastic contamination due to atmospheric deposition and indirect transport from nearby urban activities (Ounjai et al., 2022).

Public Health Implications of Microplastic Exposure

The presence of microplastics in urban drinking water and food sources poses potential health risks. Research has demonstrated that humans are exposed to microplastics through multiple pathways, including drinking water, inhalation, and food consumption.

Microplastics in Drinking Water

Studies indicate that urban drinking water sources are widely contaminated with microplastics. Kosuth et al. (2018) estimated that individuals ingest an average of 5,800 microplastic particles annually, with drinking water accounting for the majority of this intake(Kosuth et al., 2018). Pratesi et al. (2021) found that all sampled urban tap water contained microplastics, with concentrations reaching 219 particles per 500 mL in some regions(Pratesi et al., 2021). These findings underscore the urgency of addressing microplastic contamination in municipal water supplies.

Microplastics in Food Sources

Marine organisms are known to bioaccumulate microplastics, creating a secondary pathway for human exposure through seafood consumption. Research has demonstrated that fish and shellfish from contaminated waters contain significant amounts of microplastics, raising concerns about food chain transmission (Zhang et al., 2015; Zhu et al., 2024). Bioaccumulation studies suggest that microplastics ingested by marine organisms may pose long term health risks to humans, emphasizing the need for stringent monitoring and regulatory measures (Raffik et al., 2022; Sangkham et al., 2023).

Chemical Contaminants Associated with Microplastics

Beyond their physical presence, microplastics act as carriers for hazardous chemical pollutants. Studies have detected persistent organic pollutants (POPs), heavy metals, and endocrine disrupting chemicals adsorbed onto microplastic surfaces (Alkan et al., 2021). These contaminants pose significant health risks, as ingestion of microplastics could facilitate the transfer of toxic substances into biological systems. Li et al. (2020) observed that chronic exposure to plastic associated chemicals could contribute to endocrine disorders, reproductive issues, and metabolic dysfunction (Elkhatib & Oyanedel-Craver, 2020).

Microplastic contamination in urban water systems presents significant environmental and public health challenges. High concentrations of microplastics have been reported in urban rivers, lakes, and WWTPs, with sources ranging from consumer waste and industrial processes to stormwater runoff. Inefficiencies in wastewater treatment further exacerbate microplastic pollution, necessitating urgent improvements in filtration technology. The health risks associated with microplastic ingestion through drinking water and food consumption underscore the need for comprehensive monitoring and regulatory interventions. Future research should focus on assessing long term health effects and developing effective mitigation strategies to reduce microplastic pollution in urban environments.

The study's findings corroborate and expand upon existing theories regarding environmental pollution in urban ecosystems. Specifically, the presence of microplastics in WWTP effluents supports the theory of *technological externality*, wherein outdated infrastructure inadvertently contributes to environmental degradation (Townsend et al., 2019). The inability of conventional treatment systems to filter microplastics aligns with Elkhatib and Oyanedel Craver's (2020) analysis, emphasizing the technological lag in responding to emerging pollutants (Elkhatib & Oyanedel-Craver, 2020).

The link between land use and contamination further validates *urban ecological systems theory*, suggesting that anthropogenic pressures such as infrastructure density and waste output disproportionately impact ecosystem resilience (Vidal et al., 2021). Moreover, the association of microplastics with hazardous chemicals reinforces *toxicological pathway theory*, where pollutants are not only carriers of harm themselves but also conduits for other environmental toxins (Abedin et al., 2022; Z. Li et al., 2020).

The increasing documentation of microplastic exposure via drinking water and food suggests a need for a revised *public health framework*, one that integrates environmental exposure assessment with chronic disease risk. The presence of microplastics in gastrointestinal tracts and consumables indicates systemic exposure that may alter immune responses and endocrine functions (Kosuth et al., 2018; Wibowo et al., 2021). This underscores the importance of interdisciplinary integration between environmental sciences, medicine, and public policy.

Recent Findings on Microplastic Ingestion

Recent studies have shown that humans are increasingly exposed to microplastics through drinking water and food sources, validating longstanding concerns about the health implications of plastic pollution. For example, Li et al. (2024) indicate that microplastics infiltrate urban drinking water supplies, emphasizing the potential health risks associated with chronic consumption(S. Li et al., 2024). Similarly, the prevalence of microplastics found in marine organisms, as highlighted by Vidal et al. (2021), reinforces the theory that microplastics can enter food webs, ultimately affecting human health through dietary intake(Vidal et al., 2021). Wibowo et al. (2021) demonstrated the detection of microplastics in consumables associated with a farming community, aligning with previous studies suggesting that pollutants in the environment can find their way into food sources(Wibowo et al., 2021).

Findings from research on bottled water and tap water contamination further reinforce the existing body of knowledge. Kosuth et al. (2018) documented high levels of contamination in drinking water, raising concerns regarding potential impacts on human health through direct ingestion(Kosuth et al., 2018). This implicates not only environmental pollution but also suggests that fundamental shifts in urban waste management policies are urgently required to mitigate the risks associated with microplastic contamination in potable water.

Health Risks from Associated Chemical Contaminants

In conjunction with physical microplastic ingestion, the potential health risks arising from the chemical contaminants adsorbed onto microplastics have been highlighted in recent literature. Chemicals such as phthalates and persistent organic pollutants (POPs) are commonly associated with plastic waste and have documented endocrine disrupting properties. Studies by Abedin et al. (2022) and Rochman et al. (2022) corroborate existing theories that the leaching of these harmful chemicals poses significant risks to human health, including hormonal imbalances and reproductive issues(Abedin et al., 2022; Rochman et al., 2022).

Research indicates that microplastics can serve as vectors for chemical contamination, aligning with prior hypotheses linking plastic pollution to adverse health outcomes. The findings on chemical contaminants in urban water bodies, as illustrated by evaluations of wastewater treatment plants and their effluents, support theories that the breakdown products of plastics can have deeper ecological and health ramifications than initially anticipated (Conard et al., 2023; Tadsuwan & Babel, 2021). Current discussions surrounding potential bioaccumulation of these chemicals through the food chain highlight an evolving understanding of the health risks associated with plastic pollution.

Land Use Patterns and Transport Mechanisms

The exploration of how urban land use affects microplastic contamination lends insight into the broader discourse on environment and public health. Research has consistently shown that areas with high population density contribute more significantly to microplastic pollution due to increased waste production and inadequate management (Rochman et al., 2022; Tiyanun et al., 2022). The study by Vidal et al. (2021) further elaborates on how watershed land use patterns influence accumulation and transport mechanisms of microplastics into waterways, validating earlier assertions that human activities profoundly impact urban water quality(Vidal et al., 2021).

The recent focus on how microplastics from various land use settings including residential, industrial, and agricultural correlate with varying levels of contamination has revealed a nuanced relationship between urban development and public health. Studies indicate that agricultural runoff can contribute significantly to microplastic pollution, supporting theories of interconnectivity between urban and rural environments when discussing public health risks (Vidal et al., 2021).

COVID 19 and Recent Contextual Changes

The global COVID 19 pandemic has heavily influenced plastic use, particularly through increased reliance on personal protective equipment (PPE) and its consequent impacts on plastic pollution. Research highlighting the escalation of microplastic pollution due to PPE waste, as seen in studies conducted by Wang et al. (2022) and Abedin et al. (2022), raises important considerations regarding the emerging patterns in plastic consumption and the refined understanding of microplastic sources in urban environments amid the pandemic(Abedin et al., 2022; Wang et al., 2022). This paradigm shift poses urgent questions about how public health policies must adapt to new realities of plastic pollution driven by unprecedented levels of single use plastics during health crises.

Limitation

While this study presents a comprehensive review of microplastic contamination in urban water systems, several limitations should be acknowledged. The variability in methodologies used across different studies introduces challenges in directly comparing microplastic concentrations. Additionally, the lack of standardized protocols for sampling and quantification may affect the accuracy of reported values. The long term health effects of microplastic exposure remain insufficiently understood, necessitating further research with controlled experimental designs. Moreover, the role of emerging contaminants associated with microplastics, such as antibiotic resistant bacteria and viruses, has yet to be thoroughly investigated. Future research should aim to address these gaps through interdisciplinary collaboration and advancements in analytical techniques.

Implication

The findings of this study have significant implications for public health policies, environmental regulations, and urban waste management strategies. Policymakers should consider implementing stricter regulations on plastic production and disposal to reduce the prevalence of microplastic contamination in water systems. Additionally, improvements in wastewater treatment technologies, such as the integration of advanced filtration methods, are crucial for mitigating microplastic pollution. Public awareness campaigns should also be prioritized to educate communities on sustainable waste disposal practices. Future research should focus on long term epidemiological studies to better understand the potential health risks of chronic microplastic exposure, as well as investigations into effective bioremediation techniques for removing microplastics from aquatic environments.

CONCLUSION

This narrative review highlights the pervasive nature of microplastic contamination in urban water systems and its escalating implications for environmental and public health. It contributes to the literature by integrating evidence across environmental monitoring, wastewater management, and human exposure pathways. Key findings reveal that ineffective filtration in WWTPs, urban runoff, and inadequate waste management are the primary contributors to microplastic infiltration into both ecological and human systems.

By aligning these findings with established theories, this review underscores the urgency of addressing microplastic pollution through integrated urban environmental governance. Future research should prioritize standardization in detection methods, cross sector health impact assessments, and scalable innovations in remediation technology. Furthermore, policy interventions must be context specific and equity driven to effectively mitigate both the environmental and human health dimensions of this global challenge.

REFERENCES

Abedin, Md. J., Khandaker, M. U., Uddin, Md. R., Karim, M. R., Ahamad, M., Islam, Md. A., Arif, A. M., Hossain, S. M. M., Sulieman, A., & Idris, A. M. (2022). Amassing the Covid-19 Driven PPE Wastes in the Dwelling Environment of Chittagong Metropolis and Associated Implications. *Chemosphere*, *297*, 134022. https://doi.org/10.1016/j.chemosphere.2022.134022

Alkan, N., Alkan, A., Castro-Jiménez, J., Royer, F., Papillon, L., Ourgaud, M., & Sempéré, R. (2021). Environmental Occurrence of Phthalate and Organophosphate Esters in Sediments

Across the Gulf of Lion (NW Mediterranean Sea). *The Science of the Total Environment*, *760*, 143412. https://doi.org/10.1016/j.scitotenv.2020.143412

Axelsson, C., & Sebille, E. v. (2017). Prevention Through Policy: Urban Macroplastic Leakages to the Marine Environment During Extreme Rainfall Events. *Marine Pollution Bulletin*, *124*(1), 211–227. https://doi.org/10.1016/j.marpolbul.2017.07.024

Conard, W. M., O'Reilly, K. E., Hartlage, C. S., & Lamberti, G. A. (2023). Widespread Microplastic Pollution in Indiana, <scp>USA</Scp>, Rivers. *River Research and Applications*, *39*(10), 2092–2101. https://doi.org/10.1002/rra.4204

Dris, R., Gaspéri, J., Rocher, V., Saad, M., Renault, N., & Tassin, B. (2015). Microplastic Contamination in an Urban Area: A Case Study in Greater Paris. *Environmental Chemistry*, *12*(5), 592. https://doi.org/10.1071/en14167

Dris, R., Imhof, H. K., Sánchez, W., Gaspéri, J., Galgani, F., Tassin, B., & Laforsch, C. (2015). Beyond the Ocean: Contamination of Freshwater Ecosystems With (Micro-)Plastic Particles. *Environmental Chemistry*, *12*(5), 539. https://doi.org/10.1071/en14172

Elkhatib, D., & Oyanedel-Craver, V. (2020). A Critical Review of Extraction and Identification Methods of Microplastics in Wastewater and Drinking Water. *Environmental Science & Technology*, *54*(12), 7037–7049. https://doi.org/10.1021/acs.est.9b06672

Flores-Munguía, E. J., Rosas-Acevedo, J. L., Ramírez-Hernández, A., Aparicio-Saguilán, A., Carmona, R. M. B., & Violante-González, J. (2023). Release of Microplastics From Urban Wastewater Treatment Plants to Aquatic Ecosystems in Acapulco, Mexico. *Water*, *15*(20), 3643. https://doi.org/10.3390/w15203643

Kosuth, M., Mason, S. A., & Wattenberg, E. V. (2018). Anthropogenic Contamination of Tap Water, Beer, and Sea Salt. *Plos One*, *13*(4), e0194970. https://doi.org/10.1371/journal.pone.0194970

Kumayon, I., Prajapati, S., Brinkmann, M., & Kahan, T. T. (2023). Levels and Composition of Microplastics and Microfibers in the South Saskatchewan River and Stormwater Retention Ponds in the City of Saskatoon, Canada. *Environmental Science and Pollution Research*, *30*(42), 95367–95375. https://doi.org/10.1007/s11356-023-29077-5

Leslie, H. A., Brandsma, S., Velzen, M. J. M. v., & Vethaak, A. D. (2017). Microplastics en Route: Field Measurements in the Dutch River Delta and Amsterdam Canals, Wastewater Treatment Plants, North Sea Sediments and Biota. *Environment International*, *101*, 133–142. https://doi.org/10.1016/j.envint.2017.01.018

Li, P., Chen, B., Deveaux, G., Luo, Y., Tao, W., Li, W., Wen, J., & Yuan, Z. (2022). Cross-Verification of COVID-19 Information Obtained From Unofficial Social Media Accounts and Associated Changes in Health Behaviors: Web-Based Questionnaire Study Among Chinese Netizens. *Jmir Public Health and Surveillance*, *8*(5), e33577. https://doi.org/10.2196/33577

Li, S., Stevens, C., & Jiang, C. Z. K. (2024). Impact of the COVID-19 Pandemic on Canadian Performing and Creative Artists: An Interpretive Descriptive Study Using the Social-

Ecological Model. *Plos One*, *19*(9), e0310369. https://doi.org/10.1371/journal.pone.0310369

Li, Z., Li, C., Zhang, X., Tang, S., Yang, H., Cui, X., & Huang, L. (2020). Policies and Problems of Modernizing Ethnomedicine in China: A Focus on the Yi and Dai Traditional Medicines of Yunnan Province. *Evidence-Based Complementary and Alternative Medicine*, *2020*(1). https://doi.org/10.1155/2020/1023297

Liu, Y., Li, Z., He, Y.-T., Li, Y., & Sheng, G. (2023). Antibiotic Resistomes in Face-Mask Biofilm Along an Urban River: Multiple Drivers and Co-Occurrence With Human Opportunistic Pathogens. *Journal of Hazardous Materials*, *455*, 131587. https://doi.org/10.1016/j.jhazmat.2023.131587

Lorenzo, T. D., Cabigliera, S. B., Martellini, T., Laurati, M., Chelazzi, D., Galassi, D. M. P., & Cincinelli, A. (2023). Ingestion of Microplastics and Textile Cellulose Particles by Some Meiofaunal Taxa of an Urban Stream. *Chemosphere*, *310*, 136830. https://doi.org/10.1016/j.chemosphere.2022.136830

Narwal, N., & Katyal, D. (2024). The Abundance and Analytical Characterization of Microplastics in the Surface Water of <scp>Haryana</Scp>, <scp>India</Scp>. *Microscopy Research and Technique*, *88*(1), 139–153. https://doi.org/10.1002/jemt.24657

Neves, R. A. F., Guimarães, T. B., & Santos, L. N. d. (2023). First Record of Microplastic Contamination in the Non-Native Dark False Mussel Mytilopsis Leucophaeata (Bivalvia: Dreissenidae) in a Coastal Urban Lagoon. *International Journal of Environmental Research and Public Health*, *21*(1), 44. https://doi.org/10.3390/ijerph21010044

Ounjai, K., Boontanon, S. K., Piyaviriyakul, P., Tanaka, S., & Fujii, S. (2022). Assessment of Microplastic Contamination in the Urban Lower Chao Phraya River of Bangkok City, Thailand. *Journal of Water and Health*, *20*(8), 1243–1254. https://doi.org/10.2166/wh.2022.130

Pratesi, C. B., Almeida, M. A. A. L. S., Paz, G. S. C., Teotonio, M. H. R., Gandolfi, L., Pratesi, R., Hecht, M., & Zandonadi, R. P. (2021). Presence and Quantification of Microplastic in Urban Tap Water: A Pre-Screening in Brasilia, Brazil. *Sustainability*, *13*(11), 6404. https://doi.org/10.3390/su13116404

Raffik, R., Sharma, H., Aliyu, D. S., Bondinuba, F. K., Kannadasan, B., & Ismail, R. (2022). Utilization of E-Waste as a Concrete Mixture for Infrastructural Buildings. *Materials Science Forum*, *1068*, 47–53. https://doi.org/10.4028/p-z09ao7

Riya, K. K., Anisuzzaman, M., Azad, Md. A. S., Nur, A.-A. U., Banik, P., Paray, B. A., Arai, T., Yu, Q., & Hossain, M. B. (2024). Characteristics, Contamination Levels, and Ecosystem Risk Assessment of Microplastics in Surface Water of a Highly Urbanized River From a Developing Country. *Acs Omega*, *9*(52), 50922–50932. https://doi.org/10.1021/acsomega.4c01528

Rochman, C. M., Grbić, J., Earn, A., Helm, P. A., Hasenmueller, E. A., Trice, M., Munno, K., Frond, H. D., Djuric, N., Santoro, S., Kaura, A., Denton, D. L., & Teh, S. J. (2022). Local Monitoring Should Inform Local Solutions: Morphological Assemblages of Microplastics

Are Similar Within a Pathway, but Relative Total Concentrations Vary Regionally. *Environmental Science & Technology*, *56*(13), 9367–9378. https://doi.org/10.1021/acs.est.2c00926

Sánchez, W., Bender, C., & Porcher, J. (2014). Wild Gudgeons (Gobio Gobio) From French Rivers Are Contaminated by Microplastics: Preliminary Study and First Evidence. *Environmental Research*, *128*, 98–100. https://doi.org/10.1016/j.envres.2013.11.004

Sangkham, S., Islam, Md. A., Adhikari, S., Kumar, R., Sharma, P., Sakunkoo, P., Bhattacharya, P., & Tiwari, A. (2023). Evidence of Microplastics in Groundwater: A Growing Risk for Human Health. *Groundwater for Sustainable Development*, *23*, 100981. https://doi.org/10.1016/j.gsd.2023.100981

Tadsuwan, K., & Babel, S. (2021). Microplastic Contamination in a Conventional Wastewater Treatment Plant in Thailand. *Waste Management & Research the Journal for a Sustainable Circular Economy*, *39*(5), 754–761. https://doi.org/10.1177/0734242x20982055

Tibbetts, J., Krause, S., Lynch, I., & Smith, G. H. S. (2018). Abundance, Distribution, and Drivers of Microplastic Contamination in Urban River Environments. *Water*, *10*(11), 1597. https://doi.org/10.3390/w10111597

Tiyanun, E., Kooltheat, N., Katzenmeier, G., & Srisuphanunt, M. (2022). Quality Awareness of Tap Drinking Water Among Bangkok City Residents and Implications for Sustainable Supply Management. *Water Science & Technology Water Supply*, *22*(5), 5549–5557. https://doi.org/10.2166/ws.2022.112

Townsend, K., Lu, H.-C., Sharley, D., & Pettigrove, V. (2019). Associations Between Microplastic Pollution and Land Use in Urban Wetland Sediments. *Environmental Science and Pollution Research*, *26*(22), 22551–22561. https://doi.org/10.1007/s11356-019-04885-w

Vaid, M., Sarma, K., & Gupta, A. K. (2024). Urban Drainage Channels as a Pathway for Microplastics in Riverine Systems: A Case Study of Delhi, India. *Water Science & Technology*, *90*(2), 563–577. https://doi.org/10.2166/wst.2024.181

Vaughan, R., Turner, S., & Rose, N. L. (2017). Microplastics in the Sediments of a UK Urban Lake. *Environmental Pollution*, *229*, 10–18. https://doi.org/10.1016/j.envpol.2017.05.057

Vidal, C., Lozoya, J. P., Tesitore, G., Goyenola, G., & Mello, F. T. d. (2021). Incidence of Watershed Land Use on the Consumption of Meso and Microplastics by Fish Communities in Uruguayan Lowland Streams. *Water*, *13*(11), 1575. https://doi.org/10.3390/w13111575

Wang, C., Lin, G., Lin, Y., Chen, W., & Wu, W. (2022). Occupational Health Surveillance and Detection of Emerging Occupational Diseases Among Taiwan Farmers, Through Analysis of National-based Farmers' and Medico-administrative Databases. *American Journal of Industrial Medicine*, *66*(1), 85–93. https://doi.org/10.1002/ajim.23443

Wibowo, A. T., Nugrahapraja, H., Wahyuono, R. A., Islami, I., Haekal, M. H., Fardiansyah, Y., Sugiyo, P. W. W., Putro, Y. K., Fauzia, F. N., Santoso, H., Götz, F., Tangahu, B. V, & Luqman, A. (2021). Microplastic Contamination in the Human Gastrointestinal Tract and Daily Consumables Associated With an Indonesian Farming Community. *Sustainability*, *13*(22), 12840. https://doi.org/10.3390/su132212840

Xu, Y., Chan, F. K. S., He, J., Johnson, M. F., Gibbins, C., Kay, P., Stanton, T. H., Xu, Y., Li, G., Feng, M., Paramor, O. A. L., Yu, X., & Zhu, Y. (2020). A Critical Review of Microplastic Pollution in Urban Freshwater Environments and Legislative Progress in China: Recommendations and Insights. *Critical Reviews in Environmental Science and Technology*, *51*(22), 2637–2680. https://doi.org/10.1080/10643389.2020.1801308

Zhang, L., Liu, J., Liu, H., Wan, G., & Zhang, S. (2015). The Occurrence and Ecological Risk Assessment of Phthalate Esters (PAEs) in Urban Aquatic Environments of China. *Ecotoxicology*, *24*(5), 967–984. https://doi.org/10.1007/s10646-015-1446-4

Zhao, S., Zhu, L., & Li, D. (2015). Microplastic in Three Urban Estuaries, China. *Environmental Pollution*, *206*, 597–604. https://doi.org/10.1016/j.envpol.2015.08.027

Zhu, X., Zhang, Y., Zhu, Y., Guo, Y., Zhang, Y., & Wen, B. (2024). Realization Path and Connotation of the Healthy China Strategy: Macroscopic Perspective of Dietary Structure and the Entry of Individual Health Consciousness. *BMC Public Health*, *24*(1). https://doi.org/10.1186/s12889-024-18557-z