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Impact of Latyan Dam and Urban Wastewater Discharge on the Distribution and Species Composition of Macrobenthos in the Jajrood River

Maria ZamaniAlaei[1]*

[1]Department of Biological Sciences, Faculty of Medical Sciences, Islamic Azad University, Tehran Medical Sciences Branch, Tehran, Iran.

***Corresponding Author**

E-mail: mariazamanialaei@gmail.com

ABSTRACT

This study investigates the changes in the distribution and species composition of macrobenthic communities in the Jajrood River in response to two major anthropogenic factors: the construction of the Latyan Dam and the discharge of urban wastewater. Seasonal sampling was conducted at five selected stations during the fall and winter of 2014 and the spring and summer of 2015. Stations located upstream of the dam represented relatively natural conditions, while stations downstream of the dam and within the urban area reflected regions influenced by human activities. Results indicated that downstream of the dam and within the urban zone, the density of pollution-tolerant species such as Chironomidae and Tubificidae increased significantly, whereas overall species diversity and the presence of pollution-sensitive taxa such as Ephemeroptera declined. These findings highlight the substantial impacts of dam construction and urban effluents on riverine benthic ecosystems.

Keywords: Macrobenthos; Dam impact; Urban wastewater; River ecology; Species diversity.

Introduction

Freshwater ecosystems are among the most sensitive and dynamic environments, particularly vulnerable to anthropogenic disturbances such as dam construction and urbanization. Among biological communities, macrobenthic invertebrates are widely recognized as effective indicators of ecological integrity due to their limited mobility, varying sensitivity to environmental stressors, and significant roles in aquatic food webs and nutrient cycling.

Dams, while essential for water supply, flood control, and hydropower, fundamentally alter riverine hydrology, sediment transport, and habitat continuity. These modifications often result in downstream ecological consequences, including shifts in community structure, declines in biodiversity, and favoring of pollution-tolerant species. Similarly, the discharge of untreated or partially treated urban wastewater introduces organic matter, nutrients, and contaminants into river systems, further exacerbating stress on aquatic communities.

The Jajrood River, located in the Alborz Mountains of Iran, serves as a critical water source for Tehran's drinking water and agricultural irrigation. The construction of the Latyan Dam and the subsequent expansion of urban settlements along its banks have imposed significant ecological pressures on this river system. Preliminary observations suggest notable differences in macrobenthic assemblages between upstream and downstream reaches, as well as between less-impacted and highly urbanized areas.

Recent studies have emphasized that river regulation by dams can cause profound changes in flow regimes, sediment transport, and riparian ecosystems, often resulting in a decline in biodiversity and a shift toward more tolerant species (Nilsson & Berggren, 2000; Poff & Zimmerman, 2010). Similarly, urbanization and associated wastewater discharges lead to the so-called "urban stream syndrome," characterized by altered hydrology, reduced habitat quality, and biological degradation of river ecosystems (Walsh et al., 2005).

The primary objectives of this study are to:

(1) assess the impacts of the Latyan Dam on the distribution and composition of macrobenthic species,

(2) evaluate the influence of urban wastewater discharge on benthic diversity and abundance, and (3) identify spatial patterns of pollution-tolerant and pollution-sensitive taxa along the Jajrood River.

Materials and Methods

The Jajrood River originates from the Alborz mountain range in northern Iran and flows southwest towards the Latyan Dam before continuing through semi-urban and urban areas. Five sampling stations were selected to capture a gradient of environmental impact. Seasonal sampling was conducted during fall and winter of 2014 and spring and summer of 2015.

Sampling Stations and Geographical Locations

In addition to biological sampling, water temperature and dissolved oxygen were measured in situ using portable meters. Sediment composition and turbidity were visually inspected at each station.

Diversity Indices Calculation

The Shannon-Wiener diversity index (H') and Margalef's richness index (d) were used to assess the diversity and richness of macrobenthic communities.

Shannon-Wiener Diversity Index (SWI)

$H' = -\Sigma (pi \times \log pi)$

where:

- H' = Shannon-Wiener Index
- pi = proportion of individuals belonging to the i-th species
- S = total number of species

Margalef's Richness Index (MRI)

$d = (S - 1) / \log(N)$

where:

- d = Margalef's Richness Index
- S = total number of species
- N = total number of individuals

Table 1. Sampling stations and their geographical locations.

Station	Location	Longitude	Latitude
S1	Upstream of the Jajrood River	51.696541° E	35.748943° N
S2	2 km downstream from S1	51.695940° E	35.746222° N
S3	Before the Latyan Dam	51.685852° E	35.794904° N
S4	After the Latyan Dam	51.692940° E	35.765840° N
S5	Within the city of Jajrood	51.694109° E	35.740990° N

Results and Discussion

A total of 19 species belonging to 5 taxonomic orders and 15 families were identified. Upstream stations exhibited higher species richness and abundance of pollution-sensitive taxa. Downstream and urban stations showed dominance of pollution-tolerant taxa.

Diversity Indices at Different Stations

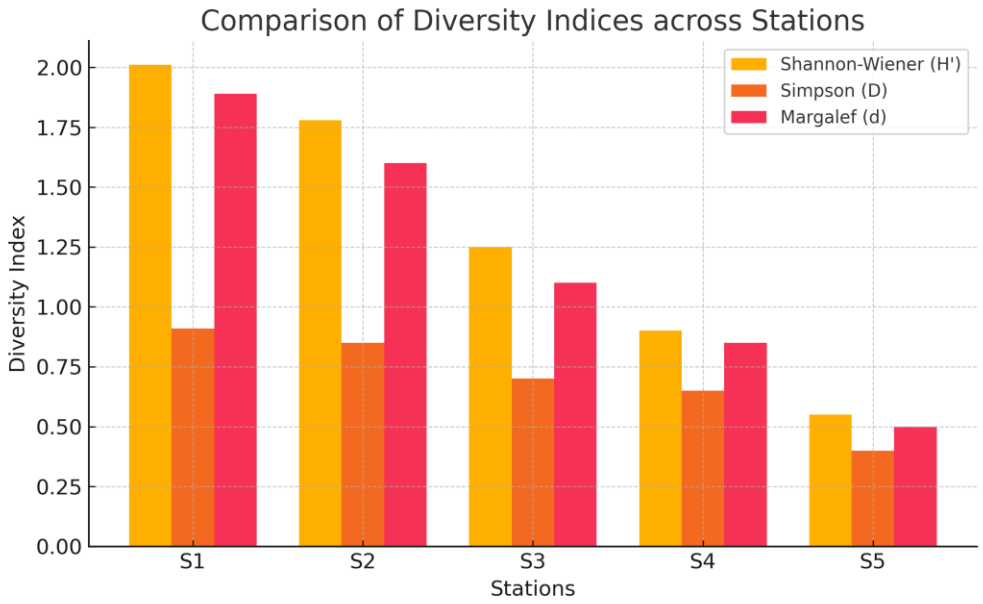

Figure 1. Comparison of Diversity Indices across Stations.

Table 2. Diversity indices (Shannon-Wiener, Simpson, Margalef) across different stations during spring.

Station	Season	Shannon-Wiener (H')	Simpson (D)	Margalef (d)
S1	Spring	2.01	0.91	1.89
S2	Spring	1.78	0.85	1.60
S3	Spring	1.25	0.70	1.10
S4	Spring	0.90	0.65	0.85
S5	Spring	0.55	0.40	0.50

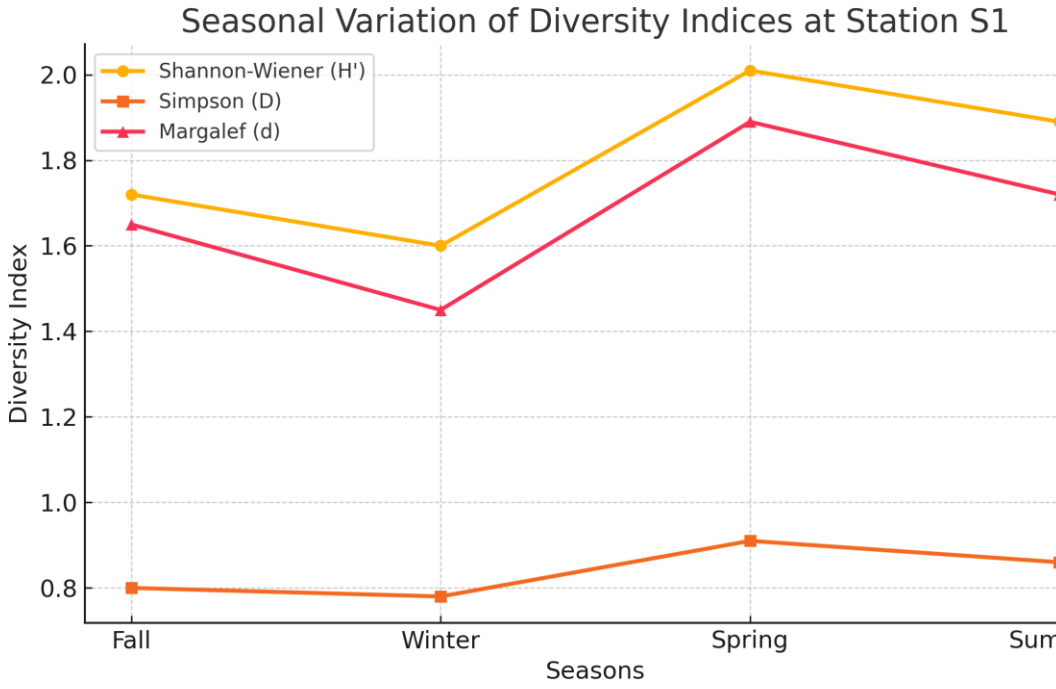

Figure 2. Seasonal Variation of Diversity Indices at Station S1

The observed changes in macrobenthic community composition and diversity have important implications for water resource management in the Jajrood River and similar systems. Policymakers in Tehran and other urban regions relying on dammed river systems should consider these ecological indicators when planning infrastructure projects or wastewater management policies. Implementing ecological flow regimes and upgrading wastewater treatment plants can significantly reduce stress on aquatic ecosystems and improve biodiversity outcomes. Moreover, incorporating biomonitoring programs using macrobenthic organisms can provide an effective early-warning system for assessing the health of river ecosystems and guiding adaptive management strategies.

The results of this study demonstrate the substantial impacts of anthropogenic activities, particularly dam construction and urban wastewater discharge, on the distribution, diversity, and community composition of macrobenthos in the Jajrood River.

The upstream stations (S1 and S2) exhibited relatively high species richness and diversity, characterized by the presence of pollution-sensitive taxa such as Baetis spp. and Gomphus spp. These findings align with previous studies indicating that pristine river segments with minimal human disturbance tend to support diverse benthic communities composed predominantly of sensitive species (Allan & Castillo, 2007; Armitage et al., 1983).

However, a notable shift in macrobenthic community structure was observed downstream of the Latyan Dam and within the urbanized area (S4 and S5). These stations were characterized by a dominance of pollution-tolerant species such as Chironomus spp. and Tubificidae. This pattern is consistent with the well-documented “replacement of sensitive taxa by tolerant species” in response to increased pollution, sedimentation, and habitat alteration (Bonada et al., 2006; Rosenberg & Resh, 1993).

The Latyan Dam appears to play a dual role in modifying the ecological dynamics of the river: by reducing natural flow variability and promoting sediment deposition downstream (Bunn & Arthington, 2002; Nilsson & Berggren, 2000), and by disrupting longitudinal connectivity that hinders the migration of sensitive taxa. Similarly, urban wastewater discharge exacerbates nutrient enrichment and organic pollution (Walsh et al., 2005), favoring tolerant species and reducing ecosystem health.

The cumulative impacts of altered hydrology and increased nutrient and contaminant inputs represent serious threats not only to local biodiversity but also to human water security, as highlighted in global assessments (Vörösmarty et al., 2010). Protecting the ecological integrity of rivers like the Jajrood is thus essential for maintaining ecosystem services critical to human well-being (Zhang et al., 2023; Zulriastin, 2003; Zamani Alaei, 2025a; Zamani Alaei, 2025b).

Conclusion

This study provides critical insights for environmental policy and water resource management. For decision-makers in Tehran and similar urbanizing regions, the results emphasize the urgent need to monitor aquatic biodiversity, upgrade wastewater infrastructure, and incorporate ecological flow considerations into dam operations. Such measures are essential for maintaining river health, safeguarding ecosystem services, and achieving long-term sustainability.

This study demonstrated that dam construction and urbanization significantly impact the diversity and composition of macrobenthic communities in the Jajrood River. Pollution-tolerant species dominated downstream and urban areas, while sensitive species thrived upstream. Effective management strategies are urgently needed to mitigate these impacts and ensure the ecological sustainability of freshwater systems.

Recommendations

- Implement advanced wastewater treatment systems.
- Modify dam release schedules to simulate natural flow regimes.
- Establish riparian buffer zones.
- Conduct regular biological monitoring using macrobenthic indicators.
- Raise public awareness and involve stakeholders in river conservation.
- Promote further research on long-term impacts of anthropogenic activities on aquatic biodiversity.

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Ethics Statement: None

References

Allan, J. D., & Castillo, M. M. (2007). *Stream ecology: Structure and function of running waters*. Springer.

Arimoro, F. O. (2011). Ecology and diversity of aquatic macroinvertebrates of the Ethiope River, Nigeria. *International Journal of Ecology and Environmental Sciences, 37*(1), 57–63.

Armitage, P. D., Moss, D., Wright, J. F., & Furse, M. T. (1983). The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites. *Water Research, 17*(3), 333–347.

Bonada, N., Prat, N., Resh, V. H., & Statzner, B. (2006). Developments in aquatic insect biomonitoring: A comparative analysis of recent approaches. *Annual Review of Entomology, 51*, 495–523.

Bunn, S. E., & Arthington, A. H. (2002). Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management, 30*(4), 492–507.

Cranston, P. S. (1996). *Identification guide to the Chironomidae (Diptera) of Australia*. CSIRO Publications.

Nilsson, C., & Berggren, K. (2000). Alterations of riparian ecosystems caused by river regulation. *BioScience, 50*(9), 783–792.

Poff, N. L., & Zimmerman, J. K. H. (2010). Ecological responses to altered flow regimes: A literature review to inform the science and management of environmental flows. *Freshwater Biology, 55*(1), 194–205.

Rosenberg, D. M., & Resh, V. H. (1993). *Freshwater biomonitoring and benthic macroinvertebrates*. Chapman & Hall.

Sahidin, S., Wahyuni, S., & Wibowo, T. A. (2018). Seasonal variation of macroinvertebrate diversity and water quality assessment in river ecosystems. *Asian Journal of Water, Environment and Pollution, 15*(2), 1–8.

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., et al. (2010). Global threats to human water security and river biodiversity. *Nature, 467*, 555–561.

Walsh, C. J., Roy, A. H., Feminella, J. W., Cottingham, P. D., Groffman, P. M., & Morgan, R. P. (2005). The urban stream syndrome: Current knowledge and the search for a cure. *Journal of the North American Benthological Society, 24*(3), 706–723.

Zhang, Y., Xu, J., & Xia, X. (2023). Impacts of hydrological variations and pollution on benthic communities in urban rivers. *Ecological Indicators, 150*, 110175.

Zulriastin, D. (2003). *Aquatic pollution and its effect on benthic communities*. Indonesian Institute of Sciences.

Zamani Alaei, M. (2025). Seasonal identification of macrobenthos in the Jajrood River. *TMP Universal Journal of Research and Review Archives, 4*(2). Retrieved from https://tmp.twistingmemoirs.com/index.php/ujrra/article/view/155

Zamani Alaei, M. Z. (2025). Seasonal identification of macrobenthos in the Jajrood River. *TMP Universal Journal of Research and Review Archives, 4*(2). https://doi.org/10.69557/ujrra.v4i2.155