VNU Journal of Science: Earth and Environmental Sciences

Journal homepage: https://js.vnu.edu.vn/EES

Original Article

Characteristics of Plastic Waste on Rivers in Hai Phong City, Vietnam

Duong Thanh Nghi[1,*], Do Thu Huong[2], Pham Quoc Hai[2],
Dinh Hai Ngoc[1], Nguyen Dac Ve[1], Nguyen Thi Thu Ha[1],
Bui Thi Mai Huyen[1], Bui Van Vuong[1], Dang Hoai Nhon[1], Tran Van Quy[3]

[1]*Institute of Science and Technology for Energy and Environment,*
A30, No. 18 Hoang Quoc Viet, Nghia Do, Hanoi, Vietnam
[2]*Office of Environmental Management, Department of Agriculture and Environment,*
4th floor, Building N of City Administrative Center, Southern Song Cam River Urban Area,
Thuy Nguyen, Hai Phong, Vietnam
[3]*Faculty of Environmental Sciences, VNU University of Science,*
334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam

Abtract: In this research, we conducted three complementary survey methods including visual observation, underwater sampling with nets, and riverside sampling with quantitative plots with six plastic waste monitoring stations on the river in Hai Phong city: An Thai, Tram Bac, Kien An, Bui Vien, Rao, Tan Vu Lach Huyen to study the plastic waste on rivers. We found the most concentrated plastic waste in the city was at Bui Vien station (1,239 objects 33.05%) and Rao station (938 objects, 25.05%). During the four months of monitoring plastic waste on the rivers in Hai Phong city (November, December of 2024 and June, August of 2025), the total amount of plastic waste collected was 3,749 objects. The amount of plastic waste in the dry season is higher than in the wet season, respectively 54.41% and 45.59%. In the nine groups of plastic waste monitored, nylon bags and packaging plastic bags account for the majority, at 24.03% and 35.48% respectively. Plastic waste with low proportion is beverage and food waste (6.68%), hygiene and sanitary waste (1.48%), fishing net and aquaculture waste (2.97%), miscellaneous items waste (8.13%), items of unidentifiable origin waste (13.44%), and other types of plastic waste (1.03%). The total amount of plastic waste will be highly concentrated in the dry season, accumulating in the urban center over

_____
* Corresponding author.
  E-mail address: nghidt@istee.vast.vn

the years and the number of types of plastic waste that need to be prioritized for treatment and management so that the urban can develop in the direction of a green, clean, smart, cultural and modern urban area.

Keywords: Plastic waste, Hai Phong city, Environmental Pollution, Vietnam.

1. Introduction

Plastic waste, including microplastic waste and large plastic waste, negatively affects the environmental landscape and has adverse impacts on ecosystem and human health. Reducing plastic waste will bring huge benefits in landscape protection, tourism development and protecting the habitat of marine life [1]. The Prime Minister signed Decision No. 1746/QD-TTg dated December 4, 2019 on promulgating the National Action Plan on Ocean Plastic Waste Management to 2030. The Plan aims to reduce ocean plastic waste by 50% in 2025, 75% in 2030, and eliminate single- use plastics from coastal tourist destinations and marine protected areas by 2030 [2]. Accordingly, the Ministry of Agriculture and Environment is making efforts to improve understanding of the issue of plastic waste in order to develop policies and investment programs on plastic management. The study conducted standardized surveys at riverside and coastal sites to determine the composition of the 10 most common types of plastic waste [3]. Hai Phong urban area is facing an increasingly big challenge in environmental protection and solid waste treatment. Every day, the city generates more than 2,000 tons of waste, putting great pressure on the existing collection and treatment system, especially plastic waste [4]. To contribute to raising awareness and scientific basis, this article presents the results of a survey of plastic waste in rivers in Hai Phong urban according to UNEP guidelines and international documents on monitoring plastic waste in rivers and at sea [5].

2. The Object and Scope of Research

The object of research: Types of plastic waste collected, observed and recorded at the monitoring station during the overview survey.

From there, plastic waste is classified into 09 groups of goods, utensils, items: i) Plastic bags; ii) Plastic packing; iii) Food and drink; iv) Hygiene and sanitary; v) Textile and shoes; vi) Fishing and Aquaculture; vii) Miscellaneous items; viii) Items of unidentifiable origin; and ix) Other [6, 7].

The scope of research: Conduct monitoring twice during the dry season in November and December 2024, and twice during the wet season in June and August 2025. Each monitoring period was conducted at 6 stations on 6 rivers in Hai Phong urban at the coordinates in order from upstream to downstream as follows: An Thai Bridge: 20.968241 - 106.52481; Tram Bac Bridge: 20.847967 - 106.564248; Kien An Bridge: 20.816941 - 106.623649; Bui Vien Bridge: 20.821747 - 106.669516; Rao Bridge: 20.828006 - 106.699287; Tan Vu Lach Huyen Bridge: 20.807076 - 106.839125.

3. Methods

Survey area and selection of monitoring points: Hai Phong is a coastal city with a dense river system flowing through it. Upstream, the point where the river begins to flow into the city is at An Thai bridge across Kinh Mon river. Downstream, where the Bach Dang estuary is at Cau Rao and Tan Vu Lach Huyen bridge. In Hai Phong city, there are three monitoring points on the river: Tram Bac brigde; Kien An bridge; Bui Vien bridge all cross Lach Tray river, part of the Thai Binh river system [8, 9].

Survey process: The methodology and survey design were based on the internationally recognized scientific handbook of the United Nations Environment Programme (UNEP), Guidelines for the Monitoring and Assessment of Marine Plastic Litter (GESAMP 2019). At each monitoring station, there are at least 2 main

members of the survey team, along with 2 to 3 volunteers who are students of interns from the university or from the Institute of Science and Technology for Energy and Environment (ISTEE) [10].

Analysis and evaluation of plastic waste: Plastic waste is monitored using three complementary methods at the same time, recorded in a statistical form and a scientific notebook according to the UNEP model: Observing plastic waste floating on the river, in parallel with collecting samples of plastic waste underwater using a net (rectangular frame mouth size: 100 cm x 50 cm; mesh size 1.2 cm; net length 200 cm) and inventorying plastic waste on both river banks at the same time according to a quantitative cell of 10-15 m^2 [11].
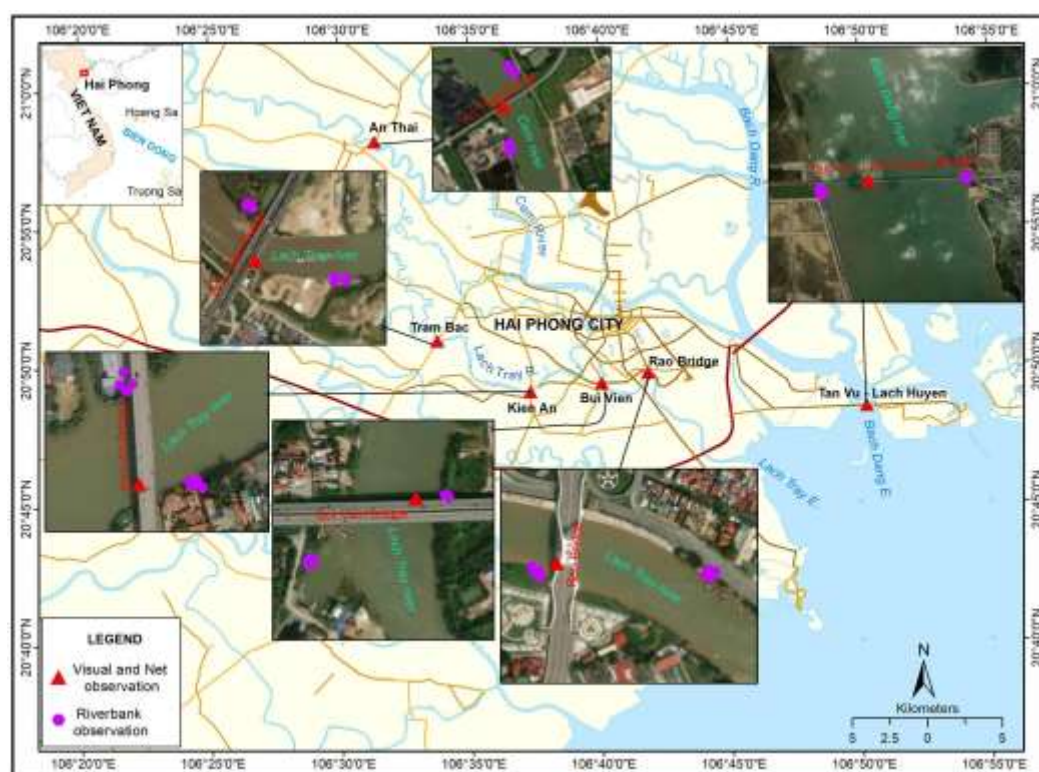

Figure 1. Diagram of plastic waste monitoring on rivers in Hai Phong urban.

4. Results and Discussion

4.1. Visual Observation Results of Plastic Waste at Monitoring Stations

Amount of plastic waste from Visual observation: From the visual observation of plastic waste on the monitoring cross section, 836 plastic waste objects were identified. Of which, the amount of plastic waste in the dry season is 453 objects, accounting for 54.14%, higher than in wet season with 383 objects, accounting for 45.86%. Among the 6 monitoring stations, the highest concentration of plastic waste is at the Rao bridge monitoring station, with 361 objects, accounting for 43.18%. Upstream, the An Thai bridge monitoring station has the lowest amount of plastic waste with 13 objects, accounting for 1.55% (Table 1).

Number of types plastic waste from visual observation: Among the 09 groups of plastic waste types observed on the survey cross section, it shows that plastic waste in the form of nylon bags and plastic packaging accounted for

the majority, with 1,638 objects (32.64%) and 1,702 objects (33.92%) respectively. The type of plastic waste with unknown origin of goods (Miscellaneous items) and food packaging (Food and drink) accounted for the majority, with 903 objects (18.0%) and 392 objects (7.81%) respectively. The remaining plastic waste ranges from 0.1% for fishing gear (Fishing and aquaculture) to 1.65% for sanitary waste (Hygiene and sanitary) (Figure 2).

Table 1. Visual observation results of the amount of plastic waste

| Visual monitoring | Time of observation (n=6) | Monitoring stations | | | | | | Tally plastic wastes | % |
		An Thai	Tram Bac	Kien An	Bui Vien	Rao	Tan Vu Lach Huyen		
Plastic waste on the River	Dry season	11	54	119	113	144	13	453	54.14
	Wet season	2	6	44	82	217	33	383	45.86

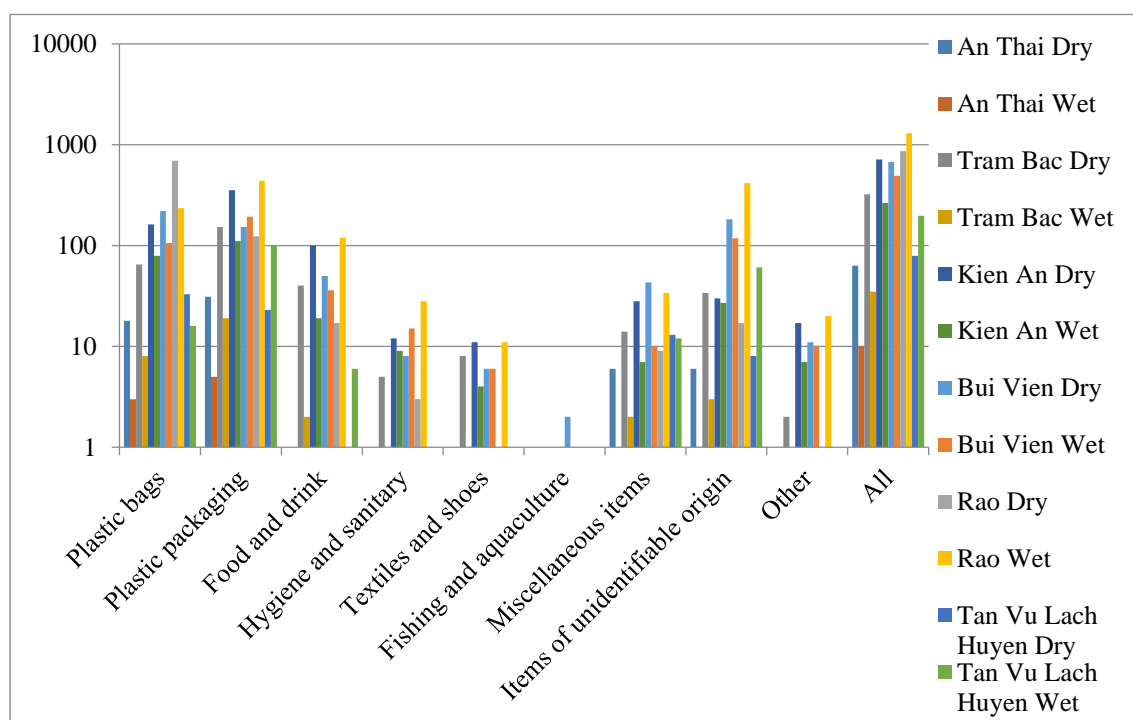Figure 2. Visual observation results of the number of types of plastic waste.

4.2. Results of Collecting Plastic Waste Samples Using Manta Net

Amount of plastic waste from manta net sampling: From the observation of plastic waste collected by manta net surfing on the monitoring cross section, 41 plastic waste objects were identified. Of which, the amount of plastic waste in the dry season accounts for 75.4% and in the wet season accounts for 24.6%. In 6 survey points, the amount of plastic waste concentrationed at Kien An bridge and Rao bridge monitoring station was 14 objects accounting for 34.14% and 10 objects accounting for 24.39% respectively. These two monitoring stations are both on the Lach Tray River flowing through the urban center (Table 3).

Table 3. Results of the amount of plastic waste collected by manta net

Net survey monitoring	Time of observation (n=6)	Monitoring Stations						Tally plastic wastes	%
		An Thai	Tram Bac	Kien An	Bui Vien	Rao	Tan Vu Lach Huyen		
Plastic waste on the River	Dry season	0	4	14	4	10	1	31	75.40
	Wet season	2	0	0	2	3	3	10	24.60

Number of plastic waste types from manta net sampling: Among the 9 groups of plastic waste collected by manta net on the survey cross section, the mixed plastic waste (Miscellaneous items), plastic packaging and unidentified origin of goods (Items of unidentifiable origin) accounted for the majority, with 92 objects (36.08%); 55 objects (21.57%) and 52 objects (20.39%) respectively. The types of plastic bags waste collected were 38 objects, accounting for 14.90%. The remaining collected plastic waste ranges from 0.39% for toiletries (Hygiene and sanitary) to 3.14% for food and beverage packaging plastic waste (Food and drink) (Figure 4).
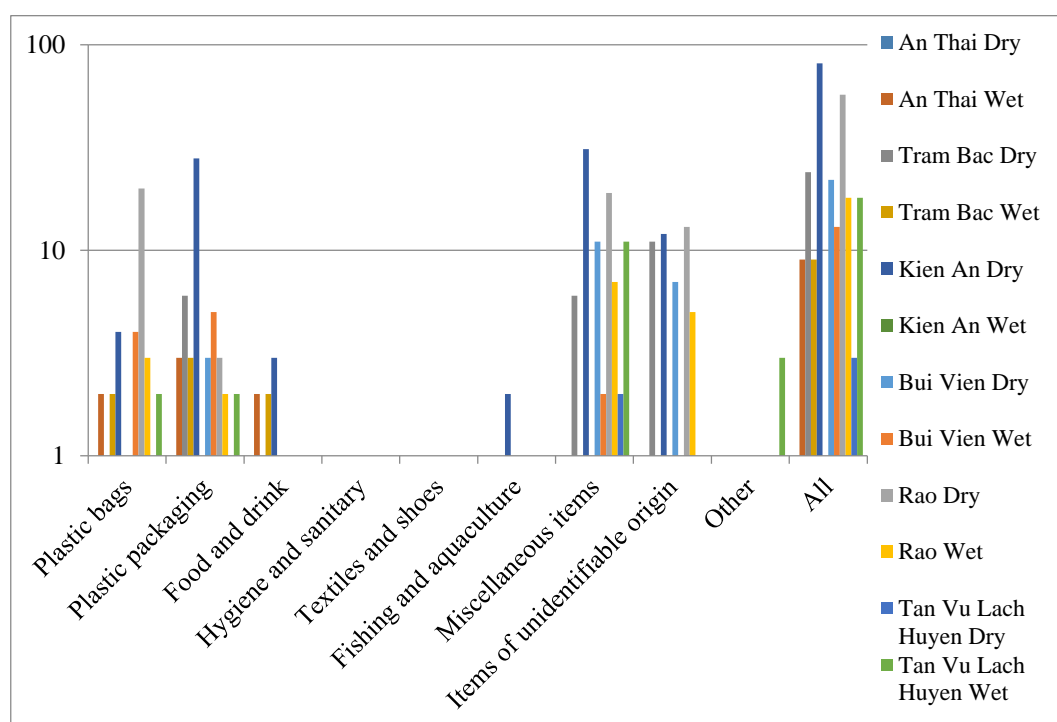

Figure 4. Results of the number of types of plastic waste collected by manta net.

4.3. Results of Plastic Waste Sampling Along the Riverbank

Amount of plastic waste collected on the riverbank: On the monitoring cross section, 1,551 plastic waste objects were collected on both river banks (with 100 square meter measuring cell). Of which, the amount of plastic waste in the dry season accounts for 53%, higher than in the wet season at 46.03%. Among the 6 survey monitoring stations, the highest concentration of plastic waste was 566 objects at

Tan Vu Lach Huyen bridge station downstream where the Bach Dang river flows into the sea. Upstream, An Thai monitoring station is still the station with the lowest amount of plastic waste, 150 objects accounting for 9.67% (Table 5).

Table 5. Amount of plastic waste collected on the riverbanks

Inventory survey monitoring	Time of observation (n=4)	Monitoring Stations						Tally plastic wastes	%
		An Thai	Tram Bac	Kien An	Bui Vien	Rao	Tan Vu Lach Huyen		
Plastic waste on the riverbanks	Dry season	69	80	115	131	87	355	837	53.97
	Wet season	81	17	179	148	79	211	714	46.03

Number of types of plastic waste collected on the river banks: Among the 09 groups of plastic waste survey on both river banks on the monitoring cross section, it shows that plastic packaging of various sizes, plastic waste of nylon bags and plastic waste of textile and shoes accounted for the majority, with 2,314 objects (37.31%), 1,081 objects (17.43%) and 729 objects (11.75%) respectively. Next, mixed plastic waste (Miscellanous items) and plastic waste of unknown origin (Items of unidentifiable origin) accounted for the majority, with 663 objects (10.69%) and 587 objects (9.46%) respectively. The remaining plastic waste ranges from 0.68% for other plastic waste to 5.92% for food and beverage packaging plastic waste (Figure 6).
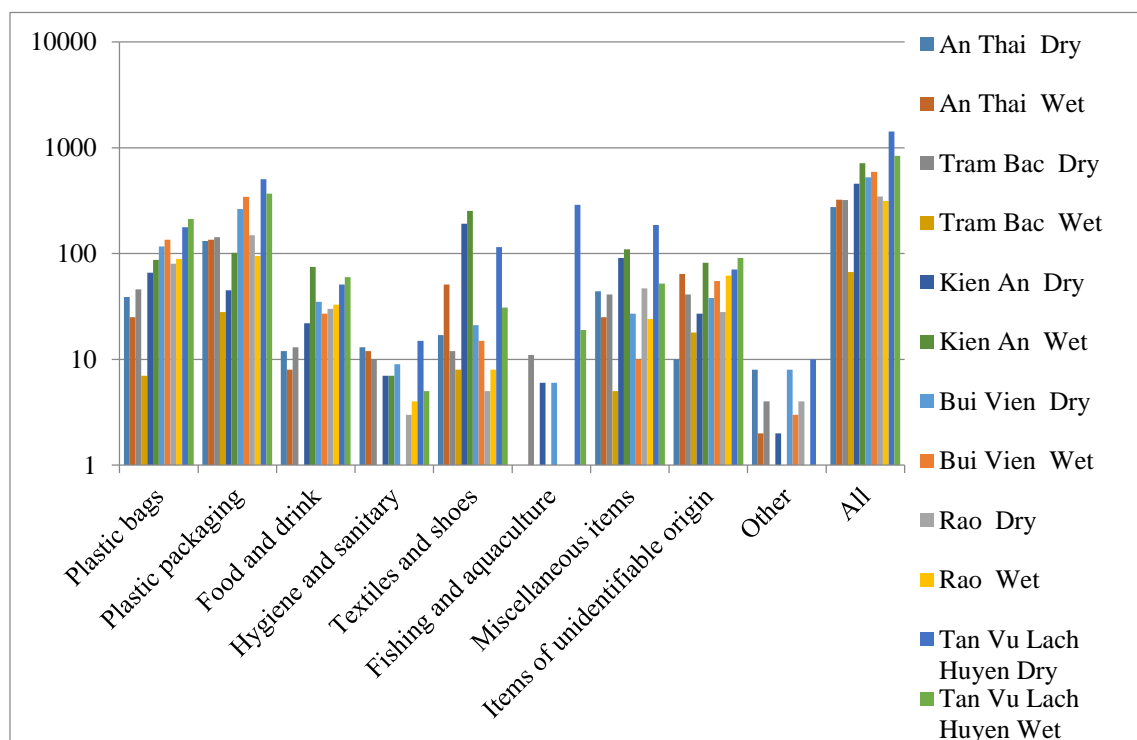

Figure 6. Number of types of plastic waste collection on riverbanks.

5. Summary of Plastic Waste Monitoring Results in the Study Area

5.1. Total Amount of Plastic Waste Monitored

The number of plastic waste monitoring from visual observation was 836 objects, from manta net collecting was 41 objects and from riverside survey monitoring was 1551 objects. Thus, the total number of plastic waste survey monitoring on the river in Hai Phong urban is 3749 plastic waste objects (Table 7). Compared to 2022, the number of plastic waste observed by drone was 700 objects and the number observed

by sampling was 330 objects [12], by 2025 the rate of plastic waste pollution will still increase significantly on the river in Hai Phong urban. It is possible that due to the Covid pandemic period, activities stopped, so the results in 2022 do not accurately reflect the current socio-economic development reality. However, monitoring points located in the inner city have a large amount of plastic waste. This shows that the potential source of waste is from residential areas. It is necessary to strengthen the management of household waste sources more effectively.

Table 7. Total amount of plastic waste monitoring on rivers in Hai Phong urban

| Monitoring methods | Time of observation | Monitoring Stations | | | | | | Tally PWs | % |
		An Thai	Tram Bac	Kien An	Bui Vien	Rao	Tan Vu Lach Huyen		
Visual survey (n=6)	Dry season	11	54	119	113	144	13	453	54.14
	Wet season	2	6	44	82	217	33	383	45.86
Net survey (n=6)	Dry season	0	4	14	4	10	1	31	75.40
	Wet season	2	0	0	2	3	3	10	24.60
Riverbank survey (n=4)	Dry season	69	80	115	131	87	355	837	53.97
	Wet season	81	17	179	148	79	211	714	46.03
Totally survey (n=32)	Dry season	80	138	248	472	285	101	1321	54.41
	Wet season	85	23	223	295	368	115	1107	45.59
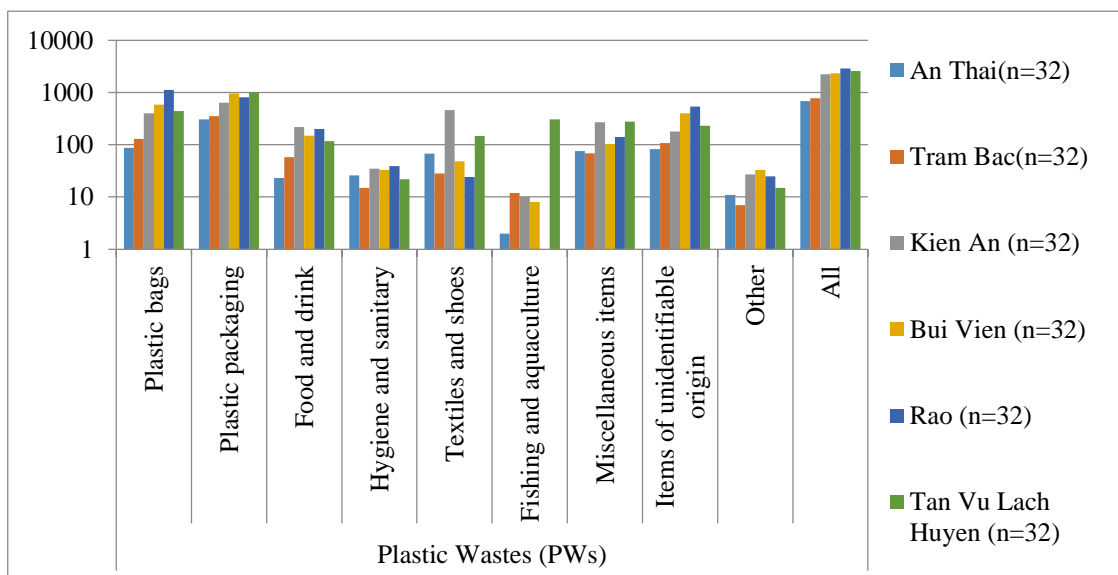
Figure 8. Total types of plastic waste monitored in rivers in Hai Phong urban.

5.2. Total Number of Types of Plastic Waste Monitored

The number of types of plastic waste monitored from visual observation is 5018 types of plastic waste, from manta net sampling is 255 types of plastic waste and from riverside monitored is 6202 types of plastic waste. The total number of plastic waste objects monitoring on the river in Hai Phong urban is 11,475 plastic waste objects (Figure 8). The most common types of plastic waste are food and beverage packaging bags and nylon bags of various sizes, accounting for 35.48% and 24.03% respectively. Compared to 2022, plastic waste in Vietnam's rivers and coastal areas accounted for 17.40% of large pieces, 6.1% of medium and small pieces; and plastic bags accounted for 8.4% [12], plastic waste of these types still increased and accounted for the majority of plastic waste in Vietnam's pollution hotspots.

6. Conclusion

The results of monitoring plastic waste on rivers in Hai Phong urban area have shown the characteristics of the distribution and composition of plastic waste in the area. The total amount of plastic waste fluctuates clearly seasonally, in the dry season (visual observation: 54.14%; manta net sampling: 75.40%; riverbank sampling: 53%) is always significantly higher than in the wet season. This trend reinforces the hypothesis that wet season flows act as a transport mechanism, accelerating the movement of plastic waste downstream and out to sea.

Spatial distribution shows that plastic waste pollution hotspots are mainly located in central urban areas, especially at the Rao bridge monitoring station (visual observation: 43.18%; manta net sampling: 24.39%); and Kien An bridge monitoring station (manta net sampling: 34,14%). In contrast, the upstream area at An Thai bridge monitoring station recorded the lowest amount of plastic waste (visual observation: 1.55%; riverbank sampling:

9.67%). Notably, the downsteam area at Tan Vu Lach Huyen bridge monitoring station collected 566 objects, which were identified as a points of plastic waste accumulation before being dumped into the sea, highlighting the role of estuaries as waste traps.

In terms of composition, plastic waste mainly comes from packaging (plastic bags, packaging), accounting for a large proportion in all three methods (visual observation: 66.56%; manta net sampling: 36.4%; riverside sampling: 54.74%). This clearly reflects the main source of emission from urban living and consumption activities. Plastic waste pollution on rivers in Hai Phong urban area is strongly influenced by two factors: i) Emission sources are concentrated in urbanized areas; and ii) Seasonal stream hydrodynamics play a key role in the transport and accumulation of plastic waste.

To effectively reduce plastic pollution, management strategies should focus on controlling sources of discharge at urban pollution hotspots, intensifying estuary clean-up campaigns at the end of the dry season, and implementing policies to reduce single-use plastic waste. Hai Phong city authorities need to pay more attention to investing in technological solutions such as automatic collection systems or more effective recycling incentive policies to solve the problem at its roots.

Further studies should focus on clarifying the transport pathways and impacts of plastic waste on the ecosystem in the basin and on human health.

Acknowledgements

References

[1] D. T. Nghi, D. H. Ngoc, L. V. Nam, Overview on Microplastic in the Marine Environment. International Workshop: Marine Plastic Pollution In Vietnam- Current Situation And Solution. Hanoi national University, Institute of Resource and Environment(CRES), 2019, pp. 31-35 (in Vietnamese).

[2] MONRE (Ministry of the Natural Resources and the Environment), National Environmental Status Report 2019, Hanoi: Ministry of the Natural Resources and the Environment, 2020, https://monre.gov.vn/English (accessed on: August 4th, 2025).

[3] L. T. Huong, Analysis of Plastic Waste Pollution in Vietnam and Some Recommendations, Environment Magazine, Institute of Strategy and Policy on Agriculture and Environment, Ministry of Agriculture and Environment(MAE), No. 9, 2022, https://tapchimoitruong.vn/chuyen-muc-3/phan-tich-o-nhiem-rac-thai-nhua-o-viet-nam-va-de-xuat-mot-so-khuyen-nghi-27036 (accessed on: August 4th, 2025) (in Vietnamese).

[4] T. Q. Cuong, Hai Phong Under Pressure to Handle More Than 2,000 Tons of Waste per Day, 2015, https://vneconomy.vn/hai-phong-truoc-ap-luc-xu-ly-hon-2-000-tan-rac-thai-moi-ngay.htm (accessed on: August 4th, 2025) (in Vietnamese).

[5] Iucn-ea-quantis, National Guidance for Plastic Pollution Hotspotting and Shaping Action, Country Report Vietnam. Bangkok: International Union for the Conservation of Nature, 2020, https://www.iucn.org/ sites/dev/files/content/documents/vietnam_final-re- port_2020-compressed _.pdf. (accessed on: August 4th, 2025) (in Vietnamese).

[6] J. R. Jambeck, R. Geyer, C. Wilcox, T. R. Siegler, M. Perryman, A. Andrady, R. Narayan, K. L. Law, Plastic Waste Inputs from Land into the Ocean, Science, Vol. 347, No. 6223, 2015, pp. 768-771, https://science.sciencemag.org/content/347/6223/768 (accessed on: August 4th, 2025)

[7] S. Emilie, D. T. Ha, T. D. Dao, D. H. Ngoc, D. T. T. Dung, D. T. Nghi, D. T. Thuy, H. D. Anh, L. T. K. Chung, L. T. P. Quynh, H. Mai, T. D. Mau, N. Q. Hung, Tr. N. Q. Anh, T. Q. Viet, T. T. N. Sang, V. Hai, V. V. Chi, Baseline Assessment of Microplastic Concentrations in Marine and Freshwater Environments of a Developing Southeast Asian Country, Vietnam, 2021,

[8] L. H. Son, P. T. K. Thoa, P. B. An, T. N. S. Ha, GIS/GPS Application for Plastic Waste Monitoring – Case Study in Residential Areas Nearby Han River Basin, Danang, The Journal of Science and Technology, Danang University, Vol. 20, No.11, 2022. pp. 7-12.

[9] M. Rani, W. J. Shim, G. M. Han, M. Jang, N. A. A.Odaini, Y. K. Song, S. H. Hong, Qualitative Analysis of Additives in Plastic Marine Debris and Its New Products, Arch Environ Contam Toxicol, Vol. 69, 2015, pp. 352-366, https://doi.org/10.1007/s00244-015-0224-x.

[10] D. González, G. Hanke, G. Tweehuysen, B. Bellert, M. Holzhauer, A. Palatinus, P. Hohenblum, L. Oosterbaan, Riverine Litter Monitoring – Options and Recommendations. MSFD GES TG Marine Litter Thematic Report; JRC Technical Report. Luxembourg: Publications Office of the European Union, 2016, https://op.europa.eu/en/publication-detail/-/publication/816a2049-dbb8-11e6-ad7c-01aa75ed71a1/language-en (accessed on: August 4th, 2025).

[11] GESAMP, Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean (P. J. Kershaw, A. Turra, F. Galgani Editors), 2019, [Online]. Available: http://www.gesamp.org/publications/ guidelines-for-the-monitoring-and-assessment-of-plastic-litter-inthe-ocean (accessed on: August 4th, 2025).

[12] World Bank, Vietnam: Plastic Pollution Diagnostics, 2022, https://openknowledge.worldbank.org/entities/publication/b3f0fc66-a0f7-56fb-a231-09915a06f8fc (accessed on: August 4th, 2025).