Research on the Impact of Tourism Development Activities on the Environment in Hanoi City, Vietnam

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Abstract
This study evaluates the relationship between tourism development and environmental pressure in Hanoi City during the period 2015-2024 on the basis of secondary data and the DPSIR analytical framework. Data were synthesized from reports and official portals of the Hanoi Department of Tourism, the Vietnam National Authority of Tourism, the Hanoi People's Committee, documents of the World Bank and IQAir, and a number of relevant statistical sources and sectoral reports concerning municipal solid waste, urban wastewater, and air quality. The results show that tourism in Hanoi grew strongly before the Covid-19 pandemic, declined sharply in 2020-2021, and then recovered rapidly during 2022-2024. In 2024, total tourist arrivals reached 27.86 million visits and total tourism revenue was approximately VND 110.52 trillion, equivalent to 96.3% of the visitor volume and 106.5% of the revenue recorded in 2019. However, urban environmental capacity has not increased at the same pace as tourism recovery. Indicators of PM2.5, municipal solid waste, and the proportion of treated urban wastewater show that Hanoi still faces substantial pressure on air quality, waste, surface water, and destination carrying capacity. The study does not claim that tourism is the sole or main cause of urban pollution. Rather, it demonstrates that increasing tourism amplifies environmental pressure in areas with high visitor density, especially the Old Quarter - Hoan Kiem Lake, the Temple of Literature - Imperial Academy, West Lake, pedestrian spaces, craft villages, and peri-urban tourist sites. The article proposes groups of DPSIR-based governance solutions, including carrying-capacity management, tourism-waste accounting, green standards for accommodation establishments, the development of low-emission tourism transport, environmental monitoring at destinations, and integration of tourism-environment data into urban management.

Keywords: sustainable tourism; urban environment; Hanoi; DPSIR; PM2.5; solid waste; urban wastewater.

1. Introduction

Over more than a decade, Hanoi has gradually affirmed its position as one of Vietnam's most important tourism centers. The capital's advantage lies not only in its role as the national political and administrative center, but also in its dense concentration of cultural heritage, historic urban landscapes, craft-village systems, culinary spaces, political and cultural events, and its connectivity with the tourism region of the Red River Delta and the northern midlands and mountains. Tourism development has generated substantial revenue, contributed to services and employment, promoted the national image, and supported the restructuring of the urban economy.

However, tourism is also an activity that consumes resources and generates waste. Tourists use transport, accommodation, food and beverage services, shopping, sightseeing, and entertainment; these activity chains create additional demand for energy, clean water, public space, transport infrastructure, waste collection, wastewater treatment, and landscape conservation. In a large city such as Hanoi, these pressures do not exist separately but overlap with pressures from population, industry, construction, daily traffic, and urban climate change.

Research on the environmental impacts of tourism development therefore needs to be situated within an integrated urban logic. If air, water, or waste pollution is attributed directly and exclusively to tourism, the analysis would fall into methodological simplification, because major emission sources in Hanoi also include intra-urban transport, industry, construction, rice-straw burning, residential activities, and other service activities. Conversely, if tourism is viewed only as a smokeless service economy, research will overlook the incremental pressure that tourism creates at specific times, spaces, and supply chains.

The scientific problem is as follows: how did tourism development in Hanoi fluctuate during 2015-2024; do urban environmental indicators reflect corresponding pressures; and what governance framework can help shift from growth in visitor numbers toward sustainable tourism development? This article adopts a secondary-data approach combined with the DPSIR model to identify the chain of links from tourism-development drivers to environmental pressures, environmental state, impacts, and policy responses.

The period 2015-2024 has particular analytical significance. It covers the pre-Covid-19 growth cycle, the shock of decline caused by the pandemic, and the post-reopening recovery period. As a result, the data series reflects not only a linear trend but also the recovery capacity of the tourism sector and the lag of the urban environmental system. The mismatch between tourism recovery and environmental treatment capacity is the central focus of this article.

The objective of this study is to assess environmental pressures associated with tourism development in Hanoi City through three groups of indicators: tourism development, waste-wastewater pressures, and air quality. On that basis, the article proposes governance solutions for urban tourism toward a green orientation, focusing on pressure control at destinations rather than solely managing the total number of visitors citywide.

2. Literature review and theoretical basis

Sustainable tourism is understood as a development process that simultaneously meets economic, social, cultural, and environmental objectives. According to the approach of UNEP and UNWTO, sustainable tourism development is not merely the conservation of resources, but also the organization of tourism activities so that negative impacts on the natural environment, culture, and local communities are controlled within acceptable limits. This view is appropriate for a heritage city such as Hanoi, where the environment includes not only air, water, and waste but also public space, landscape, urban rhythms, and the reception capacity of resident communities.

In urban tourism research, the concept of destination carrying capacity is often used to denote the threshold at which visitor numbers, activity intensity, or service consumption begin to degrade environmental quality, tourist experience, or residents' lives. Carrying capacity is not simply a fixed number, because it depends on seasonality, time of day, infrastructure structure, management capacity, tourist behavior, and the level of spatial dispersion. A pedestrian street may be overloaded on weekends but not on weekdays; a heritage site may face strong pressure on sanitation and landscape even when total visitor numbers for the entire city have not exceeded a threshold.

International studies on tourism and the environment commonly distinguish three levels of impact. The first level consists of direct impacts at destinations, such as waste, noise, water consumption, landscape encroachment, and declining experience quality. The second level is indirect impacts through supply chains, including transport, accommodation, food services, shopping, laundry, energy, and food. The third level is cumulative impacts within the urban system, when tourism interacts with population, construction, industry, and transport. Hanoi is a typical case of the third level.

The DPSIR framework, consisting of Driving forces - Pressures - State - Impacts - Responses, has been used by the European Environment Agency and many environmental studies to analyze the relationship between socioeconomic development and the environment. The strength of DPSIR is that it does not treat pollution as an isolated phenomenon, but places it within a chain of causes, pressures, states, impacts, and responses. For the topic of Hanoi tourism, this model helps separate tourism-growth drivers from the pressures generated, while avoiding overstatement of causality when the data do not allow the tourism contribution to total urban pollution to be fully isolated.

Studies on air pollution in Hanoi show that PM2.5 originates from several emission groups, including industry, rice-straw burning, road dust, transport, and residential-commercial sources. Tourism is related mainly to transport, accommodation, food and beverage services, high-density activities, and consumption at destinations. Therefore, the contribution of tourism to air pollution cannot be separated by city-level aggregate observation without micro-level data, but it can be assessed as an additional pressure in tourism-intensive spaces and peak periods.

For solid waste and wastewater, the linkage with tourism is clearer. Tourists generate waste from food and beverages, packaging, single-use products, festivals, shopping, and accommodation. Accommodation establishments, restaurants, and attractions generate domestic wastewater whose characteristics depend on room occupancy, seasonality, and service intensity. When the proportion of treated urban wastewater remains low, the expansion of service activities, including tourism, increases pressure on rivers, lakes, and drainage systems.

Based on the above review, this article approaches tourism not as the “sole cause” of Hanoi's environmental problems, but as an important driving variable within the system of urban pressures. The research questions are therefore specified into three components: how tourism development in Hanoi changed during 2015-2024; which environmental indicators reveal notable pressures; and how policy should respond to control pressure at destinations under conditions of rapid tourism recovery.

3. Research Methodology

This study applies a mixed qualitative-quantitative approach based on secondary data. The quantitative component focuses on descriptive statistics, trend analysis, comparison before and after the pandemic, and the calculation of several simple correlations between tourist arrivals and environmental pressure indicators. The qualitative component uses the DPSIR model to interpret the chain of relationships and propose policy responses. This approach is suitable for the current condition of publicly available data, in which several tourism indicators have relatively complete annual series, while environmental indicators directly related to tourism are not yet separately compiled.

Tourism-development data include total arrivals, international visitors, domestic visitors, total tourism revenue, and selected information on accommodation establishments. Data milestones were obtained from publications of the Hanoi Department of Tourism through Hanoi's official portal, the Vietnam National Authority of Tourism, and press agencies citing reports of the Hanoi Department of Tourism. For 2015, international and domestic visitor figures were drawn from information on the working session between the Vietnam National Administration of Tourism and the Hanoi Department of Tourism; several revenue indicators were harmonized with the series published in subsequent years.

Environmental data comprise three groups of indicators. First, annual average PM2.5 reflects urban air quality. Second, the generation of municipal solid waste reflects pressure on urban waste collection and treatment. Third, the proportion of treated urban wastewater reflects environmental infrastructure capacity. These indicators do not measure tourism separately, but they are capable of reflecting the environmental context on which tourism exerts impacts and by which tourism is affected.

An important limitation of the data is that publicly available environmental series are incomplete for each year from 2015 to 2024. Therefore, the study clearly distinguishes between directly published data and interpolated or

harmonized values used for trend analysis. Interpolated values are not used to assert causality; they are used only to describe the relative trend of environmental pressure during the same period. This principle helps the article avoid creating "false precision" for incomplete environmental data.

Trend analysis was conducted in three steps. First, the study describes the pre-pandemic tourism growth trajectory, the Covid-19 shock, and the recovery process. Second, it compares tourism trends with the evolution of environmental indicators. Third, it develops a DPSIR matrix to identify governance links where intervention is possible. Pearson correlations are calculated at a descriptive level and are not used as causal evidence because the number of observations is small and the environmental data are not disaggregated for the tourism sector.

To increase transparency, the article presents the integrated data table, source notes, and data limitations directly in the results section. The use of graphs is intended to support the identification of trends and does not replace qualitative analysis. This presentation is particularly necessary for the topic of tourism and the environment in a large city, where administrative data are often dispersed across the tourism, natural resources and environment, construction, transport, statistics, and district-level governance systems.

Table 2. Variables and indicators used in the study

Variable group	Indicator used	Unit	Methodological note
Tourism development	Total visitors, international visitors, domestic visitors	Million visits	Annually published data
Tourism development	Total tourism revenue	VND trillion	Published/harmonized data
Environmental pressure	Generated municipal solid waste	Tons/day	Urban pressure indicator, not disaggregated for tourism
Environmental state	Annual average PM2.5	μg/m³	Urban air-quality indicator
Response capacity	Proportion of treated urban wastewater	%	Indicator of environmental infrastructure capacity

Source: Synthesized by the author from public reports and sectoral documents; units were standardized for trend analysis.

4. Overview of Hanoi tourism and environmental context

Hanoi is an integrated tourist destination in which cultural-historical tourism plays a foundational role. Prominent resources include the Old Quarter, Hoan Kiem Lake, the Temple of Literature - Imperial Academy, the Thang Long Imperial Citadel, President Ho Chi Minh relic sites, West Lake, Bat Trang pottery village, Duong Lam ancient village, the Ba Vi area, Huong Son, and systems of festivals, cuisine, and craft villages. These resources are unevenly distributed: many sites with high visitor density are concentrated in the historic inner city, where infrastructure has long been established and cannot easily be expanded.

Before the pandemic, Hanoi achieved a high tourism growth rate. Total arrivals increased from approximately 19.79 million visits in 2015 to nearly 28.95 million visits in 2019. During the same period, total tourism revenue increased faster than visitor volume, reflecting the expansion of accommodation, food and beverage, shopping, cultural-experience services, and international tourism. Revenue growth higher than visitor growth is a positive signal of spending quality, but it also indicates that the scale of the tourism service chain expanded, bringing with it additional demand for energy, water, and waste treatment.

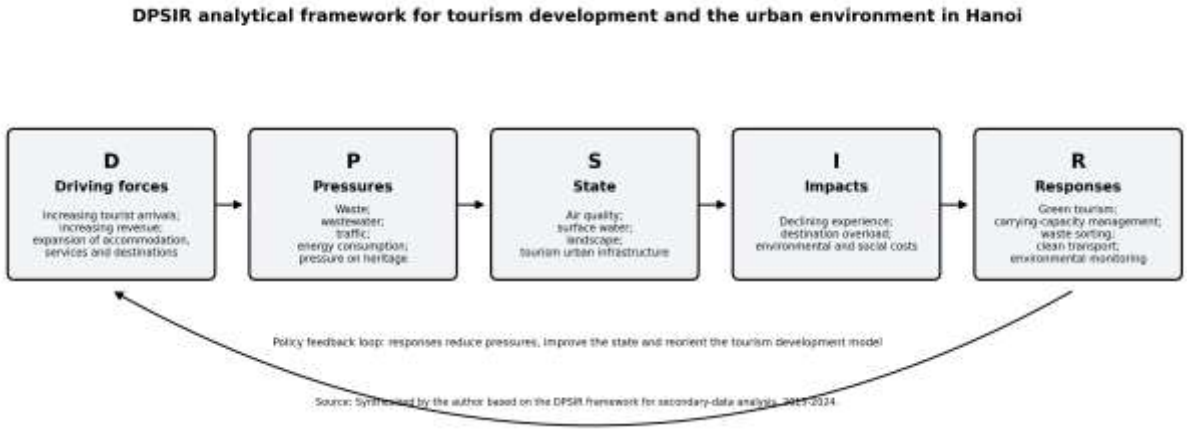
In 2020-2021, Hanoi tourism was seriously affected by the Covid-19 shock. Visitor numbers in 2020 fell to only 8.65 million visits; in 2021, arrivals were mainly domestic and reached approximately 4 million visits. This was a period in which tourism pressure on several destinations decreased sharply, but it did not mean that the urban environment improved sustainably, because other pollution sources remained. This shock shows that the relationship between tourism and the environment is not simply linear.

From 2022 onward, when tourism activities reopened, Hanoi recovered rapidly. The city received 18.7 million visitors in 2022, 24 million in 2023, and 27.86 million in 2024. Notably, revenue in 2024 exceeded the 2019 level even though visitor volume had not fully surpassed it. This indicates that tourism is recovering toward higher value, but it also raises requirements for managing destination quality, environmental sanitation, transport, services, and tourist experience.

Environmentally, Hanoi faces multidimensional pressure. Air quality, especially PM2.5, is often high compared with WHO recommendations. Daily municipal solid waste generation is measured in thousands of tons and tends to increase with population size, consumption, and services. The proportion of treated urban wastewater has improved but remains low relative to demand. These problems are not caused by tourism alone, but tourism increases local pressure at sites with high visitor density.

Hanoi's tourism space is environmentally sensitive. The Hoan Kiem Lake and Old Quarter area is subject to pressure from walking activities, street food, events, waste, and connecting traffic. West Lake faces pressure from lakeside services, wastewater, landscape, and public space. Craft villages such as Bat Trang are both tourism products and production spaces related to transport and village-environment issues. Peri-urban areas such as Ba Vi, Soc Son, and Huong Son face seasonal waste, weekend traffic, and ecological governance pressures.

Figure 1. DPSIR analytical framework applied to tourism development and the environment in Hanoi



5. Results of tourism development trend analysis, 2015-2024

The period 2015-2019 was a continuous growth cycle for Hanoi tourism. The compound annual growth rate of total visitor arrivals was approximately 9.97%, while total tourism revenue grew at an average rate of about 16.95% per year. The gap between revenue growth and visitor growth shows that the economic value per tourist tended to increase, especially as the share of international visitors rose from 16.98% in 2015 to 24.27% in 2019. During this period, Hanoi strengthened its position as an urban cultural destination while expanding night-time services, cuisine, accommodation, and shopping.

The Covid-19 shock interrupted this growth trajectory. In 2020, total arrivals fell to 8.65 million visits, equivalent to about 30% of the 2019 level. In 2021, international tourism was virtually absent in the normal sense, domestic visitors reached about 4 million, and total revenue was only VND 11.28 trillion. This decline affected not only travel, accommodation, and service enterprises but also the intensity of use of tourism spaces. Many inner-city and peri-urban destinations were closed or operated under restrictions for periods of time.

The period 2022-2024 shows rapid recovery. Total arrivals reached 18.7 million visits in 2022, 24 million in 2023, and 27.86 million in 2024. Compared with 2019, visitor volume in 2024 reached about 96.3%, while total revenue reached about 106.5%. These changes show that Hanoi tourism has almost fully recovered in visitor scale and has surpassed its pre-pandemic revenue level. Nevertheless, rapid recovery also means that environmental pressure at destinations has returned, while environmental infrastructure requires a longer investment cycle.

The visitor structure also has environmental implications. International visitors tend to stay longer and spend more, thereby generating greater demand for accommodation, transport, food services, laundry, and multi-site visits. Domestic visitors are more numerous and create pressure on weekends, holidays, and domestic events. Without management by season and space, the recovery of total arrivals may lead to local overload even when citywide average indicators do not yet reveal overcapacity.

Rapid growth in tourism revenue raises questions about growth quality. If revenue increases because of service upgrading, longer stays, and higher spending on high-value cultural products, environmental pressure per unit of revenue may decline. Conversely, if revenue grows mainly through more material consumption, single-use services, individual transport, and dense gatherings, environmental pressure may increase faster. Green tourism governance should therefore move from visitor-number targets to environmental-efficiency indicators per unit of revenue or per visitor.

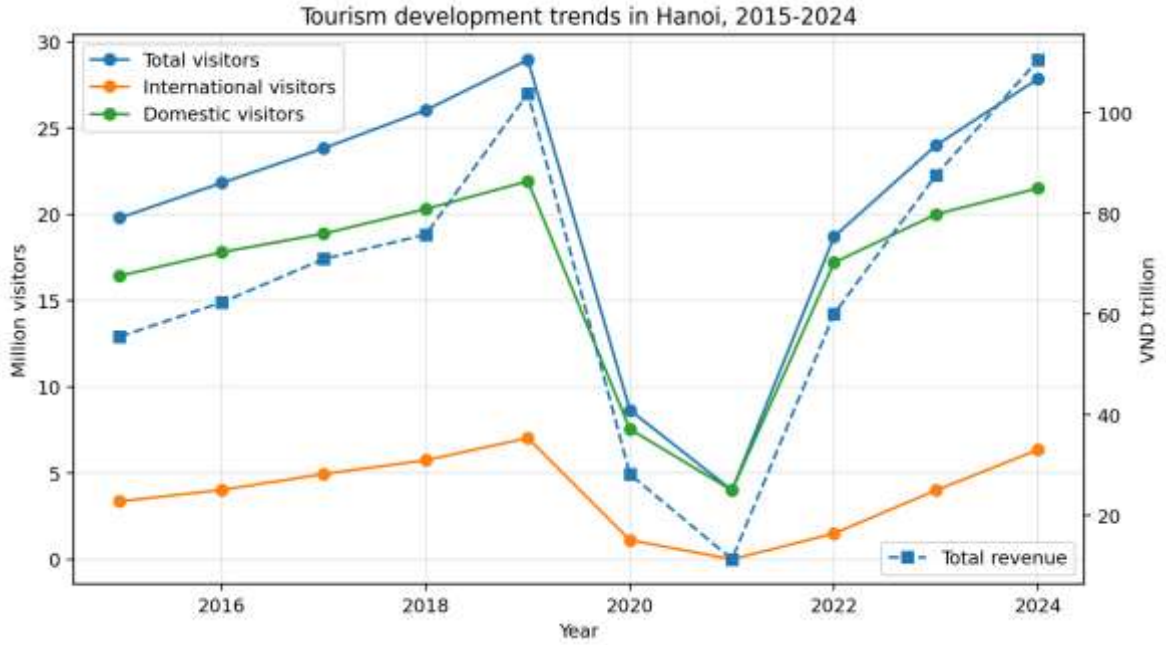
An important observation is that tourism data are currently published in a relatively complete manner, but they are not closely linked with environmental data. Tourism reports commonly mention visitor numbers, revenue, room occupancy, new products, and destination awards. Environmental reports, in contrast, address waste, wastewater, and air quality but rarely separate the portion generated by tourism. This gap forces environmental-impact assessment of tourism to rely on proxy indicators and qualitative analysis, thereby reducing the capacity to formulate policies based on micro-level evidence.

Table 3. Hanoi tourism development data, 2015-2024

Year	Total visitors (million visits)	International visitors (million visits)	Domestic visitors (million visits)	Total tourism revenue (VND trillion)
2015	19.79	3.36	16.43	55.5
2016	21.82	4.02	17.8	62.33
2017	23.83	4.95	18.88	70.96
2018	26.04	5.74	20.3	75.81
2019	28.95	7.03	21.92	103.81
2020	8.65	1.11	7.54	28.2
2021	4	0	4	11.28
2022	18.7	1.5	17.2	60
2023	24	4	20	87.65
2024	27.86	6.35	21.51	110.52

Source: Synthesized from the Hanoi Department of Tourism, the Vietnam National Authority of Tourism, the Hanoi People's Committee, and published sources cited in the reference list. Some values were rounded and units were harmonized for trend analysis.

Figure 2. Tourism development trends in Hanoi, 2015-2024



6. Results of DPSIR-based environmental pressure analysis

Under the DPSIR structure, the first driving force is the increase in tourist scale and tourism revenue. This driver stimulates the expansion of accommodation, restaurants, transport, retail, entertainment, and events. Under good management, it creates financial resources for heritage conservation and environmental upgrading. Under conditions in which environmental infrastructure improves slowly, however, this driver is transformed into pressures from waste, wastewater, traffic, noise, energy consumption, and overuse of public spaces.

Solid-waste pressure is the most easily observable manifestation. Tourists generate waste from food, beverages, packaging, souvenirs, paper, single-use plastics, and festival activities. In Hanoi, the issue is not only the total amount of waste citywide, but also waste concentrated by site and time. Pedestrian streets, night markets, cultural events, heritage attractions, and food-service areas may generate sudden increases in waste during weekends or holidays, creating pressure on collection and urban sanitation.

Wastewater pressure is associated with accommodation, restaurants, service establishments, and sanitation activities at destinations. When the proportion of treated urban wastewater remains low, any expansion of urban services increases the risk of untreated discharge into the drainage system, rivers, and lakes. For Hanoi tourism, sensitive areas include Hoan Kiem Lake, West Lake, the To Lich river basin, the Nhue-Day basin, and peri-urban areas where ecological tourism and weekend resorts are developing.

Air pressure is related to tourist transport, taxis, contracted vehicles, tourist buses, private motorcycles, buses, airport-center-attraction traffic, and tourism logistics. Although tourism is not the largest source of PM2.5 emissions in Hanoi, it may increase vehicle density in tourism spaces, especially during peak hours, weekends, and events. This effect needs to be analyzed at the route, site, and time level, rather than relying only on the annual average for the entire city.

The environmental state is reflected in PM2.5 levels that are much higher than WHO recommendations, large volumes of municipal solid waste, and a limited proportion of treated urban wastewater. These indicators show that the urban environmental baseline is already under pressure. When tourism recovers rapidly, destination systems must absorb additional pressure on top of an unstable environmental foundation. This is why the article uses the concept of “pressure amplification” rather than a unidirectional claim that tourism “causes pollution.”

The impacts of environmental pressure are not limited to degradation of the natural environment. For tourism, the environment itself is part of the product. Poor air quality reduces the experience of walking, outdoor sightseeing, and the health of sensitive groups. Waste degrades the image of the destination. Polluted surface water diminishes the landscape value of rivers and lakes. Traffic congestion increases time costs and reduces tourist satisfaction. Therefore, environmental protection is not an auxiliary cost; it is a condition for Hanoi tourism competitiveness.

Policy responses need to move from the general to the specific. At the city level, tourism data should be integrated into urban environmental planning. At the tourism-sector level, environmental criteria should be included in the assessment of accommodation establishments, destinations, events, and night-time products. At the destination level, procedures are needed for carrying-capacity management, visitor flow regulation, real-time waste collection, and communication on responsible tourism behavior. At the enterprise level, reductions in single-use plastics, water saving, energy saving, and disclosure of green practices should be promoted.

Table 4. DPSIR matrix for tourism development and the environment in Hanoi

DPSIR component	Manifestation in Hanoi	Indicative indicators
D - Driving forces	Increase in visitors, revenue, accommodation, night tourism, and events	Total visitors; total revenue; room occupancy
P - Pressures	Waste, wastewater, traffic, energy consumption, and visitor concentration	Waste/visitor; water/room; vehicles/visitor
S - State	High PM2.5, polluted rivers and lakes, destination overload, landscape pressure	AQI; PM2.5; surface water; sanitation feedback
I - Impacts	Reduced experience, higher urban costs, impacts on health and destination brand	Satisfaction level; complaints; treatment costs
R - Responses	Carrying-capacity management, green accommodation, clean transport, destination monitoring, waste sorting	Share of destinations with environmental plans; green establishments

Table 5. Environmental indicators and environmental infrastructure capacity in Hanoi, 2015-2024

Year	Annual average PM2.5 (µg/m³)	Estimated MSW (tons/day)	Urban wastewater treated (%)
2015	51	5,500	20
2016	48	5,800	21.5
2017	45.8	6,100	23
2018	40.8	6,500	25
2019	40.8	6,800	27
2020	37	6,500	28
2021	36.5	6,700	28.8
2022	40.5	7,000	29.1
2023	42.5	7,200	30
2024	45	7,600	30.9

Note: PM2.5 and MSW are aggregate urban indicators; years lacking direct publication were cautiously interpolated or harmonized for trend analysis and are not used to attribute causality specifically to tourism.

Figure 3. Annual PM2.5 indicator in Hanoi, 2015-2024

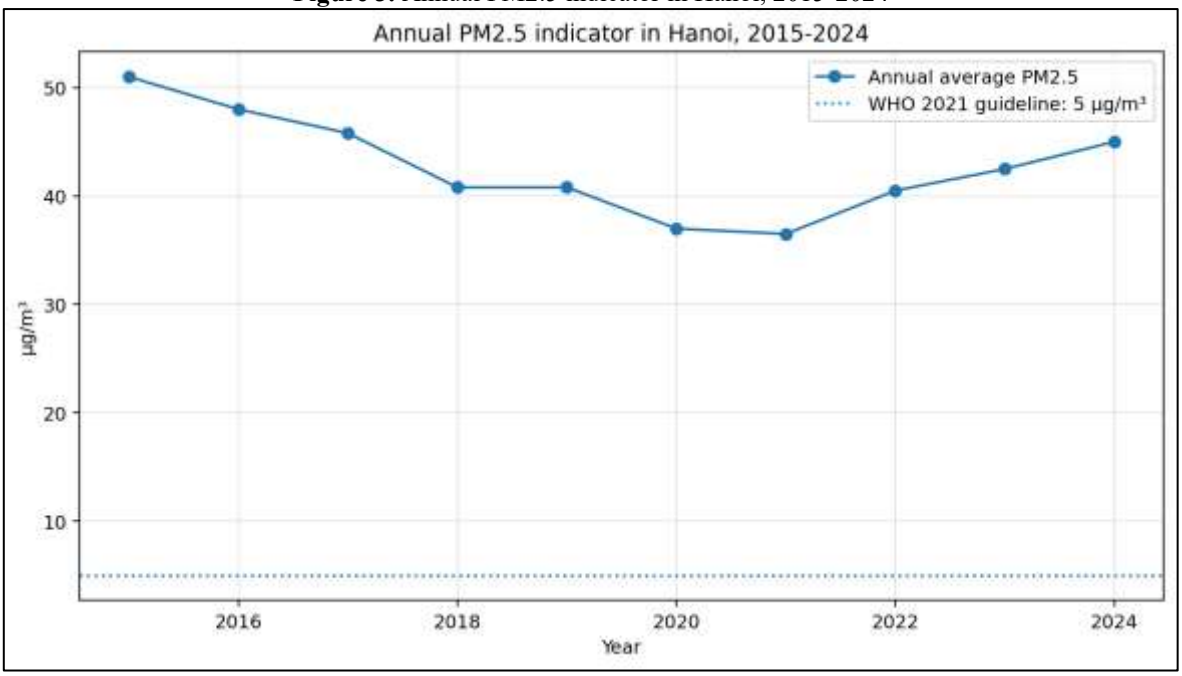
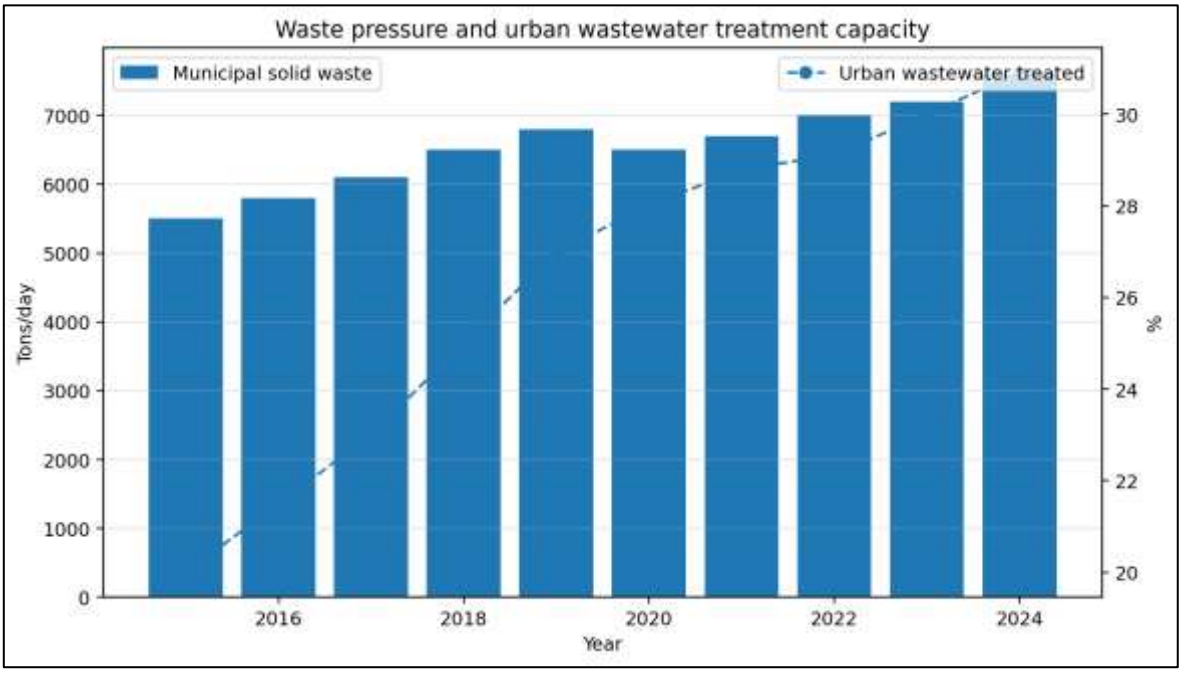


Figure 4. Waste pressure and urban wastewater treatment capacity



7. Analysis of the relationship between tourism and environmental indicators

Descriptive statistical results show that the relationship between tourist arrivals and municipal solid waste tends to move in the same direction during the observed period, with a descriptive correlation coefficient of approximately 0.16. It should be emphasized, however, that Hanoi's municipal solid waste includes all residential, commercial, service, office, school, market, restaurant, and tourism activities. Therefore, this correlation does not prove that tourism is the main source of waste generation; it only suggests that when urban and tourism activities recover, waste pressure also increases.

The relationship between total tourist arrivals and PM2.5 is less clear than the relationship with solid waste. The descriptive correlation coefficient for the 2015-2024 series is about 0.51, reflecting the fact that PM2.5 depends on many factors beyond tourism, such as industry, rice-straw burning, road dust, construction, routine traffic, meteorological conditions, and regional pollutant transport. In 2020-2021, tourism fell sharply, but PM2.5 did not decline correspondingly in a sustainable way, indicating that air pollution is a structural problem of the city and surrounding region.

The proportion of treated urban wastewater improved slowly while tourism recovered rapidly. In 2024, treated urban wastewater reached approximately 30.9%, substantially lower than the 2025 target of 50-55%. This implies that the growth of urban services, including tourism, is occurring in a context where wastewater treatment capacity remains limited. Without mechanisms requiring accommodation establishments, restaurants, and tourism areas to manage wastewater more strictly, pressure on rivers and lakes will continue to increase.

A notable point is that tourism revenue in 2024 exceeded the 2019 level, while visitor volume had not fully surpassed it. This may be a policy opportunity. If Hanoi continues to increase value per visitor through high-quality cultural products, green accommodation, controlled experiences, and rational visitor distribution, the city may reduce its dependence on quantitative growth. Conversely, if policy focuses only on increasing visitor numbers, environmental pressure will increase rapidly while treatment capacity fails to keep pace.

The data analysis also indicates the need to shift the assessment unit from the “whole city” to the “destination.” Citywide averages can conceal local overload. A tourist attraction may be overloaded with waste, traffic, and noise even when Hanoi's annual visitor number remains within the plan. Therefore, indicators such as waste/visitor/day at the destination, waste-sorting rates, visitor density/m2/hour, length of stay, the proportion of visitors using public transport, and water consumption/room/night should be added.

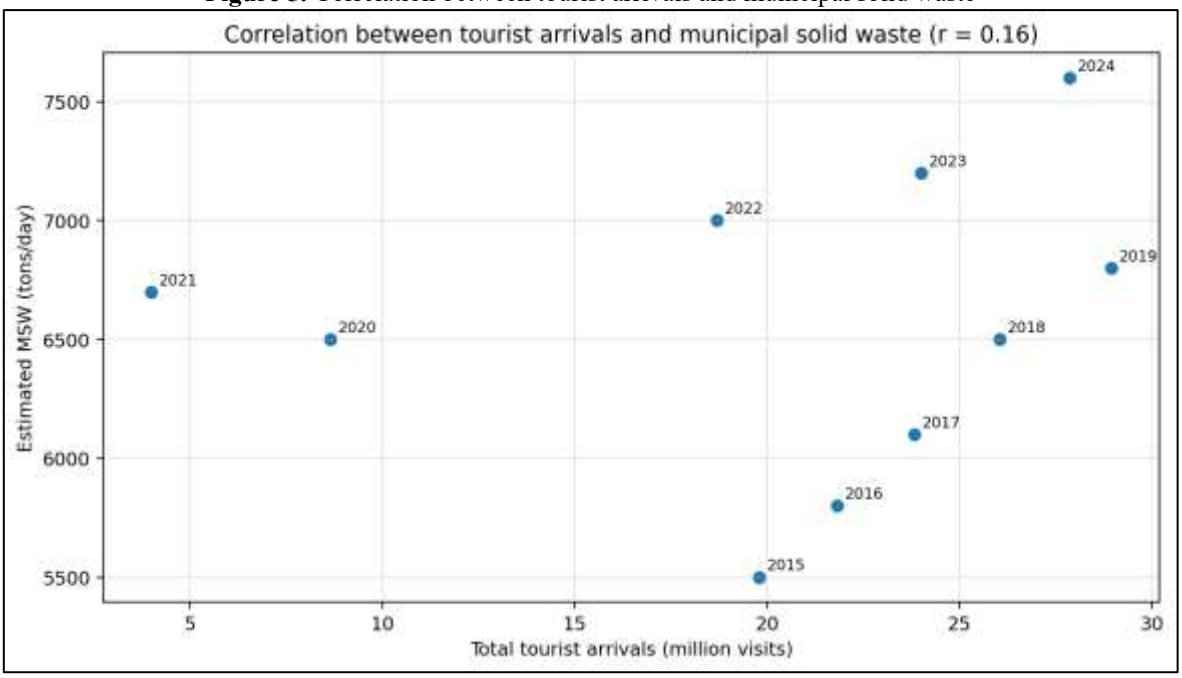
From an environmental perspective, the goal is not to reduce tourism development, but to reduce the intensity of environmental pressure per unit of tourism value. A city can receive more visitors with less pressure if tourists are distributed across time and space, use clean transport, stay at certified green establishments, limit single-use plastics, and participate in tourism products that respect local communities. This is the logic of the transition from tourism growth to sustainable tourism governance.

Table 6. Selected descriptive statistics and correlations

Indicator	Value	Interpretation
CAGR of total visitors, 2015-2019	9.97%	Pre-pandemic visitor growth
CAGR of total revenue, 2015-2019	16.95%	Pre-pandemic revenue growth
Total visitors in 2024 compared with 2019	96.3%	Recovery level of visitor scale

Total revenue in 2024 compared with 2019	106.5%	Revenue recovery/exceedance
Correlation: visitors - MSW	0.16	Descriptive correlation; does not imply causality
Correlation: visitors - PM2.5	0.51	Weak/difficult to interpret due to multiple emission sources

Figure 5. Correlation between tourist arrivals and municipal solid waste



8. Discussion

The findings reveal a governance paradox: Hanoi tourism is recovering very rapidly, whereas environmental infrastructure requires long investment cycles. Wastewater treatment plants, waste-sorting systems, public transport, ecological buffer zones, and environmental monitoring cannot be expanded within a single tourism season. Therefore, if tourism planning pursues only annual visitor numbers without being linked to environmental planning, the city will face risks of local overload and declining destination quality.

Hanoi has major advantages in cultural tourism. In theory, this form of tourism consumes fewer resources than mass resort tourism, but it is highly sensitive to the urban environment. A heritage site, old street, or lake space may not require large-scale accommodation infrastructure directly at the site, but it is easily affected by waste, noise, congestion, encroachment on space, and landscape degradation. Therefore, environmental standards for cultural destinations should be treated as standards of tourism-product quality.

In the context of increasingly intense destination competition, the environment has become a branding factor. International tourists and younger travelers tend to pay greater attention to clean air, safe walkability, green spaces, public transport, reduced plastic, and responsible local experiences. If Hanoi effectively controls the destination environment, the city can transform heritage, cuisine, pedestrian streets, night-time products, and craft villages into sustainable competitive advantages. If not, visitor growth may erode the very attractiveness of the destination.

Data constitute an important bottleneck. Hanoi currently has relatively good tourism statistics, but lacks a tourism environmental account system. There are no regular statistics on waste generated by tourists, water consumption by accommodation establishments, emissions from tourist transport, the share of green accommodation, hourly visitor density at destinations, or the environmental impacts of tourism events. In the absence of such data, policies often respond after overload has occurred rather than preventing it.

A feasible approach is to develop a “Hanoi tourism environmental pressure index.” The index can begin with data that are relatively easy to collect: visitor numbers by destination, waste collected at sites, the number of public toilets, waste collection frequency, tourist feedback, room occupancy, water and energy consumption among voluntarily participating hotels, the proportion of establishments reducing single-use plastics, and the proportion of tourists using public transport or electric vehicles. The city can subsequently expand toward the calculation of tourism carbon emissions.

The discussion also shows the need to distinguish between mass tourism and high-value tourism. Not all visitor growth generates the same pressure. A group of tourists who stay longer, use high-quality services, take guided tours, walk, or use public transport may generate high value with lower pressure than day-trippers who consume quickly, use private vehicles, and concentrate in a few overloaded sites. Therefore, regulating the visitor market is part of environmental policy.

For craft villages and peri-urban areas, tourism should be viewed simultaneously as an opportunity and a risk. Tourism can create motivation for craft preservation, increase incomes, and improve infrastructure. If it develops spontaneously, however, craft villages may face additional traffic, waste, wastewater, over-commercialization,

and loss of identity. Policy should require carrying-capacity assessment and environmental plans for each craft-village tourism cluster, rather than merely promoting products.

Finally, the study demonstrates the necessity of intersectoral governance. The Department of Tourism cannot by itself resolve waste, wastewater, air, and transport issues; the Department of Natural Resources and Environment also cannot manage tourist behavior and tourism products without sectoral data. Therefore, the DPSIR governance model should be institutionalized through data-sharing mechanisms among tourism, environment, construction, transport, culture, statistics, districts, and enterprises.

9. Policy implications and solutions

First, Hanoi needs to shift from managing visitor-number growth to managing destination carrying capacity. For areas such as Hoan Kiem Lake, the Old Quarter, the Temple of Literature - Imperial Academy, West Lake, Bat Trang, Duong Lam, Ba Vi, and Huong Son, warning thresholds should be developed either in real time or by time slot. These thresholds do not necessarily mean banning visitors; rather, they should be used to regulate flows, adjust events, increase sanitation frequency, add guiding staff, and recommend alternative routes.

Second, a tourism waste account should be established. The city can pilot the measurement of waste generated at selected tourist sites, pedestrian streets, food-service areas, night markets, and large events. Data should be standardized through indicators such as kilograms of waste per 1,000 visitors, waste-sorting rate, single-use plastic rate, sanitation cost per visitor, and the number of environmental-sanitation complaints. This provides the basis for designing tourism environmental service fees or sanitation procurement mechanisms for events.

Third, city-level green accommodation standards should be developed. These standards do not need to replace international certifications; they can serve as a basic Hanoi criteria set, including water saving, energy saving, elimination of single-use plastics, waste sorting, legally compliant collection contracts, wastewater treatment that meets standards, use of local products, and communication of green behavior to guests. Establishments meeting the standards can be prioritized for promotion on official tourism platforms.

Fourth, emissions from tourism transport should be reduced. Hanoi can develop tourism routes using electric vehicles, clean buses, public bicycles, heritage-connected walking routes, and peripheral transfer points for large tourist coaches. In the Old Quarter and Hoan Kiem Lake area, private vehicles should be restricted during tourism peak hours, while connections from metro lines, buses, and peripheral parking areas should be improved. Clean transport not only reduces pollution but also enhances the walking experience.

Fifth, wastewater management at tourism service establishments should be strengthened. While the proportion of treated urban wastewater remains low, hotels, restaurants, entertainment areas, craft villages, and peri-urban tourism sites need stricter inspection of connection, preliminary treatment, and compliance with discharge standards. For lakeside and riverside areas, higher requirements should be applied because of landscape and ecological sensitivity. Non-compliant establishments should be removed from the list of officially promoted qualified tourism services.

Sixth, environmental monitoring should be integrated with the digital tourism map. Hanoi has developed smart tourism platforms; the next step is to integrate environmental data layers such as AQI, public sanitation points, visitor density, waste complaints, walking routes, public transport, and water refill points. When tourists have better information, their movement and consumption behavior can become more dispersed, helping reduce overload.

Seventh, behavioral-change communication tools should be used. Sustainable tourism is not only the responsibility of government and enterprises. Tourists should be encouraged to carry personal water bottles, reduce single-use plastics, dispose of waste properly, respect heritage sites, use public transport, and choose green accommodation. Messages should be specific, easy to implement, and placed at contact points such as airports, hotels, pedestrian streets, heritage sites, tourism apps, and e-tickets.

Eighth, regional tourism linkages should be strengthened to reduce inner-city pressure. Hanoi can disperse visitor flows to peri-urban and neighboring destinations through cultural-ecological-craft-village routes. However, dispersing visitors does not mean transferring pressure from the center to the suburbs. Each new route should be accompanied by an environmental plan, waste collection points, toilets, parking areas, wastewater-control procedures, and mechanisms for benefit sharing with local communities.

Ninth, environmental criteria should be integrated into the evaluation of tourism-sector performance. In addition to visitor numbers and revenue, annual tourism reports should publish environmental indicators such as the number of green accommodation establishments, waste collected at key destinations, the proportion of events with environmental plans, the share of tourism products using clean transport, tourist satisfaction with environmental sanitation, and the number of destinations with carrying-capacity assessments.

Tenth, a financial mechanism for the tourism environment should be developed. The city may study environmental service fees for large events, mechanisms for enterprises to co-sponsor waste-sorting bins and public toilets, funds for landscape improvement at destinations, or sanitation procurement based on visitor volume. The key condition is that revenues must be transparent, reinvested in destination environmental improvement, and clearly communicated to enterprises, communities, and tourists.

10. Conclusion

This article has analyzed the relationship between tourism development and environmental pressure in Hanoi City during the period 2015-2024 based on secondary data, trend analysis, and the DPSIR model. The results show that Hanoi tourism experienced a strong growth trajectory before the pandemic, declined deeply during 2020-

2021, and recovered rapidly during 2022-2024. In 2024, Hanoi tourism nearly reached the pre-pandemic level in visitor volume and exceeded it in revenue, confirming the attractiveness and recovery capacity of the destination. However, tourism recovery is taking place in a context in which the urban environment remains under considerable pressure. PM2.5 remains high compared with international recommendations; daily municipal solid waste generation is substantial; and the proportion of treated urban wastewater remains low relative to green-development requirements. Tourism therefore cannot continue to be managed as a "smokeless industry" in the narrow sense. Although it is not the only pollution source, tourism creates significant additional pressure at high-density destinations and during peak seasons.

The main contribution of the study is the proposal of a cautious approach: it does not attribute all urban pollution to tourism, but it also does not detach tourism from environmental responsibility. The DPSIR framework helps identify the full chain of driving forces, pressures, state, impacts, and responses, thereby orienting policy from visitor-number growth toward the governance of carrying capacity, waste, wastewater, transport, and tourism environmental data.

The limitation of the study lies in its reliance on secondary data and the shortage of environmental data series specific to the tourism sector. Several environmental indicators had to use aggregate or interpolated values for trend analysis; therefore, the results should not be interpreted as causal evidence. Future research should collect micro-level data at destinations, survey tourism enterprises, and measure waste per visitor, wastewater per accommodation establishment, transport emissions, and residents' satisfaction levels.

From a policy perspective, Hanoi should regard the environment as a core competitive condition of urban tourism. A cultural destination seeking sustainable development must be clean, walkable, low in waste, low in congestion, rich in green spaces, supported by good sanitation infrastructure, and capable of controlling carrying capacity. When the environment is integrated into tourism governance, tourism growth will no longer conflict with environmental protection, but will become a resource for improving urban quality of life and the image of the capital.

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