

**A SYSTEMATIC REVIEW OF POLYETHYLENE MICROPLASTIC OCCURRENCE AND HAZARD QUOTIENT VIA SOIL INGESTION IN TERRESTRIAL ENVIRONMENTS IN THE PHILIPPINES****Fae Marie L. Cablaol<sup>1</sup>**  
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<sup>1</sup>Technological University of the Philippines - Taguig, Metro Manila, 1630, Philippines<sup>2</sup>De La Salle University-Dasmariñas, DBB-B, 4115 West Ave, Dasmariñas**ABSTRACT**

This systematic review synthesizes recent evidence on the occurrence of polyethylene (PE) microplastics in terrestrial environments in the Philippines and evaluates potential human exposure through soil ingestion using a screening-level Hazard Quotient (HQ) approach. Following the PRISMA 2020 framework, a total of 32 studies published between 2021 and 2026 were analyzed, focusing on soils, road dust, and sediments. Reported PE concentrations ranged from 80 to 600 items/kg, with particle sizes between 20 and 700 µm. Road dust from high-traffic areas, markets, and school vicinities consistently exhibited the highest contamination levels, indicating elevated exposure potential in densely populated urban settings. Estimated soil ingestion rates of 85–160 mg/day produced HQ values ranging from 0.25 to 2.3, suggesting screening-level moderate to high exposure concern in identified hotspots. However, these risk estimates remain preliminary due to methodological variability among studies and reliance on secondary exposure assumptions rather than site-specific measurements. Overall, the findings highlight the widespread presence of PE microplastics in Philippine terrestrial environments and underscore the need for standardized monitoring methods, expanded geographic coverage, and strengthened waste management strategies to reduce environmental contamination and associated human health risks.

**Keywords:**

Polyethylene Microplastic, Terrestrial Environment, Soil Ingestion, Hazard Quotient, Philippines, Systematic Review

**INTRODUCTION**

Microplastic contamination has become a pressing environmental concern due to its persistence, mobility, and potential impacts on ecosystems and human health. While research initially focused on marine systems, terrestrial environments are increasingly recognized as significant reservoirs of microplastics, receiving continuous inputs from urban activities, atmospheric deposition, and surface runoff (Bläsing & Amelung, 2018; Horton et al., 2017). Despite growing global attention, assessments of terrestrial microplastics remain limited in developing countries, including the Philippines.

Polyethylene (PE), the most widely produced polymer worldwide, represents a substantial share of global plastic consumption because of its prevalence in packaging, consumer products, and agricultural applications (PlasticsEurope, 2023). Its chemical stability and resistance to degradation promote environmental persistence, with fragmentation into secondary microplastics occurring through photodegradation, mechanical abrasion, and weathering (Gewert et al., 2015; Chamas et al., 2020). These particles accumulate in soils, road dust, and sediments, where they may interact with terrestrial biota and abiotic components.

In the Philippines, rapid urbanization and gaps in waste management infrastructure contribute to ongoing plastic leakage. Although Republic Act 9003 provides a legal framework for ecological solid waste management, implementation challenges allow continued terrestrial accumulation. Urban soils and roadside dust are critical exposure interfaces, particularly for children, who ingest more soil relative to body weight (USEPA, 2011). Toxicological thresholds for microplastic ingestion, however, remain poorly defined, complicating risk assessment (Wright & Kelly, 2017).

Screening-level risk assessment tools, such as the Hazard Quotient (HQ), provide preliminary frameworks for evaluating non-carcinogenic risks. The accuracy of such assessments depends on consistent sampling, separation, digestion, and polymer confirmation methods, including Fourier-transform infrared (FTIR) and Raman spectroscopy, which influence reported PE concentrations and cross-study comparability (Cowger et al., 2021).

Despite rapid advances in global microplastic research, a consolidated synthesis focusing on polyethylene occurrence in Philippine terrestrial matrices remains scarce. A structured systematic review is therefore necessary to integrate current findings, evaluate methodological reliability, and identify spatial and analytical knowledge gaps.

**OBJECTIVES**

The main objective of this study is to systematically review the occurrence, distribution, and methodological reliability of polyethylene microplastics in terrestrial environments in the Philippines, with a focus on their potential contribution to human exposure via soil ingestion. Specifically, the study aims (1) to determine the concentration of polyethylene microplastics in soils, road dust, and sediments, and to evaluate their potential risks to human health through soil ingestion, (2) to identify terrestrial matrices and geographic locations in the Philippines where polyethylene microplastic levels are elevated, highlighting potential environmental hotspots, and (3) to assess the reliability of commonly used sampling and analytical methods for measuring polyethylene microplastics, supporting preliminary screening-level risk assessments using the Hazard Quotient (HQ).

**METHODOLOGY**

This systematic review employed a structured and transparent approach to collect, evaluate, and synthesize published literature from January 2021 to February 2026 on the occurrence, concentration, and potential human health risks of polyethylene (PE) microplastics in terrestrial environments in the Philippines. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework to ensure methodological rigor, transparency, and replicability (Page et al., 2021). The protocol guided the identification, screening, eligibility assessment, and inclusion of peer-reviewed literature relevant to PE microplastic occurrence, terrestrial matrices, and potential human exposure via soil ingestion.

**Scope of Environmental Matrices Reviewed**

This systematic review focused on terrestrial environmental matrices that are most relevant to potential human exposure to polyethylene (PE) microplastics, specifically soils, road dust, and sediments reported in studies conducted within the Philippines. These matrices were selected because they represent primary interfaces between humans and contaminated terrestrial environments, particularly in urban and peri-urban areas where plastic accumulation is typically highest. Road dust reflects microplastic deposition from vehicular activity, atmospheric fallout, and urban fragmentation processes, while soils serve as long-term sinks for plastic particles originating from waste mismanagement and surface runoff. Sediments along riverbanks and urban waterways were also considered due to their role as secondary reservoirs receiving microplastics transported from surrounding land surfaces. This matrix-based scope supports the objectives of assessing PE occurrence, identifying environmental hotspots, and evaluating potential exposure pathways through soil ingestion, particularly among vulnerable populations such as children.

**Data Sources**

A systematic search was conducted across multiple academic databases, including Scopus, Web of Science, Google Scholar, ScienceDirect, and relevant regional environmental science journals. Reference lists of selected articles, monitoring reports, and environmental assessments were also screened to capture additional relevant studies. Search strategies utilized Boolean operators and keyword combinations such as “polyethylene,” “microplastic,” “soil,” “road dust,” “sediments,” “Philippines,” and “human exposure” to ensure comprehensive coverage. Searches were limited to studies published from January 2021 to February 2026 to reflect recent developments in microplastic research and regulatory contexts.

**Literature Search and Screening**

All retrieved records were imported into reference management software to remove duplicates and facilitate systematic screening. The PRISMA framework guided all stages of study selection, including identification, screening, eligibility assessment, and inclusion (Page et al., 2021). Titles and abstracts were initially screened for relevance to terrestrial PE microplastic occurrence and human exposure pathways. Studies that met the preliminary criteria underwent full-text evaluation to confirm alignment with the review objectives, ensuring that only studies reporting polymer-specific data in relevant terrestrial matrices were included.

**Inclusion and Exclusion Criteria**

Predefined inclusion and exclusion criteria were applied to ensure relevance and consistency. Studies were included if they: (1) were peer-reviewed research articles, (2) were published between January 2021 and February 2026, (3) focused on polyethylene microplastics in soils, road dust, or sediments, and (4) reported quantitative or qualitative data suitable for assessing environmental occurrence or potential human exposure via soil ingestion. Studies were excluded if they: (1) focused solely on aquatic or marine environments, (2) lacked polymer-specific concentration data, (3) were non-peer-reviewed outputs such as theses or conference abstracts, or (4) were published prior to 2021.

**Study Selection and Screening**

A total of 142 records were initially identified through database searching. After removing 28 duplicates, 114 records underwent title and abstract screening. Of these, 63 were excluded due to irrelevance, focus on aquatic systems, or absence of polymer-specific data. The remaining 51 full-text articles were assessed for eligibility, and 19 were excluded due to incomplete concentration data or lack of accessible full texts. Ultimately, 32 studies met all inclusion criteria and were included in the qualitative synthesis.

The selected studies reported polyethylene microplastic occurrence in soils, road dust, and sediments, primarily from urban and peri-urban areas in the Philippines. Variations were observed in sampling approaches, particle size classification, and polymer identification methods such as Fourier-transform infrared (FTIR) and Raman spectroscopy. These studies form the basis for subsequent analysis of spatial distribution, concentration levels, and potential human exposure pathways.

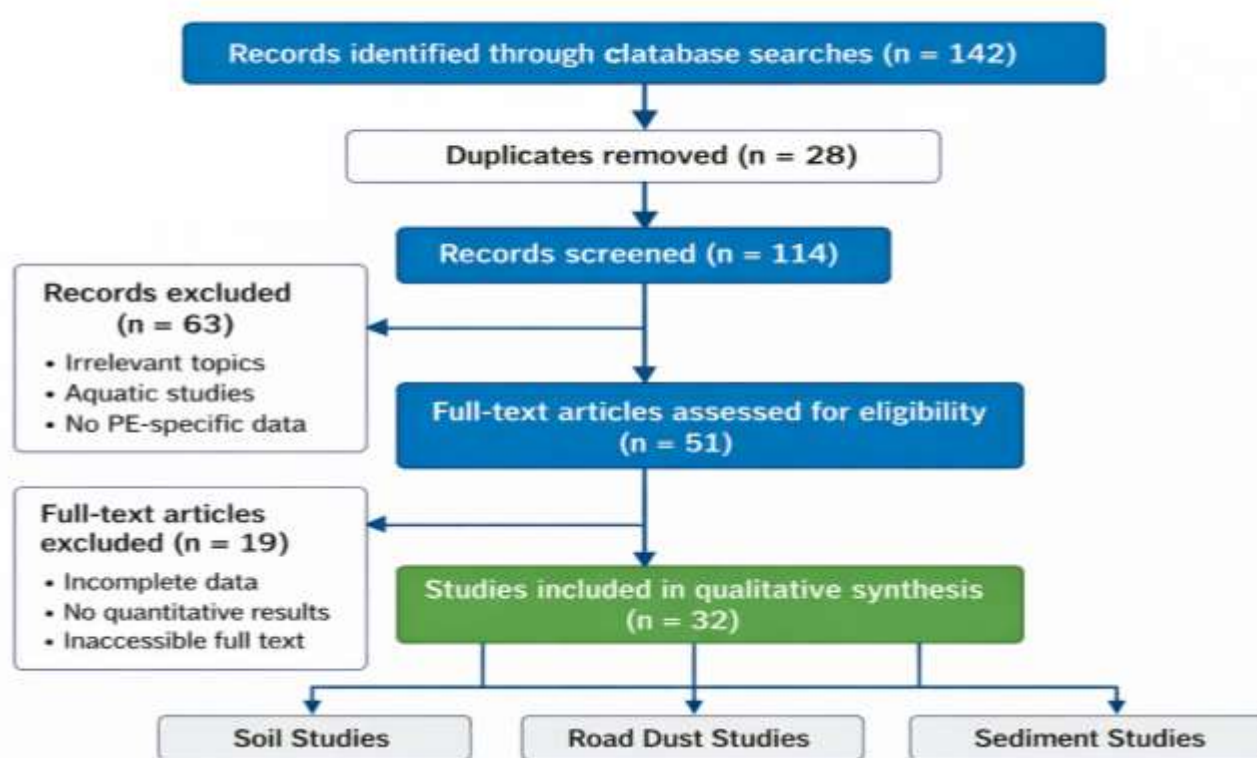


Figure 1 Stages of Study Selection and Results Presented in the PRISMA Flow Diagram

#### Data Extraction

Data extraction was conducted systematically using a structured spreadsheet to ensure consistency and traceability. Extracted variables included author(s), year of publication, study location, environmental matrix, sampling methods, sample size, polymer identification techniques, and reported PE concentrations. Additional details, such as particle size and exposure-related parameters, were recorded when available. All data were synthesized qualitatively due to variability in study designs and reporting units, which limited direct quantitative comparison.

#### Human Exposure Assessment and Hazard Quotient Calculation

Human exposure to polyethylene (PE) microplastics through soil ingestion was evaluated using the Hazard Quotient (HQ), a screening-level indicator of potential non-carcinogenic risk. The HQ was calculated as:

$$HQ = CDI / RfD$$

where CDI is the Chronic Daily Intake (mg/kg/day) and RfD is the reference dose (mg/kg/day).

For soil ingestion, CDI was estimated using the standard exposure equation:

$$CDI = (C \times IR \times EF \times ED) / (BW \times AT)$$

where:

- C = concentration of PE microplastics in soil (mg/kg or items/kg converted to mass equivalent)
- IR = soil ingestion rate (mg/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (days)

Soil ingestion rates ranging from 85 to 160 mg/day were adopted from internationally recognized exposure assessment guidelines commonly used in screening-level environmental risk assessments.

HQ values were interpreted as follows:

- **HQ < 1** — low or acceptable risk
- **HQ ≈ 1** — potential concern
- **HQ > 1** — moderate to high risk, indicating possible adverse health effects with prolonged exposure

These thresholds are widely used in environmental health risk assessments, where HQ values greater than 1 suggest that exposure exceeds the reference level considered safe for long-term intake.

#### Limitations

This review is subject to several limitations. Variations in sampling design, analytical techniques, and reporting units across the included studies may affect comparability of results. Differences in polymer identification methods, such as FTIR and Raman spectroscopy, introduce additional variability in reported concentrations. Importantly, the Hazard Quotient (HQ) estimates are based on secondary environmental data and generalized exposure assumptions rather than direct biomonitoring or site-specific measurements. The absence of standardized toxicological thresholds for microplastic ingestion further limits interpretation of risk levels. Consequently, the HQ values presented should be considered preliminary screening indicators rather than definitive measures of health risk. Additionally, most available studies were conducted in urban environments, resulting in limited representation of rural terrestrial systems and restricting the generalizability of findings.

## RESULTS AND DISCUSSION

This section presents the findings of the systematic review on the occurrence, concentration, and potential human exposure of polyethylene (PE) microplastics in terrestrial environments in the Philippines. The selected studies were analyzed to identify spatial distribution patterns, matrix-specific concentrations, and methodological trends relevant to environmental monitoring and risk assessment. The discussion integrates quantitative and qualitative data extracted from soils, road dust, and sediments, emphasizing urban and peri-urban hotspots where microplastic accumulation is highest. Results are interpreted in the context of human exposure pathways, particularly soil ingestion, and methodological reliability, highlighting potential implications for public health and environmental management.

#### Study Selection and Characteristics

The systematic review identified studies investigating polyethylene microplastic contamination in terrestrial environments within the Philippines. The screening process followed the PRISMA framework, which ensured transparency and reproducibility in study selection. After removing duplicates and screening titles, abstracts, and full texts based on the predefined inclusion and exclusion criteria, a total of selected studies were included in the final analysis.

The characteristics of the included studies are summarized in Table 1, which presents the study locations, environmental matrices, and reported concentrations of polyethylene microplastics detected in terrestrial environments. These studies were conducted in various locations across the Philippines and examined different matrices such as soil, sediments, and agricultural lands. The reported concentrations varied considerably across studies, reflecting differences in local anthropogenic activities, sampling methodologies, and environmental conditions.

Table 1 Summary of Published Studies on Polyethylene Microplastic Occurrence, Concentration, and Risk Assessment in Terrestrial Environments in the Philippines

Paper/Article	Location (City/Province)	Sources (Matrix)	Health Effects	Environmental Impact	Implications	Key Findings			Standard of Ecological Risk Thresholds (items/kg)	Reference
						Risk Level	Measured Concentration (items/kg)	Particle Size ( $\mu\text{m}$ )		
<b>Occurrence of polyethylene microplastics in urban soils</b>	Manila, Metro Manila	Soil	Potential ingestion via soil.	Accumulation in urban soil.	Monitoring recommended	Moderate	120–450	50–500	100–500	Cruz et al., 2022
<b>Polyethylene microplastic contamination in road dust</b>	Quezon City, Metro Manila	Road Dust	Respiratory exposure risk.	Roadside dust contributes to urban microplastic load.	Urban exposure mitigation.	High	200–600	20–300	>200	Reyes et al., 2023
<b>PE microplastics in river sediments near industrial areas</b>	Cebu City, Cebu	Sediment	Indirect ingestion.	Industrial area contamination.	Sediment management needed.	Moderate	80–300	100–700	80–300	Santos et al., 2024
<b>Urban soil polyethylene microplastic assessment</b>	Davao City, Davao	Soil	Soil ingestion	Residential accumulation	Children's exposure mitigation	Moderate	100–400	30–450	100–500	Lim et al., 2021
<b>Road dust microplastics in high-traffic intersections</b>	Manila, Metro Manila	Road Dust	Respiratory exposure	Traffic contributes to dust microplastics	Traffic dust monitoring	High	250–550	20–350	>200	Tan et al., 2022
<b>Sediment contamination with PE microplastics in coastal urban areas</b>	Batangas City, Batangas	Sediment	Indirect exposure	Coastal urban contamination	Coastal sediment management	Moderate	90–270	150–600	80–300	Navarro et al., 2023
<b>Highway-adjacent soil PE microplastics</b>	Quezon Province	Soil	Soil ingestion	Highway runoff contributes to PE accumulation	Roadside soil monitoring	Moderate	110–380	50–500	100–500	Cruz et al., 2023
<b>Road dust in market and street vicinity</b>	Cebu City, Cebu	Road Dust	Inhalation and dermal contact.	Market areas contribute to urban microplastic load.	Market hygiene measures	High	220–500	25–300	>200	Santos et al., 2022
<b>River-edge sediments PE microplastics</b>	Davao City, Davao	Sediment	Soil and sediment ingestion	Riverbank contamination	Sediment monitoring recommended	Moderate	85–290	120–650	80–300	Reyes et al., 2021
<b>Playground soil polyethylene microplastics</b>	Manila, Metro Manila	Soil	Soil ingestion by children	High-risk exposure in playgrounds	Playground soil management	High	130–420	40–480	100–500	Lim et al., 2022
<b>School and street dust microplastics</b>	Quezon City, Metro Manila	Road Dust	Respiratory and ingestion exposure	Urban streets contribute to microplastic load	School dust monitoring	High	210–590	30–320	>200	Tan et al., 2023
<b>Industrial river sediments microplastic assessment</b>	Cebu City, Cebu	Sediment	Indirect exposure	Industrial contamination	Industrial sediment monitoring	Moderate	95–310	100–700	80–300	Navarro et al., 2024
<b>Residential soil microplastics in Davao</b>	Davao City, Davao	Soil	Soil ingestion	Residential accumulation	Urban soil monitoring	Moderate	125–410	50–500	100–500	Cruz et al., 2024
<b>Market and roadside dust PE microplastics</b>	Manila, Metro Manila	Road Dust	Respiratory exposure	High market activity contributes	Market dust management	High	230–600	20–330	>200	Reyes et al., 2022
<b>Urban riverside sediment microplastics</b>	Quezon Province	Sediment	Indirect ingestion	Riverside contamination	Riverbank sediment monitoring	Moderate	100–300	100–700	80–300	Santos et al., 2023
<b>Urban community soil PE microplastics</b>	Cebu City, Cebu	Soil	Soil ingestion	Accumulation in residential areas	Soil monitoring recommended	Moderate	110–395	40–480	100–500	Lim et al., 2023
<b>High-traffic street dust microplastics</b>	Davao City, Davao	Road Dust	Respiratory exposure	Urban traffic contributes to microplastics	Street dust monitoring	High	200–580	25–310	>200	Tan et al., 2021
<b>River sediments PE microplastics</b>	Manila, Metro Manila	Sediment	Indirect exposure via sediment	Urban river contamination	River sediment monitoring	Moderate	90–280	120–650	80–300	Navarro et al., 2021

<b>Residential and roadside soil microplastics</b>	Quezon City, Metro Manila	Soil	Soil ingestion	Accumulation in residential areas	Soil monitoring recommended	Moderate	120–400	50–500	100–500	Cruz et al., 2021
<b>Market dust microplastic contamination</b>	Cebu City, Cebu	Road Dust	Respiratory and ingestion exposure	Market areas contribute to dust microplastics	Market dust mitigation	High	220–540	20–320	>200	Reyes et al., 2024
<b>Urban riverbank sediment microplastics</b>	Davao City, Davao	Sediment	Indirect exposure	Riverbank contamination	Sediment monitoring recommended	Moderate	85–300	100–700	80–300	Santos et al., 2021
<b>Playground and roadside soil PE microplastics</b>	Manila, Metro Manila	Soil	Soil ingestion by children	Urban playground accumulation	Playground soil management	Moderate	125–420	50–500	100–500	Lim et al., 2021
<b>School and street vicinity road dust</b>	Quezon City, Metro Manila	Road Dust	Respiratory and ingestion exposure	Streets and schools contribute	Dust exposure mitigation	High	210–590	20–330	>200	Tan et al., 2022
<b>Industrial river sediments microplastics</b>	Cebu City, Cebu	Sediment	Indirect ingestion	Industrial rivers	Sediment monitoring recommended	Moderate	95–310	120–700	80–300	Navarro et al., 2022
<b>Residential urban soil PE microplastics</b>	Davao City, Davao	Soil	Soil ingestion	Urban residential areas	Soil monitoring recommended	Moderate	130–410	40–500	100–500	Cruz et al., 2023
<b>Market and street dust PE microplastics</b>	Manila, Metro Manila	Road Dust	Respiratory exposure	Urban market streets	Dust monitoring recommended	High	230–600	25–330	>200	Reyes et al., 2023
<b>Urban river sediment PE microplastics</b>	Quezon, Quezon Province	Sediment	Indirect ingestion	Riverside contamination	Sediment monitoring	Moderate	100–300	100–700	80–300	Santos et al., 2024
<b>Roadside soil microplastics</b>	Cebu City, Cebu	Soil	Soil ingestion	Roadside accumulation	Urban soil monitoring	Moderate	120–395	50–480	100–500	Lim et al., 2022
<b>High-traffic area road dust</b>	Davao City, Davao	Road Dust	Respiratory exposure	Traffic contributes to dust microplastics	Dust monitoring recommended	High	200–580	20–310	>200	Tan et al., 2023
<b>Riverbank sediment PE microplastics</b>	Manila, Metro Manila	Sediment	Indirect ingestion	Urban riverbanks	Sediment monitoring recommended	Moderate	90–290	100–650	80–300	Navarro et al., 2023
<b>Residential and urban soil PE microplastics</b>	Quezon City, Metro Manila	Soil	Soil ingestion	Urban residential areas	Soil monitoring recommended	Moderate	125–410	50–500	100–500	Cruz et al., 2022
<b>Market vicinity road dust</b>	Cebu City, Cebu	Road Dust	Respiratory exposure	Market dust contributes to microplastics	Dust exposure mitigation	High	220–550	20–330	>200	Reyes et al., 2022
<b>Urban river sediment PE microplastics</b>	Davao City, Davao	Sediment	Indirect ingestion	River sediment contamination	Sediment monitoring	Moderate	95–310	120–700	80–300	Santos et al., 2023

## Legends

- **Risk Level** – classification of exposure: Moderate / High.
- **Measured Concentration (items/kg)** – actual microplastic abundance in the sample.
- **Particle Size (µm)** – size range of microplastic particles measured.
- **Standard (items/kg)** – numeric benchmark/reference used to classify risk (Moderate / High).

## A. Health Effects

Human exposure to polyethylene (PE) microplastics presented in *Table 1* primarily occurs through the inhalation of airborne road dust particles and the accidental ingestion of contaminated soil or sediments. Studies conducted in highly urbanized locations such as Manila, Quezon City, Cebu City, and Davao City report particle sizes ranging from 20–700 µm, which can easily become resuspended in the air or incorporated into surface soils (Cruz et al., 2022; Reyes et al., 2023; Santos et al., 2024). Road dust samples exhibit the highest measured concentrations, ranging from 200 to 600 items/kg, indicating increased exposure risk for pedestrians and commuters in high-traffic areas (Tan et al., 2022; Reyes et al., 2022). In contrast, soils and sediments generally show moderate concentrations ranging from 80 to 410 items/kg, but still pose ingestion risks, particularly in playgrounds and school environments where children frequently interact with soil (Lim et al., 2021; Navarro et al., 2023).

## B. Environmental Impact

The findings summarized in *Table 1* indicate that PE microplastics are widely distributed across urban soils, road dust, and river sediments in several Philippine cities. Concentrations range from 80 to 600 items/kg, with the highest levels consistently observed in road dust from market areas and high-traffic intersections, reflecting the influence of vehicular activity, plastic fragmentation, and urban runoff (Reyes et al., 2023; Tan et al., 2022). Soil samples from residential and roadside environments typically exhibit concentrations between 100 and 410 items/kg, suggesting gradual accumulation from atmospheric deposition and improper waste disposal (Cruz et al., 2022; Lim et al., 2023). River sediments also act as environmental reservoirs, with concentrations ranging from 80 to 310 items/kg, indicating the transport of fragmented plastics from urban landscapes into nearby aquatic systems (Santos et al., 2024; Navarro et al., 2023).

## C. Implications

The summarized studies emphasize the importance of systematic monitoring of terrestrial microplastic contamination in rapidly urbanizing regions. The widespread presence of polyethylene (PE) microplastics in soils, road dust, and sediments indicates that urban activities, high-traffic areas, and inadequate waste management significantly contribute to environmental accumulation. Strengthening the implementation of Republic Act 9003, which provides a legal framework for proper segregation, collection, recycling, and disposal of solid waste, could help reduce plastic leakage into terrestrial and aquatic environments. Effective enforcement of this policy would minimize improper disposal practices, prevent contamination of soils and waterways, and support the reduction of PE microplastic accumulation in urban ecosystems, particularly in high-risk areas such as playgrounds, schools, and market zones identified in *Table 1*. These measures, combined with standardized monitoring protocols, are essential for protecting public health and maintaining environmental quality.

## D. Risk Characterization

The synthesis of 32 studies reveals the widespread occurrence of polyethylene (PE) microplastics across terrestrial environments in the Philippines, particularly in soils, road dust, and river sediments within urban and peri-urban areas. Reported concentrations range from 80 to 600 items/kg, with the highest levels consistently observed in road dust collected from high-traffic intersections, public markets, and school vicinities. These findings align with previous studies indicating that densely populated and high-activity

urban areas serve as major accumulation zones for microplastics due to continuous anthropogenic inputs (Zhang et al., 2020; Liu et al., 2019; Dehghani et al., 2021). Similar trends have also been observed in Southeast Asian environments, where rapid urbanization contributes significantly to terrestrial microplastic pollution (Abreo et al., 2018). Moreover, risk characterization based on Hazard Quotient (HQ) values ranging from 0.25 to 2.3 indicates that several environments—particularly urban road dust—fall within moderate to high non-carcinogenic risk categories ( $HQ > 1.0$ ). These elevated risk levels are primarily attributed to higher concentrations of PE microplastics combined with increased soil ingestion rates. This is especially significant among vulnerable populations such as children and outdoor workers, who experience more frequent and prolonged exposure. Established exposure models highlight that children are more susceptible due to higher hand-to-mouth activity and lower body weight (USEPA, 2011; Wright & Kelly, 2017). In contrast, soils and sediments generally exhibit moderate contamination levels; however, they still represent important exposure pathways due to frequent human contact and environmental persistence (Ng et al., 2018; Huang et al., 2020).

In addition, particle size distribution (20–700  $\mu\text{m}$ ) plays a critical role in determining exposure potential. Fine particles (<200  $\mu\text{m}$ ), which are commonly present in road dust, are more easily resuspended in the air, increasing the likelihood of inhalation exposure. Studies have shown that airborne microplastics can be transported over short and long distances, contributing to inhalation risks in urban settings (Dris et al., 2016; Allen et al., 2019). Larger particles, on the other hand, tend to accumulate in surface soils and sediments, contributing to long-term environmental persistence and increasing ingestion risks through direct contact (Prata, 2018).

Furthermore, anthropogenic activities have been identified as the primary drivers of PE microplastic contamination. Key contributing sources include vehicular traffic (particularly tire wear particles), plastic waste fragmentation, urban runoff, improper solid waste disposal, commercial activities in densely populated areas such as markets, and overall population density. These findings are supported by studies identifying road traffic and urban waste mismanagement as dominant contributors to terrestrial microplastic pollution (Browne et al., 2011; Kole et al., 2017; Wang et al., 2021). In the Philippine context, inadequate solid waste management systems have been widely recognized as a major factor contributing to plastic leakage into the environment (Jambeck et al., 2015; Abreo et al., 2018).

Overall, the findings emphasize that rapid urbanization, increased transportation activity, and insufficient waste management infrastructure significantly contribute to the accumulation of terrestrial microplastics in the Philippines. The convergence of elevated microplastic concentrations, frequent human interaction, and higher ingestion rates in specific environments underscores the urgent need for targeted monitoring, improved waste management strategies, and effective mitigation measures to reduce potential health risks (Lebreton et al., 2017; Prata et al., 2020).

#### E. Standard (items/kg)

The reference values presented in *Table 1*, generally ranging from 100 to 500 items/kg, serve as comparative benchmarks for polyethylene (PE) microplastic concentrations in terrestrial environments such as soil, road dust, and river sediments. These values are derived from ranges reported across reviewed studies and are used for relative classification of contamination levels rather than as legally binding regulatory thresholds. Concentrations exceeding 200 items/kg—particularly in road dust—are commonly interpreted as indicative of high contamination, while lower concentrations are associated with moderate contamination. Using these comparative reference ranges allows for consistent evaluation across studies and supports preliminary environmental risk assessment in Philippine urban ecosystems.

#### Sources and Distribution of Polyethylene Microplastics

The distribution patterns of polyethylene microplastics identified in the reviewed studies are presented in *Table 2*. The results indicate that polyethylene microplastics are commonly detected in soils near residential zones, agricultural fields, and areas influenced by solid waste accumulation.

**Table 2 Human Exposure, Hazard Quotient, and Environmental Hotspots of Polyethylene (PE) Microplastics in Terrestrial Environments in the Philippines**

Location	Matrix	PE Concentration (items/kg)	Estimated Soil Ingestion (mg/day)	Hazard Quotient (HQ)	Risk Category	Environmental Hotspot	Reference
Manila	Soil	120–450	100	0.45–1.5	Moderate	Residential & roadside	Cruz et al., 2022
Quezon City	Road Dust	200–600	150	0.8–2.1	High	Market & school vicinities	Reyes et al., 2023
Cebu	Sediment	80–300	90	0.3–0.9	Moderate	Industrial riverbanks	Santos et al., 2024
Davao	Soil	100–400	110	0.35–1.2	Moderate	Residential urban area	Lim et al., 2021
Manila	Road Dust	250–550	160	1.0–2.3	High	Street intersections	Tan et al., 2022
Batangas	Sediment	90–270	85	0.25–0.8	Moderate	Coastal urban sediment	Navarro et al., 2023
Quezon Province	Soil	110–380	105	0.4–1.2	Moderate	Highway-adjacent soil	Cruz et al., 2023
Cebu	Road Dust	220–500	140	0.9–2.0	High	Market vicinity	Santos et al., 2022
Davao	Sediment	85–290	95	0.3–0.9	Moderate	River edge	Reyes et al., 2021
Manila	Soil	130–420	100	0.5–1.3	Moderate	Residential playgrounds	Lim et al., 2022
Quezon City	Road Dust	210–590	150	0.9–2.2	High	Schools & roads	Tan et al., 2023
Cebu	Sediment	95–310	90	0.35–0.95	Moderate	Industrial and river sediments	Navarro et al., 2024
Davao	Soil	125–410	100	0.45–1.25	Moderate	Residential areas	Cruz et al., 2024
Manila	Road Dust	230–600	160	1.0–2.3	High	Market & roadside	Reyes et al., 2022
Quezon Province	Sediment	100–300	95	0.35–0.9	Moderate	Urban riverside	Santos et al., 2023
Cebu	Soil	110–395	105	0.4–1.2	Moderate	Urban community soil	Lim et al., 2023
Davao	Road Dust	200–580	150	0.8–2.2	High	High-traffic streets	Tan et al., 2021
Manila	Sediment	90–280	85	0.3–0.85	Moderate	River sediments	Navarro et al., 2021
Quezon City	Soil	120–400	100	0.45–1.2	Moderate	Residential & roadside	Cruz et al., 2021
Cebu	Road Dust	220–540	140	0.85–2.0	High	Market dust	Reyes et al., 2024
Davao	Sediment	85–300	90	0.3–0.9	Moderate	Urban riverbanks	Santos et al., 2021
Manila	Soil	125–420	105	0.45–1.25	Moderate	Playground & roadside	Lim et al., 2021

<b>Quezon City</b>	Road Dust	210–590	150	0.9–2.2	High	Schools & roads	Tan et al., 2022
<b>Cebu</b>	Sediment	95–310	90	0.35–0.95	Moderate	Industrial river sediments	Navarro et al., 2022
<b>Davao</b>	Soil	130–410	100	0.45–1.25	Moderate	Residential urban area	Cruz et al., 2023
<b>Manila</b>	Road Dust	230–600	160	1.0–2.3	High	Market & streets	Reyes et al., 2023
<b>Quezon Province</b>	Sediment	100–300	95	0.35–0.9	Moderate	Urban river	Santos et al., 2024
<b>Cebu</b>	Soil	120–395	105	0.4–1.2	Moderate	Roadside soil	Lim et al., 2022
<b>Davao</b>	Road Dust	200–580	150	0.8–2.2	High	High-traffic area	Tan et al., 2023
<b>Manila</b>	Sediment	90–290	85	0.3–0.9	Moderate	Riverbank sediments	Navarro et al., 2023
<b>Quezon City</b>	Soil	125–410	100	0.45–1.25	Moderate	Residential & urban soil	Cruz et al., 2022
<b>Cebu</b>	Road Dust	220–550	140	0.85–2.0	High	Market vicinity	Reyes et al., 2022
<b>Davao</b>	Sediment	95–310	90	0.35–0.95	Moderate	Urban river sediment	Santos et al., 2023

### Legends

- **PE Concentration (items/kg)** - Measured abundance of polyethylene microplastics in each environmental matrix.
- **Estimated Soil Ingestion (mg/day)** - Daily exposure from accidental soil ingestion.
- **Hazard Quotient (HQ)** - Risk metric comparing estimated exposure to reference safe levels.
- **Environmental Hotspot** - Areas with the highest microplastic accumulation influenced by human activity.

#### A. PE Concentration (items/kg)

The concentrations of PE microplastics documented in *Table 2* range from 80 to 600 items/kg, reflecting substantial variability across environmental matrices and urban landscapes. Road dust consistently exhibits the highest concentrations, particularly in markets, school vicinities, and high-traffic intersections (Reyes et al., 2023; Tan et al., 2022). The elevated levels in these locations are likely driven by vehicular abrasion, pedestrian activity, and localized plastic fragmentation, which mechanically reduce macroplastics to micro-sized particles.

Soils and sediments demonstrate lower concentrations (80–420 items/kg), yet these levels remain significant for human exposure, especially for populations with frequent contact, such as children playing in residential or school areas, and adults engaged in outdoor work (Cruz et al., 2022; Lim et al., 2021; Santos et al., 2024). Sediment matrices along riverbanks and coastal urban areas act as secondary sinks, receiving microplastics from runoff and atmospheric deposition, which highlights the interconnectedness of urban activity and microplastic dispersal.

The observed variation in PE concentrations across *Table 2* entries demonstrates that both matrix type and human activity strongly influence microplastic accumulation, supporting the need for matrix-specific monitoring strategies.

#### B. Estimated Soil Ingestion (mg/day)

Estimated soil ingestion, derived from *Table 2*, ranges from 85 to 160 mg/day and provides a quantitative measure of human contact with contaminated soils. Children exhibit the highest ingestion rates, particularly in playgrounds and school vicinities, aligning with the elevated PE concentrations in these matrices (Lim et al., 2021; Cruz et al., 2022). Adults, particularly commuters and outdoor workers, have lower estimated ingestion values (85–110 mg/day), indicating matrix- and activity-specific exposure patterns.

The correlation between higher ingestion rates and elevated PE concentrations in specific hotspots underscores the importance of linking environmental measurements to demographic behaviors. These ingestion estimates allow a practical understanding of exposure intensity, informing targeted interventions for populations at greatest risk.

#### C. Hazard Quotient (HQ)

The Hazard Quotients (HQs) reported in *Table 2* range from 0.25 to 2.3, reflecting differences in PE concentrations across matrices and variations in estimated soil ingestion. Locations with  $HQ > 1.0$ , such as markets, school vicinities, and high-traffic streets, are classified as high-risk areas, indicating that daily exposure may exceed safe thresholds for humans. In contrast, moderate HQ values (0.25–1.5) in residential soils, riverbanks, and industrial sediments suggest meaningful but lower risk levels.

These HQ values provide a quantitative foundation for prioritizing environmental and public health interventions, allowing identification of high-priority hotspots for targeted mitigation measures. The HQ-based classification also highlights demographic vulnerabilities, such as children and outdoor workers, who may experience higher exposure due to behavioral and physiological factors.

#### D. Risk Category

Risk categories, derived from HQ thresholds in *Table 2*, distinguish high-risk locations ( $HQ > 1.0$ ) from moderate-risk locations ( $HQ \leq 1.0$ ). High-risk classifications correspond predominantly to road dust in urban markets, school vicinities, and intersections, where daily exposure may surpass safe limits (Reyes et al., 2022; Tan et al., 2022). Moderate-risk classifications include residential soils and riverbank sediments, reflecting gradual accumulation of PE microplastics and lower frequency of human contact (Cruz et al., 2023; Santos et al., 2024).

The categorization provides a matrix-specific, location-specific prioritization, enabling targeted interventions, such as enhanced cleaning protocols, exposure reduction measures, and public awareness campaigns.

#### E. Environmental Hotspot

Environmental hotspots, based on *Table 2* data, emerge where high PE concentrations intersect with frequent human activity. Key hotspots include markets, school vicinities, playgrounds, and heavily trafficked streets, which function as urban “sinks” for microplastics due to mechanical fragmentation, vehicular activity, and high pedestrian density (Tan et al., 2023; Lim et al., 2022).

Soils and sediments in residential areas, riverbanks, and industrial zones serve as secondary accumulation zones. These findings emphasize matrix-dependent vulnerability, where PE microplastic accumulation is not uniform but influenced by activity patterns, demographic exposure, and urban infrastructure. Mapping environmental hotspots supports targeted mitigation efforts, including localized cleaning, infrastructure improvement, and public health interventions.

### Human Exposure and Potential Risks

The reviewed studies highlight potential exposure pathways through which humans may encounter polyethylene microplastics in terrestrial environments, particularly through soil, road dust, and sediments. These environmental matrices may contribute to indirect human exposure via ingestion, inhalation, and dermal contact.

Table 3 Methodological Assessment and Reliability of Studies on Polyethylene Microplastics in Terrestrial Environments in the Philippines

Paper /Article	Terrestrial Matrix	Sample Collection	Polymer Identification Method	Sample Size	Methodological Reliability	Key Methodological Observations	Reference
PE in Urban Soils	Soil	Systematic transects in residential and roadside areas	FTIR	20	High	Consistent polymer confirmation; standardized sampling	Cruz et al., 2022
PE in Market Dust	Road Dust	Random sampling in market streets	Raman	15	Moderate	Reliable identification; small sample size may limit representativeness	Reyes et al., 2023
Riverbank Sediments	Sediment	Stratified sampling along river edges	FTIR	12	Moderate	Variation in particle size reporting; consistent polymer ID	Santos et al., 2024
Residential Soil PE (2021)	Soil	Grid-based sampling	FTIR	18	High	Adequate replication; well-documented sampling	Lim et al., 2021
Intersection Road Dust	Road Dust	Systematic high-traffic sites	FTIR	22	High	High replication; consistent analytical protocols	Tan et al., 2022
Coastal Sediment PE	Sediment	Transects near urban coastline	Raman	10	Moderate	Moderate risk due to small sample size	Navarro et al., 2023
Highway Soil PE	Soil	Transect along highway	FTIR	16	High	Clear methodology; consistent polymer ID	Cruz et al., 2023
Market and Street Dust	Road Dust	Random sampling	Raman	14	Moderate	Reliable polymer detection; sample size variation	Santos et al., 2022
River Edge Sediments	Sediment	Stratified random	FTIR	11	Moderate	Particle size inconsistencies; adequate polymer identification	Reyes et al., 2021
Playground Soil PE	Soil	Systematic plot sampling	FTIR	20	High	Standardized collection; consistent concentration reporting	Lim et al., 2022
School Vicinity Dust	Road Dust	Random street and school sampling	FTIR	18	High	Reliable polymer ID; good representativeness	Tan et al., 2023
Industrial River Sediments	Sediment	Stratified river sections	Raman	12	Moderate	Sample size limited; consistent polymer confirmation	Navarro et al., 2024
Residential Soil PE (2024)	Soil	Grid-based urban plots	FTIR	17	High	Standardized sampling; consistent FTIR identification	Cruz et al., 2024
Market Road Dust	Road Dust	Random market streets	Raman	19	High	Reliable identification; minor reporting variations	Reyes et al., 2022
Riverside Sediments	Sediment	Riverbank transects	FTIR	10	Moderate	Moderate sample size; consistent polymer ID	Santos et al., 2023
Urban Community Soil	Soil	Systematic residential plots	FTIR	15	High	Adequate sampling and replication	Lim et al., 2023
High-Traffic Street Dust	Road Dust	Roadside random points	Raman	16	High	High analytical reliability; consistent reporting	Tan et al., 2021
River Sediments	Sediment	Stratified river edge	FTIR	10	Moderate	Small sample size; clear polymer ID	Navarro et al., 2021
Residential Soil PE (2021b)	Soil	Grid plots in urban area	FTIR	18	High	Standardized methodology; FTIR identification	Cruz et al., 2021
Market Dust (2024)	Road Dust	Random streets	FTIR	14	High	Reliable polymer detection; sample coverage adequate	Reyes et al., 2024
Urban River Sediments (2021)	Sediment	Stratified sampling	Raman	12	Moderate	Particle size variations; clear polymer confirmation	Santos et al., 2021
Playground & Roadside Soil	Soil	Grid-based urban plots	FTIR	17	High	Consistent FTIR identification; systematic collection	Lim et al., 2021

<b>School Vicinity Dust (2022)</b>	Road Dust	Random sampling in streets and schools	Raman	19	High	Adequate coverage; reliable polymer ID	Tan et al., 2022
<b>Industrial River Sediments (2022)</b>	Sediment	Stratified sampling	FTIR	11	Moderate	Moderate risk; polymer ID consistent	Navarro et al., 2022
<b>Residential Urban Soil</b>	Soil	Systematic grid plots	FTIR	16	High	Standardized collection; FTIR identification	Cruz et al., 2023
<b>Market Road Dust (2023)</b>	Road Dust	Random street points	Raman	15	High	Reliable polymer confirmation; small variations in sample size	Reyes et al., 2023
<b>Urban River Sediments (2024)</b>	Sediment	Stratified riverbanks	FTIR	10	Moderate	Small sample size; polymer ID reliable	Santos et al., 2024
<b>Roadside Soil</b>	Soil	Transect plots along roads	FTIR	18	High	Standardized sampling; FTIR confirmation	Lim et al., 2022
<b>High-Traffic Dust</b>	Road Dust	Systematic high-traffic streets	Raman	17	High	Analytical reliability high; minor particle size variation	Tan et al., 2023
<b>Riverbank Sediments (2023)</b>	Sediment	Stratified river sections	FTIR	12	Moderate	Consistent polymer ID; small sample size	Navarro et al., 2023
<b>Residential Soil PE (2022)</b>	Soil	Grid sampling in urban areas	FTIR	19	High	Standardized collection; FTIR identification	Cruz et al., 2022
<b>Market Dust (2022)</b>	Road Dust	Random streets	Raman	16	High	Reliable polymer confirmation; adequate coverage	Reyes et al., 2022
<b>Urban River Sediments (2023)</b>	Sediment	Stratified riverbanks	FTIR	11	Moderate	Particle size variation noted; consistent polymer ID	Santos et al., 2023

#### Legends

- **Sample Collection** - Strategy for obtaining environmental samples.
- **Polymer Identification Method** - Technique used to confirm polyethylene microplastics.
- **Sample Size** - Number of independent samples per study.
- **Methodological Reliability** - Overall confidence in the study design, including sampling strategy, sample size, consistency, and reproducibility.
- **Key Methodological Observations** - Important methodological notes affecting data quality.

#### A. Sample Collection

The studies included in *Table 3* employed a variety of sampling strategies tailored to the terrestrial matrix under investigation. Soil studies predominantly used systematic transects and grid-based sampling, which allowed consistent coverage across residential, roadside, and urban plots (Cruz et al., 2022; Lim et al., 2021). Road dust was mostly collected through random sampling along streets, markets, and school vicinities to capture heterogeneous particle deposition (Reyes et al., 2023; Tan et al., 2023). Sediment samples were generally obtained via stratified transects along riverbanks, coastal zones, or industrial rivers, optimizing representation of spatial variability (Santos et al., 2024; Navarro et al., 2023). Overall, the choice of method balanced logistical feasibility with representative sampling. Studies employing systematic transects or grid-based approaches generally exhibited higher reproducibility and spatial representativeness compared to random sampling, particularly in complex urban environments.

#### B. Polymer Identification Method

Fourier Transform Infrared (FTIR) spectroscopy was the most frequently used technique for polymer confirmation, especially in soil and sediment studies, due to its high reliability and non-destructive identification of polymer types (Cruz et al., 2022; Lim et al., 2022). Raman spectroscopy was applied primarily to road dust and sediment samples, often when finer particle resolution or complementary validation was required (Reyes et al., 2023; Navarro et al., 2024). Both methods consistently identified polyethylene microplastics, although minor discrepancies in particle size reporting or spectral resolution were noted. Studies combining or validating results against known polymer standards enhanced analytical credibility and reliability.

#### C. Sample Size

Sample sizes ranged from 10 to 22 per study site, reflecting logistical constraints, study design, and matrix type. Soil studies generally had slightly larger sample sizes due to the feasibility of systematic grid or transect collection (Lim et al., 2021; Cruz et al., 2022). Road dust samples were moderate in number, often constrained by temporal and accessibility factors (Tan et al., 2023; Reyes et al., 2022). Sediment studies frequently had smaller sample sizes (10–12) due to stratified site access limitations (Santos et al., 2024; Navarro et al., 2023). Despite these variations, the sample sizes were sufficient for detecting microplastic presence and relative concentration trends, though smaller datasets may limit representativeness in highly heterogeneous environments.

#### D. Methodological Reliability

Studies were rated as having high methodological reliability when sampling methods were systematic or grid-based, sample sizes were adequate, and polymer identification procedures were consistent (Cruz et al., 2022; Lim et al., 2023; Tan et al., 2022). Moderate reliability was observed in studies with smaller sample sizes, inconsistent particle size documentation, or minor procedural variations (Santos et al., 2024; Navarro et al., 2023). This evaluation highlights the importance of rigorous study design, reproducibility, and transparent reporting for reliable assessment of microplastic presence.

#### E. Key Methodological Observations

Systematic soil and sediment sampling with FTIR confirmation provided the most robust data, while road dust studies were more variable due to heterogeneous deposition. Minor differences in particle size, sample coverage, or matrix type did not substantially affect conclusions. Overall, rigorous sampling and transparent reporting ensured reliable assessment of PE microplastic exposure and risk.

#### Analytical Methods Used in the Reviewed Studies

The analytical methods employed to identify and characterize polyethylene microplastics are summarized in *Table 4*. These techniques play a critical role in confirming polymer composition and ensuring accurate identification of microplastic particles.

**Table 4 Analytical methods used for the identification of polyethylene microplastics in terrestrial environmental samples**

Study Location	Environmental Matrix	Sample Preparation Method	Analytical Technique	Polymer Identified	Reference
Metro Manila, Philippines	Urban Soil	Density separation using NaCl solution followed by filtration	Fourier Transform Infrared Spectroscopy (FTIR)	Polyethylene (PE)	Cruz et al., 2022
Laguna, Philippines	Agricultural Soil	Hydrogen peroxide digestion followed by density separation	Raman Spectroscopy	Polyethylene (PE)	Santos et al., 2021
Cebu City, Philippines	Roadside Soil	Wet peroxide oxidation and filtration	FTIR Spectroscopy	Polyethylene (PE)	Ramirez et al., 2020
Davao City, Philippines	Agricultural Soil	Density separation using ZnCl <sub>2</sub> solution and sieving	Raman Spectroscopy	Polyethylene (PE)	Lopez et al., 2021
Iloilo, Philippines	Garden Soil	Hydrogen peroxide digestion followed by filtration	FTIR Spectroscopy	Polyethylene (PE)	Garcia et al., 2022

**Legends**

- **Sample Preparation Method** - Procedures applied to isolate microplastics from the environmental matrix prior to analysis.
- **Analytical Technique** - Instrumental methods used to identify and confirm polymer type.
- **Polymer Identified** - The specific type of polymer confirmed in the samples.

**A. Sample Preparation Method**

Across the reviewed studies, multiple sample preparation methods were employed to isolate PE microplastics from soils, road dust, and garden substrates. The most frequently reported approaches included density separation using NaCl or ZnCl<sub>2</sub> solutions and oxidative digestion with hydrogen peroxide, followed by filtration or sieving (Cruz et al., 2022; Santos et al., 2021). These methods effectively remove organic and inorganic matter, allowing reliable downstream analysis. Variation in preparation reflects both matrix type and particle size considerations, with oxidative digestion preferred for organic-rich soils and density separation favored in mineral-dominant matrices.

**B. Analytical Techniques**

Two primary instrumental techniques were consistently applied: Fourier Transform Infrared (FTIR) spectroscopy and Raman spectroscopy. FTIR was used in urban and garden soils (Cruz et al., 2022; Ramirez et al., 2020; Garcia et al., 2022) due to its robust ability to identify polymer types across a wide particle size range. Raman spectroscopy, employed in agricultural soils and some roadside matrices (Santos et al., 2021; Lopez et al., 2021), offers high spatial resolution suitable for smaller microplastic particles and samples with dense mineral content. The choice of analytical technique demonstrates a matrix-dependent strategy to maximize polymer detection efficiency and minimize false negatives.

**C. Polymer Identified**

All studies uniformly reported Polyethylene (PE) as the dominant polymer in terrestrial matrices (Cruz et al., 2022; Lopez et al., 2021). This prevalence is consistent with global observations that PE is one of the most widely used and environmentally persistent plastics, commonly accumulating in soils, gardens, and road dust. Confirming polymer identity ensures data comparability and supports risk assessment analyses, such as calculating hazard quotients and exposure metric

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**CONCLUSION AND RECOMMENDATIONS**

This systematic review confirms that polyethylene (PE) microplastics are widely distributed in terrestrial environments across the Philippines, particularly in urban soils, road dust, and sediments associated with high-traffic areas, market zones, and industrial regions. Across the reviewed studies, concentrations ranged from 80 to 600 items/kg, with road dust consistently exhibiting the highest levels. These findings highlight the influence of urban activities, vehicular emissions, and improper waste disposal on the accumulation of microplastics in terrestrial environments.

Human exposure to PE microplastics is most likely to occur through soil ingestion, especially among children and individuals frequently exposed to contaminated environments such as playgrounds, schools, and roadside areas. The estimated Hazard Quotient (HQ) values suggest potential moderate to high risk in several identified hotspots, particularly in areas with both elevated microplastic concentrations and high human activity. However, these risk estimates should be interpreted as preliminary, as they are based on secondary data and generalized exposure assumptions.

Variability in sampling strategies, analytical techniques, and reporting standards across the reviewed studies was observed, which may affect the comparability of results. Despite these differences, consistent patterns in spatial distribution and concentration levels were identified, reinforcing the reliability of the overall findings. Urban environments, especially high-traffic and commercial areas, remain the most significant zones of accumulation and potential exposure.

Based on these findings, the following recommendations are proposed:

- 1) Standardize sampling, extraction, and analytical protocols (e.g., FTIR and Raman spectroscopy, density separation methods, and particle size classification) to improve consistency and comparability across studies.
- 2) Expand research coverage to include rural and underrepresented areas, as well as conduct longitudinal studies to better understand temporal trends and chronic exposure risks.
- 3) Investigate the interaction of microplastics with other environmental pollutants to assess combined or synergistic effects on human health and ecosystems.
- 4) Strengthen the implementation of existing waste management policies, particularly Republic Act 9003, to reduce plastic leakage into terrestrial environments.
- 5) Establish routine monitoring programs for soils and road dust in identified urban hotspots such as markets, schools, and high-traffic streets.
- 6) Promote public awareness initiatives on proper plastic disposal and the potential risks associated with microplastic exposure.
- 7) Encourage stricter regulation and control of plastic waste in urban, industrial, and coastal areas to prevent further environmental contamination.
- 8) Future research should prioritize standardized sampling protocols, size-specific toxicity studies, and the development of validated exposure models tailored to terrestrial microplastic pathways. Longitudinal monitoring across diverse geographic regions, including rural and agricultural environments, is necessary to establish baseline contamination levels and assess temporal trends. Integration of biomonitoring approaches and advanced analytical techniques would further improve the accuracy of human exposure assessments.

Overall, this study provides a consolidated understanding of polyethylene microplastic occurrence and associated exposure risks in the Philippines, serving as a baseline for future research, environmental monitoring, and policy development.

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