

# Tracing Microplastic Dispersion in Urban vs. Coastal Airsheds: Insights from Universiti Teknologi Malaysia, Kuala Lumpur and Universiti Malaysia Terengganu, Kuala Terengganu

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KEYWORDS	ABSTRACT
<p>Atmospheric microplastic Microplastic deposition Microplastic suspension</p>	<p>Atmospheric microplastics (AMP) are emerging pollutants found across diverse environments, from urban centers to remote coastal regions. This study investigates the characteristics of AMP in two contrasting Malaysian settings: the coastal site at Universiti Malaysia Terengganu (UMT) and the urban site at Universiti Teknologi Malaysia (UTM) in Kuala Lumpur. Using both active and passive sampling techniques, microplastics were analyzed for abundance, colour distribution, and shape classification. Results revealed higher microplastic abundance in deposited samples compared to suspended ones, with UMT showing a predominance of black fragments and UTM dominated by transparent fibers. These differences reflect distinct pollution sources—marine and industrial activities in coastal areas versus textile and packaging waste in urban environments. The findings underscore the influence of local environmental factors on AMP profiles and highlight the need for targeted mitigation strategies to address airborne microplastic pollution in different ecological contexts.</p>

## 1. INTRODUCTION

Atmospheric microplastics (AMP), tiny plastic particles less than 5 mm, are now recognized as widespread air pollutants, found in urban, suburban, remote, and even marine environments. Their presence raises concerns about environmental contamination, human exposure, and potential health risks, but research is still emerging, and many questions remain. Synthetic textiles, plastic manufacturing, vehicle and tire wear, and urban dust are major sources of airborne microplastics, with fibers being the most common shape detected both indoors and outdoors [1,2]. Microplastics are found in air, dust, and atmospheric deposition, with concentrations ranging from <1 to >1000 particles/m<sup>3</sup> in air and up to 760,000 particles/m<sup>2</sup>/day in indoor deposition [1-3]. Their small size and low density allow for long-range atmospheric transport, reaching remote mountains and oceans, and contributing to global microplastic cycling [2,3]. Weather, wind, and precipitation influence their movement and

deposition patterns [2,3]. This study compares AMP characteristics between two distinct Malaysian environments: the coastal site at Universiti Malaysia Terengganu (UMT) and the urban site at Universiti Teknologi Malaysia (UTM) in Kuala Lumpur. The comparison focuses on particle abundance, color distribution, and shape classification, providing insights into source attribution and environmental behavior.

## 2. EXPERIMENTAL PROCEDURE

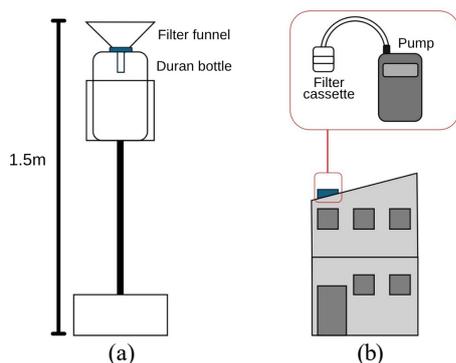
Atmospheric microplastic samples were collected using both active and passive sampling techniques at two distinct locations: UTM Kuala Lumpur (urban site) and UMT Terengganu (coastal site). To ensure consistency and minimize contamination, identical procedures and equipment were employed across both sites.

### 2.1 Sampling Apparatus and Setup

A dust deposition gauge was used to collect deposited atmospheric microplastics (DAMP). This apparatus consists of a stainless-steel funnel connected to an amber glass container, designed to prevent contamination and avoid contact with plastic materials. For active sampling, the funnel was positioned on the rooftop of a double-storey building at UTM Kuala Lumpur, maximizing exposure to ambient airborne particles. In contrast, passive sampling was conducted at a height of 1.5 meters above ground level, simulating human breathing zone exposure.

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The same configuration and sampling duration were applied at both locations to ensure the accuracy, comparability, and reliability of the results. Figure 1 illustrates the setup of the sampling apparatus used in this study.



**Figure 1.** Sampling equipment and setup (a) Dustfall sampler for passive sampling (DAMP) and (b) Sampling train for active sampling (SAMP).

## 2.1 Sampling Sites

UMT Terengganu is located along the eastern coast of Peninsular Malaysia, adjacent to the South China Sea. This coastal environment is characterized by strong maritime influences, including sea breezes, salt spray, and fishing-related activities, all of which may contribute to the presence and transport of atmospheric microplastics.

UTM Kuala Lumpur, in contrast, is situated within a densely populated urban setting in the capital city of Malaysia. The site is heavily influenced by anthropogenic activities such as vehicular traffic, industrial emissions, and urban waste, making it a representative location for studying microplastic pollution in a metropolitan atmosphere.

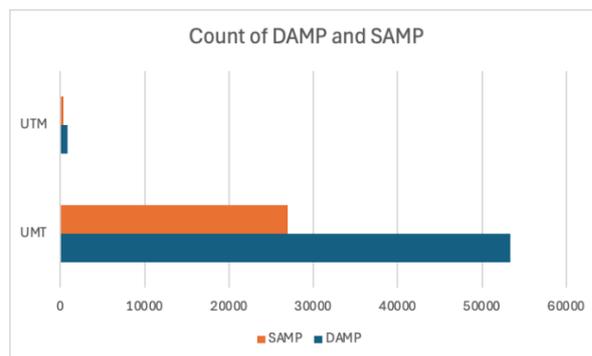
## 3. RESULTS AND DISCUSSION

This section presents a comparative analysis of atmospheric microplastic characteristics between the coastal site (UMT Terengganu) and the urban site (UTM Kuala Lumpur), focusing on total abundance, color distribution, and shape classification. Data were derived from both deposited (DAMP) and suspended (SAMP) samples.

### 3.1 Abundance

Microplastic abundance was consistently higher in deposited samples compared to suspended ones across both locations. UMT Terengganu exhibited a greater overall abundance of microplastics, particularly in the

form of fragments, while UTM Kuala Lumpur showed a predominance of fibers. Figure 2 below demonstrate the total abundance of microplastics collected at different sampling location with different sampling techniques.



**Figure 2.** Total abundance of AMP.

Atmospheric microplastic abundance is often higher in coastal areas than urban centers due to combined land-sea sources, meteorological factors, and transport dynamics. Coastal areas act as both sources and sinks for microplastics, receiving inputs from urban runoff, wastewater, and direct marine sources such as fishing gear and packaging materials. This dual input leads to a more complex and often higher microplastic load compared to urban areas, which primarily receive land-based microplastics [4,5]. Coastal agglomerations facilitate the transfer of microplastics between land and ocean, intensifying local atmospheric concentrations [4,5].

### 3.2 Colour Distribution

Color analysis as shown in Figure 3 revealed distinct profiles between the two environments. The coastal site showed a strong dominance of black particles, likely originating from maritime activities, tire wear, and synthetic materials. Studies in Southeast Asia and other coastal regions confirm that black microplastics are commonly found near coasts and are indicative of both marine and traffic-related sources [6-8]. Additionally, marine-derived microplastics, such as fragments from fishing gear and ship paint, contribute to the black particle load in these areas [6,7]. In contrast, the urban site was characterized by a higher proportion of transparent particles, possibly linked to degraded plastic films and packaging materials. These transparent particles are typically fragments or films resulting from the weathering and fragmentation of larger plastic items commonly used in cities [9-11]. Urban atmospheric microplastics also include fibers from textiles and synthetic clothing, but transparent fragments are especially prevalent due to the abundance of packaging and single-use plastics [9-11].

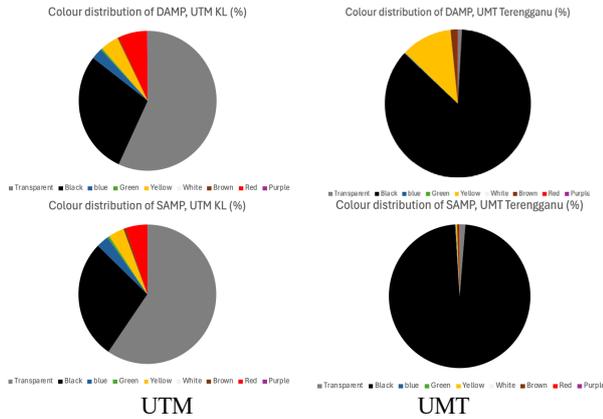


Figure 3. AMP colour distribution (%).

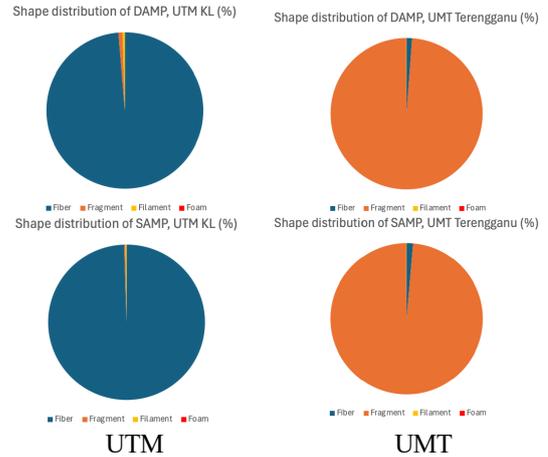


Figure 4. AMP shape distribution (%).

### 3.3 Shape Distribution

Microplastic shape analysis revealed distinct patterns between the two locations as seen in Figure 4. At UMT Terengganu, fragments were the predominant shape, comprising 98.75% of DAMP and 98.53% of SAMP samples. Fibers were present in minor quantities (1.16% in DAMP and 1.38% in SAMP), while filaments and foams were nearly absent. This pattern is consistent with other coastal and marine studies, where fragments are often the most abundant shape due to the breakdown of larger plastic debris from marine and shoreline sources, including fishing gear, packaging, and maritime activities [12-14]. The prevalence of fragments in coastal air is also linked to the mechanical and UV-driven degradation of plastics in the marine environment, which produces small, irregularly shaped particles that can be easily resuspended by wind and wave action [12,13].

Conversely, UTM Kuala Lumpur samples were dominated by fibers, which accounted for 98.68% of DAMP and 99.51% of SAMP.

Fragments were minimal (0.84% in DAMP and 0.25% in SAMP), and filaments appeared only in trace amounts. This is a common finding in urban atmospheric studies, where fibers— primarily from textiles, clothing, and indoor dust—are the main microplastic type detected [13-15]. Urban environments generate large quantities of synthetic fibers through laundry, abrasion of clothing, and industrial activities, which are readily transported and deposited via the atmosphere [13,15].

## 4. CONCLUSION

This comparative study of atmospheric microplastics between coastal and urban environments in Malaysia reveals significant differences in particle abundance, colour, and shape. UMT Terengganu, influenced by maritime activities and coastal dynamics, exhibited higher microplastic abundance, with black fragments being the dominant type. These particles likely originate from marine debris, tire wear, and industrial sources. In contrast, UTM Kuala Lumpur, situated in a densely populated urban setting, showed a predominance of transparent fibers, indicative of textile emissions and urban packaging waste.

The shape distribution further supports these findings, with fragments dominating the coastal site and fibers prevailing in the urban site. These patterns reflect the environmental behavior and source attribution of microplastics, shaped by local activities, meteorological conditions, and land-sea interactions.

Understanding the spatial variability of AMP characteristics is crucial for developing effective monitoring and mitigation strategies. Future research should expand to include polymer composition analysis, seasonal variation, and health impact assessments to build a comprehensive framework for addressing atmospheric microplastic pollution in Malaysia and beyond.

## ACKNOWLEDGEMENT

The author would like to thank the Malaysian Ministry of Higher Education for funding through the Fundamental Research Grant Scheme (FRGS), award number FRGS/1/2021/TK0/UNIMAP/022/47 from the Malaysian Ministry of Higher Education.

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