

Background of the Study

Air pollution remains one of the most serious environmental problems affecting human health worldwide. Among the various air pollutants, particulate matter (PM_{2.5} and PM₁₀) is considered especially harmful because it can enter the respiratory system, and in the case of PM_{2.5} which can reach the bloodstream. PM₁₀ mainly affects the upper airway, while PM_{2.5} being much finer can penetrate deep into the lungs and increase the risk of respiratory illness, cardiovascular disease, and premature death (World Health Organization [WHO], 2022; United States Environmental Protection Agency [EPA], 2023). Children are considered particularly vulnerable to particulate matter exposure, because their respiratory systems are still developing and they breathe at a faster rate relative to their body size (WHO, 2022). Consequently, monitoring PM_{2.5} and PM₁₀ concentrations has become an essential component of environmental protection, and public health programs.

Globally, studies have identified traffic volume, population density, and the presence of pollution sources such as roads, vehicles, and commercial establishments as major factors influencing particulate matter concentrations. Han and Sun (2019), in a study conducted in Shanghai, China, found that population density was positively associated with PM_{2.5} concentrations, because densely populated areas tend to concentrate traffic congestion, and pollution sources within a smaller space. Similarly, Tseng et al. (2021) reported that vehicular traffic and other anthropogenic emission sources were major contributors to elevated PM_{2.5} concentrations, while Castilla et al.

(2024) found that commercial and high-traffic areas consistently exhibited higher PM_{2.5} and PM₁₀ concentrations than residential areas. Together, these studies demonstrate that areas characterized by high population density, heavy traffic, and concentrated commercial activities are more likely to experience elevated particulate matter concentrations regardless of geographic location.

In the Philippines, similar patterns have been observed. Pabroa et al. (2022) examined ambient particulate matter from multiple air quality monitoring stations in Metro Manila and found that roadside monitoring stations consistently recorded higher PM_{2.5} and PM₁₀ concentrations than general ambient stations, because of heavy vehicular traffic and urban emissions. The study also reported that black carbon, an indicator of combustion-related emissions, comprised a substantial portion of PM_{2.5} emphasizing the influence of transportation activities on urban air quality. Likewise, Pabroa et al. (2024) reported that urbanized locations with dense commercial activities, industrial operations, and heavy traffic exhibited higher particulate matter concentrations than less developed areas, demonstrating that land-use characteristics significantly influence ambient air quality in the Philippine setting.

Likewise, Pabroa et al. (2024) reported that urbanized locations with dense commercial activities, industrial operations, and heavy traffic exhibited higher particulate matter concentrations than less developed areas, demonstrating that land-use characteristics significantly influence ambient air quality in the Philippine setting.

These findings are consistent with the objectives of Republic Act No. 8749, or the Philippine Clean Air Act of 1999, which establishes the country's framework for air quality management by regulating emissions, setting ambient air quality standards, and promoting regular air quality monitoring through the Department of Environment and Natural Resources (DENR). Such policies underscore the importance of localized air quality assessments in supporting evidence-based environmental management, particularly in areas where monitoring data remain limited.

Within the Davao Region, the Department of Environment and Natural Resources–Environmental Management Bureau Region XI (DENR–EMB XI, 2023) analyzed ambient air quality monitoring data collected from 2016 to 2021 to evaluate the spatial and temporal distribution of $PM_{2.5}$ and PM_{10} concentrations across the Davao City Airshed using Inverse Distance Weighting (IDW) spatial interpolation in ArcGIS. The study found that particulate matter concentrations generally decreased throughout the six-year monitoring period, with fewer areas experiencing elevated pollution levels over time. Although localized increases were observed near major transportation corridors, particulate matter concentrations consistently remained within the National Ambient Air Quality Guideline Values (NAAQGV), highlighting the importance of continuous monitoring and effective emission control measures. Similarly, in Davao del Sur, Lesidan et al. (2025) reported that long-term exposure to $PM_{2.5}$ is associated with respiratory diseases, cardiovascular diseases, chronic obstructive pulmonary disease

(COPD), and premature mortality. The study emphasized that reducing PM_{2.5} concentrations through effective air quality management can improve public health outcomes and reduce healthcare costs. Together, these studies underscore the importance of localized air quality monitoring and particulate matter assessment in supporting evidence-based environmental management and public health initiatives within the region.

Poblacion Zone III, Santa Cruz, Davao del Sur serves as the municipality's urban center, characterized by a concentration of commercial establishments, a public market, residential communities, and educational institutions. The selected monitoring sites include McArthur Highway, and Salandanan Street (commercial areas), Sta. Cruz Public Market, Miranda Village, and Sto. Niño Village (residential areas), and Sta. Cruz National High School–Junior High, Sta. Cruz National High School–Senior High, and Santa Cruz Central Elementary School (school zones). These locations were selected because they represent the municipality's major land-use categories and differ in traffic volume, population density, commercial activity, and pedestrian movement, all of which have been identified as important factors influencing ambient particulate matter concentrations (Han & Sun, 2019; Pabroa et al., 2022). However, Santa Cruz, Davao del Sur currently has no established ambient air quality monitoring system or monitoring station (Philippine Information Agency, 2025). Consequently, no localized baseline data are available on PM_{2.5} and PM₁₀

Therefore, this study aims to compare PM_{2.5} and PM₁₀ concentrations among selected commercial, public market, residential, and school areas in Poblacion Zone III, Santa Cruz, Davao del Sur. Specifically, it aims to determine the PM_{2.5} and PM₁₀ concentrations in the selected areas, and determine whether significant differences exist among the different land-use categories. The findings are expected to establish localized baseline air quality data that may assist the Local Government Unit of Santa Cruz, environmental agencies, school administrators, and future researchers in developing evidence-based strategies to improve air quality, protect public health, and support sustainable urban environmental management.

Research Questions

1. What is the environmental profile of the selected sampling sites in terms of:
 - 1.1 Land-use classification;
 - 1.2 Population density;
 - 1.3 Traffic volume; and
 - 1.4 Predominant anthropogenic activities that may contribute to particulate matter emissions?
2. What are the PM_{2.5} concentrations in the selected sampling sites of Poblacion Zone III, Santa Cruz, Davao del Sur, according to land-use category?
 - 2.1 Commercial areas;
 - 2.2 Public market;
 - 2.3 Residential areas; and

2.4 School areas.

3. What are the PM_{10} concentrations in the selected sampling sites of Poblacion Zone III, Santa Cruz, Davao del Sur, according to land-use category?

3.1 Commercial areas;

3.2 Public market;

3.3 Residential areas; and

3.4 School areas.

4. Is there a significant difference in $PM_{2.5}$ and PM_{10} concentrations among the selected land-use categories in Poblacion Zone III, Santa Cruz, Davao del Sur?

Hypotheses

Null Hypothesis (H_0):

There is no significant difference in $PM_{2.5}$ and PM_{10} concentrations among the selected commercial, public market, residential, and school areas of Poblacion Zone III, Santa Cruz, Davao del Sur.

Alternative Hypothesis (H_1):

There is a significant difference in $PM_{2.5}$ and PM_{10} concentrations among the selected commercial, public market, residential, and school areas of Poblacion Zone III, Santa Cruz, Davao del Sur.