Comparative Assessment of $PM_{2.5}$ and PM_{10} Concentrations Across the Eight Sitios in Poblacion Zone III, Santa Cruz, Davao del Sur

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ABSTRACT

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CHAPTER I

INTRODUCTION

Background of the Study

Air pollution remains a major environmental and public health concern worldwide. Among the various air pollutants, particulate matter, particularly fine particulate matter ($PM_{2.5}$) and particulate matter (PM_{10}), is of particular concern because of its ability to enter the human respiratory system. PM_{10} consists of inhalable particles with aerodynamic diameters of 10 micrometers or smaller, while $PM_{2.5}$ consists of finer particles with aerodynamic diameters of 2.5 micrometers or smaller that can penetrate deeper into the respiratory system. Exposure to elevated concentrations of particulate matter has been associated with adverse respiratory and cardiovascular health effects and increased risk of premature mortality. Consequently, monitoring ambient $PM_{2.5}$ and PM_{10} concentrations is an important component of air-quality assessment and environmental health protection.

Globally, studies have demonstrated that particulate matter concentrations can vary among locations because of differences in traffic activity, population characteristics, and anthropogenic activities. Han and Sun (2019), in a study conducted in Shanghai, China, reported an association between population density and $PM_{2.5}$ concentrations, indicating that areas with greater population density may experience different particulate matter conditions because of the concentration of human activities and emission sources. Similarly, Tseng et al. (2021) identified vehicular traffic and anthropogenic emissions as important factors associated with $PM_{2.5}$ concentrations. Castilla et al. (2024) also reported spatial differences in particulate matter concentrations across areas with varying land-use and human-activity characteristics. These findings demonstrate that ambient particulate matter concentrations may vary across geographic locations depending on the environmental characteristics and activities present in those areas.

Similar patterns have been documented in the Philippines. Pabroa et al. (2022) examined ambient air quality in Metro Manila and reported differences in $PM_{2.5}$ and PM_{10} concentrations between roadside and general ambient monitoring locations, highlighting the contribution of vehicular emissions to particulate matter concentrations. The study also examined black carbon, which is associated with combustion-related emissions, as an important component of fine particulate matter. Pabroa et al. (2024) further examined particulate matter concentrations in urbanized Philippine environments and emphasized the importance of local environmental characteristics in understanding spatial variations in ambient air quality. These findings demonstrate the relevance of localized particulate matter measurements in characterizing air-quality conditions within Philippine communities. The importance of local air-quality assessment is also reflected in Republic Act No. 8749, or the Philippine Clean Air Act of 1999, which establishes a national framework for the prevention and control of air pollution through emission controls, ambient air-quality standards, and air-quality monitoring.

Within the Davao Region, the Environmental Management Bureau of the Department of Environment and Natural Resources (DENR–EMB XI, 2023) reported spatial variations in particulate matter concentrations across the Davao City Airshed from 2016 to 2021, including localized increases near major transportation corridors. These findings indicate that regional air-quality measurements may not fully represent conditions at individual communities or specific locations. In Davao del Sur, Lesidan et al. (2025) examined the health implications associated with long-term exposure to $PM_{2.5}$, further demonstrating the relevance of particulate matter to environmental and public health concerns in the province. Santa Cruz is a first-class municipality in the province of Davao del Sur. Within the municipality, Poblacion Zone III is a central community area composed of several closely situated sitios with varying population characteristics and patterns of human activity, making it a

suitable area for examining localized ambient particulate matter conditions.

For this study, eight selected sitios in Poblacion Zone III will be examined: Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan. These sitios will serve as the sampling locations where ambient $PM_{2.5}$ and PM_{10} concentrations will be directly measured. The demographic profile of the selected sitios, particularly their population size and population density, will also be described to provide contextual information about the communities in which the measurements will be conducted. Despite existing air-quality assessments at national and regional levels, there remains a need for localized baseline information on $PM_{2.5}$ and PM_{10} concentrations within these selected sitios. Regional monitoring data may provide an overall representation of air-quality conditions but may not adequately describe variations occurring among individual communities. Direct measurement at the sitio level can therefore provide more specific information about existing particulate matter conditions and establish baseline measurements for future environmental monitoring and assessment.

Therefore, this study will measure and compare the ambient $PM_{2.5}$ and PM_{10} concentrations among eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur. Specifically, it will describe the demographic profile of the selected sitios in terms of population size and population density, determine the measured concentrations of $PM_{2.5}$ and PM_{10}, and establish whether statistically significant differences exist among the eight sampling locations. The resulting baseline measurements will provide localized information that may serve as a reference for the Local Government Unit of Santa Cruz, environmental agencies, community stakeholders, and future researchers in understanding particulate matter conditions and supporting future environmental monitoring and management efforts. The study will also support the United Nations Sustainable Development Goals, particularly Sustainable Development Goal 3 (Good Health and Well-Being), through its focus on information relevant to reducing exposure to harmful air pollutants, and Sustainable Development Goal 11 (Sustainable Cities and Communities), by

providing localized environmental information that may support informed community planning and environmental management.

Statement of the Problem

This study aims to determine the demographic profile and ambient particulate matter concentrations in the eight selected sitios of Poblacion Zone III, Santa Cruz, Davao del Sur, namely Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan. Specifically, it seeks to answer the following questions:

1. What is the demographic profile of the selected sitios—Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan—in terms of:

1.1. population size; and

1.2. population density?

1. What are the measured $PM_{2.5}$ and PM_{10} concentrations in each of the eight selected sitios during the designated sampling periods in terms of

:2.1. mean; and

2.2. standard deviation?

2. Is there a significant difference in the mean $PM_{2.5}$ concentrations among Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan?

3. Is there a significant difference in the mean PM_{10} concentrations among Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan?

Hypotheses

To address the inferential questions, the study will test the following null hypotheses at the **0.05 level of significance** :

H_{01}: There is no statistically significant difference in the mean $PM_{2.5}$ concentrations among the eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur.

H_{02}: There is no statistically significant difference in the mean PM_{10} concentrations among the eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur.

Conceptual Framework

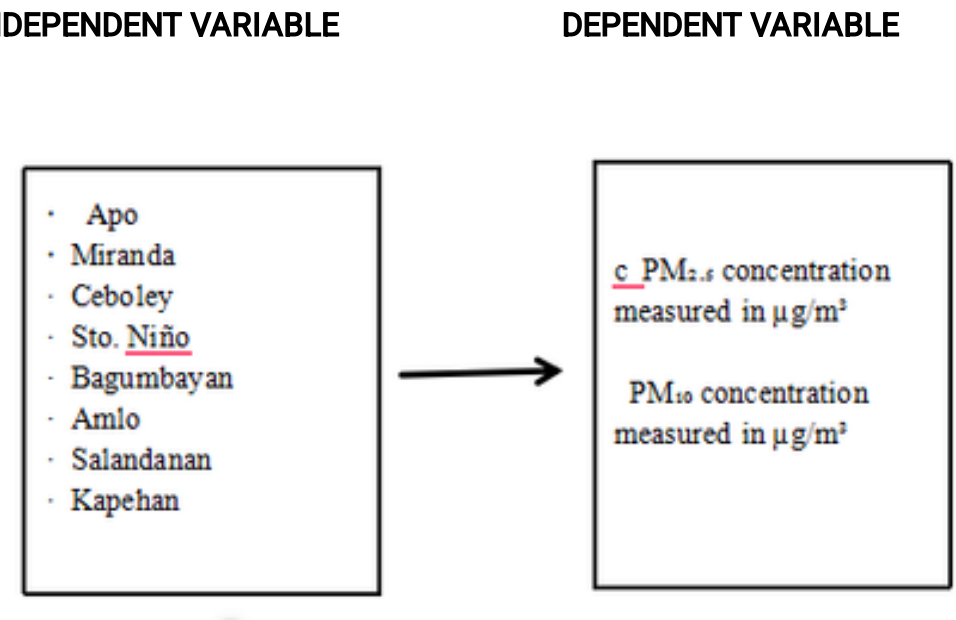

FIgure 1. Schematic Diagram of the Study

The conceptual framework illustrates the awweee relationship between the independent variable, which is the selected sitio consisting of Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan, and the dependent variables, which are the $PM_{2.5}$ and PM_{10} concentrations measured in µg/m³. The selected sitios serve as the locations where air-quality measurements will be conducted using the Temtop M2000 Air Quality Monitor. The framework shows

that the measured $PM_{2.5}$ and PM_{10} concentrations will be compared among the eight selected sitios to determine whether significant differences exist in their mean concentrations. Population size and population density will be presented as demographic information of the selected sitios and will not be treated as independent variables in the framework.

Theoretical Framework

This study is anchored on the **Source–Pathway–Receptor (SPR) Framework** , a conceptual model used in environmental pollution and risk assessment to explain how pollutants move from their sources through environmental pathways and eventually reach receptors. The source–pathway–receptor linkage was first described by **M. W. Holdgate (1979)** in A Perspective of Environmental Pollution. The framework has since been applied in environmental assessment to understand the relationship among pollution sources, pollutant transport, and locations where pollutants are measured or where exposure may occur. It is important to note that Holdgate is more appropriately described as an early author who **described the source–pathway–receptor linkage** , rather than as the sole inventor of the modern SPR framework.

The SPR Framework consists of three interconnected components: **source, pathway, and receptor** . The **source** refers to the origin of pollutants, which in this study may include vehicular emissions, commercial activities, road dust, construction, open burning, and other human activities that may generate particulate

matter. The **pathway** refers to the movement and dispersion of $PM_{2.5}$ and PM_{10} through the atmosphere. This movement may be affected by environmental conditions such as wind, temperature, relative humidity, and rainfall. The **receptor** refers to the location where pollutants are measured or where exposure may occur. In this study, the eight selected sitios—**Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan** —serve as the sampling locations or receptors.

The SPR Framework was selected because it is appropriate for explaining the possible spatial variation of particulate matter across the selected sitios. The eight locations may differ in population characteristics, traffic activity, commercial activities, and other potential particulate-matter sources. These differences may contribute to variations in measured $PM_{2.5}$ and PM_{10} concentrations. The framework therefore provides a logical basis for examining the environmental context surrounding each sampling location without assuming that all areas have the same level of pollution.

The framework is also appropriate because the present study is **descriptive-comparative and non-experimental** . The researchers will not manipulate emission sources or environmental conditions. Instead, they will measure existing $PM_{2.5}$ and PM_{10} concentrations under naturally occurring conditions and document relevant environmental conditions during the sampling periods. Thus, the SPR Framework will be used to explain the possible relationship between observed pollution sources, atmospheric pathways, and measured concentrations rather than to establish a direct cause-and-effect relationship.

In addition to the SPR Framework, this study is guided by the **Philippine Clean Air Act of 1999 (Republic Act No. 8749)** , which provides the national legal framework for the prevention and control of air pollution in the Philippines. The law emphasizes the protection of the people's right to a balanced and healthful

environment and provides for air-quality management, monitoring, and the control of pollution sources (Republic Act No. 8749, 1999). This framework is relevant to the present study because it establishes the importance of obtaining air-quality information for environmental management and public-health protection.

The Philippine Clean Air Act framework complements the SPR Framework. The **SPR Framework explains the environmental relationship among sources, pathways, and receptors**, while **Republic Act No. 8749 provides the Philippine legal and policy basis for air-quality management and monitoring** . Together, they provide both a theoretical explanation and a national policy context for assessing particulate matter in the selected communities.

The study will also consider applicable **Department of Environment and Natural Resources (DENR)** air-quality guidelines in interpreting the measured $PM_{2.5}$ and PM_{10} concentrations. DENR Administrative Order No. 2013-13 and its subsequent amendments provide the Philippine framework for ambient air-quality guideline values and monitoring considerations for particulate matter (DENR, 2013; DENR, 2020). These standards will serve as a reference when discussing the measured concentrations, while recognizing that the present study is a localized baseline assessment and does not replace official regulatory monitoring.

Therefore, the combined application of the **Source–Pathway–Receptor Framework** and the **Philippine Clean Air Act Framework** provides an appropriate foundation for this study. The SPR Framework helps explain how particulate matter may originate from different sources, move through the atmosphere, and reach different sampling locations, while the Clean Air Act provides the legal and environmental-management context for monitoring air pollution in the Philippines.

Guided by these frameworks, the study will measure and compare $PM_{2.5}$ and PM_{10} concentrations among the eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur, thereby establishing localized baseline information that may support future air-quality monitoring, environmental assessment, community awareness, and local environmental planning.

Significance of the Study

This study will be significant because it will provide **localized baseline information on $PM_{2.5}$ and PM_{10} concentrations** in eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur. It will also provide demographic information on population size and density, helping describe the air-quality conditions of the selected communities. The findings may benefit the following:

Local Government Unit of Santa Cruz. The findings may provide the municipality with baseline air-quality information that can be used as a reference for future environmental assessment and monitoring. The results may also support evidence-based environmental planning and the development of appropriate local programs related to air-quality management.

Municipal Environment and Natural Resources Office and Environmental Management Bureau. The study may provide localized particulate matter data that can complement existing regional or broader air-quality assessments. The results may also help identify locations that could benefit from further monitoring or more comprehensive environmental assessment.

Residents and Community Leaders. The findings may increase awareness among residents regarding the existing $PM_{2.5}$ and PM_{10} conditions in their respective communities. Community leaders may also use the information to promote environmental awareness and communicate potential air-quality concerns to residents and local authorities.

Public Health Personnel. The study may provide localized environmental information that can complement community health assessments and awareness activities. The findings may help emphasize the importance of understanding environmental factors that may contribute to particulate matter exposure.

Schools and Educational Institutions. The findings may provide useful information for environmental education and awareness programs. Schools may use the results as a local example when discussing air pollution, environmental health, and the importance of maintaining healthy surroundings.

Community Planners and Local Decision-Makers. The results may provide environmental information that can be considered in future community planning and environmental management. Differences in particulate matter concentrations among the selected sitios may help identify locations that may warrant further observation or assessment.

Environmental Organizations and Community Groups. The study may serve as a reference for organizations and groups involved in environmental awareness and community-based environmental activities. The baseline information may support future initiatives related to air-quality awareness and environmental protection.

Researchers and Academic Community. The study will contribute localized $PM_{2.5}$

and PM_{10} data to the existing body of environmental research. The findings may serve as reference information for future researchers conducting follow-up monitoring, comparative studies, or investigations of particulate matter and other environmental conditions in Santa Cruz and similar communities.

Future Environmental Monitoring Programs. The measurements obtained from the eight selected sitios may serve as initial baseline values for future monitoring. Subsequent measurements may be compared with the findings of this study to determine whether particulate matter concentrations change over time.

General Public. The study may contribute to a better understanding of localized air-quality conditions and the importance of community-level environmental monitoring. It may also encourage greater public awareness of the role of environmental information in supporting healthier communities.

United Nations Sustainable Development Goals. The study will support **SDG 3 (Good Health and Well-Being)** by generating information relevant to particulate matter exposure and environmental health. It will also support **SDG 11 (Sustainable Cities and Communities)** by providing localized environmental data that may contribute to informed community planning, environmental monitoring, and sustainable environmental management.

Scope and Delimitation of the Study

This study will focus on measuring and comparing ambient $PM_{2.5}$ and PM_{10} concentrations in eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur, namely Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan, during School Year 2026–2027. Data will be collected during the

designated sampling period on three separate sampling days, with three measurement sessions per day during the morning, midday, and afternoon. The Temtop M2000 Air Quality Monitor will be used at a designated measurement point within each sitio, following the same procedure for all locations. Population size and population density of the selected sitios will also be documented. Temperature, relative humidity, wind conditions, and rainfall, when applicable, will be recorded during sampling. The measurements will be expressed in μg/m³ and analyzed using the mean, standard deviation, and One-Way ANOVA at a 0.05 level of significance, with Tukey's HSD used when a significant difference is found. The study will be limited to $PM_{2.5}$ and PM_{10} and will not include other air pollutants or establish causal relationships between demographic characteristics and particulate matter concentrations. The findings will be limited to the eight selected sitios in Poblacion Zone III and the environmental conditions observed during the study period and will not replace official regulatory air-quality monitoring.

Definition of Terms

$PM_{2.5}$ (Fine Particulate Matter). Refers to particulate matter with an aerodynamic diameter of 2.5 micrometers (μm) or less. These particles are small enough to remain suspended in the air and can penetrate deeply into the respiratory system. In this study, $PM_{2.5}$ refers to the concentration measured at each of the eight sitios using the Temtop M2000 Air Quality Monitor.

PM_{10} (Particulate Matter) . Refers to particulate matter with an aerodynamic diameter of 10 micrometers (μm) or less. It includes particles within the $PM_{2.5}$ fraction as well as larger inhalable particles. In this study, PM_{10} refers to the concentration measured at each of the eight sitios using the Temtop M2000 Air Quality Monitor.

Concentration. Refers to the amount of particulate matter present within a specified volume of air. It is expressed in micrograms per cubic meter (μg/m³). In this study, concentration refers specifically to the $PM_{2.5}$ and PM_{10} values recorded during each measurement session.

Sitio. Refers to a local subdivision or locality within a barangay. In this study, the term refers to the eight sitios comprising Poblacion Zone III, Santa Cruz, Davao del Sur, which will serve as the sampling units for obtaining and comparing $PM_{2.5}$ and PM_{10} measurements.

CHAPTER II

REVIEW OF RELATED LITERATURE

CHAPTER III

METHODOLOGY

This chapter presents the procedures that will be employed in the conduct of the study. It will include the research design, sampling technique, sampling schedule, sampling sites, research instrument, data-gathering procedure, and statistical treatment of data. The procedures will be implemented consistently across the eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur.

Research Design

This study will employ a quantitative descriptive-comparative research design. The quantitative approach will be used because the study will obtain numerical measurements of ambient $PM_{2.5}$ and PM_{10} concentrations, expressed in micrograms per cubic meter (μg/m³). The descriptive component will be used to

determine and summarize the measured $PM_{2.5}$ and PM_{10} concentrations in each of the eight selected sitios using the mean and standard deviation. The comparative component will be used to determine whether statistically significant differences exist in the mean $PM_{2.5}$ and PM_{10} concentrations among the eight selected sitios. The study will be non-experimental because the researchers will not manipulate the selected sitios, particulate-matter sources, or environmental conditions. Instead, the researchers will measure the existing ambient $PM_{2.5}$ and PM_{10} concentrations under naturally occurring conditions. The use of air sensors for community-level air-quality monitoring requires appropriate planning of the monitoring objectives, sensor setup, data collection, and evaluation to obtain useful measurements (U.S. Environmental Protection Agency [EPA], 2022). The independent variable will be the selected sitio, consisting of Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan. The dependent variables will be the measured ambient $PM_{2.5}$ and PM_{10} concentrations. Population size and population density will be presented as demographic information for the selected sitios and will not be treated as independent variables. The study will therefore compare the measured particulate-matter concentrations across the eight selected sitios without attempting to establish a cause-and-effect relationship. The design is consistent with the stated purpose of the study, which is to measure and compare ambient $PM_{2.5}$ and PM_{10} concentrations among the eight selected sitios.

Sampling Technique

The study will use purposive sampling in selecting the sampling sites. Purposive sampling will be used because the eight sitios included in the study have already been identified as the specific locations to be examined. The selected sitios are Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan in Poblacion Zone III, Santa Cruz, Davao del Sur. These eight sitios will serve as the sampling locations for the measurement and comparison of ambient $PM_{2.5}$ and

PM_{10} concentrations. One designated outdoor measurement point will be established within each selected sitio. The same measurement procedure will be applied to all eight locations to maintain consistency in the collection and comparison of the measurements. The selection of multiple measurement periods within each day will also be considered in the sampling procedure. Cassidy et al. (2007) measured $PM_{2.5}$ and PM_{10} at 30 street-level locations in Baguio City, Philippines, during three periods of the day. Their study conducted 15-minute measurements during the early morning, morning rush hour, and afternoon rush hour in December 2004. In the present study, the eight selected sitios will therefore be treated as the sampling locations, while repeated measurements will be conducted at the designated measurement point in each sitio according to the established sampling schedule.

Sampling Schedule

The sampling schedule will be adapted from Cassidy et al. (2007), who conducted a particulate-matter study in Baguio City, Philippines. The study was conducted from December 13–25, 2004, with street-level $PM_{2.5}$ and PM_{10}

measurements collected at 30 locations for 15 minutes at each location. Measurements were conducted during three periods: early morning (4:50–6:30 AM), morning rush hour (6:30–9:10 AM), and afternoon rush hour (3:40–5:40 PM). The researchers selected these periods based on traffic activity and preliminary ambient pollution measurements to represent different conditions throughout the day. Following this approach, the present study will conduct measurements during three sampling periods per day: morning, midday, and afternoon, across three separate sampling days. The same schedule will be applied to each of the eight selected sitios to maintain consistency in the comparison of $PM_{2.5}$ and PM_{10} concentrations.

The exact measurement time, date, and environmental conditions during each sampling session will be recorded. The sampling periods in the present study will be an adaptation of the approach of Cassidy et al. (2007) and will not be presented as the exact schedule used in their study. Their research provides methodological support for obtaining particulate-matter measurements during multiple periods of the day rather than during only one daily period.

Sampling Sites

The study will be conducted in eight selected sitios in Poblacion Zone III, Santa Cruz, Davao del Sur. The selected sampling sites are Apo, Miranda, Ceboley, Sto. Niño, Bagumbayan, Amlo, Salandanan, and Kapehan. These eight sitios were

identified as the sampling locations for the measurement of ambient $PM_{2.5}$ and PM_{10} concentrations. One designated outdoor measurement point will be established within each selected sitio. The same measurement point will be used throughout the sampling period whenever practicable to maintain consistency in the collection of measurements.

The researchers will document the general characteristics and observable environmental conditions surrounding each measurement point. The eight sitios will serve as the sampling locations rather than different land-use categories. The study will therefore focus on determining and comparing the measured $PM_{2.5}$ and PM_{10} concentrations among the eight selected sitios.

Research Instrument

The primary instrument that will be used in the study will be the Temtop M2000 Air Quality Monitor. The instrument is designed to measure particulate matter, including $PM_{2.5}$ and PM_{10}, as well as temperature and humidity. The manufacturer identifies the M2000 as an air-quality monitor equipped with particle sensors and provides a user manual describing its measurement functions and operation (Temtop, 2022). A field data-recording sheet will also be prepared by the researchers to systematically record the measurements obtained during each sampling session. The sheet will include the sampling site, date, sampling period, measurement time, $PM_{2.5}$ concentration, PM_{10} concentration, temperature, relative humidity, wind conditions, rainfall when applicable, and relevant observations. Before data collection, the researchers will inspect the Temtop M2000 to ensure that it is functioning properly and has sufficient battery power. The instrument will be operated according to the manufacturer's instructions. The same instrument and

measurement procedure will be used at all eight selected sitios to maintain consistency in data collection. The manufacturer's manual also notes that airflow and environmental conditions can affect particulate-matter readings, which supports the recording of environmental conditions during each sampling session (Temtop, 2022).

Data Gathering Procedure

Before conducting the study, the researchers will secure the necessary permission from the appropriate school and local authorities to conduct particulate-matter measurements in the eight selected sitios of Poblacion Zone III, Santa Cruz, Davao del Sur. Before each sampling day, the researchers will inspect the Temtop M2000 Air Quality Monitor and ensure that the instrument is operational and sufficiently charged. The instrument will be operated according to the manufacturer's instructions. The M2000 provides real-time $PM_{2.5}$ and PM_{10} measurements, and its user guidance indicates that airflow and other environmental conditions may affect particulate-matter readings (Temtop, 2022). At each selected sitio, the researchers will proceed to the predetermined outdoor measurement point. The Temtop M2000 will be positioned consistently at the designated location, and the $PM_{2.5}$ and PM_{10} readings will be recorded together with the date and exact time of measurement. Measurements will be conducted during three sampling periods per day: morning, midday, and afternoon, across three separate sampling days.

This schedule will be an adaptation of the multiple-period approach used by

Cassidy et al. (2007), who measured $PM_{2.5}$ and PM_{10} during different periods of the day at street-level locations in Baguio City, Philippines. During each measurement session, the researchers will also record temperature, relative humidity, wind conditions, rainfall when applicable, and other relevant observations. Recording these conditions will provide contextual information for interpreting variations in the measured particulate-matter concentrations. After each sampling session, the researchers will check the field data-recording sheet to ensure that the required measurements and observations have been recorded. The collected measurements will then be organized according to sitio, sampling day, and sampling period. After completing all sampling sessions, the $PM_{2.5}$ and PM_{10} measurements will be encoded into a spreadsheet for statistical analysis. The original recorded measurements will be retained, and the same dataset will be used for the computation of descriptive statistics and subsequent inferential analysis.

Statistical Tools

The data collected from the eight selected sitios will be analyzed using descriptive and inferential statistical methods. The statistical analysis will be conducted separately for $PM_{2.5}$ and PM_{10} concentrations.

Mean. The mean will be used to determine the average $PM_{2.5}$ and PM_{10} concentration recorded in each selected sitio. The results will be expressed in micrograms per cubic meter ($\mu g/m^3$).

Standard Deviation . The standard deviation will be used to describe the variability of the $PM_{2.5}$ and PM_{10} measurements within each selected sitio. It will indicate how

closely the recorded measurements are distributed around their respective means.

Test of Normality. Before conducting the One-Way ANOVA, the researchers will assess whether the data satisfy the normality assumption required for the analysis. Normality may be assessed using the Shapiro–Wilk test together with appropriate graphical examination. Normality is one of the assumptions considered for a One-Way ANOVA.

Test of Homogeneity of Variance. The researchers will assess whether the variances of $PM_{2.5}$ and PM_{10} concentrations are sufficiently similar among the eight selected sitios. Levene's test will be used to assess the homogeneity-of-variance assumption. Homogeneity of variance is an important assumption for the conventional One-Way ANOVA.

One-Way Analysis of Variance (ANOVA). A One-Way ANOVA will be used to determine whether there is a statistically significant difference in the mean $PM_{2.5}$ concentrations among the eight selected sitios. A separate One-Way ANOVA will also be conducted for PM_{10} concentrations. One-Way ANOVA is appropriate for comparing the means of more than two independent groups when its assumptions are adequately satisfied. The level of significance will be set at 0.05. If the resulting p-value is less than 0.05, the null hypothesis will be rejected, indicating a statistically significant difference among the group means. If the p-value is greater than or equal to 0.05, the null hypothesis will not be rejected.

Tukey's Honestly Significant Difference (HSD) Test. If the One-Way ANOVA produces a statistically significant result, Tukey's HSD post-hoc test will be performed to determine which pairs of sitios have statistically significant differences in their mean $PM_{2.5}$ or PM_{10} concentrations. Tukey's HSD is used for

pairwise comparisons following a significant One-Way ANOVA.

If the assumptions for the conventional One-Way ANOVA are not adequately satisfied,

the researchers will not automatically interpret the standard ANOVA result as valid. The appropriate alternative statistical procedure will be determined based on the specific assumption violation and the characteristics of the collected data.

Data Analysis and Interpretation

The collected $PM_{2.5}$ and PM_{10} measurements will be organized according to the eight selected sitios and the corresponding sampling sessions. The recorded values will first be summarized using the mean and standard deviation to describe the particulate matter concentrations and their variability at each sampling location. The demographic information of the selected sitios, specifically population size and population density, will be presented separately as descriptive information. These demographic variables will not be included as independent variables in the statistical comparison of $PM_{2.5}$ and PM_{10} concentrations, consistent with the study's conceptual framework. For inferential analysis, separate One-Way ANOVA tests will

be performed for $PM_{2.5}$ and PM_{10} to determine whether statistically significant differences exist among the eight selected sitios. The level of significance will be set at 0.05. When a statistically significant ANOVA result is obtained, Tukey's HSD post-hoc test will be used to identify which pairs of sitios differ significantly.

The results will be interpreted based on the research questions and null hypotheses. The measured $PM_{2.5}$ and PM_{10} concentrations will also be presented in relation to applicable Philippine air-quality guideline values when appropriate. The interpretation will recognize that the study provides localized baseline measurements and does not constitute official regulatory air-quality monitoring.

Ethical and Environmental Considerations

The study will be conducted in accordance with the necessary permissions and protocols of the concerned authorities. Before data collection, the researchers will secure permission from the appropriate school and local authorities to conduct particulate-matter measurements in the eight selected sitios of Poblacion Zone III, Santa Cruz, Davao del Sur. The study will involve environmental measurements and will not require human participants to undergo physical procedures or provide biological samples. The researchers will conduct the measurements at designated outdoor locations without intentionally interfering with normal community activities. The researchers will record the $PM_{2.5}$ and PM_{10} measurements as obtained from the instrument and will maintain the original field records. Data will not be intentionally altered or selectively removed to produce a desired result. Environmental conditions observed during sampling will also be recorded to provide context for interpreting the measurements. The researchers will observe appropriate safety precautions during field data collection, particularly when working near roads and other areas with vehicular activity. The researchers will avoid obstructing traffic, pedestrians, or community activities while conducting the measurements. The results will be reported objectively and will be limited to the conditions and locations covered by

the study. The findings will not be presented as official regulatory air-quality measurements because the study is intended to provide localized baseline information rather than replace official air-quality monitoring.

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