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LAN653 LANDSCAPE ARCHITECTURE SEMINAR

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THE ACCLAIMED LANDSCAPE OF KNOWLEDGE SHARING

"Harmony in Spaces : Blending Heritage, Nature and Design"

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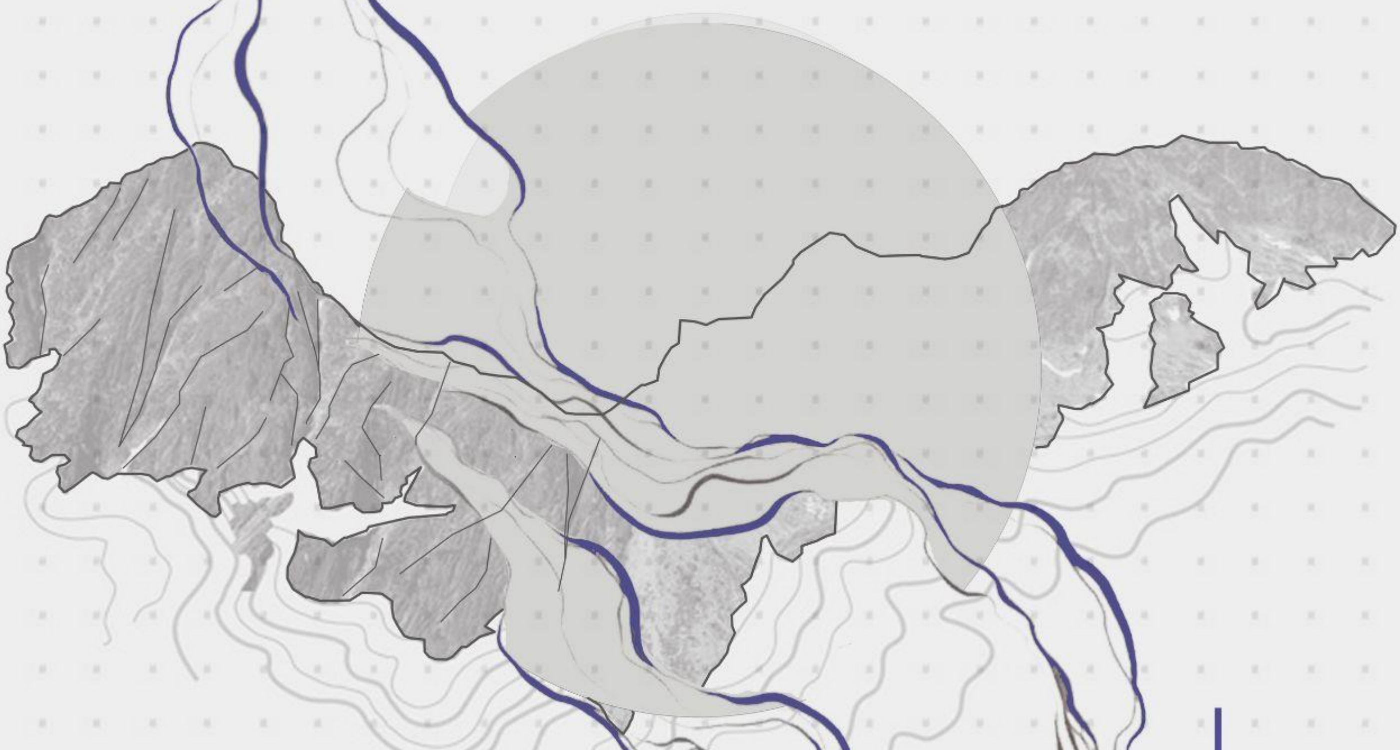

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ASSESSING THE INFLUENCE OF VEGETATION ON URBAN AIR QUALITY IN IPOH PERAK

Amsyar Hakim Badrul Hisham[1]& Atikah Fukaihah Amir[2]

[1]Department of Built Environment Studies and Technology, Faculty of Built Environment, Faculty of Architecture, Planning and Surveying, Universiti Teknologi Mara, Perak Branch, Seri Iskandar, 32610, Perak Malaysia.
Email:amsyarhakim645@gmail.com[1] atika250@uitm.edu.my[2]

Abstract

The environment plays a vital role in sustaining human life, yet rapid urbanization has significantly altered the natural balance, particularly in heritage urban areas. In densely built environments like Concubine Lane, Ipoh, Perak, the dominance of hardscapes and limited green infrastructure has led to concerns about deteriorating air quality, especially elevated carbon dioxide (CO_2) levels. This study addresses the issue by exploring the effectiveness of vegetation covers such as trees, potted plants, green walls, and rooftop greenery in reducing outdoor CO_2concentrations in pedestrian-heavy urban corridors. The aim of this research is to evaluate and compare CO_2 levels between high, medium, and non-vegetation coverage at Concubine Lane's surrounding. Using a quantitative field approach, CO_2 levels are measured in selected zones. A Delta OHM portable CO_2 monitoring instrument is employed to collect real-time, outdoor data under same environmental conditions. The data is then analysed using descriptive statistics to assess the significance of vegetation covers on air quality performance. The findings from this research are these results clearly demonstrate that areas with more vegetation show better air quality, while traffic-heavy zones and tree-barren spaces are more prone to elevated CO_2 levels.

Keyword: Vegetation Covers, Carbon dioxide (CO_2) levels, Air Quality. Urban Environment, Health.

INTRODUCTION

Urbanization has brought undeniable economic and infrastructural progress, yet it also poses serious challenges to environmental quality—particularly in the form of air pollution. Among various urban pollutants, carbon dioxide (CO_2) is a key indicator of deteriorating air quality, especially in areas with high human activity and minimal vegetation. In Malaysia, heritage areas such as Concubine Lane in Ipoh, Perak—a vibrant and densely visited urban corridor—exemplify the type of compact urban settings where greenery is limited and pollution risks are high.

Outdoor environments in heritage tourism zones require attention due to constant exposure to emissions from human traffic, food stalls, and vehicular movement (Department of Environment Malaysia, 2021). Although buildings often implement green design solutions, streetscapes and public lanes can also benefit from the strategic integration of vegetation, such as green walls, rooftop gardens, and potted plants.

As noted by Petty (2017), maintaining air quality, —whether indoors or outdoors requires managing gases such as CO_2 and particulate matter, along with temperature and humidity levels. Similarly, Zawawi et al. (n.d.) emphasize that air quality degradation often results from poor ventilation and pollution from anthropogenic activities. Green infrastructure presents an effective passive design approach to absorb pollutants and improve environmental conditions in urban spaces.

This study responds to the lack of localized empirical data on the effectiveness of urban greenery in outdoor heritage contexts, specifically in tropical cities like Ipoh. It focuses on measuring and comparing CO_2 levels between areas of Concubine Lane that include green interventions (e.g., planted corridors) and those without. The research is framed by the goals of the United Nations Sustainable Development Goals (SDGs), particularly:

- SDG 11: Sustainable Cities and Communities, which promotes green public spaces and sustainable urban planning,
- SDG 13: Climate Action, which calls for efforts to reduce greenhouse gas emissions,
- SDG 3: Good Health and Well-being, focusing on the reduction of health risks from environmental pollution.

Research Objective

1. To measure and compare the levels of carbon dioxide (CO_2) in different urban areas of Concubine Lane, Ipoh.
2. 2. To evaluate the effectiveness of urban greenery component in reducing CO_2 concentrations and improving outdoor air quality in heritage urban environments.

LITERATURE REVIEW

Green Wall Designs and Environmental Function

Green walls, also referred to as vertical greenery systems (VGS), are an emerging architectural and ecological solution that involves the integration of vegetation on vertical surfaces such as walls, facades, or partitions. Baran and Gültekin (2018) note that the concept of vertical planting dates back to historical structures like the Hanging Gardens of Babylon. Modern green walls typically consist of modular systems, hydroponic supports, or climbing vegetation designed to cover exterior or interior walls. According to Perini et al. (2011), these systems enhance both building performance and urban aesthetics by creating active, plant-based facades that contribute to energy savings and pollution control.

Beyond aesthetics, green walls serve functional purposes absorbing gaseous pollutants, regulating temperature, and reducing noise pollution. As Wesołowska and Laska (2019) assert, the vegetation within green walls interacts directly with the surrounding environment, improving human well-being and creating psychologically restorative spaces. Their structure also aids in thermal insulation, contributing to cooler microclimates in dense urban areas. Hung et al. (2019) found that green walls have measurable cooling effects, reducing wall surface temperatures by up to 5.8°C on hot days, thus helping mitigate the urban heat island (UHI) effect.

Currently, our green wall offers multiple benefits such as mitigating the urban heat island (UHI) effect. Research has indicated that this cooling approach influences both the indoor and outdoor environments of a building. Bart Felder and Köhler discovered that the cooling impact of the green wall is influenced by the outdoor temperature. As stated by Hung, Chen, Yeh, & Tseng (2019), the green wall's cooling effect on cold and hot days was recorded at 0.4°C and 5.8°C, respectively. Another benefit is noise reduction; several studies have highlighted that the foliage and branches of green wall plants significantly diminish noise. The sound-dampening effect of vegetation occurs when sound waves travel through trees, where they are reflected and refracted by branches and leaves, absorbing some of the energy and thereby lessening the noise. In contrast, living walls allow for the rapid greening of larger wall surfaces on high-rise buildings. As stated by Manso and Castro-Gomes (2015). They benefit from steady growth on surfaces and can be specifically crafted to suit different architectural styles.

Importance of Carbon Dioxide (CO_2) Monitoring for Indoor Air Quality

As stated by Peterborough Public Health (2022), when we breathe out, we release CO_2 into the atmosphere. Indeed, every breath from a typical adult has 35,000 parts per million (ppm) of CO_2. When additional individuals stay in a room, CO_2 concentrations rise rapidly if there isn't sufficient fresh air entering the area. Elevated indoor CO_2 concentrations can lead to fatigue, headaches, and various other symptoms. Rising CO_2 levels indicate that the area lacks proper ventilation. Additional indoor pollutants may also rise in a space with inadequate ventilation. This encompasses respiratory droplets and the viruses they transport. CO_2 measurements will assist in identifying whether basic measures are required to reduce transmission risk. This encompasses actions such as opening a window or decreasing the number of individuals in a room.

Air Quality Improvement

Particulate matter (PM) significantly contributes to air pollution. The small particles of PM that can infiltrate the lungs raise the chances of respiratory illnesses, lung cancer, cardiovascular issues, and strokes as stated by (Tang, 2023). Air pollution is connected to climate change because specific air contaminants like ground-level ozone, nitrous oxide, methane, and hydrofluorocarbons function as greenhouse gases. As stated by Francesca Dominici, Michael Greenstone, and Cass R. Sunstein (2014). Green walls function as natural air filters by absorbing pollutants and emitting oxygen. Research has demonstrated considerable decreases in particulate matter and toxic gases, leading to purer and healthier urban air. Given that plants are crucial in filtering air and decomposing certain pollutants, the introduction of green walls and green roofs allows for the ideal greening of urban buildings to enhance urban air purification

RESEARCH METHODOLOGY

The technique presented includes qualitative elements in the design of the environmental research.

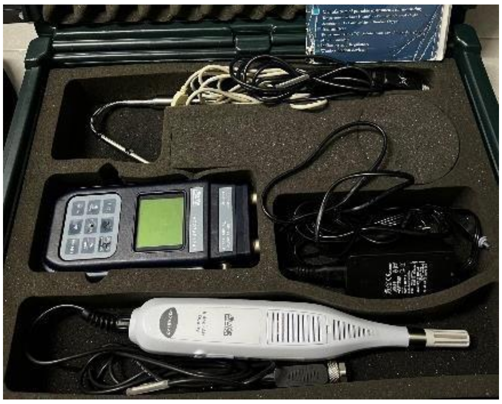

Figure 1: Delta OHM device

The researcher begins by examining the physical layout and site conditions of Concubine Lane, Ipoh to identify optimal outdoor areas for air quality observation. This includes both green-integrated zones (such as areas with vertical greenery or potted plants) and non-green areas (bare walls or exposed urban surfaces). To monitor environmental parameters, a Delta OHM instrument (Figure 1) is used. This device records key air quality indicators, including carbon dioxide (CO_2), carbon monoxide (CO), relative humidity (RH), temperature (°C), and air velocity (VA). The outdoor air quality assessment collects real-time data from various zones within the study site.

Site Plan

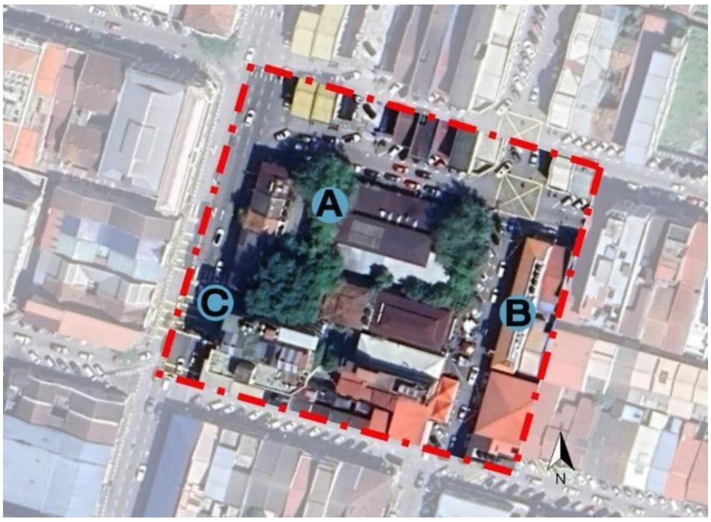

Figure 2: Plan of The Concubine Lane Ipoh, Perak
Source: Google Map

Figure 2 illustrates the selected observation zones around Concubine Lane, while Table 1 outlines the details of each zone along with their physical characteristics (e.g., presence of vegetation, shading, human activity levels). This methodology ensures a consistent comparison between green and non-green outdoor environments, helping to evaluate the impact of urban greenery on air quality in a compact, heritage-based urban setting.

Table 1. Comparison of the characteristics of all 3 Areas

Area	Location A	Location B	Location C
Area Chosen	Building Covered with Trees	Building Without Trees	Busy Roadside
Characteristic of Area	Shady area with tree covers and plants in the surroundings.	Busy space with people's business, without plants in the perimeter	The side of the main road is devoid of trees and busy cars passing by

Source: Author, (2025)

(A) **(B)** **(C)**

Figure 3: Site picture
Source: Author, (2025)

Figure 3, three different outdoor areas in Ipoh to compare air quality. Site A is an area with lots of trees and greenery. It is cooler and has shade, which helps improve the air quality. Site B has no trees and is more open. Because it has less greenery, the air quality here is not as good. Site C is located next to a busy road with many passing vehicles. The air in this area is affected by car fumes and traffic, making it more polluted. These three sites help show how trees and human activities can affect the quality of air in different places.

CO_2 [ppm]	Air Quality
2100	**BAD** Heavily contaminated indoor air. Ventilation required
2000	
1900	
1800	
1700	
1600	
1500	**MEDIOCRE** Contaminated indoor air. Ventilation recommended
1400	
1300	
1200	
1100	
1000	**FAIR**
900	
800	**GOOD**
700	
600	**EXCELLENT**
500	
400	

Figure 4: Carbon Dioxide Level
Source: Google

Figure 4, this table shows the classification of CO_2 concentration levels and their impact on air quality. It categorizes CO_2 readings into different ranges, from good to hazardous, helping to indicate how safe or polluted the air is based on the amount of carbon dioxide present.

Figure 5: Wearing mask to adhere to protocols
Source: Author, (2025)

Figure 5, during the observation conducted across four distinct areas, A, B, and C, adherence to protocols involved wearing a mask and positioning the outdoor air quality monitoring device away from observer's face while collecting readings shown.

RESULT & DISCUSSION

In this section, the results and findings are summarised. The data collected is represented in graphs and tables for easy understandings. The data shows fluctuations in these measurements, with some locations experiencing higher levels of CO_2 and CO, as well as higher humidity and temperature. The remarks in the document indicate the number of people present in the location at certain times and the table is coloured according to the outdoor air quality levels from Figure 3.

Provided are the readings taken according to the location sample.

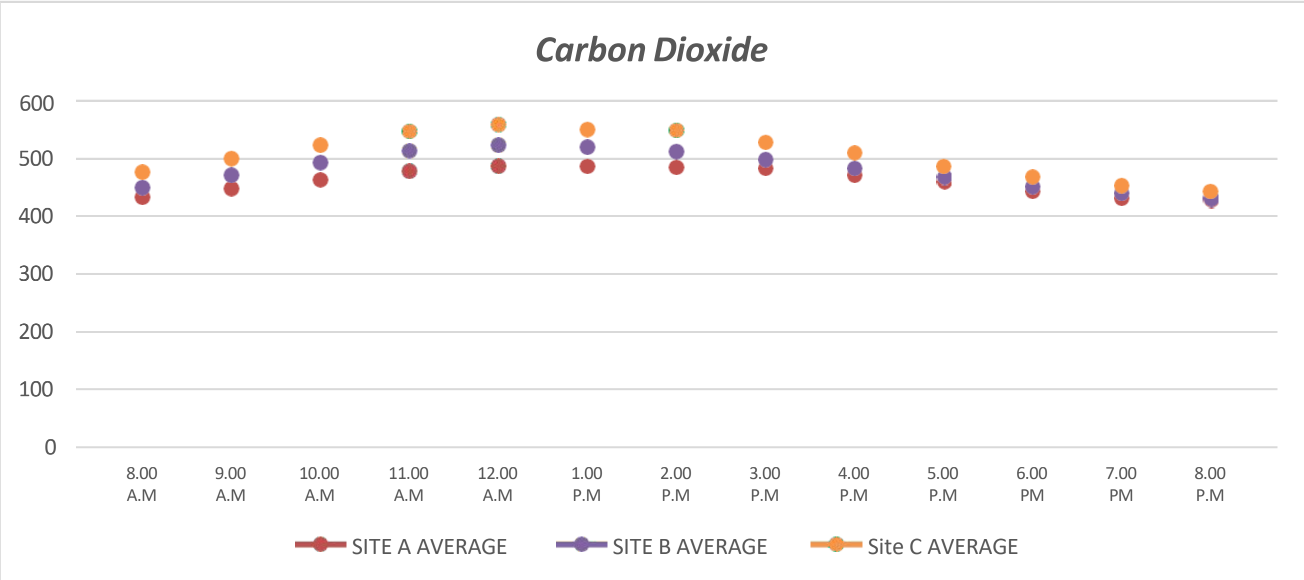

Figure 6: Carbon Dioxide Graph
Source: Author, (2025)

Location A, B, and C. It clearly shows that Location C has a high CO_2 ppm count due to the restricted airflow inside of road compared to the building covered with green. The highest data collected is 590ppm whereas the lowest is 420ppm Without adequate ventilation, high CO_2 emission can contribute to several environmental and health-related issues. When comparing outdoor air quality readings between Location A, a building covered with trees, and Location B, a building without tree coverage, it is evident that Location A has better air quality. This improvement is likely due to the presence of trees, which help absorb carbon dioxide and improve overall air conditions. Although B is not good compared to A, but in B the reading is lower than in C which is on the side of the road which has poor water quality due to traffic congestion and does not have vegetation such as trees to reduce CO_2 to water quality.

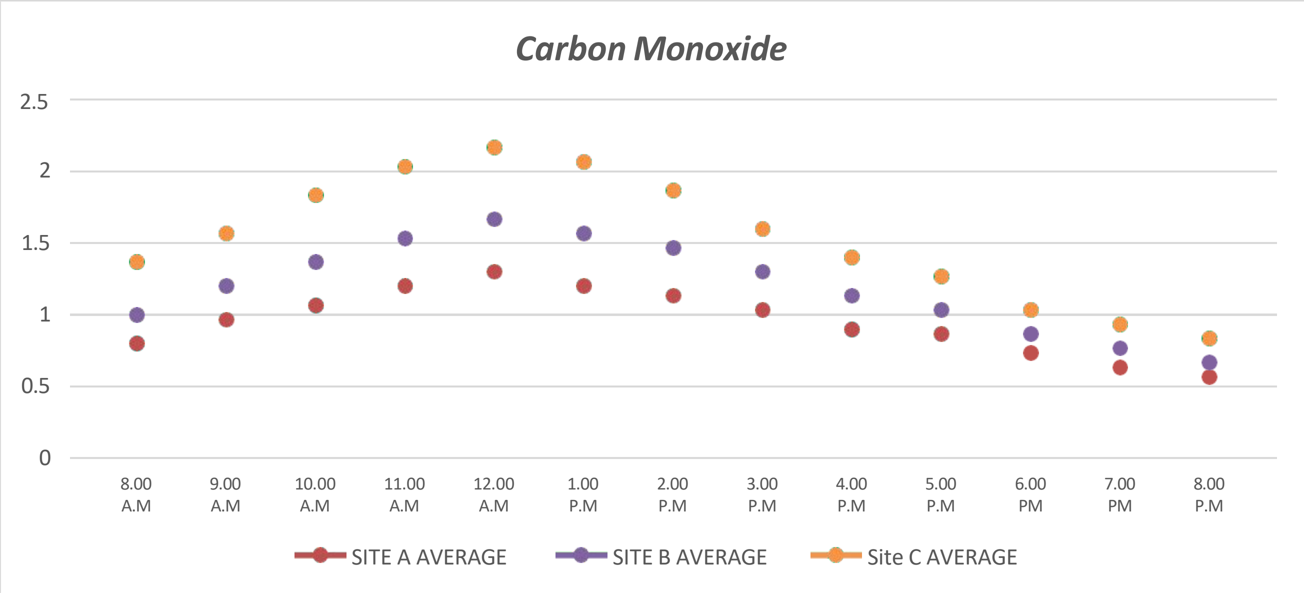

Figure 7: Carbon Monoxide Graph
Source: Author, (2025)

Figure 7 includes a graph depicting carbon monoxide levels showing Locations A, B, and C. The lowest CO count was 1 ppm, which was at Location B and the highest was 0.4 ppm, which was at Location B. Based on Figure 4, all four CO readings are within normal levels. At levels between 1-2.5 ppm, CO exposure is unlikely to cause immediate health effects in most individuals.

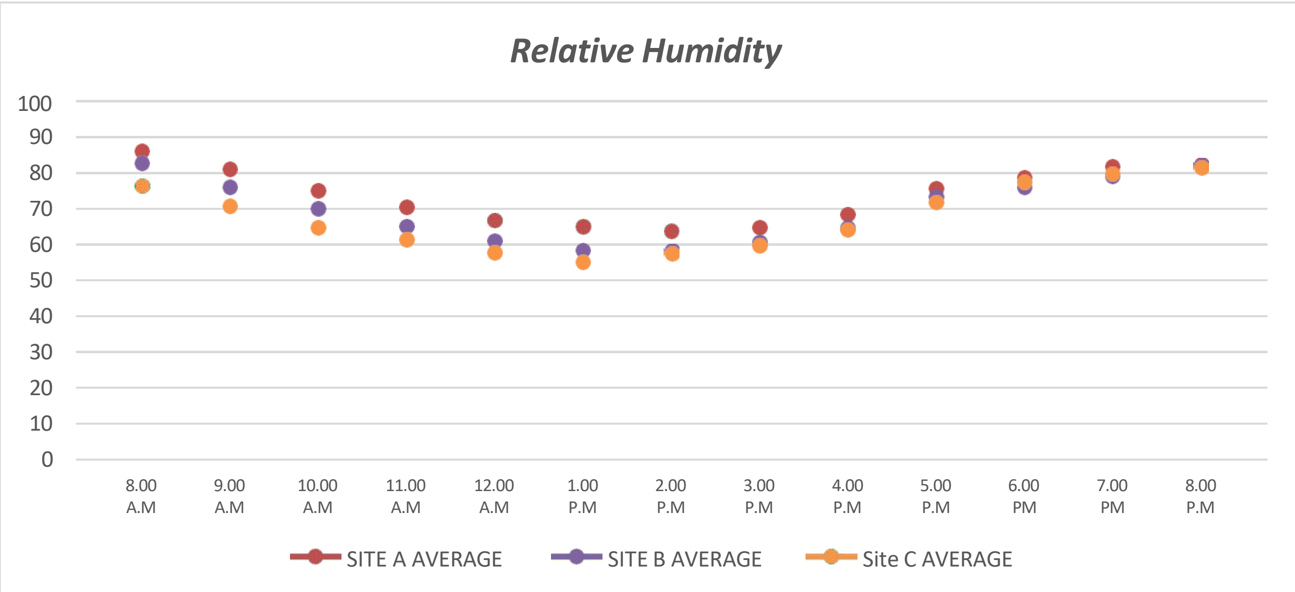

Figure 8: Relative Humidity Graph
Source: Author, (2025)

Figure 8 is a graph depicting the relative humidity levels from Locations A, B, and C. The highest humidity percentage is at location C at 95% at 8:30 PM. This is because at night, temperatures often drop, causing the air's capacity to hold moisture to decrease. As the air cools, its ability to hold water vapor decreases, potentially leading to higher relative humidity levels. If humidity remains constant but the temperature drops, the air becomes more saturated with moisture, leading to higher humidity. The lowest humidity percentage of 53% at 1:30 PM is located at location C. As the day progresses and approaches noon (1:30 PM), the temperature tends to increase. Warmer air has a higher capacity to hold moisture, meaning that relative humidity the ratio of moisture in the air to the maximum it can hold often decreases as the temperature increases.

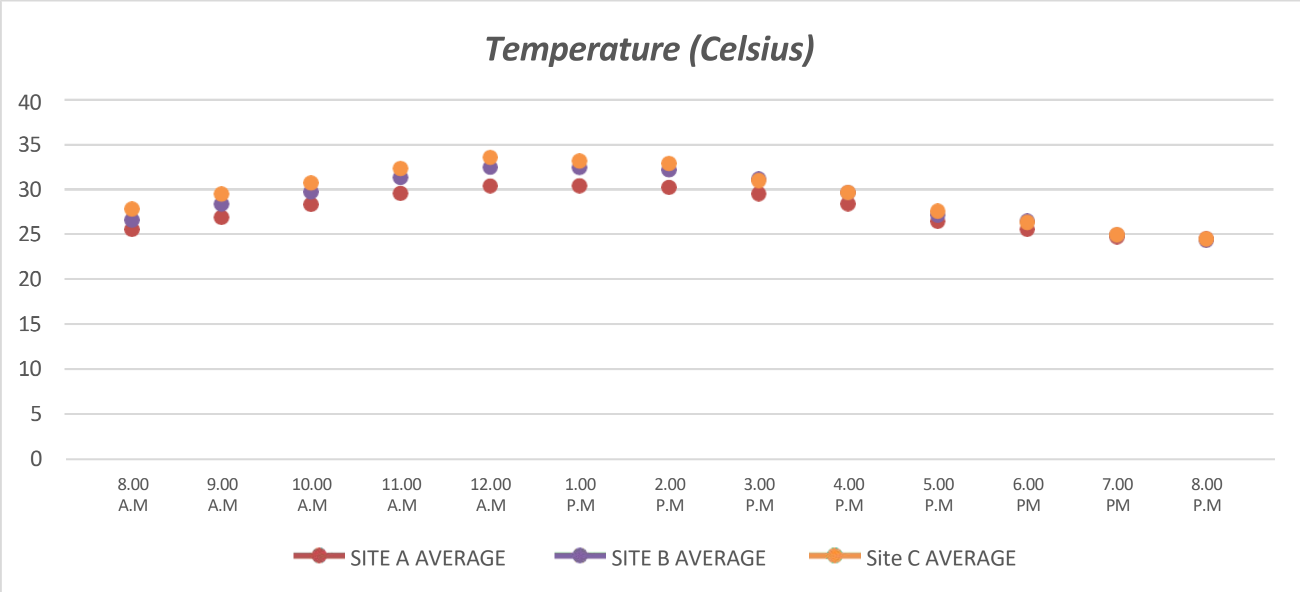

Figure 9: Temperature (Celsius) Graph

Source: Author, (2025)

Figure 9 is a graph depicting the temperature levels taken at Locations A, B, and C. The highest temperature recorded was at Location C with a reading of 33.5 °C at 1:30 PM. Currently, the sun's rays are most direct and because the sun reaches its highest point in the sky, it results in maximum heating of the Earth's surface. The Earth absorbs a large amount of solar radiation, which leads to an increase in temperature. However, the lowest temperature recorded was 24.0°C at Location A. This is because covered with trees have limited exposure to direct sunlight. As a result, they do not receive the same amount of solar radiation that heats the surface above ground. Without sunlight, the environment remains cooler. In addition to the lack of sunlight, without natural air movement, heat exchange with the outside environment is reduced.

CONCLUSIONS AND FUTURE WORKS

The impact of integrated greenery on air quality was studied in Concubine Lane, Ipoh. This research intentionally showed differences in air quality readings in the three areas. Areas with greenery had better air quality than areas without. It was shown that outdoor spaces (Location A), had better outdoor air quality, highlighting the contribution of plants to reduce carbon dioxide levels and also outdoor locations, showing that the rich vegetation in the yard (Location A) was positively correlated with better air quality compared to places with less vegetation such as indoor areas (Location B) and busy roads (Location C). Throughout the study, significant limitations were encountered, including the impact of rainy weather on data collection and limited time constraints due to the relatively long distance between myself and Concubine Lane, Ipoh. Despite these challenges, the completion of this paper was successfully achieved.

The advantages of vegetation outweighed the reduction of CO_2 and included regulating humidity, and temperature. These results highlight the critical connection between green space and more sustainable, healthy urban environments. To conclude, the study supports future urban planning which promotes the use of vegetation in both indoor and outdoor environments to promote better air qualit

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