The Role of Green Universities in Enhancing the Environment [Microclimate] of the University Campus: The Case Study of Al-Mustaqbal University

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Abstract

Chronic non-communicable diseases (NCDs) such as depression, anxiety, hypertension, diabetes, obesity, and cardiovascular diseases are becoming increasingly prevalent in urban areas in general, and specifically within university campuses. Consequently, the regular incorporation of nature exposure—which is essential for maintaining a healthy lifestyle—has become necessary. The growing research interest in linking campus green spaces with health, and the engagement with the natural world with the physical and mental well-being of site occupants (students, faculty, staff, workers, etc.), has led to a focus on advanced world concerns regarding these NCDs. This, in turn, has increased attention towards campus green spaces, which can encourage heightened daily activities and physical engagement, and promote site stewardship for their significant role in mitigating depression and stress. Given that the relationship between physical and mental health is complex and interconnected, focusing on the site extends to encouraging healthy physical behavior and alleviating or preventing poor mental health.

The results of this study substantiated these expectations. It demonstrated that the afforestation of campus green spaces contributes to the reduction of air pollutants. Readings at the optimal location (L2) were at their lowest levels in the morning: (HCHO=0.003, TVOC=0.005, PM2.5=15, PM10=20, CO2=407, CO=1.2). Midday readings at L2 were: (HCHO=0.003, TVOC=0.012, PM2.5=16, PM10=20, CO2=354, CO=1.1). Conversely, readings at location L7 varied significantly, recording in the morning: (HCHO=0.015, TVOC=0.020, PM2.5=20, PM10=26, CO2=618, CO=1.9). Midday readings at L7 were: (HCHO=0.020, TVOC=0.020, PM2.5=22, PM10=28, CO2=657, CO=2.9). The Air Quality Index (AQI) was best at L2, registering 40 in the morning and 46 at noon, while L7 showed the poorest air quality, reaching 104 in the morning and 120 at noon.

* Keywords: Healthy Campus, Air Pollutants, Afforestation, Air Quality, Green Spaces.

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Research Objectives

The primary objectives of this study are to investigate and quantify the role of various planted vegetation types within green university campuses in enhancing the environmental quality and influencing the campus microclimate. Specifically, the study aims to achieve the following:

Quantify the Impact on Air Quality: To determine the effectiveness of cultivated vegetation (including turfgrass, trees, shrubs, and herbaceous plants) in significantly reducing the concentration of key air pollutants within the campus environment.

Assess Pollutant Mitigation Efficiency: To evaluate the contribution of green spaces in decreasing levels of specific pollutants, particularly:

Volatile Organic Compounds {HCHO} and {TVOC}.

Particulate Matter {PM2.5} and {PM10}.

Gaseous Pollutants {CO}2 and {CO}.

Determine Microclimate Improvement: To analyze how different types of green spaces impact the campus microclimate by contributing to better air quality and thermal comfort.

Evaluate Air Quality Index {AQI}: To assess and compare the resulting overall Air Quality Index {AQI} across different land-use configurations (vegetated vs. non-vegetated) to highlight the benefit of green infrastructure in providing a healthier campus environment.

Introduction

The concept of a Healthy University adopts a comprehensive understanding of health, employing a holistic approach to create an environment that promotes the health, well-being, and sustainability of its community. This concept is rooted in the idea that universities should not only focus on academic excellence but also prioritize the public health of students, faculty, staff, and the surrounding community. A healthy campus is a comprehensive initiative aimed at improving health and well-being within educational institutions. This program emphasizes the importance of creating environments that support both mental and physical health, thereby fostering academic success and the overall quality of life for campus occupants. Specifically, plants, especially trees, offer significant opportunities to isolate and remove or mitigate pollution (5).

Universities have accorded paramount importance to green spaces due to their numerous critical functions. They actively prevent pollution particles from penetrating the environment through interception or absorption. They function as natural biological air filters by trapping many airborne pollutant particles. This is particularly effective when trees are planted in close proximity to the pollution source, thus forming a barrier to isolate those pollutants (7).

Furthermore, the availability of green spaces on campus, alongside other types of urban green infrastructure, provides opportunities for direct interaction with nature. Gardening, for instance, offers chances for social interaction, thereby fostering a sense of community and social bonding. As society faces increasing challenges with stress-related illnesses, knowledge regarding how green spaces influence health and well-being can aid in stress mitigation and recovery enhancement. There is a need for knowledge on how different green spaces and landscape elements contribute to health improvement to provide novel design solutions beneficial to human health (3).

A set of theories and approaches have been proposed to explain and evaluate the impact of green spaces on human health. Contemporary theories, such as Ulrich's Stress Recovery Theory (10), predict that green spaces tend to reduce stress, while built environments tend to impede stress recovery. Green spaces have been found to have more positive effects on health, emotional, and physiological states compared to most urban spaces that lack natural elements such as trees, shrubs, and turfgrass. Moreover, their positive benefits impact campus occupants suffering from stress or anxiety. Recent research has demonstrated that the response to green spaces can be directly linked to improved health, reduced anxiety and stress, and increased thermal and mental comfort (11).

Green spaces on campus also exert a positive influence resulting from engagement in daily activities and merely enjoying the visual scenes they offer. Studies conducted by psychologists discovered that exposure to nature significantly reduced fear arousal according to psychological theories, and had a major impact in lowering the negative psychological effects on those suffering from excessive arousal and stress (9).

Preliminary data from a study by (8) indicates that the sense of distress and pain is lower across all groups when located in gardens compared to inside hospital buildings, and that window views of gardens had a restorative effect.

Furthermore, environmental and psycho-social stressors affect and stimulate aggression. Aggression will decrease if a facility is designed with a set of stress-mitigating environmental characteristics. Design theory and preliminary results suggest that providing buildings surrounded by well-designed green spaces plays a significant role in reducing the serious problem of aggressive behavior that threatens the safety of patients and staff (13).

(7) noted that trees act like skin, preventing pollution particles from penetrating, either by intercepting particles or absorbing gaseous or heavy pollutants. They function as natural biological air filters by expelling many airborne pollutant particles. This is achieved when trees are planted very close to the source of pollution, thereby forming a barrier around it to isolate those pollutants. A prime example of this is certain types of trees planted along street pavements.

Individuals who have previously experienced stress have shown that exposure to natural scenes has a stress-reducing effect on them. In contrast, being in urban environments was found to impede recovery. Furthermore, recovery was demonstrably faster and better when individuals were exposed to natural environments compared to urban settings. These findings align with the Psychological Evolutionary Theory (12), which postulates that nature exposure involves a shift toward a more positive emotional state and produces favorable changes in human physiological activity levels.

Although the therapeutic qualities of nature have been acknowledged and relied upon for centuries as a valuable part of convalescence, recent history has seen the nature's therapeutic role virtually overshadowed by the technological dominance of modern medicine. As the 20th century drew to a close, and with the medical community's renewed recognition of the environment's importance for recovery, the healing garden emerged as a complement to drug- or technology-based treatments (6).

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Air pollution is a problem that has garnered widespread attention from various governments worldwide due to its direct impact on human and societal health. Air pollution is considered a serious global challenge and is defined as the addition of various hazardous chemical substances—such as toxic elements, particulate matter (PM), or biological organisms—into the air, which generally harms the health of humans, animals, plants, or the environment (1 , 7, 2).

Materials and Methods

The role of green spaces in mitigating air pollutants and enhancing air quality within the university campus was investigated at the Al-Mustaqbal University is located in Babylon/Al-Hilla, situated along the main Hilla-Najaf road. The city of Al-Hilla (approximately 32.47{N}, 44.40 {E}) is characterized by an Arid to Semi-Arid climate. a private university in Air quality measurements were conducted using a specialized Air Quality Meter, as illustrated in Figure 1.

Measurements were taken across seven distinct locations (L1 to L7) representing various land uses and spatial configurations within the campus green spaces:

L1 (Afforested and grass-covered spaces

L2 (Afforested spaces only)

L3 (Grass-covered spaces only

L4 (Unutilized or underutilized open spaces)

L5 (Pedestrian walkways)

L6 (Vehicle parking lots)

L7 (Vehicle traffic roads)

Data Collection and Analysis

Data was collected during the summer months (July, August, and September), as these are crucial periods affecting thermal comfort and the suitability of the campus environment. Readings were systematically recorded at two time intervals: morning and noon.

A total of five readings were obtained for each location per month. The monthly average was subsequently calculated for each parameter and location. Finally, the collected data was analyzed and interpreted in accordance with the established Air Quality Guide (or Air Quality Index Standards).

The experiment was executed using a Factorial Design and the data were analyzed using the Least Significant Difference {LSD} test at a 0.05 probability level .

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Figure 1: Air Quality and Pollutants Measurement Device.

Results

1. Formaldehyde HCHO Concentration (mg/m3)

The atmospheric HCHO pollution levels were measured using the Air Quality Meter across various sites within the university campus during the summer months (July, August, and September) at both morning and afternoon intervals. The results revealed a significant variation in HCHO contamination rates based on the location of measurement.

The data indicated that the lowest pollution level was observed in L1, which registered a consistent 0.003\ (mg/m3)during both the morning and afternoon periods. This was closely followed by L2, which recorded 0.004\ (mg/m3)at both times.

This significant finding is attributable to the efficiency and pivotal role of afforestation and green cover in reducing the concentration of HCHO air pollution, facilitating its removal, and consequently fostering a healthier environment within the campus green spaces.

Conversely, the highest readings were observed in L7, L4, L6, and L5 sequentially:

Morning: 0.015, 0.009, 0.012, and 0.010\ (mg/m3), respectively.

Afternoon: 0.020, 0.015, 0.017, and 0.010\ (mg/m3), respectively As indicated in Table 1.

The elevated levels in these areas are ascribed to the absence of tree planting and green vegetative cover, which otherwise plays a substantial role and has a significant effect on mitigating ambient air pollution, as further illustrated in Figures 2 and 3 (as referenced).

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Table (1): Mean Monthly Concentration of Formaldehyde (HCHO) in the Campus Sites (mg/m)

Mean Location Effect	**Afternoon (A)**	**Morning (M)**	**Location (ID)**
0.0175	0.02	0.015	**L7**
0.012	0.015	0.009	**L4**
0.004	0.004	0.004	**L2**
0.0045	0.005	0.004	**L3**
0.0145	0.017	0.012	**L6**
0.003	0.003	0.003	**L1**
0.01	0.01	0.01	**L5**
	0.010571	0.008143	**Time Effect**
0.0008 = Interaction L.S.D.		0.0003= Interaction L.S.D.	0.0006 = Interaction L.S.D.

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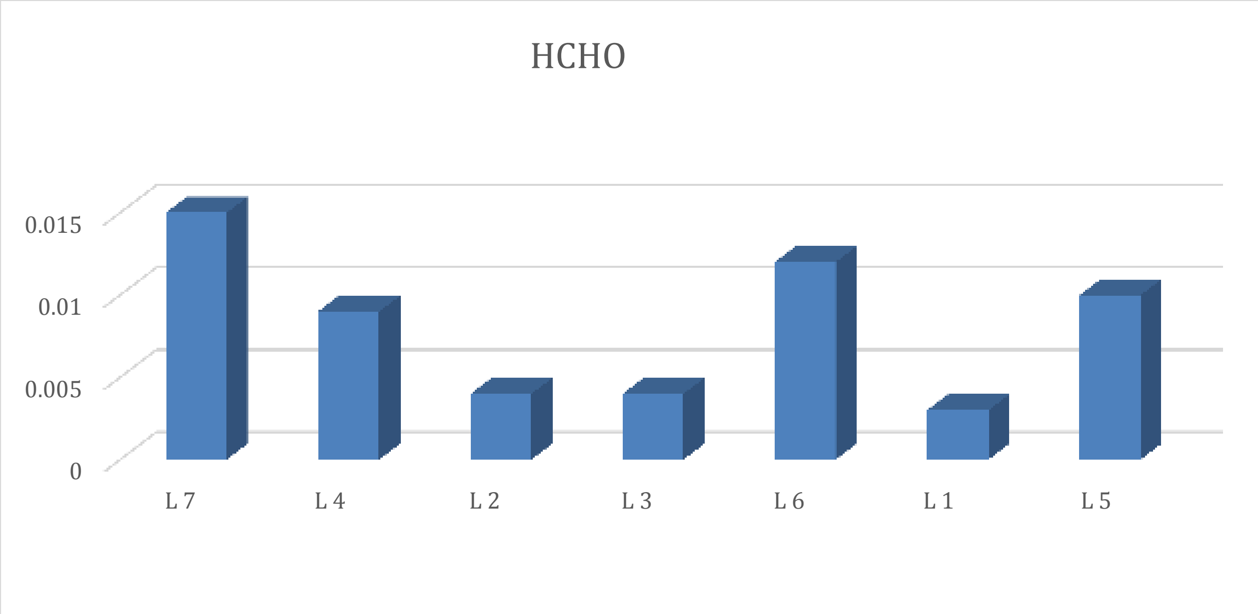

Figure 2: Monthly average concentration of HCHO in the campus spaces during the morning (mg/m3).

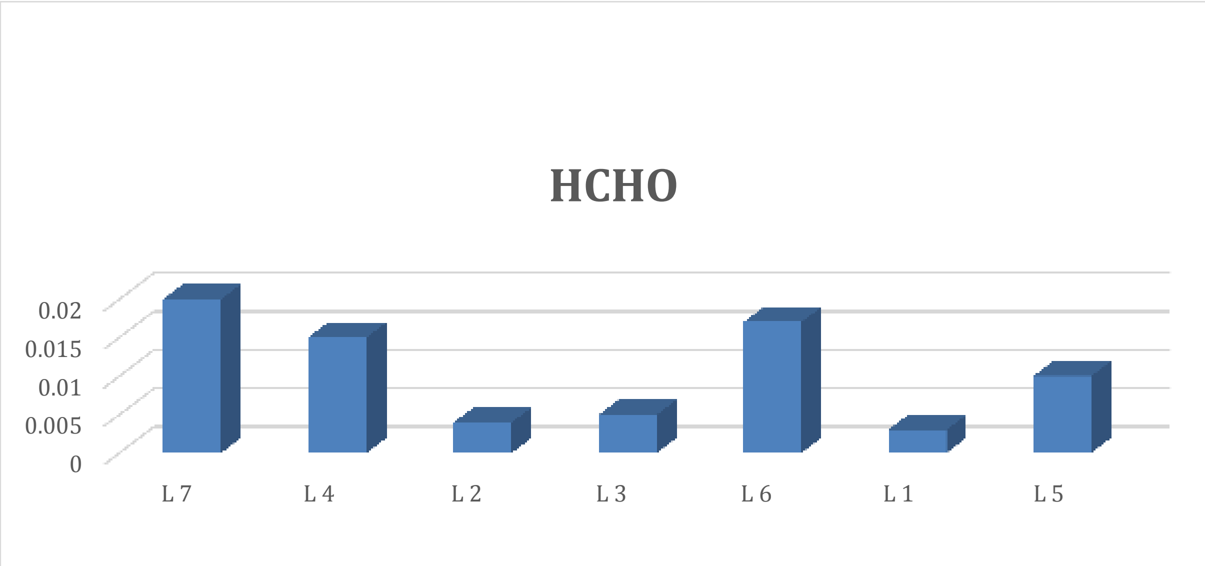

Figure 3: Monthly average concentration of HCHO in the campus spaces during the afternoon (mg/m3).

2. Total Volatile Organic Compounds (TVOC) Concentration (mg/m3)

The level of atmospheric pollution by Total Volatile Organic Compounds (TVOC) was measured using the Air Quality Meter during the months of July, August, and September, across different sites within the university campus at both morning and afternoon intervals. The results revealed a significant variation in TVOC pollution rates based on the sampling location. The lowest pollution levels were observed in L2, L1, and L3 in a descending order of concentration:

Morning Readings: 0.005, 0.006, and 0.007\ (mg/m3), respectively.

Afternoon Readings: 0.012, 0.013, and 0.013\ (mg/m3), respectively As indicated in Table 2.

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The low concentrations recorded in these locations are attributed to the efficiency of afforestation and green cover in reducing TVOC concentrations, removing atmospheric pollutants, and achieving a healthier environment.

Conversely, the highest readings were recorded in L7, L4, L6, and L5:

The high TVOC concentrations in these areas are due to the absence of green vegetative cover, which is known to play a major role in mitigating ambient air pollution. These findings are further detailed in Figures 4 and 5 (as referenced).

Table (2): Mean Monthly Concentration of Total Volatile Organic Compounds {TVOC} in the Campus Sites {mg/m}3

Mean Location Effect	Afternoon (A)	Morning (M)	Location (ID)
0.02	0.02	0.02	**L7**
0.0165	0.017	0.016	**L4**
0.01	0.013	0.007	**L2**
0.0095	0.013	0.006	**L3**
0.016	0.018	0.014	**L6**
0.0085	0.012	0.005	**L1**
0.0125	0.016	0.009	**L5**
	0.015571	0.011	**Time Effect**
0.00344= Interaction L.S.D.		0.00130= Interaction L.S.D.	0.00243= Interaction L.S.D.

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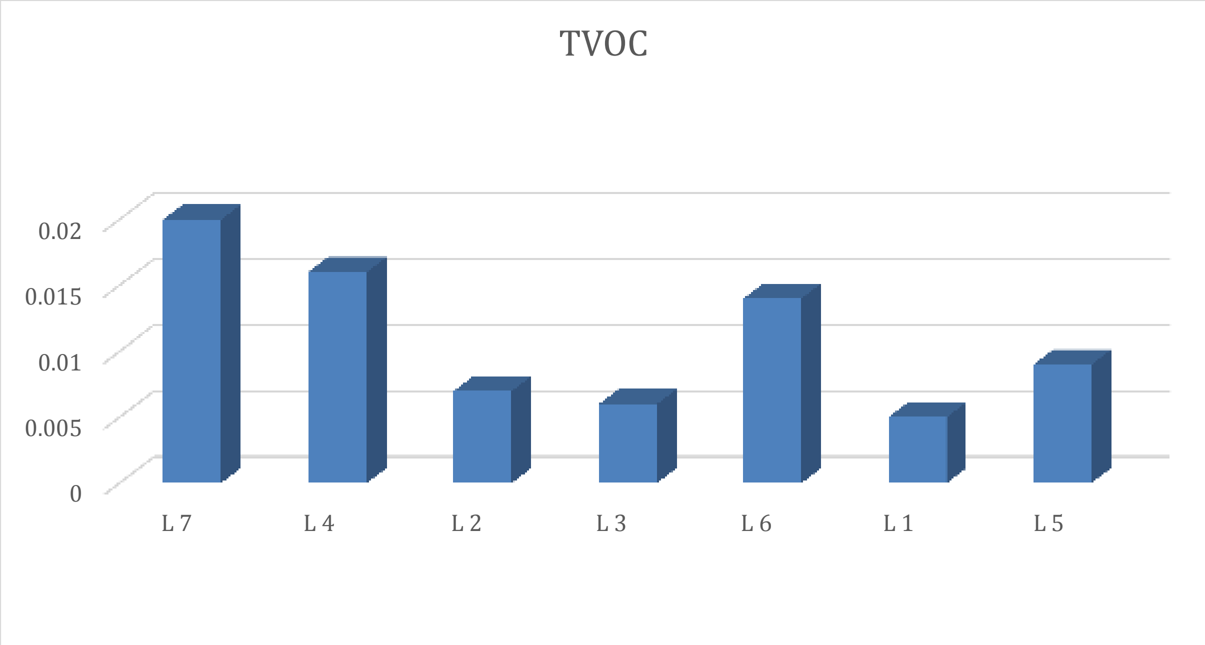

Figure 4: Monthly average concentration of TVOC in the atmosphere during the morning(mg/m3)

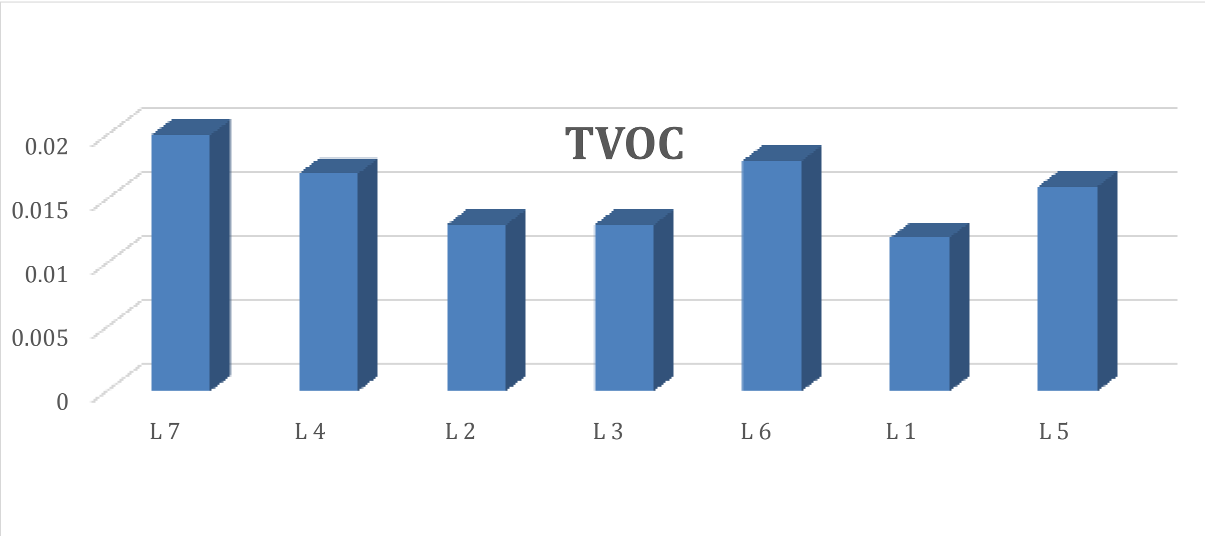

Figure 5: Monthly average concentration of TVOC in the atmosphere during the afternoon (mg/m3)

3. Fine Particulate Matter Concentration PM2.5µg /m3

The concentration of Fine Particulate Matter PM2.5 was measured across the study sites using the Air Quality Meter during the summer months (July, August, and September) at morning and afternoon intervals. The results indicated a variation in PM2.5 levels depending on the measurement location.

The lowest pollution levels were recorded sequentially in L1, L3, and L2:

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Morning Readings: 15, 17, and 16 µg /m3, respectively.

Afternoon Readings: 16, 18, and 17 µg /m3, respectively As indicated in Table 3.

The lower PM2.5 concentrations observed in these locations are attributed to the high efficiency of afforestation and green cover in reducing PM2.5 levels, facilitating the removal of atmospheric pollutants, and thus promoting a healthier environment.

This trend contrasts with the high readings recorded in L7, L6, L4, and L5:

The elevated PM2.5 concentrations in these areas are due to the lack of green vegetative cover, which plays a substantial role in mitigating surrounding air pollution, as demonstrated in Figures 6 and 7 (as referenced).

Table (3): Mean Monthly Concentration of Fine Particulate Matter {PM2.5} in the Campus Sites {g/m}

Mean Location Effect	**Afternoon (A)**	**Morning (M)**	**Location (ID)**
21	22	20	**L7**
19.5	20	19	**L4**
16.5	17	16	**L2**
17.5	18	17	**L3**
20.5	21	20	**L6**
15.5	16	15	**L1**
18.5	19	18	**L5**
	19	17.857	**Time Effect**
1.213= Interaction L.S.D.		0.458= Interaction L.S.D.	0.857= Interaction L.S.D.

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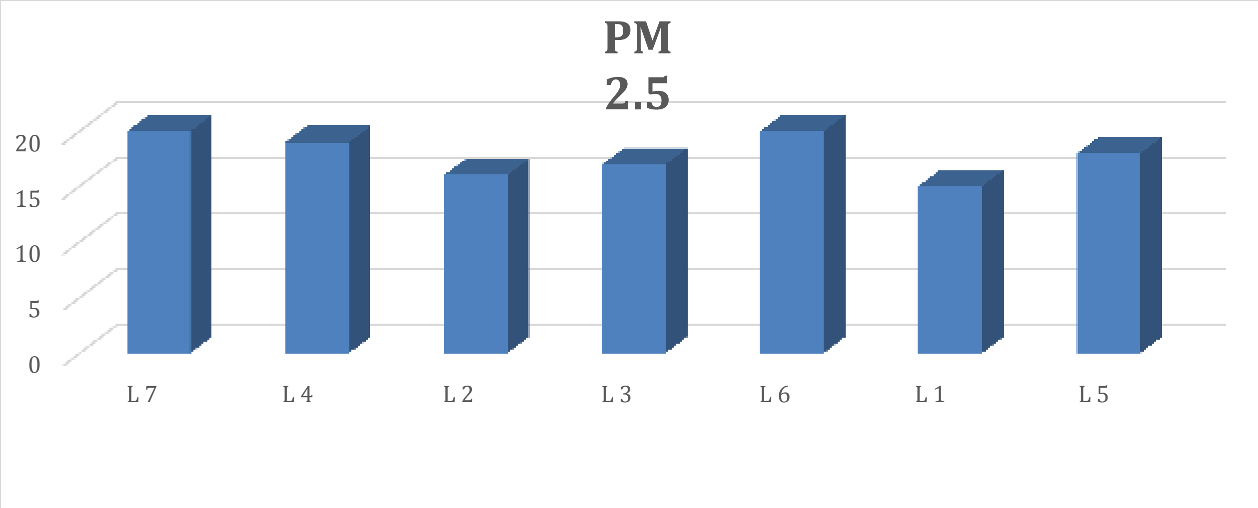

Figure 6: Monthly average concentration of PM2.5 during the morning

µg /m3

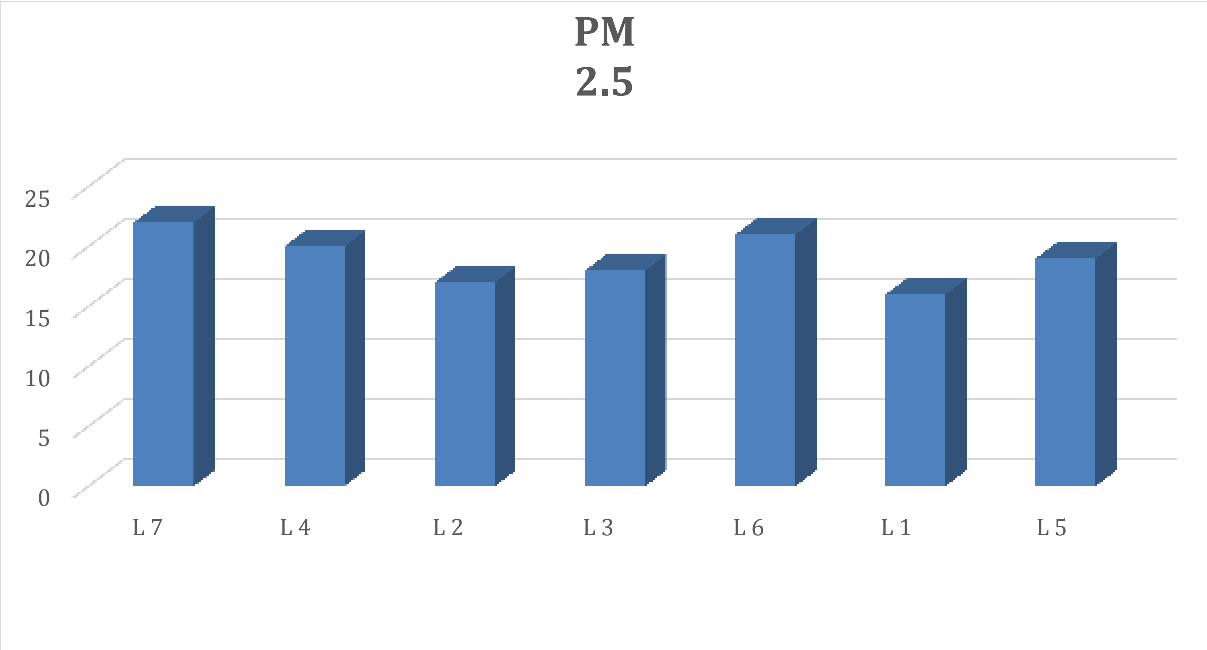

Figure 7: Monthly average concentration of PM2.5 during the afternoon

µg /m3

4. Coarse Particulate Matter PM10 Concentration µg /m3

The level of atmospheric pollution by Coarse Particulate Matter PM10 was measured using the Air Quality Meter during the months of July, August, and September across various sites within the university campus. The results showed a variation in PM10 concentrations depending on the recording location, as illustrated in Figures 8 and

The lowest pollution levels were recorded sequentially in L1, L2, and L3:

Morning Readings: 20, 21, and 22 µg /m3, respectively.

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Afternoon Readings: 21, 22, and 23 µg /m3, respectively As indicated in Table 4.

This reduction in PM10 concentration is attributed to the efficiency of afforestation and green cover in reducing the concentration of and removing atmospheric pollutants, thereby promoting a healthier environment.

This trend is the reverse of what was observed in L7, L4, L6, and L5:

The elevated concentrations in these sites are due to the absence of green vegetative cover, which is known to play a major role in mitigating surrounding air pollution, as shown in Figures 8 and 9 (as referenced).

Table (4): Mean Monthly Concentration of Coarse Particulate Matter {PM10}) in the Campus Sites {g/m}3

Mean Location Effect	**Afternoon (A)**	**Morning (M)**	**Location (ID)**
27	28	26	**L7**
25	26	24	**L4**
21.5	22	21	**L2**
22.5	23	22	**L3**
26	27	25	**L6**
20.5	21	20	**L1**
24	25	23	**L5**
	24.5	23	**Time Effect**
1.187= Interaction L.S.D.		0.449= Interaction L.S.D.	0.839= Interaction L.S.D.

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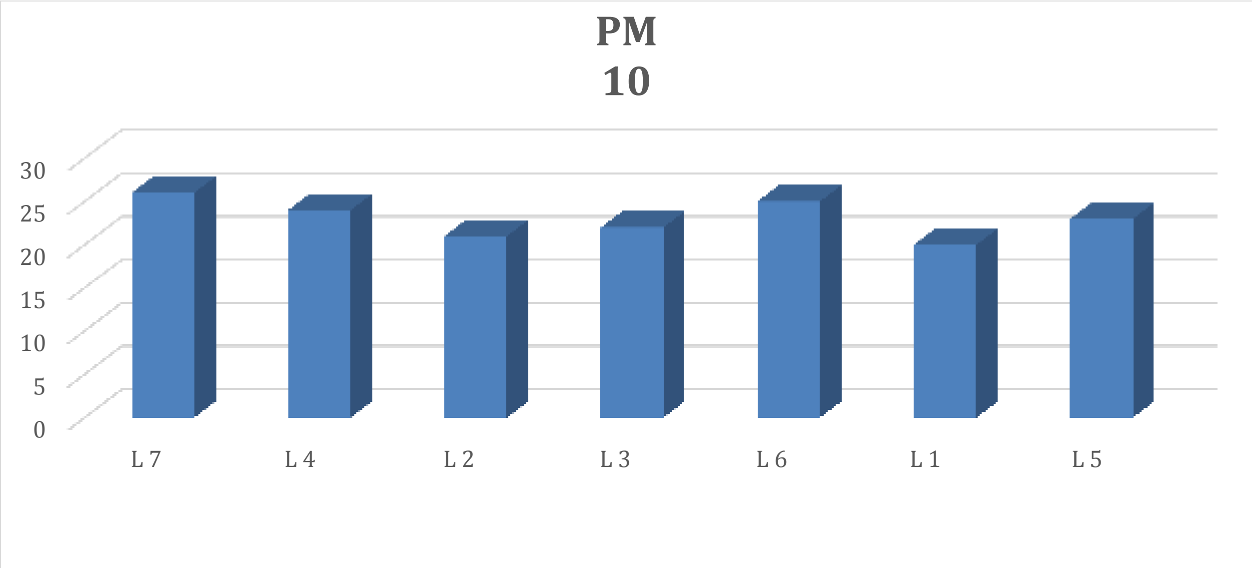

Figure 8: Monthly average concentration of PM10 during the morning µg/m3

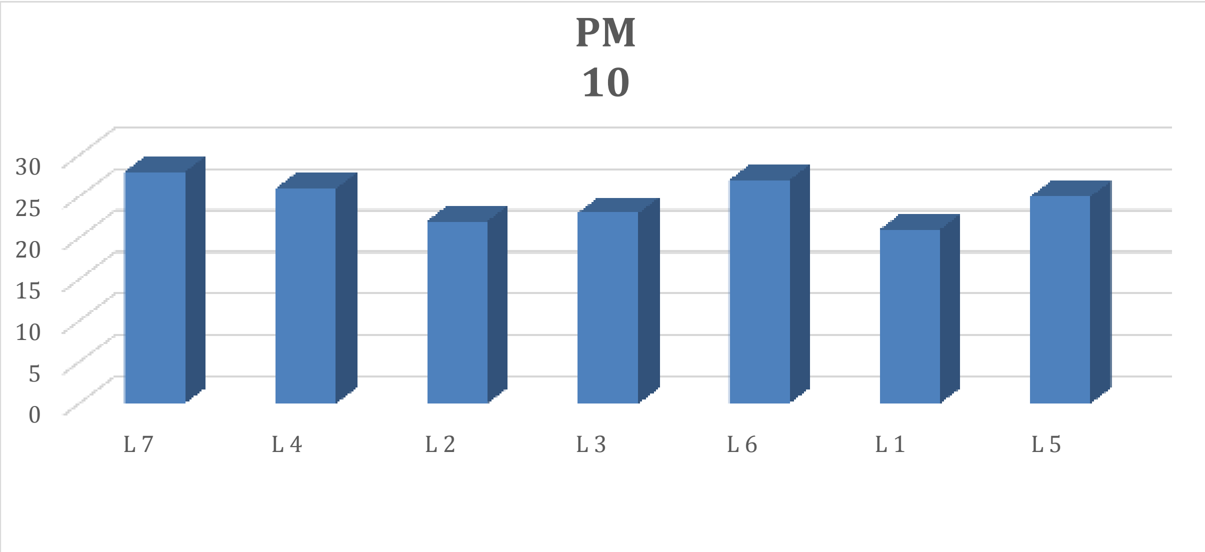

Figure 9: Monthly average concentration of PM10 during the afternoon µg/m3

5. Carbon Dioxide CO_2 Concentration ppm

The concentration of atmospheric Carbon Dioxide CO_2 was measured using the Air Quality Meter during the months of July, August, and September, at various sites within the study area during morning and afternoon periods. The results indicated a variation in CO_2 concentration based on the measurement location.

The highest levels of CO_2 were recorded in L7, L4, L6, and L5:

The high CO_2 concentrations in these areas are attributed to the scarcity or

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absence of afforestation in these sites, which contributed to the increase in carbon dioxide levels. L7 (Vehicle traffic roads) recorded the highest concentrations overall.

Conversely, a reduction in CO2 levels was observed in L1, L3, and L2:

Morning Readings: 407, 425.3, and 414ppm, respectively.

Afternoon Readings: 354, 381, and 380ppm, respectively As indicated in Table 5.

The low concentrations in these locations reflect the effectiveness of green cover and trees in sequestering atmospheric carbon dioxide. These findings are illustrated in Figures 10 and 11 (as referenced).

Table (5): Mean Monthly Concentration of Carbon Dioxide {CO}2 in the Campus Sites {ppm}

Mean Location Effect	Afternoon (A)	Morning (M)	Location (ID)
637.5	657	618	**L7**
536	583	489	**L4**
397	380	414	**L2**
403.15	381	425.3	**L3**
563	620	506	**L6**
380.5	354	407	**L1**
500.15	520	480.3	**L5**
	499.285	477.085	**Time Effect**
38.57= Interaction L.S.D.		14.58= Interaction L.S.D.	27.27= Interaction L.S.D.

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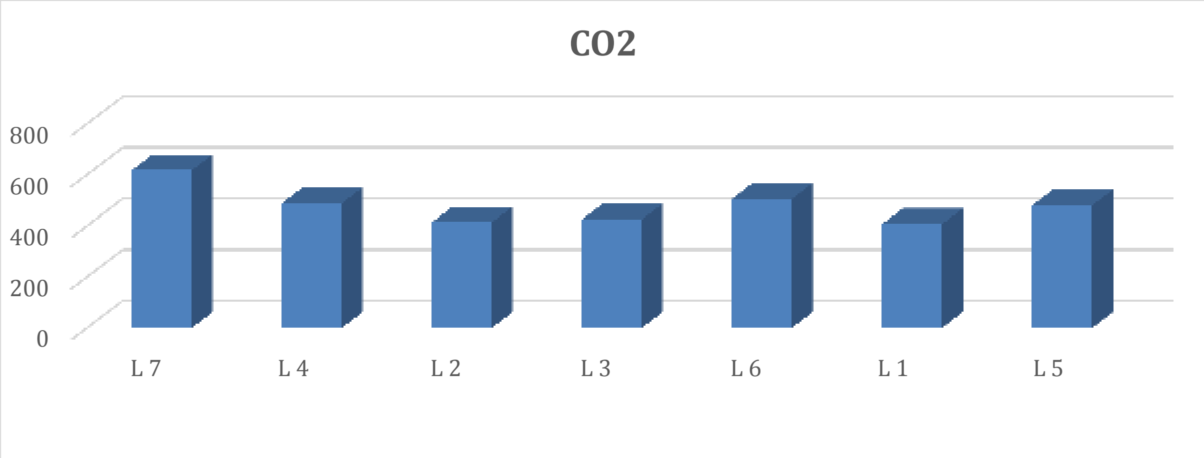

Figure 10: Monthly average concentration of atmospheric CO2 during the morning ppm.

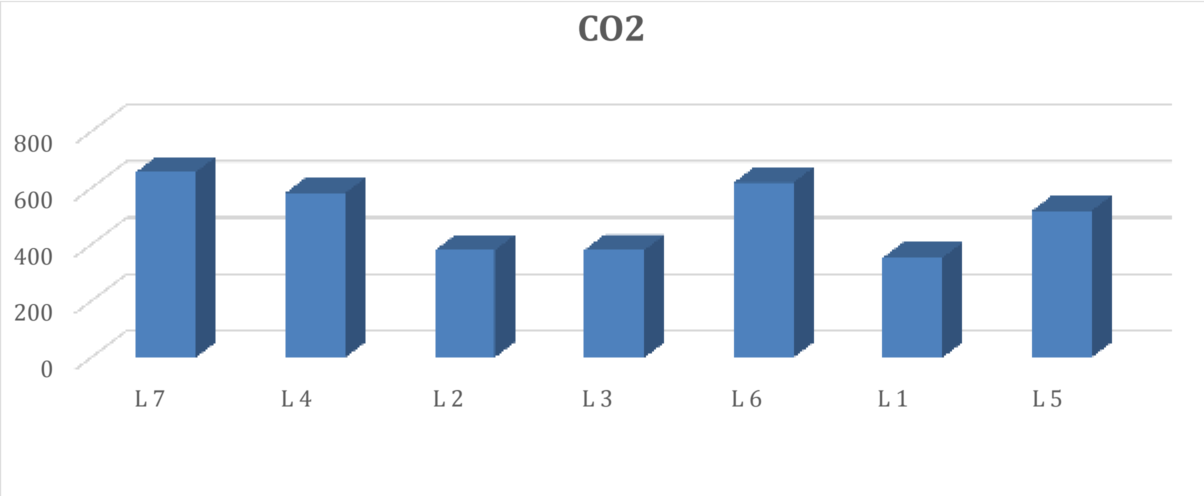

Figure 11: Monthly average concentration of atmospheric CO2 during the afternoon ppm

6.Carbon Monoxide CO Concentration ppm

The concentration of atmospheric Carbon Monoxide CO was measured using the Air Quality Meter during July, August, and September across various sites within the campus at morning and afternoon intervals. The results indicated a variation in CO concentration depending on the location, as illustrated in Figures 12 and 13.

The highest levels of CO were recorded in L7, L4, L6, and L5:The high CO concentrations in these areas are attributed to the absence of green vegetative cover, which is known to play a major role in mitigating ambient air pollution, particularly in proximity to vehicular sources (L7 and L6).

Conversely, a reduction in pollution levels was observed in L1, L3, and L2:

Morning Readings: 1.2, 1.4, and 1.3 ppm, respectively.

Afternoon Readings: 1.1, 1.6, and 1.4ppm, respectively As indicated in Table 6.

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The lower CO readings in the vegetated areas (L1, L2, L3) demonstrate the positive impact of green infrastructure on reducing the concentration of this pollutant

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Table (6): Mean Monthly Concentration of Carbon Monoxide {CO} in the Campus Sites {ppm}

Mean Location Effect	Afternoon (A)	Morning (M)	Location (ID)
2.4	2.9	1.9	**L7**
1.9	2.1	1.7	**L4**
1.35	1.4	1.3	**L2**
1.5	1.6	1.4	**L3**
2.1	2.4	1.8	**L6**
1.15	1.1	1.2	**L1**
1.95	2.3	1.6	**L5**
	1.9714	1.5571	**Time Effect**
0.319= Interaction L.S.D.		0.1206= Interaction L.S.D.	0.2256= Interaction L.S.D.

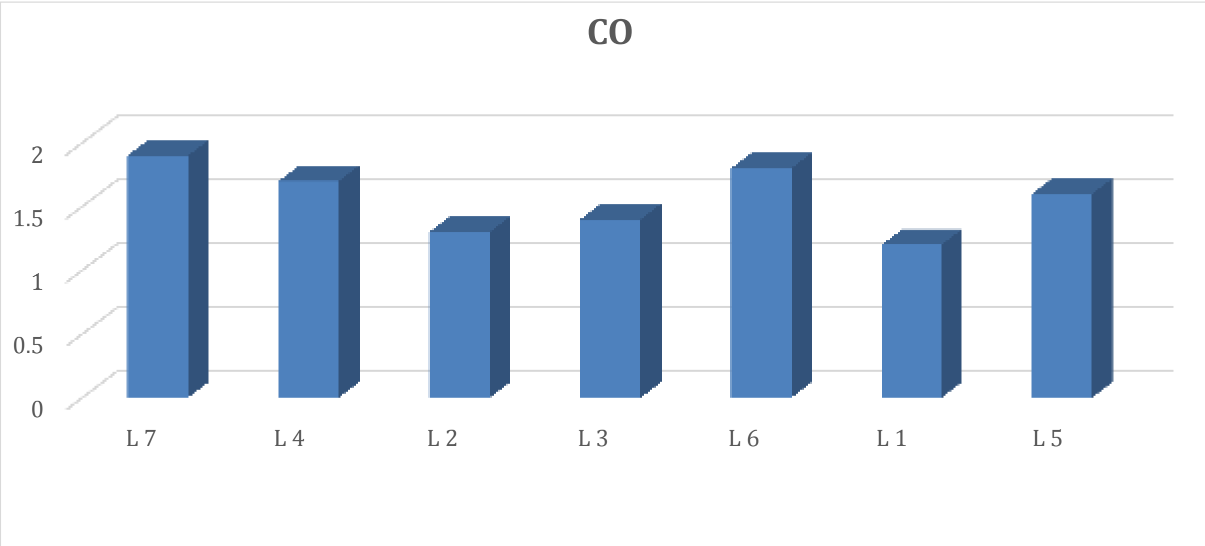

Figure 12: Monthly average concentration of atmospheric CO during the morning ppm.

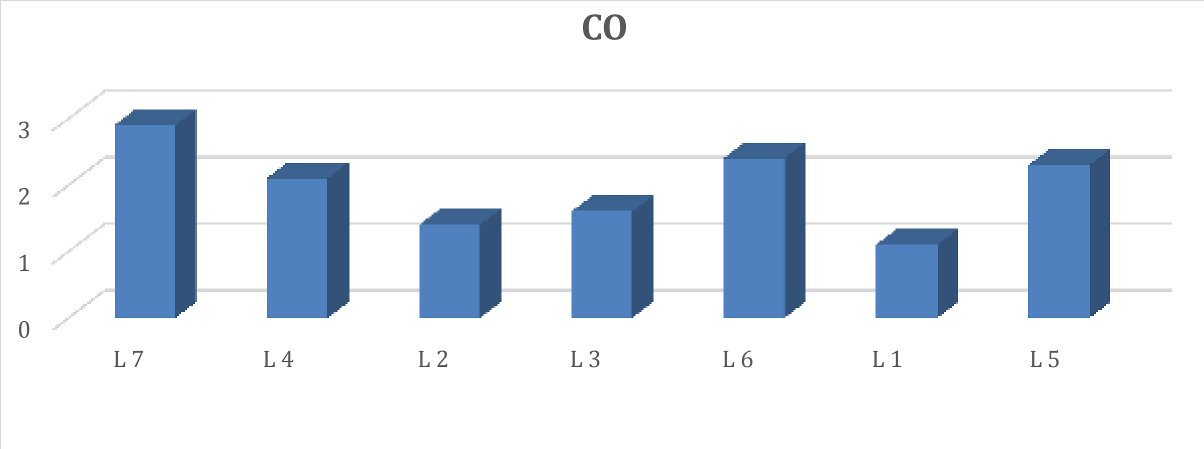

Figure 13: Monthly average concentration of atmospheric CO during the afternoon ppm.

7. Air Quality Index AQI

The Air Quality Index AQI was measured using the Air Quality Meter (illustrated in Figures 14 and 15) during the hot summer months (July, August, and September) at morning and afternoon intervals across the different university sites. A significant variation in air quality was observed, directly corresponding to the concentration of air pollutants previously measured.

The air quality was categorized as Good in L1, L2, and L3 (vegetated spaces):

Morning AQI Readings: 33, 35, and 40, respectively.

Afternoon AQI Readings: 40, 45, and 46, respectively As indicated in Table 7.

These low AQI values indicate a high quality of air and reinforce the effectiveness of the green infrastructure in pollutant removal.

Conversely, the air quality in L7, L4, L6, and L5 was categorized as Unhealthy for Sensitive Groups (or worse), with pollution levels at their highest:

The compromised air quality in these locations is attributed to the scarcity of trees and green cover, which plays a vital role in reducing pollution and enhancing overall air quality. The AQI measurements for the morning and afternoon across the study sites are further detailed in Figures 14 and 15.

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Table (7): Mean Monthly Air Quality Index text{AQI} Levels in the Campus Sites

Mean Location Effect	Afternoon (A)	Morning (M)	Location (ID)
112	120	104	**L7**
94	97	91	**L4**
40	45	35	**L2**
43	46	40	**L3**
105.5	110	101	**L6**
36.5	40	33	**L1**
94.5	100	89	**L5**
	79.714	70.428	**Time Effect**
15.38= Interaction L.S.D.		5.81= Interaction L.S.D.	10.88= Interaction L.S.D.

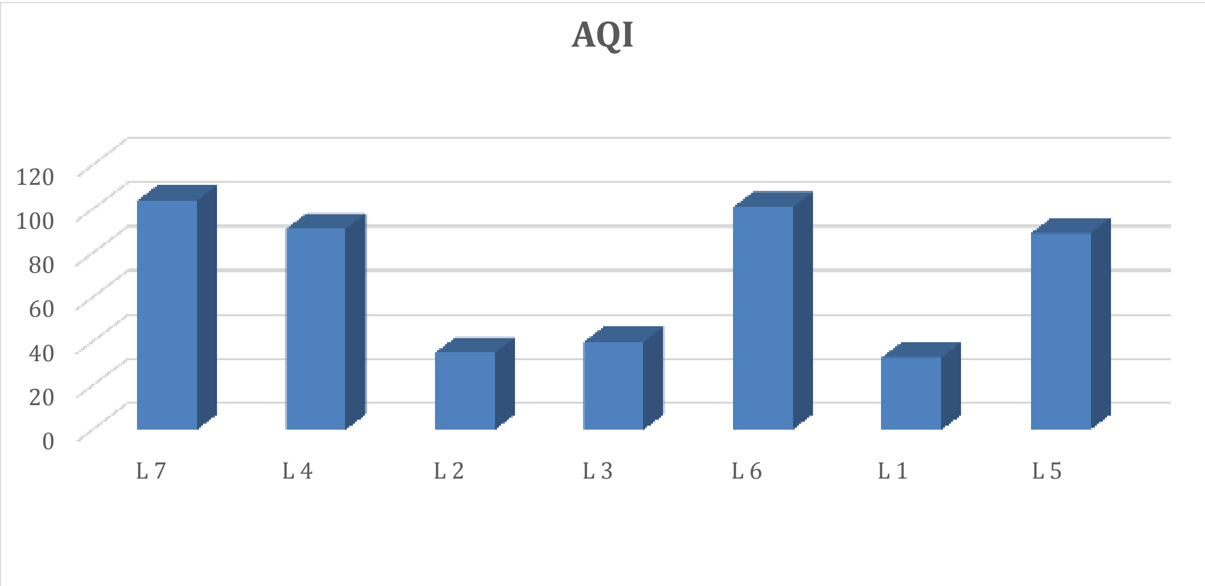

Figure 14: Monthly average Air Quality Index AQI during the morning.

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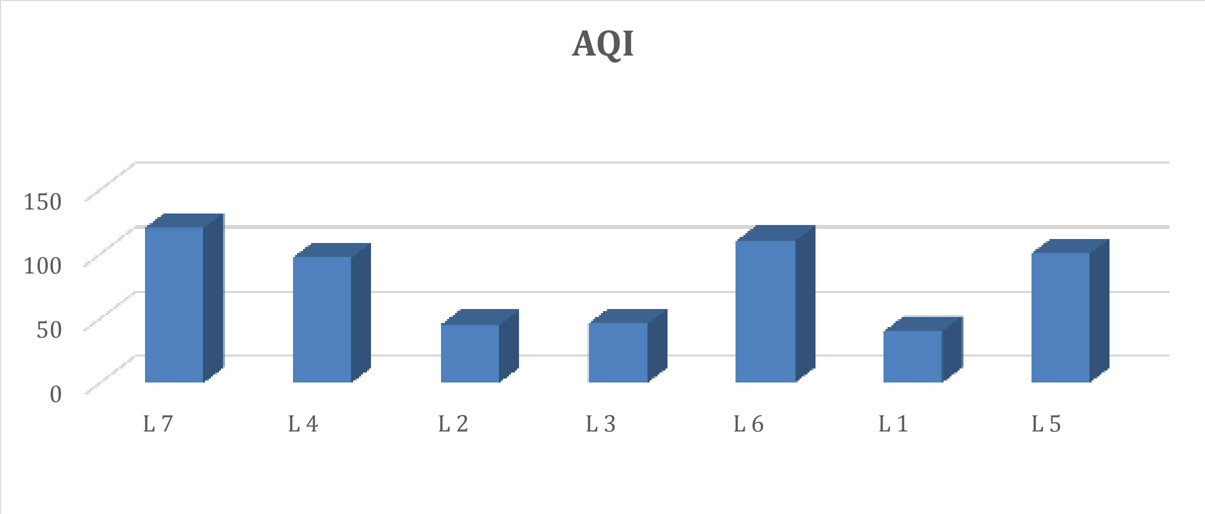

Figure 15: Monthly average Air Quality Index AQI during the afternoon.

Discussion

The results clearly demonstrate that green spaces, incorporating various plant types such as trees and turfgrass, actively improve air quality within the university campus. The data showed a distinct effect in reducing Formaldehyde HCHO pollution. Certain plant species absorb pollutants like formaldehyde and xylene, converting them into less toxic compounds or storing them within their tissues. This process effectively reduces the concentrations of Total Volatile Organic Compounds TVOC, Particulate Matter PM, and harmful gases ($CO2$ and CO).

Trees and green cover assist in combating climate change by sequestering carbon dioxide $CO2$ from the atmosphere during photosynthesis, converting it into food, and thereby reducing its atmospheric concentration. Afforestation is essentially the establishment of natural carbon sinks that enable a large number of trees to isolate the greenhouse gas $CO2$ from the atmosphere. This $CO2$ is utilized in photosynthesis—the chemical reaction that uses solar energy to convert carbon dioxide and water into sugar and oxygen—thus cleansing the environment and mitigating pollution.

Furthermore, green spaces contribute to achieving environmental and health sustainability for campus occupants. The presence of trees and turfgrass positively influences the students' physical and psychological state through the varying shades of green, while the color and shape of flowers have a significant positive impact on mood and human disposition.

Conclusions

Based on the preceding findings, we conclude that afforestation significantly mitigated greenhouse gas emissions and reduced toxic substances like $CO2$ and CO in the campus air. Specifically, green infrastructure:

1. Contributes to the sequestration of approximately 40% of atmospheric carbon dioxide, reducing its concentration and making the air cleaner and healthier.

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2. Many tree species, such as the Oleander itNerium oleander, provide protection against gas pollution emitted from vehicle exhausts that harm human health by actively absorbing them.
3. Many trees act as windbreaks, protecting against dust-laden winds that harm the respiratory system and deplete oxygen. They prevent environmental pollution by restricting the passage of windborne dust from reaching residences and built-up areas.
4. Certain tree species absorb pollutants and store them in their leaves and branches. Examples include the Pothos It Epipremnum aureum, considered one of the best air-purifying plants, the Snake Plant it Dracaena trifasciata, which removes formaldehyde and xylene from the air, and the Tiger Skin Plant (likely a common name for the Snake Plant or similar air-purifying foliage), which removes formaldehyde, xylene, and trichloroethylene.

References

1)Abdullah,M.Z.,Rafie,A.I.,and Mohammad,N.I.2014. statistical analysis of Heavy metal concentrations in moss and soil as indicator of industrial pollution .International journal of science,Vol.3,No 3,762-775.

2) Abdulrazzaq, Z. M., Al-Abdaly, H. M., & Ahmad, M. D. (2024a, March). Sustainable outdoor spaces and their achievement mechanisms at the university campus (case study-University of Anbar. In AIP Conference Proceedings (Vol. 2885, No. 1). AIP Publishing

3) Dunnett, N. (2006). Green roofs for biodiversity: reconciling aesthetics with ecology. Proceedings of the 4th Annual Greening Rooftops for Sustainable Communities, Boston, MA, USA, 11-12.

4) Hobhouse, P. (2004). Plants in Garden History: An Illustrated History of Plants and Their Influences on Garden Style. Pavilion.

5) Lawson M and Stewart C.L, 1965, p161

6) Marcus, C. C., & Barnes, M. (Eds.). (1999). Healing gardens: Therapeutic benefits and design recommendations (Vol. 4). John Wiley & Sons.

7) Nigel D. and Andy C. 2006. Resources: The row material of landscape. Editted by John Benson and Maaggie Roe. 2nd edition.

8) Marcus, C. C. (2007). Healing gardens in hospitals. Interdisciplinary design and research e-Journal, 1(1), 1-27.

9) Said, M., & Mosa, M. (2024). A proposed vision for improving the environmental performance of Egyptian universities on light of the standards of the Global Green Scale for University Rankings (GMWUR. Journal of Faculty of Education-Assiut University, 40(9.2), 1-76..

10) Ulrich, R. S. (1984). View through a window may influence recovery from surgery. science, 224(4647), 420-421.

11) Ulrich, R. S. (1986). Human responses to vegetation and landscapes. Landscape and urban planning, 13, 29-44.

12) Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of environmental psychology, 11(3), 201-230.

ISSN 2072-3857

13) Ulrich, W., & Almeida- Neto, M. (2012). On the meanings of nestedness: back to the basics. Ecography, 35(10), 865-871.