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The relation between concentration of carbon dioxide and species of trees at Kaohsiung Cultural Center

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Abstract

The purpose of this research is to identify the factors that might affect carbon dioxide levels in Taiwanese urban areas. We went to the Kaohsiung Cultural Center and used the Mobile Nose to look into CO_2 variations. Lastly, we discovered that the nearby traffic movement has the greatest influence on carbon dioxide content, followed by tree species and planting density, but this is not clearly represented in the statistics. The future study will concentrate on canopy area, form, and height range.

Motivation

Because we are curious about the carbon dioxide concentration of various public environments in the city we live in, after analyzing the characteristics of each area , We conduct research on the Kaohsiung Cultural Center—a green space located among high-rise buildings in the city.

Research Design and Methods

Tools：
Mobile Nose、tape measures 、
self -made angle gauge 、Google maps 、cellphone

figure(1)Mobile nose

figure(2)self -made angle gauge

Method

Connect the mobile Nose to the app on the phone to obtain the data of carbon dioxide concentration , then measure the tree height, count the

distribution of related tree species in the green space, and finally analyze it.

The object of our research is the cultural center of Kaohsiung. Due to the large area to be measured, we divide it into five areas A, B, C, D, and E for measurement. In Figure (3), North is on the left hand side of the picture,
red is the measurement starting point, yellow is the measurement end point; the arrow is the observation road.
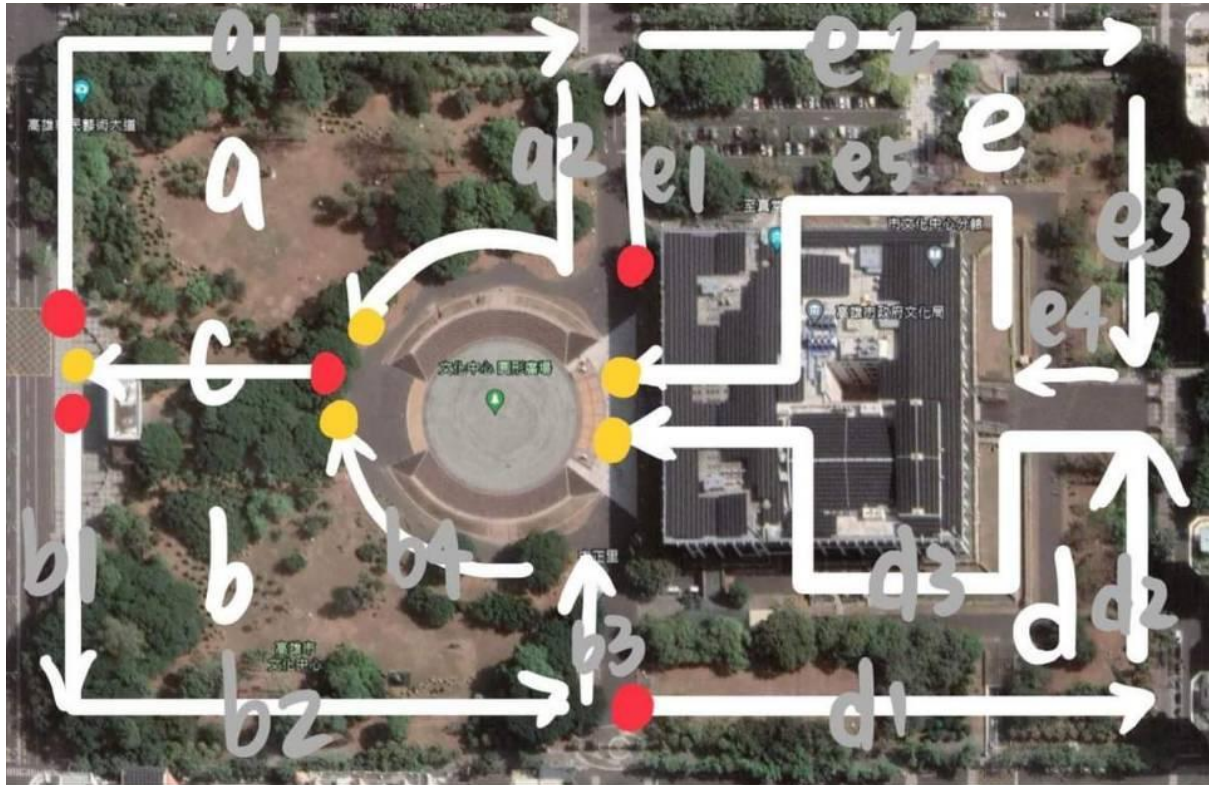
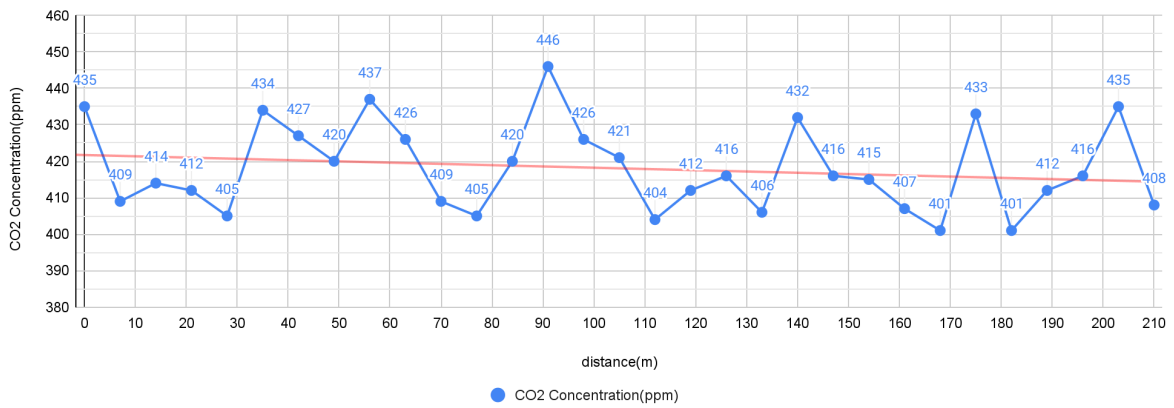

figure (3) observation roadmap

Results and Discussion:

Area A
Main tree species:*Palaquium formosanum,Alstonia scholaris,Artocarpus altilis*
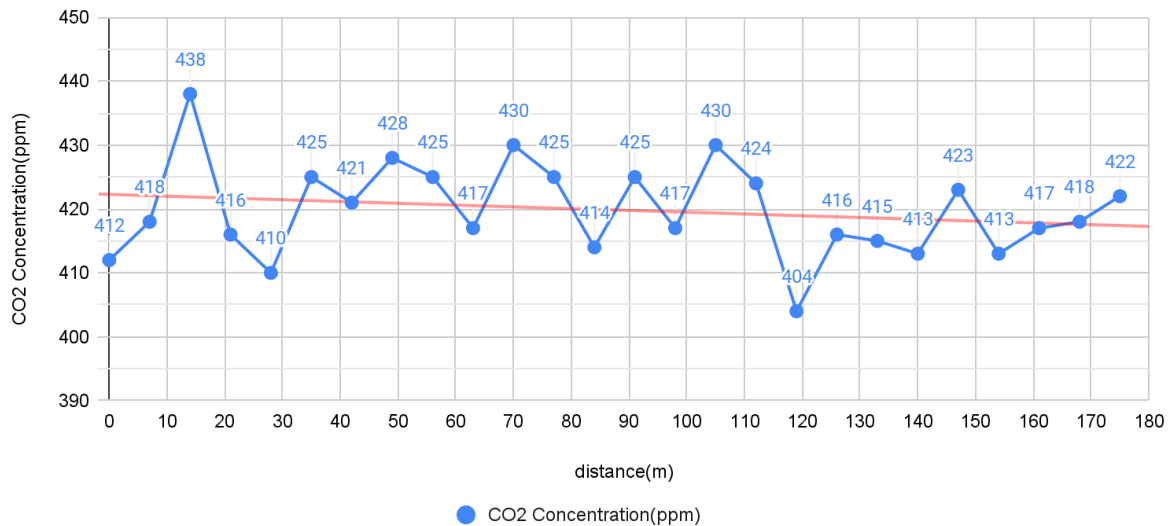**Average Tree Height:**10~15m
- **a1 Average carbon dioxide concentration:** 418.0ppm
- **a2 Average carbon dioxide concentration:** 419.8ppm

CO2 Concentration line chart(a1)

chart(1)

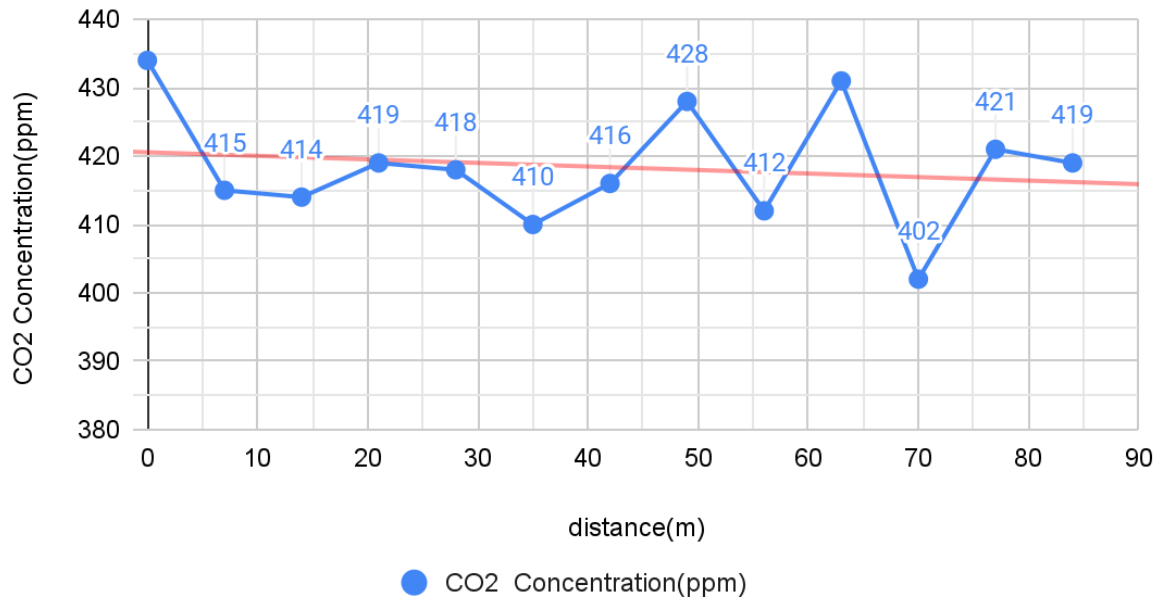CO2 Concentration line chart(a2)

chart(2)

- It can be seen from the figure that the broken line of the a1 chart is zigzag, indicating that the concentration of CO_2 changes greatly. It is speculated that the observation route of a1 is located next to the road that has heavy traffic and is affected by the traffic flow. The curve of area a2 is gentle, it may be located relatively far from the road, or the trees on the outside have absorbed part of co2 .

Area B
Main tree species:*Livistona chinensis、Ficus microcarpa*
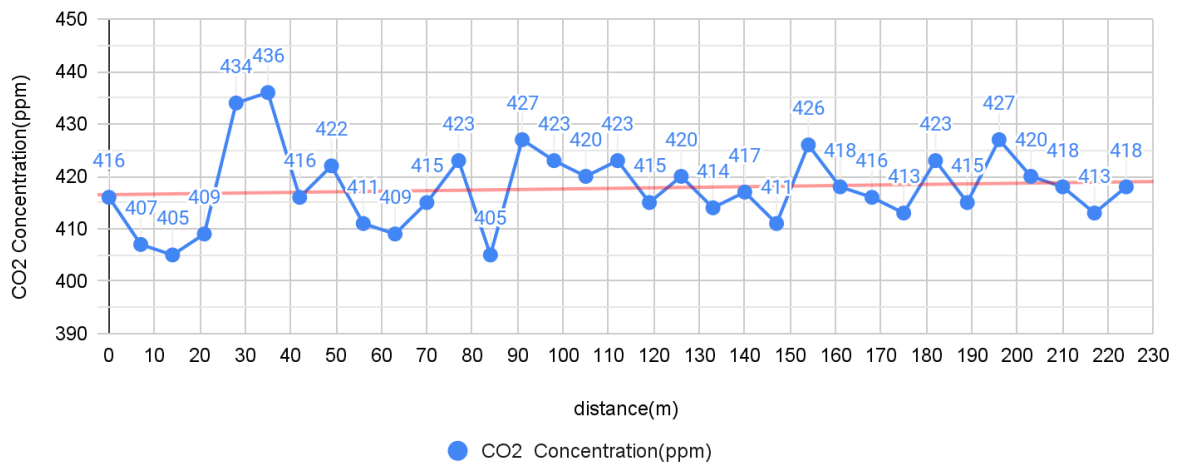
b1

4

CO2 Concentration line chart(b1)

chart(3)

- b1 Average carbon dioxide concentration: 418.4ppm
- Range: 32ppm
- Average tree height: 8~10m
- Tree Species:*Livistona chinensis*、*Alstonia scholaris*
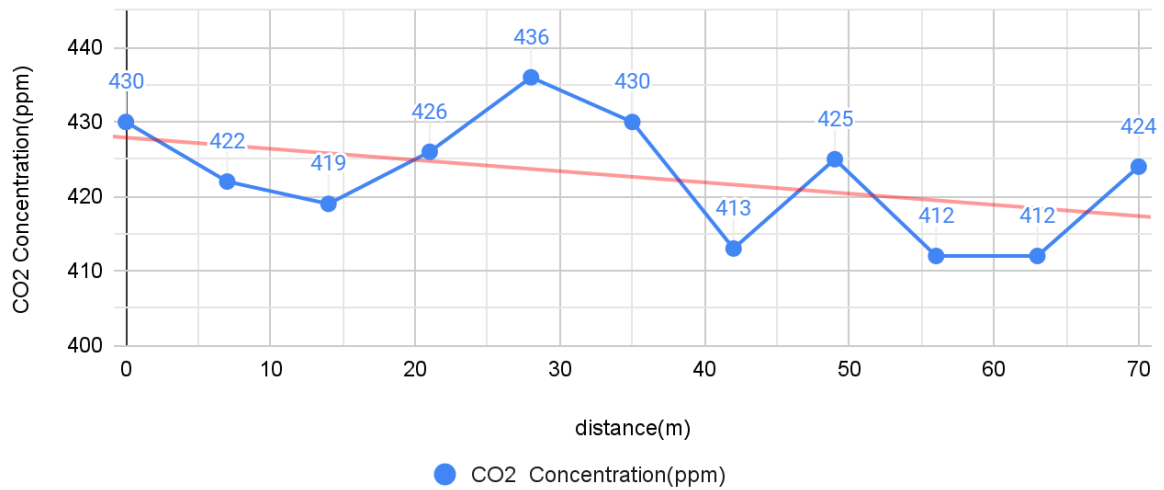
b2

CO2 Concentration line chart(b2)

chart(4)

- b2 Average carbon dioxide concentration: 417.7ppm
- Range: 31ppm
- Average tree height: 8.52m
- Tree Species: *Livistona chinensis*、*Cassia fistula*
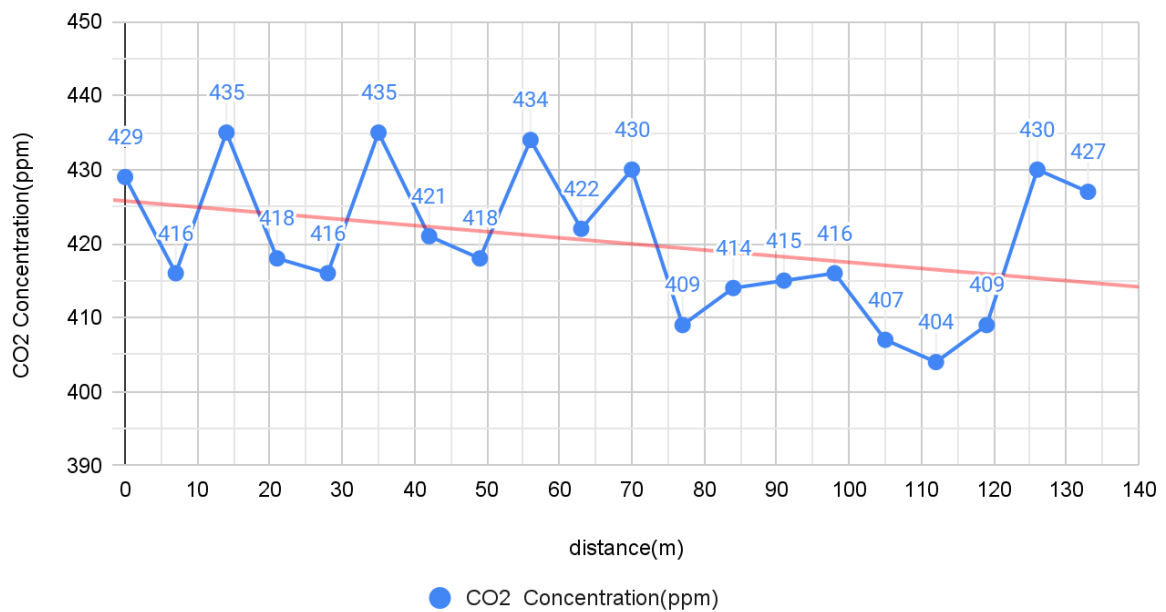
b3

CO2 Concentration line chart(b3)

chart(5)

- b3 Average carbon dioxide concentration: 422.6ppm
- Range: 14ppm
- Average Tree Height: 9.14m
- species:Alstonia scholaris、Samanea saman

b4

CO2 Concentration line chart(b4)

chart(6)

- b4 Average carbon dioxide concentration: 420.3ppm
- Range: 31ppm
- Tree Species:Samanea saman
- Average tree height: 5.42

- Summary of Area B
    - From the data above, it can be known that the value drop in b3 area is the smallest, but its average value is the largest.
    - The highest CO_2 value occurs at 28 meters at b2 and b3, while the lowest value occurs at b1.
    - It is speculated that the tree species near the Guanguan have poor purification ability for carbon dioxide, or there are fewer trees nearby. According to the field investigation, the number of them is no less than the number of trees in other areas.Therefore, it is inferred that the concentration of carbon dioxide is unless the area is extremely high. Or there are other external factors that emit a large amount of carbon dioxide, otherwise the value of carbon dioxide will not change significantly.
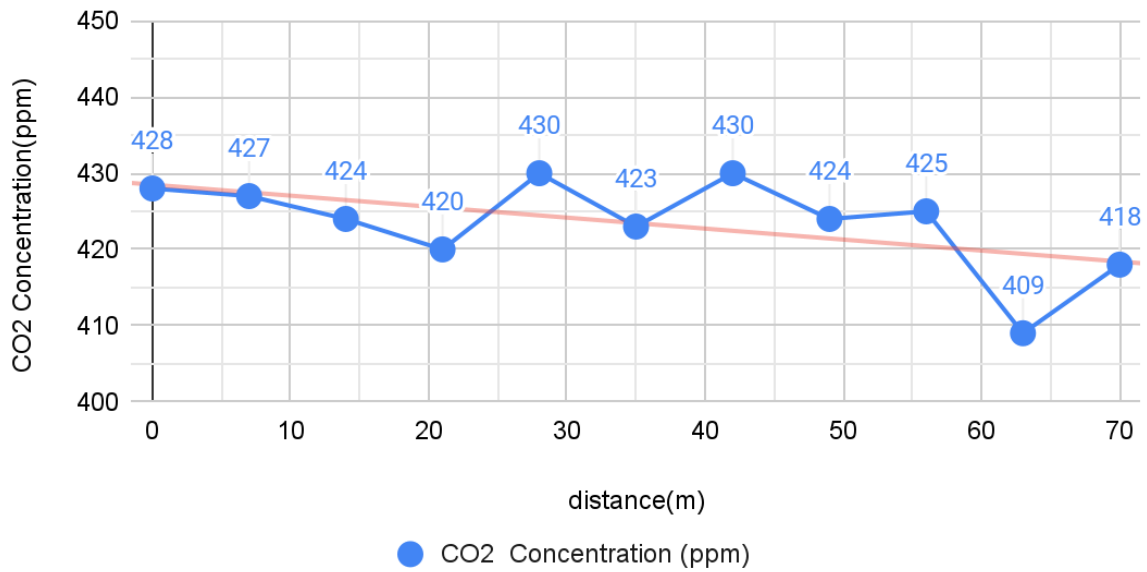
Area C
Main tree species:*Cinnamomum camphora*
Average Tree Height:5~10m

CO2 Concentration line chart(C)

chart(7)

- Average carbon dioxide concentration: 423.5ppm
- Range: 21ppm
    - The concentration of carbon dioxide in this area shows a downward trend, but the walking direction is closer to the road. It does not match the predicted data, so it is speculated that the data may be affected by the wind direction.
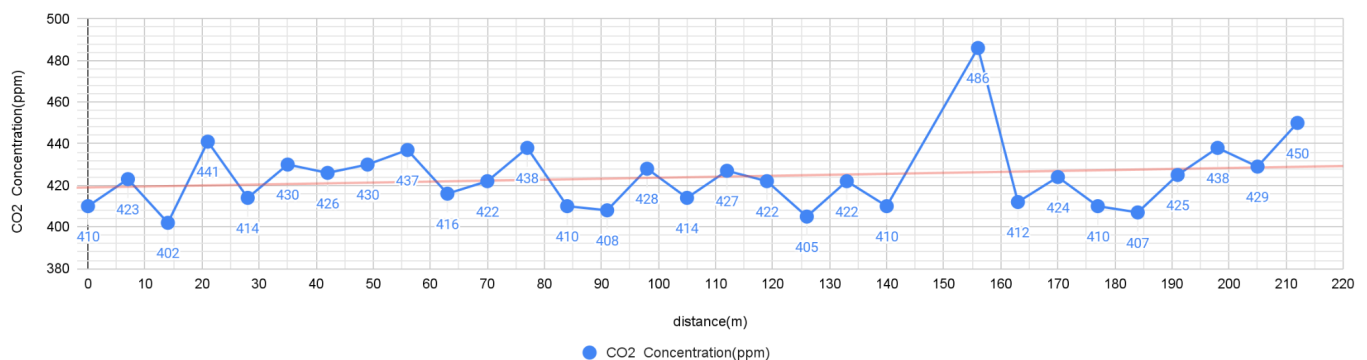
Area D
Main tree species: *Livistona chinensis, Cassia fistula, Pterocarpus indicus*
Average tree height: 8~15 meters

Figure (4) D area trees
Cassia fistulaon the left,Livistona chinensison the right

chart(8)

- d1 Average carbon dioxide concentration: 423.9ppm
- Range: 84ppm
    - The highest concentration of CO_2 is at 156 meters (486ppm). This is the entrance and exit of the driveway, and there are fewer trees, Photosynthetic may be less obvious, resulting in a higher
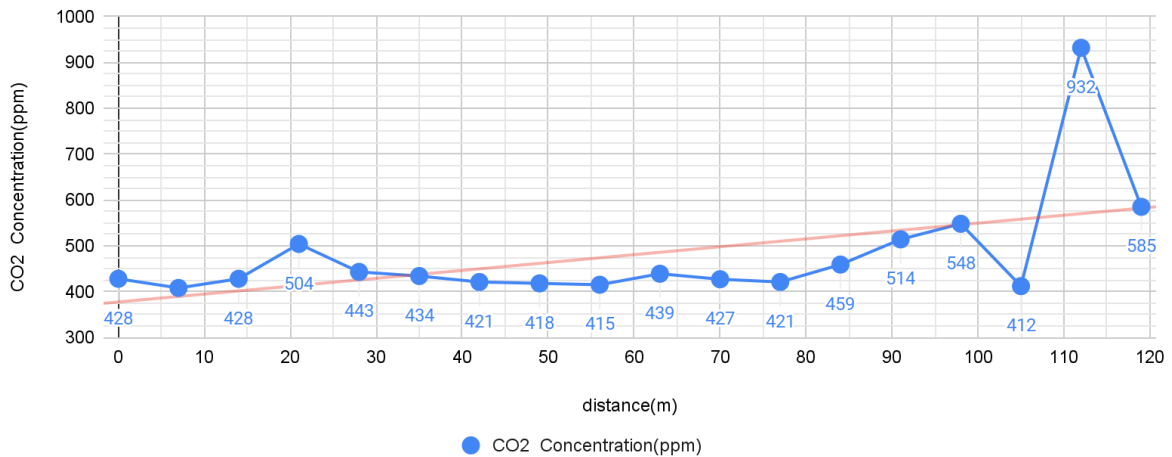
concentration of CO_2.

- ○ The CO2 concentration shows an upward trend, which is presumed to be affected by the fact that there is only one tree at the end of the route.


Figure (5) Lane entrance and exit

chart(9)

- d2 Average carbon dioxide concentration: 479.8ppm
- Range: 520ppm
  - ○ There is an extremely high value (932 ppm) at 112 meters, which is the main reason for the high average value in this area. The density of nearby trees is low (there is only one Arbor a few meters in front and back), or it is due to the proximity to the road, passing cars and other factors. The CO_2 concentration at this point may increase sharply.

Figure (6) the highest CO_2 concentration point with few trees
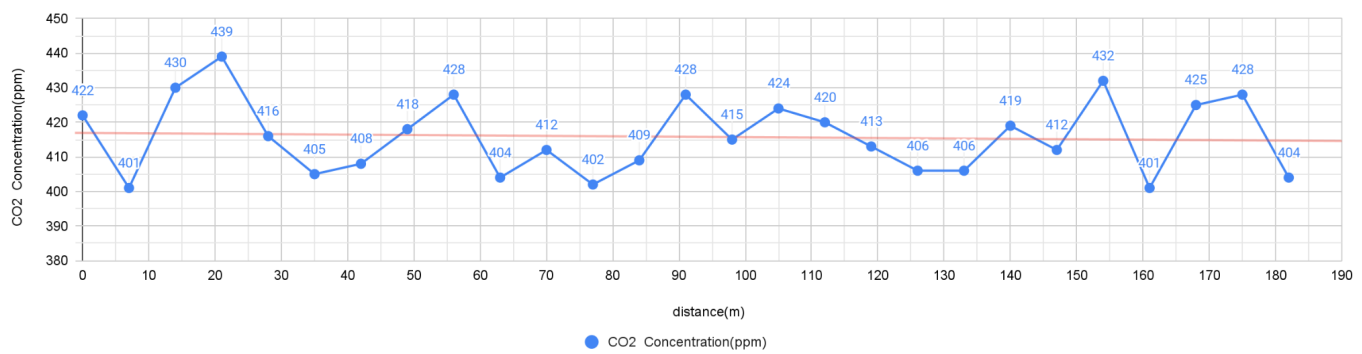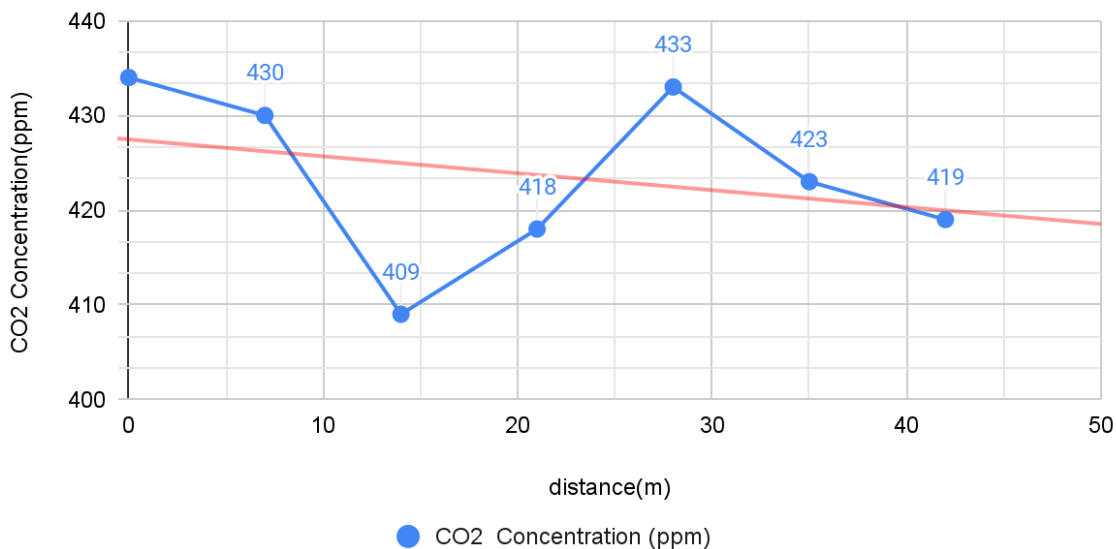

chart(10)

- d3 Average carbon dioxide concentration: 415.8ppm
- Range: 38ppm
  - This area is far away from the road, and with the obstruction of street trees, the average carbon dioxide concentration is lower than that of the other two areas.

- Summary of Area D: The concentration of carbon dioxide in this area is mainly affected by factors such as tree density and whether it is close to the road. The passing cars and motorcycles will also affect the data.

Area E
Main tree species: *Cassia fistula,Livistona chinensis*
**Average tree height:** 10~20 meters

CO2 Concentration line chart(E1)

chart(11)

- e1 average carbon dioxide concentration: 423.7ppm
  - According to statistics from the Ministry of Transport, electric vehicles in Taiwan account for less than 3%, so most of the parking lots are gasoline vehicles that emit more carbon dioxide. Because this route passes through the entrance and exit section of the parking lot, the carbon dioxide emission is large, but the amount that the trees can absorb immediately is small, making the carbon dioxide concentration in this area the highest.

CO2 Concentration line chart(E2)
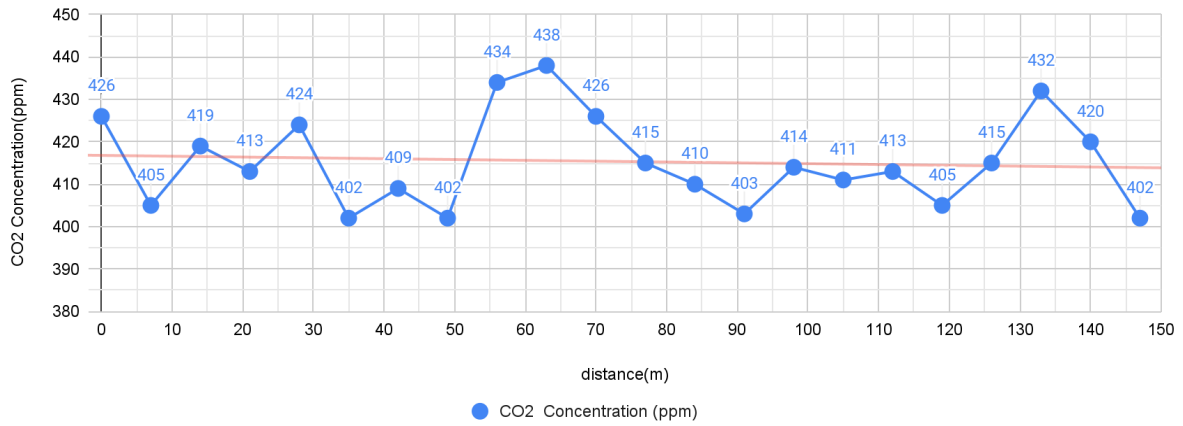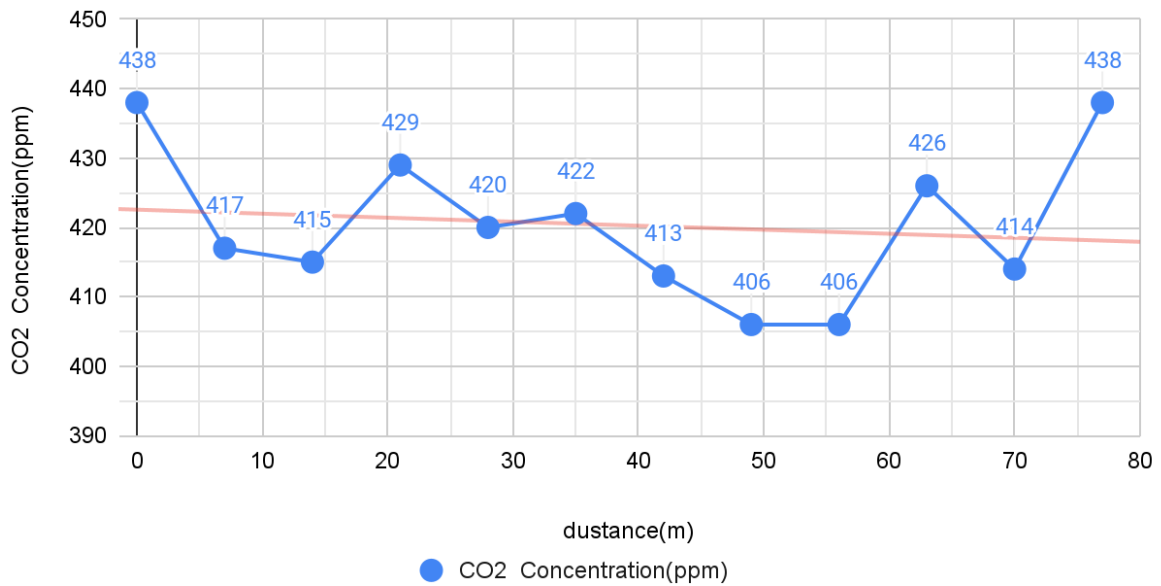

chart(12)

CO2 Concentration line chart(E3)
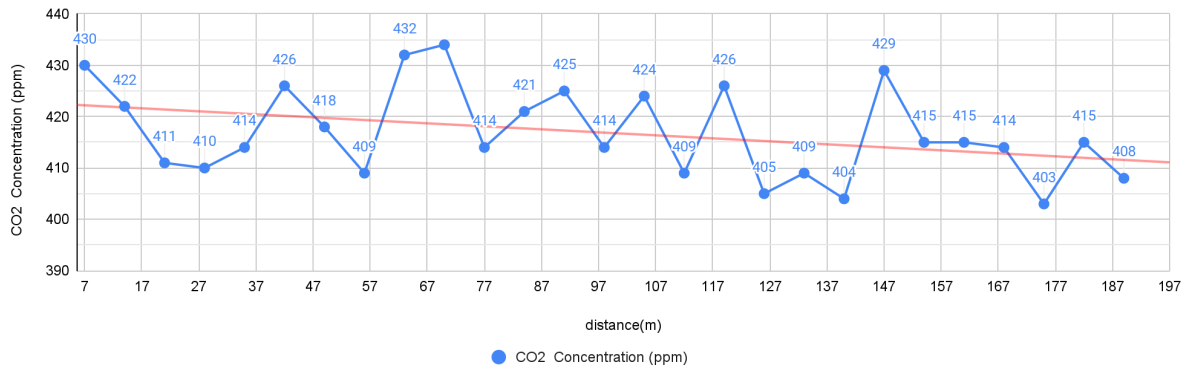
chart(13)

- e2 average carbon dioxide concentration: 415.4ppm
- e3 average carbon dioxide concentration: 416.9ppm
  - The measurement routes e2 and e3 both pass between two rows of street trees, and the carbon dioxide concentration is lower in area e. It is speculated that the planting of street trees can effectively slow down the increase of carbon dioxide concentration.
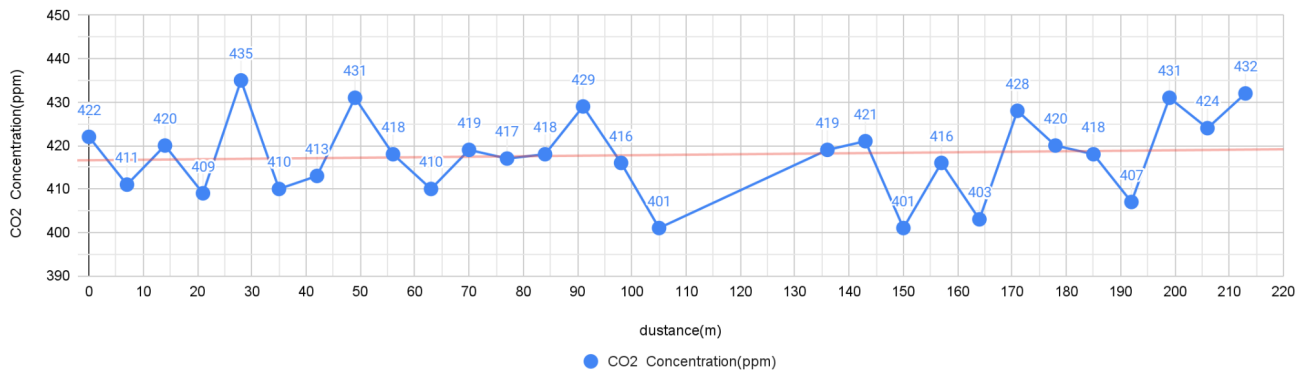
CO2 Concentration line chart(E4)

chart(14)

- e4 average carbon dioxide concentration: 420.3ppm
  - The number of trees here is very small, and this is the entrance of the venue,so it is speculated that the concentration here is high due to human activities.

CO2 Concentration line chart(E5)

chart(15)

- e5 average carbon dioxide concentration: 417.8ppm
  - Among all the routes in this section, it is the farthest path from people and vehicles. It is speculated that the CO_2 concentration here is originally low, and it is difficult to tell whether it is related to the carbon dioxide absorption of trees.

- Conclusion of Area E:In the case of trees planted equidistantly, the difference between the carbon dioxide concentration near the parking lot and the data measured inside the sidewalk shows that trees can effectively

reduce the carbon dioxide produced by human activities.

Conclusion

1. Carbon dioxide concentration is mainly affected by tree planting density and whether there are vehicles passing by. Where trees are sparsely planted and where vehicles pass by, the concentration of carbon dioxide is higher than other places.

2. There was no obvious correlation between tree height and carbon dioxide concentration. Since the photosynthesis of trees is mainly located in the leaves of the canopy, the follow-up research direction can explore canopy area, shape, height range and other factors.

3. The average concentration of CO_2 in the cultural center is mostly between 415-423ppm, and the average concentration is higher (480ppm) located near the entrance and exit of the lane (d2).

4. The most common tree species in the cultural center area are Livistona chinensis and Cassia fistula. This combination of tree species can serve as shade and flower viewing functions, and achieve the purpose of street trees.