



Monitoring and protection of the Marmont Alley

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The research question

- Marmont Alley is a plane tree alley near the Primary School Dubovac
- Planted from 1809. to 1811. (Karlovac - Dubovac, Grobničko Polje, Rijeka) during the construction of the Louisiana Road (Karlovac – Rijeka)
- In Karlovac the road begins with the plane tree line, named in the honour of the Marshal Marmont (1774. – 1852.) from the Napoleon Bonapartes time
- The alley is a monument of park architecture from 1968.



In June 2019 the construction work had began on the national road D6 which begins with the Marmont Alley in Karlovac and concerns the community about possible tree damage.

Research questions:

What is the importance of the Marmont Alley for Dubovac and the city of Karlovac in the carbon cycle?

How much CO₂ is absorbed during the life of trees and what is the amount of carbon stored in trees?

What is the amount of gas pollution?

Are the values of harmful gases higher when the air humidity is higher?





Hypotheses

- Marmont Alley is an important factor in the carbon cycle, in the city of Karlovac and city's district Dubovac because the plane trees have absorbed large amounts of carbon during their existence
- Air humidity has an impact on the amount of gasses
- The amount of gas pollutants is higher in the period without vegetation and in higher air humidity

Research methods

Research period: January 2022. – December 2023.
Total number of trees in the alley : 102



1. GLOBE protocols:

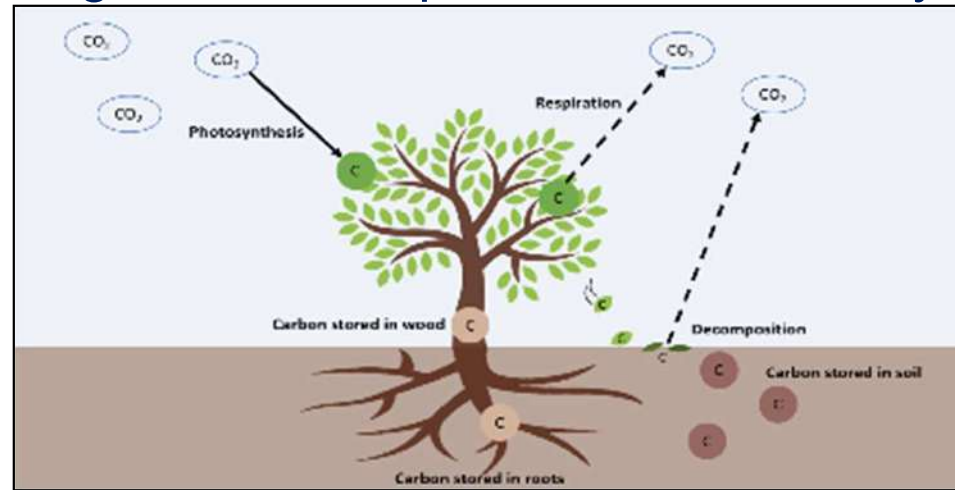
- location determination - GLOBE Observer App
- tree height - GLOBE Observer App
- tree circumference - measuring tape
- atmospheric station GLOBE: air humidity, air temperature, precipitation



2. Calculation of stored carbon and absorbed CO₂

Tree age = tree circumference / 1 year growth

1 year growth of the plane tree: 2,75 cm/year



fresh mass (green weight-GW) in kg

$$GW = 0,0346 * d^2 * h \text{ (if the } d > 28 \text{ cm)}$$

$$\text{or } GW = 0,0577 * d^2 * h \text{ (if the } d < 28 \text{ cm)}$$

dry mass (dry weight -DW) = GW / 2

amount of absorbed carbon (Carbon storage) = DW / 2

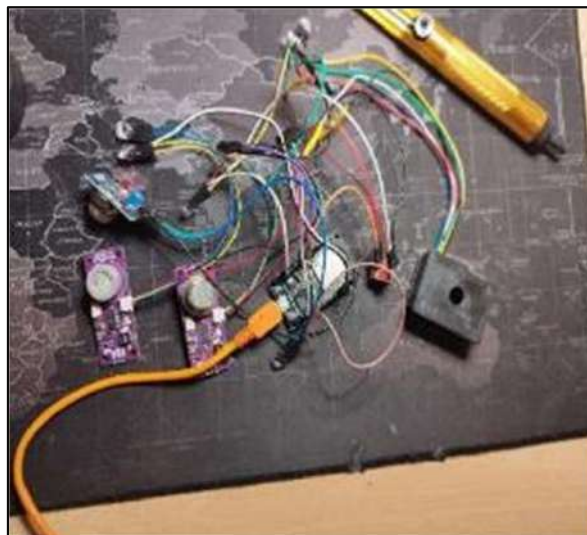
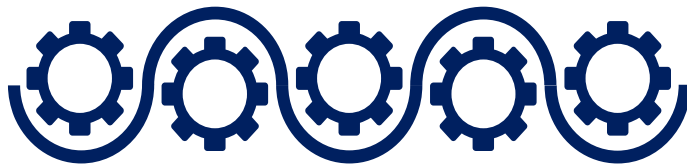
absorbed CO₂ in the lifetime of a tree = Carbon storage * 3,67

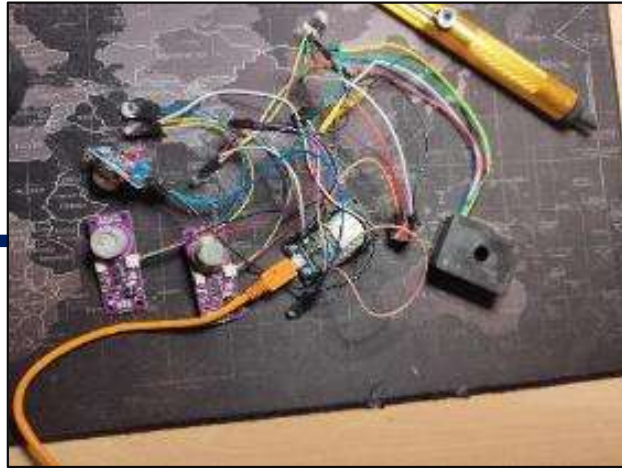
because $Mr(\text{CO}_2) / Ar(\text{C}) = 3,67$

chest diameter of a tree in cm = tree circumference / π

3. meteo station_1 Arduino with sensor MQ135 (CO₂, NH₃, smoke, other gasses)

- The students (electronic and IT group) made a station which measures harmful gasses in **September 2022**.
- The station is located in the Marmont Alley
- The station was connected to the server via wi-fi.

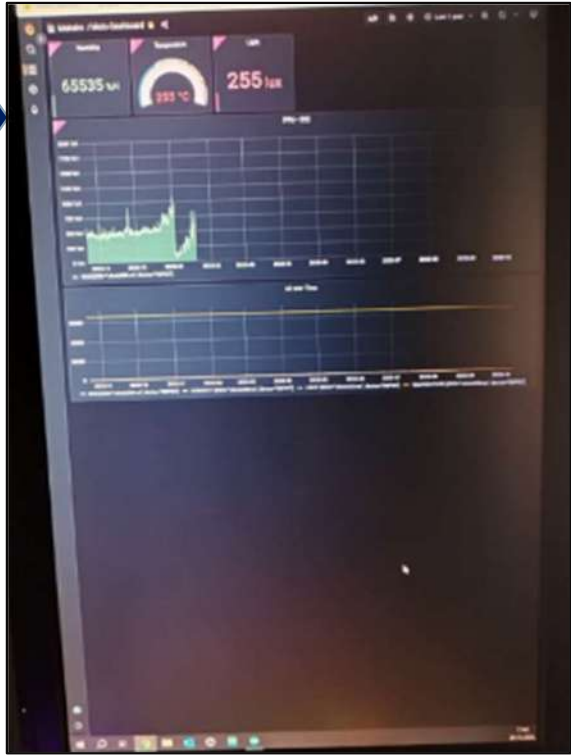




build
the station



connect to
the server



4. meteo station_2 Arduino with separate sensor

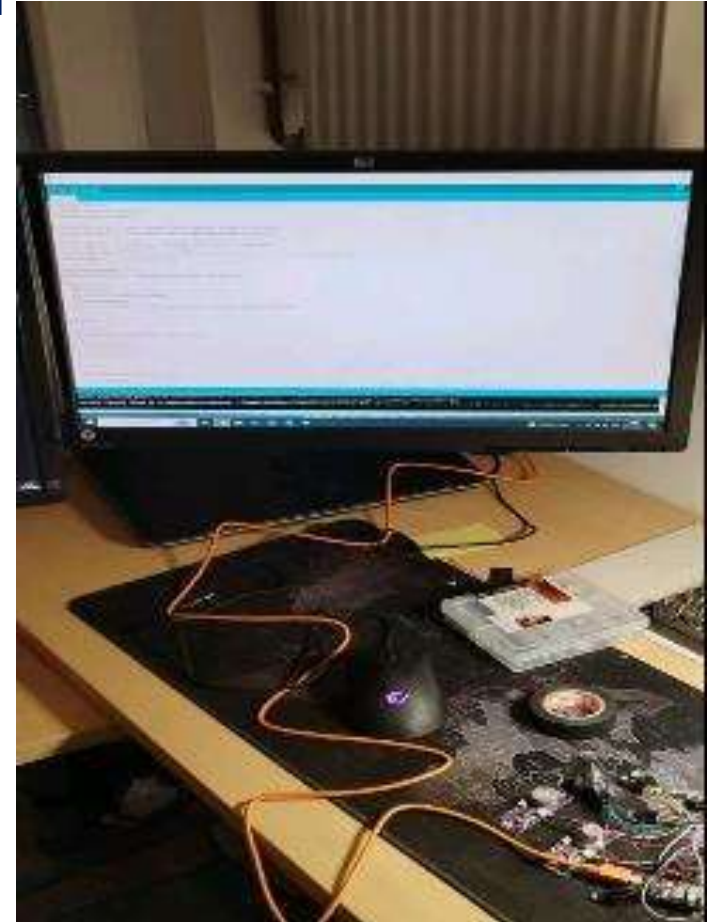
Ozone sensor- MQ131



CO sensor – MQ 7



- The students (electronic and IT group) made a new station in **October 2023.**
- The station is located in the Marmont Alley
- The station was connected to the server via wi-fi.



RESULTS

Measured for 102 plane trees.

Average tree height: 17,48 meters
Average tree age: 67,23 years

Total mass of a green weight (GW) =
333132 kg
Total dry mass (DW) = 256565 kg
Total mass of carbon storage = 85097 kg
Total mass of stored CO₂ = 297589 kg



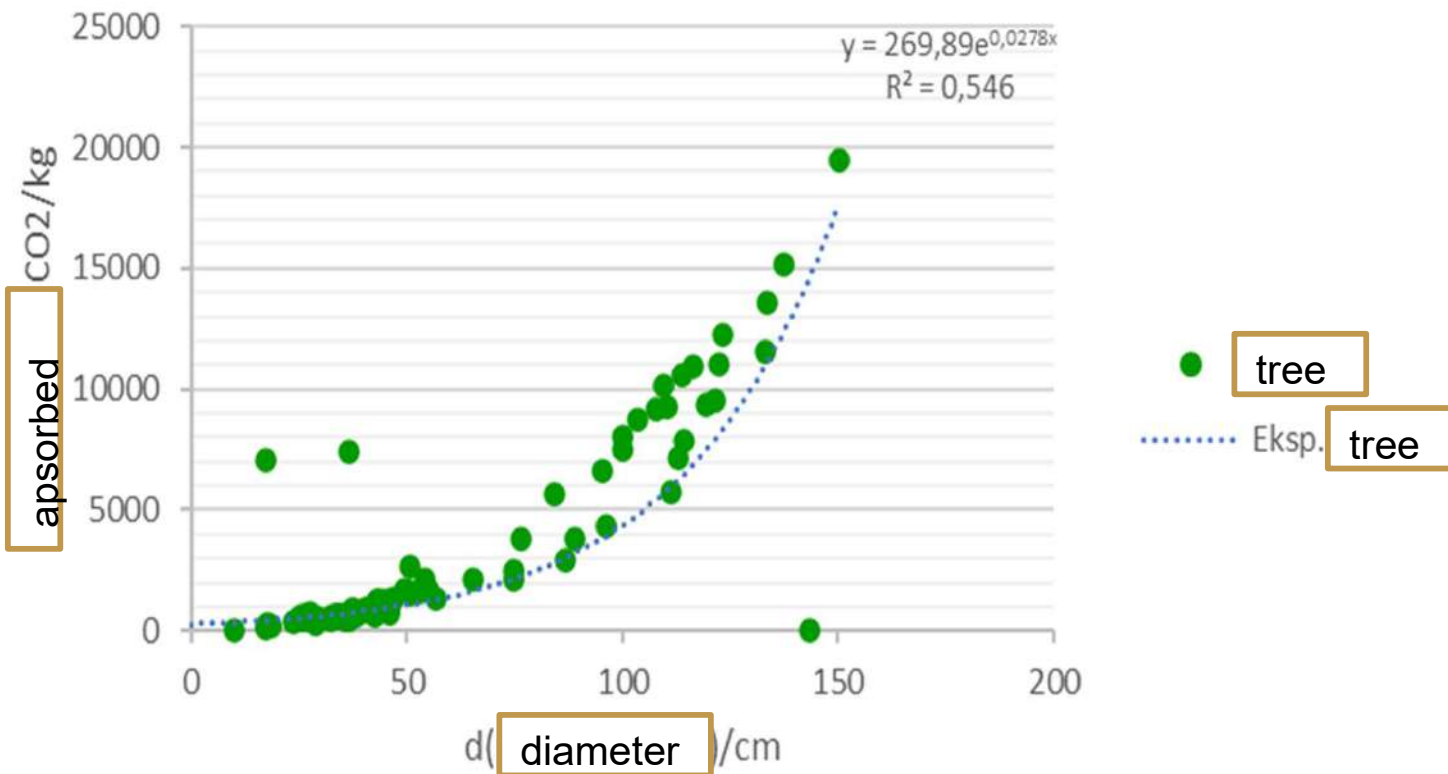
Comparison of three trees of different ages and sizes with the amount of GW, DW, carbon storage and absorbed CO₂

Mark of tree	Age of tree/Years	circumference/cm	dimeter/cm	Tree height/m	GW(green weight)/kg	DW (dry weight)/kg	Carbon storage/kg	Apsorbed CO ₂ /kg
S11	37,8	104	33,1	18,67	708,64	354,32	177,16	650,18
S17	61,8	170	54,11	22,91	2323,48	1161,74	580,87	2131,8
S57	152,7	420	133,7	23,92	14807,32	7403,66	3701,83	13585



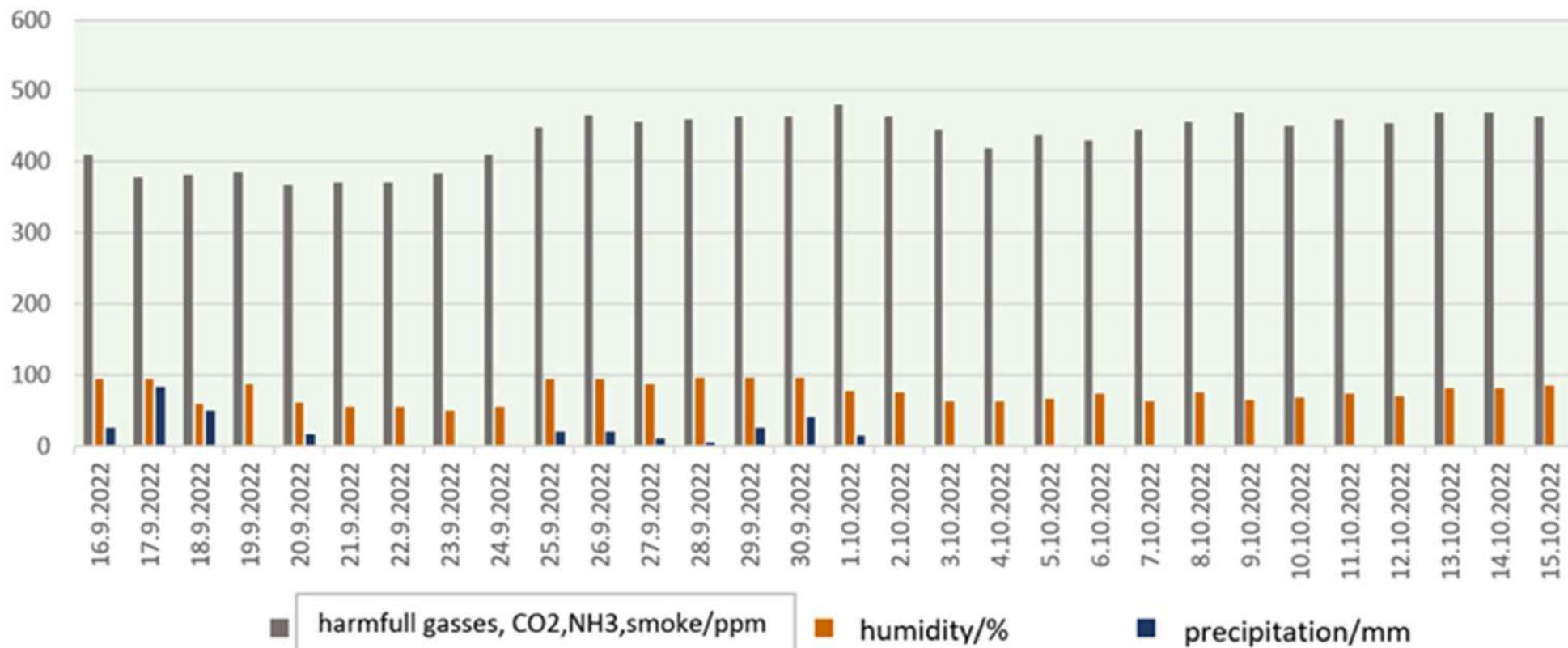
Amount of absorbed CO₂ for all plane trees in the street (102)

Comparison of absorbed CO₂ and tree chest diameter

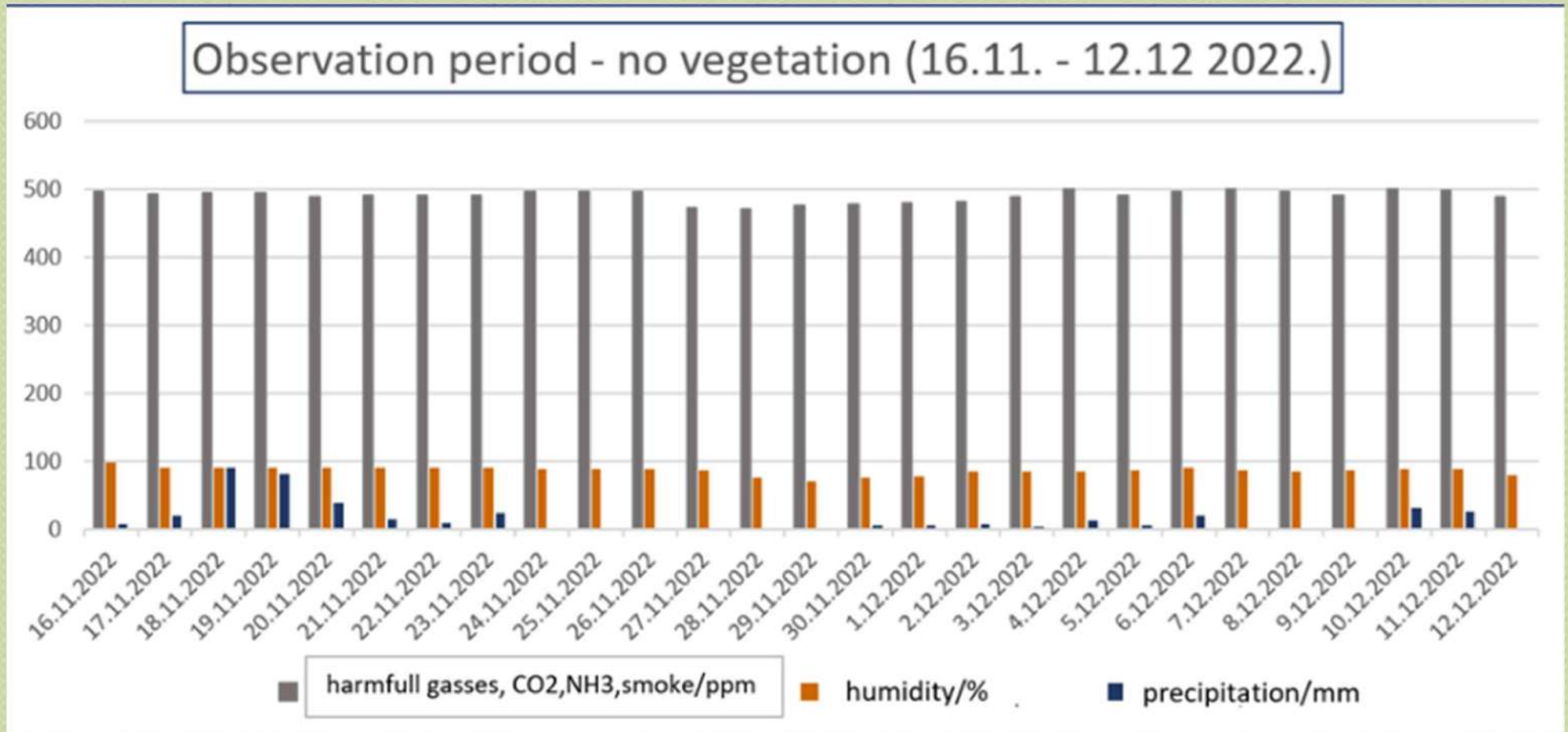


Comparison of air humidity (%), amount of gasses (ppm) and precipitation (mm) Meteo 1.

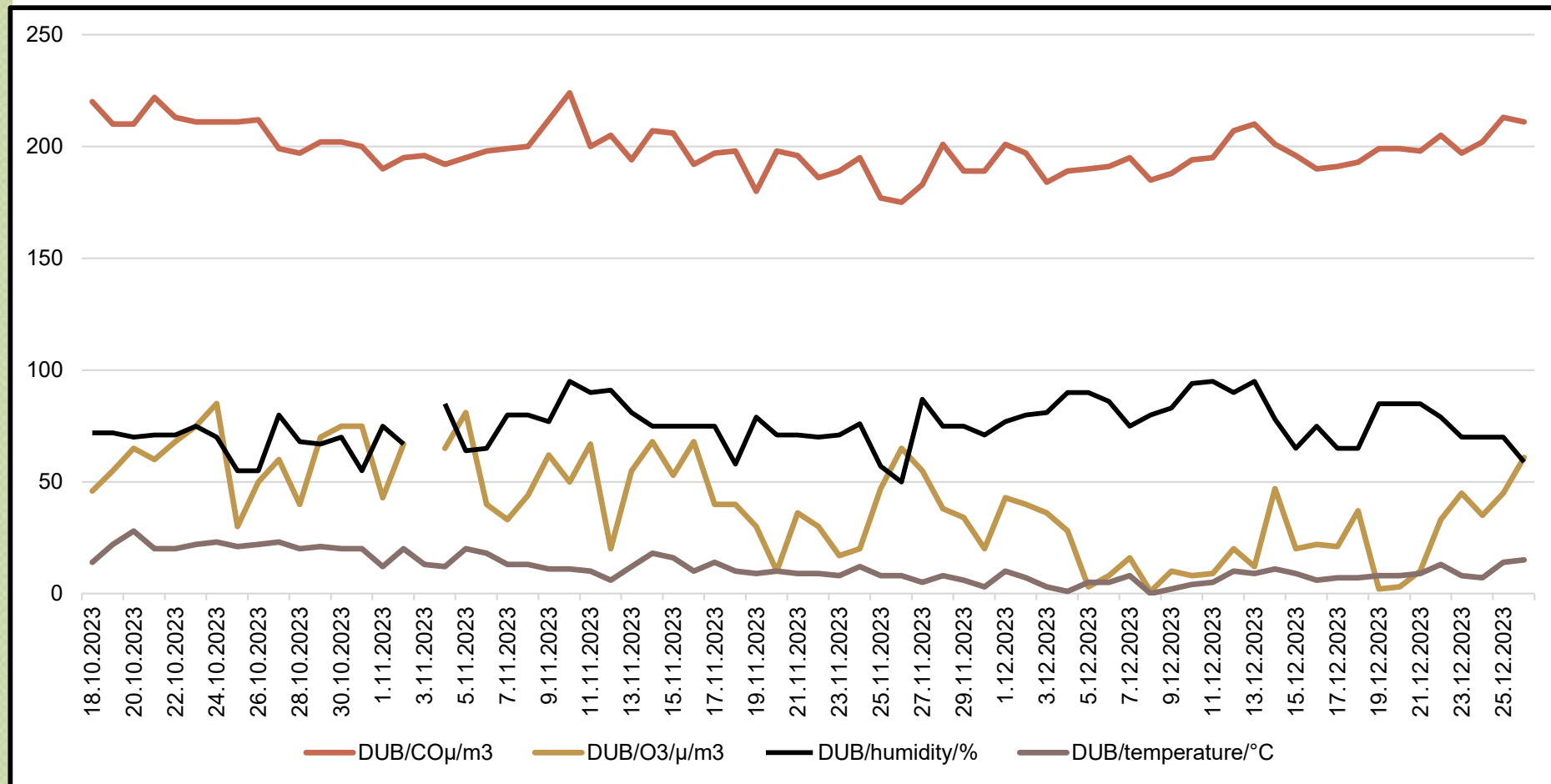
Observation period - with vegetation (16.9. - 15.10. 2022.)



Comparison of air humidity (%), amount of gasses (ppm) and precipitation (mm)
Meteo 1.



Comparison of air humidity (%), temperature (°C) with O₃ and CO (μ/m³) October - December 2023. - Meteo 2.



Conclusions

- Plane trees have absorbed more than 200 tons of CO₂ during their existence and they contain more than 80 t of carbon storage thus removing that amount of carbon from the atmosphere
- The amount of CO₂, NH₃, smoke and other gasses is higher when air humidity is higher
- The amount of CO₂, NH₃, smoke and other gasses is higher in the period without vegetation
- As air temperature decreases and air humidity increases, ozone values are lower
- The values of CO in the research period ranges from 170 – 220 μ/m³



Analysis

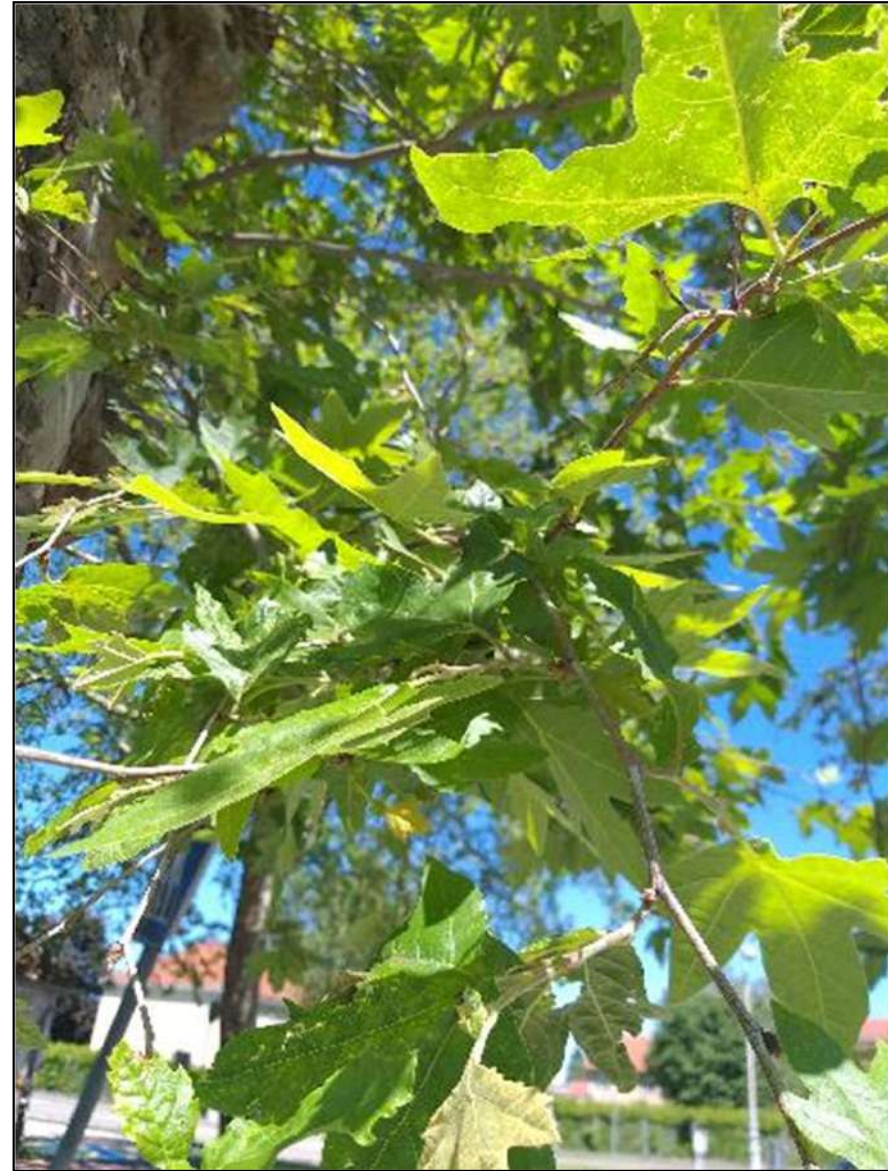
For further research it is necessary to:

- Prolong the measurements of all parameters
- Compare measured parameters throughout the year
- Permanent system setup for gas monitoring
- Set up the sensors for PM10, PM2,5



Sources and literature

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Thank you for attention