Marmont alley

Marmont alley, Karlovac 18 th century

Students: Josip Ferenčina, Luka Mataković, Maksim Stanković Šprajc

Dubovac primary school , Karlovac

The research question

- Marmontova aleja is a plane tree alley near the Dubovac primary school

- Planted from 1809. to 1811. (Karlovac - Dubovac, Grobničko Polje i 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 age

- 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 Marmontova aleja in Karlovac and concerns the community about possible tree damage

Research questions:

What is the biological importance of Marmontova aleja for Dubovac and the City of Karlovac?

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

How much oxygen does one plane tree produce in one day?

Why is it important for us to protect this tree line?

Hypotheses

- Marmontova aleja is an important biological factor in the city of Karlovac and city's district Dubovac because the plane trees have absorbed large amounts of carbon during their existence, which is especially important due to the intensive traffic and burning of fossil fuels.

- One plane tree produces significant amounts of oxygen in one day during the growing season

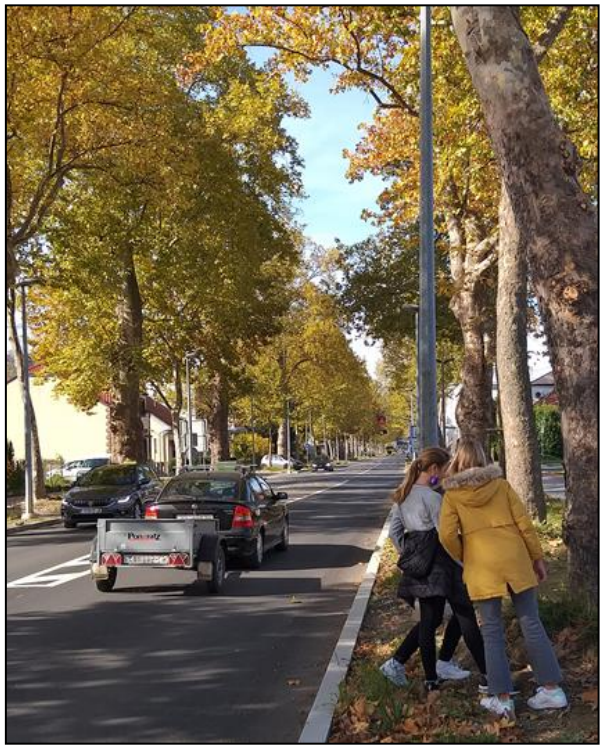
- The vegetation season of plane trees lasts from April to November

Research methods

Research period: March - December 2021
The total number of trees in the alley : 102

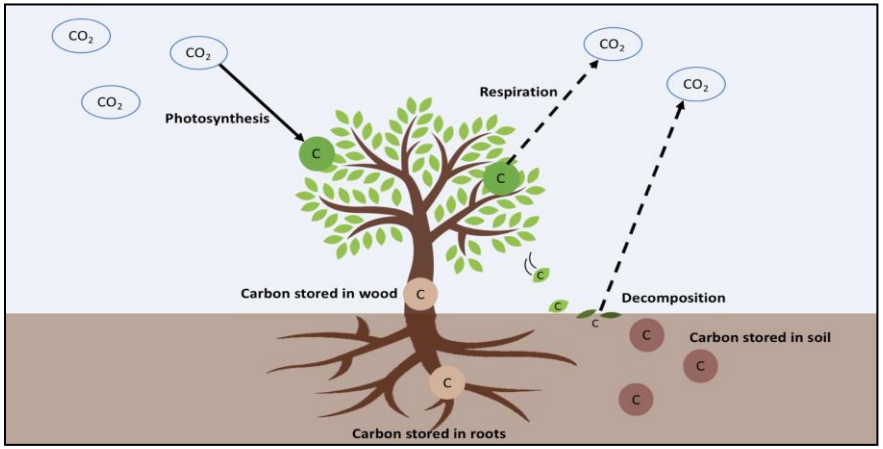
GLOBE protocols:

- biometry (for 102 plane trees)
- location determination - GLOBE observer
- tree height - GLOBE observer application
- plant species identification - the key to species identification
- circumference of wood - measuring tape technology
- observation and recording of budding and greening



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

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

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

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

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

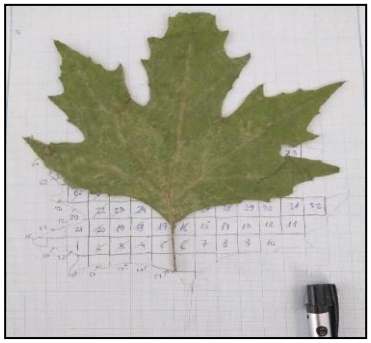
absorbed CO_2 in the lifetime of a three = Carbon storage * 3,67

because $Mr(CO_2) / Ar(C) = 3{,}67$

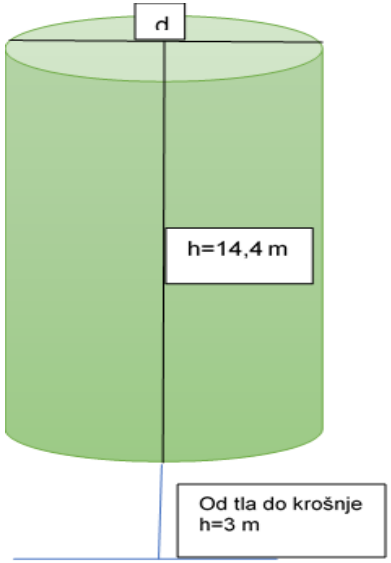
chest diameter of a tree in cm = tree circumference /π

The amount of oxygen produced on one plane tree of average size

- determining the number of leaves in 1 dm^3
- determining the leaf area



- 1 cm^2 of tree leaves produces 0.05 ml of oxygen in 1 hour at ideal temperature and pressure with optimal humidity
- Calculation of the volume of oxygen produced in 1dm^3
- calculating the tree canopy volume of the average plane tree



- calculating the volume of oxygen produced for one tree in one day

RESULTS

Measured for 102 plane trees : tree height and range

Measured for 102 plane tree: age, GW, DW, C, chest diameter, absorbed CO_2

drvo/oznaka	visina/m	opseg/cm	starost/godine	green weight/kg	dry weight/kg	carbon storage/kg	apsorbirani CO2/kg	stanje nakon 1.12.2021.	prsni promjer/cm
51	25,3	432	157	1656,33	8284,66	4142,33	15202,36	posječeno - nova mladica	137,5098708
52	25,5	365	132	1192,83	5960,81	2980,46	10938,27		116,1831085
53	17,91	127	46	1013,72	506,86	253,43	930,09		40,42535555
54	18,1	105	38	700,28	350,14	175,07	642,51		33,42253805
55	21,56	155	56	1817,73	908,86	454,43	1667,77		49,33803236
56	20,2	118	43	987,03	493,52	246,76	905,61		37,56056657
57	16,1	101	36,7	576,35	288,17	144,09	528,8		32,1492985
58	16,64	91	33	483,56	241,78	120,89	443,67		28,96619964
59	24	347	126	10139,39	5069,7	2534,845	9302,89	posječeno - nova mladica	110,4535305
510	17,38	108	39,2	711,197	355,59	177,799	652,52		34,37746771
511	18,67	104	37,8	708,64	354,32	177,16	650,17		33,10422816
512	17,62	355	129	7792,502	3896,251	1948,125	7149,62		113,0000096
513	16	78	28,3	569,64	284,82	142,41	522,65		24,82817112
514	10,95	115	41,8	508,185	254,093	127,05	466,274		36,60563691
515	10,44	144	52,3	759,671	379,84	189,92	697,006		45,83662361
516	21,99	54	19,6	7705,78	3852,89	1926,445	7070,05		17,18873385
517	22,91	170	61,8	2323,47	1161,74	580,87	2131,79		54,11268065
518	7,76	54	19,6	132,416	66,208	33,104	121,5		17,18873385
519	17,2	173	62,9	1806,5	903,25	451,625	1657,46		55,06761031
520	17,94	108	39,2	734,322	367,161	183,58	673,74		34,37746771
522	15,34	279	101,5	4190,352	2095,176	1047,59	3844,65		88,80845825
523	19,83	92	33,4	589,025	294,51	147,255	540,43		29,28450953
524	25	338	123	10022,82	5011,41	2505,705	9195,94		107,5887415
525	16,87	87	31,6	747,256	373,628	186,814	685,607		27,6929601
526	25,17	265	96,4	6202,856	3101,43	1550,715	5691,124		84,35211984
527	17,38	115	41,8	806,607	403,303	201,652	7400,63		36,60563691
528	12,14	75	27	399,63	199,815	99,907	366,66		23,87321446
529	15,85	127	46	897,123	448,5615	224,28	823,11		40,42535555
530	19	359	130,5	8593,28	4296,64	2148,32	7884,33	posječeno - nova mladica	114,2732491
531	15,01	118	43	733,44	366,72	183,36	672,93		37,56056657
532	26,57	344	125	11033,803	5516,9	2758,45	10123,51		109,4986008
533	21,1	135	49	1349,48	674,74	337,37	1238,148		42,97183463
534	13,17	101	36,7	471,46	235,73	117,865	432,564		32,1492985
535								mladica	0
536								mladica	0
537								mladica	0
538								mladica	0
539	14,65	302	109	4688,867	2344,43	1172,215	4302,03	posječeno - nova mladica	96,12958563
540	27,2	472	171,6	21265,21	10632	5316,3	19510,82		150,2422663
541	16,7	82	29,8	657,14	328,57	164,29	602,93		26,10141067
542	20,6	240	87	4163,96	2081,98	1040,99	3820,43		76,39437268
546	13,32	142	51,6	942,535	471,267	235,63	864,77		45,20003084
547	14,69	349	127	6278,93	3139,465	1569,73	5760,9	posječeno - nova mladica	111,0901503
548	13,8	115	42	640,452	320,226	160,113	587,62		36,60563691
549	20,36	382	139	10426,07	5213,04	2606,52	9565,93	posječeno - nova mladica	121,5947765
550	17,09	142	51,6	1209,15	604,575	302,29	1109,4		45,20003084
551	14,05	235	85,5	2722,83	1361,415	680,7	2498,17		74,80282325
552	13,03	80	29	488,12	244,06	122,03	447,85		25,46479089
553	15,68	205	74,5	2312,4	1156,2	578,1	2121,63		65,25352667
554	17,67	102	37	645,22	322,61	161,305	591,98		32,46760835
555	22,6	460	163,6	16060,152	8030,076	4015,038	14,735	posječeno - nova mladica	143,2894488
556	16,93	129	47	988,64	494,32	247,16	907,07		41,06197532
557	23,92	420	152,7	14807,11	7403,55	3701,78	13585,53	posječeno - nova mladica	133,6905122
558	8,71	59	21,4	177,44	88,72	44,36	162,8		18,78008328
559	23	300	109	7264,13	3632,065	1816,03	6664,84		95,49296586
560	15,64	56	20	287,018	143,509	71,75	263,34		17,82535363
561	19,75	159	58	1752,174	876,087	438,044	1607,62		50,61127219
562	7,32	31	11	41,17	20,585	10,29	37,77		9,867606472
563	16,2	120	43,6	818,64	409,32	204,66	751,102		38,19718634
564	17,1	142	51,6	1210,016	605,008	302,5	1110,2		45,20003084
565	13,09	55	20	231,731	115,865	57,9325	212,613		17,50704374
566	17,31	117	42,5	831,54	415,77	207,885	762,94		37,24225668
567	15,64	117	42,5	751,314	375,66	187,83	689,336		37,24225668
568	14,47	117,5	42,7	701,055	350,53	175,265	643,23		37,40141163
569	20,73	187	49,8	1365,355	682,677	341,34	1252,72		43,60845441
570	19,5	160	58,2	2915,04	1457,5	728,76	2674,55		50,92958179
571	12,23	272	99	3175,26	1587,63	793,815	2913,3		86,58028904
572	15,35	117	42,5	737,39	368,695	184,35	676,56		37,24225668
573	20,53	418	152	12587,85	6293,93	3146,965	11549,36	posječeno - nova mladica	133,0535324
574	12,12	91	33	352,19	176,095	88,05	323,14		28,96619964
575	10,36	112	40,7	456,08	228,04	114,02	418,45		35,65070725
576	18,18	159	57,8	1612,83	806,415	403,2	1479,74		50,6112719
577	14,28	121	44	733,7	366,85	183,425	673,17		38,51549623
578	23,19	384	139,6	11999,97	5999,985	2999,993	11009,97	posječeno - nova mladica	122,2309963
579	23,5	315	114,5	8182,79	4091,395	2045,698	7507,71		100,2676141
580	18,37	142	51,6	1299,88	649,94	324,97	1192,64		45,20003084
581	15,61	111	40	674,93	337,465	168,733	619,25		35,33239737
582	12,06	84	30,5	497,93	248,965	124,483	456,85		26,73803044
583	13,28	143	52	952,93	476,465	238,23	874,31		45,51831372
584	11,8	235	85,5	2286,78	1143,4	571,7	2098,14		74,80282325
585	13,87	188	50,2	926,94	463,47	231,735	850,46		43,92676429
586	14,9	134	48,7	938,87	469,435	234,72	861,42		42,65352475
587	15,53	108	39,2	635,68	317,84	158,92	583,24		34,37746771
588	18,52	92	33,5	550,113	275,056	137,53	504,73		29,28450953
589	19,02	147	53,5	1442,3	721,15	360,575	1323,31		46,79155327
590	25,8	325	118	9563,17	4781,585	2390,8	8774,24		103,450713
591	16,82	146	53	1258,15	629,075	314,5375	1154,35		46,47324338
592	11,58	134	48,7	729,678	364,839	182,42	669,48		42,65352475
593	14,91	109	39,6	621,64	310,82	155,41	570,35		34,69577759
594	19,11	141	51,2	1332,99	666,495	333,25	1223,02		44,88169395
595	25,35	387	140,7	13323,8	6661,9	3330,95	12224,6		123,185926
596	14,78	141	51,2	1030,96	515,48	257,74	945,9		44,88169395
597	13,05	144	52,3	949,63	474,815	237,4	871,258		45,83662361
598	25,74	357	130	11512,24	5756,12	2878,06	10562,48		113,6366294
599	25,3	314	114	8753,8	4376,9	2188,45	8031,6		99,94930426
5100	17,83	166	60,4	1724,43	862,215	431,107	1582,16		52,83944111
5101	12,82	178	64,7	1425,38	712,69	356,345	1307,78		56,65915974
5102	20,71	375	136,4	10220,07	5110,035	2555,02	9376,9		119,3662073

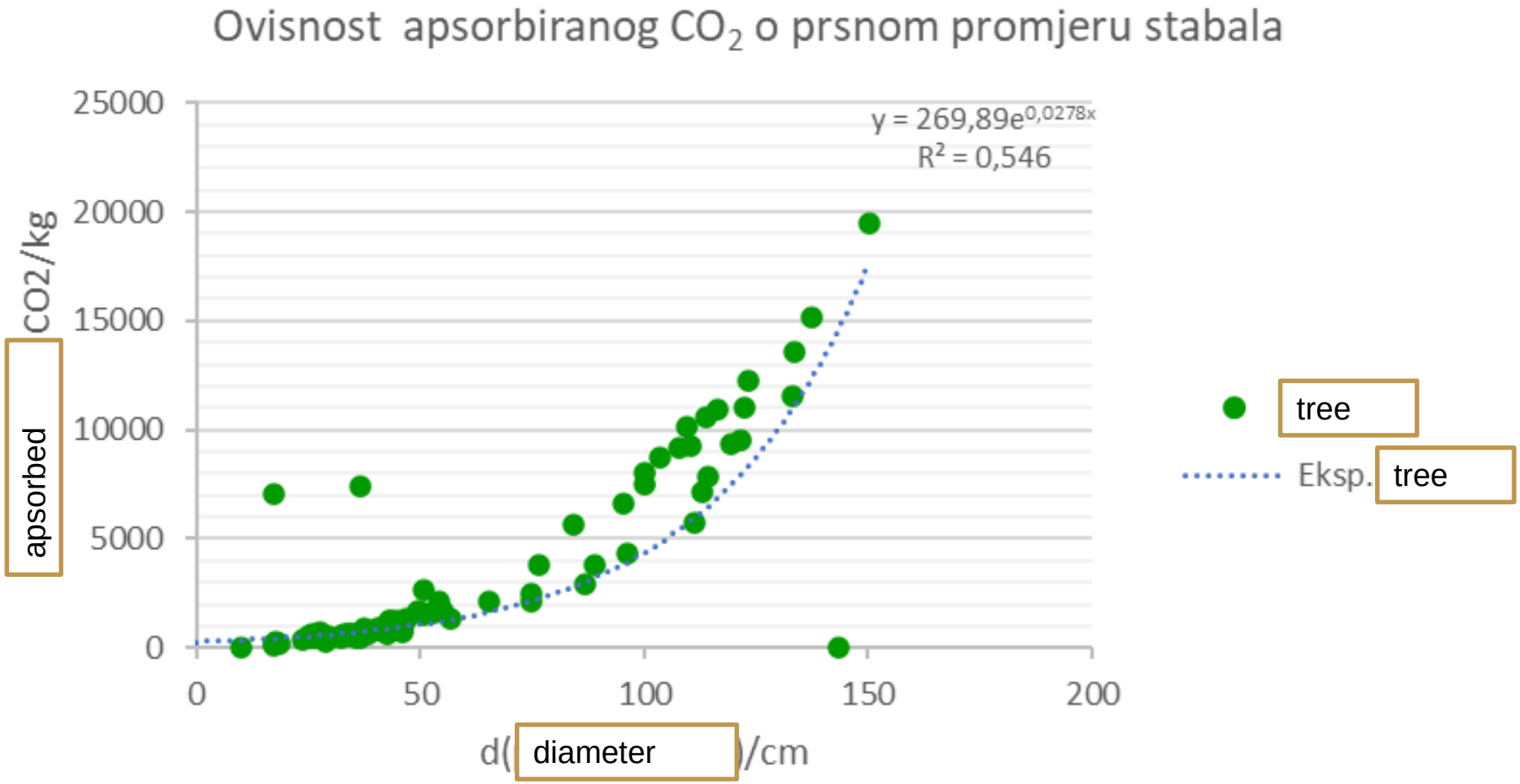
Average tree height: 17,48 meters
Average tree age: 67,23 years

Total mass of a living tree(GW)= 333132 kg
Total dry mass (DW)= 256565 kg
Total mass of stored carbon= 85097 kg
Total mass of stored CO_2= 297589 kg

Comparison of three trees of different ages and sizes with the amount of GW, DW, stored carbon and absorbed CO_2

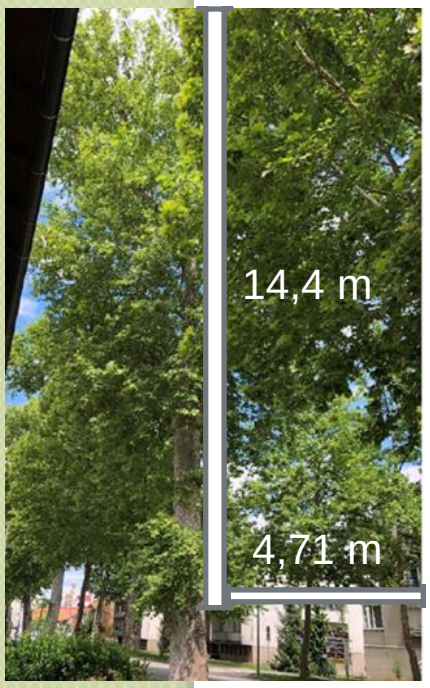
Mark of tree	Age of tree/Years	circumference/cm	dimeter/cm	Tree height/m	GW(green weight)/kg	DW (dry weight)/kg	Carbon storage/kg	Apsorbed CO_2/kg
S11	37,8	104	33,1	18,67	708,64	354,32	177,16	650,18
S17	61,8	170	54,11	22,91	2323,48	1161,74	580,87	2131,8
S57	152,7	420	133,7	23,92	14807,32	7403,66	3701,83	13585

Amount of stored CO_2 for all plane trees in the street (102)



Amount of produced O_2 for one plane tree of average height

- Number of leaves in 1 dm^3 = 2
- Total leaf surface of 2 leaves = 160 cm^2
- **Total volume of O_2 in 1 dm^3** = 160 cm^2 x 0,05 ml/1 h= 8 ml O_2 /1 h



r (canopy): souces

- Volume of the tree canopy: $r^2\pi$ * h

  $(4,71m)^2$ * 3,14 * 14,4 m= 1003,07 m^3 = 1003070 dm^3

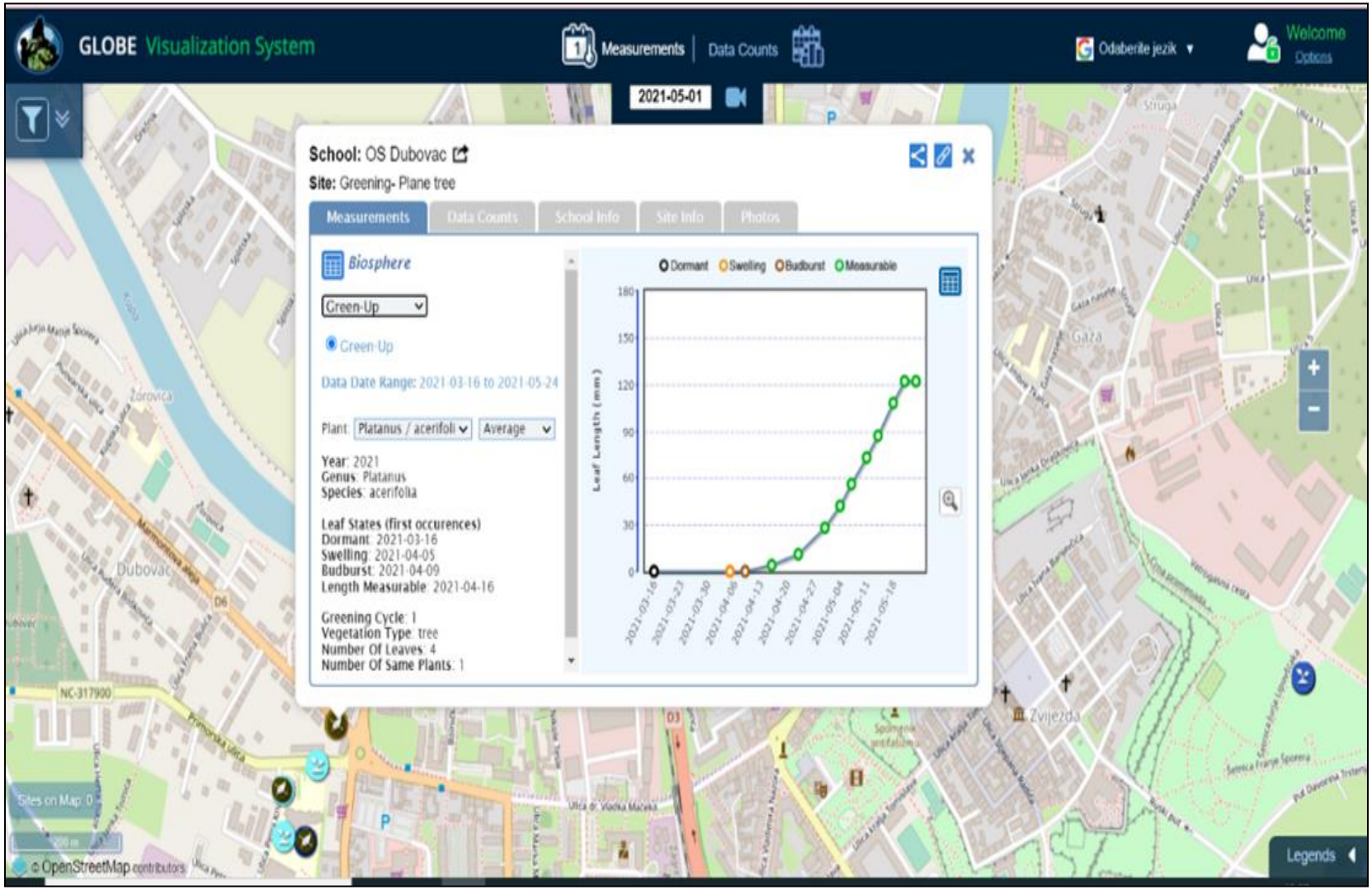
- **Volume of produced O_2 in the tree canopy in 1 hour:**

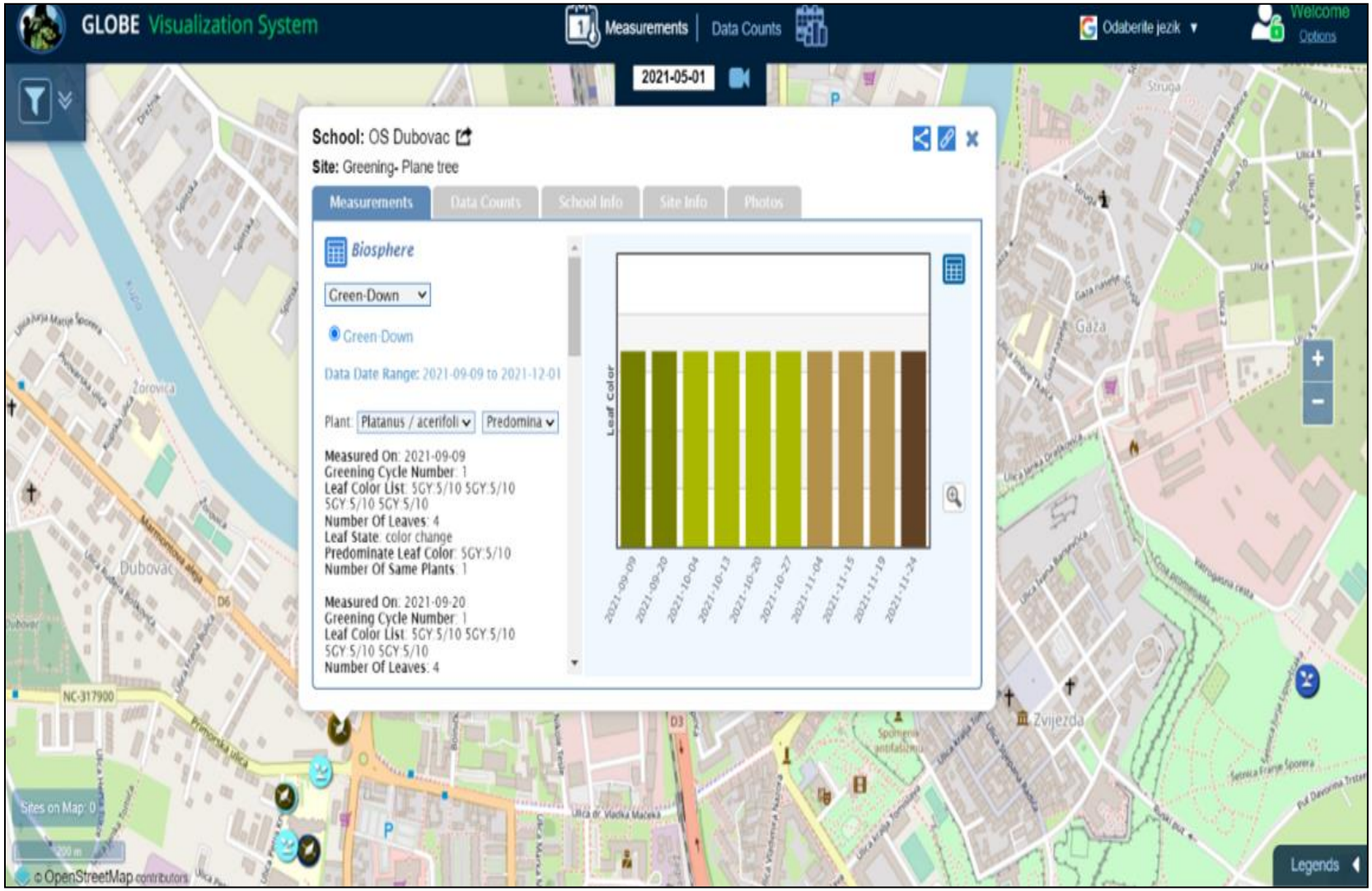
  1003070 dm^3 * 8 ml= 8024560 ml u 1 h =

  8024,56 L u 1 h

- **Volume of produced O_2 in a tree canopy in 1 day:**
- 8024,56 L * 8 h= 64196,2 L

Vegetation period on the observed plane tree




GLOBE Visualization System
Measurements
Data Counts
Odaberite jezik
Welcome
Options
2021-05-01
School: OS Dubovac
Site: Greening- Plane tree
Measurements
Data Counts
School Info
Site Info
Photos
Biosphere
Green-Down
Green-Down
Data Date Range: 2021-09-09 to 2021-12-01
Plant: Platanus / acerifoli
Predomina
Measured On: 2021-09-09
Greening Cycle Number: 1
Leaf Color List: 5GY:5/10 5GY:5/10 5GY:5/10 5GY:5/10
Number Of Leaves: 4
Leaf State: color change
Predominate Leaf Color: 5GY:5/10
Number Of Same Plants: 1
Measured On: 2021-09-20
Greening Cycle Number: 1
Leaf Color List: 5GY:5/10 5GY:5/10 5GY:5/10 5GY:5/10
Number Of Leaves: 4
Leaf Color
2021-09-09
2021-09-20
2021-10-04
2021-10-13
2021-10-20
2021-10-27
2021-11-04
2021-11-15
2021-11-19
2021-11-24
Dubovac
Gaža
Zvijezda
NC-317900
Sites on Map: 0
© OpenStreetMap contributors
Legends

Conclusions

The hypothesis about the biological importance of the Marmontova aleja of the city Karlovac and the city's district Dubovac was confirmed by the results of the research.

- plane trees have absorbed more than 200 tons of CO_2 during their existence
- they contain more than 80 t of stored carbon thus removing that amount of carbon from the atmosphere.
- the tree-lined avenue contributes to the reduction of the greenhouse effect, especially when CO_2 absorption occurs at the site of its intensive formation
- if ideal conditions lasted 8 hours a day, one tree of average size could produce approximately more than 60,000 L of oxygen
- the vegetation period lasts from April to November

Analysis

It was not possible to use the GLOBE - TREE age calculator to calculate the age of the plane tree because there was no option to calculate the age and amount of carbon stored in the plane trees.

It is not possible to accurately calculate the amount of oxygen produced in one hour or day because photosynthesis depends on many factors, temperature, humidity, and light intensity which can change within one day or hour.

It is not possible to accurately calculate the amount of oxygen produced per cm^2 because the values change between each plane tree.

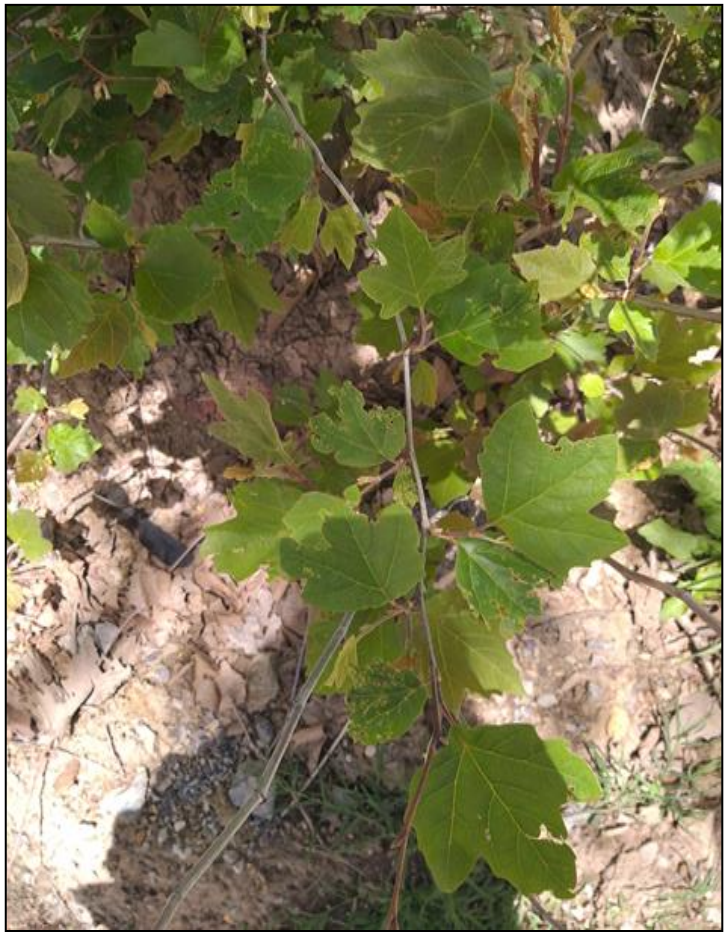
The following studies should measure atmospheric factors (cloud, temperature, humidity) in order to calculate the approximate amount of oxygen in ideal conditions during the growing season from April to November.

Appreciations

- to the local community, which invited the students to present the project to the residents

- to the public institution Natura Viva from Karlovac for the promotion of the project in the city of Karlovac, Croatia

- to Brian Campbell for the invitation to present the research project at the „Trees around the GLOBE” webinar, on December 8th2022.



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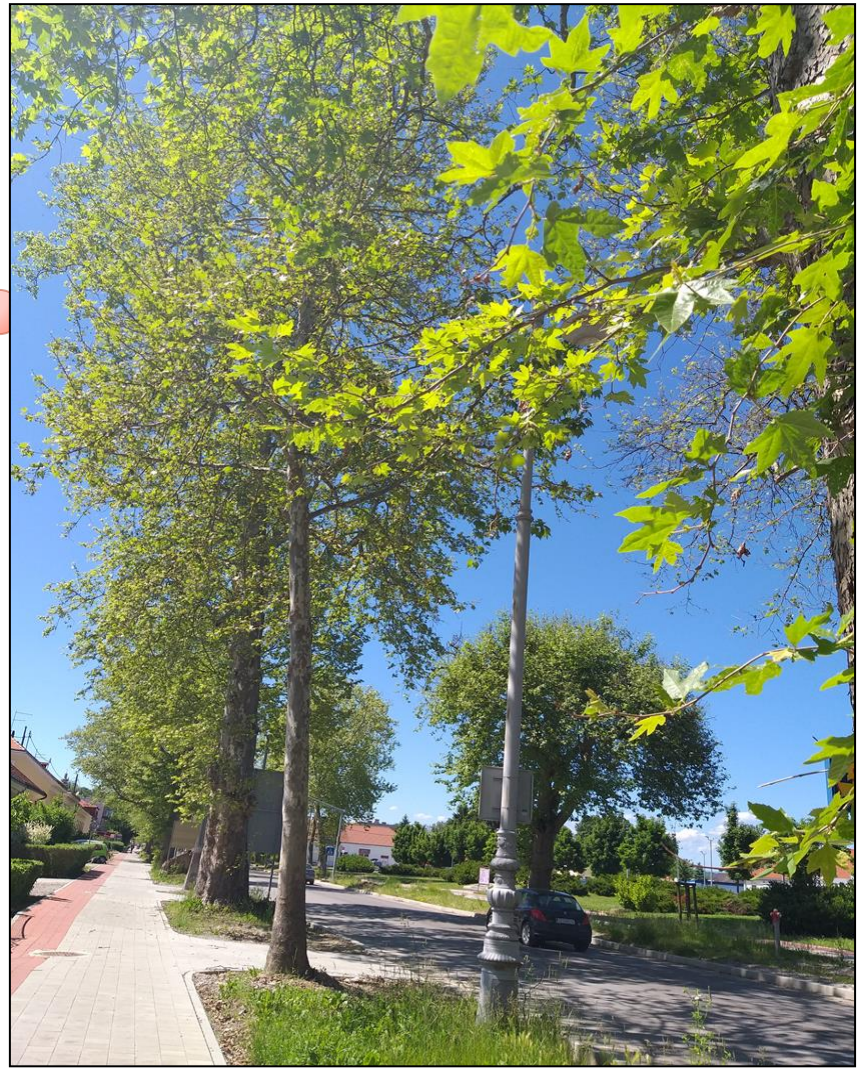

THANKS FOR THE ATTENTION!

Dubovac Primary school, Karlovac, Croatia