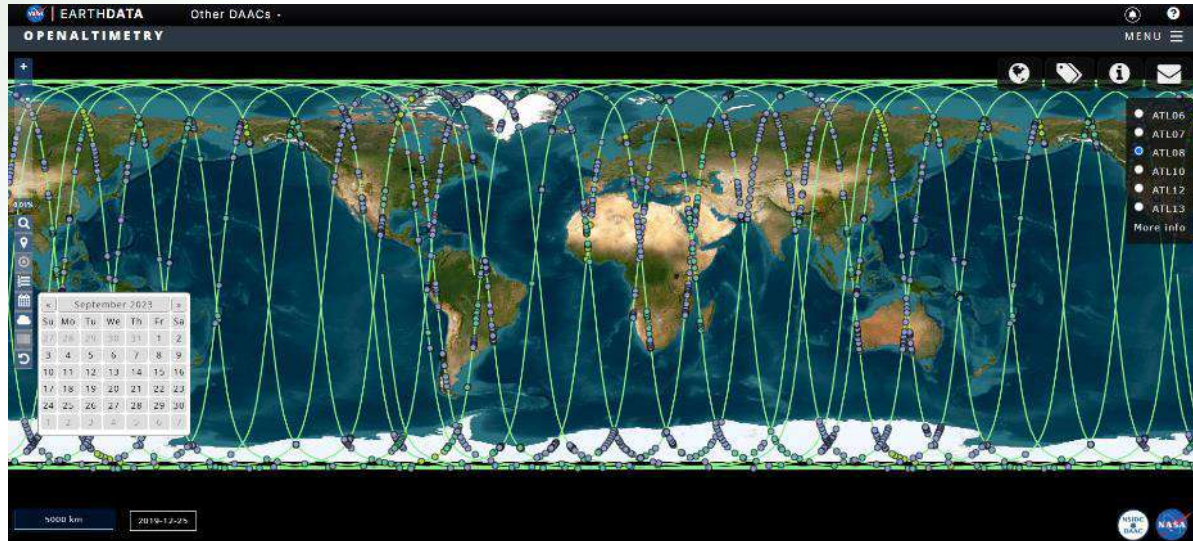


Digitalna tehnologija u istraživačkim projektima s učenicima

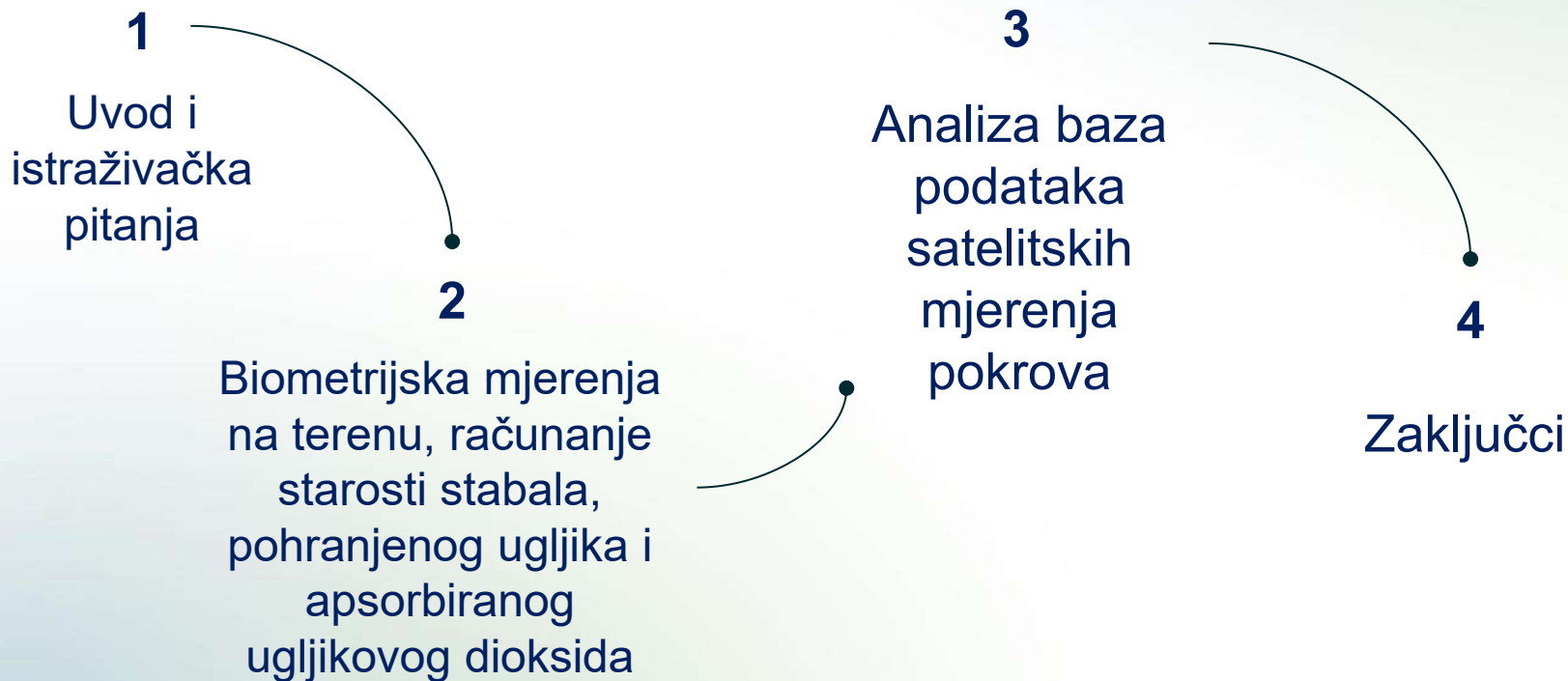


Snježana Marković – Zoraja, prof., učitelj savjetnik
Kristina Fratrović, dipl. ing., učitelj izvrsni savjetnik
OŠ Dubovac, Karlovac

15. Hrvatski biološki kongres međunarodnim sudjelovanjem
20. – 23. studeni 2025.
Zagreb, Hrvatska

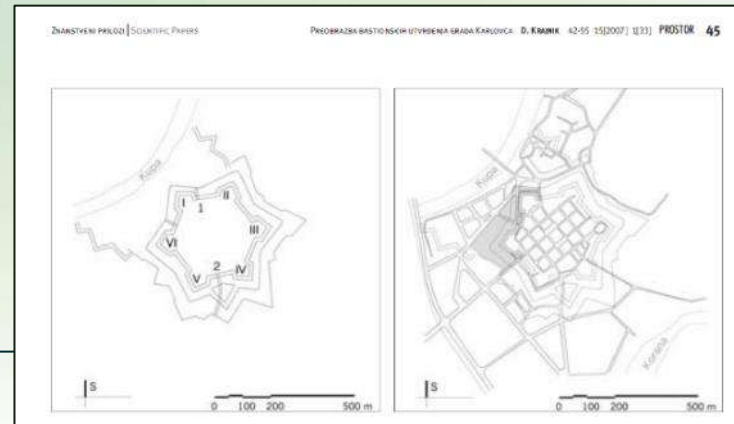
Istraživan je pokrov i ciklus ugljika na Karlovačkoj Promenadi (šk.god.2024./2025)

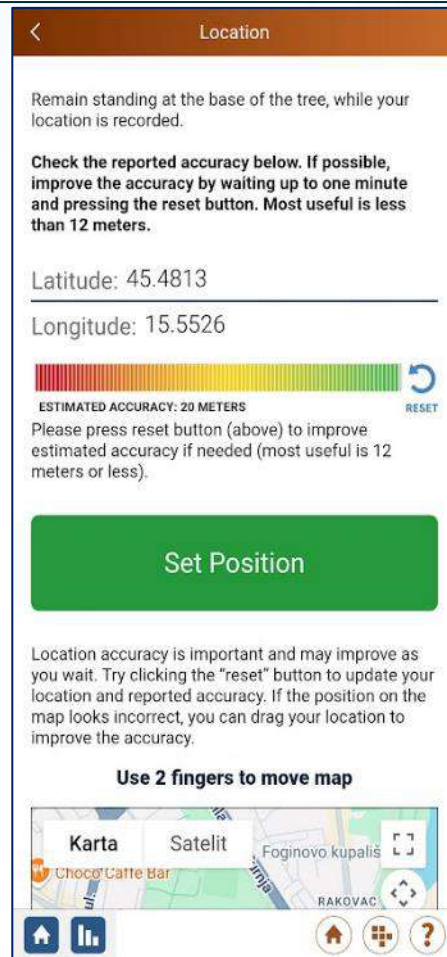
Etape istraživačkog projekta s učenicima 8. razreda osnovne škole



Uvod i istraživačka pitanja

- Kolika je visina i starost stabala karlovačke Promenade?
- Koliko je pohranjenog ugljika i apsorbiranog CO₂ u svim stablima?
- Razlikuje li se izmjerena visina stabla na terenu od baze podataka satelitskih podataka?

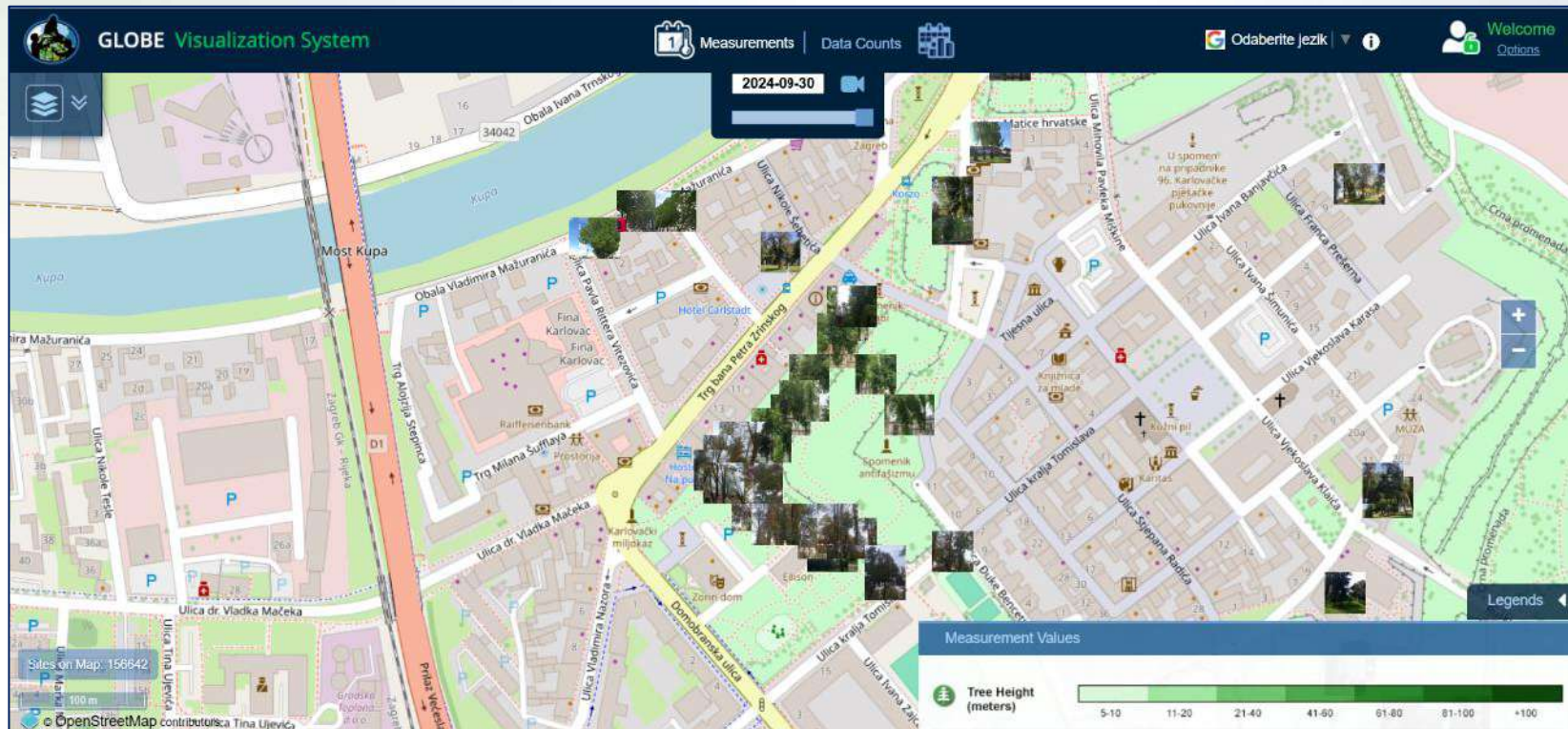




Unesene vrijednosti visine i opsega stabala Karlovačke promenade u bazu podataka GLOBE programa (ikone)



Unesene vrijednosti visine i opsega stabala Karlovačke promenade u bazu podataka GLOBE programa (fotografije stabala)



Odabirom ikone:

- očitavamo izmjerene biometrijske podatke i datum kad su napravljena mjerenja
- vidimo fotografiju stabla

The screenshot displays the GLOBE Visualization System interface. At the top, there is a navigation bar with the GLOBE logo, the text "GLOBE Visualization System", and several icons for "Measurements", "Data Counts", and "Options". A language selector is set to "Ođaberite jezik". The main area shows a map of a city street grid with green tree icons. A popup window titled "Croatia Citizen Science" is open, showing details for site "33TWL432380". The popup has tabs for "Measurements", "Data Counts", "Site Info", and "Photos". The "Measurements" tab is active, showing a dropdown menu for "Biosphere" and "Biometry - Tree Heights". Below this, it displays the "Data Date Range" as "2021-05-02 to 2024-09-18" and "Measurement: 1". The "Data Source" is "GLOBE Observer App", measured at "2024-09-18 09:49:00". The tree's "Tree Height" is "11.75 m", "Circumference (cm)" is "171.00", "Location Method" is "automatic", "Location Accuracy M" is "1000", "Mv Updated At" is "2024-11-01 09:49:17.264044+00", and "Elevation" is "113.20 m". To the right of the text is a photograph of a large, leafy tree in an urban setting. At the bottom of the popup, there is a "Measurement Values" section with a legend for "Tree Height (meters)" ranging from 5-10 to +100, with a color scale from light green to dark green.

GLOBE Visualization System

Measurements | Data Counts | Options

Ođaberite jezik | Welcome Options

2025-03-19

Croatia Citizen Science

Site: 33TWL432380

Measurements | Data Counts | Site Info | Photos

Biosphere

Biometry - Tree Heights

Data Date Range: 2021-05-02 to 2024-09-18

Measurement: 1

Data Source: **GLOBE Observer App**
Measured At: **2024-09-18 09:49:00**
Tree Height: **11.75 m**
Circumference (cm): **171.00**
Location Method: **automatic**
Location Accuracy M: **1000**
Mv Updated At: **2024-11-01 09:49:17.264044+00**
Elevation: **113.20 m**

Measurement Values

Tree Height (meters)

5-10 11-20 21-40 41-60 61-80 81-100 +100

<https://is.globe.gov/GLOBE/popUpContents.jsp#tabs-1>

Izračunata je starost svih 190 stabala

starost stabla = opseg stabla (cm) · faktor starosti

Faktor starosti:

- divlji kesten (*Aesculus hippocastanum* L.): 0.5
- lipa (*Tilia* sp.): 0.8

starost	Promenada (190 stabala)
do 62.5 godine	64%
63 - 125 godine	34%
više od 125 godina	2%

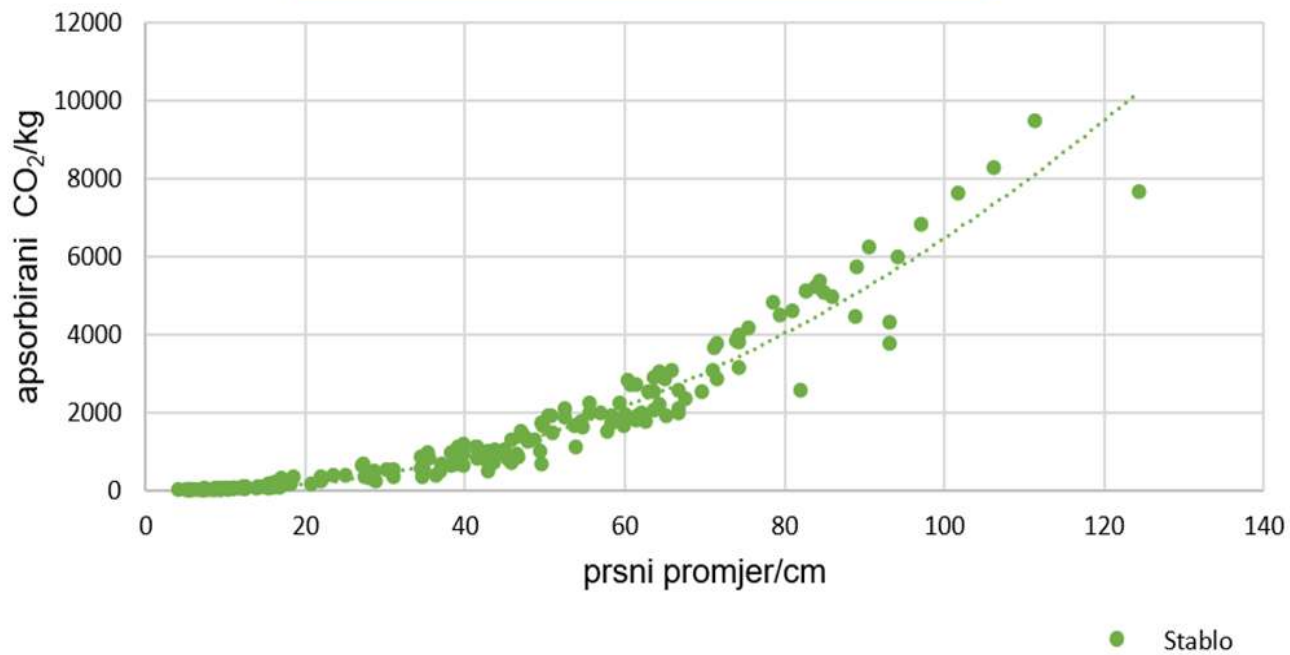


Izračunavanje pohranjenog ugljika i apsorbiranog CO₂

- **dijametar/cm** = $\frac{\text{opseg stabla}}{\pi}$
- **svježa biomasa - GW/ kg**
 $GW = 0.0346 \cdot d^2 \cdot h$ (ako je $d > 28$ cm)
 $GW = 0.0577 \cdot d^2 \cdot h$ (ako je $d < 28$ cm)
- **suha biomasa - DW/kg** = $\frac{GW}{2}$
- **pohranjeni ugljik - CC/kg** = $\frac{DW}{2}$
- **apsorbirani CO₂/kg** =
pohranjeni ugljik · 3.67
jer je $\frac{Mr(CO_2)}{Ar(C)} = 3.67$

interval promjera stabla/cm	interval starosti stabala/godine	brojnost stabala	pohranjeni ugljik/kg	apsorbirani CO ₂ /kg
1 - 50	1 - 62.5	120	12 896	47 328
51 - 100	63 - 125	66	54 571	200 575
101 - 150	> 125	4	8 966	32 906
		190	76 433	280 809

Ovisnost apsorbiranog CO₂ o prsnom promjeru



„Trees Around the GLOBE” Webinar 73, 10. rujna 2024.

Brian Campbell Senior Earth Science Specialist

Earth Sciences Division
Global Science & Technology, Inc.
NASA Wallops Flight Facility, Wallops Island, VA 23337

Trees Around the GLOBE Webinar 73 on September 10, 2024

Brian Campbell
103 subscribers

Učenci prezentiraju istraživački projekt

Trees Around the GLOBE Webinar 73 on September 10, 2024

Brian Campbell
103 subscribers

Znanstvenik tumači učenicima kako čitati i tumačiti satelitske slike pokrova.

Trees Around the GLOBE Webinar 73 on September 10, 2024

Brian Campbell
103 subscribers

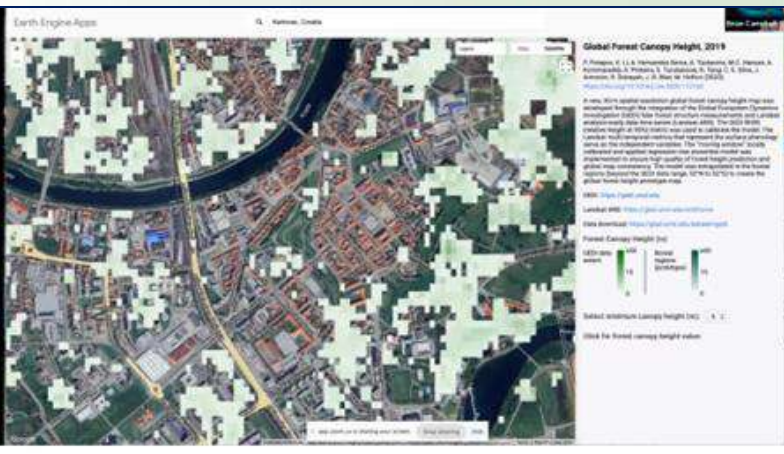
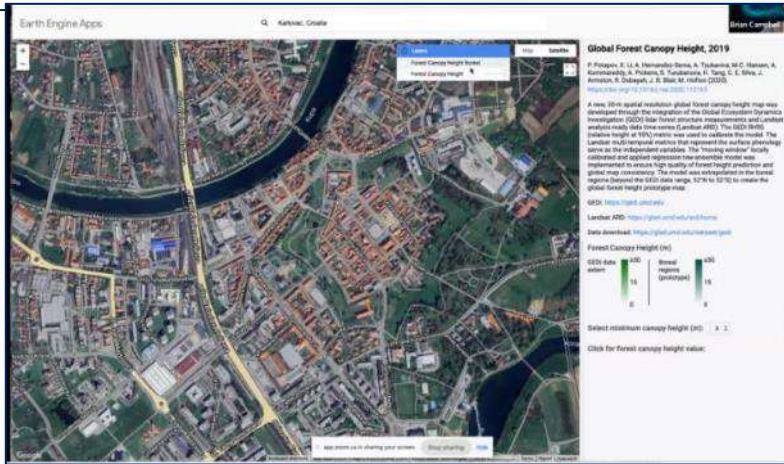
<https://www.youtube.com/watch?v=kX4LofRWVIE&t=1561s>

Analiza baze podataka Global Ecosystem Dynamics Investigation (GEDI)

- globalna karta visine šumskog pokrova (prostorne rezolucija 30 m)
- mapiranje globalne visine šume temelji se na algoritmu strojnog učenja po pikselu (predviđa vrijednost visine šume iz prostorno-vremenskih podataka)



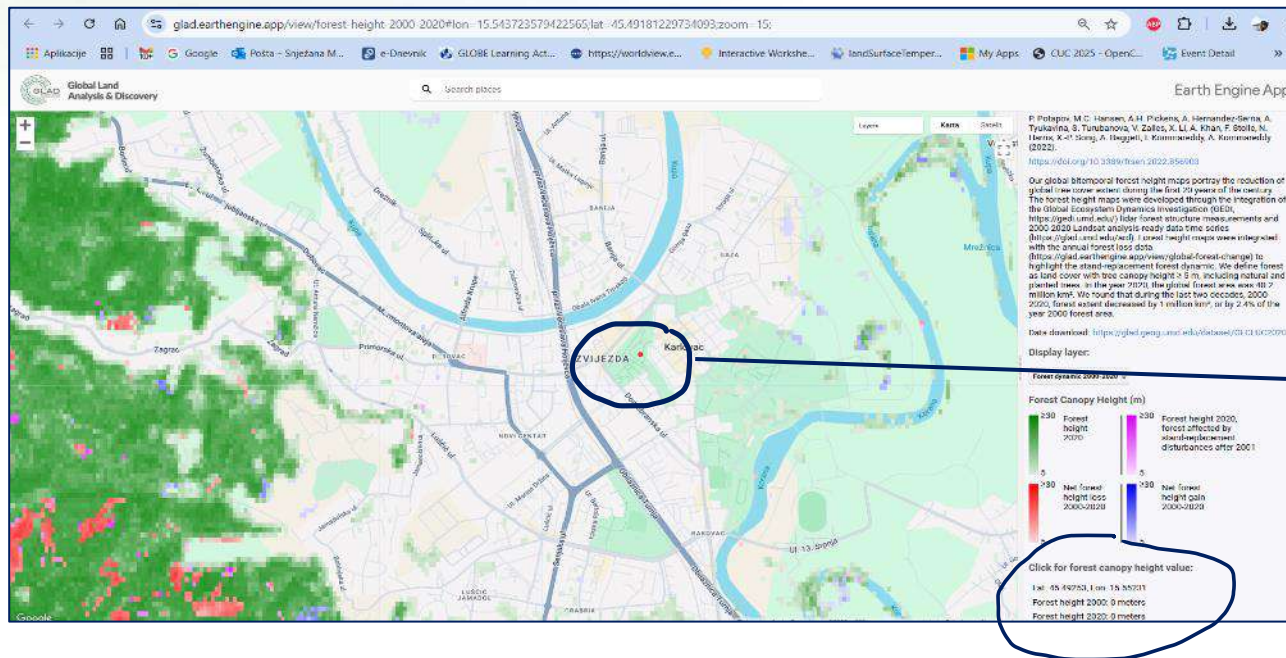
Earth Engine apps – Global Ecosystem Dynamics Investigation - očitava visinu pokrova



Odabirom pixela i označivanjem dobije se samo prosječna visina cijelog pixela, ali ne određenog stabla.

Analiza baze podataka Earthengine

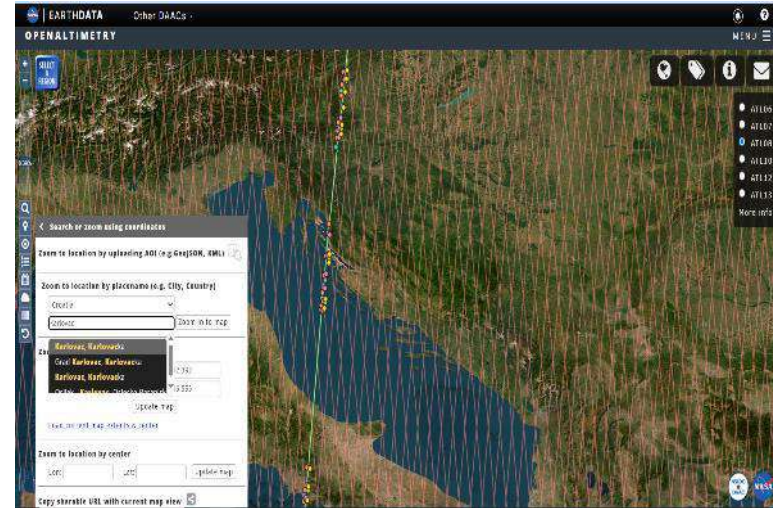
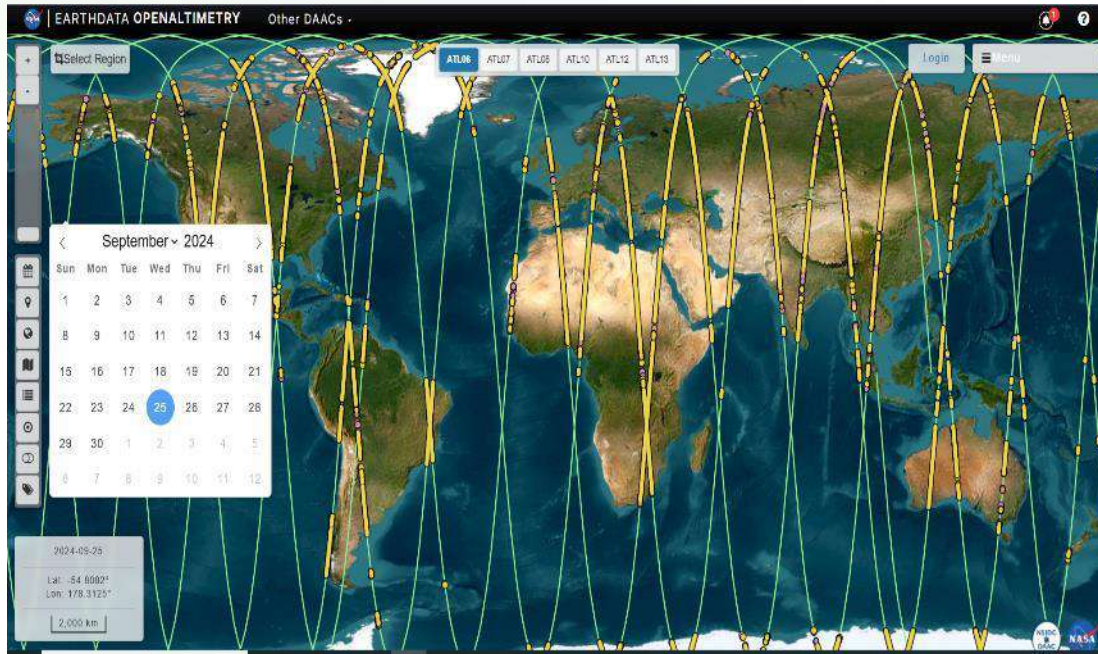
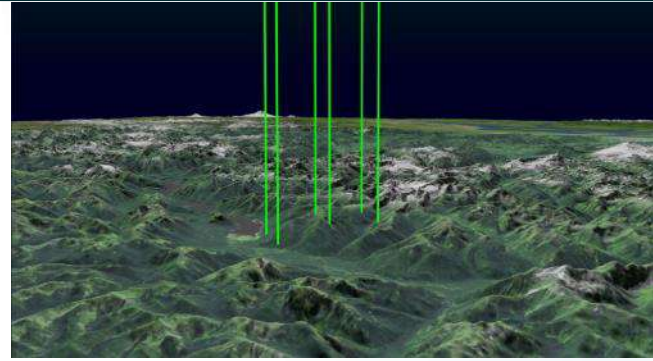
- dinamika promjene šumskog pokrova od 2000.- 2020.
- nastala integracijom GEDI i vremenski nizovi podataka Landsata



Nema podataka
(nema piksela na
istraživanom području)

Analiza baze podataka satelita OPENALTIMETRY- ICE Sat 2

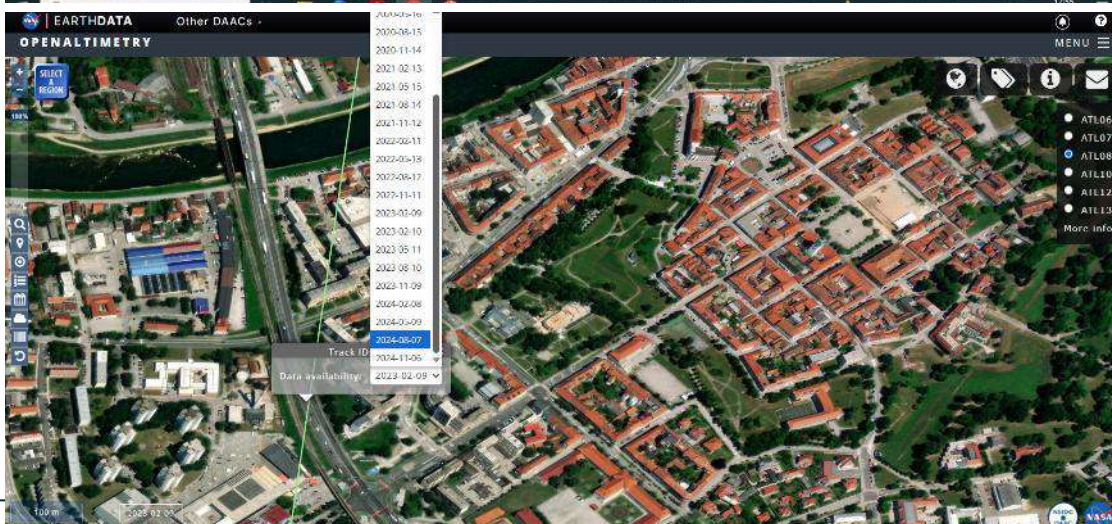
alat za vizualizaciju i za istraživanje nadmorske visine,
visine leda, voda i pokrova



<https://openaltimetry.earthdatacloud.nasa.gov/data/icesat2/>

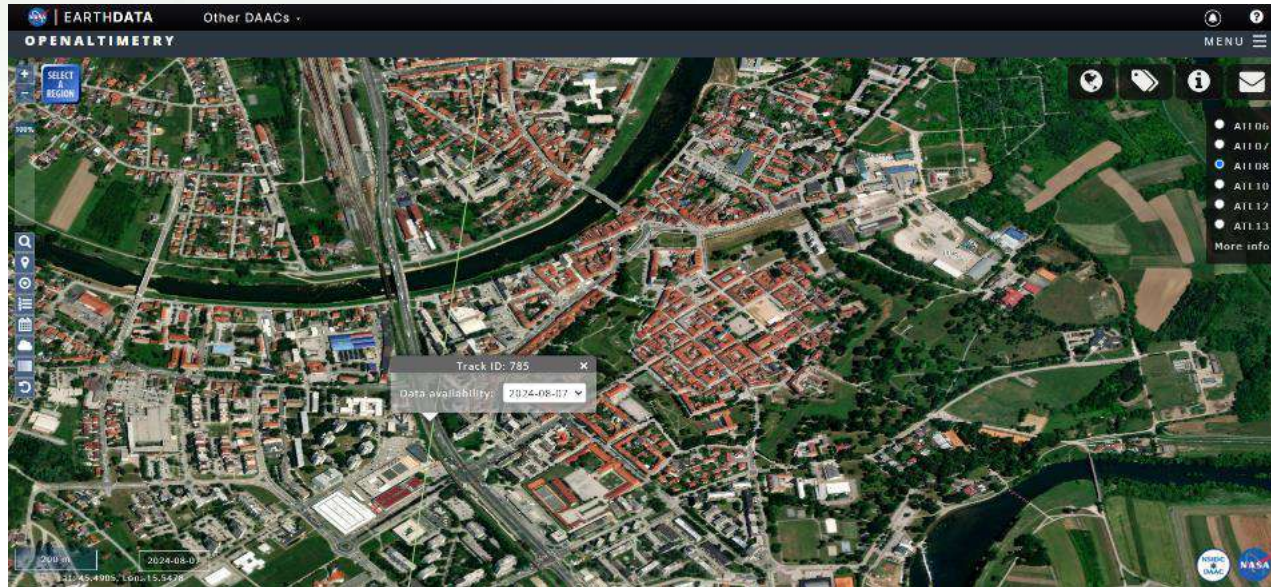


odabir datuma



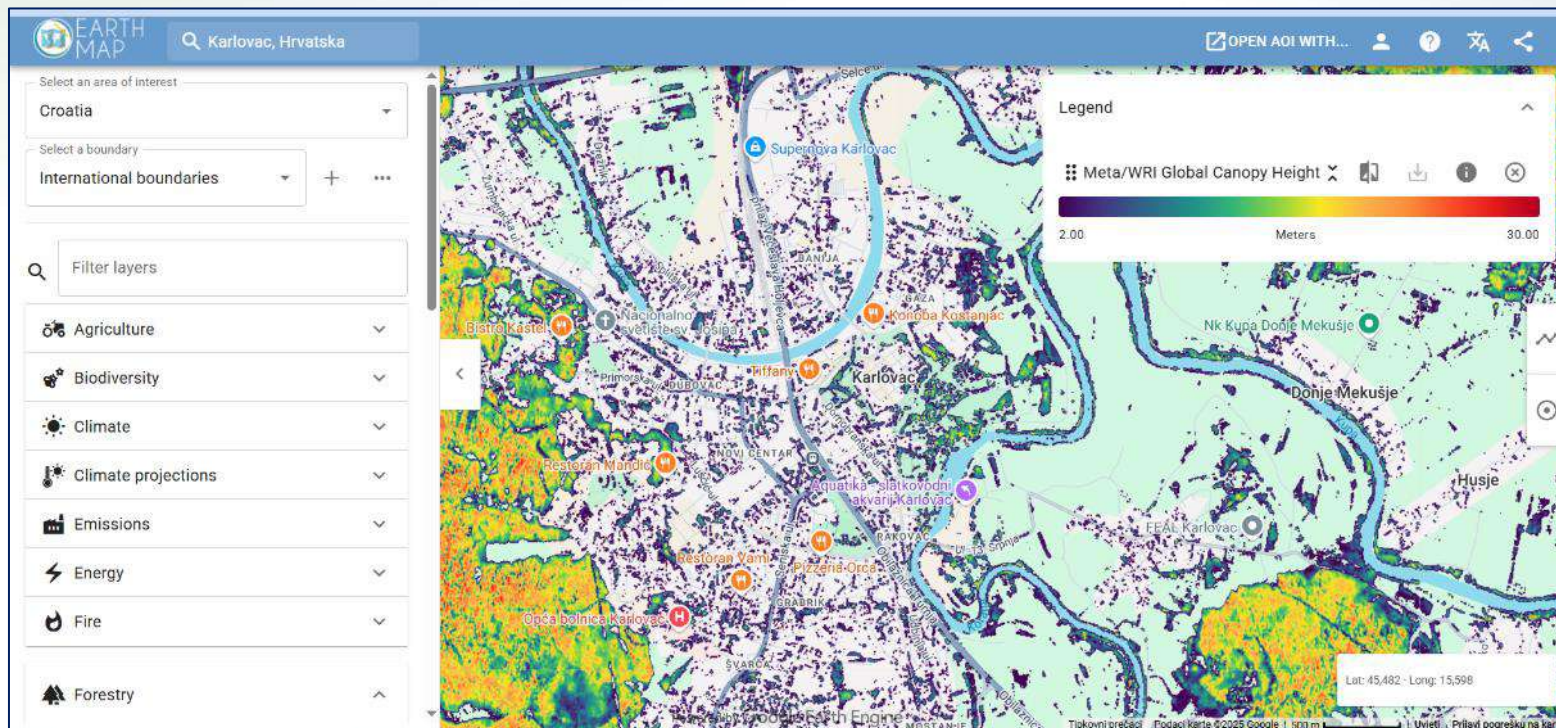
- popis datuma u kojima satelit prolazi prostorom
- preuzimanje podataka (visina pokrova)

putanje kretanja i snimanja satelita ne prolaze iznad Karlovačke Promenade

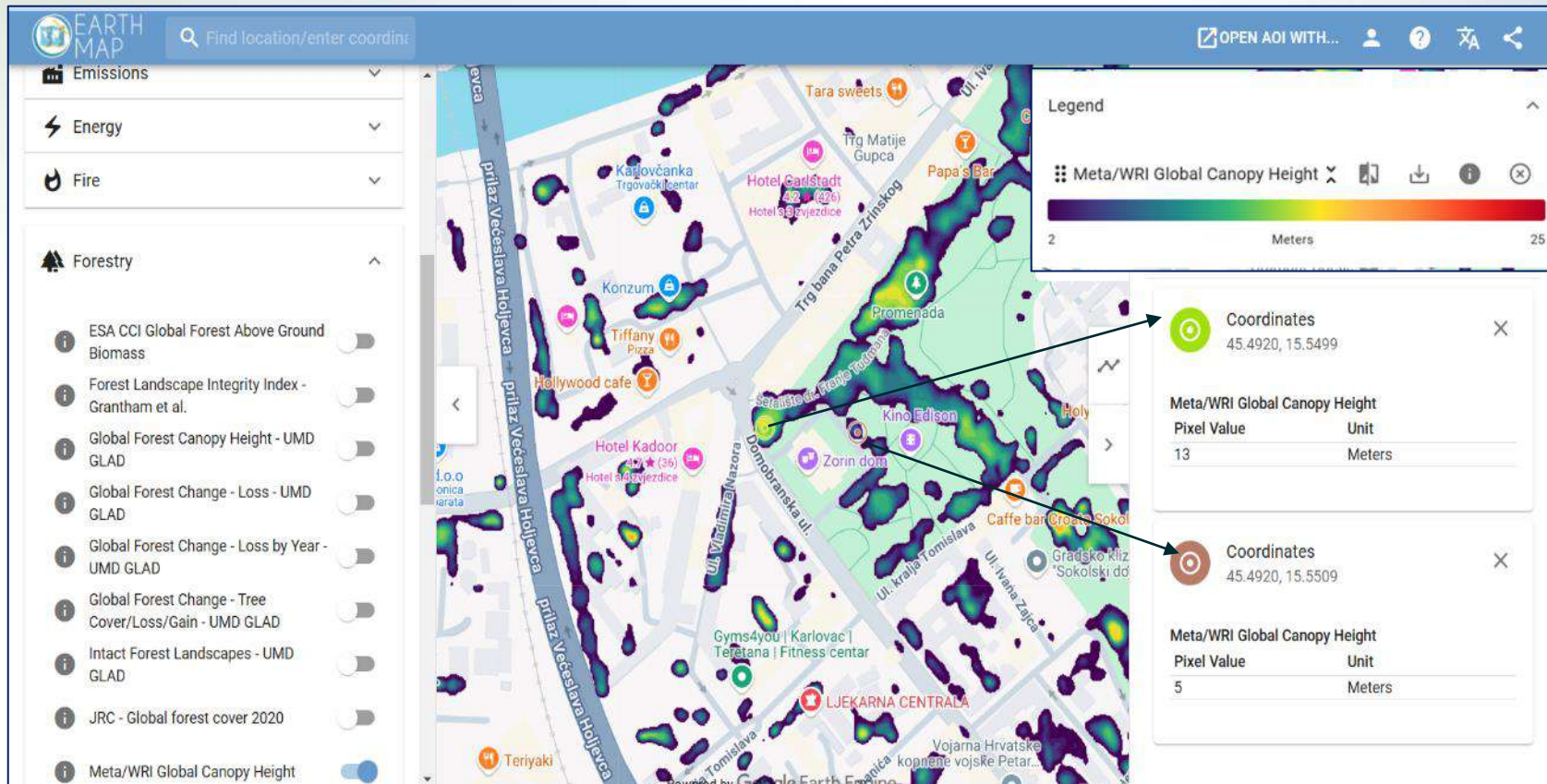


Analiza baze podataka EARTHMAP – Meta/WRI

- korištenjem satelitskih slika i UI modela predviđa visinu krošnje stabla ili grmlja
- procjenjuje zalihe ugljika na Zemljinoj površini

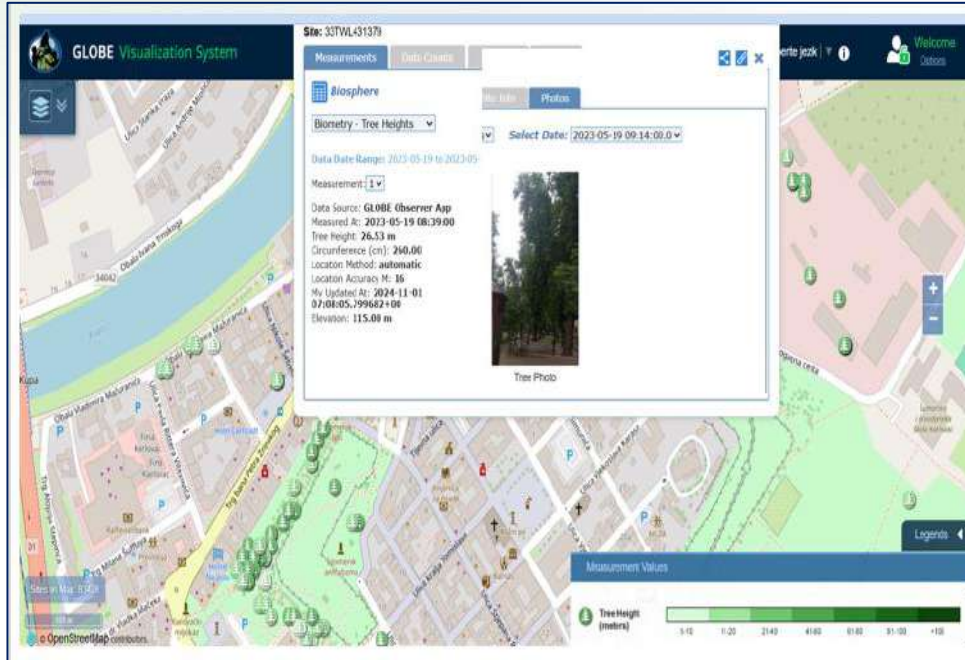


Prikaz visine pokrova na odabranom pikselu



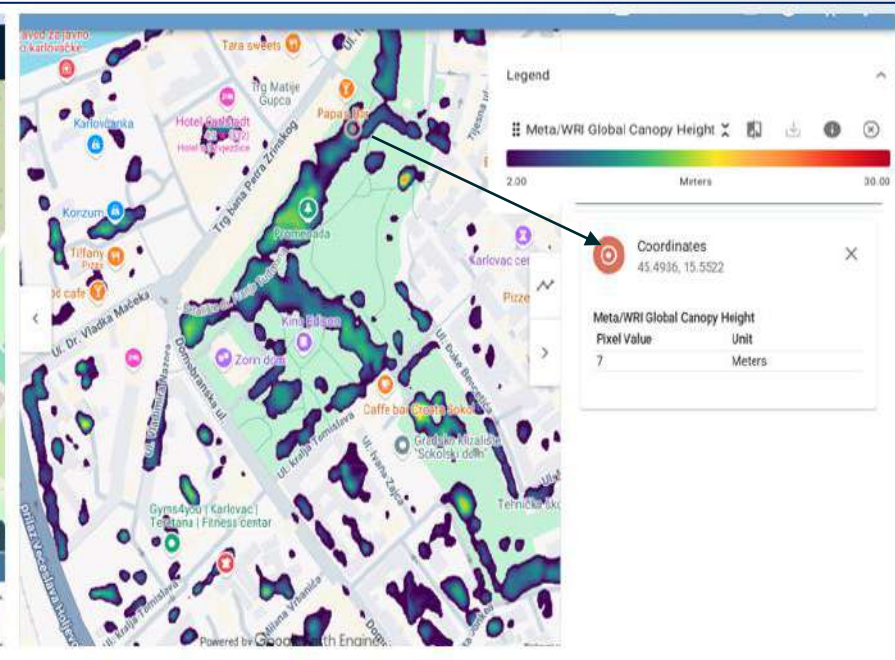
globe.gov baza podataka (NASA)

uneseni podatci biometrijskih mjerenja



26 metara

baze podataka EARTHMAP



7 metara

Zaključci

- stabla Karlovačke Promenade apsorbirala su više od 280 t CO₂
- sadrže više od 76 t pohranjenog ugljika

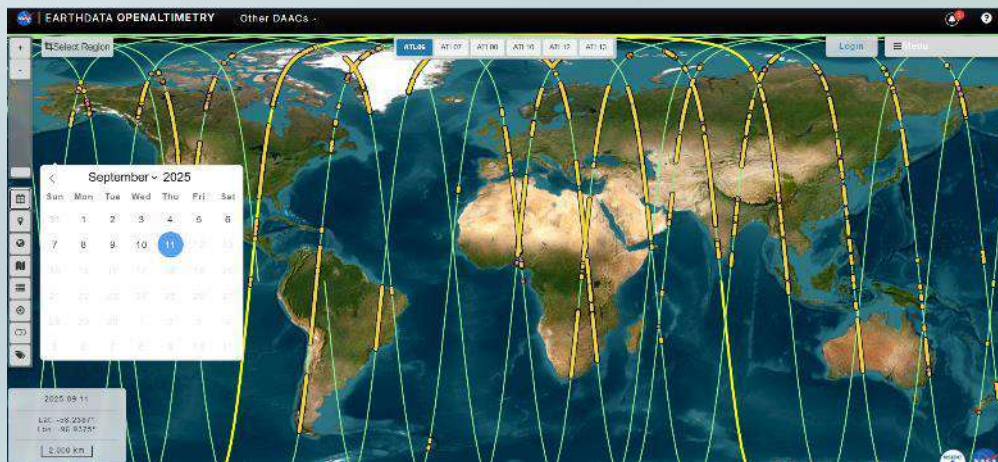


ICE Sat 2: nema podataka, putanje satelita ne prolaze prostorom

GEDI: djelomično očitavanje podataka (očitava prosjek visine pokrova na pikselu)

EarthMap: djelomično očitavanje podataka

Earthengine: nema podataka (dinamika promjene pokrova 2000. – 2020.)



- sateliti još uvijek ne mogu snimiti sve površine na Zemlji
- snimanje pokrova ometa naoblaka, građevinski objekti u urbanim sredinama
- satelitske slike potrebno je analizirati i usporediti sa stanjem na terenu

Istraživački projekt s učenicima je nagrađen na internacionalnoj smotri istraživačkih projekata, 7. veljače 2025.

The Best of GLOBE Europe and Eurasia 2025 - Session 2 ...

YouTube · Europe and Eurasia Globe · 7. velj 2025.

YouTube

The Best of GLOBE Europe and Eurasia 2025 - Session 2 Recording



**The Best of GLOBE
Europe & Eurasia 2025**

Awarded Projects
Upper Primary & Lower Secondary Schools

Special Award
The use of satellite imagery and
collaboration with NASA

1:53:35 / 2:01:55



**The Best of GLOBE
Europe & Eurasia 2025**

Awarded Projects
Upper Primary & Lower Secondary Schools

Special Award
Primary school Dubovac
Croatia

1. Krajnik, D. 2007. Preobrazba bastionskih utvrdenja grada Karlovca. *Prostor* 15(1): 180-193
https://www.researchgate.net/publication/27199499_Preobrazba_bastionskih_utvrdenja_grada_Karlovca
2. Earth Engine Apps
<https://glad.earthengine.app/view/global-forest-canopy-height-2019>
3. *The GLOBE teachers guide*. The GLOBE program
<https://www.globe.gov/do-globe/globe-teachers-guide>
4. *Carbon storage calculator: worksheet*. Natural resources Wales
<https://cdn.naturalresources.wales/media/687190/eng-worksheet-carbon-storage-calculator.pdf>
5. *Measuring Carbon In Trees: The Urban Nature Project*. National Museum Wales.
<https://museum.wales/media/52595/measuring-carbon-in-trees.pdf>
6. Fransen, Bas. 2019. *How to calculate the CO₂ sequestration*. EcoMatcher
<https://www.ecomatcher.com/how-to-calculate-co2-sequestration>
7. *Farming carbon 2020*. Queensland Government
<https://www.qld.gov.au/environment/plants-animals/habitats/regrowth/regrowth-guides/euc-open/euc-open-carbon>
8. Open Altimetry
<https://openaltimetry.earthdatacloud.nasa.gov/data/icesat2/>
9. Beiser G. *Baum & Mensch: Umfang und Alter der Bäume*. 3. überarb. Aufl. [3. izmenjeno izdanje]. Graz: Stocker; 2012.

Hvala na pažnji!



SCAN ME

<https://forms.gle/rdgRkgz8nrWtN4eK9>