

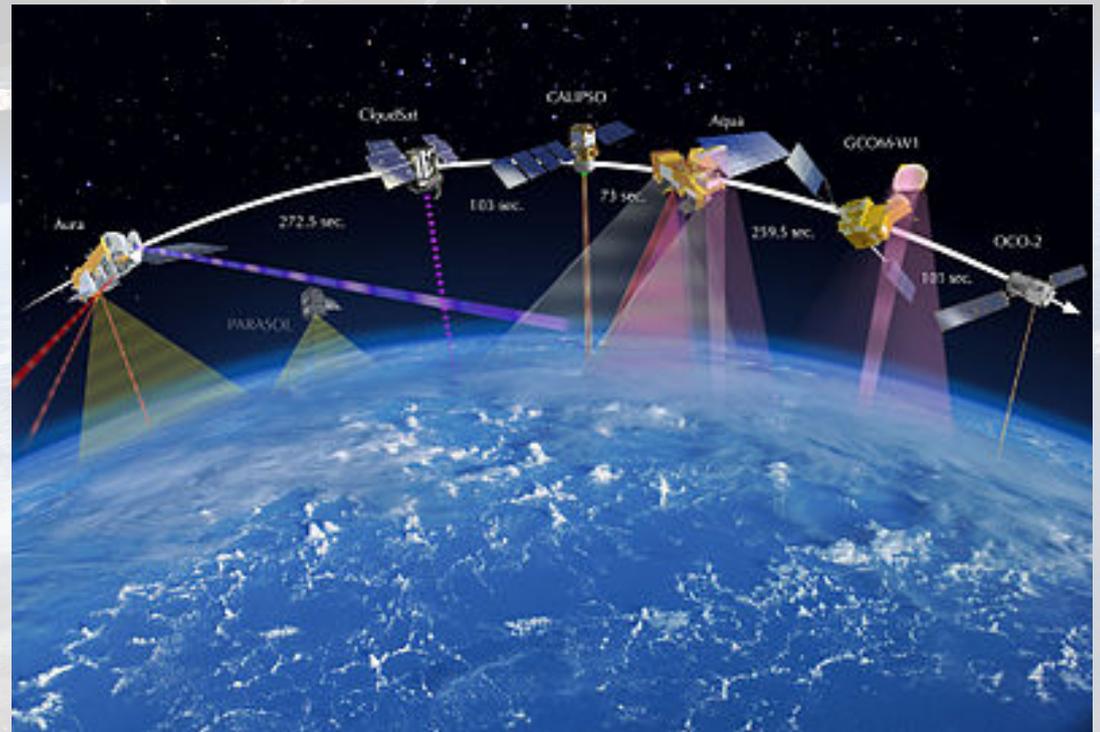
The background of the slide is a photograph of a satellite in space, with the Earth's horizon and clouds visible below. The satellite's solar panels and various instruments are clearly visible.

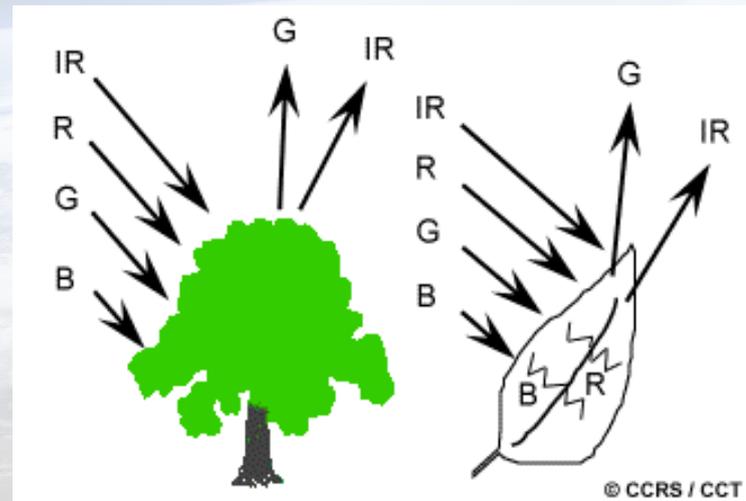
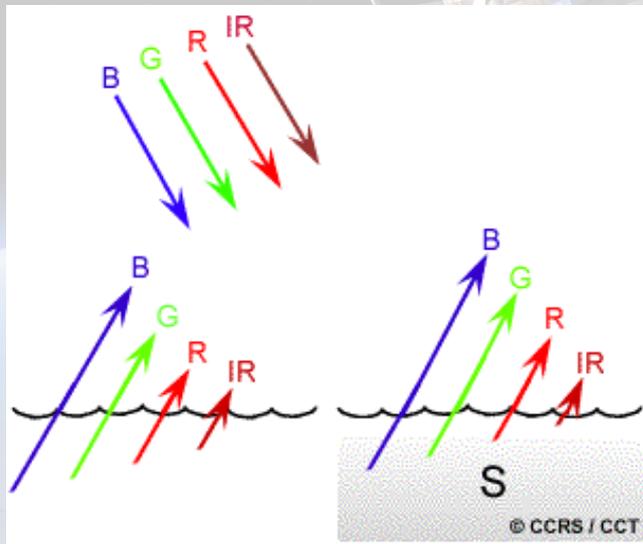
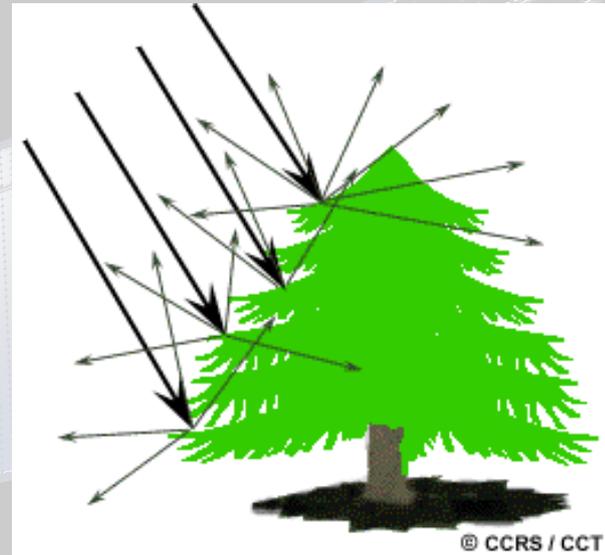
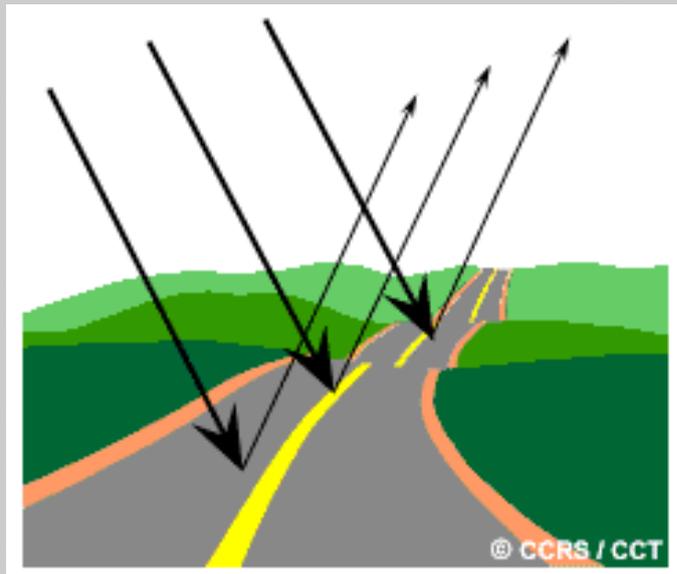
OSNOVE COPERNICUS PROGRAMA I PRIMJENA SATELITSKIH PODATAKA ZA ANALIZU VEGETACIJSKOG POKROVA

Doc. dr. sc. Mario Miler
Luka Rumora, mag. ing. geod. i geoinf.

Što su daljinska istraživanja?

- Daljinska istraživanja (DI) su znanost i tehnologija prikupljanja i obrade snimki i slika promatrane scene na osnovi kojih se prikupljaju informacije i podaci bez fizičkog kontakta s objektima na sceni





Povijest

- Satelitske misije započele 1960-ih godina



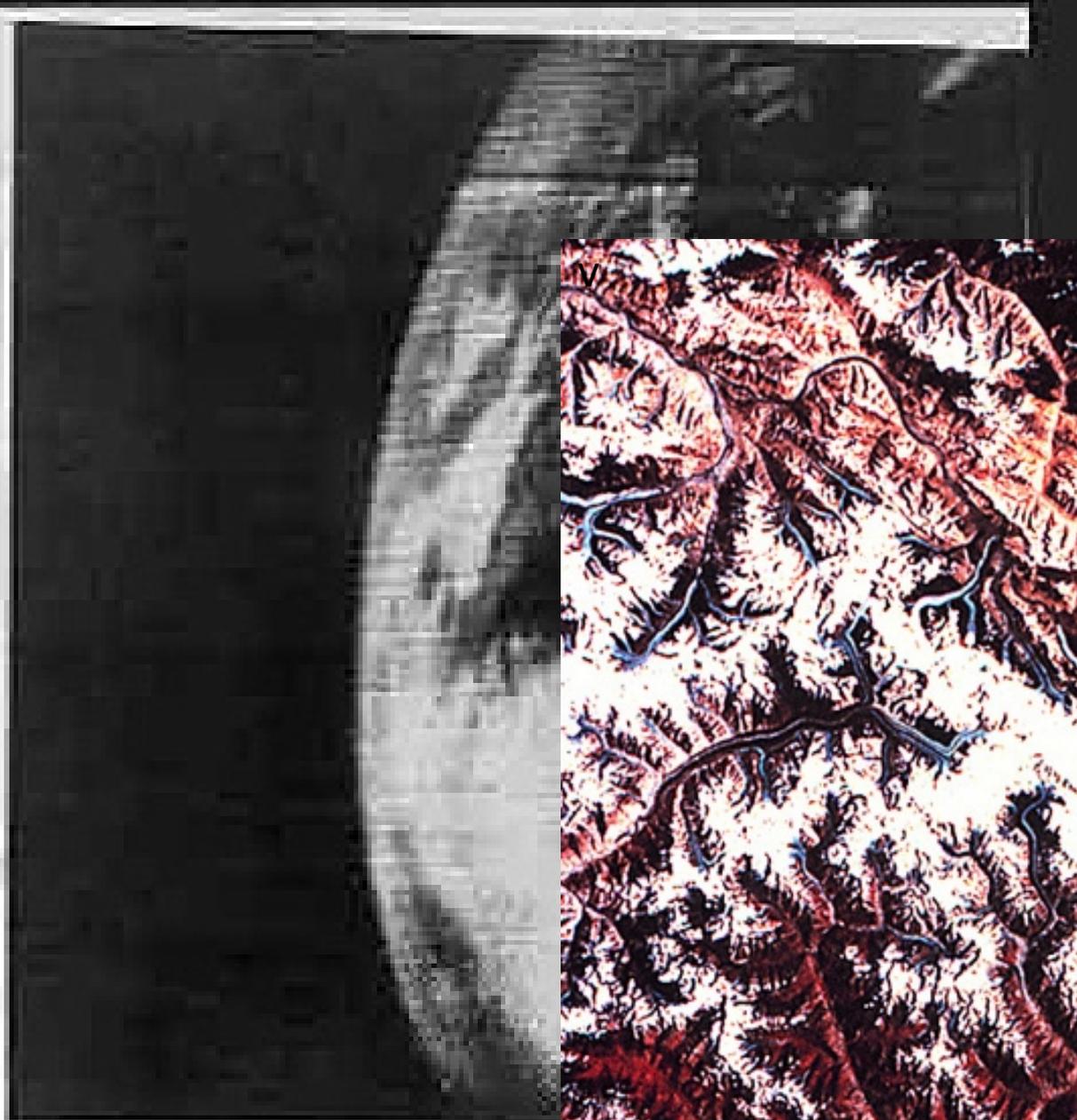
FIRST TELEVISION PICTURE FROM SPACE
TIROS I SATELLITE APRIL 1, 1960



60-ih godina

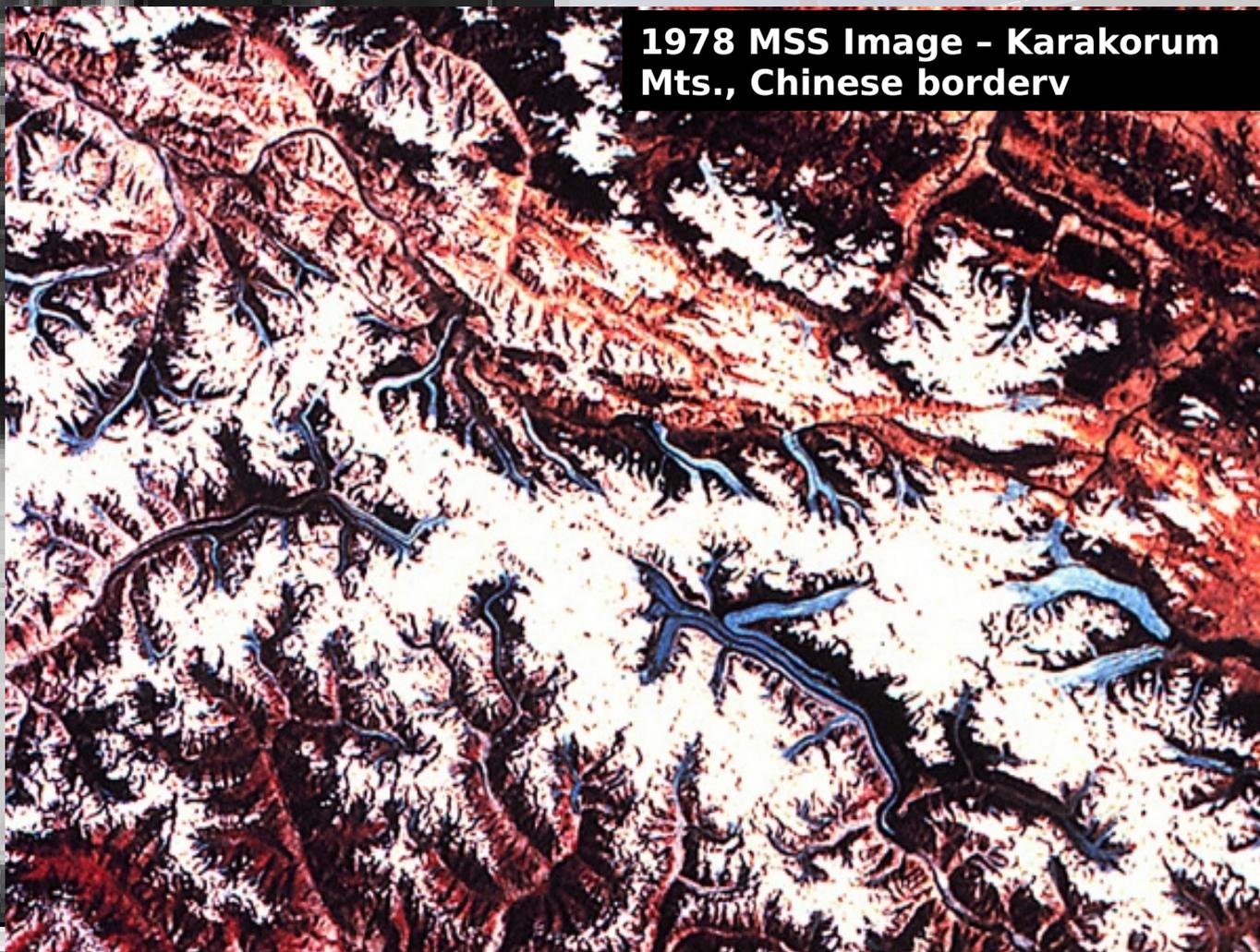


FIRST TELEVISION PICTURE FROM SPACE
TIROS I SATELLITE APRIL 1, 1960

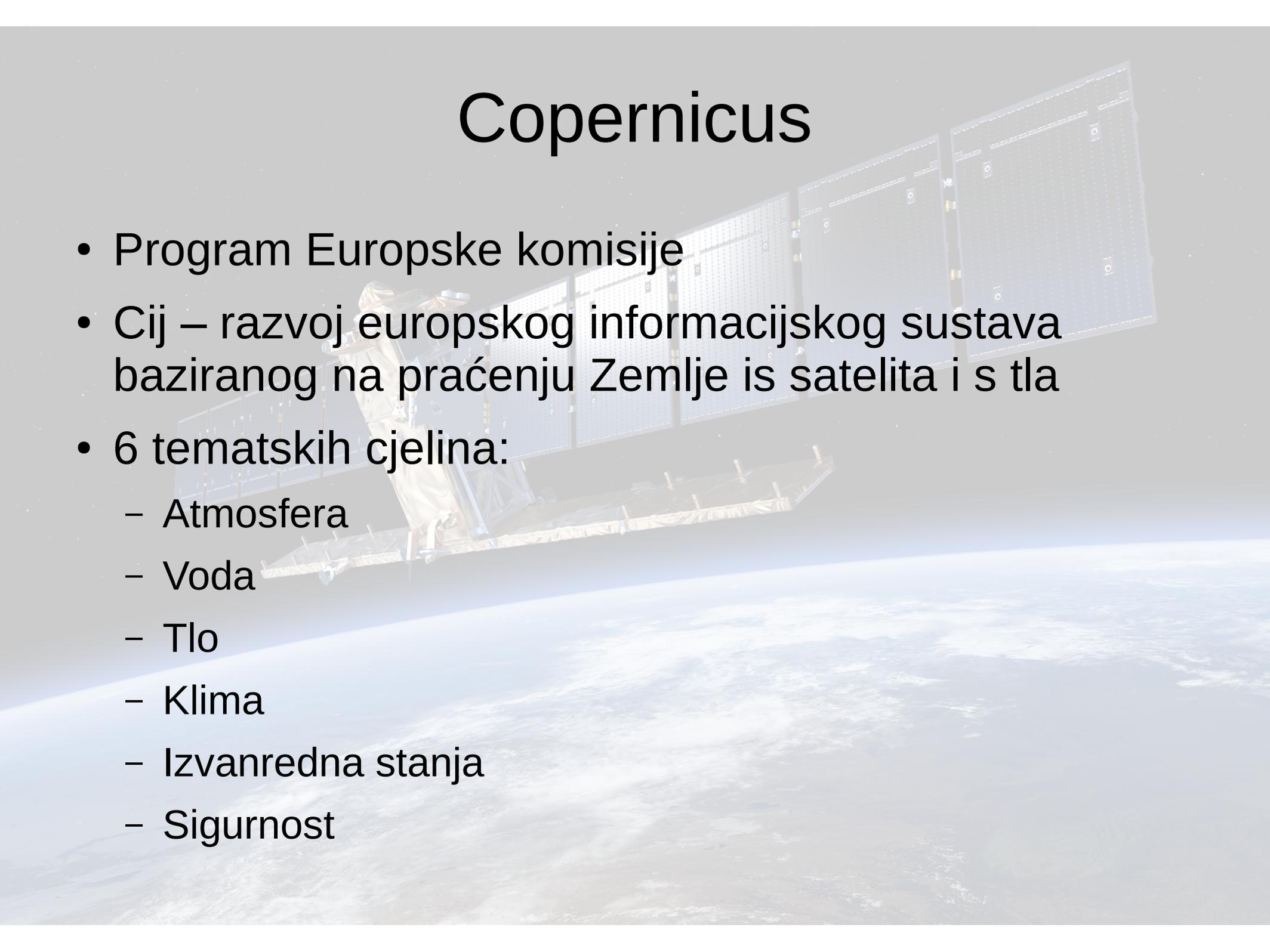


60-ih godina

1978 MSS Image - Karakorum
Mts., Chinese borderv



Copernicus

A satellite with large solar panels is shown in space, orbiting Earth. The satellite is positioned diagonally across the frame, with its solar panels extending from the top right towards the bottom left. The Earth's surface is visible below, showing clouds and landmasses. The background is a dark, starry space.

- Program Europske komisije
- Cij – razvoj europskog informacijskog sustava baziranog na praćenju Zemlje is satelita i s tla
- 6 tematskih cjelina:
 - Atmosfera
 - Voda
 - Tlo
 - Klima
 - Izvanredna stanja
 - Sigurnost

Geodetski fakultet



- Copernicus Relay Hrvatska
- Promoviranje Copernicus programa i servisa
- Suradnja Europske komisije s zainteresiranom javnošću
- Pružanje tehničke podrške na lokalnoj, regionalnoj i nacionalnoj razini

Geodetski fakultet



- Copernicus Akademija
 - Inicijativa za spajanje europskih sveučilišta
- Cilj mreže
 - Razvoj predavanja, treninga, obrazovnih materijala
 - Povećanje razmjena ideja
 - Suradnja između obrazovnih ustanova i privrede
- 72 organizacije iz 23 europske države

EO4GEO

Sufinancirano sredstvima
programa Europske unije
Erasmus+



- Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake
- Prema inovativnoj strategiji za razvoj vještina i izgradnju kapaciteta u geo-informacijskom sektoru koji podržava Copernicus User Uptake
- 26 partnera iz 16 zemalja
 - Obrazovanje, privatni i javni sektor
- Trajanje 4 godine (1. siječanj 2022.)
- Proračun 3.876.045,00 Eura

EO4GEO

- Razvoj novih kurikula u geoprostornom sektoru
- Interdisciplinarna inovativna rješenja za edukaciju i osposobljavanje
 - scenariji učenja temeljeni na predmetima i suradnji
 - učenje u laboratorijskom okruženju
 - obuka na poslu
 - su-stvaranje znanja, vještina i kompetencija

EO4GEO

- Razvoj i provođenje novih aktivnosti podržanih daljinskim mjerenjima i geoprostornim tehnologijom za
 - Integrirane aplikacije
 - Pametne gracove
 - Klimatske promjene

Copernicus podaci

- Sateliti za praćenje Zemlje su podijeljeni u dvije grupe:
 - Sentineli – sateliti razvijeni za specifične potrebe
 - Doprinoseće misije – misije koje doprinose kvaliteti podataka, ali njima upravljaju nacionalne, europske ili svjetske organizacije

Sentinel

A satellite with large solar panels is shown in space, orbiting Earth. The satellite is positioned diagonally across the frame, with its solar panels extending from the top right towards the bottom left. The Earth's surface is visible at the bottom, showing clouds and the horizon.

- Sentinel sateliti su podijeljeni u 6 kategorija:
 - Sentinel 1
 - Pruža cjelodnevne radarske informacije za potrebe praćenja kopna I oceana
 - Sastoji se od dva satelita
 - Sentinel 2
 - Optičke snimke visoke rezolucije za potrebe praćenja vegetacije, tla, vodenih površina i priobalja
 - Sastoji se od dva satelita
 - Sentinel 3
 - Optički podaci visoke precizosti, radarski podaci i altimetsrijski podaci za potrebe praćenja tla i morskog područja
 - Mjeri topografiju morske površine, temperaturu tla I vode, boju oceana I tla
 - Sastoji se do jednog satelita (planiran i drugi)

Sentinel

A satellite with large solar panels is shown in space, positioned above the Earth's horizon. The satellite consists of a central body and several large, rectangular solar panel arrays extending outwards. The Earth's surface, showing clouds and landmasses, is visible in the lower half of the image.

– Sentinel 4

- Podaci za praćenje atmosfere (aerosol, kvaliteta zraka) u suradnji s EUMETSAT-om
- Planiran za 2019.

– Sentinel 5

- Praćenje atmosfere (ozona, dušikovog dioksida, sumpornog dioksida, ugljičnog monoksida, metana, ...) u suradnji s EUMETSAT-om
- Sastoji se od jednog satelita

– Sentinel 6

- Visoko kvalitetni altimetrijski podaci za mjerenje visine mora
- Planiran za 2020.

Preuzimanje podataka

- scihub.copernicus.hr/dhus



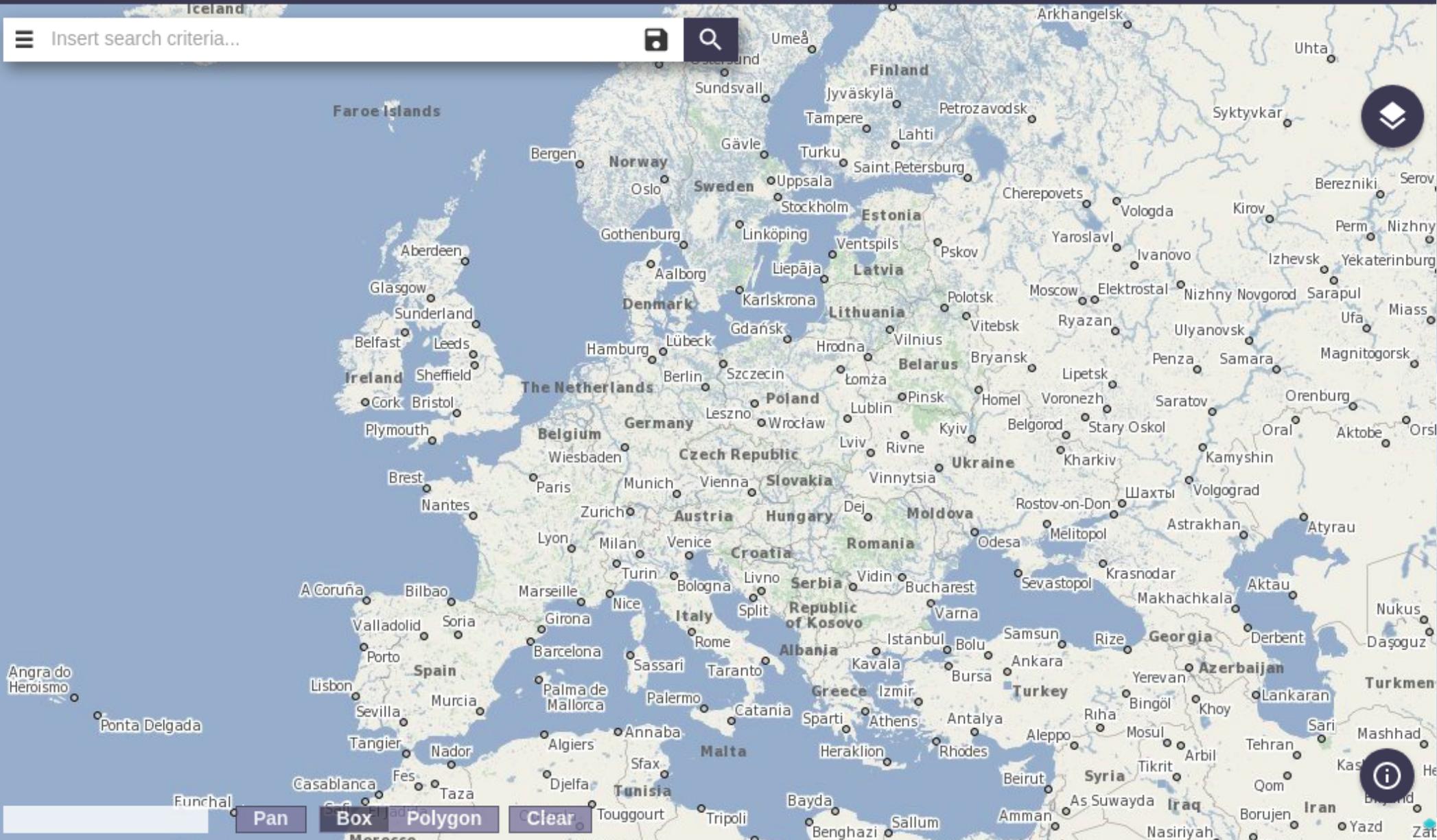
Preuzimanje podataka



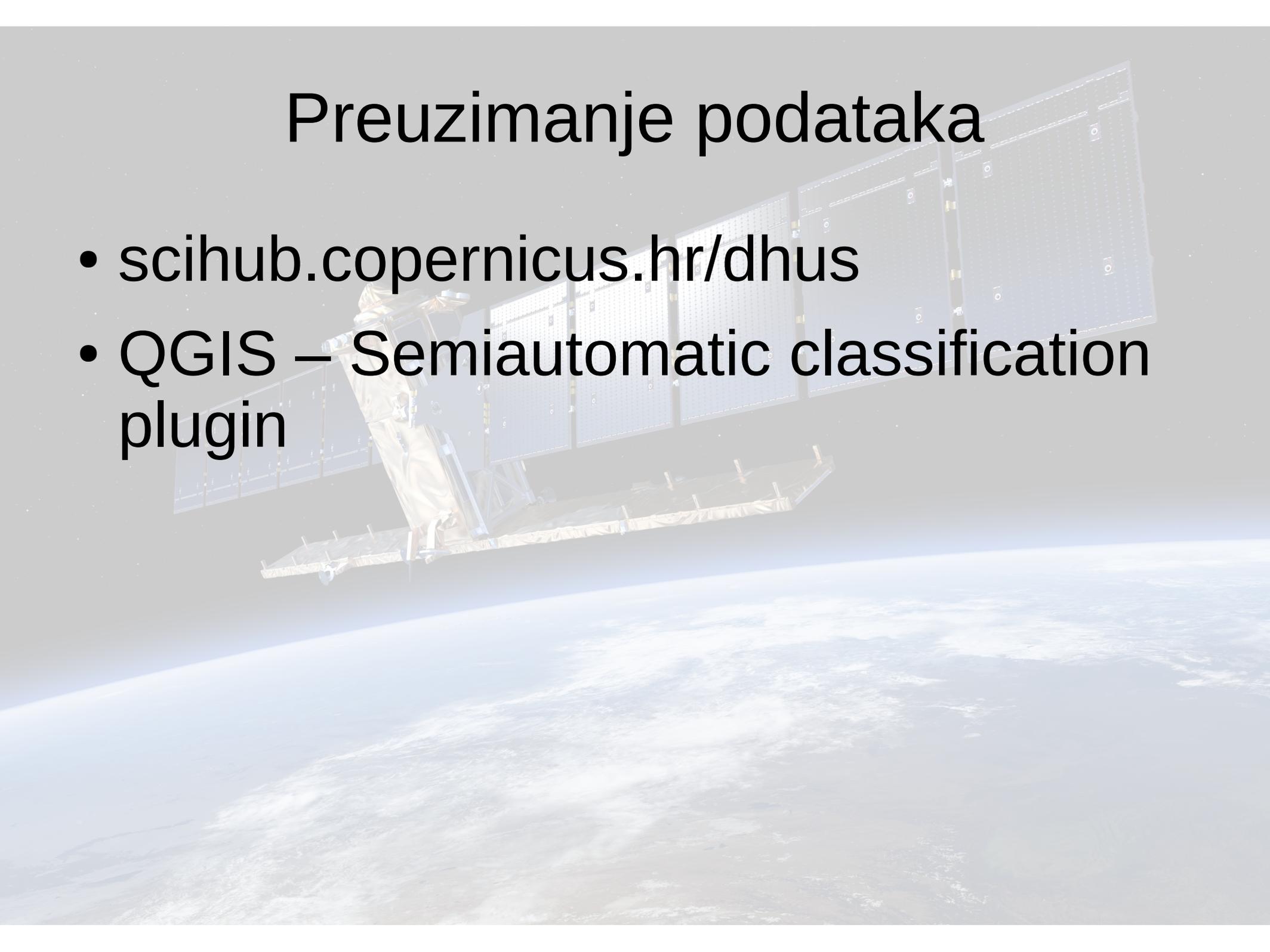
Copernicus Open Access Hub



Insert search criteria...



Preuzimanje podataka

A satellite with large solar panels is shown in orbit above the Earth's surface. The satellite is gold-colored and has several large, rectangular solar panels extended from its body. The Earth's horizon is visible in the background, showing a blue sky and a white cloud layer over a brownish-green landmass.

- scihub.copernicus.hr/dhus
- QGIS – Semiautomatic classification plugin

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 Tools

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 Band

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UL Y (Lat)

Search

Date from to

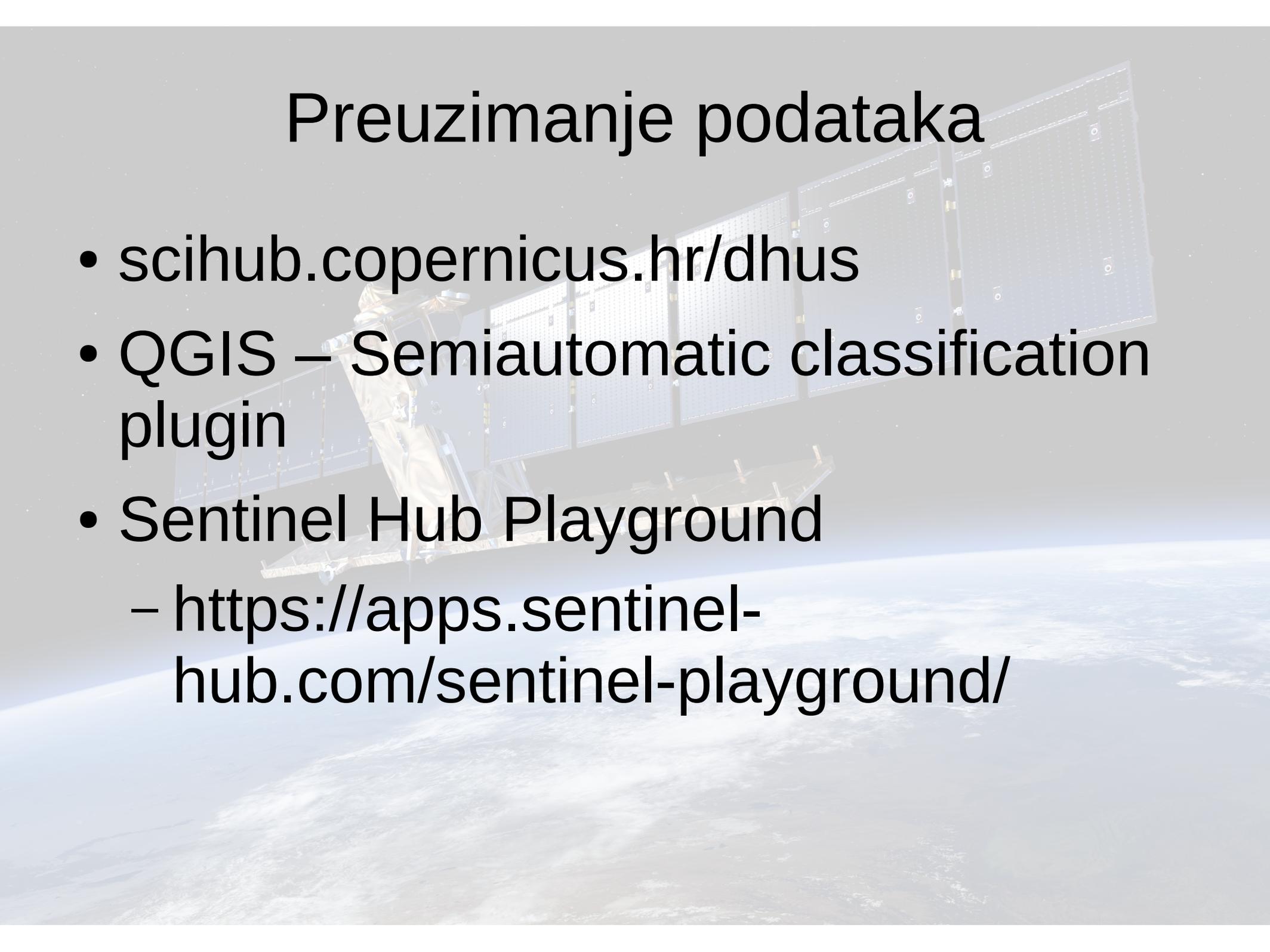
Max cloud cover

Sentinel images

Image list

ImageName	Granule	AcquisitionDate	Zone	CloudCover
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Preuzimanje podataka



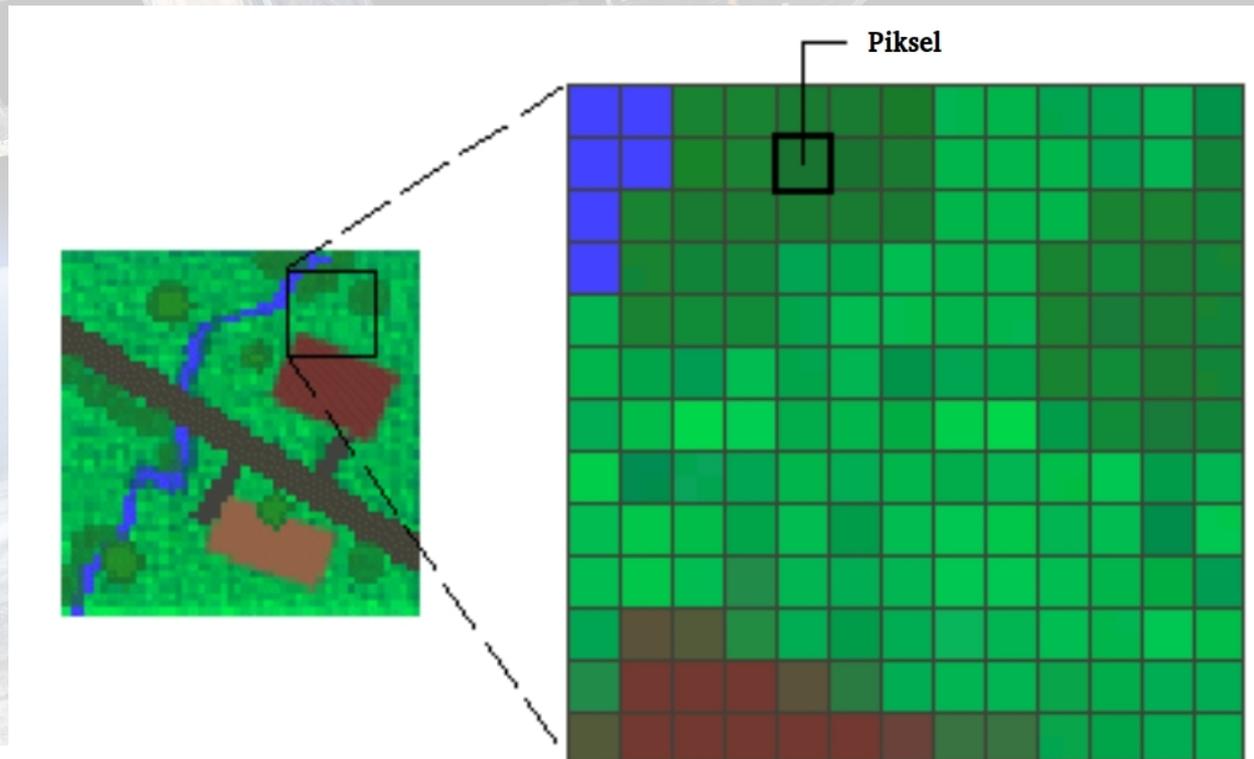
- scihub.copernicus.hr/dhus
- QGIS – Semiautomatic classification plugin
- Sentinel Hub Playground
 - <https://apps.sentinel-hub.com/sentinel-playground/>

Vizualizacija podataka

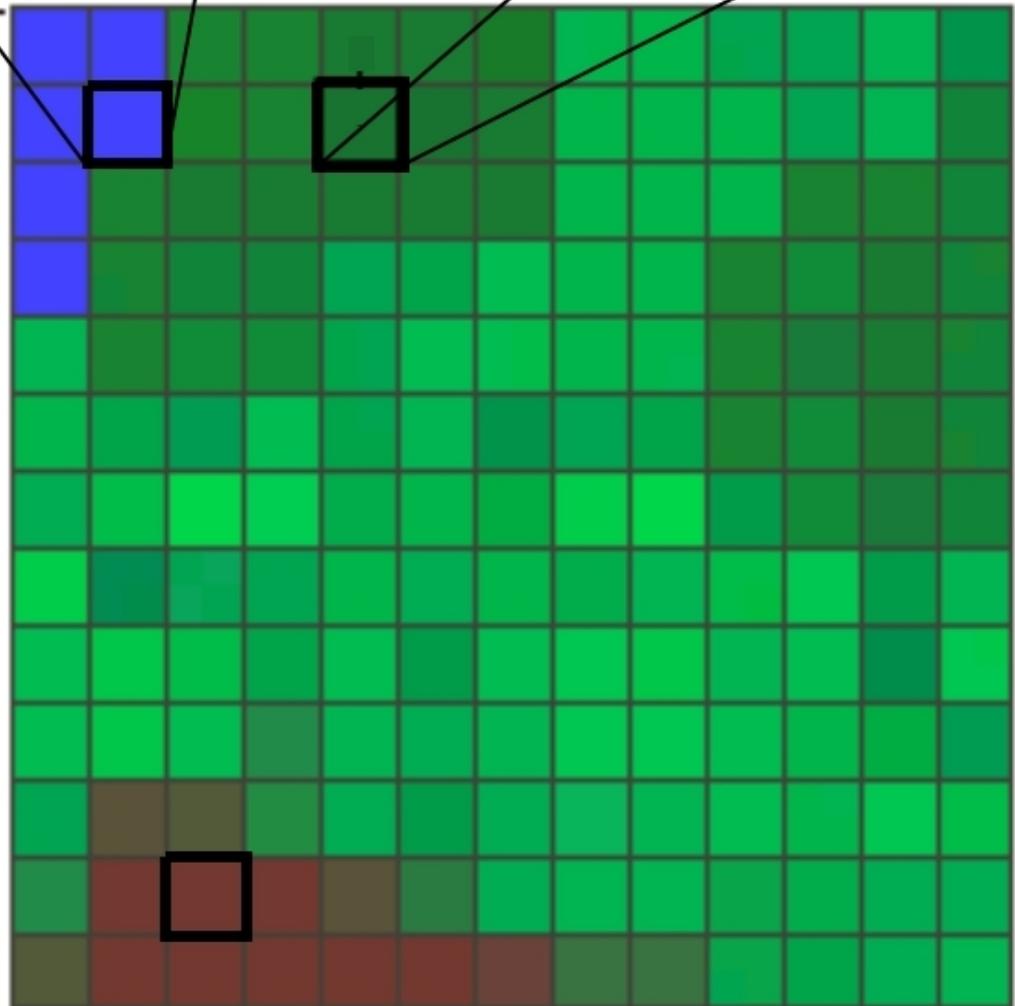
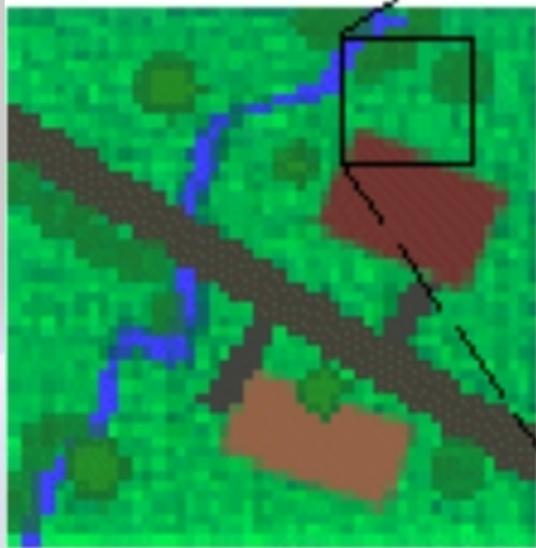
The image shows the Sentinel Hub Playground interface. At the top, the header includes the Sentinel Hub logo, the word "Playground" in yellow, a date selector set to "2018-02-28", a weather indicator showing "6 %", and a search bar with "Zagreb". Below the header, there are navigation controls for zooming in (+) and out (-), and a share icon. On the left side, there is a "Rendering" panel with two tabs: "Rendering" (active) and "Effects". Under the "Rendering" tab, several options are listed with corresponding icons: "Custom" (Create custom rendering), "Natural color", "Color Infrared (vegetation)", "False color (urban)", "Agriculture", "Vegetation Index", "Moisture Index", "Geology", and "Bathymetric". At the bottom of this panel is a "GENERATE" button. The main area of the interface displays a satellite image of Zagreb, Croatia, rendered in a false color scheme where vegetation is bright green and urban areas are dark purple. A winding river is visible in the lower half of the image. In the bottom right corner of the image, there is a scale bar indicating "2 km" and a small "OpenStreetMap © Sentinel Hub" logo. At the very bottom of the interface, there is a text prompt: "Get Sentinel and Landsat imagery in your GIS".

Digitalna slika (raster)

- skup, odnosno mreža piksela koji stvaraju sliku
- Pikel – element slike
 - položaj piksela na zaslonu (koordinate po širini X i visini Y), nijansa boje i intenzitet osvijetljenosti
 - količina određuje kvalitetu slike, veličinu datoteke na disku i na stvarne dimenzije
- Broj piksela od kojih je sastavljena slika definiran je razlučivošću

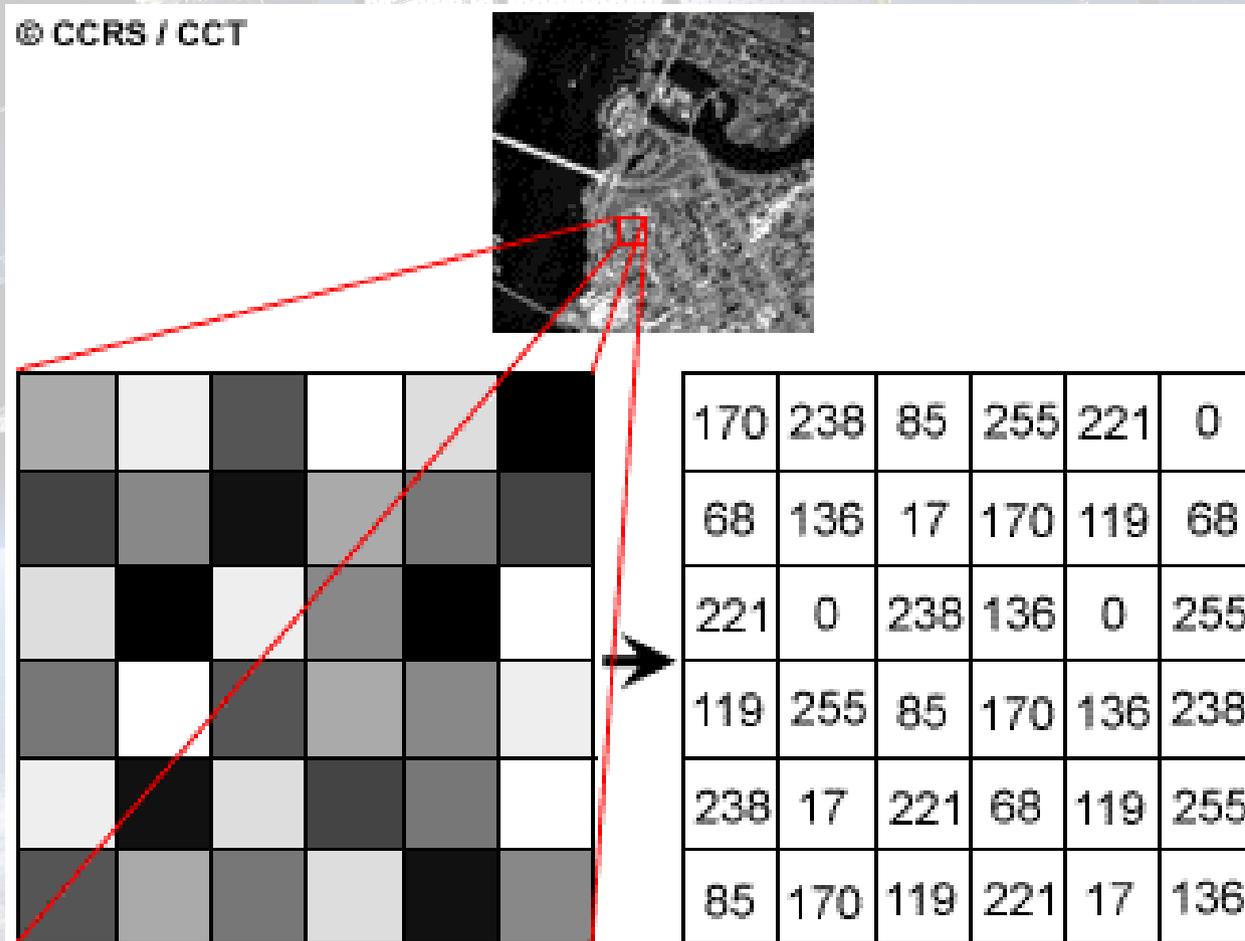


R 9%	R 26%	R 45%
G 45%	G 26%	G 22%
B 19%	B 100%	B 19%



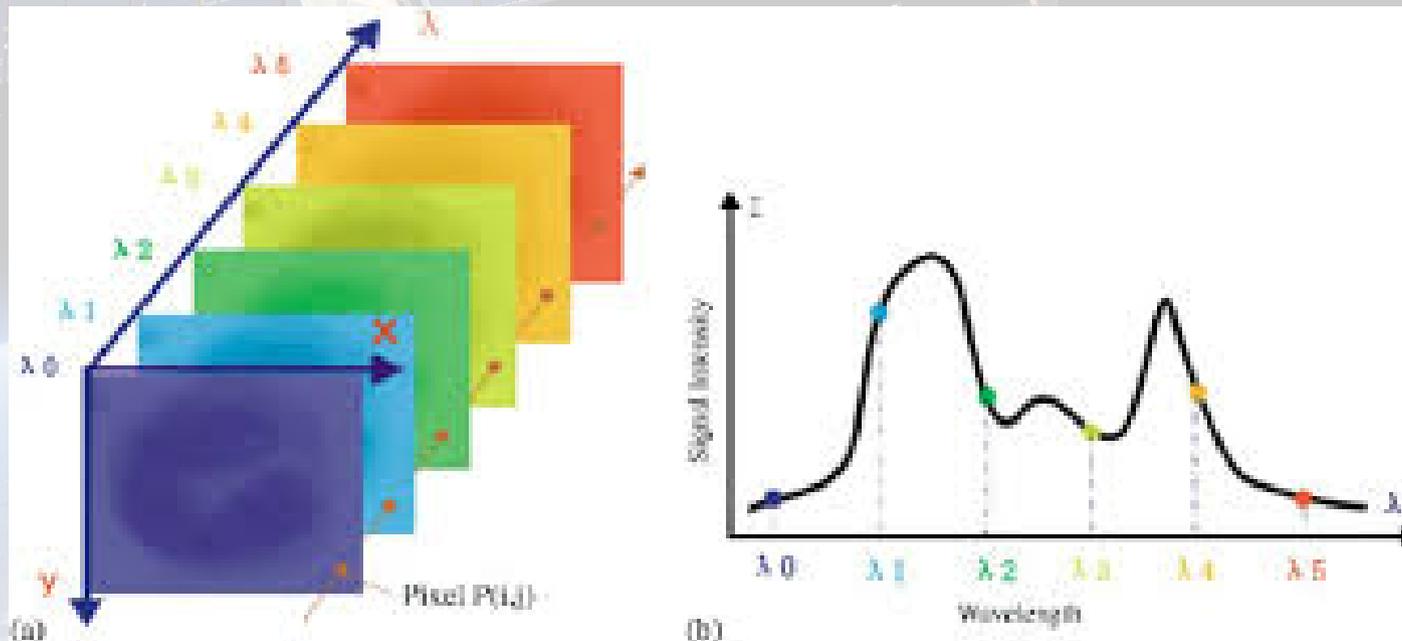
Primjer satelitske snimke

- Snaga elektromanetskog spektra prevodi se u slike



Multispektralne snimke

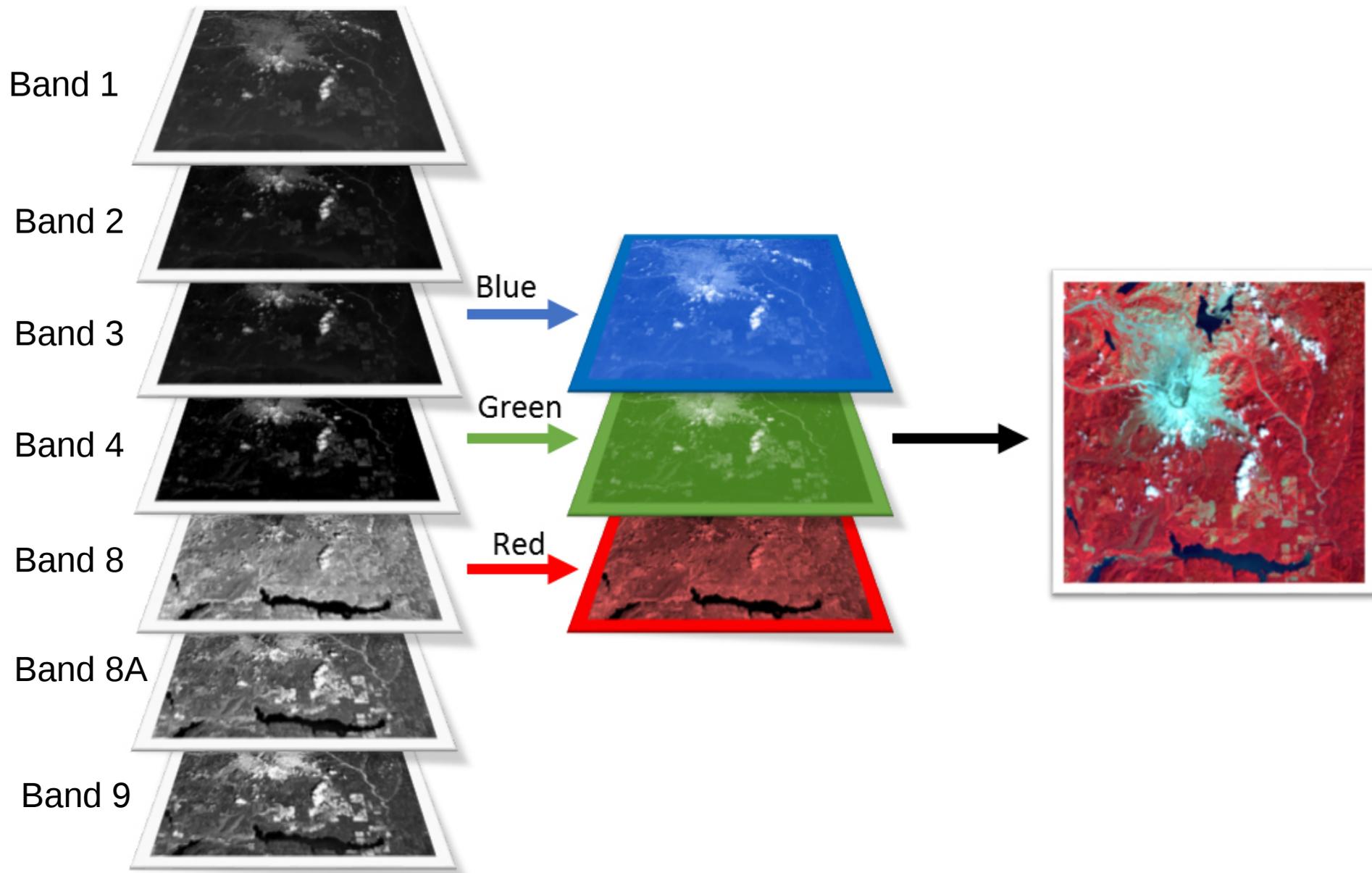
- Sastoje se od nekoliko spektralnih kanala
- Svaki kanal se samostalno prikazuje u sivoj skali boja ili kao kombinacije tri kanala



Sentinel-2

Sentinel-2 Bands	Central Wavelength (μm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Kombinacije kanala



Kombinacije kanala (2)

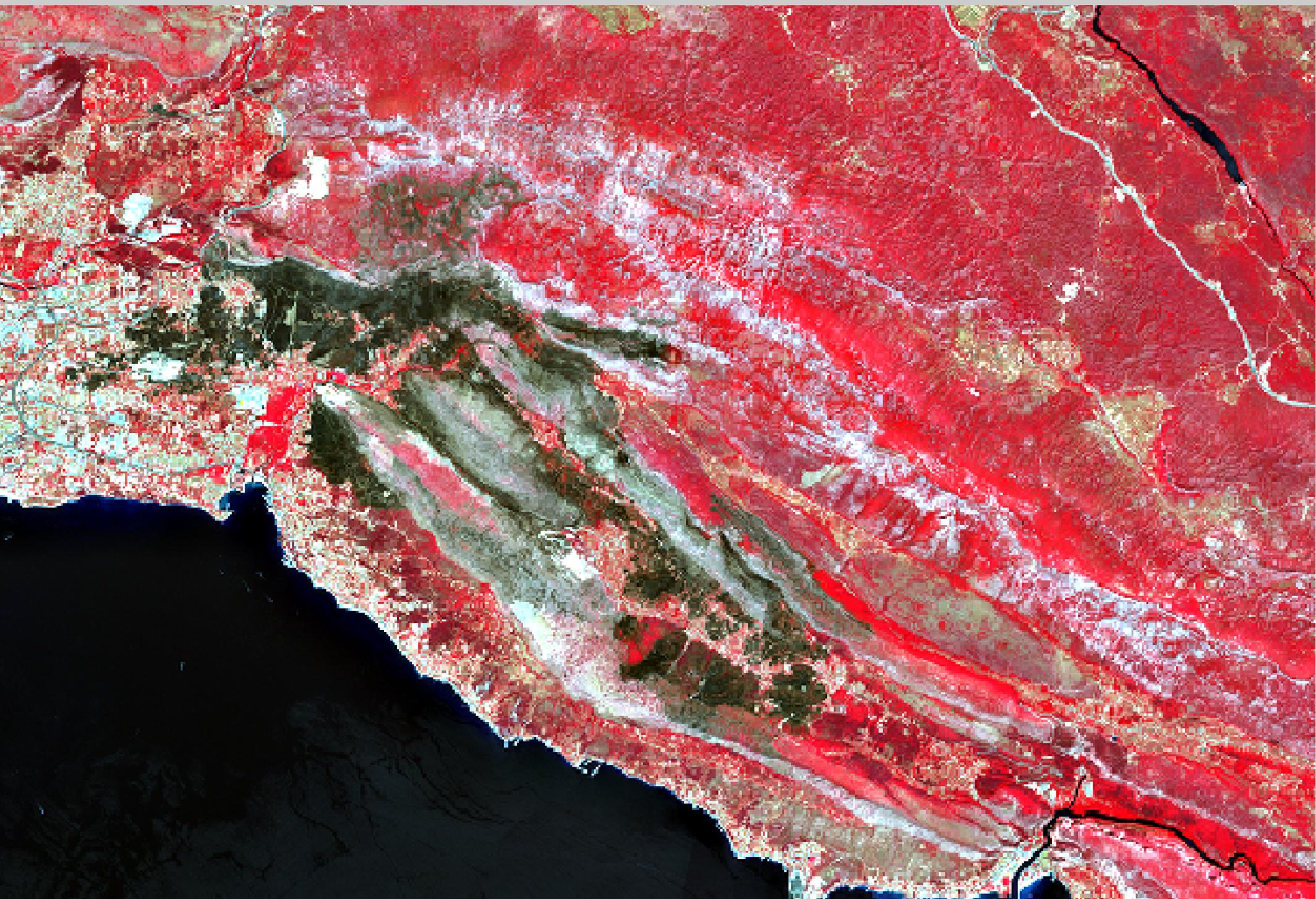
- 4-3-2 (Kompozit pravih boja)
- 8-4-3 (Kompozit lažnih boja 1)
- 12-8-3 (Kompozit lažnih boja 2)
- 12-8-4 (Kratkovalna infracrvena)
- 8-11-2 (Zdrava vegetacija)

Kompozit pravih boja

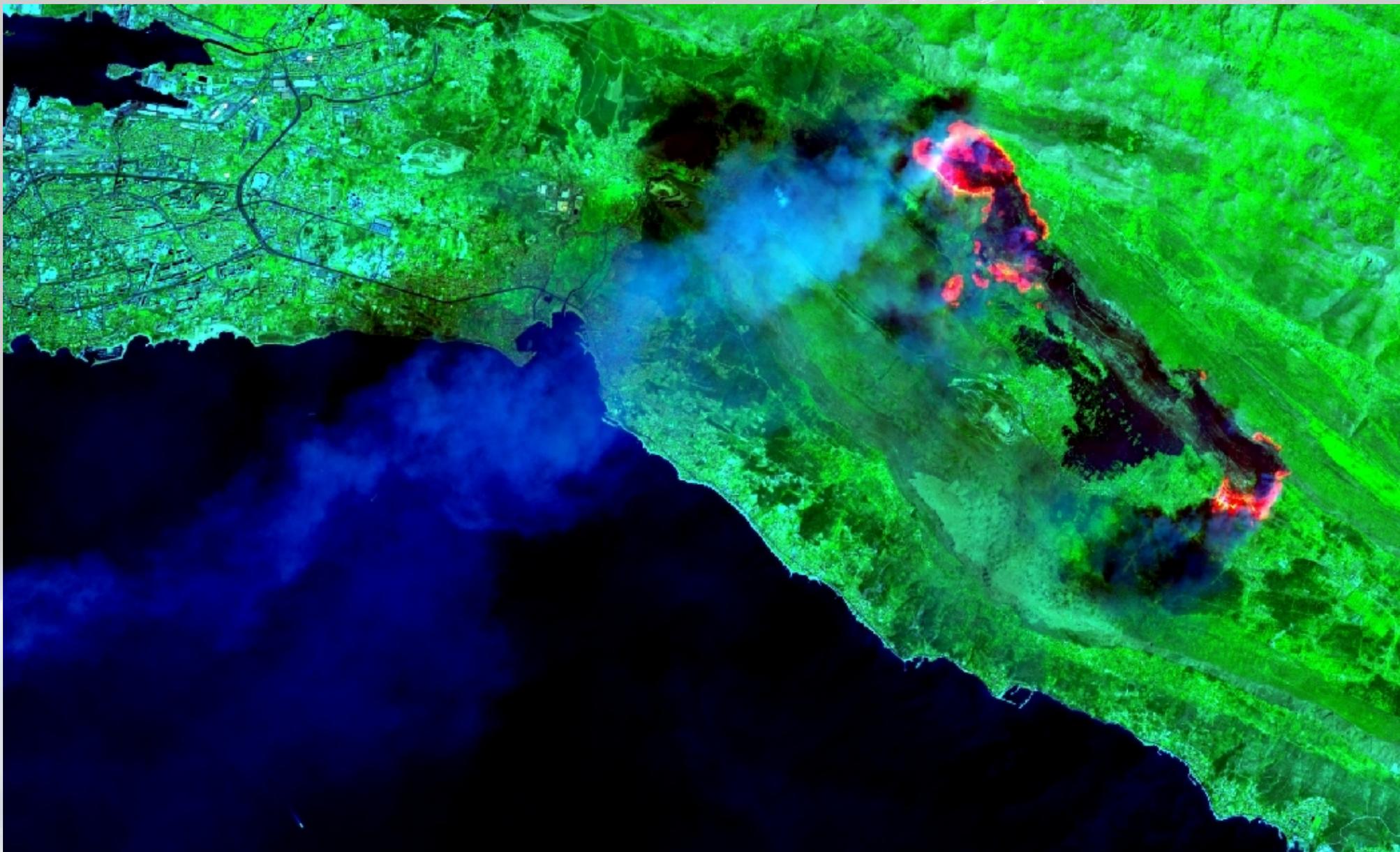


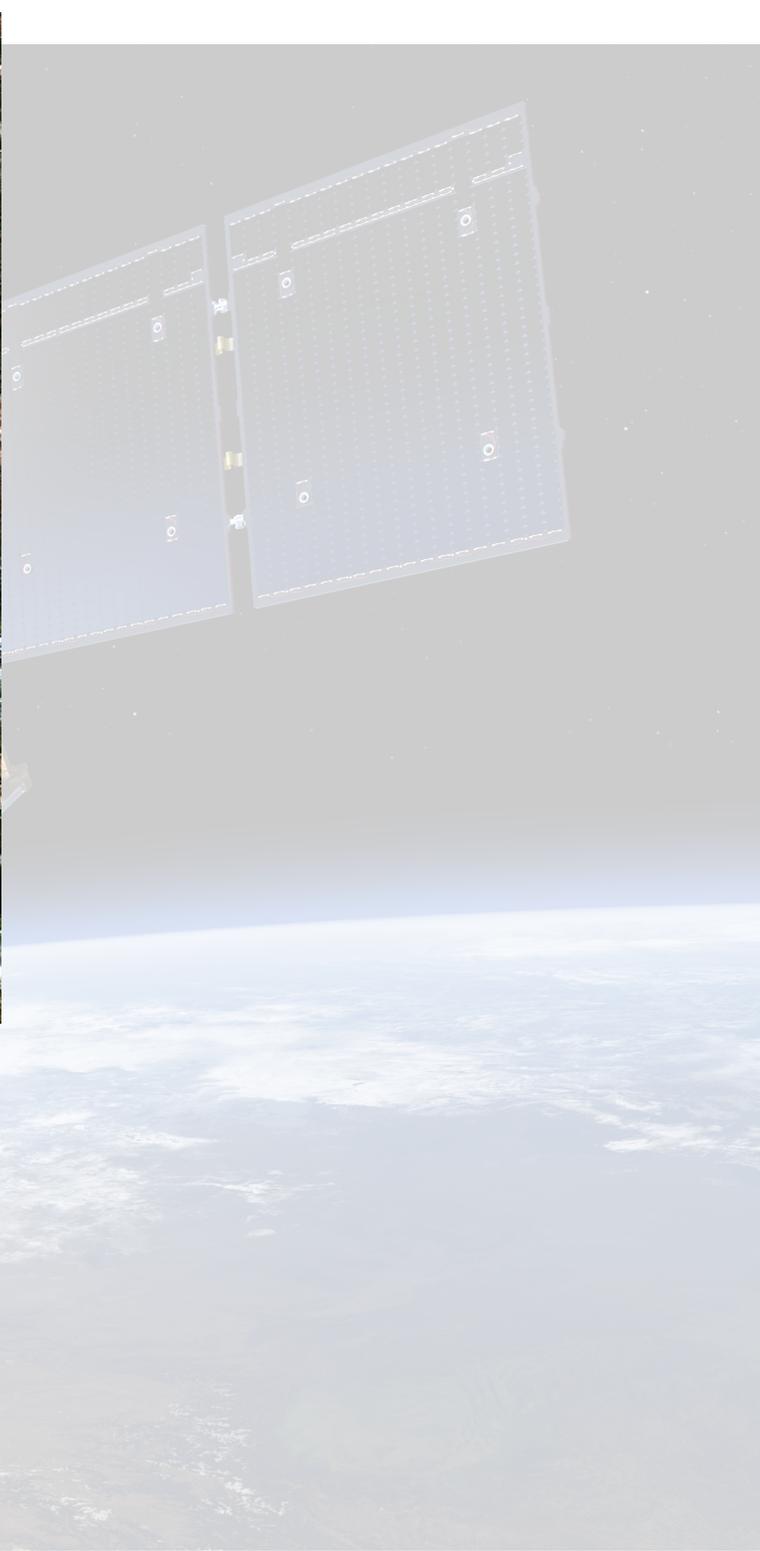
Kompozit “lažnih” boja 1



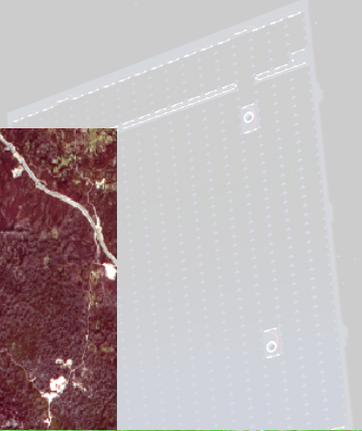
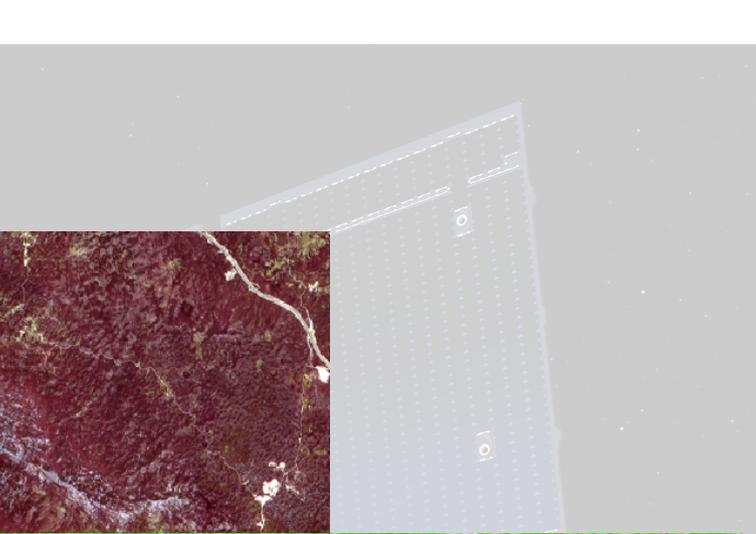
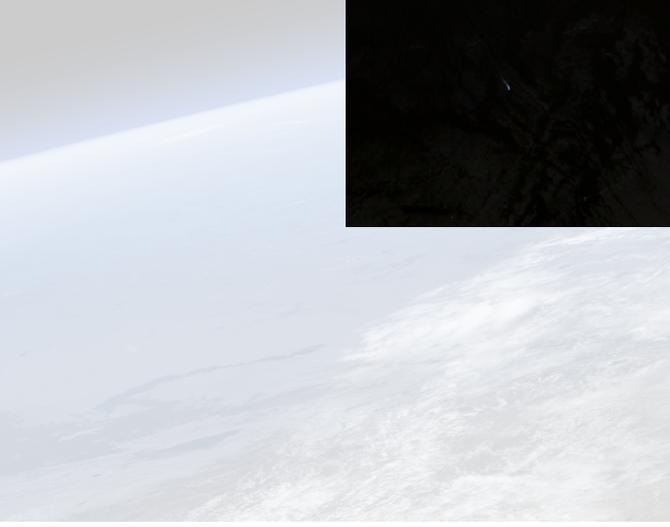
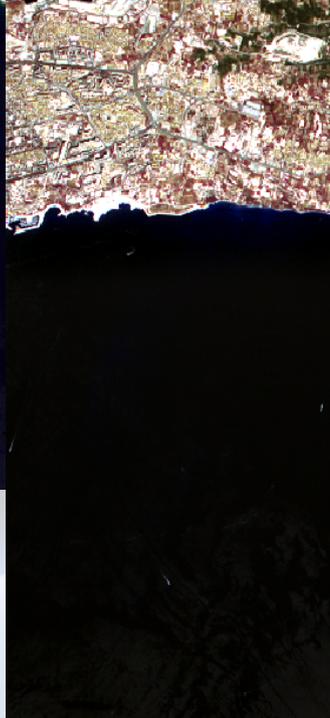
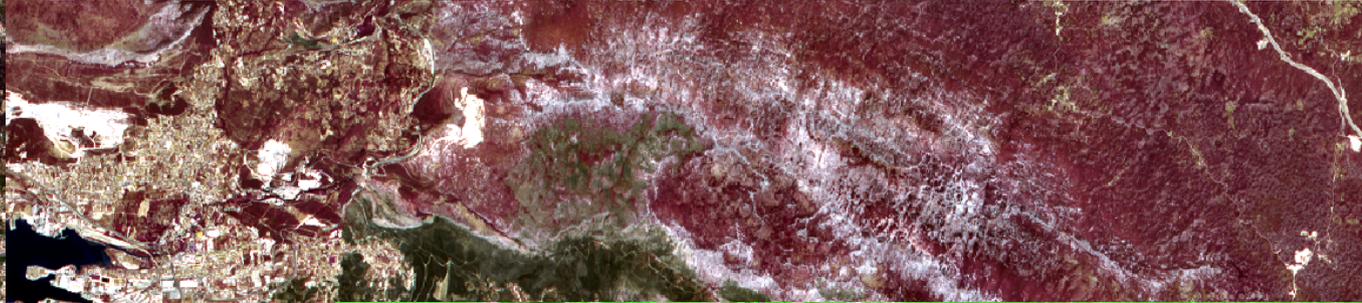


Kompozit “lažnih” boja 2



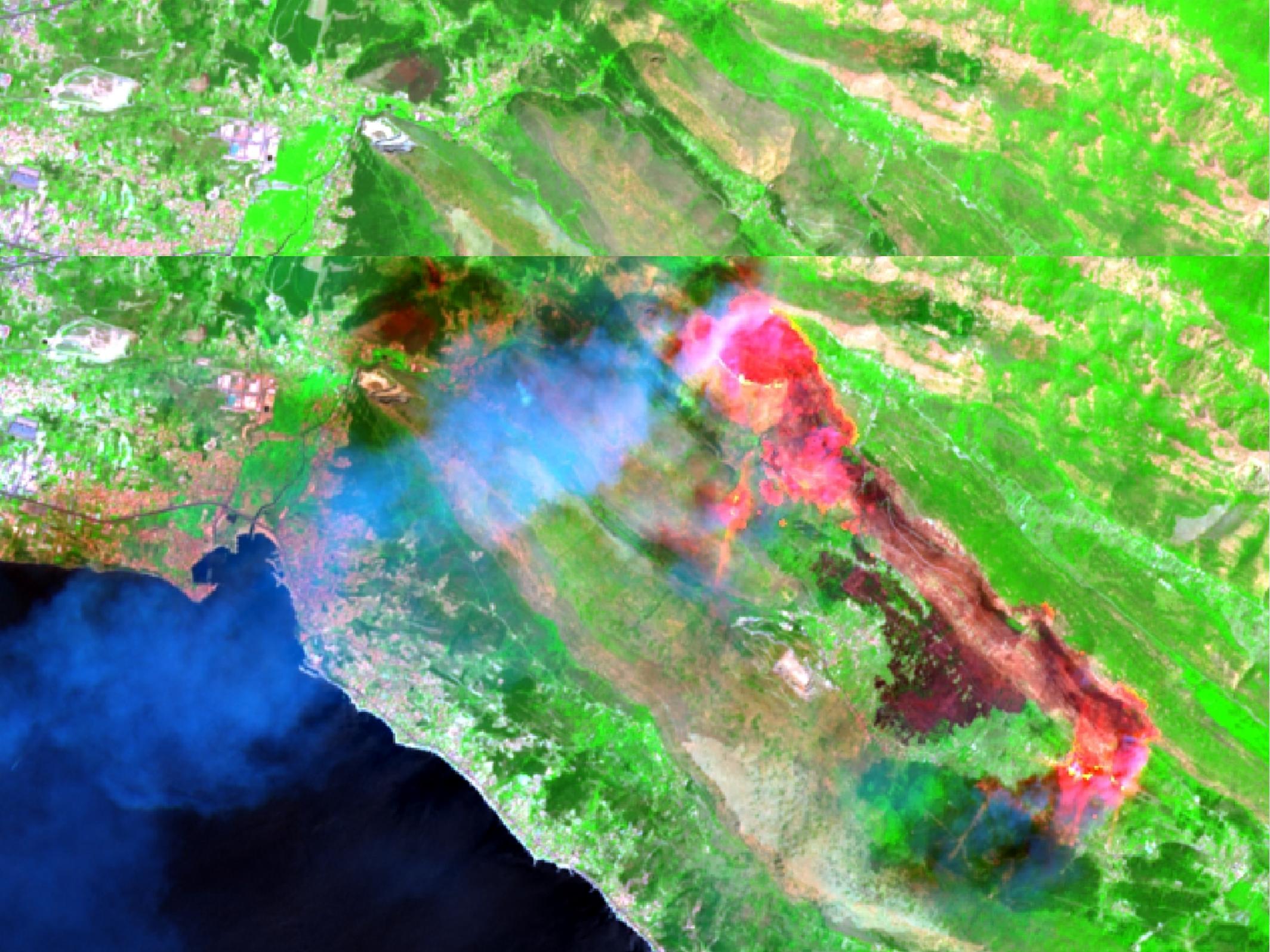




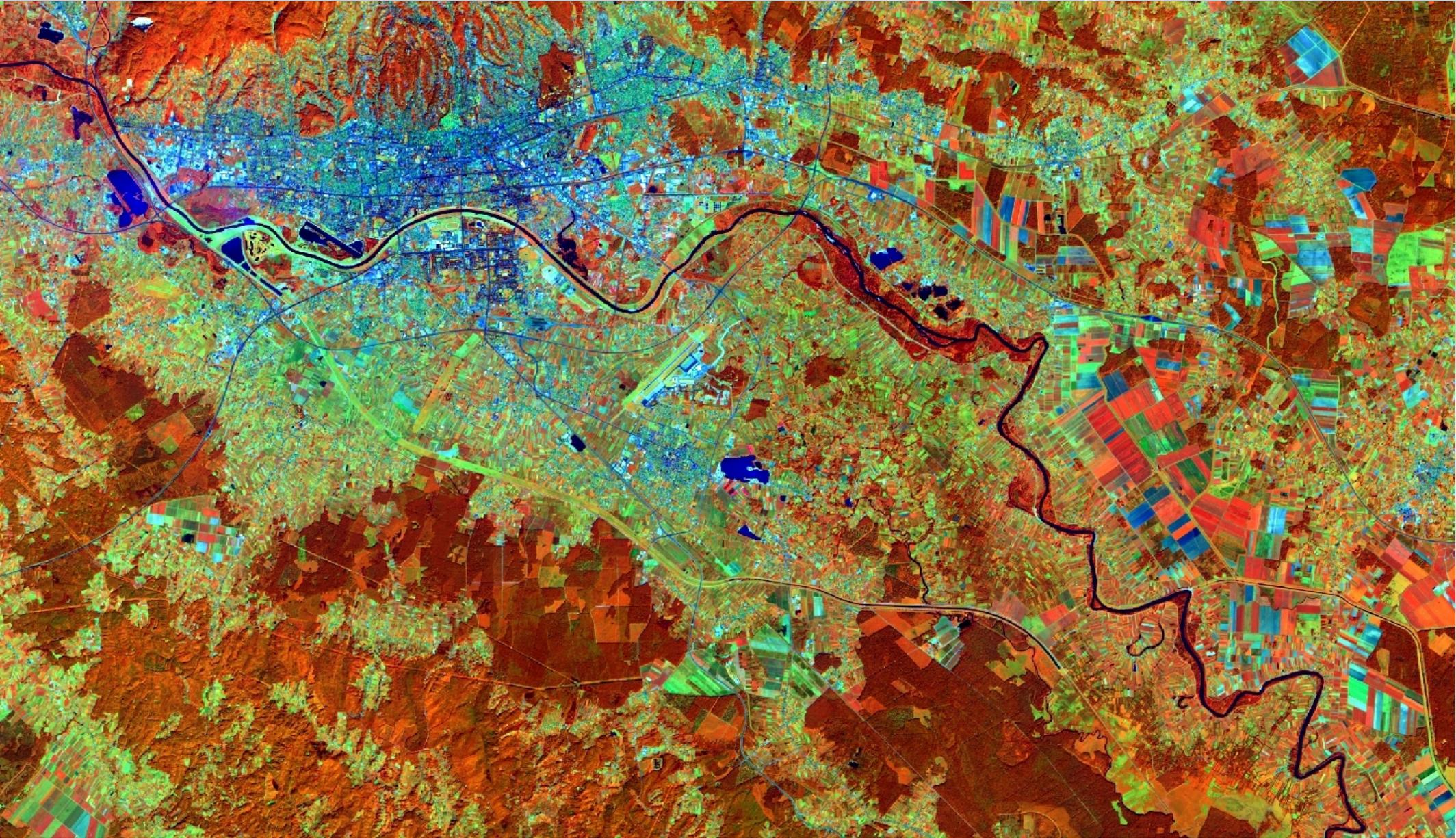




SWIR (kratkovalni infracrveni)



Zdrava vegetacija



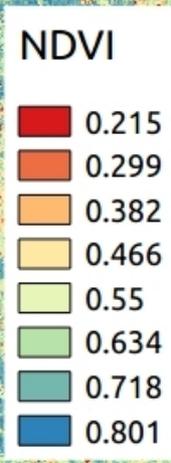
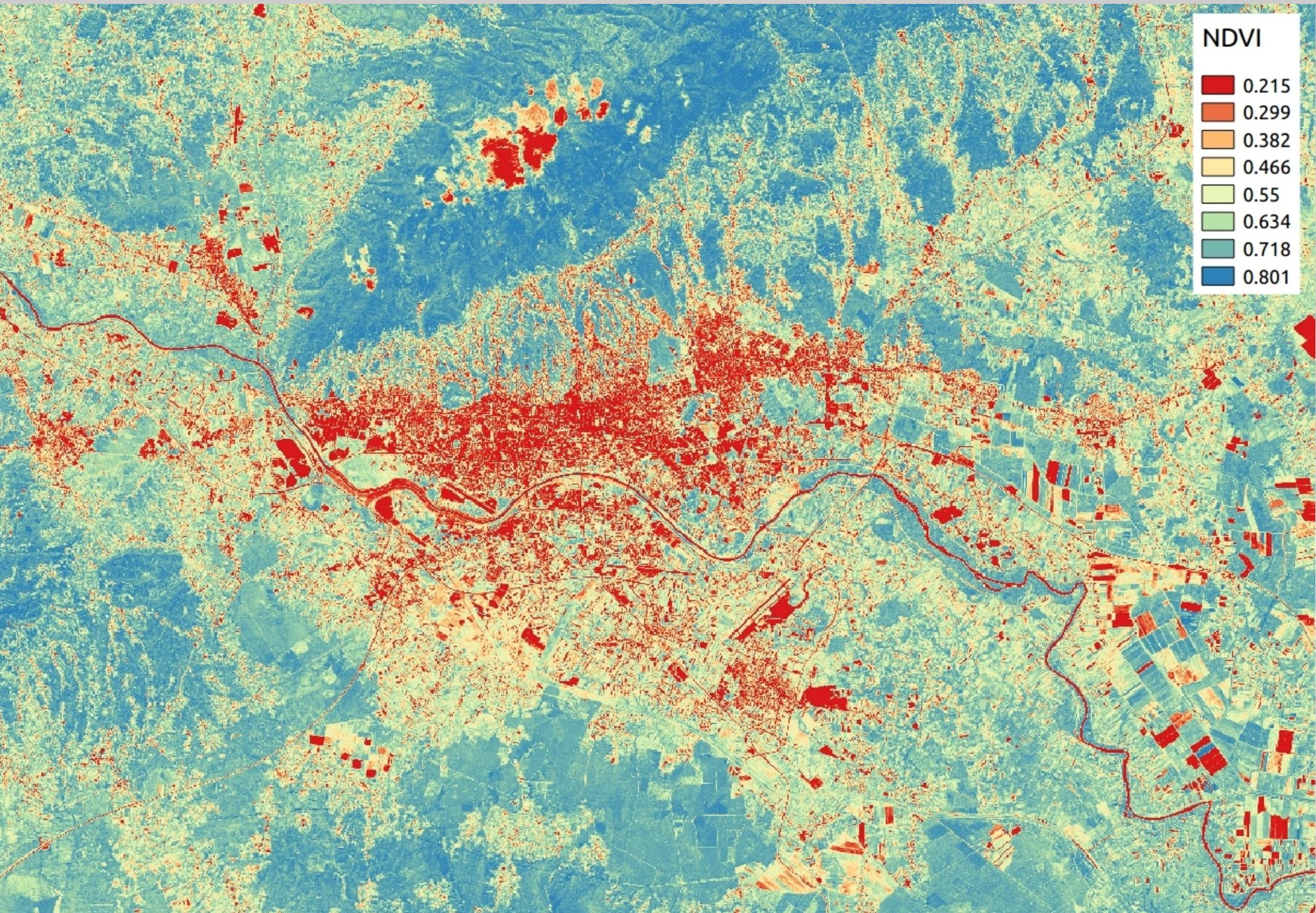
Spektralni indeksi

- biljke apsorbiraju vidljivu svjetlost (od 0.4 do 0.7 μm) – fotosinteza
- biljke reflektiraju blizu-infracrvenu svjetlost (od 0.7 do 1.1 μm)
- Više listova – veći utjecaj na valne duljine
- blizu-infracrvene i crvene valnih duljina – relativne količine vegetacije
- Vegetacijski indeks – indikator relativne gustoće i zdravlja vegetacije za svaki element slike (piksel) na satelitskoj snimci

Vegetacijski indeks normalizirane razlike (NDVI)

- Najčešće korišteni vegetacijski indeks
- Predstavlja normaliziranu razliku između crvenog i blizuinfracrvenog (NIR) kanala
- Formula:

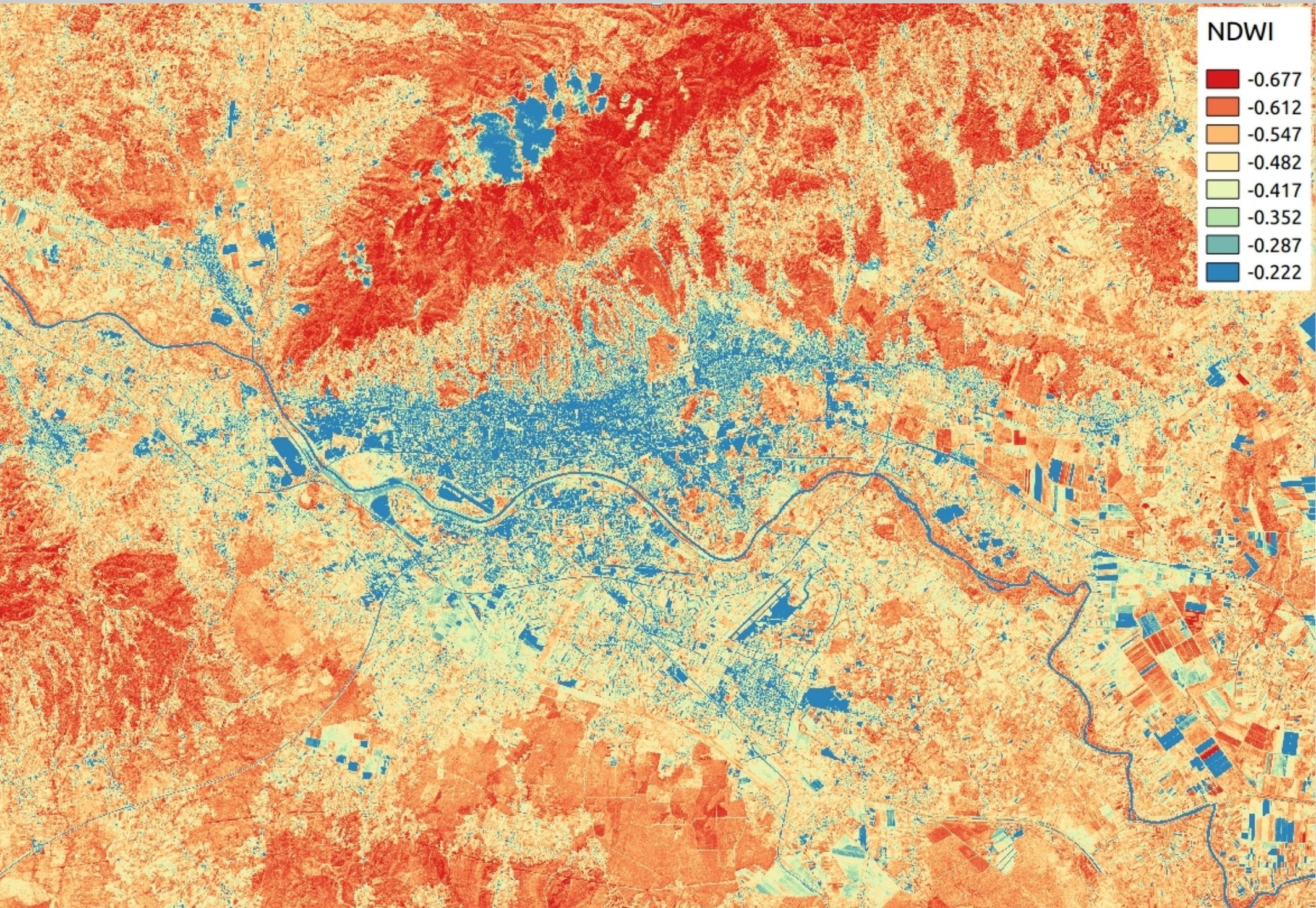
$$NDVI = \frac{NIR - Red}{NIR + Red} = \frac{B8 - B4}{B8 + B4}$$



Vodeni indeks normalizirane razlike (NDWI)

- Spektralni indeks koji prikazuje vodu u listu tj. Mjera molekula tekuće vode u vegetaciji
- Formula:

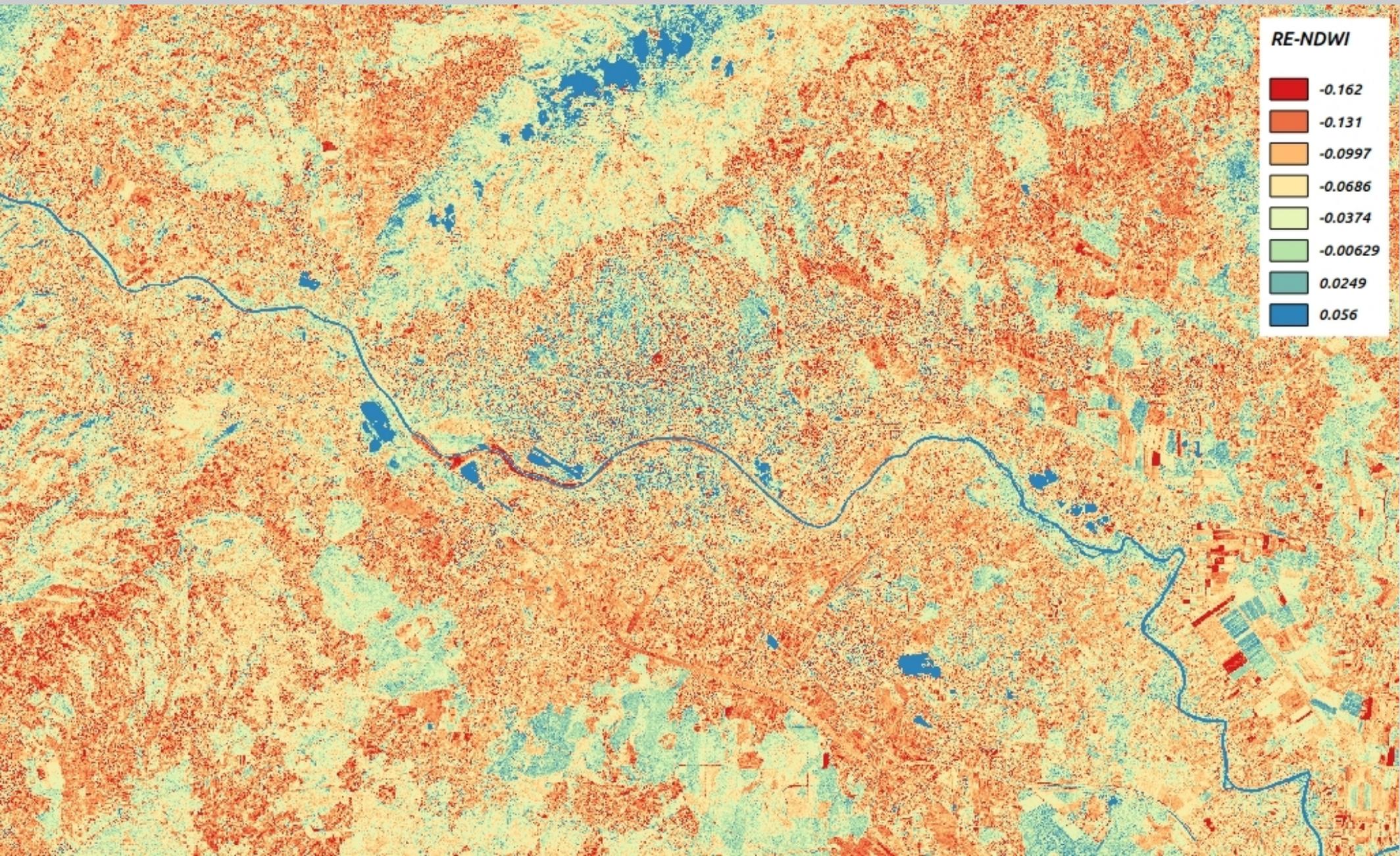
$$NDWI = \frac{(\text{Green} - \text{NIR})}{(\text{Green} + \text{NIR})} = \frac{(B03 - B08)}{(B03 + B08)}$$



Rubni crveni vegetacijski indeks normalizirane razlike (RE-NDVI)

- Kod NDWI-a voda i izgrađeno zemljište često imaju slične vrijednosti
- Iz tog razloga razvijen je Red edge NDWI (RE-NDWI)
- Formula:

$$RE - NDWI = \frac{(\text{Green} - \text{Red edge})}{(\text{Green} + \text{Red edge})} = \frac{(B03 - B05)}{(B03 + B05)}$$

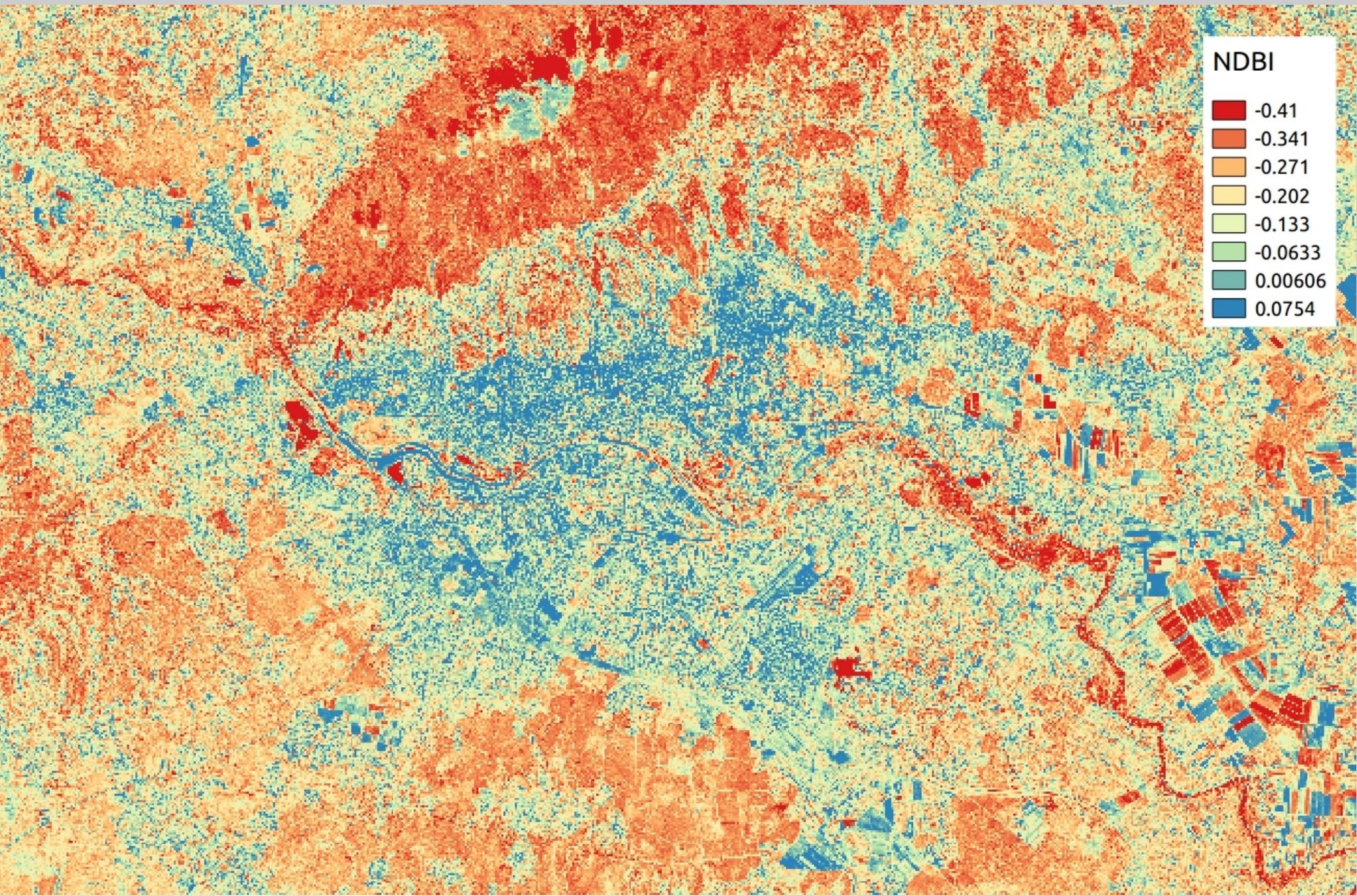


Izgrađeni indeks normalizirane razlike (NDBI)

- Indeks koji ističe urbana područja
- Formula:

$$NDBI = \frac{(SWIR-NIR)}{(SWIR+NIR)} = \frac{(B11 - B08)}{(B11 + B08)}$$

- Aplikacije – urbano planiranje





Hvala na pažnji

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email: Copernicus_Academy_Croatia@geof.hr