

Remote sensing

Duccio Rocchini

Professore Ordinario
Alma Mater Studiorum Università di Bologna
<https://www.unibo.it/sitoweb/duccio.rocchini>



Intro



Intro



Satellite images



Satellite images



Satellite images



European
Commission



Duccio Rocchini



Nominated expert
by the European Commission and
the European Space Agency for the Biodiversity sector
for the development of the ESA Space program until 2030

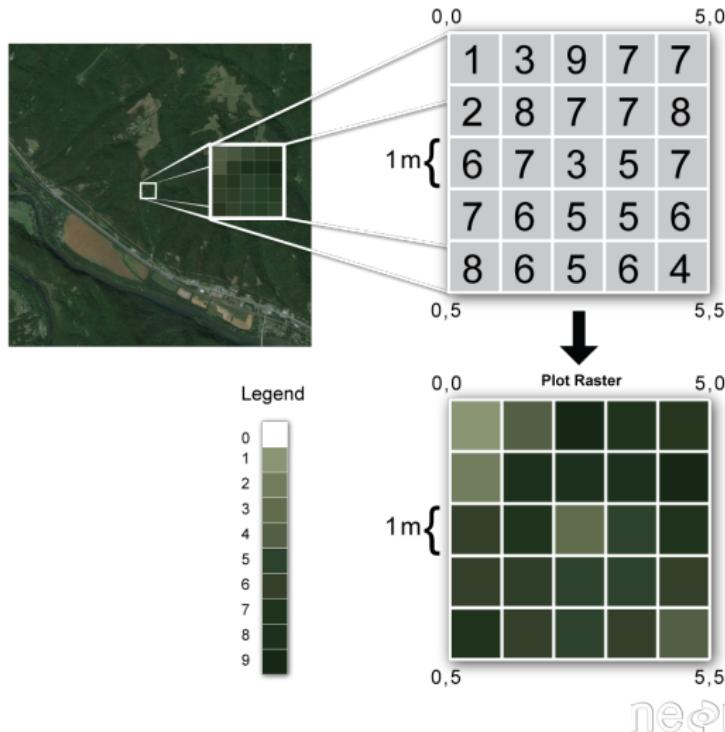


Satellite images as matrices of numbers



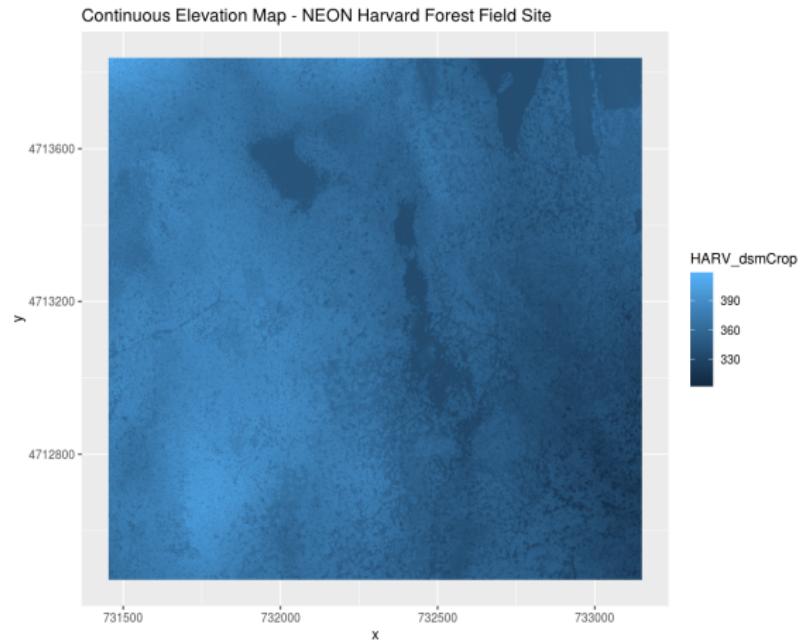
www.shutterstock.com · 104259125

Satellite images as matrices of numbers

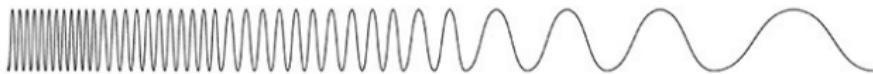
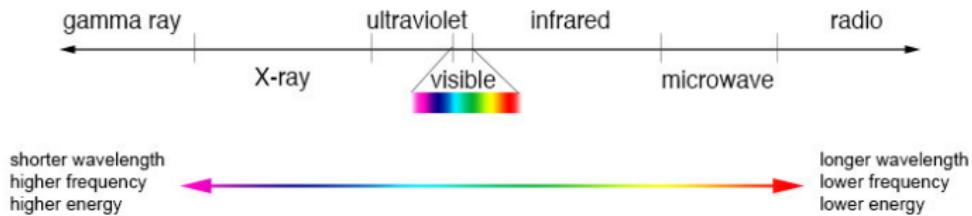


neon®

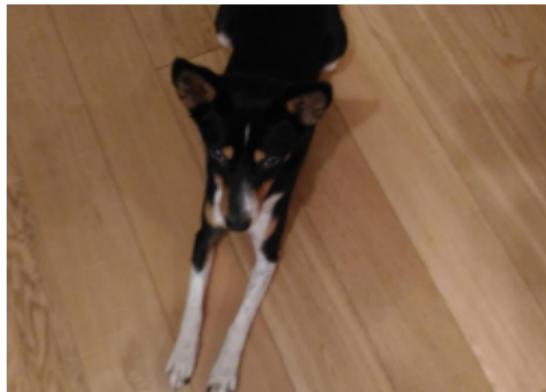
Satellite images as matrices of numbers



Satellite images as matrices of numbers



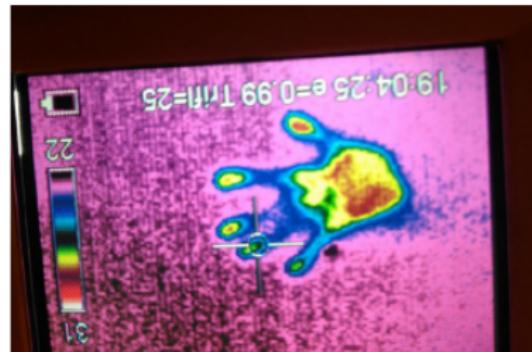
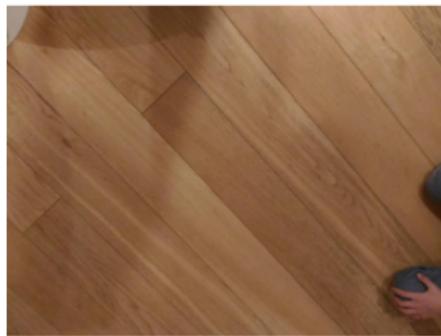
Satellite images as matrices of numbers



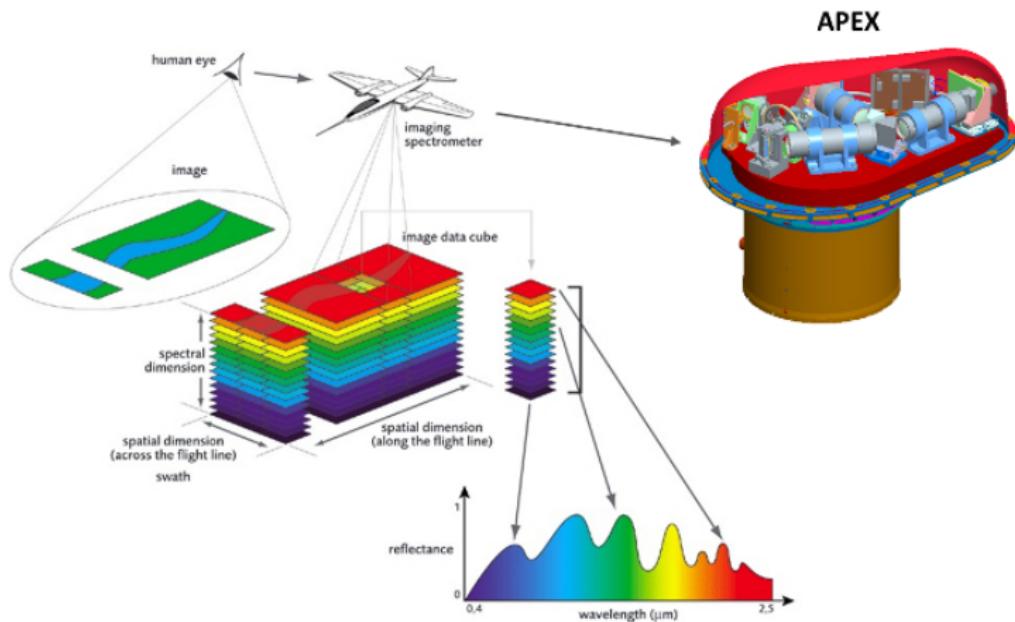
Satellite images as matrices of numbers



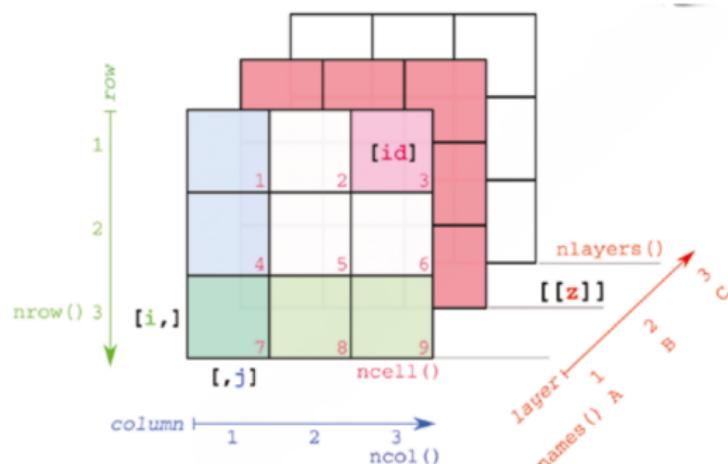
Satellite images as matrices of numbers



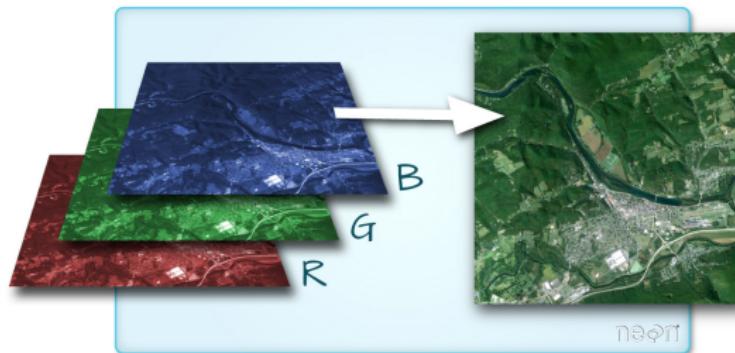
Satellite images as matrices of numbers



Satellite images as matrices of numbers

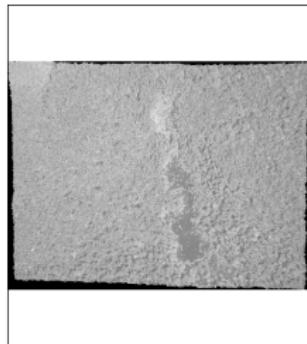


Satellite images as matrices of numbers

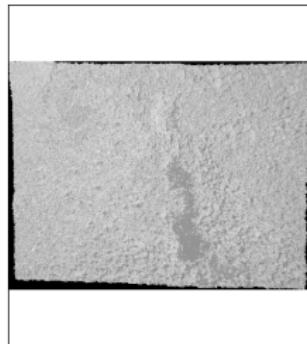


Satellite images as matrices of numbers

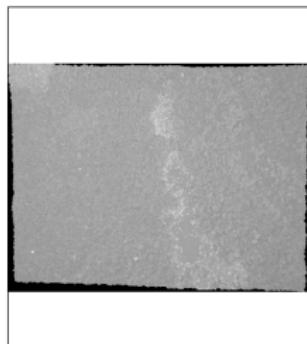
Red.Band



Green.Band



Blue.Band

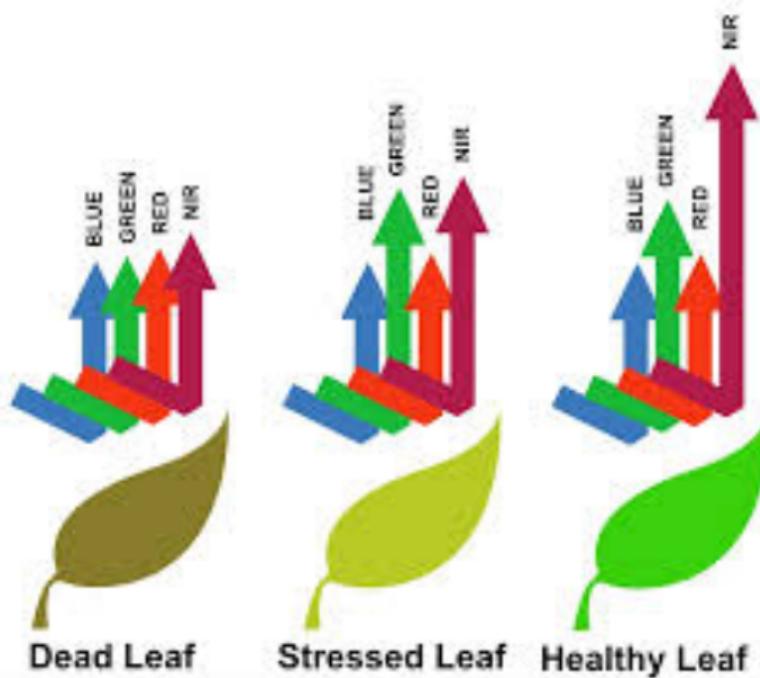


Satellite images as matrices of numbers

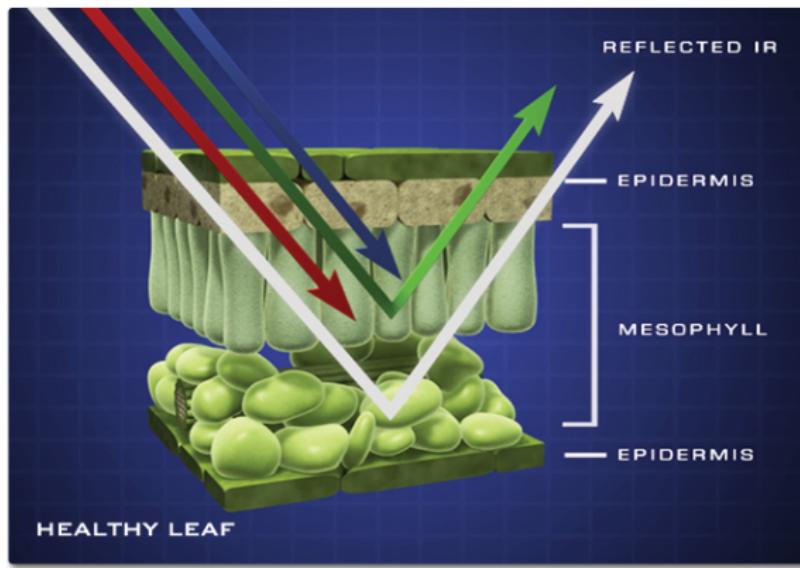
3 Band Color Composite Image
NEON Harvard Forest Field Site



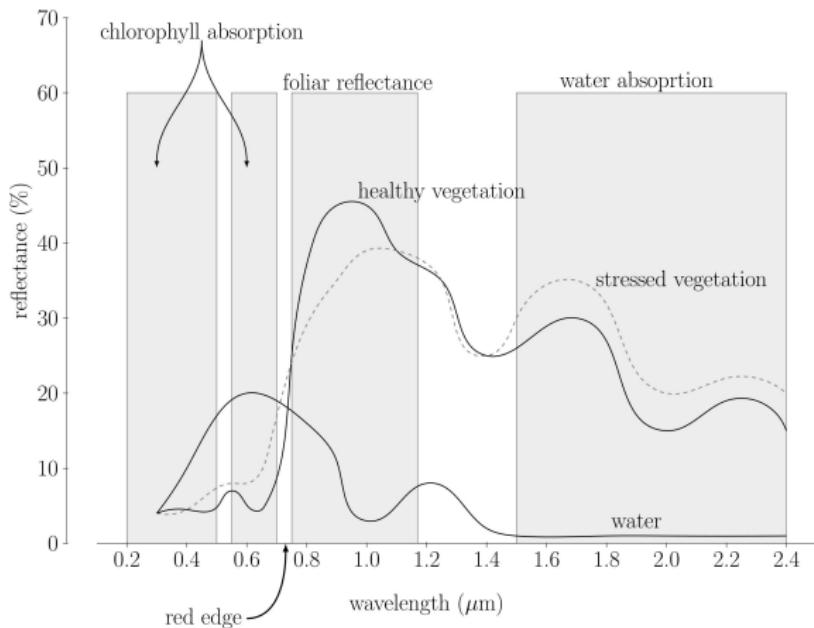
Leaves reaction to light



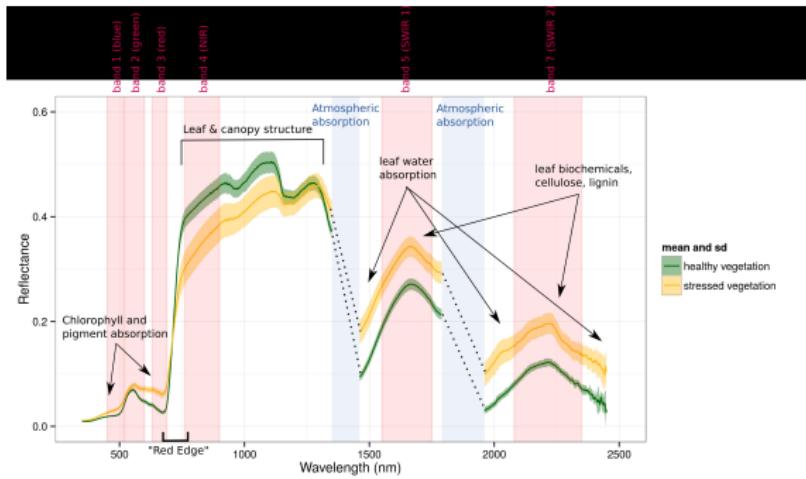
Leaves reaction to light



Spectral signatures



Monitoring vegetation health

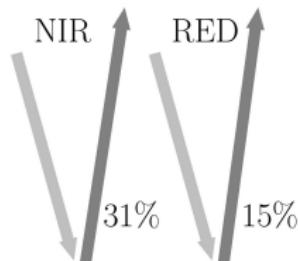
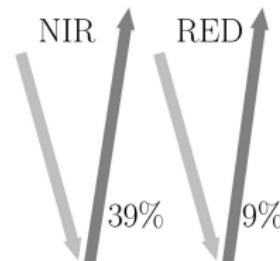


Vegetation indices

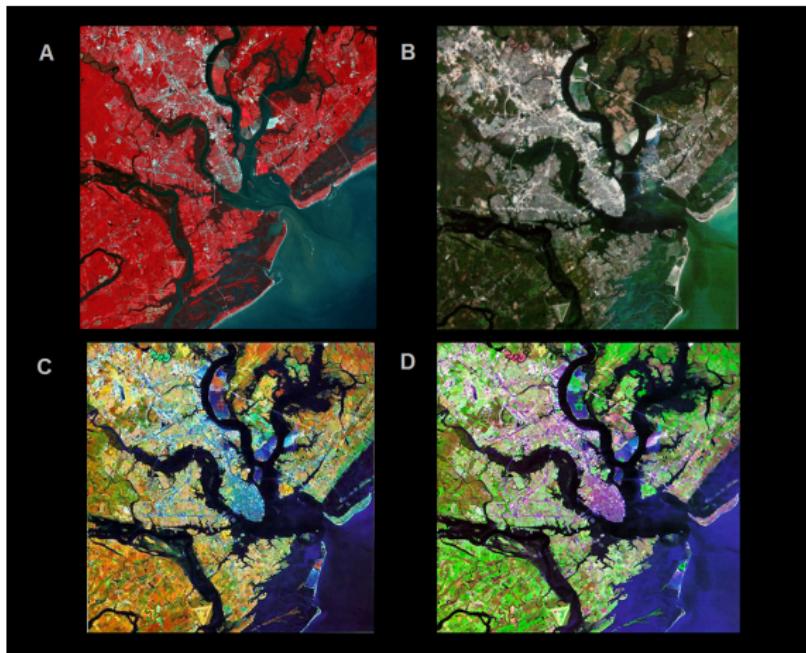
$$\frac{NIR - RED}{NIR + RED} = \text{NDVI}$$

$$\frac{0.39 - 0.09}{0.39 + 0.09} = \mathbf{0.63}$$

$$\frac{0.31 - 0.15}{0.31 + 0.15} = \mathbf{0.35}$$



Colour composites

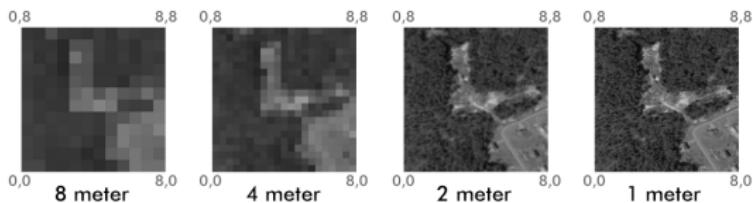


Remote sensing data



Remote sensing data

Raster over the same extent, at 4 different resolutions



MODIS (NASA)

Moderate Resolution Image Spectroradiometer
Minimum pixel size: 500m

The screenshot shows the official NASA Terra website. On the left, there's a large image of the Terra satellite in space, with its solar panels extended. The main content area has a dark header with the NASA logo and the word "TERRA" in large white letters, followed by "The EOS Flagship". Below the header is a navigation bar with links for About, Science, Data, Multimedia, News, Resources, and Leadership. Under "Terra Instruments", there are six small thumbnail images: ASTER, CERES, MISR, MODIS, and MOPITT. A sub-navigation menu for "Terra Instruments" includes links for ASTER, CERES, MISR, MODIS, and MOPITT. The "MODIS" section is currently active, indicated by a blue background. It contains a brief description of MODIS' capabilities, several sample images of Earth from space, and a detailed paragraph about its role in monitoring Earth's energy budget. To the right of the main content, there's a large, detailed map of Earth showing cloud cover and other environmental data.

NASA | Earth Observatory | Terra in Visible Earth

TERRA
The EOS Flagship

About Science Data Multimedia News Resources Leadership

Terra Instruments ASTER CERES MISR MODIS MOPITT

Terra Instruments

ASTER CERES MISR MODIS MOPITT

MODIS

Moderate Resolution Imaging Spectroradiometer

With its sweeping 2,330-km-wide viewing swath, MODIS sees every point on our world every 1-2 days in 36 discrete spectral bands. Consequently, MODIS tracks a wider array of the earth's vital signs than any other Terra sensor. For instance, the sensor measures the percent of the planet's surface that is covered by clouds almost every day. This wide spatial coverage enables MODIS, together with MISR and CERES, to help scientists determine the impact of clouds and aerosols on the Earth's energy budget.

In addition to recording the frequency and distribution of cloud cover, MODIS measures the properties of clouds such as the distribution and size of cloud droplets in both liquid water and ice clouds. MODIS also measures the properties of aerosols—tiny liquid or solid particles in the atmosphere. Aerosols enter the stratosphere from numerous sources like volcanoes and human commerce and natural

MODIS (NASA)

Moderate Resolution Image Spectroradiometer
Maximum spatial resolution: 500m

 Copernicus European Commission

Services Opportunities Access to Data How to Library Use Cases About Copernicus

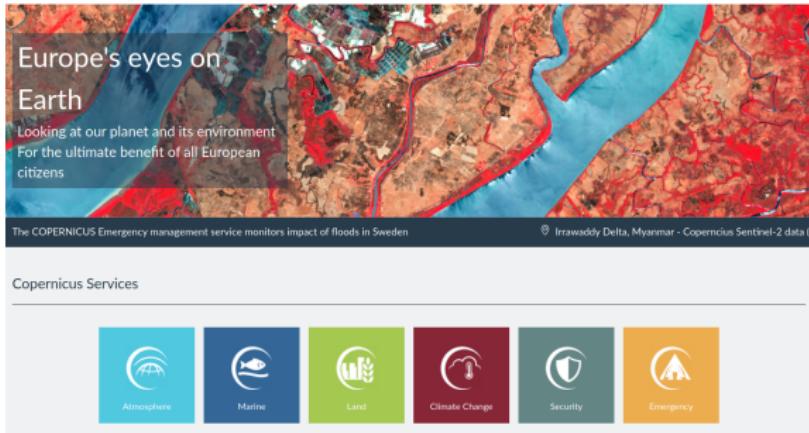
Europe's eyes on Earth
Looking at our planet and its environment
For the ultimate benefit of all European citizens

The COPERNICUS Emergency management service monitors impact of floods in Sweden

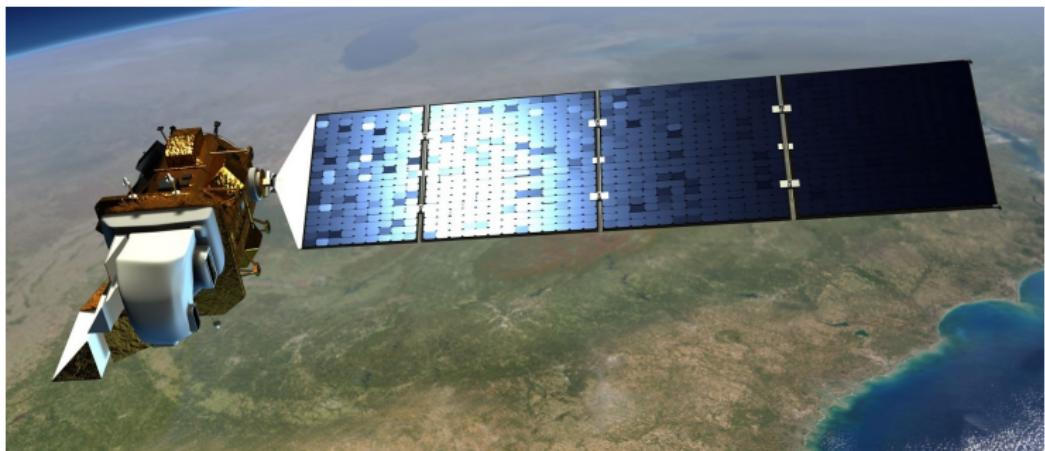
Iravaddy Delta, Myanmar - Copernicus Sentinel-2 data (c) 2016 ESA

Copernicus Services

Atmosphere Marine Land Climate Change Security Emergency

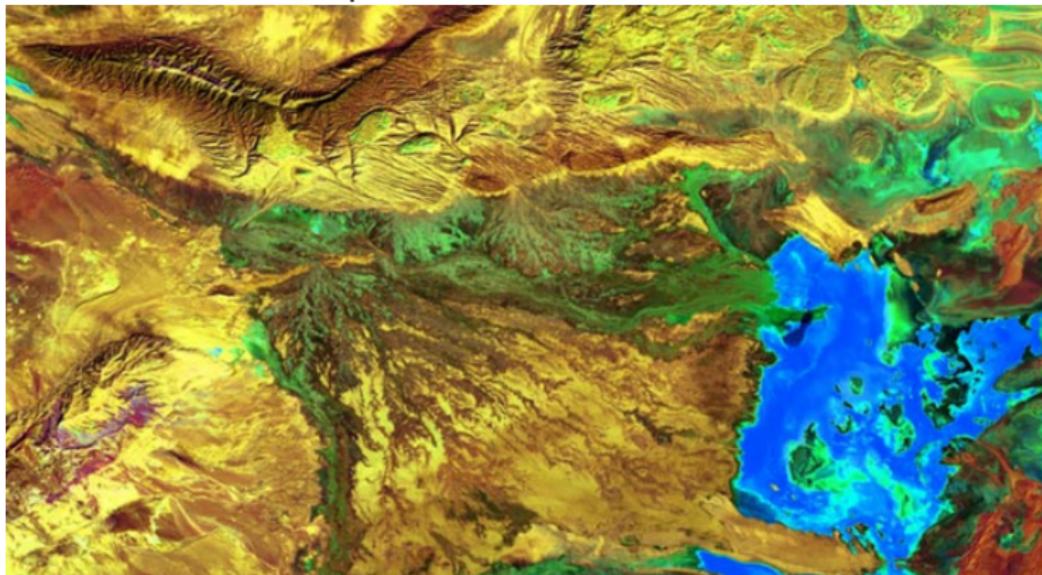


Landsat (NASA)



Landsat (NASA)

Spatial resolution: 30m



Landsat (NASA)



[Main Page](#)
[Community](#)
[Development](#)
[Documents](#)
[GRASS Help](#)
[Recent changes](#)
[Help](#)

[Tools](#)
[What links here](#)
[Related changes](#)
[Special pages](#)
[Printable version](#)
[Permanent link](#)
[Page information](#)

[Page](#) [Discussion](#)

[Read](#) [View source](#) [View history](#)

[Log in](#) [Request account](#)



LANDSAT

Contents [hide]

- [1 Data Availability](#)
- [2 Modules overview](#)
 - [2.1 Generic modules applicable to Landsat](#)
 - [2.2 Landsat specific modules](#)
 - [2.3 Landsat specific GRASS AddOns](#)
- [3 Pre-Processing](#)
 - [3.1 Overview](#)
 - [3.2 Importing data](#)
 - [3.2.1 Notes](#)
 - [3.2.2 Hint: Minimal disk space copies](#)
 - [3.2.3 Automated data import](#)
- [4 Post-Processing](#)
 - [4.1 Natural color composites](#)
 - [4.2 Create a MASK to only show data where coverage exists for all bands](#)
 - [4.3 Calculate Top-of-Atmosphere Reflectance and band-6 Temperature](#)
 - [4.4 Haze removal](#)
 - [4.5 Atmospheric correction](#)
 - [4.6 Cloud identification](#)
- [5 Download sample data](#)
 - [5.1 Preprocessed Landsat-7 data for North Carolina](#)

Landsat (NASA)



Landsat (NASA)

CORRIERE DELLA SERA.it

INFORMAZIONI UTILI A DEFINIRE STRATEGIE DI PROTEZIONE AMBIENTALE

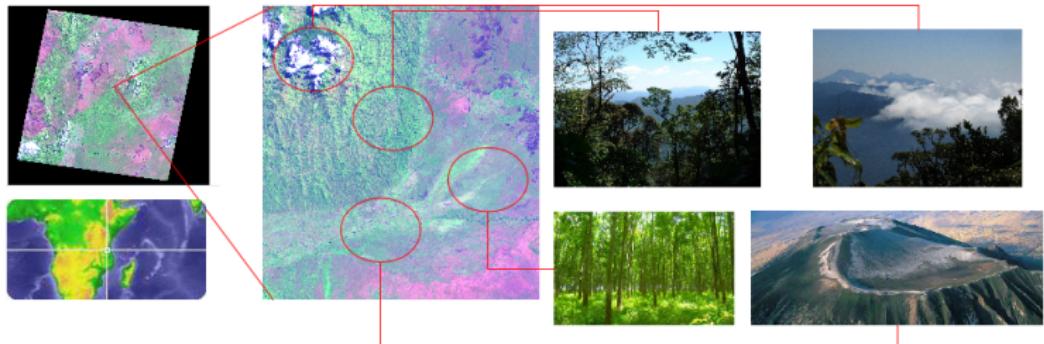
La biodiversità si controlla dal satellite

Duccio Rocchini, primo italiano premiato da fondazione Usa per il monitoraggio degli habitat dallo spazio

MILANO - Ambiente: cosa proteggere? Ce lo dice il satellite. Dalle enormi matrici numeriche provenienti dallo spazio è possibile ricavare mappe territoriali dettagliate. Queste immagini, opportunamente elaborate, possono essere utilizzate per individuare le zone a più alta biodiversità, ipotizzare l'andamento dei cambiamenti climatici e raccogliere informazioni utili a definire strategie di protezione ambientale. Ne sa qualcosa Duccio Rocchini, ricercatore della Fondazione Edmund Mach [appena premiato dalla Earth and Space Foundation](#) per essersi distinto nel campo assai specialistico della «stima della biodiversità da immagini satellitari».

TELERILEVAMENTO - Il ragionamento pare semplice. Rocchini utilizza i meccanismi propri del telerilevamento, che trasformano in pixel i dati numerici prodotti inizialmente dal satellite. Un pixel dopo l'altro viene composta la «fotografia del territorio, che può essere ripreso anche con lunghette»

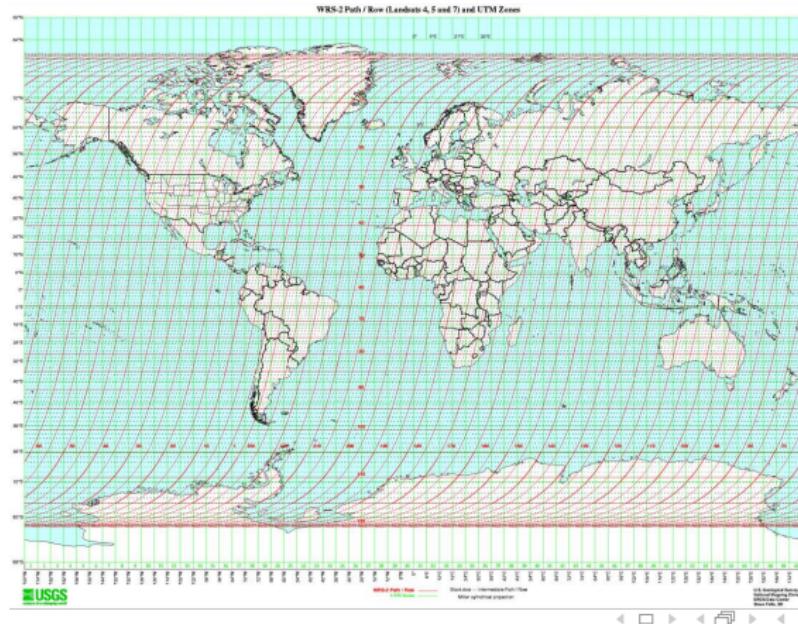
Landsat (NASA)



Landsat (NASA)

Landsat orbits (path and row system)

<https://www.youtube.com/watch?v=yPF2jpjB3Qw>



Sentinel (ESA)

Spatial resolution: 10m

The screenshot shows the official website for the Sentinel-2 mission. At the top, there's a navigation bar with the 'sentinel-2' logo, the 'esa' logo, and tabs for 'ESA', 'OBSERVING THE EARTH', 'COPERNICUS', and 'SENTINEL-2'. Below the navigation, a green banner features the text 'Colour vision' and 'Introducing Sentinel-2'. To the right is a search bar with a magnifying glass icon. The main content area has a large image of Earth from space. Overlaid on this image is a white circle containing a smaller view of a coastal area with green land and blue water. A white arrow points from the main image towards the circle. Below this graphic, the text '→ EARTH FROM SPACE' is followed by a descriptive paragraph about Santa Claus stopping at Canada's Reindeer Island. To the left of the main image, there are sections for 'Applications' (Plant health, Changing lands, Water bodies, Disaster mapping) and 'About the mission' (Facts and figures, Satellite constellation, Instrument, About the launch). At the bottom left, there's a link to 'Operations and data'. On the right side, there are two smaller boxes: one for the 'Sentinel-2 launch campaign blog' featuring an arrow icon, and another for 'The launch campaign in pictures' showing a photo of a rocket launching.

sentinel-2

esa

ESA OBSERVING THE EARTH COPERNICUS SENTINEL-2

Colour vision

Introducing Sentinel-2

ESA > Our Activities > Observing the Earth > Copernicus > Sentinel-2

Search here

Applications

- Plant health
- Changing lands
- Water bodies
- Disaster mapping

About the mission

- Facts and figures
- Satellite constellation
- Instrument
- About the launch

Operations and data

→ EARTH FROM SPACE

In the 253rd edition, discover Canada's Reindeer Island – where we believe Santa Claus stops for a rest during his busy night before Christmas

sentinel-2

Sentinel-2 launch campaign blog

The launch campaign in pictures

Sentinel (ESA)



Sentinel (ESA)





ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Contact:

Duccio Rocchini, PhD - Full Professor @:
Alma Mater Studiorum University of Bologna, Italy
duccio.rocchini@unibo.it



This presentation has been made by only relying on Free and Open Source philosophy: Linux, L^AT_EX, R, GRASS GIS.