

Picterra

The ultimate guide to

satellite imagery sources

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Updated for 2022 *3*

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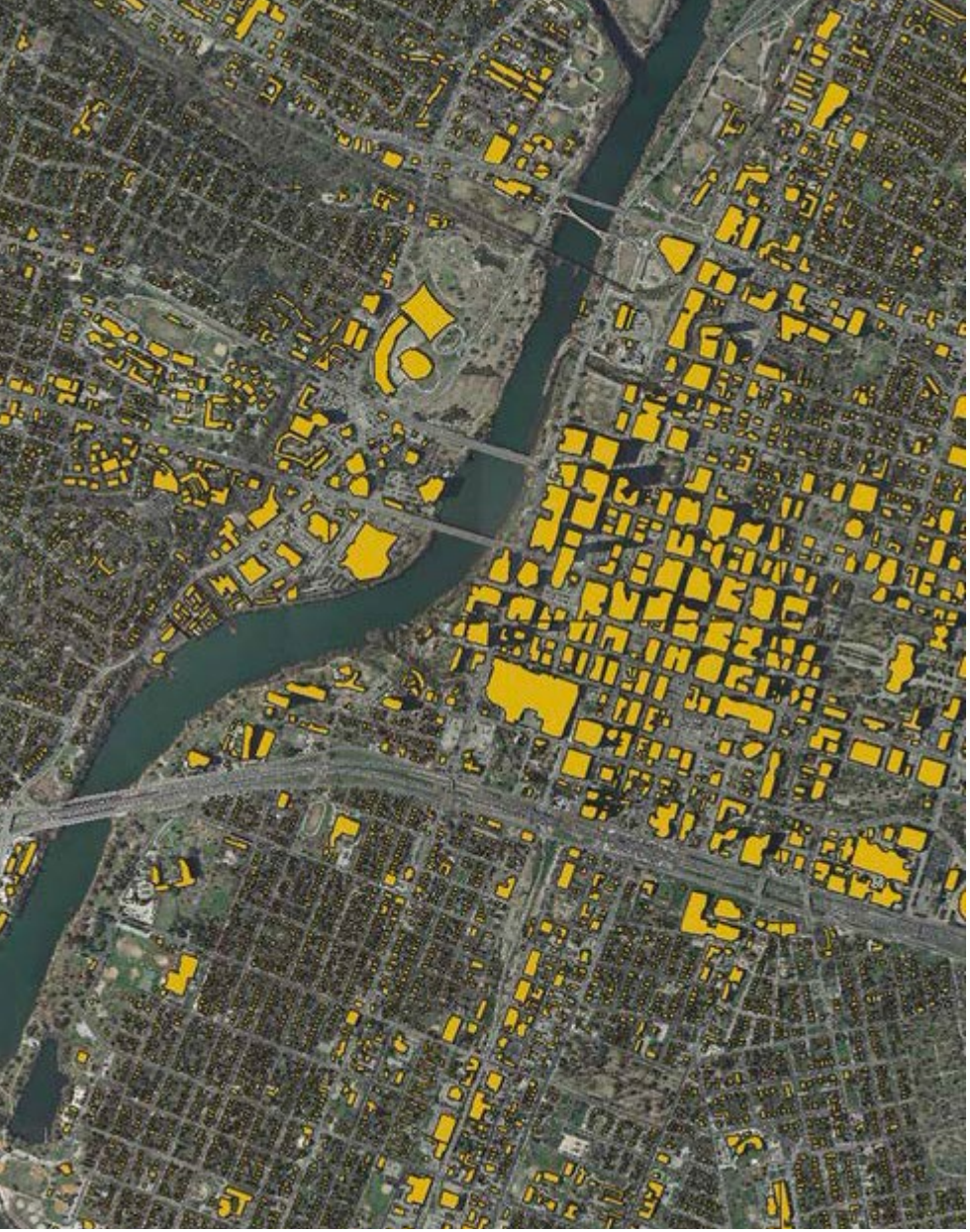
Satellite imagery sources

Updated for 2022



Earth observation (EO) technology has come a long way since the 1840s, when some of the first cameras were strapped to balloons and kites. Until a few decades ago, EO imagery acquired by satellites captured only selected areas at low- resolution (by current standards) mainly for military purposes. Today, it covers the entire planet in high-resolution, on-demand, and in near real-time.

Even so, finding your way around the EO ecosystem can be a challenging task due to its technical nature, distinct terminology, and often complex purchasing processes.



Much satellite imagery is available for free from public sources and affordable amounts of satellite imagery from commercial sources can be well worth the investment even for medium and small organizations. There are also many public and commercial websites that aggregate EO imagery and can help you select the sources and types most useful to you, store and manage these data for you, and analyze them to extract the insights that can improve your company's business or advance your public agency's goals.

For a growing number of organizations, EO data has become indispensable. Many more organizations would benefit from EO imagery but believe that they cannot manage the complex technical issues of acquiring, managing, and using these data, nor afford the cost of doing so. Yet even a small investment in learning about the different kinds of EO imagery, where to acquire it, and how to use it can go a long way. Hopefully, this guide and a handy table with satellite sources can help you get started.

Recent Changes

in the EO Marketplace

In recent years there has been a big push in increasing spatial resolution (for a full definition see further in this guide) for commercial uses. Previously only companies such as Maxar offered EO imagery at 30cm resolution but now many more providers such as Airbus, Umbra, and Albedo have or are launching imagery products available at up to 10cm resolution. Such resolutions will enable many more use cases in various industries and allow organizations that had not considered the use of EO imagery to analyze this rich source of data.

The purchase of satellite imagery was once referred to as '**closer to a hostage negotiation than a sales transaction**'. Thankfully pricing models and the overall purchasing process have become easier recently. This includes transparent pricing from the likes of new providers SkyFi and subscription based models such as that employed by Planet.

Before starting to download EO imagery, it is helpful to know a few basic concepts about EO satellites and the data that they collect. One practical reason is that most download sites will ask you to choose various parameters to narrow your search of all the available imagery.

Orbits

Satellites orbiting Earth at different altitudes provide different perspectives, some always focused on the same area while others are constantly circling our planet. There are essentially three types of Earth orbits:

- **Low Earth orbit** (LEO, 160 km to 2,000 km), which is used by most scientific and commercial satellites,
- **Medium Earth orbit** (MEO, 2,000 km to 35,780 km), which is used by navigation satellites and those designed to monitor a particular region and,
- **High Earth orbit** (HEO, ≥ 35,780 km), which is used by many weather satellites and some communications ones.

A satellite's orbital height determines how long it will take to orbit, because its motion is mostly controlled by Earth's gravity: the lower it is, the stronger the gravitational force on it and, therefore, the greater its speed. One orbit can take from as little as a couple of hours to as much as 24 hours. (Our planet's natural satellite, the Moon, which is 384,403 kilometers from Earth's center, completes each orbit in 28 days.) In addition to height, an orbit also has two other parameters: eccentricity, which describes its deviation from a perfect circle, and inclination, which is its angle in relation to Earth's equator.



Two orbits are particularly relevant for EO satellites:

At an altitude of about 36,000 km, a satellite is in a geosynchronous orbit, meaning that its orbit matches Earth's rotation so that it appears to hover over the same longitude, though its latitude may wobble. This orbit is precious for meteorology, because it provides a constant view of the same area, for communication satellites, and for monitoring the sun.

On a sun-synchronous orbit, which takes about 99 minutes, half over Earth's daytime side and half over its nighttime side, a satellite always crosses the equator at the same local solar time. This keeps the angle of sunlight on Earth's surface as consistent as possible, though it will change from season to season, making it possible to accurately compare images from the same season over several years to track change over time, such as climate change.

For more on satellite orbits, **see this excellent article by NASA**.

Temporal resolution

Temporal resolution, also known as the revisit time, is the amount of time between satellite passes over the same geographic extent. While for each satellite this depends on its orbit and its capacities to look off-nadir, i.e. on the sides with a certain view angle, most satellites operate as part of a constellation of satellites of the same kind, working together to increase their global daily coverage. For example, Planet's constellation of

150 mini satellites covers the whole globe every day, while the lone Landsat-8 satellite takes 16 days to do so.



Spatial resolution

Spatial resolution is directly related to the size of each pixel in an image: the smaller the pixel, the finer the image's clarity. It ranges currently from 250 m to 0.3 m. (The resolution of classified military EO satellites is higher, 30cm being since 2014 the maximum allowed.) While most imagery with a resolution lower than 10 m is free, imagery at higher resolutions is usually a commercial product. While a 10 m resolution is useless to a realtor wanting to examine a property, it can be superb to a geologist studying a glacier.

Panchromatic (see below) imagery always has a much higher resolution than multispectral (see below) imagery.



Panchromatic vs. multispectral

Panchromatic images combine the information from the visible bands of red, green, and blue into a single band, thereby using the total light energy in the visible spectrum. They render a single intensity value per pixel, which is commonly visualized in grayscale images, making them appear black and white.

Due to the higher amount of solar radiation collected per pixel, panchromatic sensors can detect brightness changes at smaller spatial extents than multispectral ones.

Conversely, multispectral sensors capture data in multiple bands, thereby collecting less energy for each band. Therefore, to collect the minimum amount of light energy required to detect brightness differences they must sample a larger area. This is why panchromatic images are at higher resolution than multispectral ones.

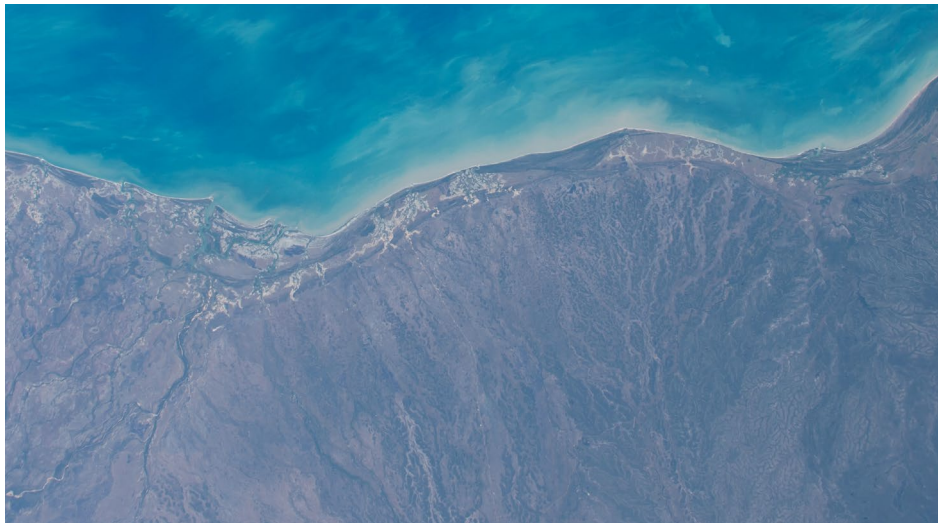


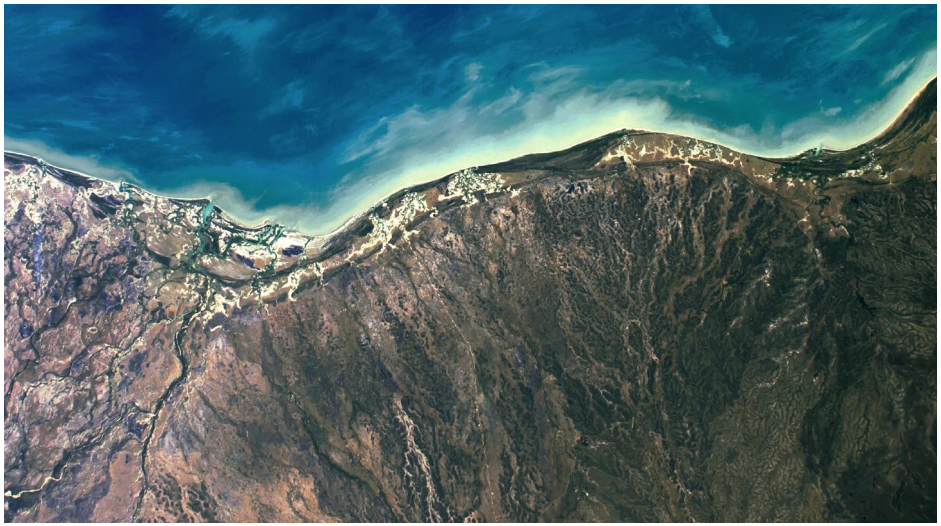
Sensors

Most instruments aboard EO satellites are either passive or active. The former, which are by far the most common for imaging, measures the amount of electromagnetic energy reflected by Earth's surface or atmosphere, such as visible light or near-infrared. Their main drawback is that they are affected by cloud coverage. The latter, such as Synthetic Aperture Radar (SAR) satellites, send energy pulses to the surface and then record returns to the sensor. They can generally see through clouds. SAR is widely used in applications that require constant monitoring to detect change over time, as well as for interferometry (to measure subsidence and ground motion), maritime monitoring, and polarimetry (to classify land cover, map crops and forests, and measure biomass and soil moisture).

Atmospheric correction

Atmospheric correction refers to techniques - some more scientific and some more artistic - to reduce the impact on image quality of the atmosphere. This is often necessary because the atmosphere scatters light, especially at shorter (blue) wavelengths, causing natural color satellite images to look bluish and hazy and forests to look less green than expected. Some data providers correct imagery, while others leave that up to users.





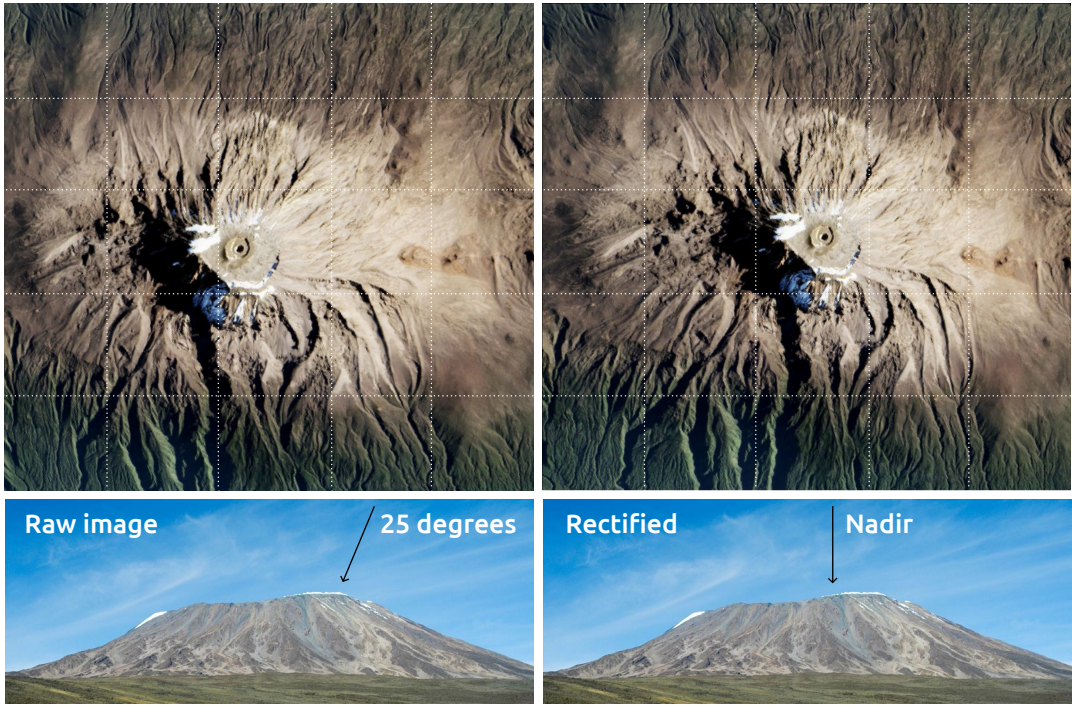
Pansharpening

Pansharpening is a technique that merges high- resolution panchromatic (grayscale) images with low-resolution colored images.



Orthorectification

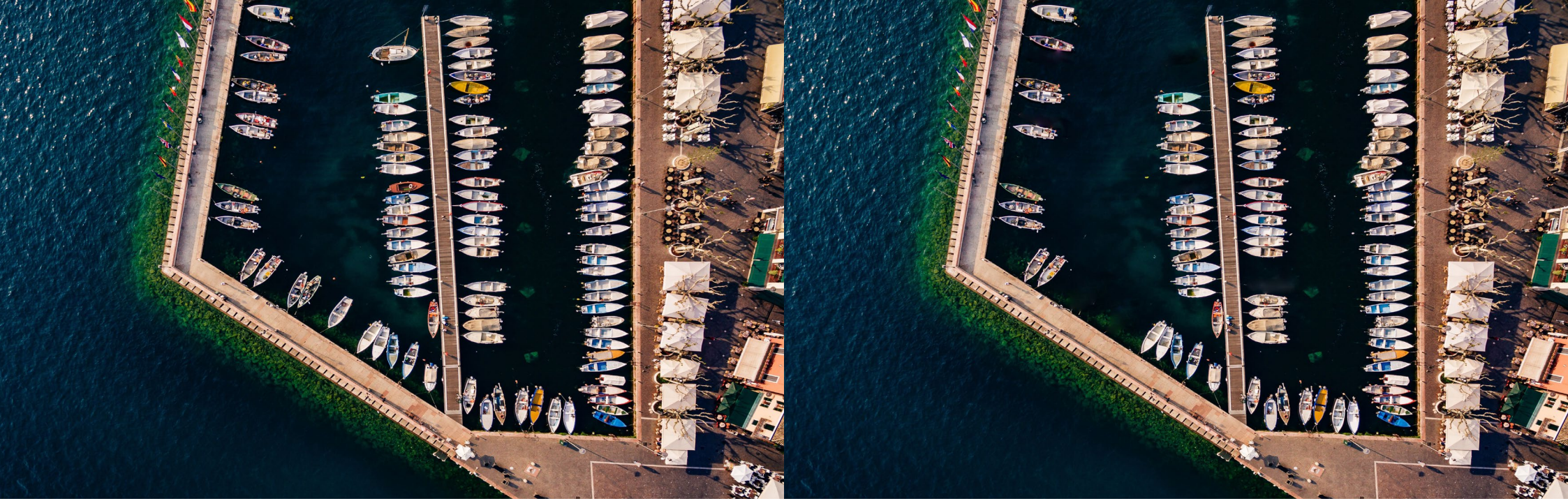
Orthorectification is the process of removing from aerial and satellite images geometric distortions due to tilt and relief that make it difficult to accurately compare a map and an image of the same geographic area. Once they are orthorectified, images show features in their correct planimetric locations. Orthorectified images provide a perfect base for creating and revising mapping and GIS databases or for registering existing feature layers. They can be used for change detection and other analytical applications that require a high degree of absolute accuracy.



Archive

All EO imagery providers have vast archives. The Landsat satellites, which have a resolution of about 15 m, have been around for more than 40 years, so the Landsat program's archive is ideal for showing changes over long times and monitor slow processes.

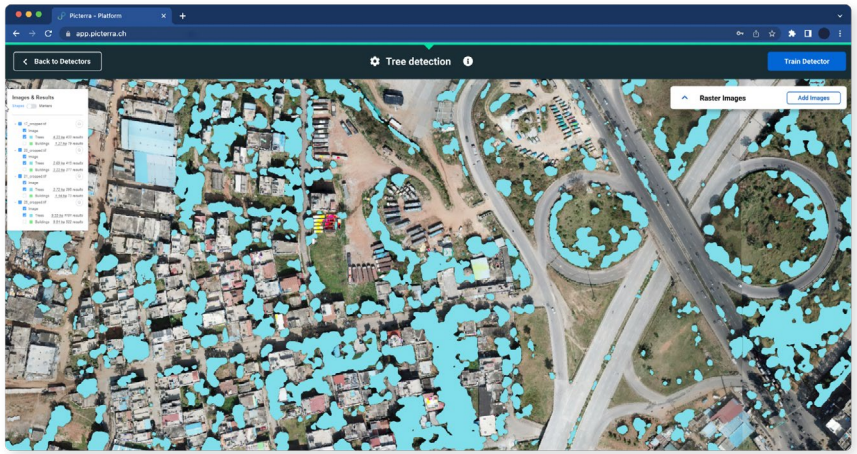




Satellite tasking

It is a common misconception that satellite imagery can't be used in rapid change detection because we only depend on archives.

On the contrary, it's also possible to task a satellite and monitor the area of interest, .e.g. weekly or monthly.





Source: [Picterra Platform]

Machine learning (ML)

Machine learning (ML) is a type of artificial intelligence (AI) in which computers learn from vast amounts of training data and build a model by using algorithms to learn relationships between the input data and the output results. It can discover patterns and trends buried within huge volumes of data that are not apparent to human analysts.

GIS

Geographic information systems

Geographic information systems (GIS) are software programs that gather, manage, and analyze geographic data. They often use satellite imagery as a layer. By far the most widely used commercial GIS is ArcGIS. QGIS is a free, open-source GIS.

If you are not already familiar with the world of EO imagery, you might want to start by comparing free Landsat, MODIS, and Sentinel imagery with sample high-resolution imagery from Maxar.

Landsat, a joint program between NASA and the U.S. Geological Survey (USGS) that has been in existence for more than 40 years, provides the longest available continuous space-based record of Earth's land. It images Earth once every 16 days. The latest satellite in the mission, Landsat-8, was launched in 2013, and is currently the second highest resolution available for free for optical data. NASA's MODIS constellation images Earth every one to two days and the Sentinel satellites, operated by the European Space Agency (ESA), do so every two to three days.

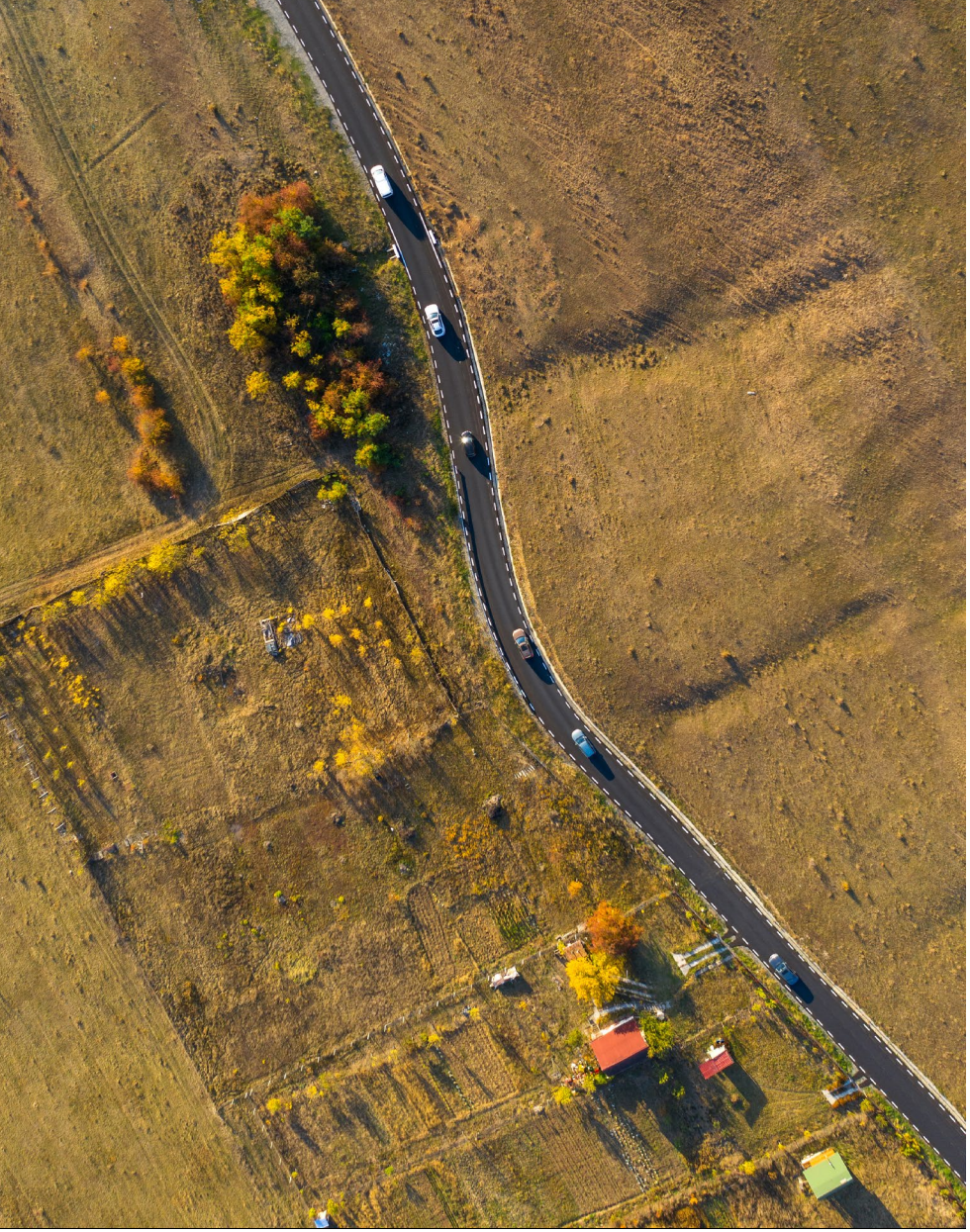
There are several ways to access Landsat and MODIS data, but a good starting point is **Earth Explorer**, a free in-browser platform that also offers access to data from other NASA satellites. (A guide to using this platform is available **here**.) The best way to access Sentinel data is via the **Copernicus Open Access Hub**. Data from all three of these satellite constellations can be downloaded for free from either **Earth on AWS** or **Google's Earth Engine Catalog**. Be advised, however, that these files are very large, so you should explore the data before downloading a lot of it.

Maxar owns and operates the WorldView-1, WorldView-2, WorldView-3, and GeoEye-1 satellites. They all have sub-meter resolution; WorldView-3 has a resolution of .3 m and you can download sample imagery **here**.



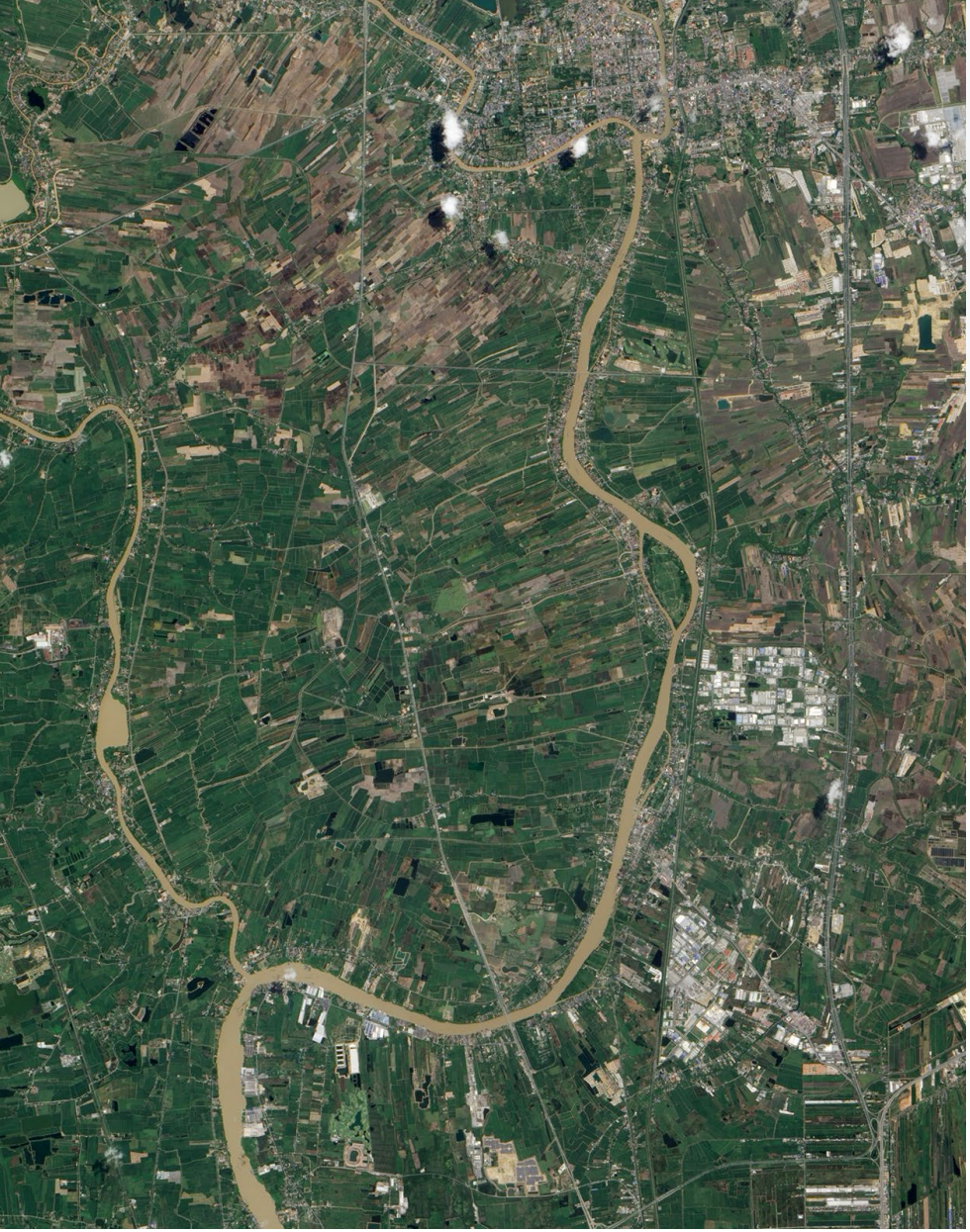
Next, you will need to determine which factors matter the most for your intended use of EO imagery. Obviously, you need a source that has coverage of your area(s) of interest (AOI). Beyond that, you will need to be able to answer the following questions:

- What spatial resolution do you need?
- Is natural color (which measures the visible spectrum) fine for your purposes or do you need other spectral bands to reveal features or phenomena otherwise invisible?
- Will you be content with downloading imagery already processed by the provider or will you need to access the raw image files?
- How frequently will you need to have a fresh look at your AOI?
- What is your budget?
- Will you need the right to sell the imagery or use it in any other commercial way?



Here are a few important considerations:

- Free satellite data is typically at low resolution (you can detect buildings but not cars) or dated (from a couple of months to a couple of years), while near-real-time satellite data at high resolution is usually available for free only for humanitarian reasons, such as through Maxar's Open Data program.
- Real-time, high-resolution data is still only a Hollywood fiction and near real-time high-resolution data still takes, in most cases, a few days. However, due to recent advances in automating the capture and distribution of EO data - such as in-flight pre-processing, cloud storage, and automatic ordering - the lag between scene capture and data transfer may soon drop to minutes.
- The imagery you see on Google Earth at the highest zoom level is aerial photography, not satellite imagery.
- Obtaining pricing information requires lengthy conversations - and, often, negotiations - with a sales representative.



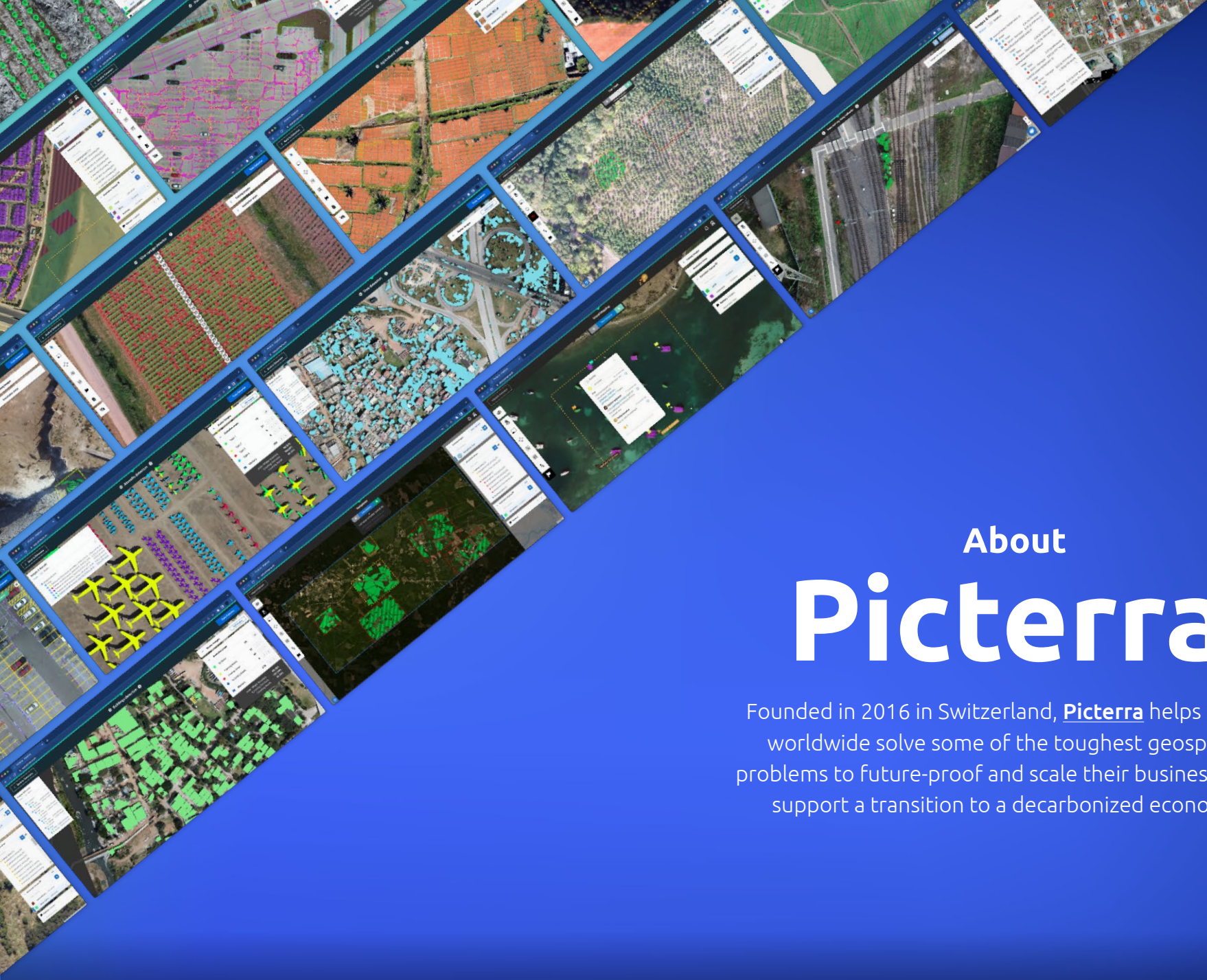
For free imagery, three excellent sources are:

- USGS Earth Explorer
- Sentinel Hub
- Google Earth Pro.

On most sites, searching for images involves the following steps:

- register and obtain a login,
- define an AOI, by entering the name of a location, drawing a polygon, or uploading a shapefile or a KML file,
- select other search parameters, such as which satellites to include, the date range, and the maximum cloud percentage,
- preview the imagery, download selected files.

Finally, now that you are familiar with the key concepts and variables you need to know to select the best sources of satellite imagery for your needs, this table should help you find them.

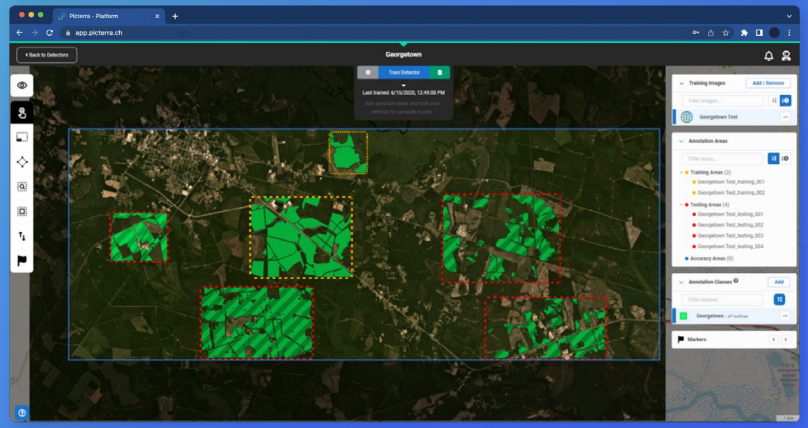


About

Picterra

Founded in 2016 in Switzerland, **Picterra** helps clients worldwide solve some of the toughest geospatial problems to future-proof and scale their businesses and support a transition to a decarbonized economy.







With access to more Earth Observation (EO) images than ever before, companies across industries are realizing the strategic importance of this data, even ones that traditionally never saw a use case for satellite, drone, and aerial imagery.

Picterra is the connecting power between the raw data from EO imagery providers, and the domain experts who deliver geospatial services and advisory to their clients. Our clients can create more value for their customers by using Machine Learning (ML) to crunch large volumes of data and prototype new models up to 95% faster than before in a broad range of industries.

Picterra's cloud-native and secure ML platform is trusted by over 100 enterprise clients, including Cyient, Fugro, General Motors, and The World Bank.

SKYTEC AERIAL DATA SPECIALISTS · CYIENT · sensand · FUGRO

FEDS Drone-powered Solutions · THE WORLD BANK · leidos · gm

For more information, visit www.picterra.ch



Find out more at

picterra.ch

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Appendix

Satellite imagery providers:

Company / Agency	Public	Private	Non-profit	Satellite operator	Imagery source / distributor	Highest spatial resolution (m)	Temporal resolution (dys)	Spectral bands (MS)
Airbus		✓		✓	✓	0.25	0.5	multi-resolution optical, radar
Amazon		✓			✓			
Azavea		✓						
Bellingcat		✓						
Bird.i		✓			✓			
Capella		✓		✓				SAR only
Descartes Labs		✓			✓			
Earth Observing System		✓			✓	0.40		
Esri		✓			✓	1.00		
European Space Agency (ESA)	✓			✓	✓	5.00	2 to 3	21
European Space Imaging		✓			✓	0.30		wavelengths between 450 nm and 2273 nm
Geocento		✓			✓			
Google		✓			✓			
Here		✓			✓			
ICEYE		✓		✓	✓	0.25	0.125	SAR
Indian Space Research Organization (ISRO)	✓				✓			
Japan Aerospace Exploration Agency (JAXA)	✓				✓	30.00		
L3Harris Geospatial		✓			✓			
Mapbox		✓			✓			
MapTiler		✓			✓			

Company / Agency	Public	Private	Non-profit	Satellite operator	Imagery source / distributor	Highest spatial resolution (m)	Temporal resolution (dys)	Spectral bands (MS)
Maxar		✓		✓	✓	0.31	1	5 MS
Microsoft Corporation		✓			✓			
National Aeronautics and Space Administration (NASA)	✓			✓	✓	15.00	1	6 MS
National Institute for Space Research (INPE)	✓				✓			
National Oceanic and Atmospheric Administration (NOAA)	✓			✓	✓			
Natural Resources Canada	✓				✓			
Planet		✓		✓	✓	0.50	1	2 MS
Radiant.Earth		✓	✓		✓			
Remote Pixel		✓	✓		✓			
Satellite Imagery Corporation		✓			✓	0.30		
Sentinel Hub		✓			✓	10.00		
SI Imaging Services (SIIS)		✓			✓	0.40		
Skyfi					✓	0.30		
Skywatch		✓			✓			
Spaceflight Industries		✓			✓			
SpaceWill		✓			✓	0.50		
Spectator Earth		✓			✓			
Synspective		✓		✓		1.00		SAR only
U.S. Geological Survery (USGS)	✓			✓	✓	15.00	16	6 MS
Umbra		✓		✓		0.15	0.25	SAR only
URSA Space Systems		✓			✓			SAR only
Urthecast		✓			✓			
Vito		✓			✓			
Zoom Earth		✓						