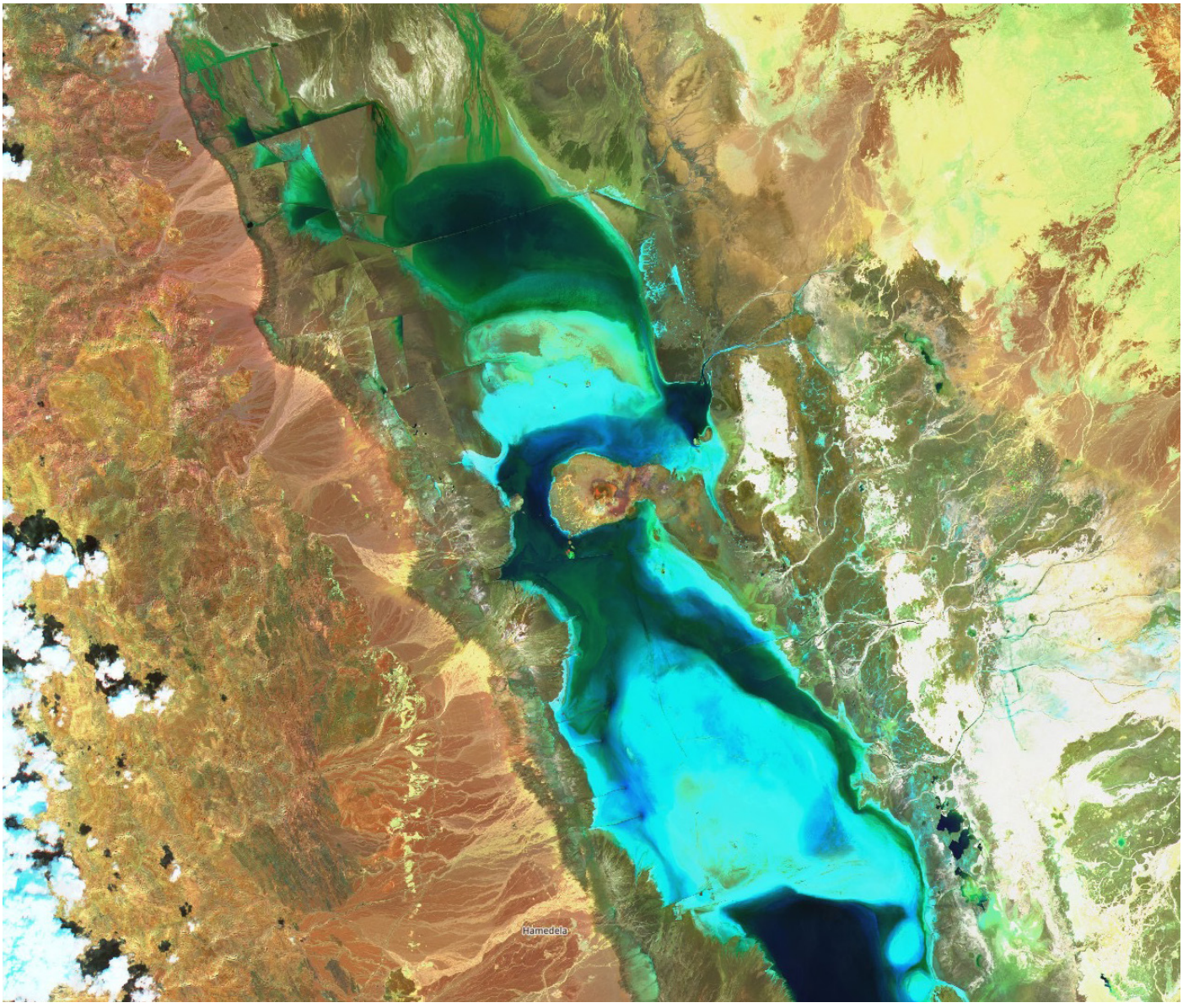
# teach with space

## → COPERNICUS BROWSER TEACHER GUIDE




CREDIT Copernicus Browser

## Copernicus Browser Teacher Guide

The goal of this guide is to help you navigate the main tools of the Copernicus Browser and demonstrate how to use them with your students in the classroom. To showcase its utility, we will delve into and analyse a case study, the focus will be on an extreme drought event in 2015 at Lake Poopó, the second biggest lake in Bolivia, which completely dried out for an extended period. This example will be used to:

- demonstrate the complexity of climate change and the impact of extreme climatic events over time
- initiate discussions surrounding climate change, incorporating political narratives by using EO data
- guide the student on the first steps of how to conduct online research on a subject matter

Satellite imagery, provided in a user-friendly way from the Copernicus Browser, is a powerful tool for researchers, decision makers and the general public, but it can also be a powerful tool for educators, touching on very interdisciplinary matters of our modern societies, such as climate change and sustainability, which require the combination of subjects like language, social sciences, physics, maths, programming etc.

## What is the Copernicus Browser?

The Copernicus Data Space Ecosystem Browser (or Copernicus Browser for short) is a browser-based application that provides easy and free access to satellite images from different Earth Observation missions (a full list of available data references can be found here). With this online tool, you can access images which provide a perspective on how the Earth looks from above or delve deeper into satellite data. The browser enables the study of a wide range of topics, both statically and through time; some examples of what can be explored are agriculture, atmosphere and air pollution, floods and droughts, geology, ocean and water bodies, snow and glaciers, urban, vegetation and forestry, volcanoes, and wildfires. The highlighted examples in these themes can serve as inspiration for school projects and lessons.

Satellite imagery is an interesting tool for students to explore and understand the world around them. It allows them to study complex topics like deforestation, melting glaciers, or urban growth in a more applied way by providing them with real images and data they can access and analyse. By working with these images, students can spot patterns, identify changes over time, and connect what they're learning in the classroom to real-world events. It makes subjects like environmental science, geography, and physics more exciting and relatable.

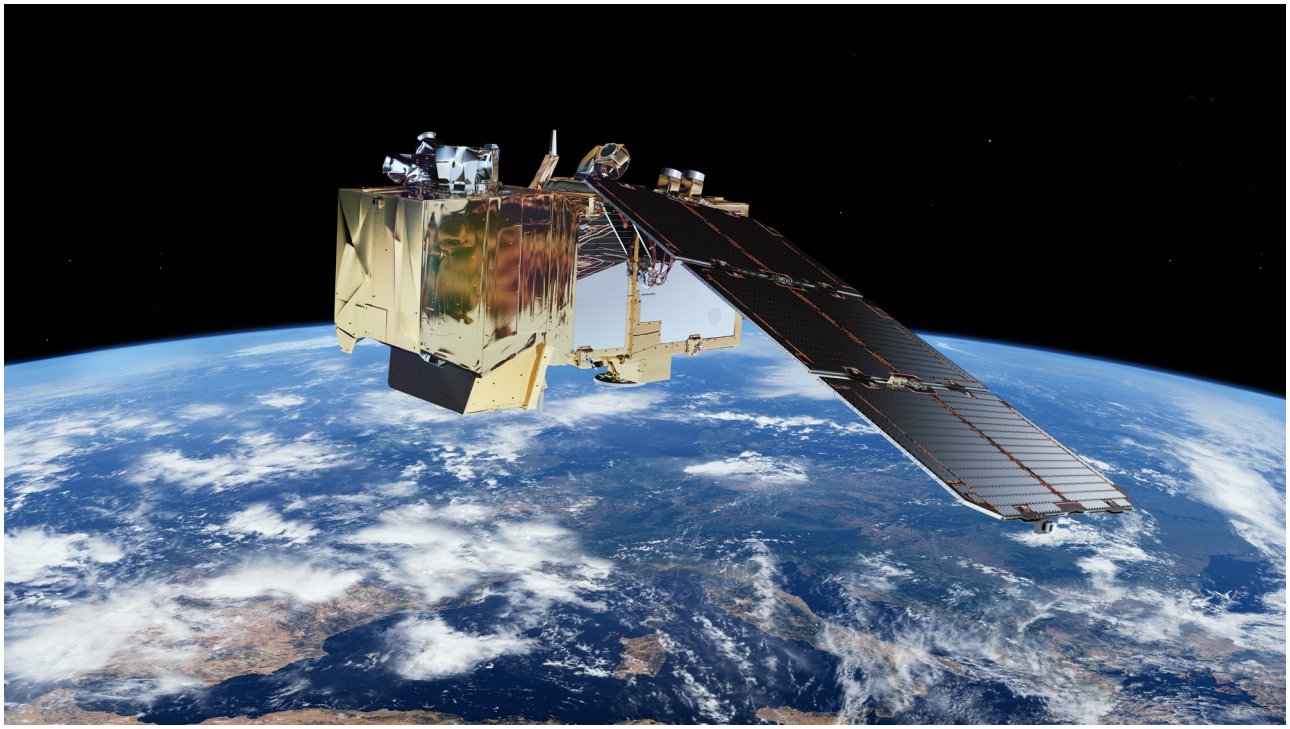
The Copernicus Browser can also be very actively used in the Climate Detectives project, where students take their learning a step further by using Earth Observation data to investigate climate and environmental issues in their local area. Whether it's tracking air quality, studying changes in vegetation, or observing the effects of rising temperatures, they become problem-solvers tackling real-world challenges. This hands-on experience allows them to address local issues that matter to them, their friends and their families. By working with real-world data, students not only enhance their understanding of climate science but also build confidence in using technology to address pressing environmental problems.

## The Copernicus Programme

The Copernicus Browser primarily uses data from the Copernicus Programme, a collaborative initiative between the European Space Agency and the European Commission that collects and shares information about our planet. This programme provides free and open access to satellite images and measurements, allowing users to study everything from urban growth to environmental changes.

At the core of the Copernicus Programme are the Sentinel satellites, a series of advanced Earth Observation satellites that continuously monitor our planet. Each mission focuses on specific thematic areas like land use, ocean monitoring, or atmospheric conditions. Together, the Sentinels provide detailed, high-quality data that fuels the Copernicus system used by researchers, policymakers and public authorities alike.

By combining this technology with open access, the programme not only supports scientific research and policymaking but also gives everyone the chance to explore and understand our planet in novel, exciting ways. The Copernicus Browser takes the vast data collected by the Sentinels and transforms it into an intuitive, easy-to-use tool, making it simple to explore and an excellent resource for learning.



Sentinel 2: CREDIT ESA/ATG medialab

## Setting the scene: Lake Poopó

In December 2015, a local newspaper in Bolivia alerted its population about a significant event that had taken place. Lake Poopó, the second-largest lake in the country, had almost completely dried up. As a result, the local ecosystem had been severely affected, with fish dying out and the animals feeding on them either being forced to migrate or starving to death.

The consequences for the indigenous people living near the lake had also been profound. They had relied on the lake for centuries, fishing and using its water for their daily lives. These new conditions forced them to shift their livelihoods to other sources of income, such as salt gathering, moving farther away to cultivate rice fields, or even migrating to different cities in search of new ways to survive.

The government of Bolivia attributed this prolonged drought, which persisted for several years after 2015, to climate change [1][2][4]. However, other perspectives soon emerged. Three years later, a major British newspaper published an article on Lake Poopó [4], highlighting the dramatic situation: "What was once the country's second-largest lake is now a salt flat, and the vanishing waters are taking an indigenous community's way of life with them." This article, along with others from the journalism and scientific communities that continue to surface, sheds light on other aspects of the issue beyond climate change.

A study by the University of Surrey and the University of San Andrés [5] found that precipitation (the amount of water falling from the sky in any form) and evapotranspiration (the amount of water evaporating from the lake) do not indicate a trend of diminishing water levels in the lake. In other words, it rains enough for the lake to be sustained if this were the only relevant metric. While climate change does have an impact on the issue [1][2], other factors play an important role in the dramatic decline in Lake Poopó's water levels. The rise in quinoa agriculture has grown by 45.5% from 1980 to 2011, followed by a 60% increase in just five years [2][6], using water that once flowed into the lake. Simultaneously, mining in the broader area around the lake has had a major impact on its stability and health, ultimately becoming detrimental to its ecosystem.

Despite these factors, reports of droughts affecting the lake date back as early as 1994, lasting for three years [9]. This raises questions about the significance of the lake's drying. Could the online information we gather be exaggerated or selectively presented for specific purposes? To explore this further, we can use the Copernicus Browser to examine how the lake has changed since 2016, when the first Sentinel-2 data became available.

## Suggested activity

Similar to the approach presented in the introduction, before using the Copernicus Browser, you can encourage your students to research the chosen subject, whether selected by you or by them, either online or offline - in your school's library. This can be a good opportunity to address how proper research is conducted, which can help with forming more complete opinions on the underlying issue.

Remind students that when conducting research, it is essential to evaluate the credibility and reliability of their sources. Always use references from reputable authors or well-established sources to ensure that the information is trustworthy and accurate. Credible sources are accountable for the information they provide, meaning their data can be questioned or corrected if proven wrong. Additionally, when multiple sources report similar information or draw the same conclusions, it increases the likelihood that the information is reliable and true.

# Getting started with the Copernicus Browser

To access the Copernicus Browser, use the following link:
https://browser.dataspace.copernicus.eu/

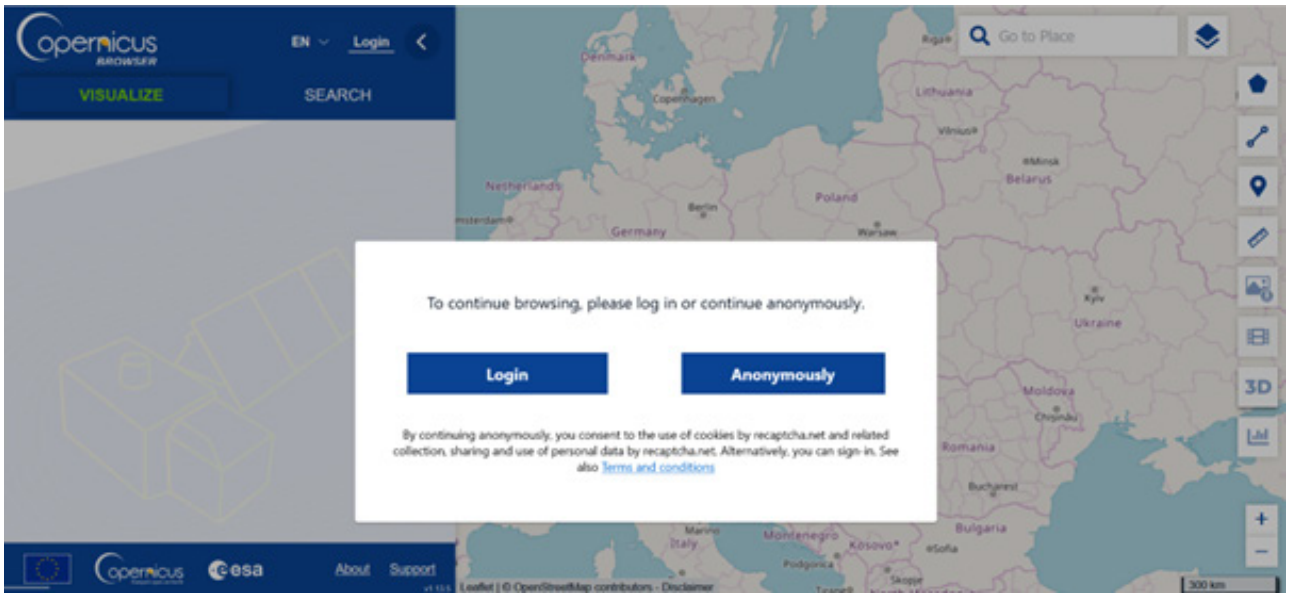



Figure 2

## 1.Creating an account (Optional)

You are initially prompted to choose between logging in or continuing anonymously. Having each student create an account can take a considerable amount of time during class. Even if you do not create an account, you can still access all the tools of the application, except for the timelapse function. To gain full access to all the tools, you can create an account by clicking on the login button.

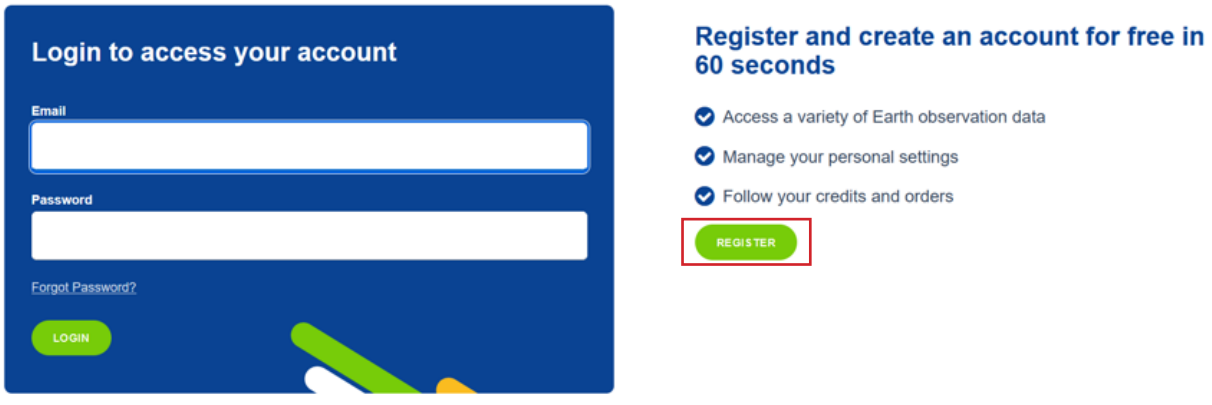



Figure 3

On the right, you can register a new account.

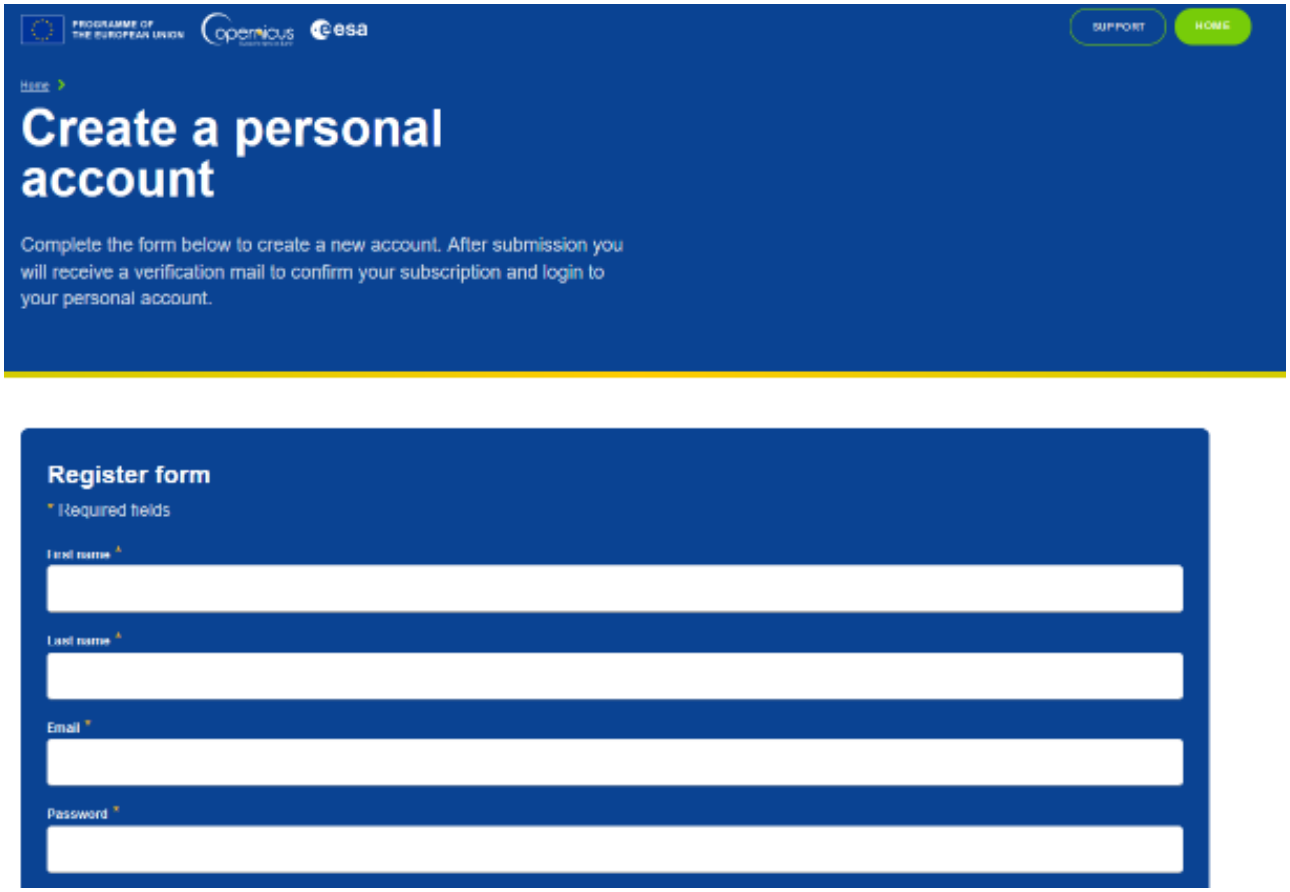



Figure 4

Fill in your information and wait for a confirmation email in your inbox. Depending on the system's status, the email may take several minutes to arrive, so it is better to create an account in advance.

## 2.Overview of the tool

After creating an account or continuing anonymously, you should see the following image. If you prefer, you can change the language to one of the available languages [1].

The application has three main parts:

- **On the left,** you can create data visualisations by searching for an image [2], selecting a satellite [3], applying instruments or visualisation techniques depending on the satellite [4], and comparing images to each other [5].
- **In the middle**, you can view and interpret the visualised data in a user-friendly way.
- **On the right**, you can use tools on top of the visualised image to take measurements [6], examine specific parts of the image [7], download the image [8] or create a timelapse (short video)[9].

**Attention!**

The pre-selected basemap (background) is a mosaic of different satellite images and may sometimes be mistaken for the images you visualise. To change this, go to the top right-hand side corner.

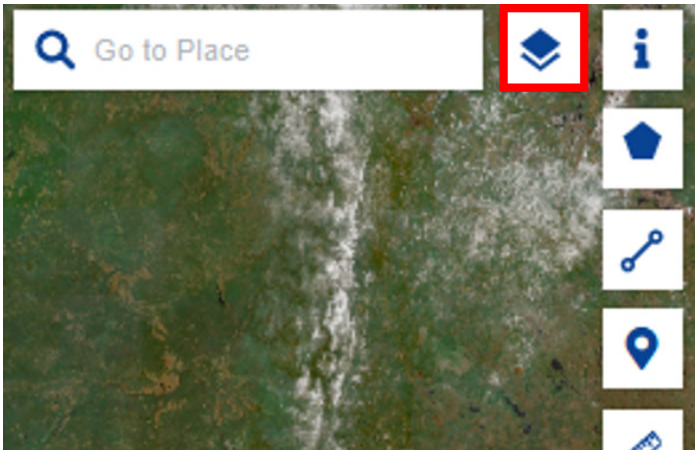



Figure 6

And change from Sentinel-2 Mosaic to OSM Background

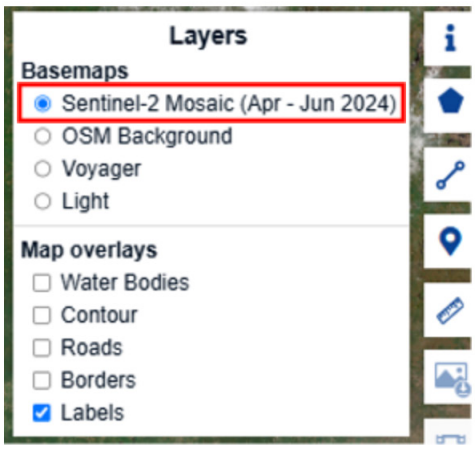



Figure 7

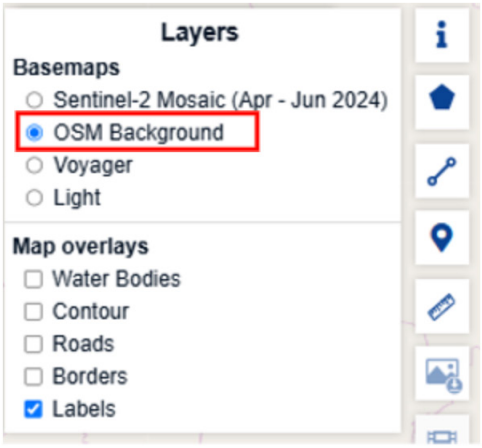



Figure 8

## 3.Visualizing your satellite image

First, let's locate Lake Poopó on the map. To find a specific location, type the name of the place you are looking for into the search bar at the top right.


Figure 9

After typing in the name, we can see two lakes pop up, with the first one being in Bolivia, which is the one we are looking for.

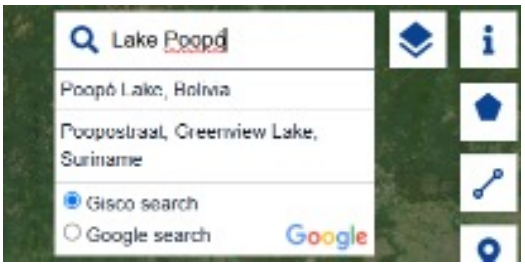



Figure 10

After clicking on the suggested box, you will be directed to this area in Bolivia:

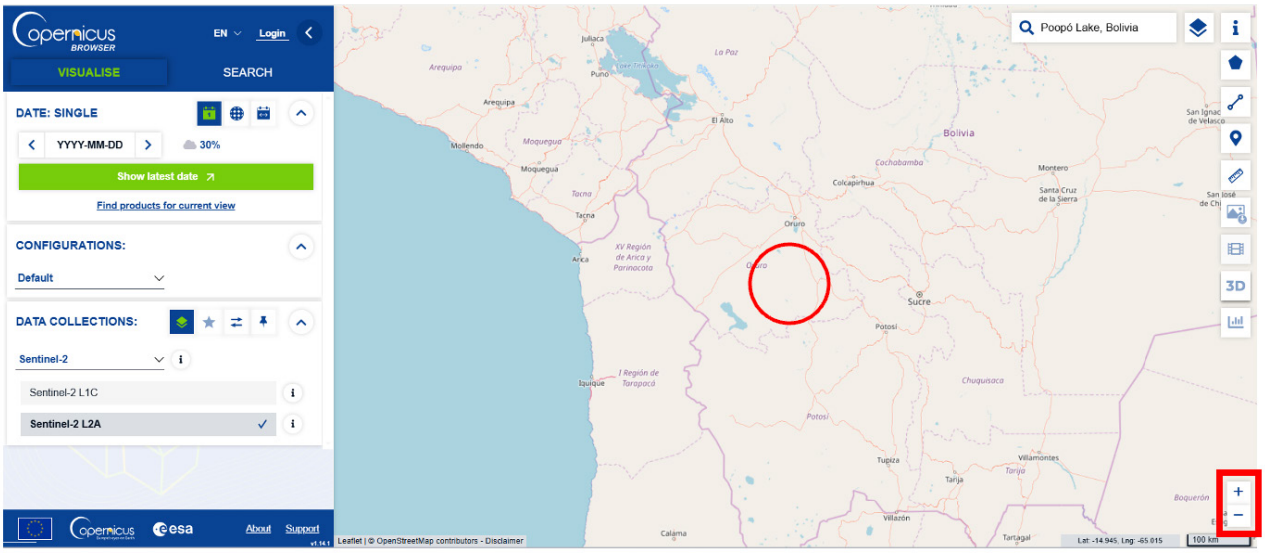



Figure 11

Lake Poopó is in the centre of the image, marked by the red circle. You can zoom in either by using the scroll wheel on your mouse or by simply clicking on the plus sign in the bottom-right corner of the screen. You can zoom out in the same manner if needed. The lake should look like this:

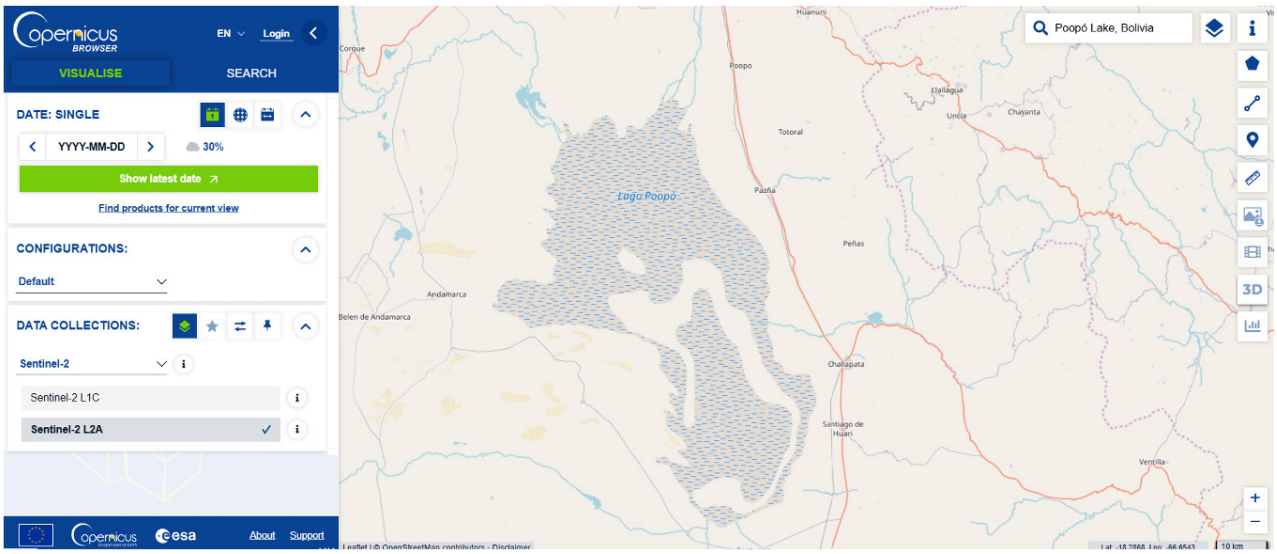



Figure 12

Now that you have located the lake, you need to find a satellite image from a specific date to see what it looks like from space. Simply click on the vibrant green button on the left-hand side of the screen, and the browser will find an image that meets the criteria you have set.

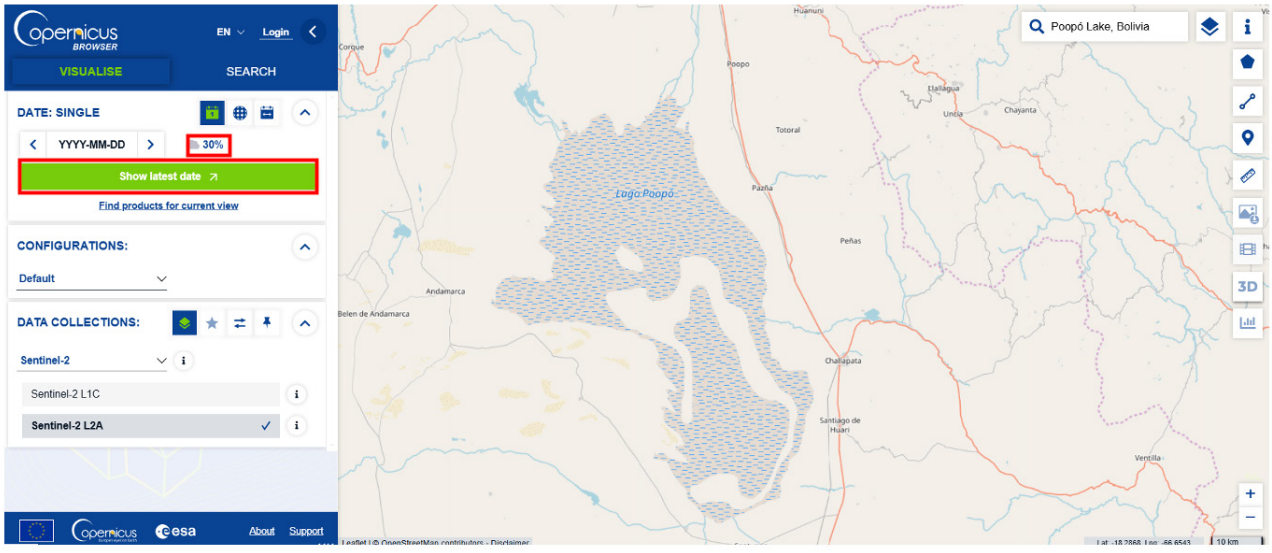



Figure 13

For now, the only criteria set are the area you have navigated to in the browser - around Lake Poopó - and the cloud coverage. The cloud coverage is shown by a cloud icon with a percentage next to it, likely set to 30% if you have just opened the browser. This filter ensures that only images with up to the selected cloud cover percentage (e.g., 30%) will be shown. You can adjust this percentage by clicking on the cloud icon.

When the green button is clicked, the following image appears - based on the conditions as of January 14th, 2025, when this guide was created.

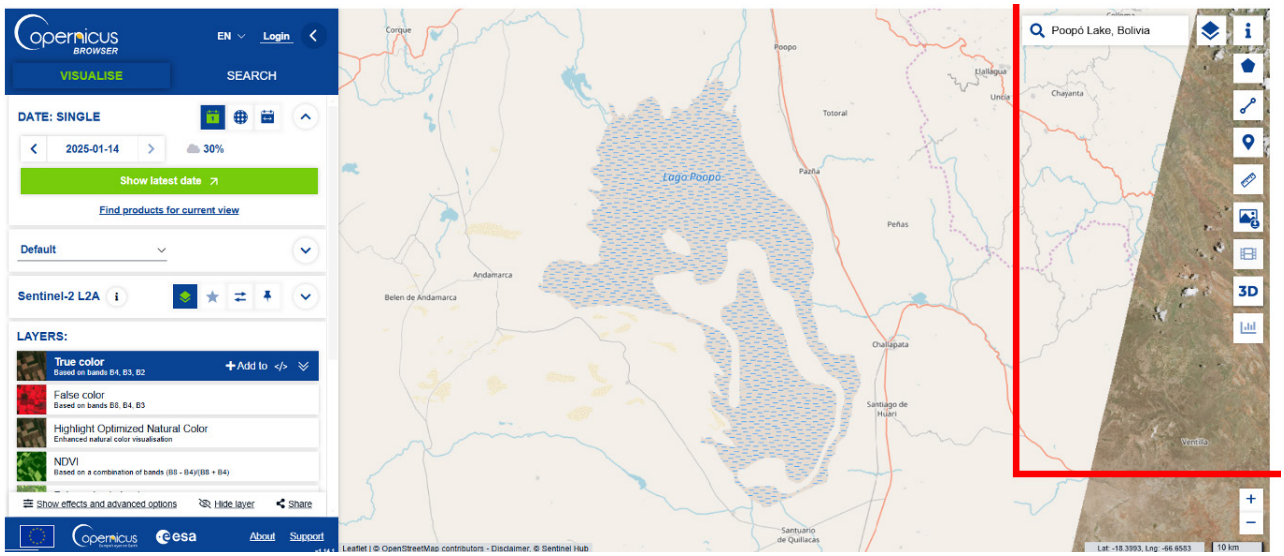



Figure 14

As you can see, most of the image is not covered by satellite data, and only the bottom-right part reveals how the ground looks from above.

## Did you know?

This happens because satellites follow specific orbital patterns around the Earth and are not always positioned over the location you wish to investigate. The areas of Earth that the satellites scan are called swaths.

Since you might not have found an image of the lake in this way, try clicking on the date box above the green button.

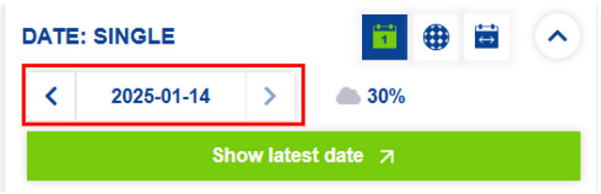



Figure 15

And the following calendar will open up

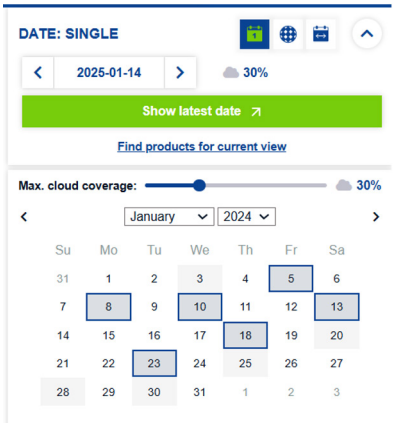



Figure 16

You will now see multiple dates highlighted in blue boxes, indicating when the set criteria (location and cloud coverage percentage) are met. Click on these dates to find one that fully shows the lake. The light grey coloured boxes indicate dates that do not fully meet the criteria but can still be used if you need data from a specific date. The white boxes indicate that no data is available for that date. You can also adjust the cloud coverage by sliding the bar next to the cloud icon. For example, the following image was taken on the 28th of December 2024, meeting all the set criteria.

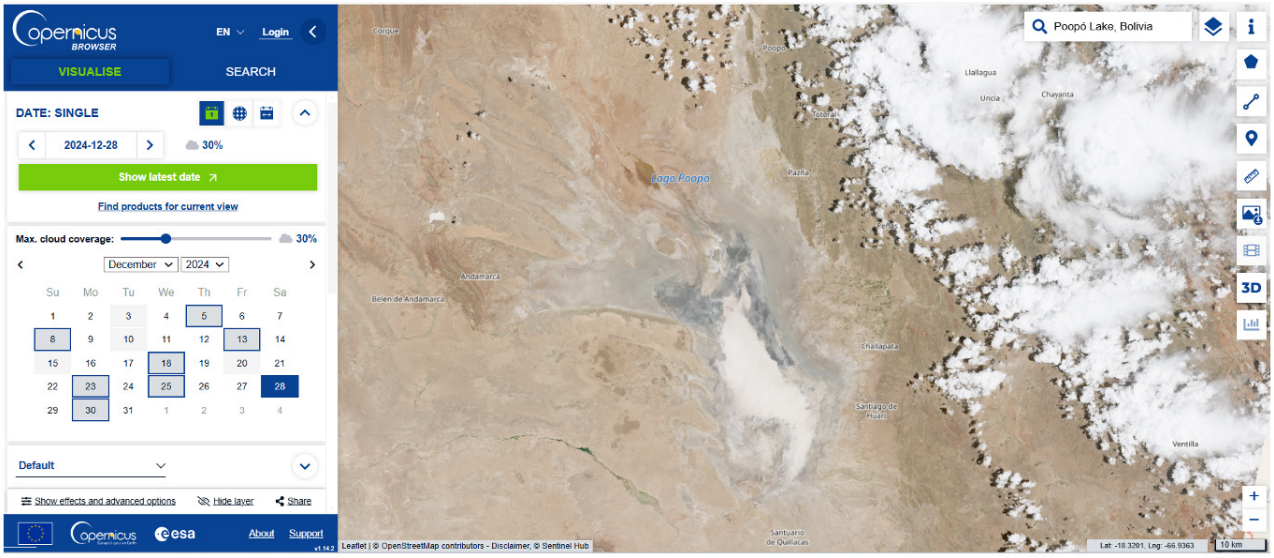



Figure 17

These images are taken by a constellation of satellites called Sentinel-2, designed to capture high-quality images of the ground. There are more satellites from which you can choose that can be used for different types of images. You can see which satellite you are using each time on the left part of the screen. Clicking the information icon will provide you with useful information about the selected satellite.

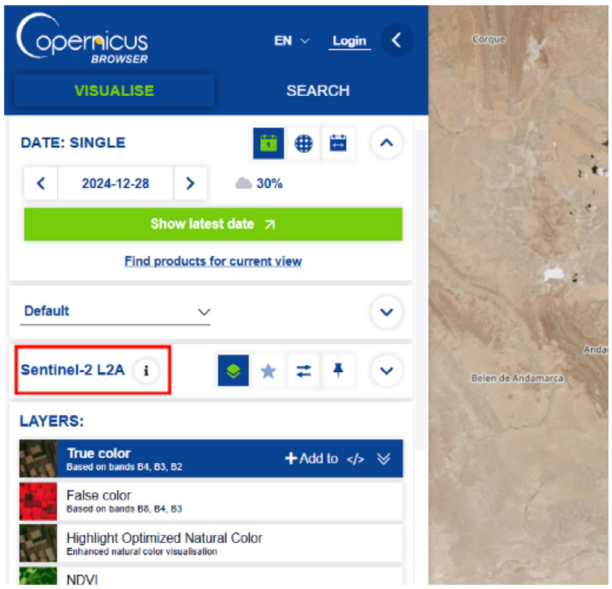



*Figure 18*

If you want to change satellite, you can click on the arrow:

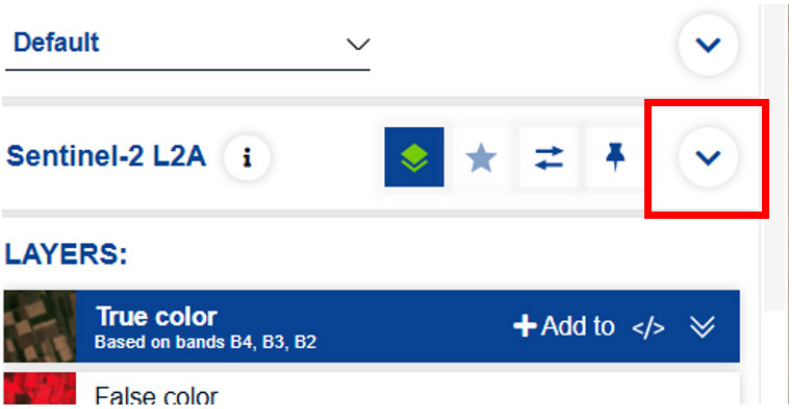



Figure 19

Then choose the satellite mission you need from the dropdown list.

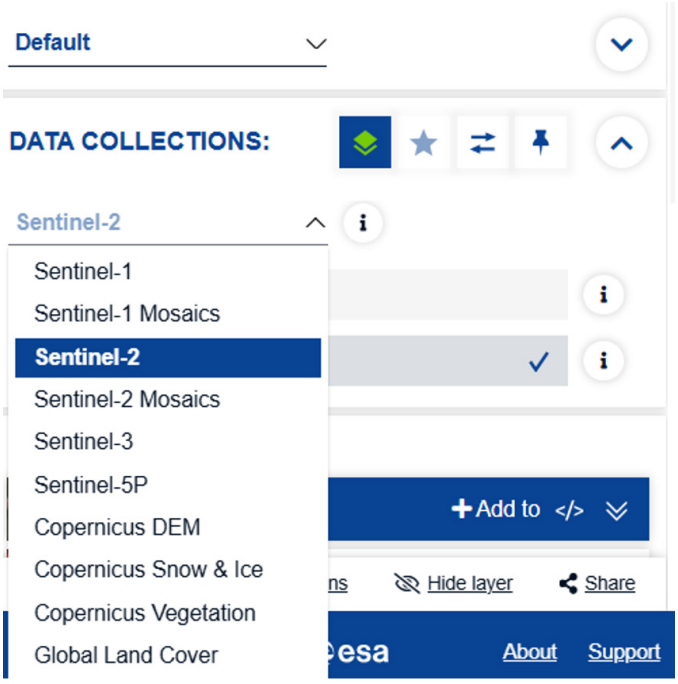



Figure 20

For this guide you are only going to be using the Sentinel-2 satellites.

## 4.Saving your satellite images in the application

Now that you have learned how to find images on the platform, you can start searching for specific dates to better understand the research on Lake Poopó. The previously discussed articles highlighted lake's drying in 2015. Try to find the closest available date to 2015 and observe how the lake appears.


Figure 21

**Since the Sentinel-2 satellites do not provide data from 2015 for this area, the earliest available image is from 31st of October 2016.**

The lake does not appear to have much blue colour but it is not clear what you are looking at yet. You can **save the image for later** by clicking on the "Add to" icon and selecting "Add to Pins". Please note that if you are not logged in, your pins will be lost when you close the browser. However, if you have an account, your pins will be saved and accessible each time you log in. Once an image is saved to your pins, you can find it by clicking the orange-highlighted button.

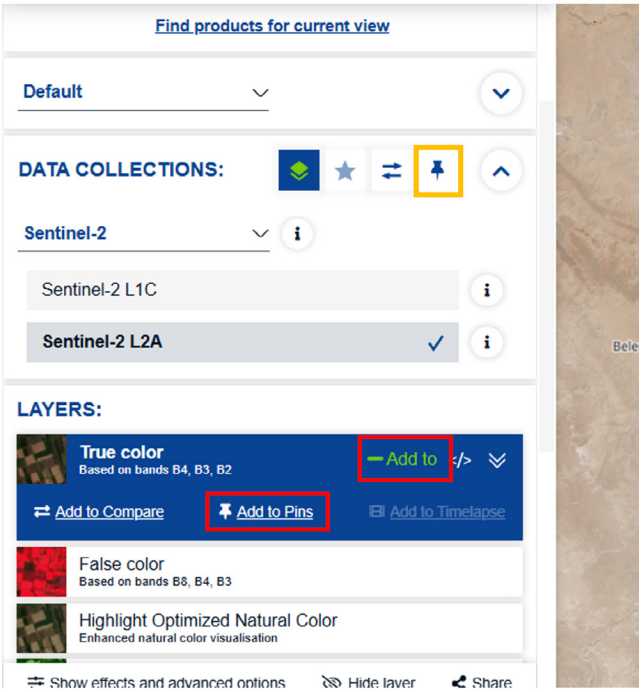



Figure 22

Now, try searching for different dates to see how the lake changed throughout the year or across different years. For example, you can check the image from 22nd July 2022.


Figure 23

See how different the lake looks! The water is now clearly visible in a blue-green colour! **Be sure to save this image to your pins as well**.

## 5.Measuring distances and areas

We have gotten a first glimpse of the scale of the disaster, but we can go deeper and determine the exact area affected by the drought using the polygon tool on the right-hand side of the screen.

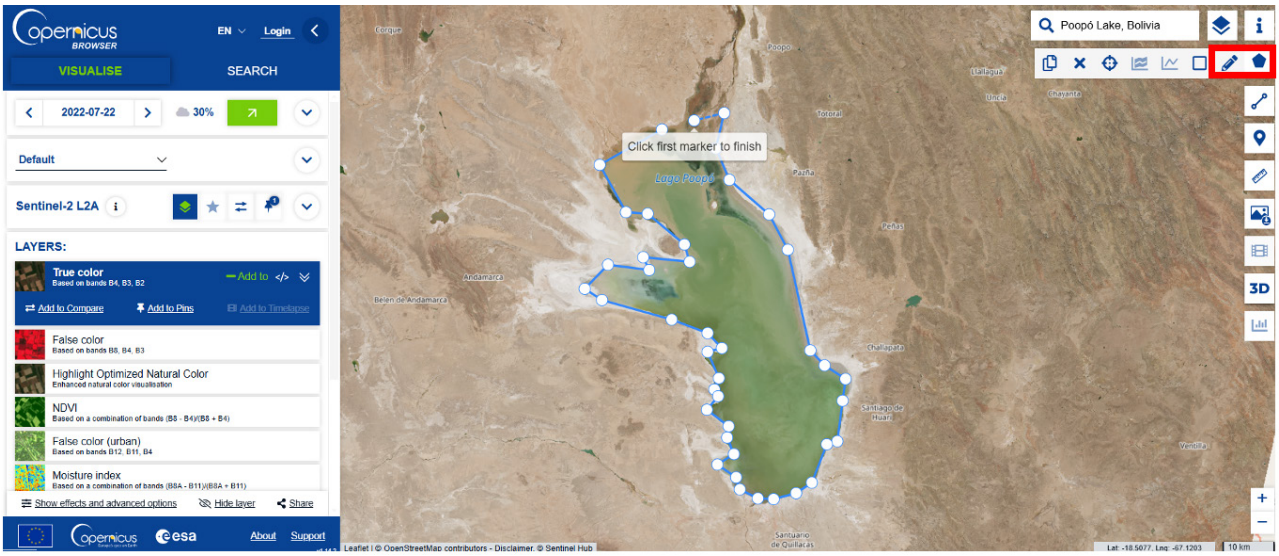



Figure 24

With this tool, you can draw an area of interest, by placing multiple small markers on the map to create a polygon. To finish drawing your area of interest, simply click on the first marker that you placed on the map.


Figure 25

After completing the polygon, you can see that the total enclosed area is shown in the appropriate unit of measurement. In this case, the water in the lake covered an area of 1645.19km squared – as big as the entire city of London! You can find similar examples of analogies to help your students better grasp the scale of the area.

With a similar tool, you can also measure the perimeter of the selected area. To do this, start drawing in the same ways as when measuring the area.

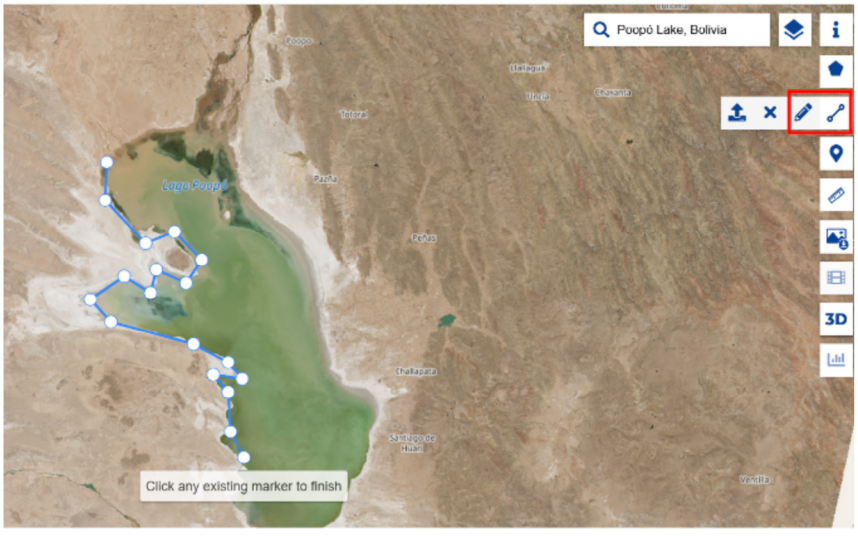



Figure 26


Figure 27

When you finish, the length of the perimeter will appear next to the selected tool. The perimeter here is 246 km.

Regarding the rest of the tools on the right, you can use the ruler icon to measure both perimeter and area at the same time. Additionally, you can download the image to your computer or even view a 3D representation of the landscape by clicking the yellow highlighted buttons.

## 6.Comparing images

Now that you have a clearer understanding of the disaster's scale, you can visually compare the two periods using the compare tool. First, open your saved pins by clicking on the following icon on the left-hand side of the screen.

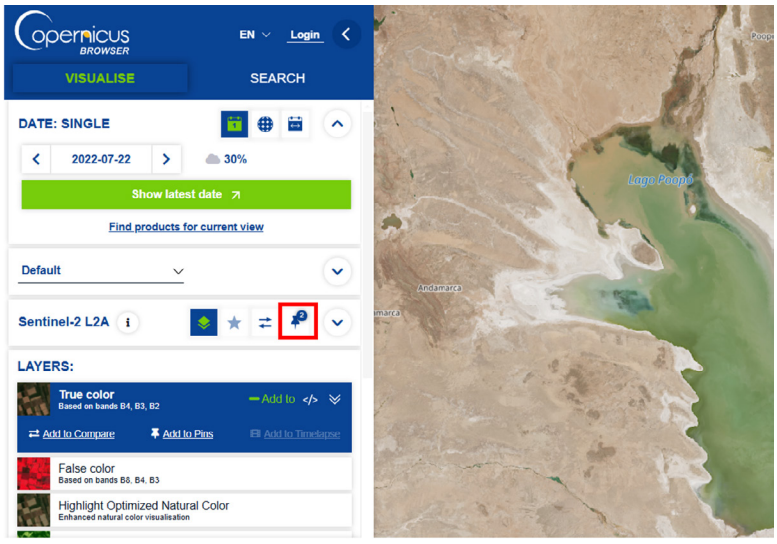



Figure 28

There, you will be able to navigate through your saved images. For now, you only have two of them: the empty lake and the nearly full lake. Click on the button that shows two arrows highlighted in red in order to place these images inside the “Compare” tool. You can find the compare tool right next to the pins group, highlighted in orange.


Figure 29

Go ahead and click on the Compare tool button which will direct you to the following toolbox. Here, all of the images that you selected are stacked on top of each other, with only the top image visible at first. Try moving the sliding bar to the left or right to see what happens.

As you slide the bar of the top image to the left, the image beneath the top layer gradually becomes visible. Now, you can see part of the lake with water and part of the lake without water, reflecting the differences between the dates you selected. This is a great way to visualise changes over time and gain a better understanding of how the landscape has changed.

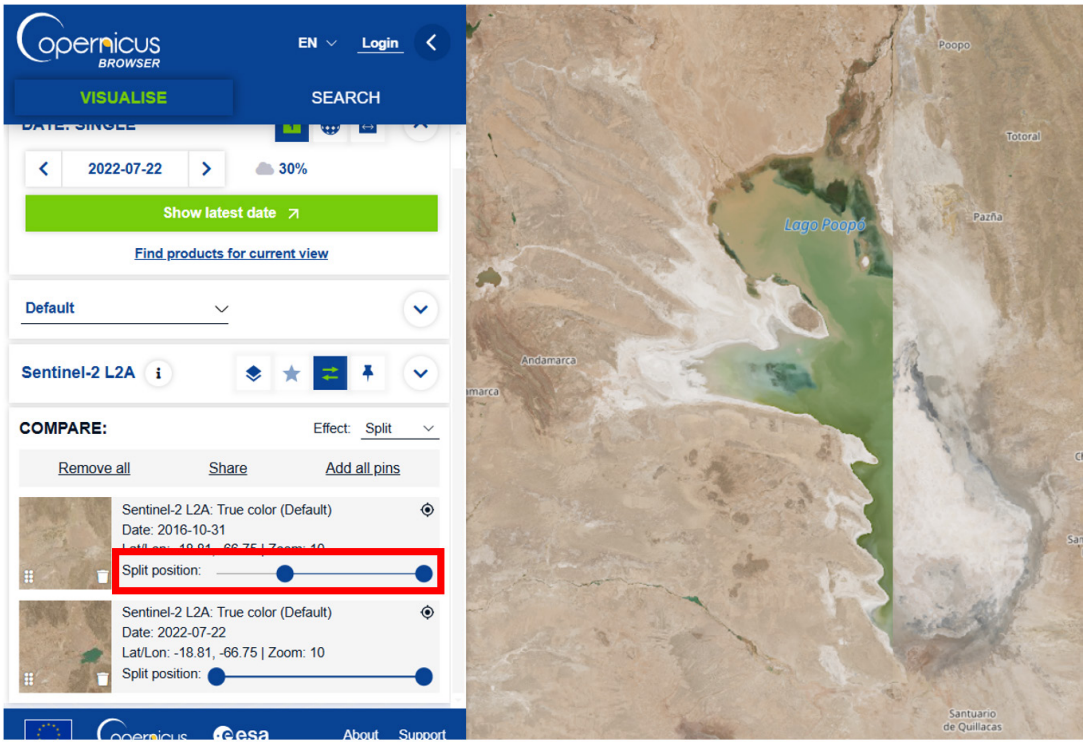



Figure 30

## 7.Creating a timelapse

Another tool for visually tracking changes over time is the timelapse tool, which **can only be used if you are logged in.** However, this is the only part of the application that requires an account.

To use it, click on the "cinema" icon on the right and select the area you want to observe (in this case, the lake as a whole), and then click on the play button in the middle of the blue rectangle. If you cannot click on it, **first find an actual satellite image of the place** by going through the dates, as shown in the first part of this guide. Also, make sure to deselect any measurements you have taken with the ruler or other tools to measure the perimeter or area before continuing with the timelapse. Otherwise, you will only see the enclosed area in the timelapse and not the entire image.


Figure 31

Next, you will be taken to a new interface where you need to search for images from scratch. On the left side, you can select the date range, the number of images to display (sorted by orbit/day/week/month/year), the cloud coverage (as explained in the beginning of this guide) and the minimum tile coverage (e.g. 25% percentage means that **at least** 25% of the image will contain satellite data). On the right side, you can preview the results by clicking the play button, adjust the speed of the timelapse and downloading it.

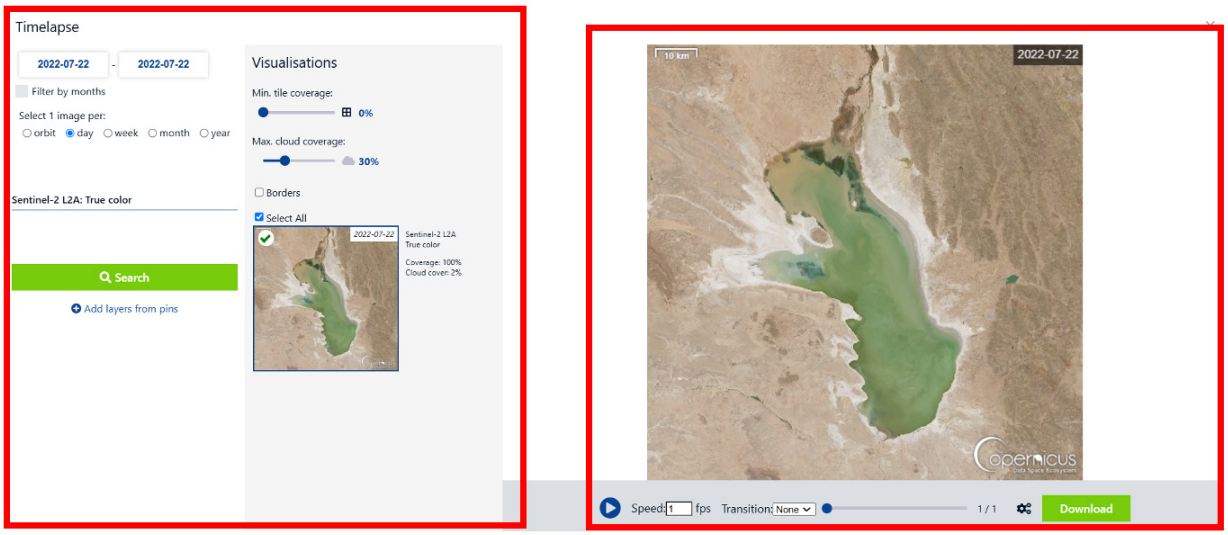



Figure 32

To investigate what actually happened to the lake over time, set the timelapse to cover the entire period from the oldest available data (31/10/2016 in this case) to the most recent images (depending on when you are using this guide) . Since the timespan is quite large, you can choose to view 1 image per week, set the minimum tile coverage to around 80% and the maximum cloud coverage to around 20%. Click “Search” and observe how the history of the lake evolved.

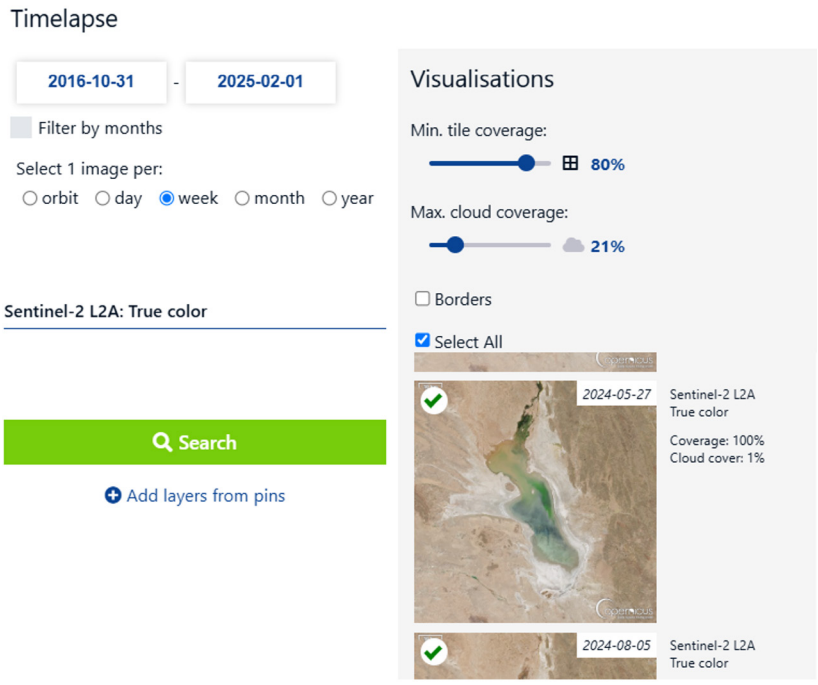



Figure 33

As you can now observe more clearly, the lake is indeed very dry, and for most of the timespan, it is completely gone. It seems that every year, the lake partially refills during the spring and summer months, with its peak occuring in 2022, when a significant refill can be observed. On the other hand, in 2021 the lake remained completely drained for almost the entire year.

You can download the timelpase as a .gif file for use in presentations or other formats outside your browser by clicking the “Download” button on the right side of the screen.

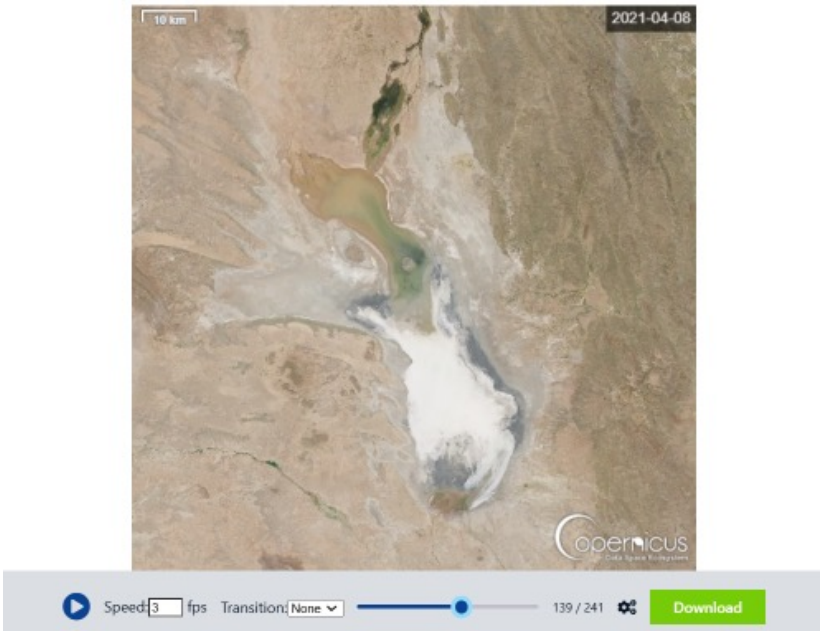



Figure 34

## Did you know?

Using the timelapse tool can help you understand how the overall situation evolves through time, while at the same time providing an excellent visualization technique which can be used to showcase the situation.

## 8.Visualizing images in different ways

Until now, you have been viewing images in their standard form, as they appear to the human eye using a combination of the red, green, and blue parts of the light spectrum. However, satellite imagery and image processing allow for different combinations of the spectrum to be used, providing deeper insights into what is happening in an image.

For this reason, there are predefined indixes and different types of visualisations available. After searching for an image on a specific date, you can explore the “Layers” box, where you will find options such as “True color”, which represents the image as seen by the human eye, but also other types of visualizations which you can explore.

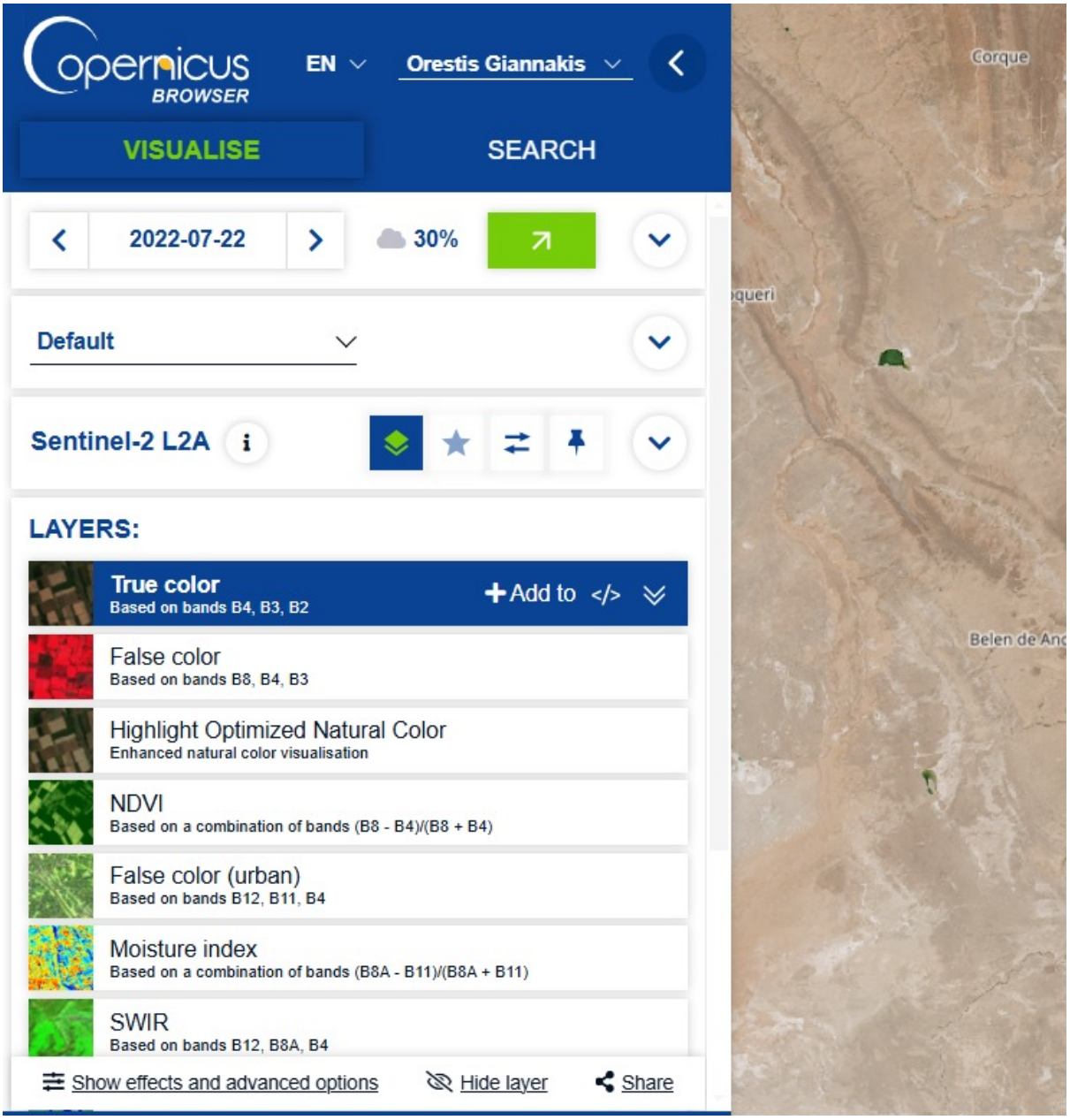



Figure 35

Try clicking on the one named NDVI (Normalized Difference Vegetation Index). You will now see the exact same location in the exact same time, but displayed in **different colours which are not the colours our human eyes would naturally percieve from space.**

This index uses the Near-Infrared part of the spectrum, combined with the Red part of the visible spectrum, to generate an image that conveys different information. For each of the different indices or visualizations, you can find more information on what they do and what the colours mean, by clicking on the double arrow icon.

In this specific case, the green parts of the image indicate that there is vegetation. The greener a region appears, the healthier the vegetation is. Grey areas represent barren land, such as rocks, sand or snow, while black areas indicate water. This makes it much easier to distinguish water from other features, allowing for a clearer interpretation of the satellite data.

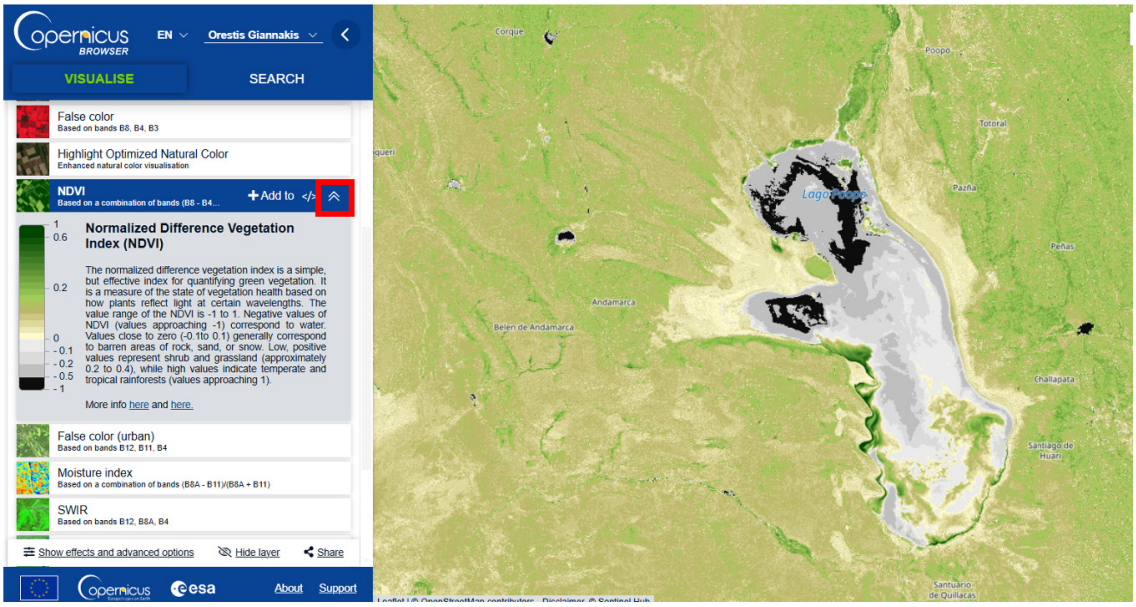



Figure 36

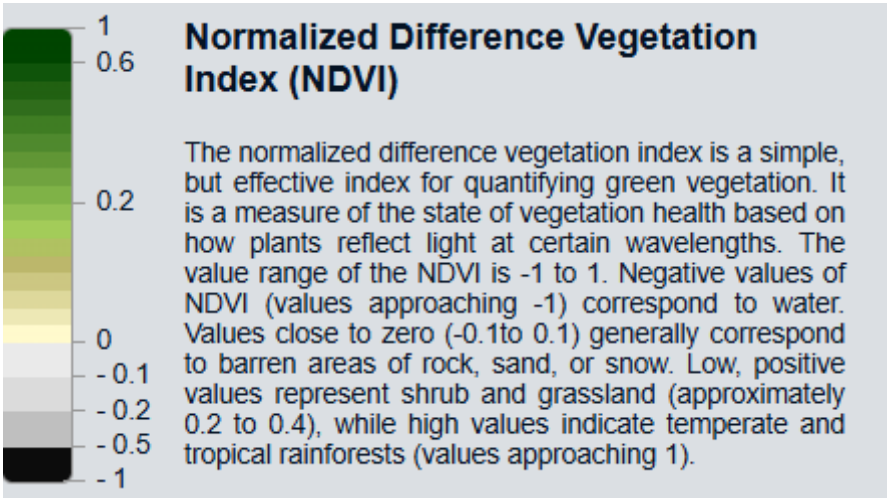



Figure 37

You can try using this index to also understand how the drought of the lake evolved through time, similar to how the timelapse was used. Use the area of interest tool explained in the “Measuring distances” section to select the lake, then click on the “Statistical info” button shown below.

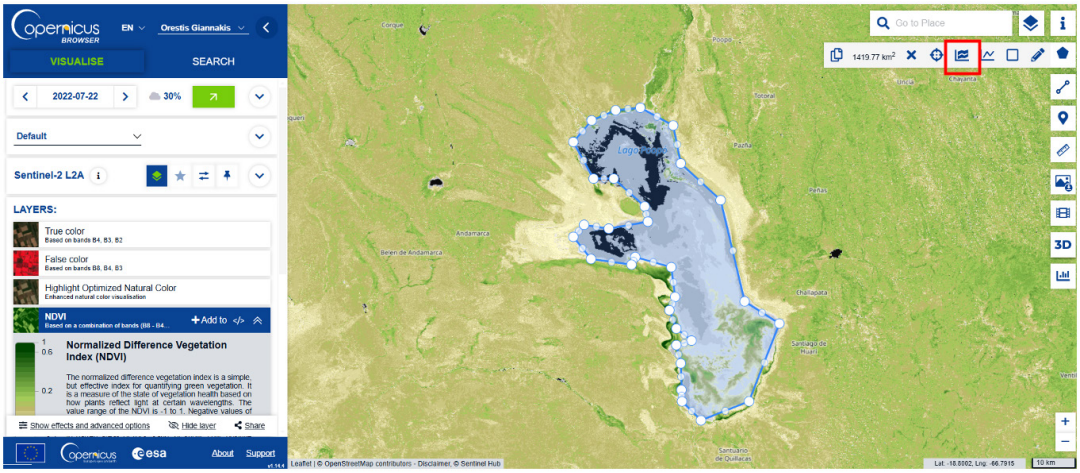



Figure 38

A new data box will pop up, from which you can see the evolution of the specific index over time. Set the cloud coverage to around 20% again, but this time go back 5 years instead of 1 month to better understand the previously mentioned evolution.

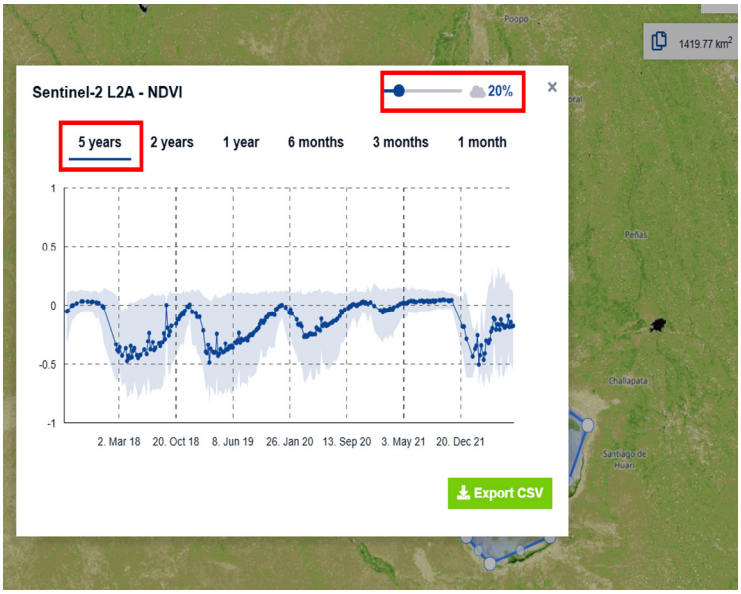



Figure 39

Now, all that remains is for you to understand what the numbers mean. By referring to the additional information about the index mentioned earlier, you can find that values of -0.2 and below indicate the presence of water in your area of interest. The data now makes much more sense, since you can clearly see that the lake was periodically emptying and refilling almost every year - except for 2021, which aligns with the observations made with the timelapse function. It is also easier to see that the lake refilling during the spring and summer months, and emptied during the autumn and winter months.

## Note

The NDVI layer was chosen in this case study as it is useful and relevant for many scenarios you may come across. However, depending on your research focus, you might explore other themes. For example, relevant to the case study in this guide, you could select the theme “Ocean and Water Bodies” and conduct a similar analysis using the Normalized Difference Water Index (NDWI) layer, which is specifically designed to highlight the presence of water.

## 9.Other indices and visualizations

You can also explore other indices and visualizations depending on the type of event unfolding in your selected research. By clicking on the “Themes” button, you can browse different themes that might be relevant to your study or provide inspiration. However, only after selecting a theme and choosing a specific date will the platform display the proposed indicies and visualizations for that particular theme.

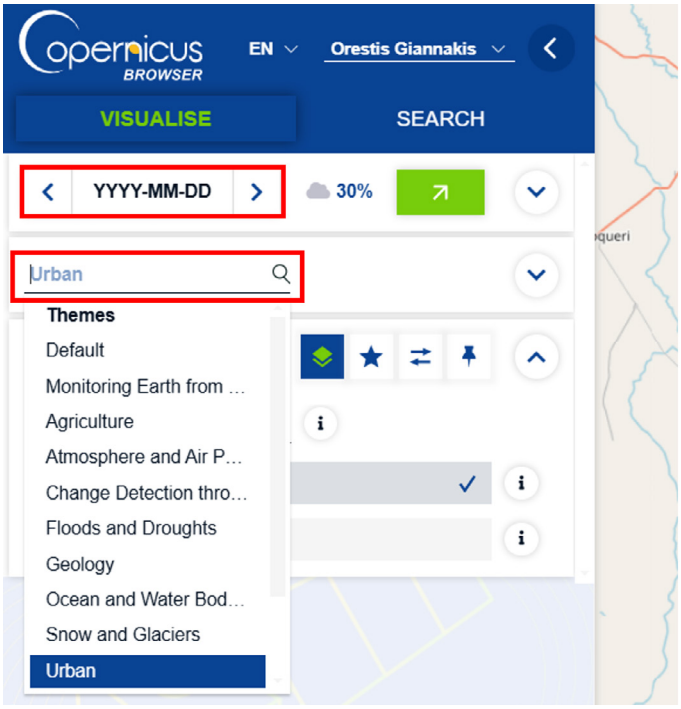



Figure 40

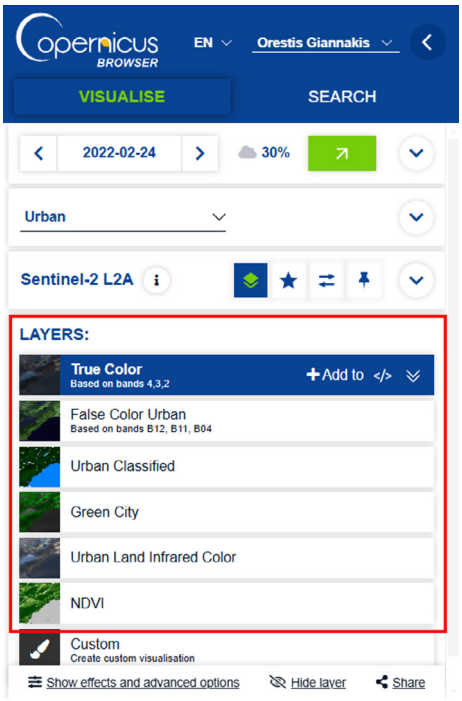



Figure 41

# 10.Conclusions

In this teacher guide, we used the Copernicus Browser to further investigate the drying of Lake Poopó, gaining a better understanding of what has happened in this area over the period for which satellite data is available. The Copernicus Browser was used in conjunction with online articles, newspapers, scientific publications to extend the information found and provide a more comprehensive view of the lake's evolution over the years.

By acquiring the skills to use the Copernicus Browser, you and your students can become reporters, policy makers, and researchers, identifying and investigating your own case studies. A great way to start is by selecting a local event that interests your students and using all available resources - such as online articles, newspapers, in-situ data, and experts' opinions – to build a well-rounded analysis. The Copernicus Browser itself can serve as a valuable tool to support your findings and form a conclusive opinion on the topic you are researching about.

This approach empowers students to take ownership of their research, formulate their own opinions and critically verify the information they encounter online.

## Key Takeaways

- **Satellite data provides valuable insights** into environmental changes over time, allowing students to investigate real-world case studies.
- **Tools like the Copernicus Browser enable interactive learning**, helping students visualise changes in landscapes, such as drying lakes, deforestation, and urban expansion.
- **Combining satellite imagery with other sources** (e.g. scientific publications, news articles, and in-situ data) helps students develop a more comprehensive understanding of environmental issues.
- **Hands-on exploration fosters critical thinking**, enabling students to analyse, interpret, and verify information rather than passively consume content.
- **Local case studies can make learning more engaging**, allowing students to connect global environmental challenges to their own surroundings.
- **Using satellite data in education prepares students for future careers**, introducing them to geospatial analysis, Earth observation, and data-driven decision-making.

# → Supporting links

## More about Copernicus Browser

Copernicus Ecosystem youtube channel:
https://www.youtube.com/@copernicusdataspaceecosystem/videos

Video tutorial for Copernicus Browser:
https://www.youtube.com/watch?v=FolIn5r6ZWk

Another tutorial for Copernicus Browser:
https://documentation.dataspace.copernicus.eu/Applications/Browser.html

https://dataspace.copernicus.eu/explore-data/data-collections

## Links for Lake Poopó


[1] https://www.sciencedirect.com/science/article/abs/pii/S0016718518300861

[2] https://storymaps.arcgis.com/stories/ca450f6dc50c4ff0a56f752dfc178d34

[3] https://www.wfp.org/stories/cop27-dried-lake-and-indigenous-community-precipice-bolivia

[4] https://www.theguardian.com/world/2018/jan/04/the-ecological-catastrophe-that-turned-a-vast-bolivian-lake-to-a-salt-desert

[5] https://www.mdpi.com/2072-4292/12/1/73

[6] https://www.preventionweb.net/news/lake-poopo-why-bolivias-second-largest-lake-disappeared-and-how-bring-it-back

[7] https://muse.jhu.edu/article/760930

[8] https://dictionary.cambridge.org/dictionary/english/discursive

[9] https://www.tandfonline.com/doi/pdf/10.1623/hysj.51.1.98?needAccess=true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