



CESAR Scientific Challenge

A 3D Earth

Research on topographic maps with data from the *Copernicus Programme* and *Google Earth*

Teacher's guide





Table of contents

Didactics	4
Your Scientific Challenge	16
Phase 0	18
Phase 1	20
Activity 1: Refresh concepts.....	21
Activity 2: How to draw a map?	23
Activity 3: Identify relief and hydrography in a physical map.....	25
Activity 4: Where to draw something on our map?.....	27
Activity 6: Does my island have water, reservoirs or rivers?	42
Activity 7: Study of climate change with maps.....	44
Activity 8: Earth exploration by the European Space Agency missions.....	46
Activity 9: What have you learnt so far?	49
Phase 2	50
Activity 10: Ask for a videocall with the CESAR Team if needed.....	51
Phase 3	53
Activity 11: Identify the course of a river on a topographical map.....	54
Activity 12: Topography in augmented reality: Sandbox.....	56
Activity 13: What can you see in a topographical map?.....	58
Activity 14: Study topographical maps with Google Earth.....	62
Activity 15: Create your topographic map with Google Earth.....	71
Phase 4	81
Activity 16: Evaluation.....	82
Activity 17: Present your results.....	82
Links	83
Phase 0.....	84
Phase 1.....	84
Phase 2.....	84



Phase 3.....	84
Phase 4.....	84
Credits:	85



Didactics

Learning objectives



Figure I: The considered top 10 skills in the 2020. (Credits: Rethinking).

The CESAR Team generates activities for students to develop the considered top 10 skills in the 2020, where problem solving requires critical thinking and creativity. Our proposal is to execute these activities in teams. Students will find the environment where to develop their communication skills, managing different opinions and approaches, and making use of their emotional intelligence.

The CESAR scientific challenges aim to follow the thinking skills order established by the Bloom's taxonomy diagram, from a low order thinking skills (**remembering, understanding**) to a high order thinking skills (**evaluating, creating**), passing through mid-order thinking skills (**applying** methods and concepts for **analyzing** events).

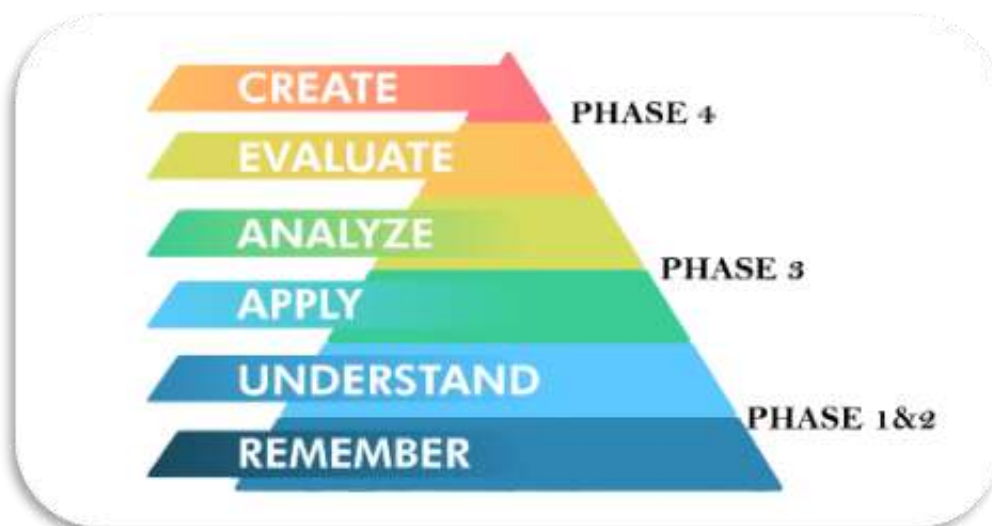


Figure II: Bloom's Taxonomy diagram. (Credits: <https://medium.com/@ryan.ubc.edtech/>)



Teaching Techniques:

In order to achieve the previously mentioned Learning Objectives, the CESAR Team recommends the use of some techniques like, ***flipped-classroom, solution of daily life problems (using the scientific method) and collaborative work.***

In this activity students will make use of the *flipped classroom* for Phases 0 and 1 to get ready for the problems solution of their Challenge during Phase 3. Phase 2 is optional and consist on a video call with us. In Phase 4, each team will evaluate their Experience and share it with the Scientific Community (their class/center and us, the CESAR Team). All phases are recommended to be executed as collaborative work (using **forum and blogs**). Here we detail the process:

- **Your Scientific Challenge:** We introduce the Challenge to students and ask for their support
- **Phase 0: Putting things into context**
 - The role of the **European Space Agency** their center in Spain (European Space and Astronomy Centre, ESAC) as well as the CESAR Team. (in videos)
 - **Nowadays role models** for students to build the **Teams for their Challenge**. We recommend that Teams are formed by 4-6 people, each one of them with well-defined tasks. When possible, try to balance them in gender and diversity of capabilities.
- **Phase 1 and Phase 2: *remembering and understanding*** using different sources:
 - **Phase 1:** scholar cv material & new concepts (videos, documents, games)
 - **Phase 2 (optional):** learn from an expert
 - For the teachers: talks provided by experts on the topic in previous CESAR teacher workshops.
 - For the classroom: A video call with the CESAR Team to solve doubts that may have appeared until the moment in what students have just learnt. At this stage, students had already become “experts” on the topic of the Challenge .
- **Phase 3: *applying*** the already known concepts following a methodology (procedures) for ***analyzing data*** and ***solving daily life problems*** (their Scientific Challenge).
- **Phase 4:**
 - ***evaluating*** their learning process during the Challenge (self and co-evaluation)
 - ***creating*** a final product to show to the Community (class/school/us) their learning process. With this you could participate in the CESAR Scientific Challenge contest.



As Figure III shows, the CESAR Scientific Challenges should execute all mentioned Phases. Phase 0 and 1, are the roots for all the Scientific Experiences, always to be done in the classroom/home. Phase 2 (video call executed from the classroom to us) is optional.

Depending on the type of Phase 3, there are various CESAR Experience Types:

- **Type I: Space Science Experience(s) @ESAC:** At ESAC, (as always in the past), completely run by the CESAR Team. Total duration 1.5 hours, with 45 minutes for the Activity and another 45 minutes the tour around the ESA spacecraft models.
- 1. **Type II : On-line Space Science Experience(s):** In the classroom/home, (Type I but completely guided by the teacher). Total duration 1h (MIXED when combined with Type I/III)
- 2. **Type III: On-line Research Project:** In the classroom/home, completely guided by the teacher. Total duration several days. (Type II but executing more or all the Activities of the Guide).

Phase 4 is always executed in the classroom/home to evaluate the learning process per Team as a whole.

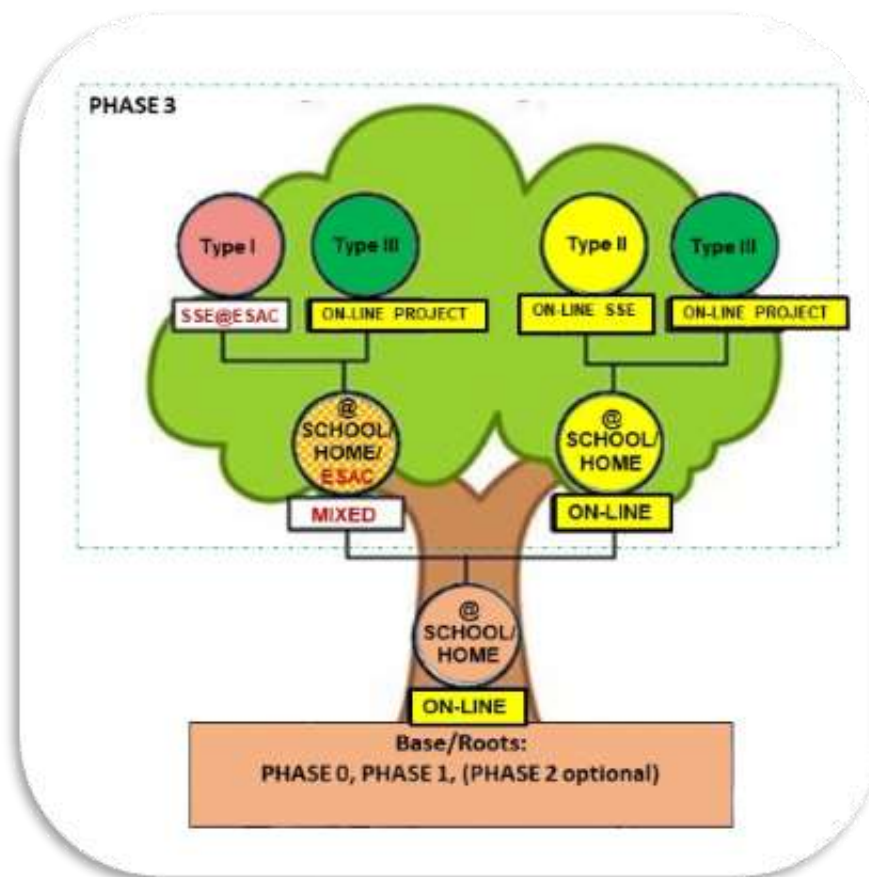


Figure III: Decision tree of the CESAR Experiences according to Phase 3 (Tipo I @ESAC, Tipo II y III, on-line) .In yellow are indicated those paths that can be run completely on-line. (Credits: teacherspayteachers.com)



Teachers are the best ones in assessing the Type of Experience (Challenge) for their classroom and school year conditions. **Per each Type of Experience we propose you different Adventures. The teacher decides if each Team in the class execute an Adventure and once finish they put them in common or whether all the Teams execute the same Adventure(s) at the time (see Tables I, II and III).** Teachers can also decide whether they want to execute some Activities on-line, and when it became feasible, to ask for the already well known an SSE @ESAC (Type I), for the same Challenge but different Adventure or another Challenge (see Figure III).

The CESAR Team recommends you to follow the phases in order (for an optimum learning process) and do not start one before closing the previous one. The Table [Summary of Activities](#) will mention when the execution of a previous Activity is required. The CESAR Team can be contacted once in phase 2 (with the class) and in phase 3 (only for the teacher). For that, dedicated slots of 30 minutes are scheduled.

For the Scientific Challenge, the [Fast Facts](#) section provides the information regarding the school curriculum and the contents of each of the Activities (by Phase) can be found in the Table [Summary of Activities](#). The flavors of Adventures, per each Type of Scientific Experience are in Tables I, III and III.

• **Table I: Space Science Experience @ESAC (SSE @ESAC):**

PHASES	<u>0</u>	<u>1</u>	<u>2</u>	<u>3 (@ESAC)</u>	<u>3 (@school)</u>	<u>4</u>	Minimum duration
ACTIVITIES (Adventure 1)	3 videos	1,2,3,4 y 8	10*	11,12, 13		17	3,30h
ACTIVITIES (Adventure 2)	3 videos	1,2,3,5.2 y 8	10*	12, 13	14	17	3,30h
ACTIVITIES (Adventure 3)	3 videos	1,2,3,4 y 8	10*	11,12, 13	14	17	3,40h
ACTIVITIES (Adventure 4)	3 videos	1,2,3,5.2 y 8	10*	12, 14	15	17	3,40h

• **Table II: On-line Space Science Experience (On-line SSE):**

PHASES	<u>0</u>	<u>1</u>	<u>2</u>	<u>3 (@school)</u>	<u>4</u>	Minimum duration
ACTIVITIES (Adventure 1)	3 videos	1,2,3,4,5.1,8 y 9	10*	11,13	16 y 17	3,45h
ACTIVITIES (Adventure 2)	3 videos	1,2,3,5.2,8 y 9	10*	13,14	16 y 17	3,45h
ACTIVITIES (Adventure 3)	3 videos	1,2,3,4,8 y 9	10*	11, 13, 14	16 y 17	3,55h
ACTIVITIES (Adventure 4)	3 videos	1,2,3,5.2,8 y 9	10*	12, 14, 15	16 y 17	3,55h
ACTIVITIES (Adventure 5)	3 videos	1,2,3,6,7,8 y 9	10*	12, 14, 15	16 y 17	5h

• **Table III: Research Project: All Activities**

PHASE	<u>0</u>	<u>1</u>	<u>2</u>	<u>3 (@school)</u>	<u>4</u>	Minimum duration
ACTIVITIES	All videos	1,2,3,4, 5, 6,7,8 y 9	10*	11, 13, 14, 15	16 y 17	5h



10* This activity is Optional

REALLY IMPORTANT

- ✓ As a teacher, **register as part of the CESAR Community** [here](#) (If you approach us for the first time, it may take some time – a non-automatic process -, but you will not regret ;o))
- ✓ **Once you have been confirmed as part of the CESAR Community** ask for the CESAR Scientific Experiences to live with your class **and you will be guided in the process:**
 - Click [here](#) to request an on-line experience – Type II & III
 - Click [here](#) to request a combined experience - Type I (Only for schools in the Comunidad de Madrid and close cities)
- ✓ **Guides are very long (many possible tools) to build your Experience but also very flexible**

It is your time! Choose your Adventure!

Fast facts



BASIC DATA	The students should already know...
<p>Age range: 10-12 years</p> <p>Type: Practice</p> <p>Complexity: Easy</p> <p>Preparation time: from 2 to 4 hours, depending on the chosen experience</p> <p>Required time: Between an hour and a full term, depending on the chosen format</p> <p>Location: Inside</p> <p>Includes the use of: Computers or tablets, Internet, Google Earth Pro</p>	<ul style="list-style-type: none"> • Representations of the Earth: maps and planispheres. Scales. • Orientation in space. Globes. • Geographical diversity of the landscapes around the world: topography and hydrography. • Human intervention in the environment and a sustainable and fair energetic development. • Comparing surfaces of flat shapes by overlapping them, breaking them down and measuring them.

Curriculum relevance	Students will learn ...
<p>Natural sciences: Introduction to the science activity. Matter and energy. Technology, objects, and machines.</p> <p>Social sciences: The world we live in.</p> <p>Mathematics: Processes, methods, and attitudes in mathematics. Measurements</p>	<ul style="list-style-type: none"> • Tools that transform flat representations into three dimensional ones, and vice versa. • Pinpoint in a topographical map the main landmarks and their hydrographic slopes. • Analyze the importance of studying all the previous data and their usefulness in science and society.

You will need...	Students will improve ...
<p>Installing the Google Earth Pro program, available for free, in case you choose to do Challenge 3.</p>	<ul style="list-style-type: none"> • Their understanding of critical thinking. • The strategies of the scientific method. • Their teamwork and communication. • Self-evaluating skills. • The application of theoretical knowledge to real situations. • Their skills in ICT (Information and Communication Technology)..

Summary of activities



Phase	Activity	Material	Results	Requirements	Time
Phase 0	Putting things into context	VIDEOS: a) Images of Earth from the ISS b) Sound (and vision) of Silence c) ESAC: ESA window to the Universe d) This is ESA	The students will get familiar with: <ul style="list-style-type: none"> • Images of Earth • ESAC • ESA 	None	(10 – 20) min
Phase 1	1. Refresh concepts	:	The students will review definitions from their academic course which are related to the scientific case.	None	10 min
Phase 1	2. How to draw a map?	Worksheets: Space for Kids - A view of Earth	The students will improve: <ul style="list-style-type: none"> • Their sense of direction. • Their skills to communicate results and to work in teams. 	None	(15 – 20) min
Phase 1	3. Identify the relief and the hydrography in a physical map 3.1 Islands 3.2 Lakes	Worksheet Earth from Space: Barcelona Mapa físico de España de Anaya (Spanish)	The students will improve: <ul style="list-style-type: none"> • Their successful search of observational data through direct and indirect sources. • Their skills to communicate results and to work in teams. 	None	(10 – 15) min



Phase 1	4. Where to draw something on our map? 4.1. Self evaluating your map	Worksheet Millimeter ruler Strings or threads to measure length	The students will improve: <ul style="list-style-type: none"> The development of strategies to measure figures both in exactly and approximately. The correct selection of the reference point for expressing a taken measure. Their skills taking measurements. Their skills to communicate results and to work in teams. 	None	(30 – 40) min
Phase 1	5. What types of maps are there? 5.1. Topographic maps (plasticine, sheet, colours) 5.2. Topographic maps with Geogebra	Worksheet Geogebra, Graficadora 3D ESA - Pine Island retreat	The students will improve: <ul style="list-style-type: none"> Their skills using information technologies and applications to simulate processes and to present conclusions. 	None	1h - 1h 30 min
Phase 1	6. Does my island have water, reservoirs or rivers? 6.1. How to use that water?	Worksheet Space for Kids – The water cycle ESA - Space for Kids – ESA satellites help us to make the most of Earth's precious water Space for Kids – Satnav technology could save precious water Space for Kids - River Geogebra, Graficadora 3D	The students will improve: <ul style="list-style-type: none"> Their evaluation of the sustainable use of natural resources. 	Activity 5 is mandatory, and Activities 3, 4 and 6 are recommended.	30 min



Phase 1	7. Study of climate change with maps	ESA Euronews: Studying climate threats with Sentinel	The students will improve: <ul style="list-style-type: none"> Their analysis of the causes and consequences of climate change and the responsible actions to stop it. 		10 min
Phase 1	8. Earth exploration by the European Space Agency missions	Space for Kids – Europe's space Sentinels ESA - Etna slopes Norwegian fringes	The students will understand: <ul style="list-style-type: none"> Techniques and processes performed by ESA's missions through satellite observations. 	Needed to have executed Activities 1 to 5	(30 – 40) min
Phase 1	9. What have you learnt so far?	questionnaire	The students will improve: <ul style="list-style-type: none"> Their evaluation skills 	Activities 5, 6, 7 and 8 are recommended beforehand.	10 min
Phase 2	10. Ask for a video call with the CESAR team if needed	http://cesar.esa.int/index.php?Section=Scientific_Cases&Id=23&ChangeLang=en	The students can have first-hand information from ESA's experts.	Activities from 1 to 9 are recommended beforehand.	(30-40) min
Phase 3	11. Identify the course of a river on a topographical map	Worksheet Tindaya Mountain (Fuerteventura) Topographical map showing the Pinilla dam (modified) Color pencils	The students will improve: <ul style="list-style-type: none"> Observing and interpreting topographical maps and contour lines. Analyzing the 3D representation of mountains, slopes, valleys, and rivers. 	Activities 5 and 6 are highly recommended.	15 min
Phase 3	12. Topography in augmented reality: Sandbox	Sandbox	The students will improve: <ul style="list-style-type: none"> Space vision. They will go from a 2D map to a 3D 	Activity only available at ESAC with CESAR	30 min



				<p>manipulative rendering.</p> <ul style="list-style-type: none"> • Their scientific reasoning and critical thinking. 	Team's Sandbox.	
Phase 3	<p>13. What can you see in a topographical map?</p> <p>13.1. Identify the geographical features</p> <p>13.2. Where would you place an artificial dam?</p>	<p>Worksheet</p> <p>Topographical map of Pinilla dam (modified)</p>	<p>The students will improve:</p> <ul style="list-style-type: none"> • Observing and interpreting topographical maps and contour lines. • Valuing the sustainable use of natural resources. 	Activities 1 to 5, and 8 are highly recommended beforehand.	30 min	
Phase 3	<p>14. Study topographic maps with Google Earth</p> <p>14.1. Get used with Google Earth</p> <p>14.2. Time travel with Google Earth and terrain evolution</p>	<p>Worksheet</p> <p>Electronic device with Google Earth Pro installed</p>	<p>The students will improve:</p> <ul style="list-style-type: none"> • Their skills using information technologies and applications to simulate processes and to solve problems. • Observing and interpreting topographical maps and contour lines. • Analyzing the 3D representation of several landmarks and geographical features. • Their raising awareness on the environment. 	Activities 1, 5, 7, 8, 10 and 11 are needed before this one	30 min	
Phase 3	<p>15. Create your topographic map with Google Earth</p> <p>15.1. How to know the height of your terrain?</p> <p>15.2. How to create contour lines in your terrain?</p> <p>15.3. How to plan your</p>		<ul style="list-style-type: none"> • 	Activities 13 and 14 are needed before this one	1 h 15 min	



	hiking route?				
Phase 4	16. Evaluation	questionnaire	<p>The students will check if the concepts have been internalized.</p> <p>The students will improve:</p> <ul style="list-style-type: none"> • Their scientific reasoning and critical thinking. • Their strategies to work as scientists. • Their self-evaluating skill. • Their skill to apply theoretical knowledge to real situations. 	Activities 1, 7, 8, 10 and 11 are mandatory beforehand.	10 min
Phase 4	17. Present your results	Free format chosen by the students	<p>The students will improve:</p> <ul style="list-style-type: none"> • Their skills to work in teams and to communicate results. • Their knowledge on topography. 		30 min – 2h



Your Scientific Challenge



Decoding the 3D scientific information from satellites

Scientists of the COPERNICUS Space Programme analyse the scientific data from Earth collected by the ESA satellites "Sentinel". Their main goal is to protect our planet, Earth.

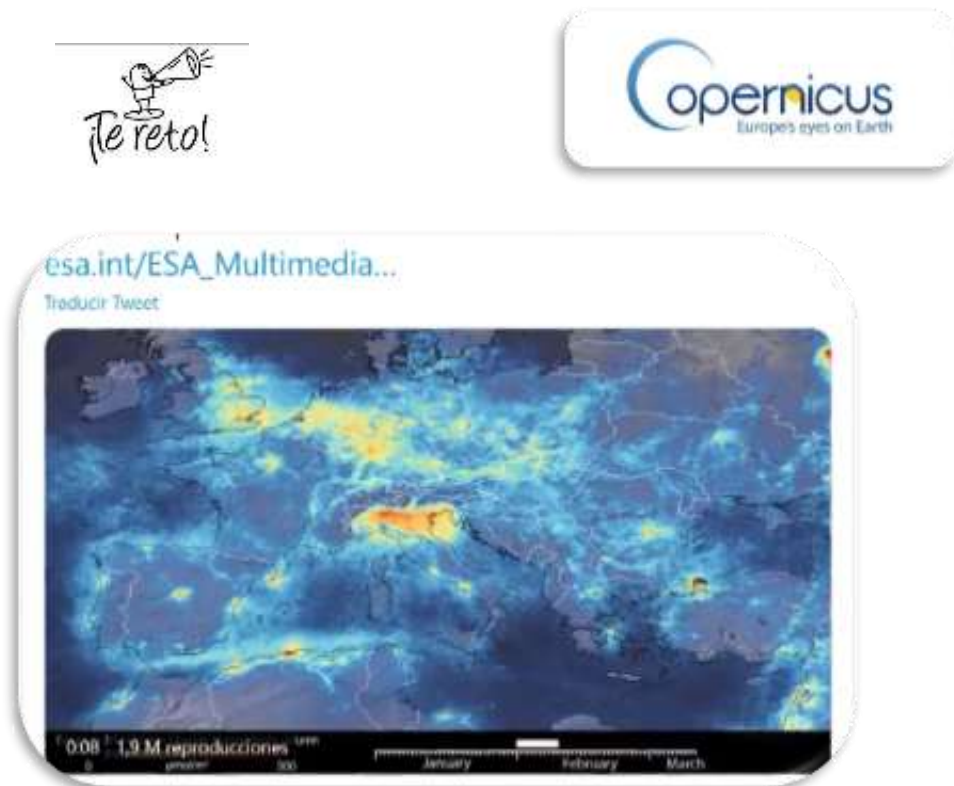


Figure 1: Image of Copernicus programme (Credits: ESA)

The first thing that we are going to do is to explore the terrain in 2-Dimensions (2D) and to identify patterns in it. We will be able to create our own 2D maps, with scales, references and level curves.

From that moment on, we will jump into the 3D, by testing our space vision and studying changes in the terrain along the years and will be able to create our own path.

Could we count on you to help our scientist?



Phase 0



To understand the situation, start watching these **videos**:

- [Images of Earth from the ISS](#)
- [Sound \(and vision\) of Silence](#)
- [ESAC: ESA window to the Universe](#)
- [This is ESA](#)

Work in teams

Work in teams of (4-6) students. Each member of the Team will have a specific role in the investigation.

- Ask the teacher for the Challenge ID and your Team number to fill out Table 0.
- Write down your names according to the agreed tasks.

Challenge ID		Number of your Team	
<p>Writer: _____</p> <p>Responsible of the material: _____</p> <p>Reader: _____</p> <p>Speaker: _____</p> <p>Drawer: _____</p>			



Phase 1



Activity 1: Refresh concepts

This brief theoretical activity will help students to review definitions or basic concepts. Fill in each sentence with the words or concepts given below:

maps, scale, planes, two-dimensional, physical maps, deltas, sketches, cartography, mountains, earth globes, legend, topographical, geographical features and landforms

Solutions to the activity in the student's guide are:

Cartography is the science in charge of the study and making of maps.

The **planes** and **sketches** are forms of representation of the surroundings or geographical areas.

The planes are **bidimensional** representations of a town, city, or a house.

There are two ways of representing, in a reduced size, the surface of the Earth: through **globes** and maps.

The **maps** contain a lot of information as points, lines, and polygons, besides a measured scale and a legend.

The **scale** is the numerical expression of equivalence between the drawing of the map and their real size of the represented surface.

The **legend** in a map explains the used symbols on it and gives necessary information to understand it.

There are two big groups of maps: the **physical maps** and the thematical maps.

The physical or **topographical** maps try to represent the exact and detailed form of a surface, considering mainly relief and altitude.



Topographical maps show elements as mountains, valleys, rivers, and other ***geographical features or landforms***.

There are fluvial landforms as river deltas, islands, or lagoons.

River deltas appear at the mouth, but the source of the rivers themselves are in the **mountains**.

- If you want to know more about the **Scales of the Universe** [click here](#)

Activity 2: How to draw a map?

This activity is an introduction to the scientific knowledge and its application in relation to the contents of the Social Sciences primary courses.

Each group will work on the worksheets that appear on the student's guide. They will make their predictions and think strategies to prove their hypothesis. They will start with pictures showing water as in a beach and they are faced with the dilemma of a plain having abandoned them there and having to find out if that terrain is an island or part of a continent.

After that, they will present to the others what they have been working on: [Space for Kids - A view of Earth](#)

There is not a unique valid question, but every reasoned given answer will be considered correct. Next there are some examples of possible answers and the location of the pictures.

Choose between Option A or B and answer the following questions in Teams:



	<p>A</p>
	<p>B</p>

Figure 2 Images of places in Spain (Credits: Google Maps)



Imagine the next situation...you suddenly wake up in the next place and only see this image (A or B) in front of you:

1. Where do you think you are?

Option :	
----------	--

2. Is this a slope to the sea, or an island or a lake...?

By walking beside the water's edge. If we can see mountains all the way on the other side of the edge, we will be in a lake. If, on the contrary, the mountains appear or disappear either right, left, or behind, and we can see a horizon of water, we will be surrounding an island.

3. How to find where you are?

We can draw the landscape on a piece of paper as we see it and walk around. If we get far away on a ship, we can draw a more detailed drawing. We can also take pictures and collect them by piecing them together. The pictures can be taken from the ground, or from an airplane, or a canopy, etc.

4. Could you draw a map of the place? Suggest means, machines, and tools that you will need and how to do it.

--

5. Present your results and share them with the other groups.

Planes and aerial photography helped us to know better our country, our continent and our planet. Thanks to satellites we can see everything with a glance: [Space for Kids - A view of Earth.](#)

Activity 3: Identify relief and hydrography in a physical map

Let's remember the elements that appear on a physical map. Consult on the Internet the information that is asked for if it is necessary

Activity 3.1: Islands

1. Locate and circle Cies Islands (*black circle in Figure 7*)



Figure 2 Edited image from, physical map of Spain from Ed. Anaya (Credit: Blog Aula de língua galega)

2. Write down the name of the river on the map and one of its tributaries.

For instance: Miño river, and its tributary, Sil river.

3. Where are their sources and where do they flow into?

Source of Miño river in Pedregal de Irimia (Sierra de Meira, Lugo) and mouth into the Atlantic Ocean.

Source of Sil river in Peña Orniz and mouth into Miño river.

Activity 3.2: Lakes

1. Locate and circle the Lake of Sanabria (*black circle in Figure 8*)



Figure 3 Edited image from the physical map of Spain from Ed. Anaya (Credit: Blog Aula de língua galega)

2. To which river does the inlet and outlet flow of the lake correspond?

Tera river

3. How was the lake formed?

The basin originated after a glaciation

4. To which mountain range does it belong?

Sierras Segundera and Cabrera



Activity 4: Where to draw something on our map?

In this activity the students work on the measure of distances and developing strategies to measure both exactly and approximately, complementing the concepts in the Mathematics and Social Sciences primary courses. The aim is to understand planes and scales.

Material required:

- Pencil, paper and crayons.
- Smartphone to take a picture and upload it to this document.
- Measuring tape or ruler.
- Cord or wool.

Experiment:

Imagine that your team have been left alone on an unknown island.

1. Draw a map of how you imagine your island.

- You must include as many details as possible
- You must think carefully about the distance between them
- And where to draw, for instance, their mountains, their rivers, lagoons, cascades, trees, forests, etc.





2. Calculate Distances:

2.1 On the Map:

- Locate a **reference point (A) on the map**. (Hint: It can be a mountain, a tree, the mouth of a river, etc.)
- Choose another point (B) on the island near it.
- Take a string and connect point A and B. Make a mark on the string for each of these points.
- Put the string on the ruler and measure the length (in centimeters). This will be the **distance in your plane**. Write this data here (in cm).

Measurement 1 (**distance in plane**)

2.2 In class: Imagine that your class is the island and you are going to measure distances on it by counting steps.

- Stand up and take where you are as a reference point (A).
- Choose another point (B) from the class
- Put one foot in front of the other (feet together) to measure. Move around (guided by the teacher) to get used to calculating distances in feet.
- The number of steps between points A and B will be the actual distance** (if your class was an island)
- Write the number of feet of the measurement (N):**



- Measure with a ruler foot in centimeters (cm)**

- Therefore, the **actual distance** will be the number of feet (N) **multiplied** by the measurement of the foot (in cm):

Measure 2 (**actual distance**)

N x (measure of your foot in cm)

3. Calculate scales (or proportions)

- Divide the actual distance (**Measurement 1**) by the distance in the plane (**Measurement 2**) to obtain the **proportionality constant, k**

$$k = \frac{\text{(Measurement 1)}}{\text{(Measurement 2)}}$$

- We usually write the scale of a plane as [1: K]. What is the scale of your map?**

[1:]



Activity 4.1: Self-evaluating our map

It is important that the students reflect on the fact that there are no relief on the maps and that real distances can be very different, because the heights between several places must be considered.

A terrain should not only be drawn on a map, but it also should have a distance reference to pinpoint mountains, rivers, or paths. We need to add coordinates, distances, and a reference system. The satellites help us to know and find those data. For instance, navigation satellites like the Galileo system help us to know where we are and how far to the places we want to go, or they say how long it takes to take a tour. They can also guide us on hiking routes or walks by the rivers, seas, and oceans.

On the same map you just drew:

1. **Measure** the distance between two other points on the map with the string (Note: Use the ruler to see how many centimeters (cm) the string measures)

2. Do you remember the value of the proportionality constant of your map, K ? **Multiply your distance from the plane (in centimeters) by K and you will get the real distance.**

3. Does this measure make sense in reality?



4. What if we measure the distance to the highest peak of a drawn mountain? Will the distance between your drawings in the plane be the same as the real one?

It is not only important to be able to draw a map of a place but also to have a distance reference to locate mountains, rivers or paths. **We need to add coordinates, distances and a reference system.** We also have to reflect the **altitudes** in them.

The satellites help us to know and find those data.

For instance, navigation satellites like the [Galileo](#) system help us to know where we are, how far are the places we want to go, or how long it takes to take a tour. They can also guide us on hiking routes or walks by the rivers, seas, and oceans.



Figure 5: Image from the video in the article "Galileo signal team wins European Inventor award" (Credits: [ESA](#))

Activity 5.2: Topographic maps (with Geogebra)

Activity 5.2.1: Get familiar with Geogebra 3D Graphics

Follow the steps of the following **procedure**:

1. Click on the link (or download the app) [Geogebra, 3D Graphing](#). You will see something like Figure 7, where three axes are shown that are used to draw our figures in 3D.

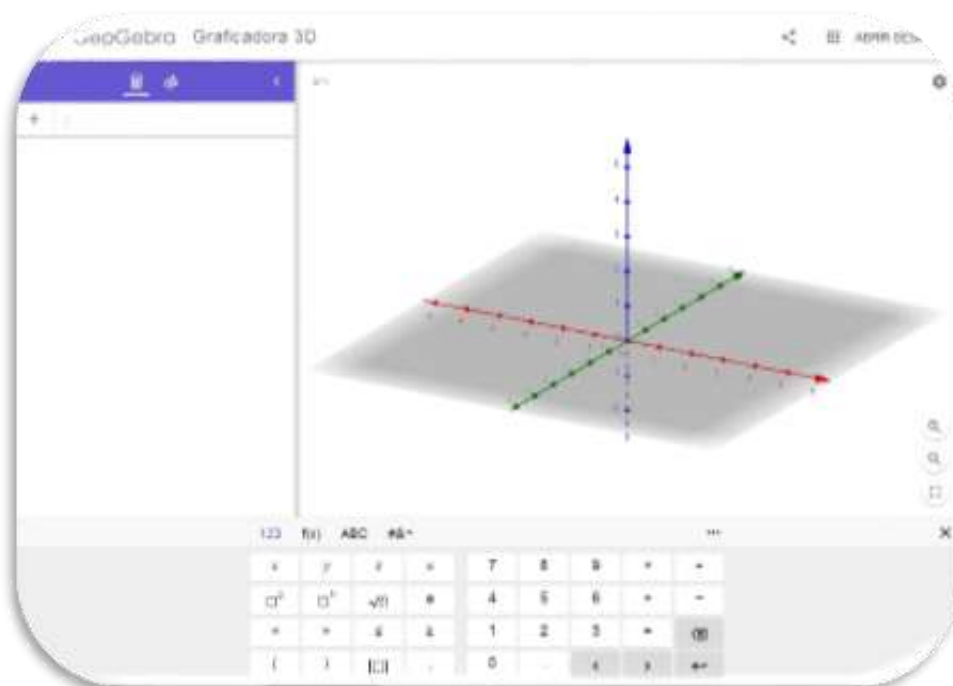


Figure 7 Image of the starting screen (Credit: [Geogebra, 3D](#))

Activity 5.2.2: Create a mountain with Geogebra

1. Repeat [Activity 5.2.1](#) if you have not already done so
2. To reproduce a mountain, Figure 8 on the Tablet

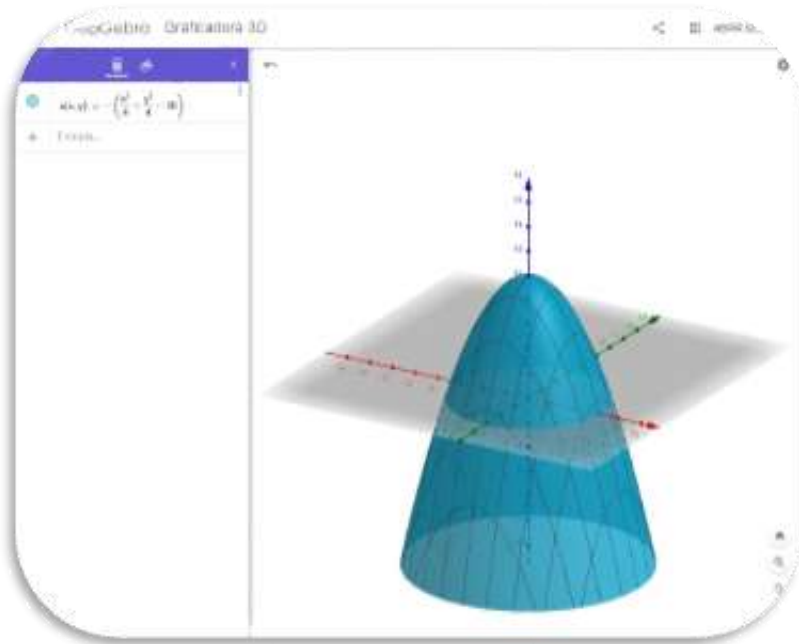


Figure 8 Image of the mountain (Credits: Geogebra, 3D Graphics)

- 1.1. Using the keys on the 3D Calculator, type in the following and press enter:

$$(x \text{ []}^2 > \div 4 > + y \text{ []}^2 > \div 4 > - 10 > \leftarrow$$



- 1.2. Click on the magnifying glass with a minus to see the whole.

Define contour lines

We are going to cut a mountain into slices (horizontal planes) at different heights. Imagine that your mountain is 1000 m high, cut it into planes that are 200 m high from each other (Figure 9)

To do so, follow this **Procedure**:

1. We start from the mountain drawn in [Activity 5.2.2](#). If you have not done this activity, do it
2. Write the following in calculator mode:

$$z=2 \leftarrow z=4 \leftarrow z=6 \leftarrow z=8 \leftarrow$$

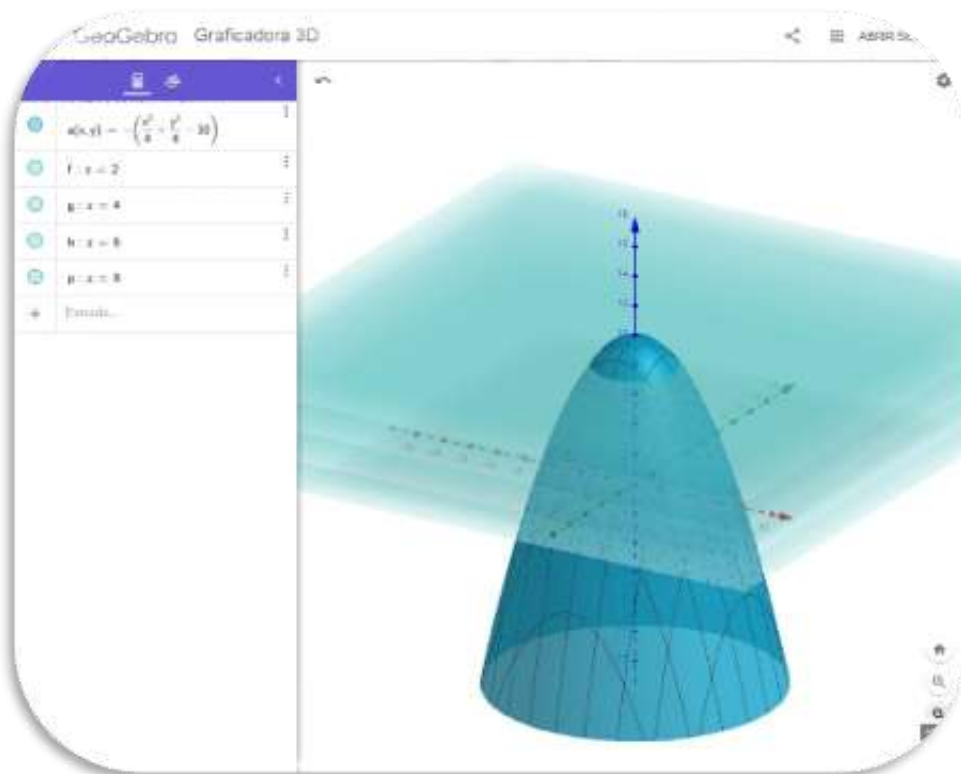


Figure 9. Example image of cutting planes (Credits: Geogebra, 3D Graphics)

You will see in the application an image like the one in Figure 9, where the planes come out in the same colour by default.

3. Colour the plans.

Select the plane and assign it a colour, as shown in **Figure 10**.

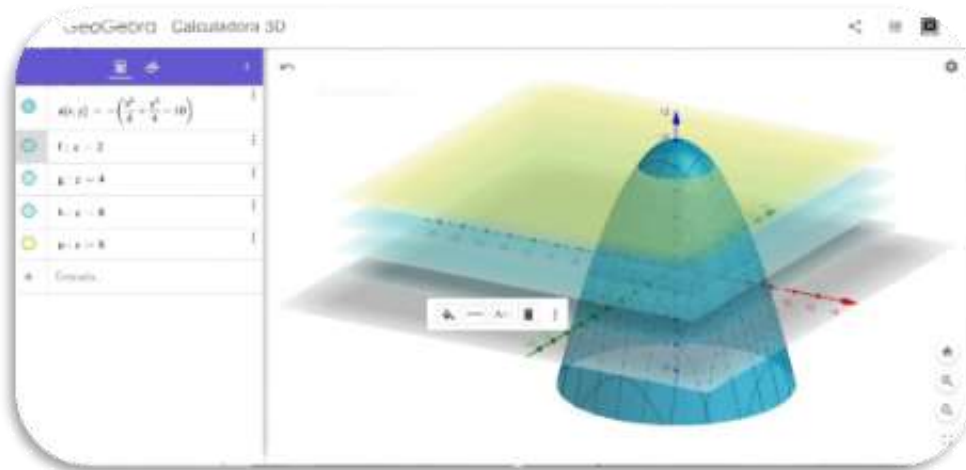


Figure 10-A: Colouring cutting planes (Credits: Geogebra, 3D Graphics)

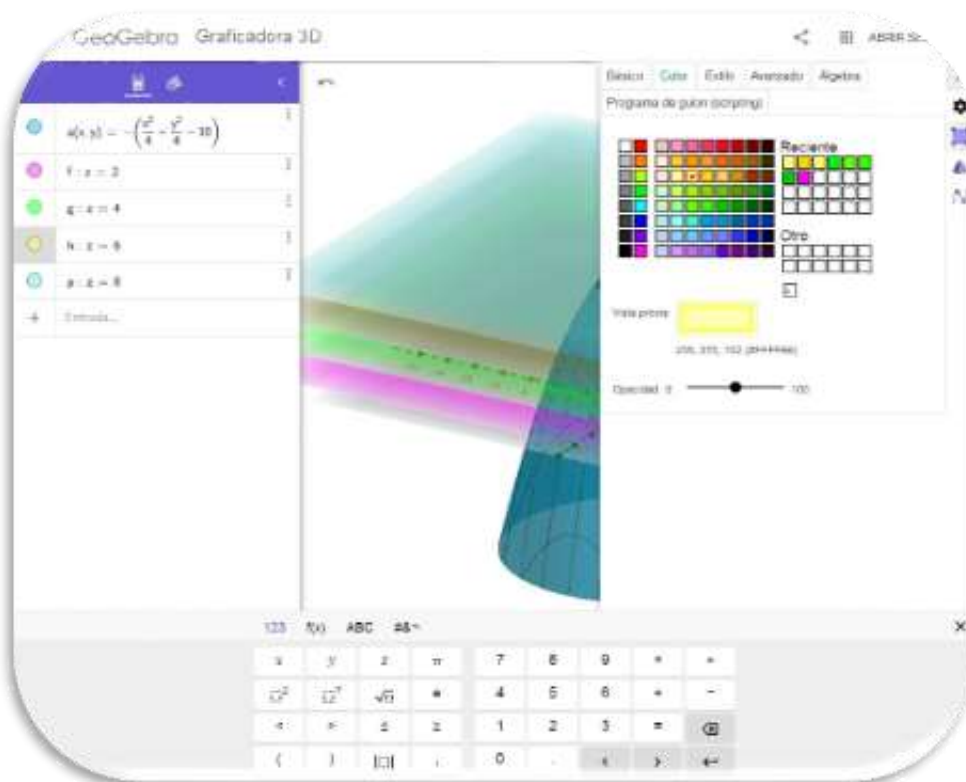


Figure 10-B Explanatory image (Credits: Geogebra, 3D Graphics)

Move Figure 11 to see the mountain and its slices from different points of view (perspectives).

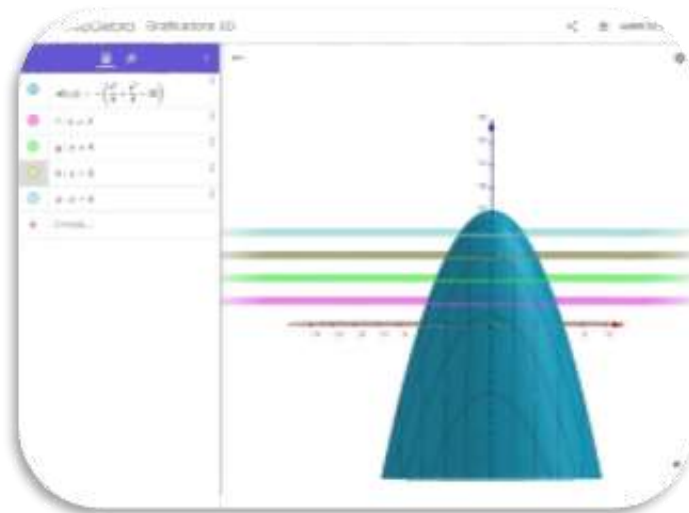


Figure 11 Explanatory image (Credits: Geogebra, 3D Graphics)

4. Identify the **contour lines**.

We call the regions that create the cutting planes on our mountain "contour lines" (see Figure 12)

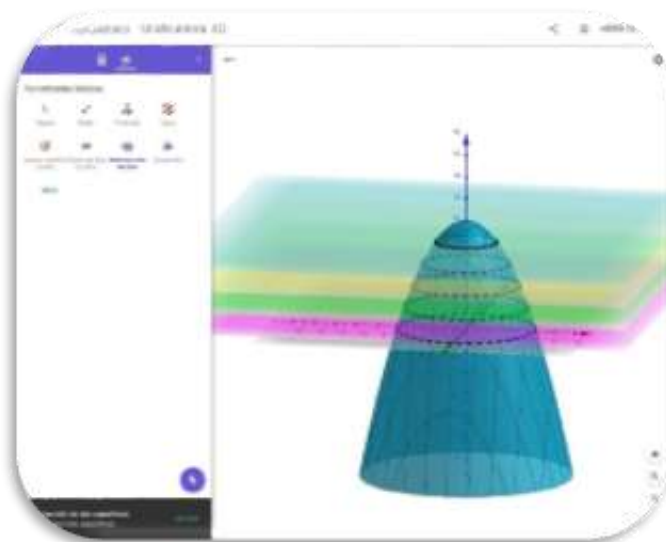


Figure 12 Explanatory image (Credits: Geogebra, 3D Graphics)

Create your own topographic map.

1. Change the viewpoint of Figure 12 and look at it from above.
2. Check that you see **concentric curves (or contour lines)** as in Figure 13.

This is a topographic map, in which each contour line represents a height.

Try to draw the contour lines on the map of your island.

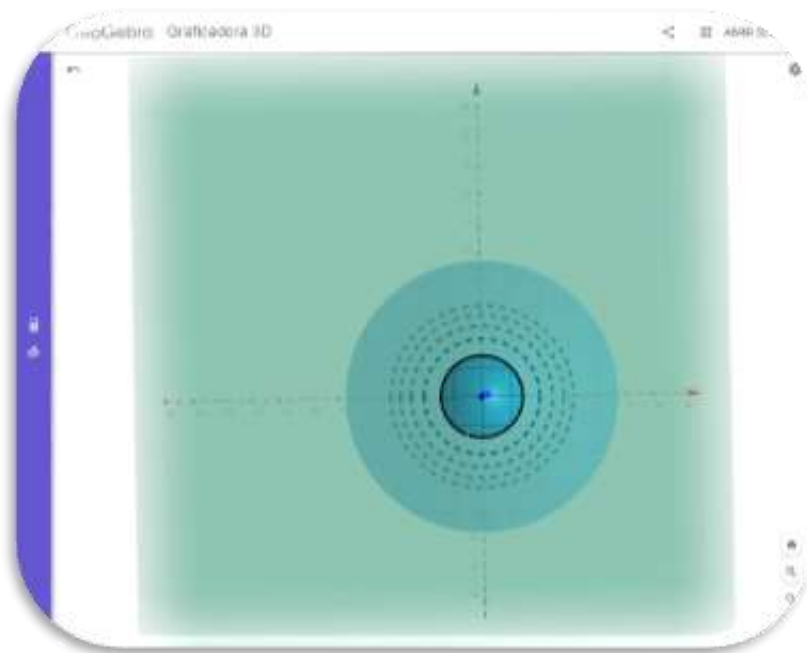


Figure 13 Example of a topographic map (Credits: Geogebra, 3D Graphics)

Activity 5.2.3: Create a valley with Geogebra

You will create a 3D figure representing a valley (Figure 14).

Preparation:

- If you have done [Activity 5.2.2](#), clear the screen. To do this, go to the menu on the top left (three small strips) and click on "Clear all". Then start the procedure.
- If you have not done [Activity 5.2.2](#), follow the procedure below

Procedure:

- Type the following in the 3D Calculator and press enter:

$$x []^2 \div 10 > - y []^2 \div 5 > \leftarrow$$

- Add the maps $z=-2$ y $z=-4$
- Click on the magnifying glass with a minus to see the whole.

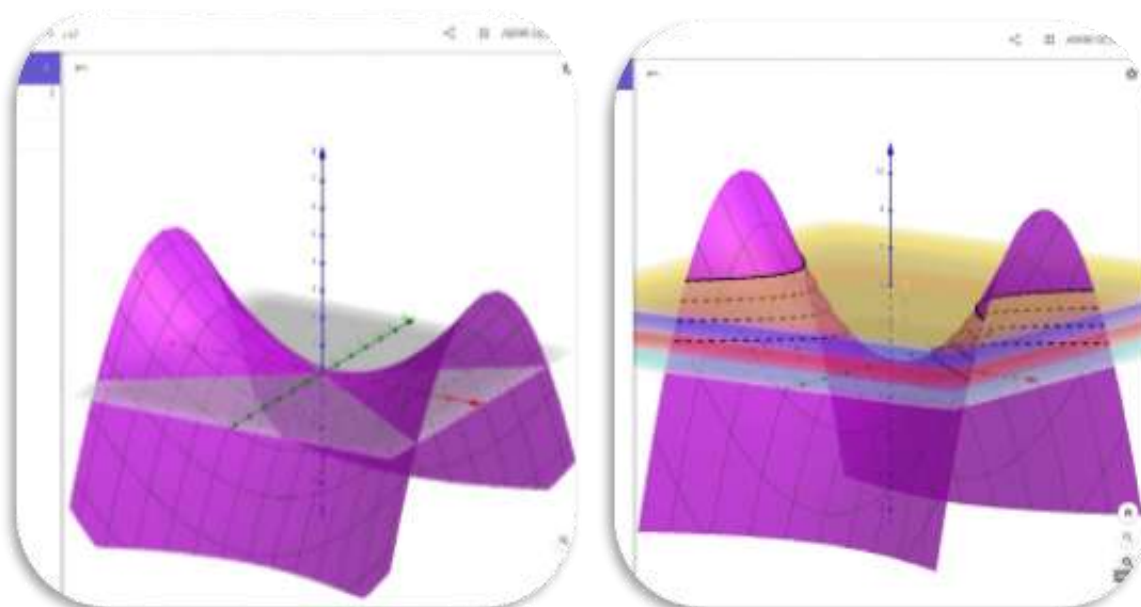
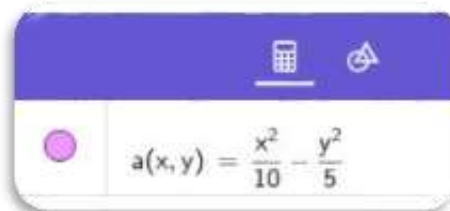


Figure 14 A & B Representation of a valley (Credits: Geogebra, 3D Graphics)

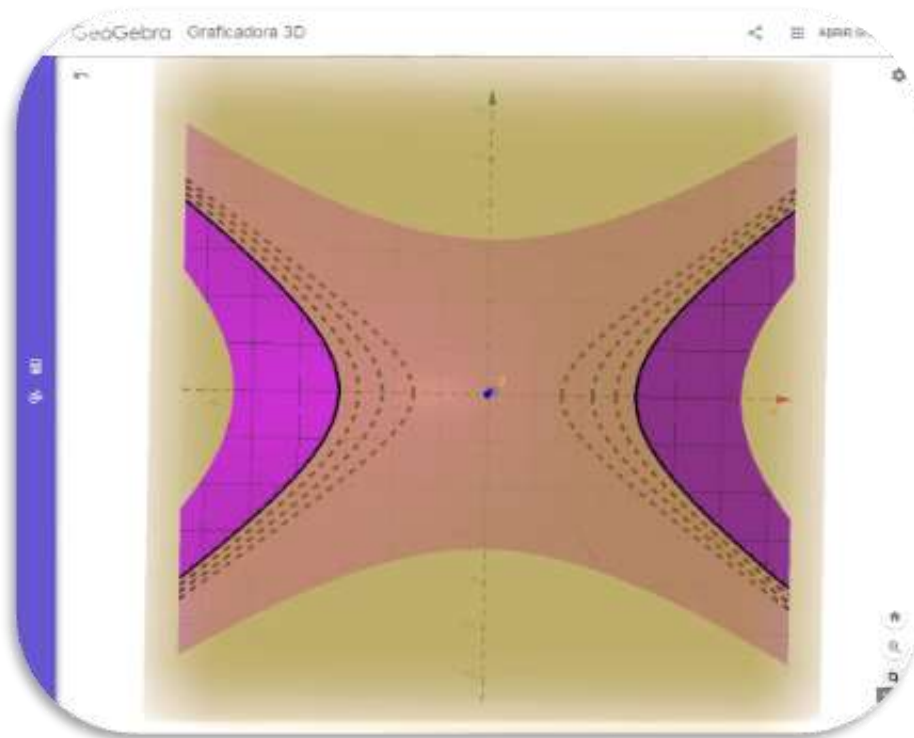


Figure 14C: View from above of the same figure (Credits: Geogebra, 3D Graphics)

If we enlarge or reduce our topographic map with the magnifying glass, we can simulate how we would see on a map if the mountain has a greater or lesser slope depending on whether the lines are closer together or further apart respectively.

You can see an example of a satellite topographic map [ESA - Pine Island retreat](#) where you can see the different heights or layers of our contour lines in various colours

Activity 5.2.4: Create an island with Geogebra

You will create a 3D figure representing a valley (Figure 14).

Preparation:

- If you have done [Activity 5.2.2](#) or [Activity 5.2.3](#), clear the screen. To do this go to the menu on the top left (three small strips) and click on "Clear all". Then start the procedure.
- If you have not done [Activity 5.2.2](#) or [Activity 5.2.3](#), follow the procedure below

Procedure:

- Type the following in the **3D Calculator** and press enter:

$$x []^2 \div 4 > + y []^2 \div 4 > - 10 \downarrow$$



$$f(x,y) = \frac{x^2}{4} + \frac{y^2}{4} - 10$$

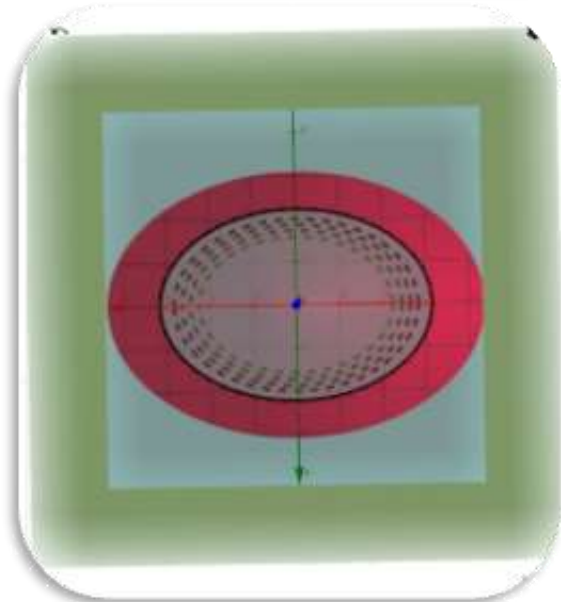
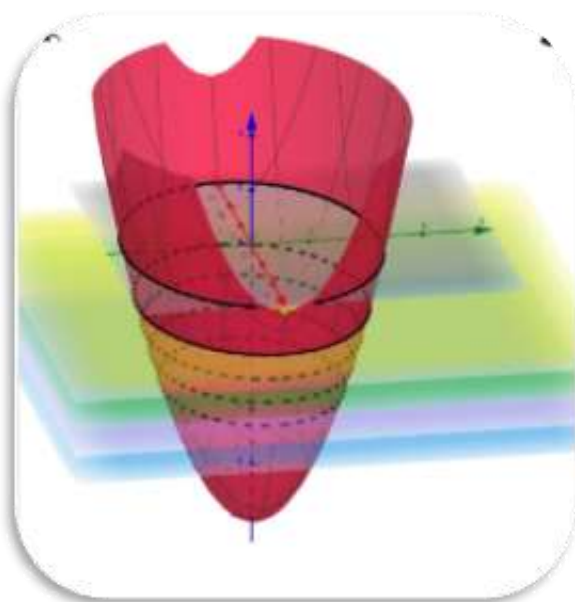


Figure 15 Different perspectives of the same figure (Credit: Geogebra, 3D Graphics)

We must only write to section the figures by underground planes or cutting planes with heights $z=-1$, $z=-2$, etc.

In the case of repeating the figure from [Activity 5.2.3](#), it would be:

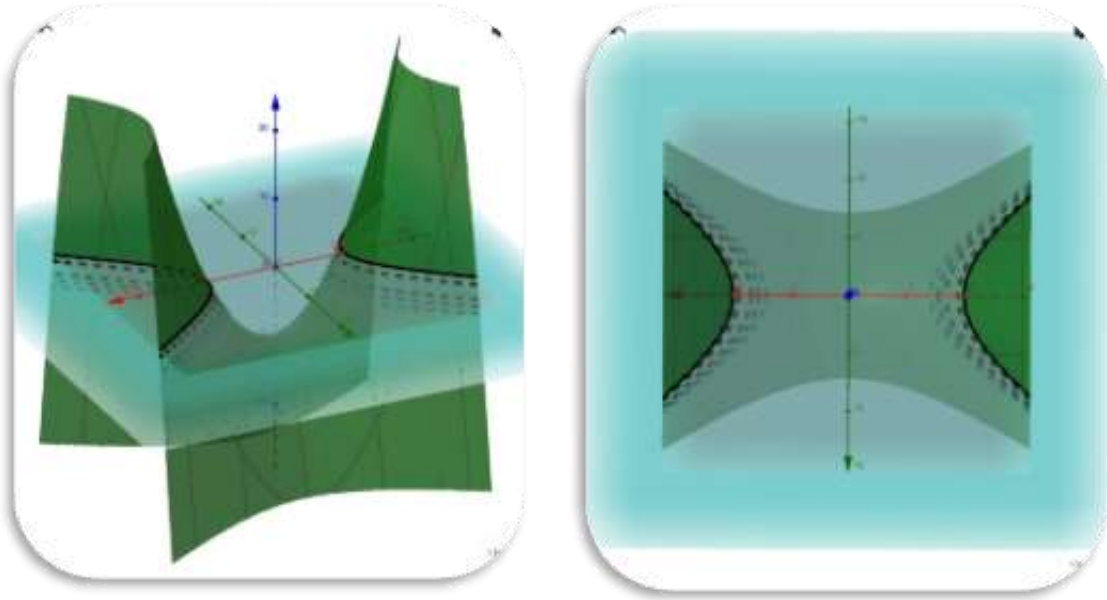


Figure 16 Different perspectives of the same figure (Credit: Geogebra, 3D Graphics)

Do you think that Figure 16 could contain a reservoir or be the link between islands?



Activity 6: Does my island have water, reservoirs or rivers?

1. Watch this [video](#) before starting this activity on the water cycle.
2. Analyze the hydrography (distribution of the water or water bodies) of your map of the island by answering the following questions:

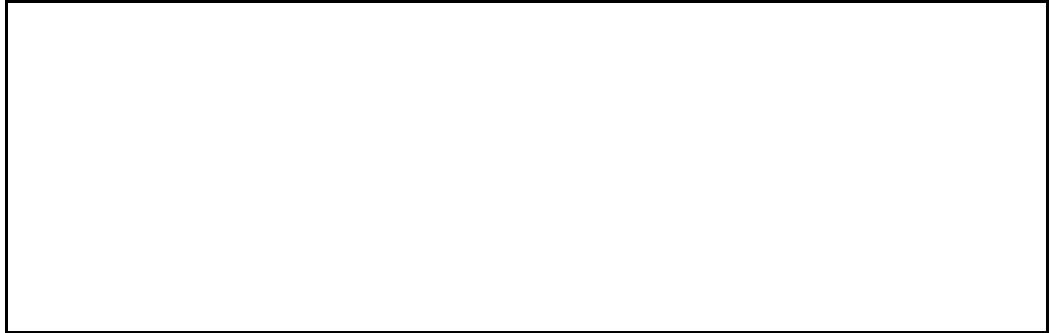
- How have the bodies of water within the island been created?

- If we imagine a body of water crossing our island, dividing it into two parts, would it be a river?

- Would it make sense to draw a river on a flat surface? (Hint: Think about the path the water follows in the course of a river)



- Could we draw a lake on a flat surface? And how would you draw its depth?



Activity 6.1: How to use that water?

Water is essential for living beings and for survival on our island. If we stay a long time on an island, we must analyze how to collect it, if it will be drinkable or if we will need a reservoir to dispose of it in times of drought.

Thanks to the satellites, all this information usually comes from images or similar data to those analyzed in the previous activities.

Each group will read one of the following news and must expose to the others what they have read.

- [ESA - Space for Kids](#) - ESA satellites help us tap into the Earth's precious water
- [Space for Kids](#) - Water-saving satellite navigation technology
- [Space for Kids](#) – The rives

Activity 7: Study of climate change with maps

Figure 17 shows us a map of the Earth, and above it, colors. These colors instead of showing heights (contour lines) as in **the topographic map** give us **information about the temperature of the Earth or the oceans.**

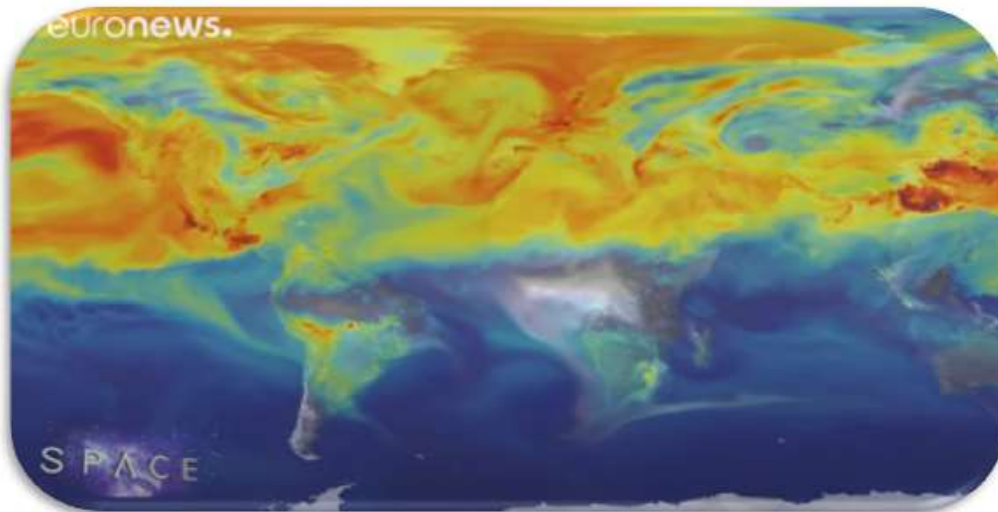


Figure 17 Image capture of the animation (Credits: ESA Euronews)

1. Watch the video: [ESA Euronews: Estudiando las amenazas climáticas con Sentinel](#)
2. Explain how scientists use satellites to better understand what is happening in places like this, and around the planet.

3. What measures do you propose in the video to improve the environmental conditions of our planet?



Figure 18 Layers of the Earth's atmosphere (Credits: geologyweb)

Activity 8: Earth exploration by the European Space Agency missions

The Copernicus program is a project led by the European Space Agency and by the European Union through the Environment Agency. The aim is to provide accurate information for environmental management, minimize the effects of climate change and generate civil security.

ESA is the main sponsor and designs, supervises and co-finances the development of **Sentinel missions**. The Copernicus program also has **Meteosat and MetOp-SG** instruments that form the basis of EUMETSAT. **ESA and EUMETSAT are working together** to collect information from about 30 satellites, such as Landsat.

Let's learn a little more about the **Sentinel family of satellites**, or space sentinels

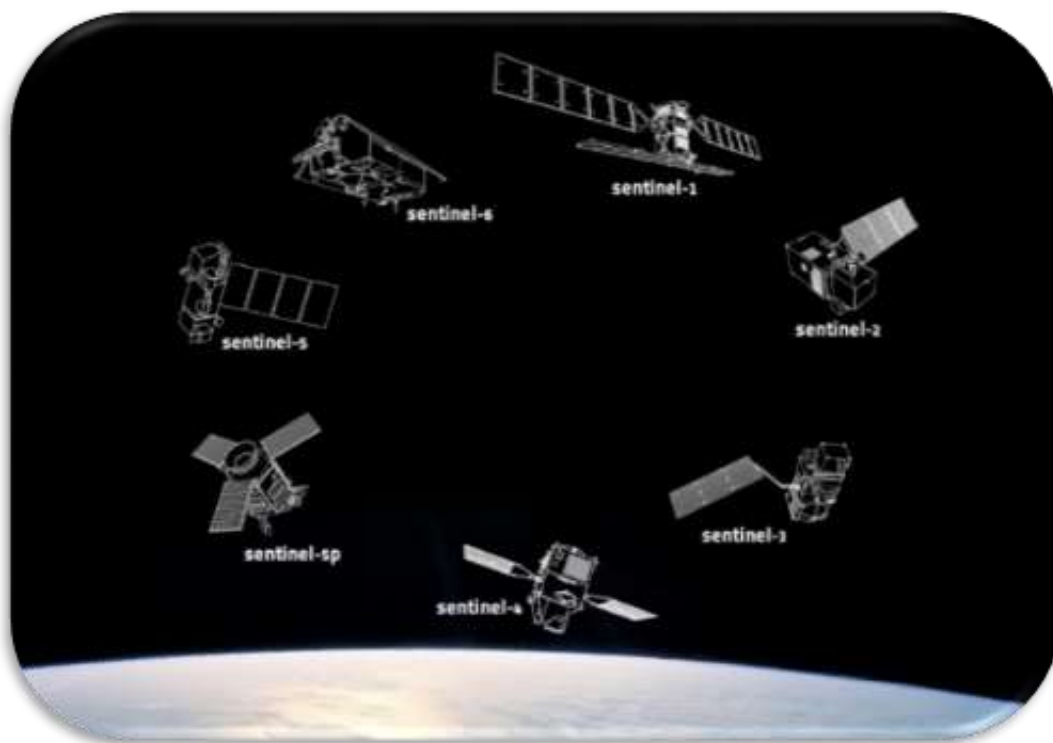


Figure 19. Representation of the different Sentinel missions (Credits: ESA)

- [Sentinel-1](#) (satellites 2A and 2B) take images by radar, day and night and in all weather conditions.



- [Sentinel-2](#) (satellites 2A and 2B) take very detailed color (optical) images.
- [Sentinel-3](#) (satellites 3A, 3B and 3C) measure sea surface altitude, soil and sea surface temperature, and ocean color.
- [Sentinel-4](#) has several instruments that measure air quality in the atmosphere and are on board two third generation Meteosat satellites.
- [Sentinel-5P](#), will be used to examine pollution in the earth's atmosphere, detecting gases such as carbon monoxide and aerosols.
- [Sentinel-6](#) will be launched in November 2020 (and Sentinel-6B in 2025) to study the composition of the Earth and the topography of the oceans, respectively.

Figure 20 shows the lifetime of the Sentinel satellites.

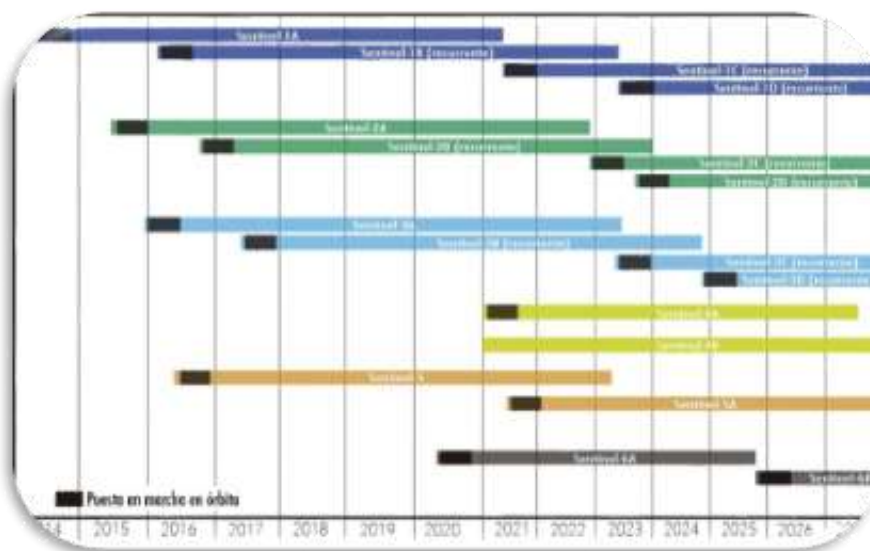


Figure 20 Sentinel families lifetime (Credits: researchgate)

Sentinel satellites also allow us to make topographic maps in 3D. Observe, by clicking on the [link](#), the animation created with the colored contours thanks to the images taken by Sentinel 1A of a group of Norwegian islands in the Lyngen Alps

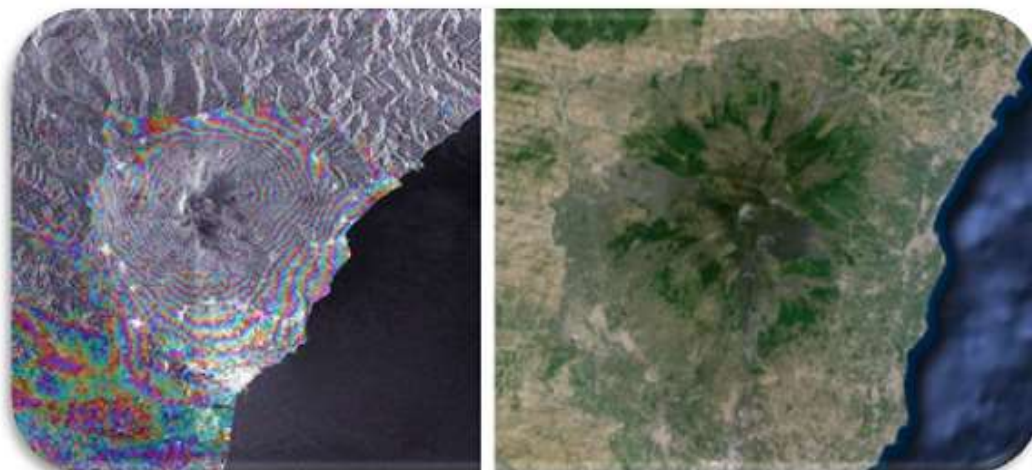


Figure 21 Aerial image of Etna volcano, Italy (Credits: left ESA - Etna slopes and right Google Maps)

1. Write the Sentinel mission number (1-5P) and its objective :

Sentinel-	Discover which living beings inhabit the surface of the ocean, knowing their color
Sentinel-	Study the air pollution that affects Paris.
Sentinel-	Study changes in the vegetation, soil or water surface of a natural park .
Sentinel-	Monitoring Arctic sea ice during storm periods .
Sentinel-	Study changes in the hole in the ozone layer .

Table 1: Sentinel missions objectives



Activity 9: What have you learnt so far?

To find out what you have learned so far play the following [questionnaire](#)



Phase 2



How to proceed in this Phase depends on the results obtained in the latest Activity of Phase 1 (questionnaire)

- **Case 1:** Your students replied quite well to the quizz
→ **Go to PHASE 3**
- **Case 2:** Your students did not reply very well to quizz or they have many questions related to the topic of the Scientific Challenge
→ Review PHASE 1 (see below) with this complementary material:

http://cesar.esa.int/index.php?Section=Scientific_Cases&Id=23&ChangeLang=en

- Expert talks given at CESAR Teacher workshops (pdf and/or videos)
- ESA dedicated videos
- CESAR Monographic (booklets)
- Simulators/websites



→ **Go to PHASE 3**

- **Case 3:** You can not make it alone and you need interaction with the CESAR Team – Ask for a 30 min video call with your class in Phase 2

Activity 10: Ask for a videocall with the CESAR Team if needed

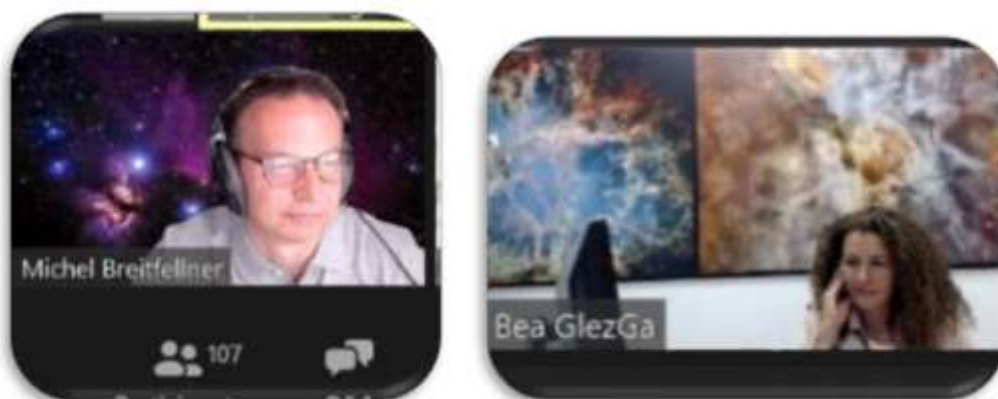


Figure 22: Image of the CESAR Team making a video call (Credits: ESA)



Note: Per scientific challenge you could request

- A 30 minute call with your class (in Phase 2) to clarify concepts
- A 30 minutes video call, just with the teacher (in Phase 3) to review issues with the software/results



Phase 3

Activity 11: Identify the course of a river on a topographical map

Develop a hypothesis¹:

1. Draw on the image which path you think the water would follow after a heavy rain.



Figure 4 Tindaya Mountain, Fuerteventura (Credit: Google Images)

2. Explain in the box why you think it happens like this:

Since the water will always move from the highest to the lowest points, rivers should be drawn following the furrows of the mountain..

3. Now try to draw the mountain with the rivers on a plan:

Each team, depending on the rivers they have drawn on the slope, will have to draw a different drawing. The teacher may check these drawings taking into account what is explained in the next section..

¹ A hypothesis is the initial idea about how you think something happens. Therefore, it should not be considered correct or incorrect, but will serve as a basis for your investigation.

Once you have made your drawing, compare it to this Figure 24.

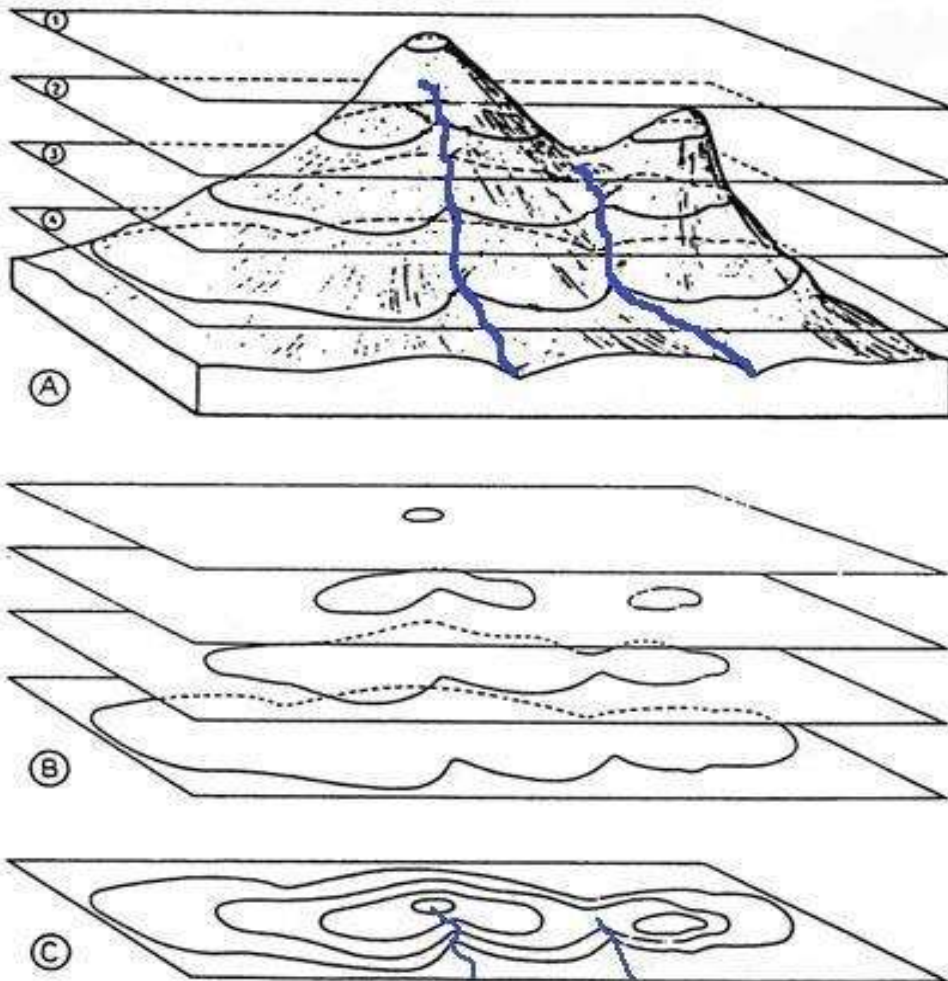


Figura 24 Imagen de recurso web (Créditos: Topografía del relieve)

Activity 12: Topography in augmented reality: Sandbox

Note: This Activity can only be done complete with the Sandbox. The CESAR Team offers it in the Type I Experiences.

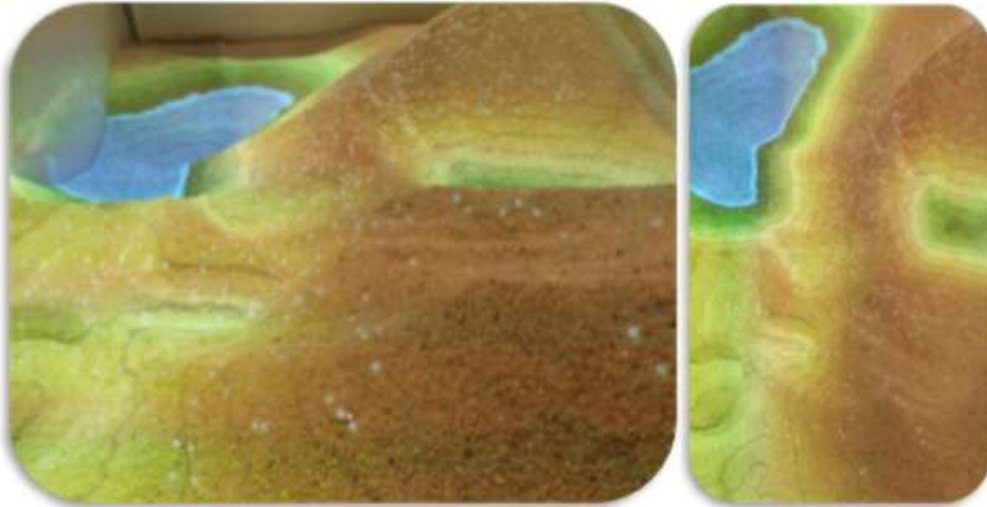


Figura 25 Líneas de contorno como las producidas por la Caja de Arena (Crédito: CESAR-ESAC)

You are going to reproduce a topographic map with augmented reality

Materials:

- Computer with access to google maps
- Sandbox

Procedure (by teams):

1. Choose one of the landscapes in Table X
2. Search in google maps how is this landscape
3. Go to the sandbox and reproduce the chosen landscape.
4. Write down what you see (colors) and try to draw your map with **contour lines**.



Activity 13: What can you see in a topographical map?

Activity 13.1: Identify the geographical features

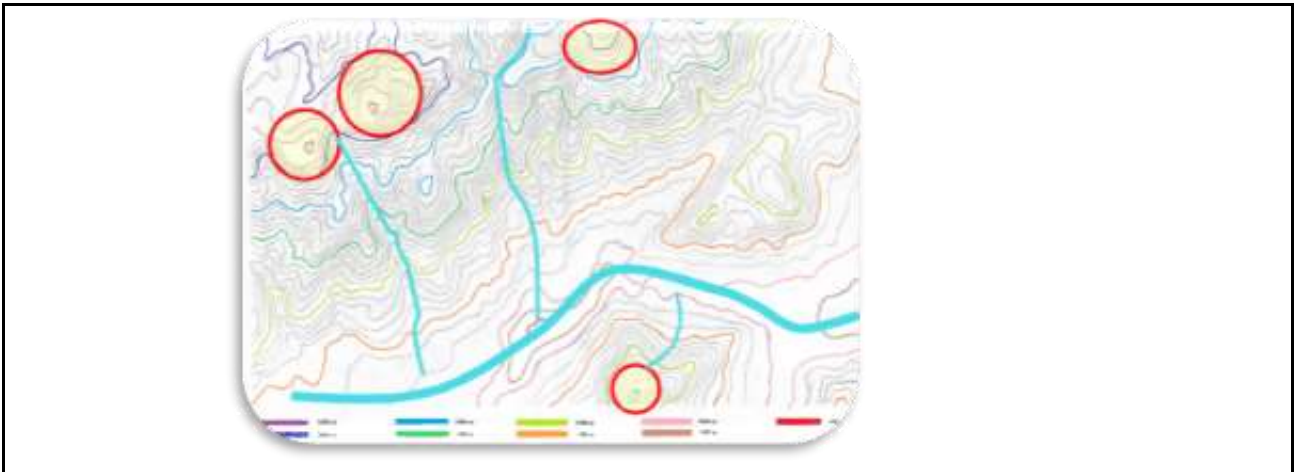
Figure 26 is the topographic map you will be working with.

Procedure:

1. Observe the data on the map and look for the highest mountain or mountains.
2. Trace the course of one or more rivers, from these highest points, to where you think the river reaches.
3. Answer the following questions:
 - Is it possible that there is a lake on the map? Why?

- Do you think that in the previous image there are tributaries or more than one river? Why?

- Where would these tributaries start from?



- Do you think that the river water will always go down at the same speed? Why?

- What do you think it means when the contour lines are very close? And further apart?

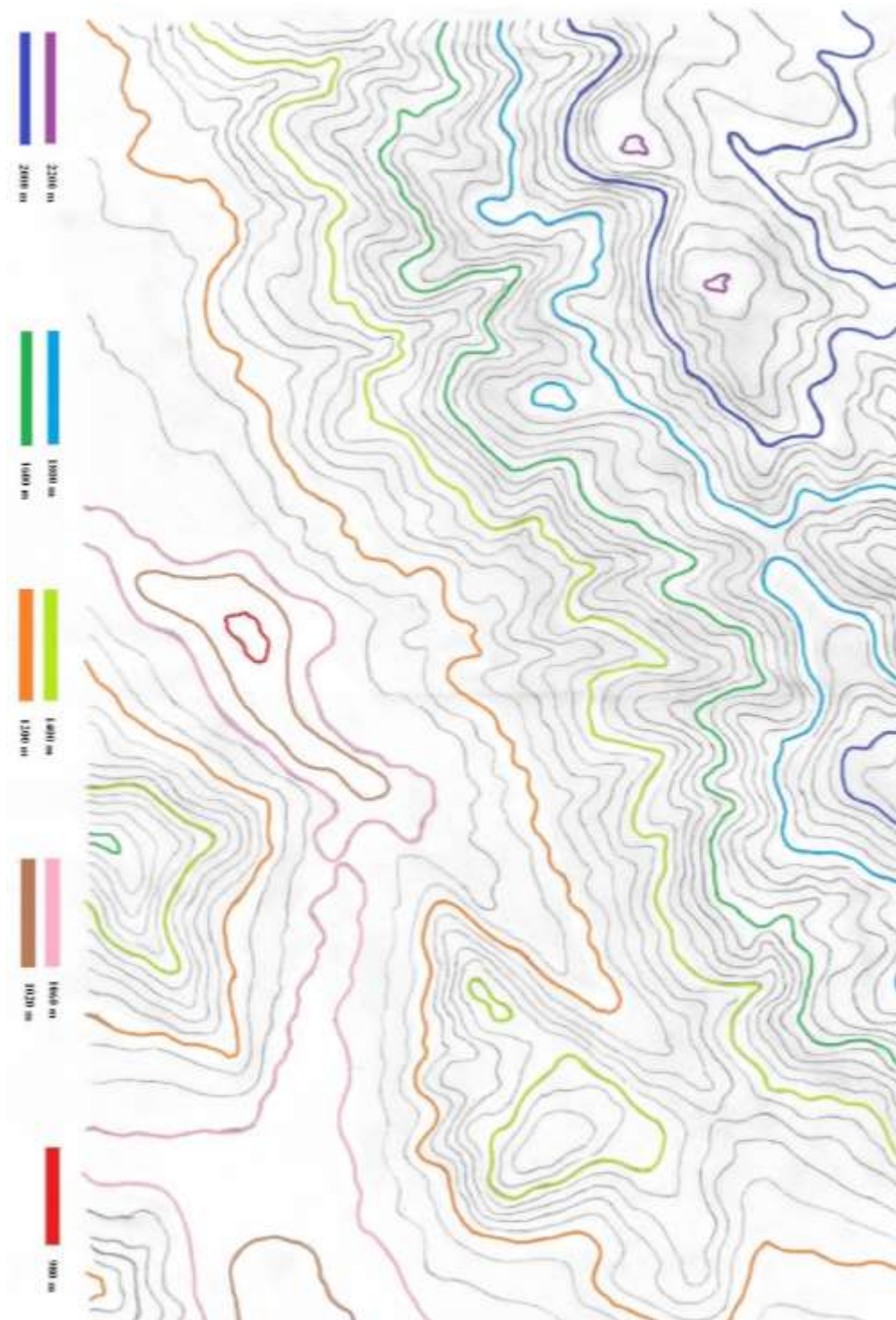


Figura 26 Este mapa muestra la topografía que rodea el embalse de la Pinilla en Madrid. La escala altimétrica del embalse ha sido diseñada para el ejercicio, no es real.

Activity 13.2: Where would you place an artificial dam?



Figure 27 Hoover Dam in Colorado, USA (Credit: Google)

Dams are walls built to stop the course of rivers and form reservoirs. For this study you will use the map in Figure 26.

Procedure:

Analyze Figure 26 and indicate:

1. Where do you think a natural reservoir could be formed
2. Where would you put a dam to increase the size of the reservoir
3. Redraw the reservoir



Activity 14: Study topographical maps with Google Earth

Activity 14.1: Get used to Google Earth Software

To learn how to use Google Earth we indicate the steps to follow, using the indicated material:

Material:

- Computer or device with touch screen.
- Installing [Google Earth Pro](#) software.

Procedure:

1. Open the Google Earth Pro program and you will see an image as Figure 28
2. With the mouse wheel you can zoom in or out to get a better view of the whole Earth. This is the image that we observe.

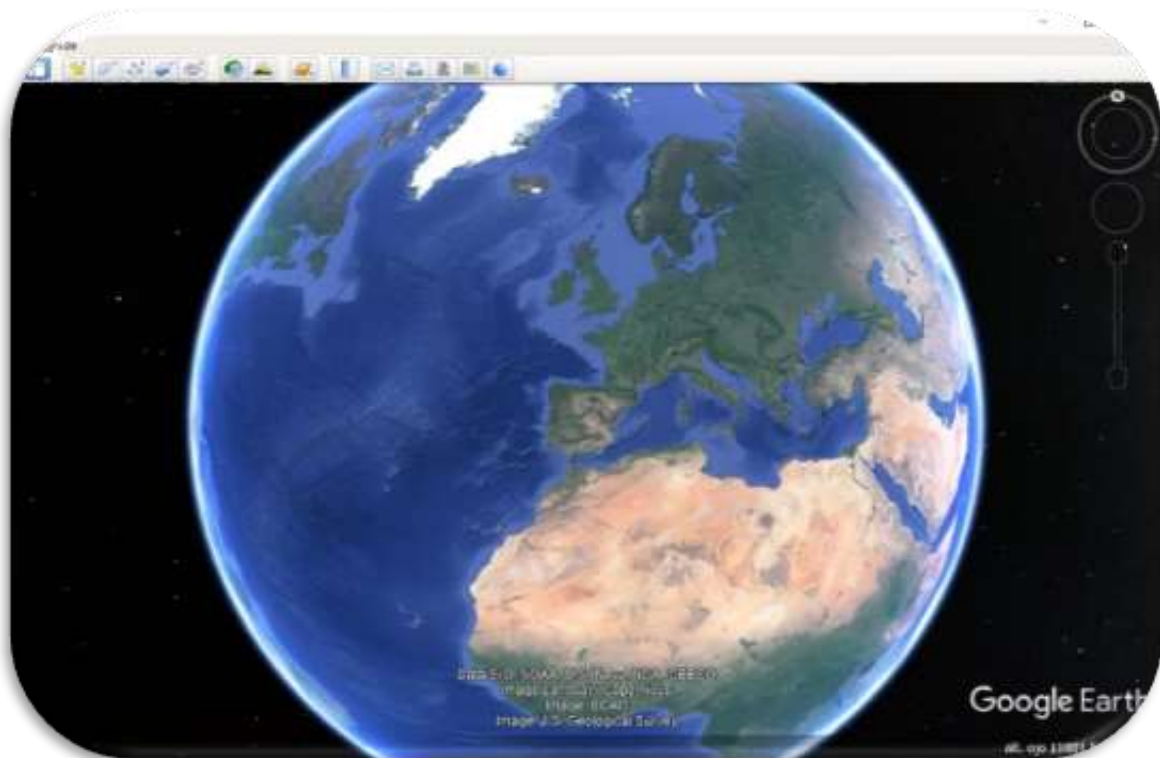


Figure 28 Google Earth Pro Software image (Credits: Google Earth)

3. In the search engine, type “Reservoir of Pinilla” (yellow oval in *Figure 29*) and go there by clicking on the button “Search”.

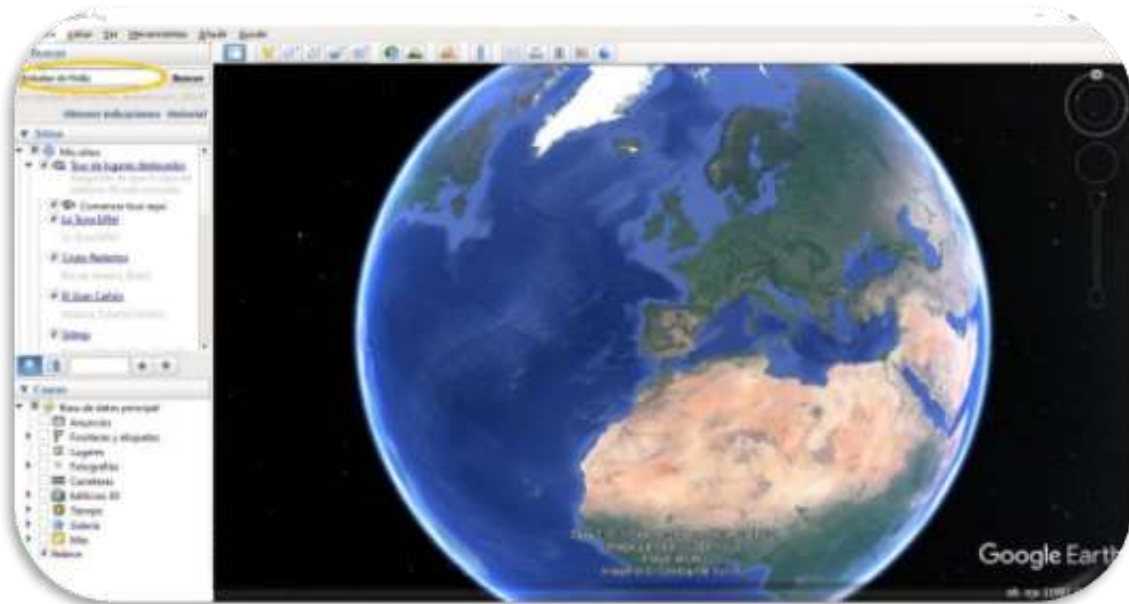


Figure 29 Google Earth Pro Software image (Credits: Google Earth)

4. To better distinguish the irregularities, go to:
Tools-> Options -> Elevation Exaggeration

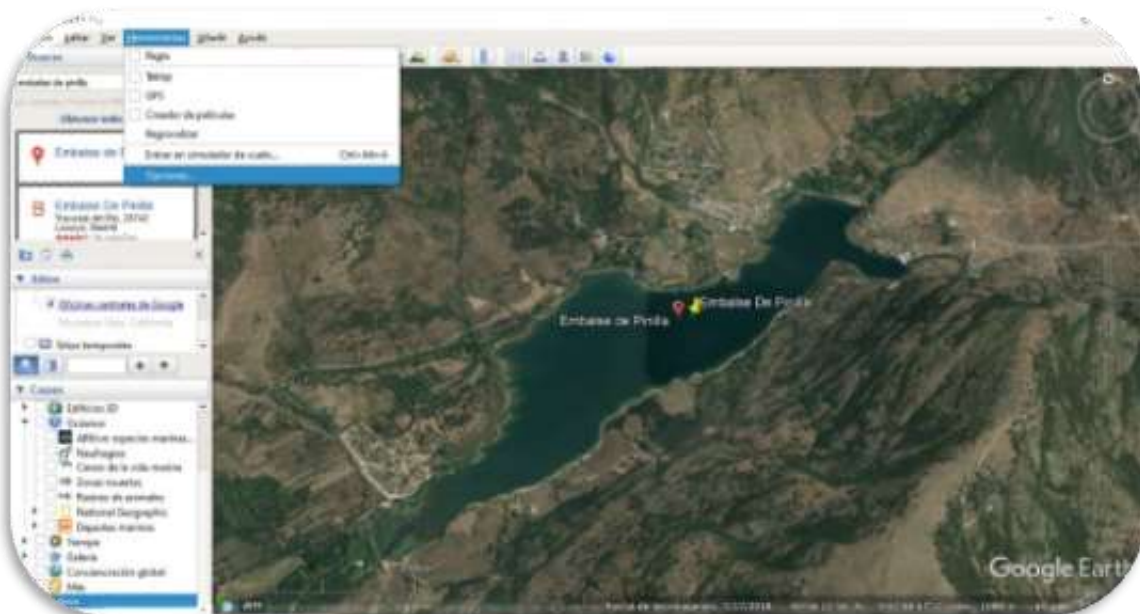


Figure 30 Image from Google Earth Pro Software (Credit: Google Earth)

Write a 3 (marked with an orange oval and a 1 in the next image), click on Apply (green oval and a 2) and then click on OK (blue oval and a 3).

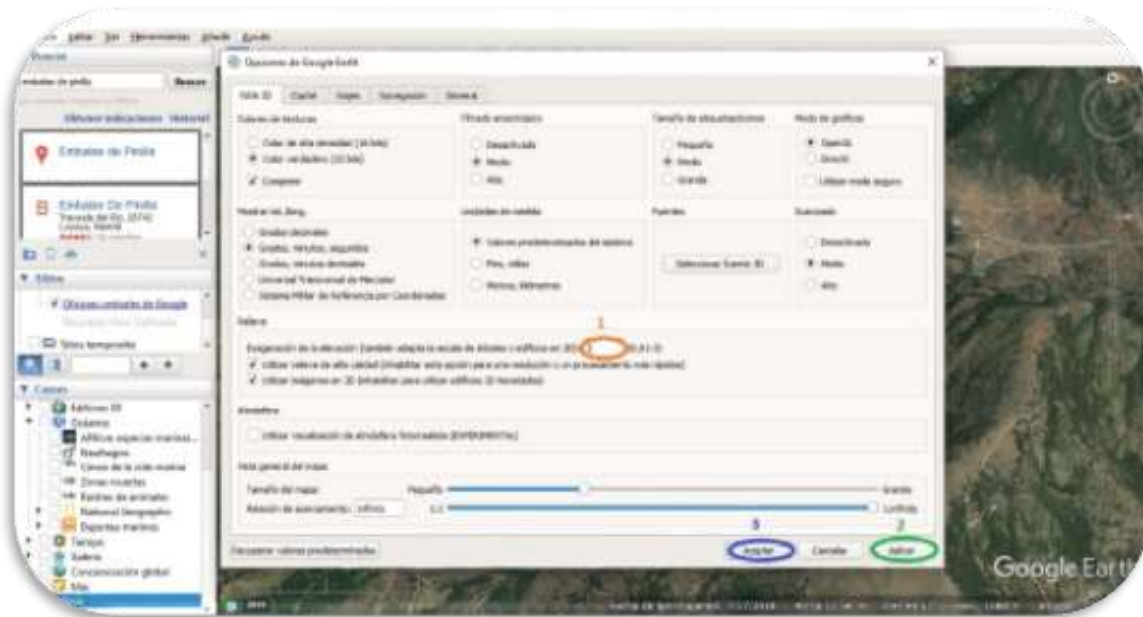


Figure 31 Imagen del Software Google Earth Pro (Créditos: Google Earth)

- Click on the icon of a person on the right (under the compass) and drag it to the center of the reservoir (where we release it and you can see the landscape as if you were there and not in class).



Figure 32 Google Earth Pro Software image (Credits: Google Earth)



6. Try to distinguish the different peaks that you saw on the topographic map in Activity 12. (Note: It is important that the Relief layer is active, otherwise you will see a flat image.)

7. Did you imagine that the 3D map of the 2D map of the Pinilla reservoir was as you have seen it here?

Tell us what differences you see (details) between the two views (2D and 3D) of La Pinilla reservoir

8. Repeat this Activity (see a detailed 3D map) for your favorite place.

Activity 14.2: Time travel with Google Earth.

Google Earth allows you to analyze a terrain on various dates. In this way we can identify if there are temporal changes (with time) in that terrain. Let's travel in time!

1. Follow the procedure for **the Pinilla reservoir** and then for **As Encrobas Lake** (also known as Meirama Lake) in Galicia.

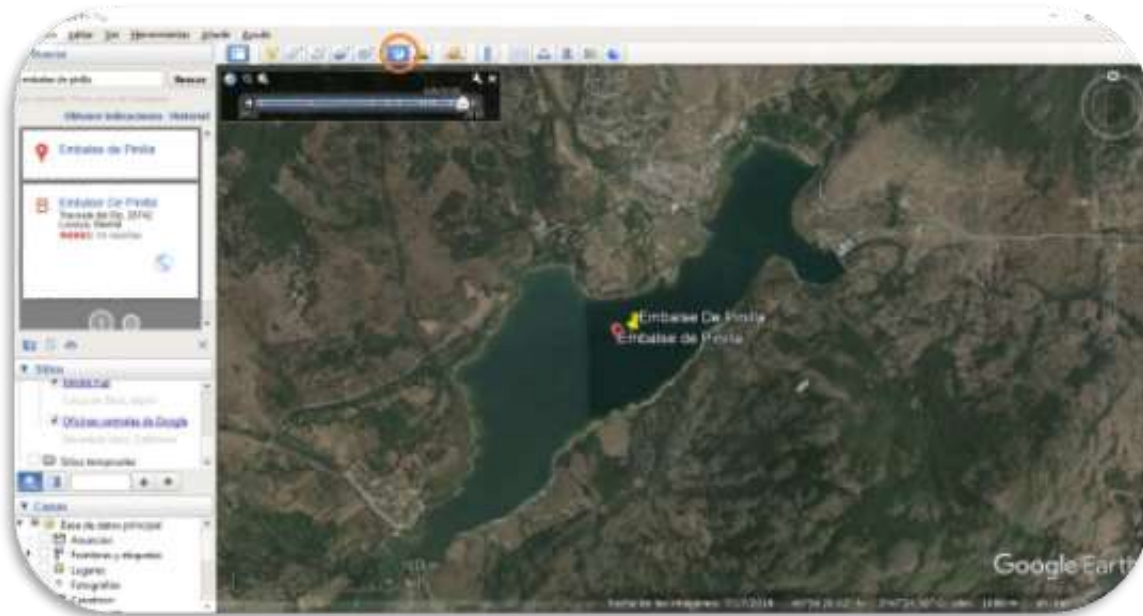


Figure 33 Image from Google Earth Pro Software (Credit: Google Earth)

Procedure:

1. Write in the search engine the land to be studied (for example: "Pinilla reservoir")
2. Activate the tab that shows historical images, (see Figure 33) and a timeline will be displayed (top left)
3. taken from the land on various dates (date on bottom menu)
4. **See** when the reservoir has more or less water and if we have spent some period of drought.



5. Write here what you have found in your temporary study





Repeat the procedure for the As Encrobas Lake (also known as Meirama Lake) in Galicia and solve this investigation



Observe the surroundings of the lake, do you see any mountains or high areas that justify that a lake has been formed here? Does any river reach there?

There are no high mountains in this landscape, unlike in the Pinilla Reservoir. It is worth reminding that some lakes can be formed thanks to underground waters, which is what happened here. This lake filled up with rain and underground water, and later several close rivers and tributaries were taken advantage of to finish filling it.

1. Go back in time to search for the origin of this lake. Write down your observations for the different dates below.

Date (month/day/year)	Describe what you see	What satellite took the picture?	Paste a screenshot of what you see
--------------------------	-----------------------	----------------------------------	------------------------------------

<p>10/7/2017</p>	<p><i>A full lake can be observed.</i></p>	<p><i>Landsat/Copernicus</i></p>	
<p>9/26/2015</p>	<p><i>Zooming in, the northeast side of the lake has less water, it does not go up to the shore.</i></p>	<p><i>Landsat/Copernicus</i></p>	
<p>5/16/2014</p>	<p><i>Part of the lake remains to be filled. Besides, the vegetation is less dense.</i></p>	<p><i>Landsat/Copernicus</i></p>	
<p>3/13/2012</p>	<p><i>The lake is at half its capacity and there is rare vegetation on its shore. There are roads which, in the previous pictures, were covered in water.</i></p>	<p><i>Landsat/Copernicus</i></p>	

4/5/2011	<i>The level of water is very low, and there are many more roads (which were covered in water in the previous pictures).</i>	<i>Landsat/Copernicus</i>	
4/10/2010	<i>The lake is almost empty. In the areas closer to the lake there is less vegetation than in recent times.</i>	<i>Landsat/Copernicus</i>	
7/22/2005	<i>There is no water. Roads can be seen throughout the area, and small cottages or even vehicles can be seen, too.</i>	<i>Landsat/Copernicus</i>	

2. Has there been any alteration to the topography?

Yes, indeed. The absence of water is clearly seen when going back in time, and instead there was an open pit mine. As time goes by, the lake can be seen filling up, bit by bit.

3. Studying the pictures, what do you think has happened?

The lake of As Encrobas is one of the most important environmental actions that have happened in Spain. It was a mining exploitation for 28 years, and it was slowly turned into an artificial lake. The reconstruction work started before the mining exploitation ended, which is why there are pictures with an empty lake and big green areas. Zooming out from the lake, the thermal power plant can be seen where the extracted lignite was used.



4. Share it with your colleagues to see if you can get an answer.

Note: You can also observe the passage of time with the following address in a browser: <https://earthengine.google.com/timelapse/>

Look at the menu on the left and share what differences in time between the different zones:

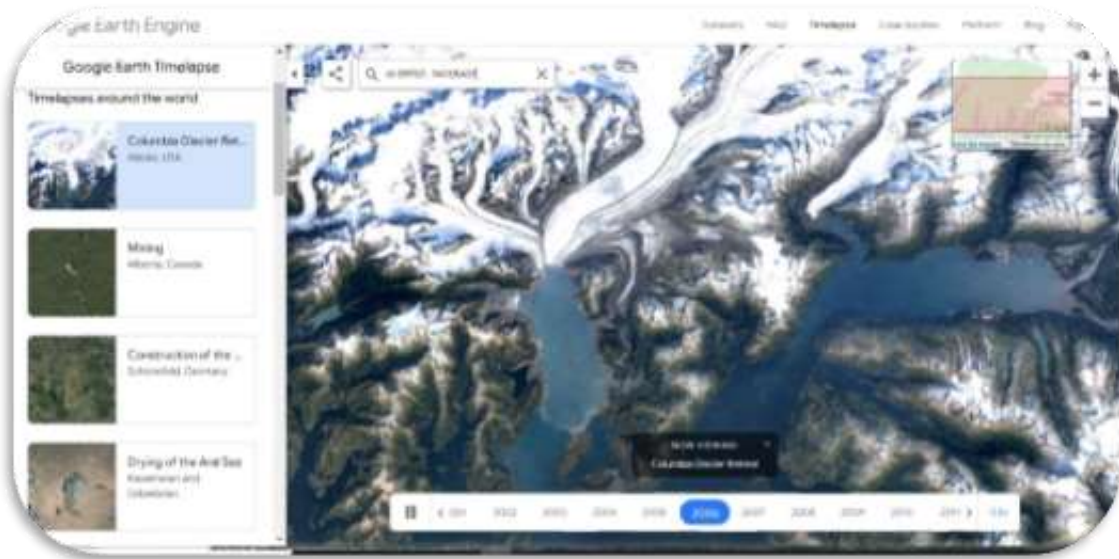


Figure 34 Timelapses from Google Maps (Credits: Google maps)

Areas	Time variation
Alaska, USA	
Alberta, Canada	
Schonfeld, Germany	
Kazakhstan y Uzbekistan	
Dalian, Liaoning, China	



Bahía, California, USA	
Las Vegas	
Dubai	

Activity 15: Create your topographic map with Google Earth

Now we will focus on the mountains of Spain to build topographic contour maps (Hint: review Figures 6 and 24 to remember how contour maps and/or Activity 5 are built)

Do you know some of the highest peaks in Spain? Write down the ones you remember.

Teide (Tenerife)

Mulhacén (Sierra Nevada)

Aneto (Pirineos)

Veleta (Sierra Nevada)

Posets o Llardana (Pirineos)

Activity 15.1: How to know the height of your terrain?

1. Choose a piece of land (for example, El Teide).
2. By clicking with the right mouse on the red indicator you will see in the lower right menu the meters of height

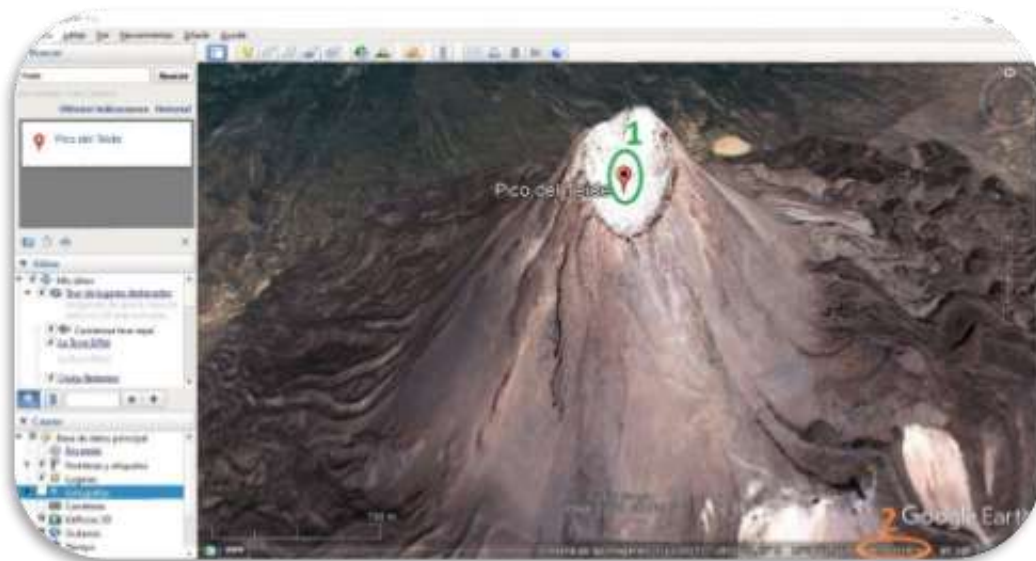


Figure 35 Image from Google Earth Pro Software (Credit: Google Earth)

Activity 15.2: How to create contour lines in your terrain?

1. Write on the browser Mulhacén.
2. Click on the peak of the mountain and select the option "Add a polygon". It will open a window as in the *Figure 36*.

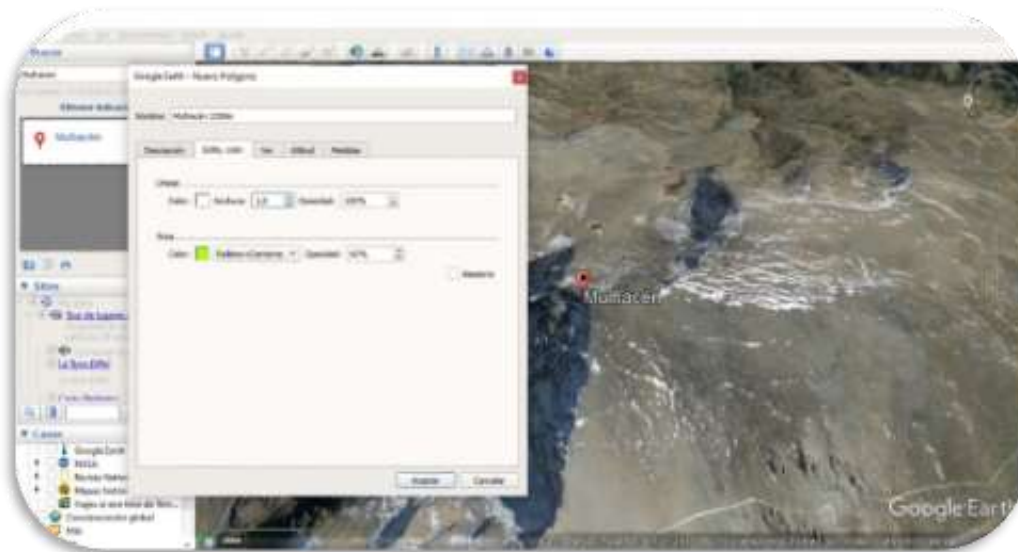


Figure 36 Image from Google Earth Pro Software (Credit: Google Earth)

3. Go to the menu tab that says "Style, color" and for a particular height (contour).
 - Choose the color of the line that borders the polygon
 - Choose the one in your own polygon.
4. Look at the elevation value (bottom right) and every time you have the same height click left.
5. Always go in the same direction and add points. Keep in mind that the more points you add, the more accurate the contour line will be, but for our research a few points will be enough. In our case we have chosen 3250m as the lowest height for the Mulhacén contour lines..

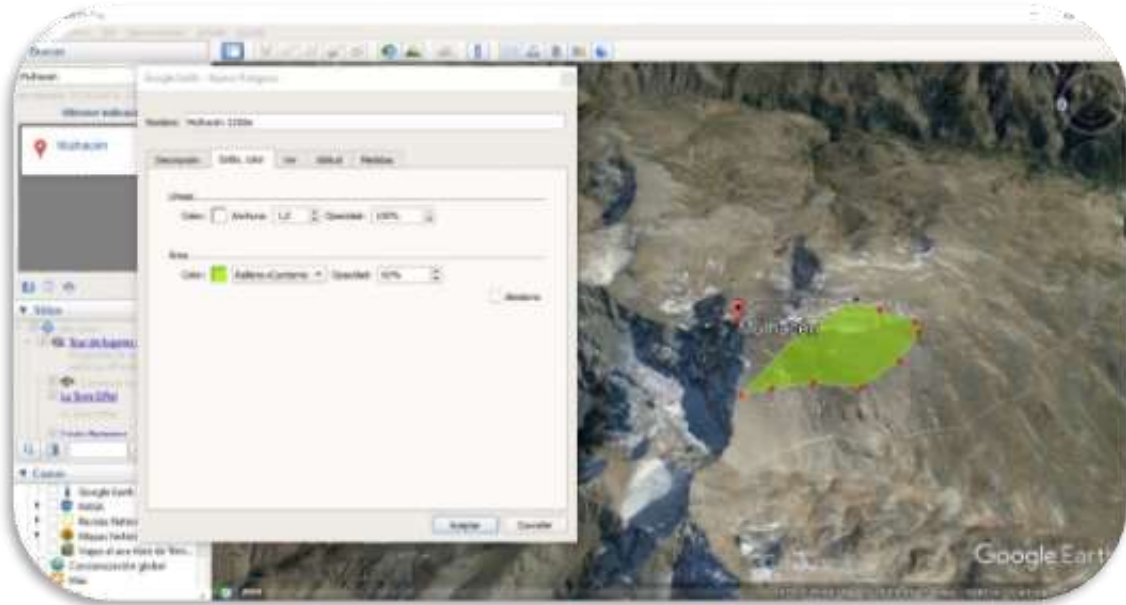


Figure 37 Google Earth Pro Software image (Credits: Google Earth)

6. When you finish selecting all the points you want for your curve, click "OK" in the window you had open and you will have something like this:



Figure 38 Google Earth Pro Software image (Credits: Google Earth)

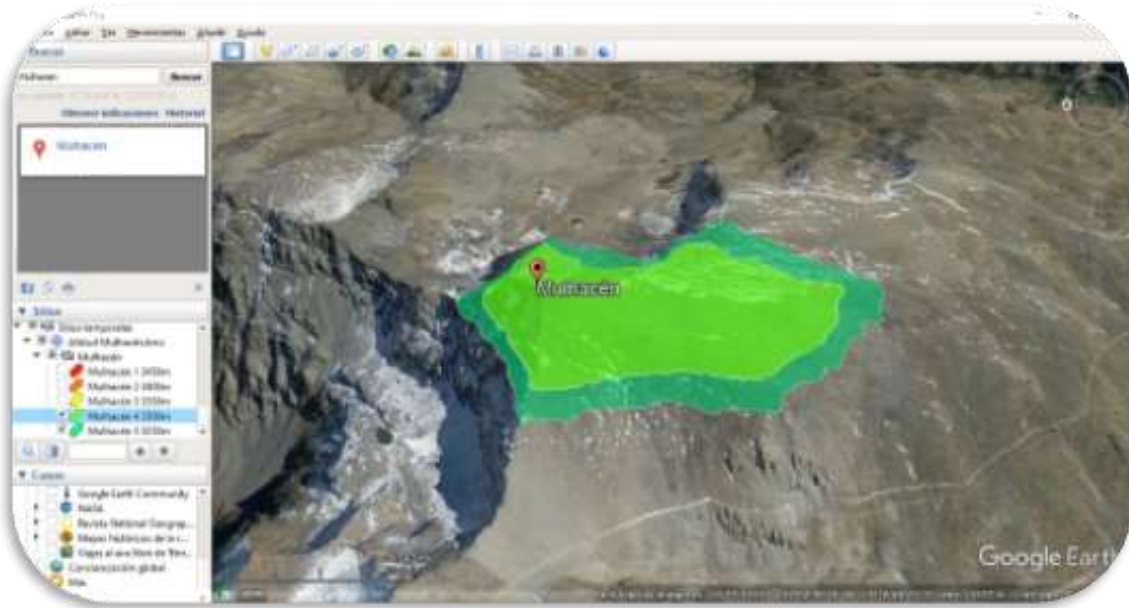


Figure 39 Google Earth Pro Software image (Credits: Google Earth)

7. Add at least two more contours, needed for research. In Figure 37 and 38 these are at heights of 3300 m, 3350 m, 3400 m and 3450 m.

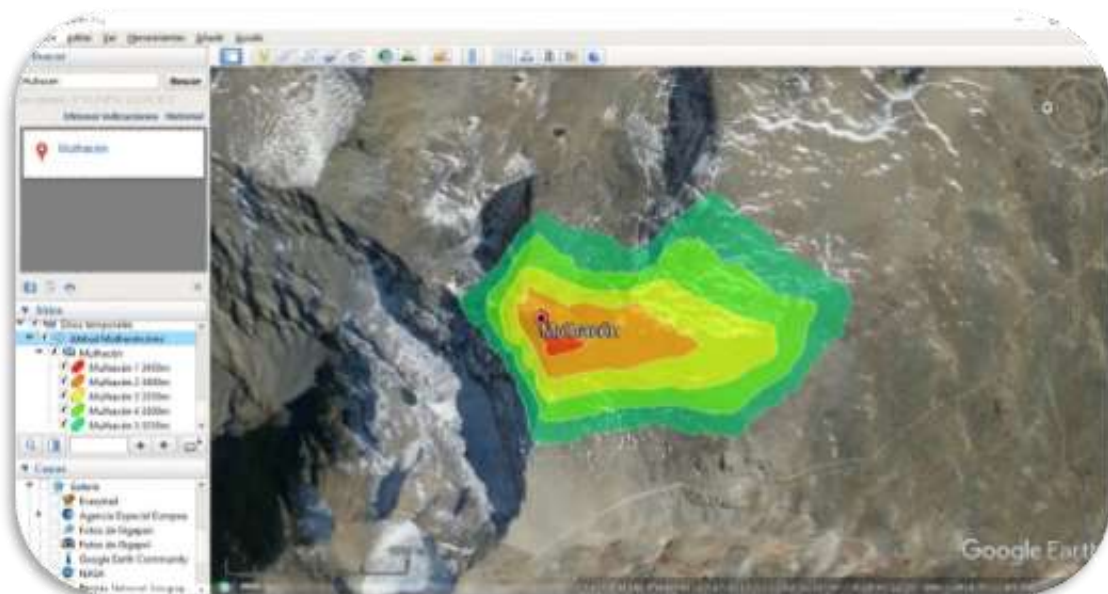


Figure 40 Google Earth Pro Software image (Credits: Google Earth)

8. Change the map view by dragging the person's icon to the area where you are

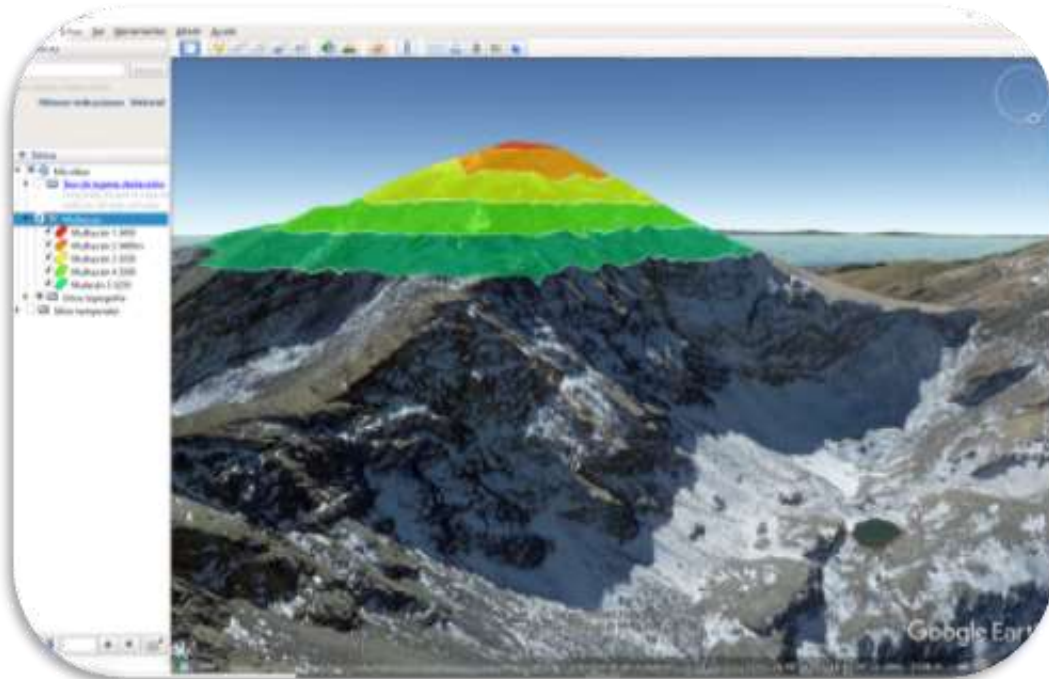


Figure 41 Google Earth Pro Software image (Credits: Google Earth)

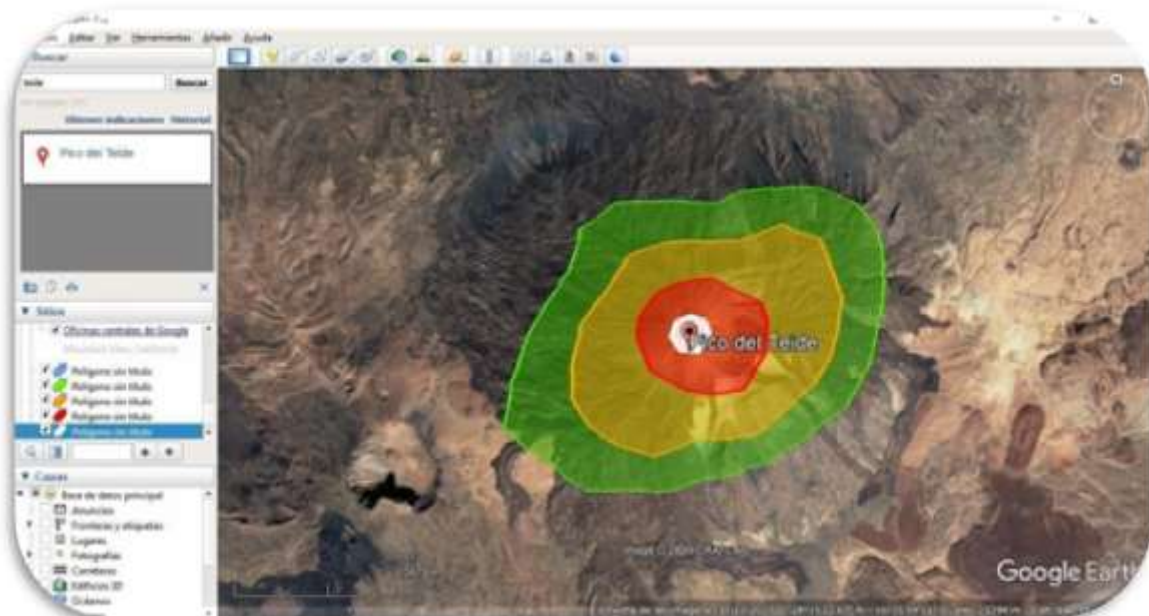


Figure 42 Google Earth Pro Software image (Credits: Google Earth)

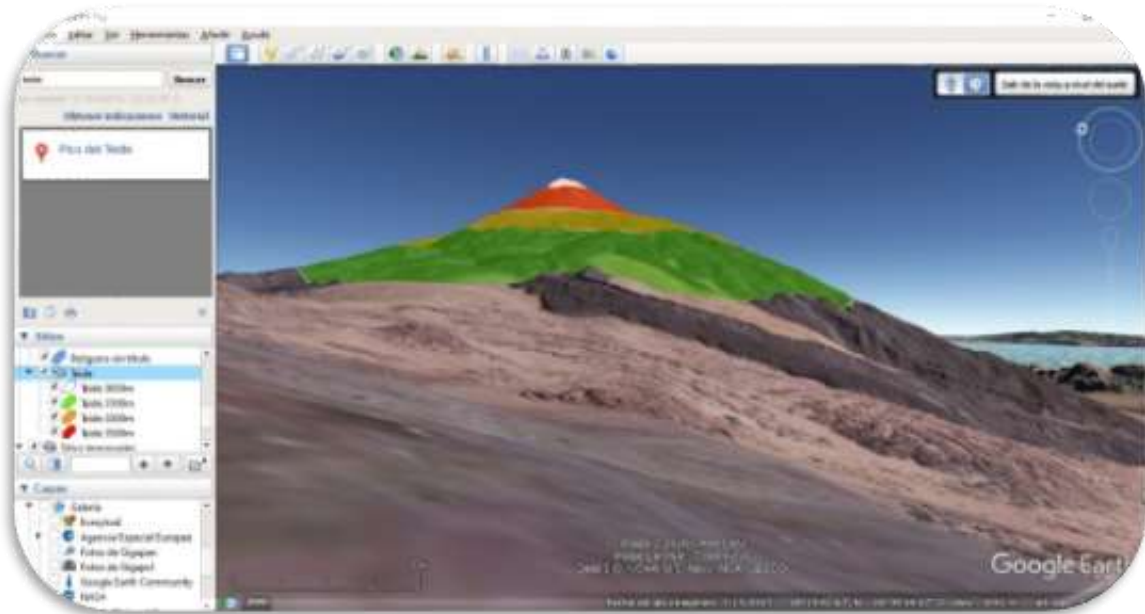


Figure 43 Google Earth Pro Software image (Credits: Google Earth)

Activity 15.3. How to plan your mountain route

You are going to use this wonderful tool to try to discover which would be the best mountain route if you had to climb a mountain.



Figure 44 Image of young people on a mountain route (Credits: Pixabay)



The Mulhacén is shown below as an example.

You will work as a team following this procedure:

- Each Team will be assigned a slope of the mountain (North, South, East and West)
- Each of them must create a route of descent from the highest point of the Mulhacén to an altitude of 3250 meters.
- The route you choose should be as straight as possible and should be 1.5 kilometers long.
- Go ahead and good luck!!

1. Activate the "ruler" tool in the main menu..



Figure 45 Google Earth Pro Software image (Credits: Google Earth)

2. Select the "route" tab and leave the "show elevation profile" box checked

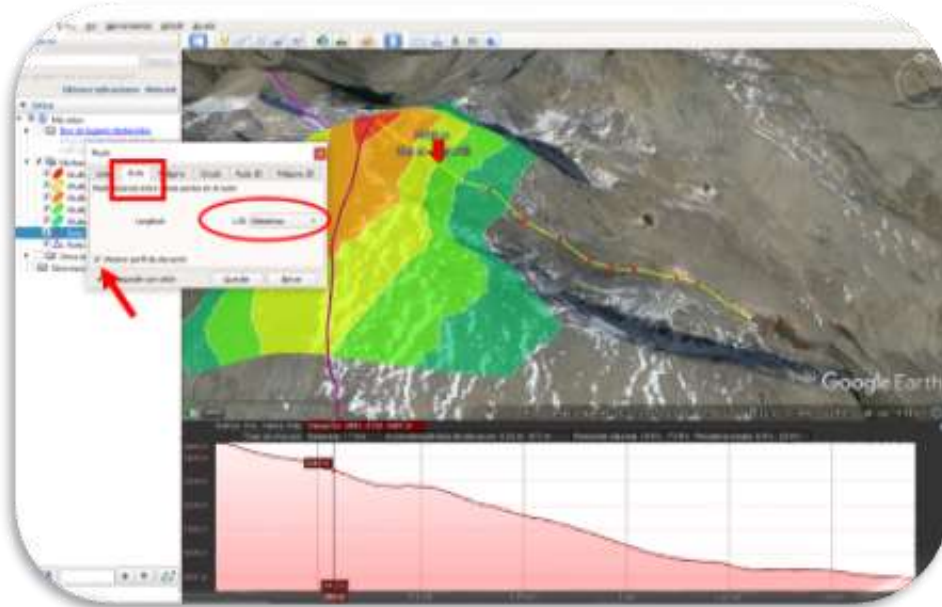


Figure 46 Google Earth Pro Software image (Credits: Google Earth)

3. Mark with the mouse on the map the points of the route, in the same way you did to form the polygons in [Activity 15.2](#)
4. Double click.

Now you will study the slope data and the elevation profile provided by the program itself.

- Make a screenshot like the one in the figure, and paste it here:

- What is your average slope?



- And the maximum slope?

- Do you think it is a viable route without using climbing and/or mountaineering equipment?

Now put together all the routes and discuss what you think would be the most appropriate route of descent.

Important note: High mountain routes can be extremely dangerous. The topographical study of mountain routes is essential to be able to carry out them safely. In addition, it is very important to always be accompanied and to make sure that we have the necessary technical knowledge and we are in the physical conditions for the chosen route.



Phase 4



Congratulations! You have completed your Science Challenge! Tell us your story!

Stop to think about the Experience with your Team and teacher and complete these Activities.

Activity 16: Evaluation

- **In Teams:** Fill in this [questionnaire](#) so that you can check what you have learned in the Challenge.
- **With your teacher:** Give us your feedback and think about the skills developed in this Scientific Challenge.

Activity 17: Present your results

Students will have to create a final product (an A0 poster in pdf format, using power point, for example) showing what they have learned in the different phases of the Scientific Challenge.

This poster is the ticket to participate in the CESAR international adventure competition .

IMPORTANT NOTES:

- It would be very interesting if you could present it to your schoolmates on a certain date, simulating a congress of scientists.
- Any document involving photos of your students can be published on the CESAR website or social networks. Therefore, please only attach those images for which you have explicit permission for publication, intellectual property and image. The CESAR Team is not responsible for their intellectual property and image.

Congratulations teacher!

**Thanks to your dedication your class will receive a
CESAR Team Super Diploma**

Are you ready for new Adventures with us?



Links



Phase 0

- [Images of Earth from the ISS](#)
- [Sound \(and vision\) of Silence](#)
- [ESAC: ESA window to the Universe](#)
- [This is ESA](#)

Phase 1

- [Space for Kids - A view of Earth](#)
https://www.esa.int/kids/es/Multimedia/Videos/Paxi_en_la_ISS/A_view_of_Earth
- [Earth from Space: Barcelona](#)
https://www.esa.int/ESA_Multimedia/Videos/2020/06/Earth_from_Space_Barcelona
- [Galileo](#) http://www.esa.int/ESA_Multimedia/Videos/2016/12/Galileo_Initial_Services
- [Maps](#) <https://en.wikipedia.org/wiki/Map>
- [Geogebra, 3D Graphing](#) <https://www.geogebra.org/3d?lang=es>
- [ESA - Pine Island retreat](#)
http://www.esa.int/ESA_Multimedia/Videos/2014/03/Pine_Island_retreat
- [Video about the wáter cycle](#)
https://www.esa.int/kids/en/Multimedia/Paxi_animations/English/The_water_cycle
- [ESA - Space for Kids - ESA satellites help us to make the most of Earth](#)
https://www.esa.int/kids/es/Noticias/Los_satelites_de_la_ESA_nos_ayudan_a_aprovechar_la_valiosa_agua_de_la_Tierra
- [Space for Kids 1](#)
- [Space for Kids – 2](#)
- <http://cesar.esa.int/form.php?Id=15&k=HkTe1EM22b&ChangeLang=en>

Phase 2

- http://cesar.esa.int/index.php?Section=Scientific_Cases&Id=23&ChangeLang=en

Phase 3

- [Google Earth Pro](#) <https://www.google.es/earth/download/gep/agree.html>
- [Timelapse app](#) <https://earthengine.google.com/timelapse/>

Phase 4



- <http://cesar.esa.int/form.php?Id=15&k=HkTe1EM22b&ChangeLang=en>
- [Bases of the SSE contest http://cesar.esa.int/upload/202001/bases_concurso_sse_final.pdf](http://cesar.esa.int/upload/202001/bases_concurso_sse_final.pdf)

Credits:

This Scientific Challenge contains part of the material of the educational activities [Asociación Planeta Ciencias](#) and CESAR Team. The CESAR Team is fulfilled in occasions with trainees thanks to the [Young Graduate trainees program offered by ESA](#).

- [Young Graduate trainees program offered by ESA.](#)
https://www.esa.int/About_Us/Careers_at_ESA/Graduates_Young_Graduate_Trainees
- [Asociación Planeta Ciencias http://planetaciencias.es/](http://planetaciencias.es/)