

Embroidering my pixel

GLOBE		Associated SDG	Type of Activity
Sphere	Protocols		
Biosphere	Land Cover Classification Biometry	15: Life on Land	Motivation

Overview

A pixel is the smallest homogeneous unit that is part of an image. We have probably heard the phrase: "The image is pixelated," when such image is not very clear and small blurry squares appear in it. Satellites capture images of the Earth's surface that are made up of pixels, which must later be described in detail by anyone studying land cover. Using the cross-stitch embroidery technique (or painting), students will be able to understand how an image is composed, applying what they have learned at their study site.

Time

50 minutes

Prerequisites

- To identify the cardinal points
- To know how to embroider or paint

School level

Last year of elementary school and high school

Purpose

Students will recognize that images are made up of a series of small squares called pixels that they will represent on canvas or paper, applying the concept learned to describe their study site.

Student Outcomes

- Students will explain the concept of pixel.
- Students will associate art with science to embroider (paint) an image composed of pixels on canvas or paper.
- Students will apply the concept of pixel to identify dominant image elements in a selected area.

Background

People often take photographs to remember special moments. Many of these photographs are taken when we travel somewhere, and we want to remember the landscapes we have visited. Our cameras can take pictures with a lot of detail, when we are only a few meters away from the photographed object; but they can also capture very distant images that barely allow us to recognize some elements of the landscape. The more distant the image we capture, the less detail of the landscape we can see.

If we enlarge a picture a lot, or zoom in on it, we can notice how it is composed of small squares that are losing resolution every time (sharpness). If we zoom in on them, we will only see squares of one color. These squares or squares of a single color (homogeneous image composition) are called pixels, minimum units of information in an image with a certain value (ESRI, 2022).

Earth observation (EO) is the collection of information about the Earth's physical, chemical and biological systems through remote sensing technologies, typically with satellites carrying imaging devices (EU Science Hub, 2022). In this regard, it is important to remember that, although we may not be very aware of it, we are being photographed from space by satellites that are on average at an altitude of 500 km or so.

The information generated by satellites is very important because it allows to study the climate (Fick et al., 2017), the land cover (Merlotto et al., 2012), the state of corals in the sea (Hedley et al., 2016), the surface temperature (Mantas & Xiam, 2021), among many other applications.

Land cover is one of the most studied variables. This is everything that covers the surface of the Earth, which can be natural or artificial (man-made) elements. The coverage of a place is generally expressed as a percentage. There are several studies that allow a classification of the type of cover found in a place, assigning it a code that allows its comparison through space and time. One such code is what we will call the MUC code (Modified UNESCO Classification), which will be applied throughout this activity to characterize pixels (homogeneous image elements) within a study site.

Guiding Research Questions

- What is the landscape like near our school?
- What elements dominate the landscape?
- How many pixels are in a photograph?
- What is the importance of pixel size?
- Is everything really the same inside a pixel?

Scientific Concepts

- Pixel
- Remote sensing
- Satellite
- Cover

Materials and Tools

- Fabric for cross stitch embroidery
- Color threads
- Needle



- Image to embroider in cross stitch
- Sheets of graph paper
- Pencils
- Colors or crayons
- Camera (you can use your cell phone)
- Compass (optional)

What to Do and How to Do it

• ***Beginning***

- The teacher will ask the students to choose a figure to be embroidered in cross stitch or may show the student an embroidery that has already been made. From this image, the teacher will explain to the student how an image is made up of small squares (pixels) that add up to form a complete image.
- Then, the students will recognize the elements of the image. For example, how many different colors there are and what structures make it up. If it were a flower, it would be made up of petals, stems and leaves. Each part takes up some space in the embroidery, representing a percentage of it. From this point you can better understand what the cover is.
- Next, the students will explain what a pixel is and what cover means in their own words.
- The teacher will show students a landscape and ask them to identify all the elements they can find in it.
- Based on the students' answers, the teachers will explain that there are different types of elements that cover the surface of the earth: buildings, houses, lakes, pastures, forests, fields, etc.

• ***Development***

- In a field visit, the students select a square area that will represent a pixel, this can be 10m*10m if the terrain is small, and placing themselves in the center of it, they will locate the cardinal points: N, S, E and W.
- Using a camera, the students will take a picture towards each of the cardinal points, as well as towards the ground. Then, they will draw two diagonals in a SE and SW direction as if marking an X point on the ground.
- From one corner of the square the students will walk along the diagonals and every two steps they will record their findings on a sheet of graph paper.
- In order to record their findings, the students will use a numerical and color code, suggested in Table 1, which results from a simplification of the MUC code, while the colors have been standardized to the system used by the CORINE inventory for the land cover types. It is important to mention that there may be points with more than one number because they have more than one type of land cover.

Table 1
Land cover types according to and MUC code and suggested colors for its representation.

Cover	MUC Code	Color
Trees	0	Dark green
Shrubs	2	Light green
Grassland	4	Yellow
Barren lands	5	Brown
Water	7	Light blue
Cultivated lands	8	Orange
Built-up areas	9	Red

• Closing

- The students will analyze their drawings and identify which numbers are most common in the diagonals and which color dominates.
- The teachers will ask the students what color they think their pixel would look like at 500 km altitude and consequently, they will be able to identify that that will be the dominant color.
- The teachers will explain to the students that the element that stands out most is the one seen on satellite images.
- Finally, teachers will ask students to evaluate the activity using the CASH (Conceptual, affective, surprising and helping) effective learning technique, which can be translated as follows: C (what concepts they learned), A (what they felt while doing the activity), S (what surprised them the most) and H (what they think will be most useful to them at the end of the activity).

Frequently Asked Questions

What is remote sensing?

It is the acquisition of information about an object without being in direct physical contact with it (at a distance) by measuring the radiation it reflects and emits at a certain distance. Remote sensors provide a global perspective and data on Earth systems to guide decision-making on the current and future state of the Earth (NASA, 2022).

What is a pixel?

The word pixel comes from the English word "picture element". It is the smallest element shown in an image that can be attributed some characteristics such as dimension, color, and intensity. A pixel is represented in a remotely sensed image as a cell in an array of data values (ESRI, 2022).

What are satellites?

Satellites are objects that orbit around a planet. These can be natural like the moon, but there are also many artificial man-made satellites observe our planet. The latter measure the amount of energy reflected from the Earth's surface, this information is recorded by special sensors and converted into images composed of "picture elements" arranged in columns and rows, called pixels. Each satellite has different pixel sizes. Satellites can have different pixel dimensions, which can be for example 30m x 30m for Landsat, 250m*250m for MODIS and 10m*10m for Sentinel. This means the smallest image unit in the area. However, we all know that in the field there are many smaller elements that occupy a percentage within that area, something that we can only see if we visit a certain area.

Can I work in smaller squares if I don't have large natural areas of 30 m x 30 m or 10 m x 10 m around my school?

Of course, what is important is to do the activity to allow the students to become familiar with their environment and know what a pixel is.

What if my students are very young and I don't want them to use embroidery needle and thread?

You can do the activity regardless, using colors and graph paper to simulate cross stitch patterns.

Resources

- USGS Satellite Imagery Page: [EarthExplorer \(usgs.gov\)](https://earthexplorer.usgs.gov)
- How to embroider a cross stitch step by step: [guide to cross stitch - YouTube](#)
- Suggested cross stitch gallery: bit.ly/3DY

Bibliography

- ESRI, 2022. GIS Dictionary. Pixel Definition - Esri Support GIS Dictionary. Retrieved from <https://bit.ly/3fgikFh>.
- EU Science Hub, 2022. Earth Observation. Retrieved from <https://bit.ly/3UzryNm>.
- Fick, S. E. Hijmans, R. J. 2017. WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. Int. J. Climatol. 37, 4302-4315 <https://doi.org/10.1002/joc.5086>
- Hedley, J. D., Roelfsema, C.M., Chollett, L. et al., 2016. "Remote Sensing of Coral Reefs for Monitoring and Management: A Review," Remote Sens. 8, no. 2: 118. <https://doi.org/10.3390/rs8020118>.
- Mantas, V. M., Xian, G., 2021 "Land Surface Temperature Differences Between Natural and Artificial Turf Sports Fields as Estimated from Satellite: Examples from the United States and Europe," IEEE International Geoscience and Remote Sensing Symposium IGARSS, 2021, pp. 1777-1780, doi: 10.1109/IGARSS47720.2021.9554145.
- Merlotto, A., Piccolo, M.C., Bértola, G.R., 2012. Urban growth and land use/land cover changes in the cities of Necochea and Quequén, Buenos Aires. Argentina. Rev. Geogr. Norte Gd 53:159-176. <https://doi.org/10.4067/S0718-34022012000300010>
- NASA. 2022 EARTH DATA. What is Remote Sensing? Retrieved from Earthdata ([nasa.gov](https://earthdata.nasa.gov))