Monitoring natural phenomena from the classroom with Edusat. Proposal for a teaching guide (and support material)

Rosa Olivella[1], *Carla Garcia*[2], *Laura Olivas*[1], *Pep Sitjar*[1]

Abstract

Satellite images and remote sensing allow us to identify the effects of natural and human-made changes that occur on Earth: fires, floods, urban development, deforestation, etc. Thanks to the Copernicus programme, satellite images of the entire world are now available, with a near-daily frequency that allow the identification and monitoring of all these natural phenomena and human activities that produce notable changes to the Earth's surface.

All these phenomena are forming part of the concerns of many young people who see the future of their planet in danger. The Edusat platform explores these phenomena from space and provides a didactic guide to understanding the effects of global environmental change, right in the classroom. In this way, we bring remote sensing closer to a public that until now was rarely involved in this discipline. We do it from a didactic and practical point of view, connected with real data from Sentinel satellites and thanks to EO Browser application.

Keywords

Climate change, Copernicus, remote sensing, satellite images, teaching material

[1] Geographic Information Systems and Remote Sensing Service (SIGTE) - University of Girona, Spain, rosa.olivella@udg.edu
[2] Faculty of Science – University of Girona, Spain.

1. Introduction - Remote sensing as an educational resource

The social, economic and territorial dynamics that humanity has adopted since the First Industrial Revolution have led to the indiscriminate consumption of natural resources. The exploitation of these resources has put the well-being of the inhabitants of planet Earth, as well as the physical systems that support it, at severe risk. This process has been described as "Global Environmental Change" and results in four well-known phenomena: pollution, biodiversity loss, change in land use and land cover, and climate change [1] [2].

The scientific strength of the negative consequences of climate change, pollution or biodiversity loss further intensifies critical reflection among citizens. This sense of protest and struggle is especially intense among young people, who are fighting against the passivity of politicians for policies to mitigate climate change. As such, these young people need to have the necessary competences in order to evaluate and disseminate the consequences of global environmental change in a critical and objective manner.

The availability of satellite imagery from around the world on a daily basis (depending on weather conditions) makes it easy to identify and monitor all of these natural phenomena and anthropic processes that involve notable changes to the land surface [3]. These images taken from space make it possible to study the evolution of natural and anthropic episodes such as wildfires, floods, melting glaciers, deforestation or urbanization [4].

Copernicus is the Earth observation program coordinated and managed by the European Commission and the European Environment Agency, with the aim of providing accurate and up-to-date information on six areas: climate change, security, emergency, atmosphere, marine environment, and land surface [5].

All of this information is especially designed to provide a global view of the Earth's health, with the aim of helping governments to focus on environmental policies and to effectively monitor their implementation. Industries, organizations and researchers are also encouraged to make use of this data in conjunction with their own data in order to develop new functionalities and applications. Copernicus offers a complete set of open data, including the large volume of images captured from Sentinel satellites. This data is available through various websites, applications and services, and it is designed for different user profiles, from highly specialized to less experienced ones.

The Edusat project [6] presented in this paper aims to set out, in an educational and interactive way, the fundamentals of remote sensing in order to make the process of collecting and processing satellite images understandable.

Therefore, the main objective of this reference material is to present remote sensing to a non-specialized audience and to offer a user-friendly tool for the analysis of land surface changes as well as a tool for the dissemination of results.

2. The Edusat platform

Edusat is a web platform that contains educational resources for exploring satellite images that are open to the entire educational community.

The website was launched in May 2021 and is a multilingual (Catalan, Spanish and English) platform. Edusat offer resources in a dynamic way (images, videos, time lapses, maps, gifs, etc.) in order to clearly explain global environmental change. The resources offered are:

- basic principles of remote sensing,
- case studies (explaining various natural and anthropological phenomena),
- exercises to work on with the EO Browser teaching guide.

Using Edusat, we propose a teaching guide that aims to bring remote sensing to a non-specialized audience and to provide teachers, students and researchers with support material. This paper sets out a teaching guide for a classroom workshop.

The overall aim of Edusat is specified in these three specific objectives:

- To introduce students to the field of remote sensing and to show them how to identify real natural phenomena.

- To introduce students to the Copernicus programme, giving them access to freely available satellite images.

- To enable students to identify the causes and consequences of natural phenomena such as floods, drought, deforestation, etc.

The purpose of making the materials openly available is to empower users to learn about a resource, regardless of whether or not they have completed the courses we offer. The dissemination of the materials enables anyone

to become familiar with the applications and the usefulness of satellite imagery.

At the moment of writing this paper there are nine case studies developed that allow us to demonstrate the usefulness of satellite images to observe and analyze the current phenomena of global environmental change. The case studies are accompanied by videos which explain step by step how to obtain the results we show for each phenomenon studied so that the user can get the same results using the videos as a quick-start guide.

3. The learning material

The teaching guide is the proposal that we offer educators to use Edusat in order to work with remote sensing and case studies in the classroom.

It is structured as a single session -or set of sessions, depending on teaching context- with different parts or blocks (Figure 1).

3.1. Block 1. Context and assumptions

Estimated duration: 2 hours

3.1.1. Context

The first block comprises of a theory session in which the teacher explains the principles of remote sensing (satellites, sensors, electromagnetic radiation and band combinations), showing students how this technology can help to detect natural disasters or human activity resulting from the climate crisis. The goal of this block is to provide the students with context on the issue of global environmental change and to explain the principles of remote sensing in a simple, enjoyable way.

3.1.2. EO Browser [7]

This block also contains a section in which the teacher shows the students how to use the EO Browser application to search for satellite images and make band combinations.

EO Browser is an application developed by the Sentinel Hub company [8] which makes it possible to view high-resolution images from Sentinel, Landsat and other satellites on a single website.

Furthermore, the EO Browser enables users to create comparisons or time lapses of satellite images so that the changes that have occurred in the territory can be easily identified by comparing several images taken on different dates.

For now, this application is an open-access tool that offers basic functions such as displaying the natural-colour images of satellites; as well as advanced parameters of band combinations or the application of multiple indices through inter-band algorithms.

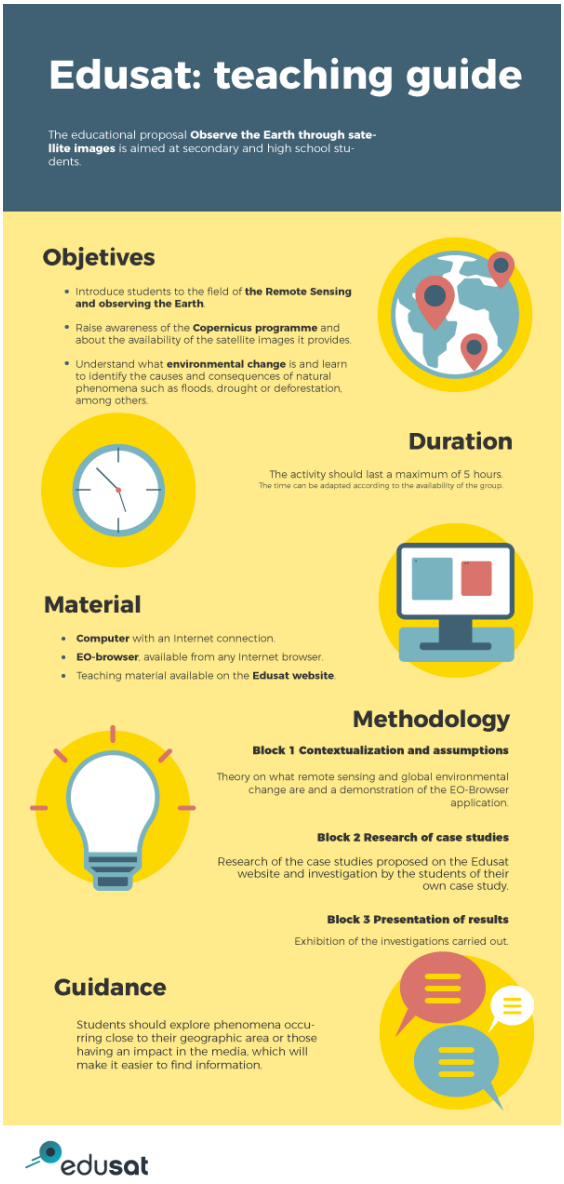

Figure 1. Teaching guide infographic

3.1.3. Case study

The students explore real examples of phenomena from around the world that can be studied using satellite images and well-documented case studies available in Edusat, related to phenomena such as fires, floods,

receding glaciers, volcanic eruptions, logging, drought or urban sprawl. The case studies documented in Edusat are listed in table 1.

Table 1. Table of Edusat case studies for territorial analysis based on remote sensing

Phenomenon	Case study	Date
Forest fires	Ribera d'Ebre, Spain	June 26, 2019
	Amazon, South America	Summer 2019
Floods	Storm Gloria, Spain	January 20, 2020
Glacier regression	Aneto Peak, Spain	2015-2020
	Amery Ice Shelf, Antarctica	October 2019 – February 2020
Volcanic eruptions	Kilauea, Hawaii	May 3 – August 15, 2018
Deforestation	San José de Chiquitos, Bolivia	August 2015 – November 2020
Droughts	Acuelo lagoon, Chile	September 2016 – October 2019
Urban sprawl	Beijing airport, China	2014 – 2019

For each case study, the following is stated:

- The causes and consequences of the studied phenomenon (fire, flood, etc.)
- How Sentinel sensors can detect it: satellite types, indices, band combinations, etc.

As such, in a truly practical manner, students can become familiar with the principles of remote sensing and how the Copernicus program can be used to detect real and up-to-date phenomena.

3.2. Block 2. Researching a new case study

Estimated duration: 2 hours

The second block is based on group work. The aim is to explore the information that satellites give us on a specific event and identify what changes occurred before and after the phenomenon.

Students must search digital media and compile information on their case study (exact date when the phenomenon occurred, where it occurred, photographs of the event and any other information that might be of interest for their research). Then they must explore satellite images using the EO Browser application and make the corresponding band combinations in order to produce a result.

3.3. Block 3. Presentation of the results

Estimated duration: 1 hour

In the third block, each group presents its case study, explaining the results to the other groups. For the presentation, the group has to share satellite images and explain why it has used certain band combinations and not others.

In this block, the student can also practice communication skills and techniques that are also related to geographic information, such as story maps.

4. Discussion

Since we launched the Edusat website in May 2021, we have been using this educational and didactic resource in several workshops and webinars, not only for students but also for teachers and other interested groups. Teaching these workshops has helped us to evaluate the quality of the learning guide and put it into practice in the context of extra-curricular education. The different experiences are listed below in table 2.

Table 2. Table of workshops organized using Edusat teaching material

Institution	Age	Duration	Nº of students
Foundation for Helping Children and Youth with High Capabilities (FANJAC)	13-17 years old	12 hours (4 sessions of 3 hours each)	20
Foundation for Helping Children and Youth with High Capabilities (FANJAC)	11-15 years old	3 hours	20
Rafael Campalans High school (Anglès)	17-18 years old	1 hour	25

Campus Prebat (University of Girona) – online	15-16 years old	2 hours	30
Campus Jove de Recerca (University of Girona)	17-18 years old	2 hours	40
Inmaculada Concepció High school (Lloret)	17-18 years old	1 hour	20
Montessori High school (Girona)	17-18 years old	1 hour	37

Some workshops have been organized in collaboration with the Department of Geography with the aim of disseminating the discipline of geography and encouraging new young students to study this subject. The innovative and up-to-date character of the workshop has confirmed the engagement of the students who have shown a proactive attitude investigating and exploring new natural phenomena by themselves.

At the same time, the workshops have given us the opportunity to show and disseminate the research and projects being undertaken in the university and to introduce young people to the world of academia.

Most of the workshops have been performed in person. However, the technological and digital component of the Edusat learning material allows us to also teach in a virtual context during the pandemic lockdown or when the measures were more restrictive.

One strong factor of the Edusat platform is its flexibility, which allows us to adapt the content and the exercises to different levels and ages (from 11 to 18 years old). On the other hand, having a well-documented teaching guide has allowed any teacher to teach the workshop according to the needs of the class.

During the workshops, the students have explored different case studies documented on the website such as wildfire in the Ribera d'Ebre region (Figure 2), the effects of Storm Gloria on the Catalan coastline, or the fires in Amazonia. However, we have also worked and explored other current natural phenomena such as the La Palma volcano in the Canary Islands, the floods in northern Europe, or the rupture of the A-76 iceberg. However some of these case studies are not yet documented on the website.

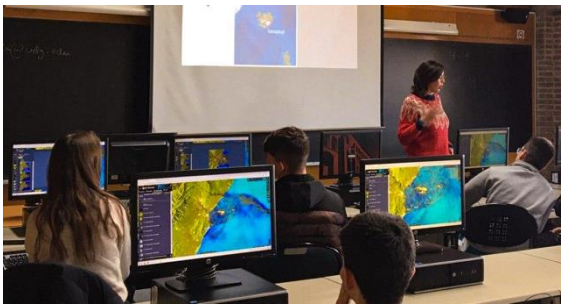

Figure 2. High school students observing the flooding in the Ebro Delta after Storm Gloria with Sentinel 1

As we can see in table 3, we also have organized different online webinars to present the Edusat website to teachers and the general public. These webinars have focused on how to use the teaching guide in order to encourage teachers to use Edusat website in their classroom.

Table 3. Table of webinars organized using Edusat teaching material

Title	Attendance	Language
Edusat, learning platform for Earth Observation	51	Spanish
Demo: Edusat, learning platform for Earth Observation	34	Catalan
Edusat Platform: a new tool to analyse the transformations on the earth's surface	25	English

The recorded sessions can be viewed on the Vimeo channel:

https://vimeo.com/channels/unigisgirona

5. Conclusions

The teaching process we propose at Edusat has been designed based on the different experiences we have carried out in sessions with young people.

Depending on the context, the process has been extended to 15 hours, in others it has been compressed into a 1-hour session. In each case, the youngsters were able to sit in front of

the computer and manipulate satellite images directly.

As a result of these experiences, it was possible to capture the interest of teachers in providing advanced but affordable technological tools, as well as encouraging methods to get closer to digital natives.

With the publication of Edusat, we hope to extend it to a much wider audience and that many teachers can follow the instructions and offer this resource in the classroom.

Also, from our point of view, we plan to continue developing case studies, to connect them with the phenomena that may be taking place, and to fill the platform with more visual resources to better explain, for example, the complex concept of remote sensing.

We believe that Edusat is a borderless platform that can be exported to many educational contexts worldwide to meet a global phenomenon that often has local effects, and we believe that this double dimension is well reflected in the case studies.

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