Physik

Teaching materials on the topic

Reflection in focus - Earth observation by radar satellites

GRADES 7–9

Material for teachers

Project Information

These teaching materials were created as part of the "Cop4Schools - Crossing borders in education" project.

The project is an initiative aimed at enhancing awareness and understanding of Earth observation in school education. By utilizing the extensive data from the Copernicus program, Europe's leading Earth observation program, Cop4Schools provides teachers and students with the opportunity to experience interactive and hands-on lessons.

Overview

Grades `7` `8` `9`

Difficulty ● ● ● ○ ○

Time required 45 minutes (optional extension to 90 minutes)

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Goals

The students should...

- recognise the different reflection properties (specular or diffuse) on a radar image,

- understand and explain the principle of reflection using the example of a radar satellite,

- identify different surfaces using a radar image,

- develop ideas for the further comprehensive use and utilisation of radar images.

Topics

Reflection	Satellite images
Radar	Electromagnetic waves
Flood	Surfaces

Media and materials

Worksheet "Reflection in focus - Earth observation by radar satellites"
Sentinel-1 Satellite data
Digital device
Educational video

Didactic comments

Relevance of the topic

Obtaining information about the Earth's surface using radar satellites is becoming increasingly relevant in the context of climate change. Current studies show a clear connection between extreme weather events and advancing climate change. As a result, the number of flood disasters is also increasing. Sentinel-1 can be used to identify and classify flooded areas so that more effective measures can be developed in future to protect these areas and the people living there.

Reference to selected curricula

NRW curriculum physics for secondary level I

- Content area 5 Optical instruments → Mirroring and the law of reflection
- Grades 7-8

Baden-Württemberg Physics curriculum for secondary level I

- Curriculum unit optics and acoustics
- Grades 7-9

Bavaria Year 7 curriculum Nature and technology

- NT 7.1.3 Optics
- Grade 7

Recommendations for promoting media and methodological skills

To promote media literacy, it is advisable to deal with the use of the satellite image together with the students beforehand. The pupils can then use the tool to work on the worksheet independently.

Differentiation: By working on the optional task 5, media competence is additionally promoted through independent research on the Internet.

Lesson planning

Phase 0 (preparation): For the use of tool, it is advisable to reserve a computer room, a laptop class or similar for the lesson in advance. In addition, the pupils should be informed one lesson beforehand that the digital end device used at school should also be brought along for supplementation.

Differentiation: To shorten the lesson, the first part of task 2, watching the educational video "How are radar images created?" and making notes on it, can be given to the pupils as preparatory homework.

Phase 1: The preparatory task 1 is best done in pairs or in plenary. This means that the pupils open the tool in pairs if they have to share a computer and the satellite image is first viewed in plenary on their own computers under the guidance of the teacher. At this point, the students can be given background information and/or brief instructions on the tool and Sentinel-1.

Phase 2: The subsequent tasks 2, 3 and 4 are best worked on individually.

Phase 3: Differentiation: In order to extend the lesson, open task 5 can be included. Small groups must be formed for task 5.

Phase 4: The results can then be backed up in plenary as desired to ensure that all pupils have saved the correct results in their documents.

Timetable – 1st lesson

Time	Phase	Teaching process / Methodological-didactic commentary	Social format	Media
10 Min.	Access	Introduction to the tool (display of content, map and radar image) The interactive environment and the tools can be found at: fis.rub.de/lerneinheit/reflection-from-satellite The students call up the radar image, make their very first guesses as to what or what differences can be seen in the image and develop the key question of the lesson together: To what extent can radar images provide information about the Earth's surface?	Plenary	Computer/ laptop/ digital device (at least every second student), projector/ digital board
10 Min.	Elaboration	The students determine the surfaces with purely specular reflective properties in the radar image and explain what these surfaces could be.	Individual work	WS no. 2
5 Min.	Elaboration	The students transfer what they have already learned and fill in the table.	Individual work	WS no. 3
10 Min.	Elaboration	The students recognize the causes of the two bright areas and justify their assumptions.	Individual work	WS no. 4
10 Min.	Security	The results of the work are secured in plenary and the key question is answered together.	Plenary	projector/ digital board
5 Min.	Access	Differentiation: link to the previous teaching unit or even lesson	Plenary	projector/ digital board
10 Min.	Elaboration	The students come up with their own ideas for the further use of radar satellites. After coming up with their own ideas, they can also research them on the Internet.	Individual work	WS no. 5a

15 Min.	Elaboration	The students get together in working groups and collect their ideas. The results are then saved in the form of a mind map on a poster (digital or analog) and prepared visually so that they can be presented afterwards.	Group work	WS no. 5b
15 Min.	Presentation and Security	The working groups present their results. This should lead to further and more detailed answers to the key question.	Plenary	Beamer/ Digitale Tafel

Task 2

a) The surfaces with purely specular reflection properties are those with smooth surfaces and very low roughness. In the radar image, the darkest pixels reflect the surfaces with purely specular reflective properties, as almost the entire signal is reflected in a different direction and therefore only a very small part of the signal returns to the sensor.

b) They could be different surfaces. It is obvious that it is a calm water surface. These could be lakes or rainwater retention basins. Based on the distribution of these surfaces visible in the satellite image, it is clear that these are floodplains.
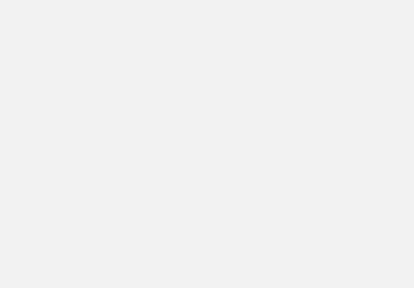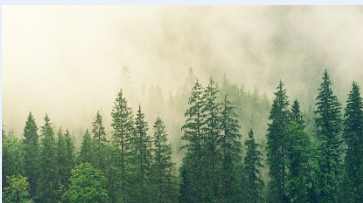
Task 3

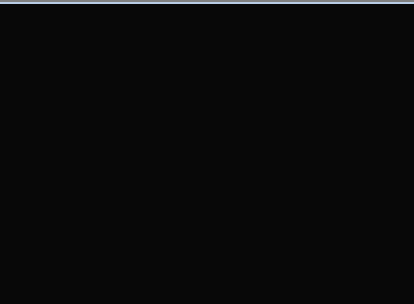| Surface	Pixel	Reason
		Buildings have many vertical surfaces, so that the signal is very diffusely backscattered and a large part returns to the sensor. (high backscattering)
		Forests have neither an extremely smooth nor a rough surface, so that the signal partially returns to the sensor. (medium backscatter)
		Calm water surfaces have a very smooth surface so that the signal is reflected in a different direction and hardly anything comes back to the sensor.

Table 1: Different surfaces. Building - forest - water surface.

Task 4

In section A, the cause of the conspicuously bright areas is the relief. The bright pixels in the radar image are caused by the exposed side of the hill to the satellite, so that a large part of the signal is scattered back to the sensor. By fading the radar image in and out, the relief can be determined more precisely using the labeled contour lines, among other things.

In section B, the buildings in the village of Zarko (Ζάρκο) are the cause of the conspicuously bright areas. Due to the vertical surfaces of the buildings, the main part of the signal is scattered back to the sensor. By fading the radar image in and out, you can see that it must be a settlement.

Task 5 (optional)

The following mind map should serve as an option and orientation aid. There may be deviations, which are even desirable due to the free task format.