



Educational Materials on the subject

Earth by Night - Light Pollution in Central Europe

Form 11

Teacher Material

Project Information

These teacher materials have been developed in the course of the project “Columbus Eye – Live Images from the ISS in School Education”. The project Columbus Eye is sponsored by the Space Agency of the German Aerospace Centre with funds from the Federal Ministry of Economics and Energy in accordance with the resolution of the German Parliament under the funding code 50 JR 1307.

The ultimate goal of the project is to develop a wide range of digital learning materials to be used in school education, including interactive learning tools and worksheets, provided via a learning portal.

<http://columbuseye.rub.de/english/>



Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

RUHR
UNIVERSITÄT
BOCHUM



DLR

Overview

form

11

level



Time required

1 - 2 hours

Author

Claudia Lindner

Goals

The students are to...

- interpret and spatially locate satellite images,
- recognise differences in urban structural development based on natural physiogeographic characteristics,
- recognise and analyse the conflict potential between nature and mankind,
- discuss benefits and problems of extensive night lighting.

Subjects

anthropogenic influences

settlement structure

Planet Earth at night

light pollution

false colour images

Media and Materials

worksheet “Light Pollution in Central Europe”

didactic commentary

slides

app “Earth by Night”:



URL for the app: <https://play.google.com/store/apps/details?id=com.ColumbusEye.Main>

Didactic Commentary

Lesson Plan

Phase 0: (preparation) the students should download the app “Earth by Night” a couple of days before the planned lesson. To that end, the teacher can either send the link to the students, hand out the respective QR-code (see slide 1 in “Presentation_LightPollution”) or project it to the classroom wall, so the students will be able to access the download page. To save the students’ data volume, one should recommend them to download the app at home. Tip: It is possible that the app will not work with certain smartphones, based on problems with the phones’ operating system or hardware. This should not be a problem, if every working group has access to at least one smart phone which can operate the app “Earth by Night” during the following working phase with the worksheet.

Phase 1: After a general introduction and the handing out of the worksheets, the students are to orient themselves with regards to the satellite image of the Ruhr area. If the students’ school can be found on the satellite image, they should be able to locate it on the image without help. Should there be problems, the teacher can always give the hint to use the clearly visible river on the left side of the image as an orientation help. The given channel combination should help the students to identify forests and to consequently realise the purpose behind the false colour combination: visualizing the contrast between city and vegetation. To underline that contrast, the teacher should also point out the differences between the false colour image and the real colour image, in which the green and grey areas blur into one another.

Phase 2: To work on task 2, the slides with the Sentinel-2 mosaics need to be projected on the classroom wall. The comparison between real colour images and false colour images should enable the students to make out further structures. Furthermore, the students must use the app now: they are to watch the video in which the two satellite images are compared.

They are divided into small groups with at least one smart phone supporting the app. By using the app and pointing the smart phone camera at Marker 1, the image on their screen is superimposed with the ISS- video. The video can be started by tapping. Based on the various image data, the students are to draw conclusions with regards to settlement structure. They should also be able to make out bigger industrial areas and traffic routes. Tip: The hand symbol refers to a “virtual button”: You push a button on the paper which is included only in the programme. The button’s purpose is to provide additional orientation help by adding city names.

Phase 3: In task three, the students are to compare the video with the digital map. At this point there should be at least two smart phones in every small group which support the app “Earth by Night”. The additional task can be given as homework if there are no desktop PCs or tablets at the students’ disposal in their school.

Tip: Here the virtual button can be found in the upper left corner. It is once again represented by the hand symbol and it gives access to the same map with an additional Bing Maps Overlay to provide further orientation help.

Phase 4: To solve task 4, the students must read the attached newspaper article. After developing own ideas in small groups, the students are to discuss their findings at the blackboard.

Preparation and Follow-Up

On the website <http://www.fis.uni-bonn.de/en> there is a worksheet called „Erde bei Nacht - Energieverbrauch um Rhein, Ruhr, Maas und Schelde (Planet Earth at Night – Energy Consumption around Rhine, Ruhr, Meuse and Scheldt)”, which covers the subject of energy generation and energy consumption in the respective regions in more depth. The related teacher materials include information about remote sensing in general, the used satellite image from Marker 1 and the relating video.

Solutions

1. Marker 1 shows a so-called false colour image in which the red recording channel has been replaced with the infrared one. Locate the image section in Germany and elaborate on the advantages of this type of visualization.

Additional information: Marker 1 is an infrared-green-blue composite image taken by Sentinel-2.

The detail shows the Ruhr area. The wide river on the left is the Rhine. In the middle part of the Rhine one can see Europe's biggest inland harbour, the Duisburg-Ruhrorter harbour. The longish lakes along the midsection of the image are reservoirs along the Ruhr.

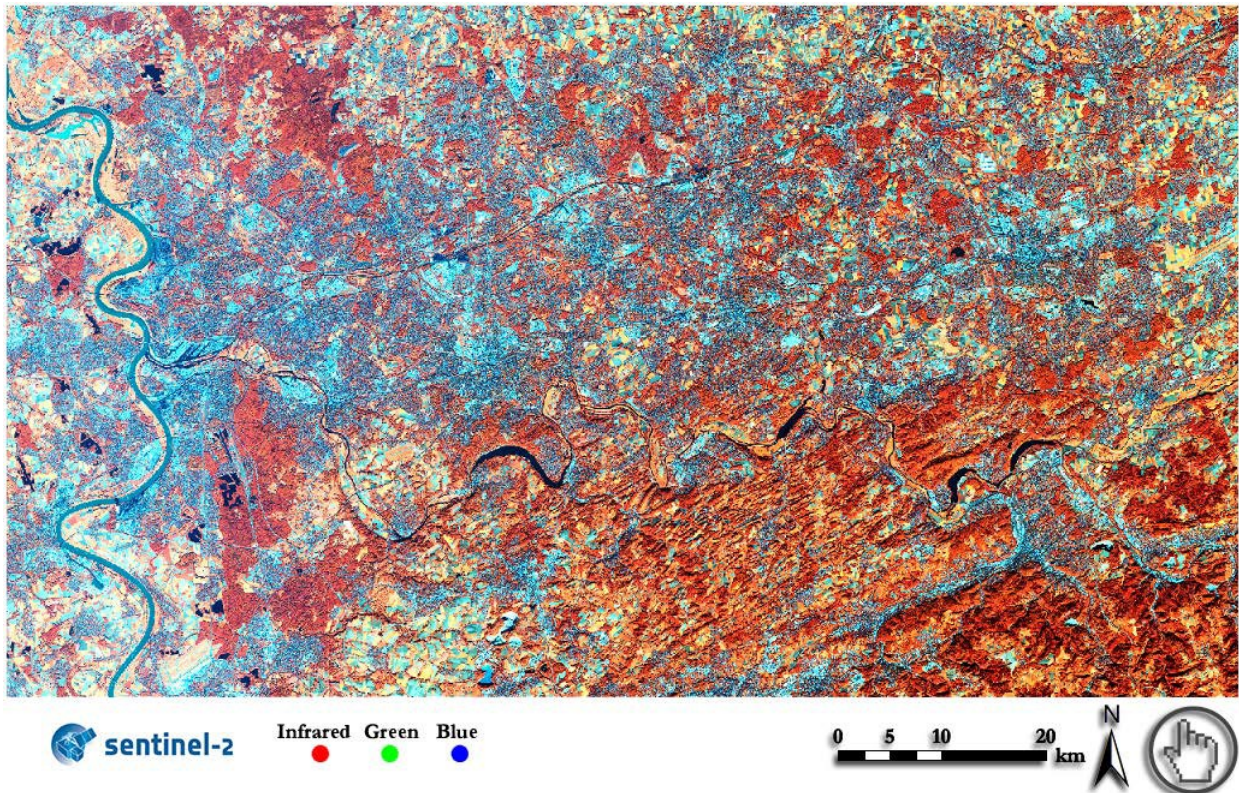


Image1 Orientation help for Sentinel-2B-image from 15/10/17 in the colour channels infrared (B8, 833nm), green (B3, 559nm), blue (B2 492 nm).

Due to the selected channel combination, the contrast between sealed areas (residential-, commercial- and industrial areas in blue/turquoise) and vegetation areas (orange forests, yellow fields) is more distinct than in conventional RGB images. The problem with RGB images is that the grey sealed areas only stand out from surrounding vegetation if they are big enough.

2. Use the App “Earth by Night” together with marker 1. Describe the distribution of the light spots in the video by identifying the structures and patterns. What can be found out about natural conditions and patterns of settlement? Also consult the false colour image itself!

Most of Belgium's territory is located on flat land, traversed by rivers and small lakes. Settlement is possible almost anywhere and this has led to an even distribution of villages, towns and cities, which significantly fragment the landscape and habitats for wildlife. Centres of settlement can be found along rivers, such as the Sambre and the Meuse. Along the Albert Canal, from Antwerp to the hinterland, there are multiple industrial centres. Bigger cities are easily distinguishable from one another. They are surrounded by star roads and suburbs. The metropolitan area “Flemish Diamond” (orig. “Vlaamse Ruit”) between Antwerp, Gent

and Brussels stands out significantly. It includes round about 5 million inhabitants.

In NRW settlement centres only exist along the rivers. There are vast areas which are not suited for settlement, due to natural characteristics, such as steep hills. The lights of smaller settlements trace the outlines of valleys, while the lights of the Ruhr area's cities blur into one another; even the green belts around the cities are hard to make out. City development took place along the important traffic roads or rivers and near natural resources, which, in the video, can only be made out indirectly through populated areas.

3. Use the App "Earth by Night" together with marker 2 (page 3). Compare the video to the map. Are the areas which appear dark in the first video really dark? What effect do the light sources have in the distance?

Light emitted by the cities' street- and system lighting is reflected and widely scattered through particles in the air and more importantly water particles in the clouds. Even in a distance of 20km a big city's light dome can illuminate the sky so that some animals or people may confuse it with a sunset or a sundown, which can cause problems such as disturbed day and night cycles.

The light pollution has a negative impact on growth cycles of plants as well as sleep- and hormone cycles of people and animals and this can lead to health problems. Blackbirds living in the cities e.g. breed earlier during the year and stay up longer at night than their country dwelling conspecifics. Birds and insects are attracted by the lights. This disturbance of the sense of direction may lead to death by exhaustion. Furthermore, astronomic observations become more difficult the closer the observer gets to a light source such as a city or an industrial area.

4. Read the attached newspaper article and discuss the necessity and the problems of constant night lighting. How can these problems be solved or reduced?

The main purposes of night lighting are traffic safety, public safety and the extension of working hours. However it has many disadvantages. Unfavorable lighting conditions can cause camouflage zones, in which objects cannot be distinguished through contrast any longer and the consumption of energy increases significantly.

Targeted spatial and temporary lighting can preserve the advantages of night lighting, reduce its impact on health and minimize energy consumption. The direction of the emitted light should aim directly at the street and not the surrounding buildings, gardens or green areas. Lighting aimed at the sky should be removed altogether. One should only ever turn on a light, where it is really needed. This can be implemented e.g. through a light ordering service (via SMS/app to the provider) or motion sensors. Additionally, one could reduce the light intensity. Both the targeted spatial and temporary lighting can be easily implemented through LEDs. In addition, LEDs are energy-saving and long-lived. One disadvantage is the high proportion of blue light emitted by LEDs, which makes it appear brighter. The blue light has a negative impact on the cycles of various living beings.

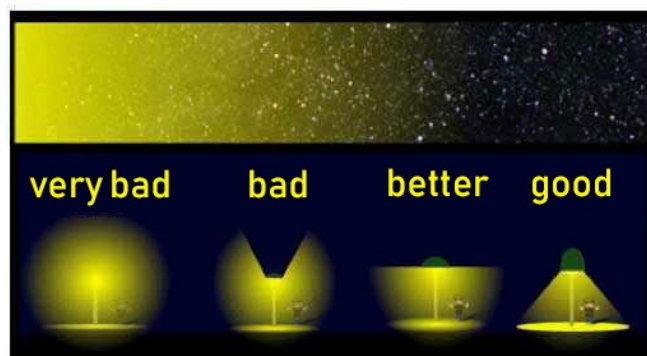


Image2 levels of light pollution caused by different lighting directions of street lamps