EDUSPACE - THE EUROPEAN EARTH OBSERVATION WEB SITE FOR SECONDARY SCHOOLS

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ABSTRACT

Eduspace is the web site for Earth Observation (EO) enabling secondary schools to bring EO into the classroom for teaching and learning. The content is structured with relevant projects based on EO data, analysed with the help of appropriate tools and guidelines for both students and teachers.

The content is developed with the co-operation of EO specialists and experienced teachers to ensure that the projects are both scientifically correct and relevant for the classroom. Eduspace projects can be used in the teaching and learning of several subject areas such as human geography, physical geography, environmental sciences, physics, biology and computer science. Many projects can form the basis for cross-curricular work involving two or three subjects.

Each project concentrates on a specific theme such as weather systems, climate and climate change, glacier dynamics, deforestation, a national park, a world heritage site, urban expansion and agricultural patterns. There are examples from almost all continents.

The goal is to put the students in the centre of the learning process, working with real EO data using semi-professional tools, guided by the project description with more or less detailed exercises and questions.

In the classroom, access to relevant data is important. Eduspace has collections of data from Europe, Africa, South America and the Himalayan region covering both landscapes and city areas. In many cases the study can be based on a series of images of the same location, to study changes over time. The Eduspace Image Catalogue has full coverage of Europe with ERS, Landsat 5 and Landsat7 images, with MERIS and ASAR data to come. All Eduspace users can search and download images of 1000x1000 pixels size (this will be increased in the near future). These satellite data can then be visualised and analysed using the image processing software LEOWorks developed especially for Eduspace.

LEOWorks is a simple yet very powerful tool. It has been designed for the dual purpose of usefulness in the classroom and as an introduction to image processing. Working with multispectral images, it is possible to combine single bands into colour images, to make measurements of lengths, to make both unsupervised and supervised classifications based on selection of training fields, to calculate NDVI and to make an animation to mention a few of the tools available. In addition to this, LEOWorks has a GIS module that can read industry standard GIS files as well as enabling the students themselves to create GIS layers as part of their work with Eduspace projects.

A project is divided into four parts: introduction; background information; exercises with or without the use of LEOWorks; and a list of useful external links. The projects can be used as they are or can form the basis of the teacher's own plan for teaching the specific theme.

The projects focus on visualisation of the raw EO data by stressing the importance of the pixel value. This means that the students can analyse the images with this knowledge and therefore understand many of the operations used in image processing analyses.

Although the projects are aimed at secondary and upper secondary school students, some of the projects can be used in EO introduction courses at university level.
Currently Eduspace is available in the following languages: English, German, French, Spanish, Italian, Danish, Dutch and Portuguese.

INTRODUCTION

ESA and its national and industrial partners have developed the multilingual Website. It aims to provide students and teachers in Europe with a modern learning and teaching tool, which offers an entry point to space image data and in particular to a wide-spread visibility of Earth Observation applications for education and training. It inspires teachers to incorporate Earth observation in their curricula and it provides for in-service training. It encourages teachers to use Earth Observation data by providing ready-made projects. It shall stimulate the curiosity of students with attractive space-borne images and further resources and tools, amongst which there is the educational image processing software LEOWorks. The site also includes the means to facilitate collaborative work with other schools, especially within the same geographical region.
Figure 1: The EDUSPACE entry page
It is thought that teachers and students can use this material for most curriculum subjects, including Geography, Science and Environment, Physics, Chemistry, Computer Science, and even in the Arts. The materials or images might be used as a motivating icebreaker for starting a class. Likewise they could be used in culminating a lesson in demonstrating real life aspects on a satellite image.
The pedagogical goal for the web site is to put the students in the centre of the learning process. This is done by providing the necessary material which is relevant data in the form of specific satellite images, a tool to describe and analyze the data and guidelines in the form of more or less detailed and open exercises and questions.

MATERIAL

A tremendous development has taken place during the last few years in the field of availability for the general public of Earth Observation data in the form of satellite images. Now students are aware of the usefulness of using these images when navigating and taking virtual tours around their neighbourhood or around the world. Eduspace shows what Earth Observation can be used for in many subject areas when analyzing the multispectral data with the image processing software LEOWorks. For a successful result in the classroom the following must be available: data, tools and case studies showing how to use the material. Eduspace provides this on the web site.

DATA

Eduspace offers large collections of satellite images from the ESA systems such as ERS and ENVISAT together with images from other systems such as the Landsat family. The images are available free of charge to download for registered users. The images are mostly in the form of the multispectral bands with no image enhancement. Most of the images are georeferenced. There are resources for Europe, Africa and the Himalayan region. For Africa and the Himalayan region selected urban and landscape areas can be downloaded from the image gallery. The images consist of radar images from Envisat ASAR and ERS and optical images from Landsat. These images can then be visualised and analyzed using LEOWorks. For selected landscapes and city areas a case study shows how the data can be used to study a landscape or a city.
To get an overview of the whole continents an interactive Spot 4 Vegetation satellite image mosaic is provided together with population density data and the topography of the continent or region. The students can zoom in and out and shift between the different layers to study the relationship between the physical landscape and the distribution of population. The maps can be downloaded so the students can use the maps e.g. in a report or essay.
Figure 2: The EDUSPACE Image Catalogue

For Europe Eduspace offers the Eduspace Image Catalogue. It allows the user to perform multi-mission inventory searches on the main ESA supported missions together with time series of Landsat images. It also allows registered users to download limited parts of a scene of a 1000×1000 pixels size.

LEOWorks

LEOWorks image processing software is free and any registered user can download the executable file as well as an exhaustive tutorial. LEOWorks is a specially created piece of software which has been conceived in such a way as to introduce teachers and students to the world of digital image processing, in an intuitive manner. Although it offers nearly all the processing possibilities and options provided by professional software of that kind, it can just be used to play with digital images in order to explore the means to manipulate image data.
LEOWorks has been designed to give schools many options to input images, to edit images, but also to visualise digital values. Many options, some of which are unique provide a special emphasis that can help students understand the images they are working with, for example through altering the histogram. There are a variety of filters implemented and there is also a module to superimpose images of different origin. With respect to well-known commercial software processing, the processes are not optimised, but has to be done step by step. This has been done on purpose in order to preserve the educational value of how digital images can be manipulated.
LEOWorks focuses on understanding the importance of the pixel value in the multispectral images. This means that the major image processing procedures are open and visible for the student. A good example of this is the Interactive Stretching where the image is linearly enhanced by selecting the low and the high value for the grayscale used. The student is manipulating the histogram and can see the result in the satellite image.
A basic GIS module is included in LEOWorks. This enables the user to import themes and to create new theme layers based on the study of the image. The theme layers can be exported in the widely used .shp format. In some of the case studies the GIS software ArcExlorer is used.
LEOWorks is currently undergoing further developement.

CASE STUDIES

The case studies are the core content of Eduspace. They are grouped both thematically and geographically.
A case study has four sections starting with an introduction followed by a background section with necessary information to compliment the content of a normal textbook on the subject to enable the student to work with the exercises and questions in the worksheet section. A collection of external links is found in the Link section. The exercises and questions in the worksheet are inspired by Bloom's Taxonomy of cognitive learning starting with simple descriptive questions followed by questions involving the analyses of the images using LEOWorks. This leads to building understanding and knowledge of the problem or the theme that is the subject of the case study.
Currently there are Europe from Space, Africa from Space and Himalaya from Space representing a geographical division. Each of these modules has sections covering an overview of the region, selected cities, selected landscapes and a section covering the weather and climate. The sections contain collections of satellite images and selected case studies.
In Africa from Space data from the following cities are found: Addis Abbaba, Algiers, Cairo, Cape Town, Casablanca, Daka, Dar es Salam, Freetown, Harara. Johannesburg-Pretoria, Khartoum, Kinshasa, Lagos, Nairobi, Tripolis and Tunis. The data can be viewed on the screen with a small description or they can be downloaded for further inspection and analyses using LEOWorks. For Cairo and Lagos case studies are produced to show how the images can be used in the teaching and learning of these two large African cities.
Figure 3: From the case study Kilimanjaro, Tanzania
In the Africa from Space landscape section the following areas are covered: Atlas Mountains, Nissago Islands, Kilimanjaro, Lake Chad, Nile Delta, Niger Inland Delta, Okavango Delta, Great Erg, Tibesti, Lake Turkana an Victoria Falls. Four case studies focuses on Niger Inland Delta, Ngorongoro, Kilimanjaro and the Congo River Basin. For the two UNESCO World Heritage sites

Ngorongoro and Kilimanjaro the focus points are the threats to the area from deforestation and the tourist industry. The different threats to the Kilimanjaro Forest Reserve such as the logging of indigenous tree species, the burning of forest areas, charcoal production, forest villages, livestock grazing, cultivated fields in the indigenous forest, landslides and quarries are studied using a collection of GIS theme layers that can be integrated with the satellite images using LEOWorks. Time series of Landsat images show the development from 1984 to 2000 both in overview and in details showing the dwindling ice cover on the top of the volcano.
Five case studies in the Himalaya from Space have been produced by local scientist and earth observation specialists in co-operation with experienced teachers.
Global Change and Disaster Monitoring are two theme based modules. In the Global Change module sections covering land, ocean and atmosphere are found. Under land a case study on deforestation shows the situation and the development in Rondonia, Brazil. The students will first work with a low resolution NOAA image to analyze a situation with extensive burning of the forest. The students are guided to find actual fires using the thermal infrared band and compare this with the visible bands showing smoke and patterns of cultivated fields. Seven small areas are covered by Landsat TM images. The students will use LEOWorks to construct colour combinations and use these image for the mapping of rain forest, rivers, roads and cultivated fields.

ENVISAT FOR SCHOOLS

The ESA satellite ENVISAT is the focus of the module ENVISAT for Schools. Here Students can learn about the satellite as such, its instruments and the many applications. Special focus is on its ASAR radar instrument and the MERIS sensor which is used for mapping the Sea Surface Temperature, SST. Case studies follow expeditions around the world in search for evidence of global warming and to Antarctica.

REMOTE SENSING PRINCIPLES

A module is concentrated on the principles of remote sensing. Here the student can get knowledge about the concept of multispectral digital images with the understanding of the importance of pixel value. The different satellite orbits and their use for weather satellites and resource satellites are featured. A collection of viewgraphs is available for the use in the classroom for the teacher or a student to demonstrate e.g. the construction of a false colour image.

LANGUAGES

Currently Eduspace is available in the following languages: English, German, French, Spanish, Italian, Danish, Dutch and Portuguese.

CONCLUSIONS

THE EDUSPACE website will continue to develop over the coming years. New educational case studies ranging from the extraction of vegetation parameters, to world heritage site monitoring and studying glaciers affected by climate change to name just a few, are developed by the EDUSPACE team.

The EDUSPACE website of the European Space Agency is strongly promoting the use of Earth Observation in the classroom and beyond at university. EO data is becoming frequently more important throughout society and many decision-making processes running our society. The use of EO data will therefore increase with years to come and decision-makers of tomorrow that are sitting in the classroom today need to be exposed to the huge potential that lies within remote sensing. EDUSPACE will continue to put the students in the centre of the learning process using EO Data. That is ultimately the aim of the EDUSPACE website.