

SEOS - Earsel's project on science education through earth observation for high schools

SEOS - Projeto EARSeL de educação científica para escolas de ensino médio, através de conhecimentos de observação da terra

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Abstract

SEOS is an initiative for using remote sensing in science education curricula in high schools funded under the 6th Framework Programme of the European Commission (EC). Eleven partners from several European countries, in cooperation with the European Space Agency (ESA) and teachers from European high schools, created e-learning tutorials for science students in high schools. The tutorials cover many disciplines such as physics, biology, geography, mathematics and engineering, emphasising the interdisciplinary character of remote sensing. They are the core element of the SEOS Learning Management System, allowing teachers to create their own courses, to distribute already available or new worksheets to the students for homework and to collect the results. Forums are available for teachers, students and other users to exchange information and discuss topics relevant for their study.

Keywords: Science education; eLearning; remote sensing tutorials; earth observation.

Resumo

SEOS é uma iniciativa em ciência da educação para a utilização de sensoriamento remoto nos programas curriculares em escolas de nível médio, financiadas no âmbito do 6º Programa da Comissão Europeia (EC). Onze parceiros de vários países europeus, em cooperação com a Agência Espacial Europeia (ESA) e com professores de escolas europeias de nível médio, criaram cursos-tutoriais de aprendizagem a distância para estudantes de ciências em escolas de ensino médio. Os tutoriais abrangem muitas disciplinas, como física, biologia, geografia, matemática e engenharia, enfatizando o caráter interdisciplinar do sensoriamento remoto. Essas disciplinas formam a base central do Sistema de Gestão de Aprendizagem a Distância SEOS, permitindo que professores criem seus próprios cursos, distribuindo material didático especializado e proporcionando interações

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via e-mail, para os alunos como tarefas de casa, recolhendo-se posteriormente os resultados. Fóruns estão disponíveis para professores, estudantes e outros usuários para trocar informações e discutir temas relevantes para continuidade desse tipo de transferência do conhecimento e por conseguinte, capacitação de competência.

Palavras-chave: ciência da educação; treinamento à distância; tutoriais de sensoriamento remoto; observação da terra.

The SEOS Project

The Project SEOS (Science Education through Earth Observation for High Schools), funded by the European Commission in 2007-2010 and coordinated by the European Association of Remote Sensing Laboratories (EARSeL, <http://www.earsel.org>), is an effort to enhance the sensibility of high school students towards their environment and encourage interest towards natural sciences (EUROPEAN COMMISSION, 2004) with the help of remote sensing images of the Earth.

A consortium of EARSeL member laboratories, supported by the European

Space Agency (ESA) as an observing member, worked together to realise 17 learning tutorials. Teachers from six partner high schools in Belgium, UK, Germany and Denmark evaluated the tutorials, tested them in the classroom, and reported on their experience with the tutorials and on the assessment done by students in the project meetings. This feedback turned out to be a key element for the creation of educational websites.

The tutorials cover a wide array of topics ranging from remote sensing of the atmosphere, ocean and land surface to current environmental issues such as pollution, natural disasters, land use change and climate change (Figure 1).

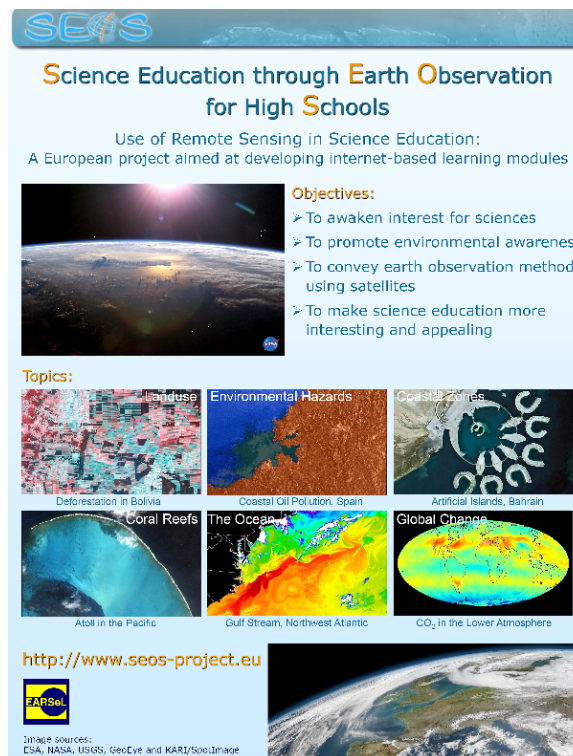


Figure 1. Overview of goals and themes of the SEOS project

The project covers many disciplines such as geography, biology, physics, mathematics and engineering, and emphasises the interdisciplinary character of remote sensing. Young users are encouraged to transpose their own personal observations into a global perspective. They should learn to understand and apply effective working methods which enable them to gather necessary information and interpret these correctly. In this way they gain insight into the nature of scientific enquiry, and develop their investigative skills. Ultimately, the aim of SEOS is to convey basic methods of scientific research, which is a key qualification in the field of modern science education.

Integrating earth observation into science education in high schools provides students with a basis for using environmental monitoring techniques in their subsequent working life. For this reason the tutorials basically start with a main focus on introductory science courses at high school. From there interested readers are guided through links to more complex contents which aim at advanced courses at high school and university (Figure 2).

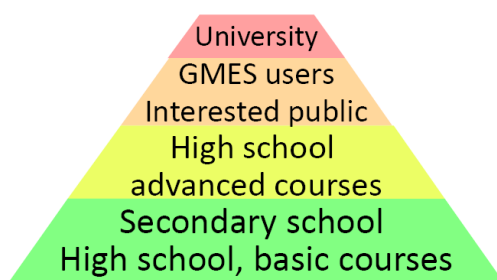


Figure 2: The various SEOS user groups. The first level of tutorials applies to curricula at secondary school. From there, more complex contents can be accessed through links, aiming at advanced high school courses, study programmes at university, and more specific user groups at environmental agencies. Open access through the internet also supports the concept of lifelong learning.

Aside from being used in schools, the tutorials also meet the demands of training courses for the users of the Global Monitoring for Environment and Security (GMES; <<http://www.gmes.info>>) and Global Earth Observation System of Systems (GEOSS, <<http://www.earthobservations.org/geoss.shtml>>) services. Moreover, UNESCO uses the SEOS training materials for educational purposes in selected developing countries, thus extending the benefits of this project to an even larger audience.

The Tutorials

Based on real examples, the tutorials use remote sensing images and data to involve students in different aspects of current environmental research and monitoring. They demonstrate how information from satellites can be directly relevant to everyday life conditions and emphasise the importance of awareness of the environment.

The tutorials use the method of Enquiry-based Learning (EUROPEAN COMMISSION, 2007). This is supported by worksheets highlighting an interesting scenario in the environment followed by questions or tasks which can be solved when studying the web-based SEOS tutorials. Advanced information on a more complex level is available through links to supplementary pages, which is particularly relevant with tutorials that are used in physics and mathematics classes, or even in university courses.

The tutorials cover a broad range of topics, from daily weather data to long-term climatic conditions, land use and land cover changes, marine pollution and environmental hazards, ocean currents, coral reefs and coastal water quality, natural and cultural heritage and conservation, time series analysis, classification and modelling, and climate change, to

name but a few (<http://lms.seos-project.eu/learning_modules#>). Connections between different topics are made clear, and links make it possible for teachers and students to follow their own route through the lessons according to their own interests.

The tutorial *A World of Images* features selected satellite images showing different facets of the Earth which enable young students to appreciate the beauty of our home

planet as seen from space. A virtual spaceship takes the user to a flight through the Milky Way galaxy, passes by the planets of our solar system and finally reaches the planet Earth which opens up into a mosaic of colourful images (Figure 3). A click on an image opens up explanatory texts with links to related tutorial pages. Intriguing questions at the end of the text can be dealt with during lessons or given as homework.

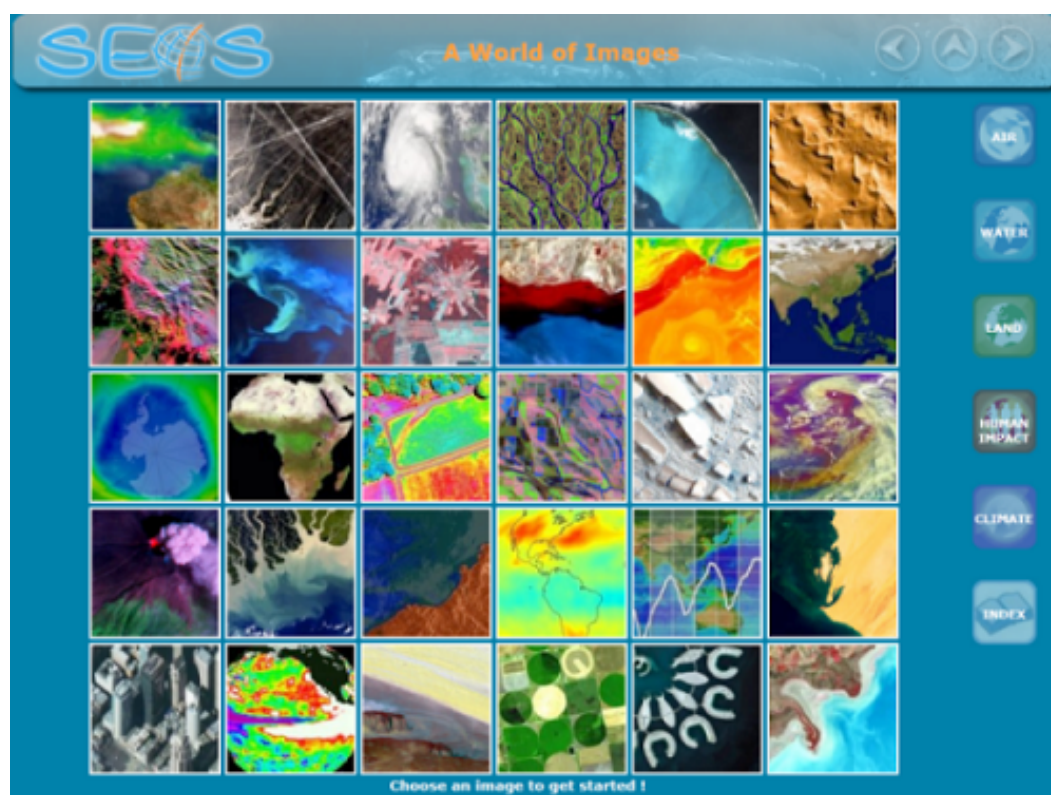


Figure 3. A mosaic of satellite images in the tutorial *A World of Images*, showing an overview of satellite imagery. Specific themes can be accessed with the logos on the right side of the page. A mouse click at one of the thumbs opens a new page showing the full image with basic information on the subject, satellite and instrument, image date and originator. More links allow a download of images with full resolution, and open a separate box with detailed explanations and questions for homework, and links to further information available in other SEOS tutorials.

The tutorial entitled *Introduction to Remote Sensing* provides an introductory overview on all aspects of Earth observation using aircraft and satellites.

Cross references guide readers to deeper information in Physics for which there are tutorials dealing with:

- Understanding Spectra from the Earth;
- Marine Pollution;
- Ocean Currents;
- Laser Remote Sensing, and
- Satellite Navigation with GPS.

For geography and biology education, there are tutorials dealing with the topics:

- Conservation and Protection of World Heritage;
- Coral Reefs;
- Land Use and Land Use Change;
- Remote Sensing and Geo-information Technologies in Agriculture;
- Natural Resources Management, and
- Ocean Colour in the Coastal Zone.

For mathematics education there are tutorials entitled:

- 3-D Models Based upon Stereoscopic Satellite Data;

- Time Series Analysis;
- Classification Algorithms and Methods, and
- Modelling of Environmental Processes.

In the following some tutorials are presented with educational topics related to forestry, natural resources, agriculture, and land cover / land use change.

The Tutorial on Natural Resources Management

This tutorial presents an introduction to the phenomenon Land Use Change on a global and on several regional scales, and puts the subject into the social context of increasing human population. Besides global vegetation changes a specific focus is put on the effects of urbanisation with the evolution of megacities like Mexico City, Mumbai and Johannesburg, and on the consequences of tourism with the development of the island of Tenerife as an example.

The causes and consequences of deforestation are discussed using the example of land clearance of Rondônia (Figure 4). Other themes are the impact of mining on the



Figure 4. Contents page of the tutorial on Natural Resources Management, as an example of the configuration of all SEOS tutorials

environment in the region of the Escondida pit in Chile, and the consequences of intensive irrigation on the size and ecological conditions of the Aral Sea.

The Tutorial on Land Use and Land Use Change

This tutorial presents an introduction to the phenomenon Land Use Change on a global and on several regional scales, and puts the subject into the social context of increasing human population. Besides global vegetation changes a specific focus is put on the effects of urbanisation with the evolution of megacities like Mexico City, Mumbai and Johannesburg, and on the consequences of tourism with the development of the island of Tenerife as an example.

The causes and consequences of deforestation are discussed using the example of land clearance of Rondônia (Figure 5). Other themes are the impact of mining on the environment in the region of the Escondida pit in Chile, and the consequences

of intensive irrigation on the size and ecological conditions of the Aral Sea.

The Tutorial on Classification Algorithms and Methods

Here students learn about the principles of satellite image categorisation and classification. Following an introductory chapter dealing with objects and their categorisation based on data, this covers an introduction into mathematical tools such as the frequency distribution, measures of value and spread, the probability density function, the concept of covariance and correlation, types of distributions in probability theory, and minimum distance and maximum likelihood classification, and a discussion about errors and costs in classification..

To achieve a basic understanding of mathematical equations these subjects are introduced with examples from the daily life of students, and applied to a Landsat Thematic Mapper image classification of the Skagen area (Figure 6) in Denmark later-on.



Figure 5. Land clearance in Rondônia, Brazil. Source: United Nations Environment Programme (UNEP).

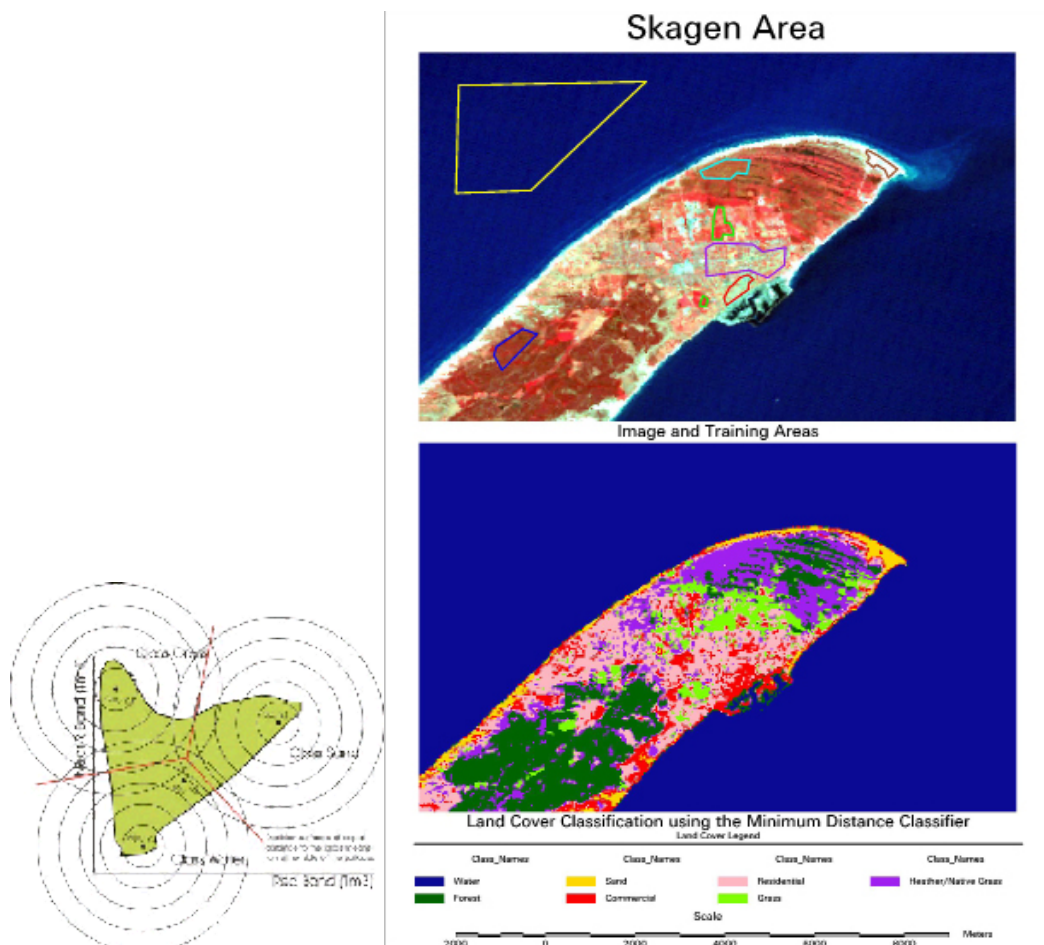


Figure 6. Minimum distance classification of objects in Thematic Mapper image of Skagen, Denmark, with the classes grass, sand and water. In the same way, a maximum likelihood classification is presented and visualised in the tutorial, and their differences are evaluated. As an exercise students perform classification of the data with image classification software.

The Learning Management System

The tutorials are the core element of the SEOS Learning Management System (<<http://lms.seos-project.eu>>), allowing teachers to create their own courses, to distribute already available or new worksheets to the students for homework and to collect the results. Specific forums are available for teachers, students and other (e.g. GMES) users to exchange information and opinions, and to discuss topics relevant for their study.

Together with the partner high schools, a strong emphasis has been placed on proper didactical methods for conveying the contents of the tutorials. The learning material is applicable for different teaching methods and group work/projects. Worksheets containing questions about the topics are available at different working levels and thus encourage students to learn and explore independently.

Outlook

By their nature the SEOS tutorials are not restricted to Europe-specific subjects

but cover themes having global relevance. Publication through the world-wide-web makes it possible to update their contents and to add new information as a result of actual developments. Institutions interested in making available their educational activities through the internet are invited to contribute with additional pages or new tutorials and these efforts are supported by the author in his coordinating role.

Learning Management System and tutorials are available in English, German and French, and partly also in Greek, Dutch and Arabic language. Besides science education the tutorials can therefore be used for language teaching as well. Translation of several tutorials in Turkish, Spanish, and Czech is in progress. Versions in other languages shall be included through cooperation with partners in countries where SEOS is considered to be a contribution to improve environmental and science education.

SEOS can be accessed on the internet (<<http://www.lms.seos-project.eu>>) using standard browsers, e.g., with Internet Explorer 5, Mozilla Firefox 3, Safari 3, or newer versions. Published under the umbrella of the European Association of Remote Sensing Laboratories (EARSel) the tutorials will remain available online and free of charge for each user.

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