Project no. **SCA5-CT-2006- 030849**

Project SEOS

Science Education through Earth Observation for High Schools

Final Activity Report
(Revision 1)

Period covered:
01 August 2007 to 31 October 2009

Date of preparation:
11 January 2010

Start date of project: 01 August 2007

Duration: 27 months

Project coordinator: Dr. Rainer Reuter
Project coordinator organisation: Carl von Ossietzky University of Oldenburg

Final Activity Report

Introduction:

In the year 2000, the European Union launched several initiatives to make Europe the most dynamic and competitive knowledge-based economy in the world by 2010. The man objectives were focused on increasing literacy and numeracy, accessibility of information and communication technologies (ITC), at the same time decreasing the level of gender imbalance in the fields of mathematics, science and technology by at least 15 %.

In-depth reforms of the education and training systems were felt necessary. The need for more effective and attractive teaching methods in mathematics, science and technology disciplines was recognised. By linking learning to practical day-to-day experiences, current working and social conditions, these disciplines which are otherwise purely theoretical disciplines can be made more interesting and attractive for students. A strong and effective partnership between schools, universities, research institutions and enterprises was highly encouraged.

Project SEOS, an initiative for using remote sensing in science education curricula in high schools, is an undertaking which pursues exactly these aims and objectives of the European Union. The project started in August 2007 and ended in October 2009. It was funded under the 6th Framework Programme of the European Commission (EC). The aim of the project was to realise 15 internet-based eLearning tutorials on selected topics in earth observation.

The tutorials focus on the interdisciplinary character of remote sensing and cover many disciplines such as physics, biology, geography, mathematics and engineering. The tutorials are divided into subject groups, as follows:

Remote Sensing for Earth Observation:
- Tutorial 1 *A world of images*

Geography and Biology:
- Tutorial 2 *Conservation of natural and cultural heritages*
- Tutorial 3 *Coral reefs*
- Tutorial 4 *Remote sensing and geo-information in agriculture*
- Tutorial 5 *Landcover / landuse change and land consumption*

Physics and Monitoring Technology
- Tutorial 6 *Understanding spectra from the earth*
- Tutorial 7 *Ocean colour in the coastal zone*
- Tutorial 8 *Currents in the ocean measured from space*
- Tutorial 9 *Remote sensing using lasers*

Environmental Sciences, Hazards & Environmental Management
- Tutorial 10 *3D models based upon stereoscopic satellite data*
- Tutorial 11 *Natural resources management*
- Tutorial 12 *Marine pollution*

Mathematics, Statistics & Modelling
- Tutorial 13 *Classification, algorithms and methods*
- Tutorial 14 *Modelling of environmental processes*
- Tutorial 15 *Time series analysis*

Eleven partners from several European countries worked together to realise the tutorials using the current research results of remote sensing, with data from the European Space Agency (ESA), own archives, as well as from external sources:

Partner 1	University of Oldenburg Institute of Physics Oldenburg, Germany
Partner 2	European Association of Remote Sensing Laboratories (EARSeL), Strasbourg, France
Partner 3	UNESCO, Division of Ecological and Earth Sciences, Paris, France
Partner 4	Mediterranean Agronomic Institute of Chania, Chania, Greece
Partner 5	Institute for Science Networking GmbH, Oldenburg, Germany
Partner 6	Gent University, Geography Department, Gent, Belgium
Partner 7	VU University Amsterdam, Institute for Environmental Studies, Amsterdam, The Netherlands
Partner 8	University of Aarhus, Faculty of Agricultural Sciences, Tjele, Denmark
Partner 9	Belgian Federal Science Policy Office, Brussels, Belgium
Partner 10	National Oceanography Centre, Southampton, United Kingdom
Partner 11	University of Education Heidelberg, Heidelberg, Germany
Cooperating Partner	European Space Agency ESA

To ensure their viability for use in the classroom and integration in the school curricula, the tutorials were tested in different partner high schools in Europe:

in Belgium:	Sint Laurensinstituut ASO, 9060 Zelzate Kunsthumaniora Muziek-Dans, 9000 Gent
in Denmark:	Middelfahrt Gymnasium, 5500 Middelfahrt
in Germany:	Hermann Lietz-Schule, 26474 Spiekeroog Gymnasium zu St. Katharinen, 55276 Oppenheim Freie Evangelische Bekenntnisschule, 28279 Bremen
In the UK:	Peter Symonds College, Winchester, Hampshire SO22 6RX King Edward Sixth School, Southampton, S015 7UQ, UK

Summary of Activities

Period 1 from 01 August 2007 to 31 July 2008 comprised mainly of organisational and management activities and creating the first drafts of the learning tutorials.

The kick-off meeting was held on October 11-12, 2007 in Oldenburg, attended by representatives from all partners as well as EC Scientific Officer Thierry Brefort. In this kick-off meeting, the following major objectives were achieved:

- The members of the Scientific Management Board were appointed.
- The didactic requirements and structure for the modules were defined.
- The technical requirements for the project were discussed.
- The terms and conditions of the contract with the EC were discussed.
- The next activities such as meetings, public outreach, etc. were defined and agreed upon.

The Special Interest Group was established during the EARSeL Council Meeting on January 19, 2007 in Paris, France. During this time, the negotiations for Project SEOS were still on-going. The SIG is chaired by Rainer Reuter (University of Oldenburg, Germany), Mario Hernandez (UNESCO, Paris, France) and Alexander Siegmund (University of Education, Heidelberg, Germany).

For the reporting and monitoring of activities, management tools such as reporting templates, checklists and deadlines were defined and communicated to the partners.Communication with and among partners is done mainly through the mailing list. In addition, important documents and links are announced and made available in the SEOS homepage.

The pre-financing amounting to 595,000.00 € was received from the EC on December 21, 2007. The first tranche amounting to 309.957,00 € was distributed to the partners on December 31, 2007 and were received by the partners within 45 days.

Two project meetings were held during the first project year;

a) on Jan. 31 to Feb. 2, 2008 in the premises of ESA/ESRIN in Frascati, Italy,
b) on June 7, 2008 in Istanbul, Turkey.

In both meetings, partners reported on the actual status of tutorial realisation. Partner teachers were involved during the discussions regarding content, layout and structure of the tutorials.

The first workshop of the SIG on Education and Training took place on June 5-6, 2008 in conjunction with the 28th EARSEL Symposium in Istanbul, Turkey and was attended by approximately 100 participants coming from different remote sensing organizations, including SEOS partners. The workshop discussion brought about interesting and useful ideas on the topic: *How can we improve the transfer of research to teaching in schools and universities?*

The first draft versions of the tutorials were available in the project website as early as Month 11.

Period 2 from 01 August 2008 to 31 October 2009 was highlighted by the following activities:

a) testing the draft tutorials in high schools
b) further improving the draft tutorials based on the results of testing
c) finalising the drafts and publishing them in the project website
d) promoting SEOS to the public by way of different outreach activities, and
e) translating the final versions into other European languages.

The testing phase started towards the end of Period 1 and continued on sporadically until 31 August 2009. A total of 12 tests were conducted in partner schools in Belgium, England, Germany and Greece. Teachers and students gave feedback as to acceptability and practicability of the tutorials in terms of didactical approach, technical presentation, relevance to school curricula and level of interest of users. Although it proved to be difficult to match the schedules for testing with the schedules of the partner schools, this was solved by testing finished chapters instead of complete tutorials and combining tutorials with related topics. Details of the testing phase are thoroughly described in Deliverable Report No. 50.

Based on the results of testing as well as on feedback received from teachers during project meetings, the first version were further improved and developed. Updated versions of the tutorials were regularly uploaded in the SVN for review of the Coordinator. Finished versions were published in the SEOS website. More details about the tutorials are contained in the Deliverable Reports 27b to 41b.

Side by side with the realisation of the tutorials, numerous public outreach activities were undertaken to promote the results of the project to the public. Highlights of such activities include presentations during the 2nd Workshop of EARSeL's Special Interest Group on Education and Training, presentations during teachers' trainings held by UEH, presentations in external conferences and symposia attended by SEOS partners, public exhibitions and events in the partners' localities, and article contributions in scientific and teachers' journals. These activities are described in detail in Annex 1 – Plan for use and dissemination of knowledge, as well as in Deliverable Report No. 15. Details about the Workshop are contained in Deliverable Report No. 26

Translation started as early as Month 20 and continued until Month 27. To maximize the available time, partners were instructed to translate their own tutorials in their respective mother language. As prescribed in Workpackage 5300, the tutorials have been translated in the Dutch, French, German, Greek and Arabic languages. Upon initiative of UNESCO, Tutorial 2 has also been translated into Spanish and Italian. The status of translation of tutorials in the languages prescribed in Workpackage 5300 is summarized in the following table:

Module No.	French	German	Dutch	Greek	Arabic
1	x	x	x		x
2	x	x	x	x	
3	x	x	x		x
4	x	x	x	x	x
5		x	x		x
6	x	x	x	x	x
7					
8		x			
9		x			
10		x	x		
11			x	x	x
12	x	x	x	x	
13					
14					
15		x			

The biggest constraint encountered during the project implementation was limited time. The change of the project period from 24 to 27 months helped to augment some setbacks experienced during Period 1, but other hindrances in Period 2 caused further delay in the completion of some tutorials. Although efforts had been made to meet all requirements, it was necessary to cut down the volume of work foreseen for some workpackages.

However, despite enormous time constraints and difficulties in management aspects, we have succeeded to achieve our aims and objectives of developing and implementing high quality eLearning tutorials

- that integrate remote sensing methods and techniques in the school curricula, by including themes and topics that are interdisciplinary and by making use of colourful and interesting satellite images;
- whose scientific content not only conforms with the educational level and standards of the target groups (high school students in classes 11-13) but are also well adequate for the instruction of GMES users in the public and private sectors;
- that help to develop scientific literacy among young students by making school subjects such as physics, chemistry, biology, mathematics, and geography more attractive and interesting, thereby encouraging them to pursue higher education in these fields later on;
- that involve the scientific and educational community as a whole by using not only the partners' own data but also data from other sources, by seeking the cooperation of other scientific institutions, and by linking many topics to external sources;

- that promote a better understanding in different nations by being available not only in English but in five other major languages, thereby making a high impact not only in Europe but also in other parts of the world;

- that encourage not only high school students but also the general public to learn more about our planet Earth, thereby raising environmental awareness and ecological sensibility;

- that implement gender mainstreaming strategies in the organisational, technical and didactical aspects, particularly in terms of design and use of gender sensitive language;

- that are presented in a layout, design with navigational and technical features that are appealing to both female and male users of different age groups.

Publishable Results

Satellite images, research data, photographs and other material used in the realisation of the tutorials were provided by the archives of the 11 partner-institutions, by ESA/ESRIN, by NASA, by the Alfred-Wegener-Institute for Polar and Marine Research, and other institutes. Copyright permissions were acquired for material coming from external sources. Drafts of the tutorials have been made accessible for the general public in the project website http://www.seos-project.eu and are now available in the Learning Management System (LMS). Teachers and GMES users are granted access to the SVN and LMS upon registration. The tutorials are covered by Creative Commons License and the access is for free.

The following pages describe briefly the objectives, topics, and navigation features of each tutorial.

Tutorial 1: A World of Images

The introductory tutorial "A World of Images" is meant to provide an overview of the current usage of remote sensing so as to enthuse students about the capabilities of this technology for the management and maintenance or Earth resources. In close connection to the other tutorials, this tutorial was constructed around a set of selected remote sensing applications to demonstrate the usefulness of different image types for different purposes from local to global scales.

Each application is presented on a one-screen basis where a central image acts as an "eye-catcher". Text is voluntarily kept concise, however, a few links allow additional information to be displayed.

The navigation was designed to be intuitive. The tutorial opens with a short animation offering a flyby inside the solar system until reaching Earth. The animation ends on a screen covered with images' quicklooks leading to the different applications. Each quicklook pairs off with a stylised icon illustrating at a glance the issue covered by each remote sensing application. Furthermore, a menu organises the applications into 4 themes (air, water, land and human impact).

The tutorial is also available in Dutch, French, German, and Arabic and soon to be translated into Greek.

Opening page of Tutorial 1

Tutorial 2: Conservation of Cultural and Natural Heritages

This tutorial is oriented to support overall education with a series of examples of remote sensing as applied to the protection, monitoring, mapping and management of our cultural and natural heritage.

The module shall also encourage students to learn more about the history of a certain civilization or more about why the great wall was constructed, by whom, etc. Land use and land changes are also illustrated with examples dealing with issues that include climate change, desertification, water pollution, floods, land subsidence, land degradation and sedimentation, as well as cartography. It aims at teaching high school students the importance of the protection of our natural and cultural heritage. It shows the possibilities of remote sensing to monitor cultural heritage sites, manage natural sites and natural disasters, mapping the protected sites, and how this information can be integrated and analysed in a GIS to manage and protect our heritage. This topic shall open the curiosity of students to learn about history and monuments in their surroundings and in the whole world.

The first chapters give a general overview about what World Heritage (WH) is, UNESCO's Convention Concerning the Protection of the World Cultural and Natural Heritage, the World Heritage list and how remote sensing is helping on the protection of the WH sites. This information serves the pupils to understand the following case studies that are explained in the different chapters. The tutorial continues with a chapter on Cultural Heritage and remote sensing that contains four different case studies. The chapter on Natural Heritage also contains four case studies where remote sensing tools have been used in order to protect the different sites. Some additional material on UNESCO's work and remote sensing examples about the World heritage in Danger List have been added. Finally, a teachers' corner and a list of useful links have been developed. Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is also available in Dutch, French, German, Greek, Italian, Spanish and soon to be translated into Arabic.

Opening page of Tutorial 2

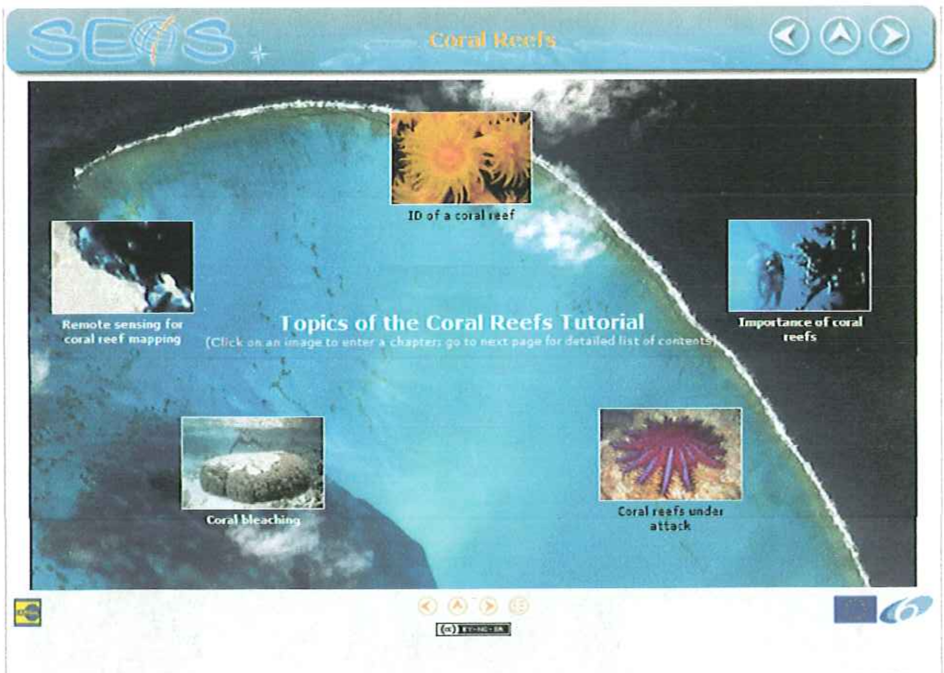
Tutorial 3: Coral Reefs

The tutorial is primarily intended for geography courses on the coastal zone, oceanography, global change and 'Third World' problematic, and for biology courses on marine life and environmental issues. It aims at teaching high school students the importance of the coastal zone, and coral reefs in particular, to many millions of people. It shows the possibilities of remote sensing to map the coastal zone, in casu coral reefs, and how this information can be integrated and analysed in a GIS to manage and protect the vulnerable coastal zone.

The tutorial starts with an introduction on coral reefs (what are coral reefs, where can you find them, the different parts of a reef and the different kind of reefs). In the following chapters, the importance of coral reefs to many people as well as to animals is pointed out, as well as the most important threats to coral reefs and especially coral bleaching. The information that is given in these chapters makes it easier for the students to understand the chapter on how remote sensing helps to mange and protect the coral reefs. In this final chapter, several applications explain how remote sensing can be integrated and analysed in a GIS to manage and protect the coral reefs (bathymetry, geomorphological zonation, changes in time, mapping the risks...).

To deepen the knowledge, some chapters have additional pages that serve for students who want to know more about a subject that is not fully explained in the chapter itself (for example: 'acidification', 'photosynthesis'...). Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is also available in Dutch, French, German, Arabic and soon to be translated into Greek.



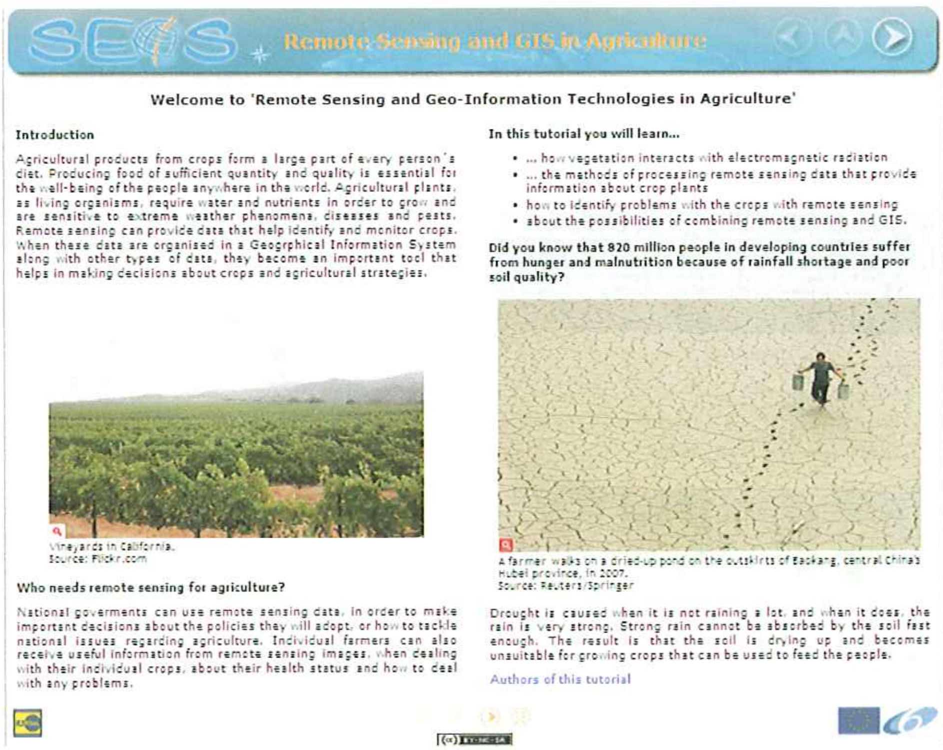
Opening page of Tutorial 3

Tutorial 4: Remote Sensing and Geo-Information Technologies in Agriculture

The Tutorial "Remote Sensing and Geo-information Technologies in Agriculture" informs interested actors (from high school pupils to professionals) about the applications and solutions provided by Remote Sensing and Geo-Information technologies on contemporary and long-term agricultural issues. It demonstrates agricultural management tools and methodologies that combine past knowledge preserved through maps and data in databases with the current status of agricultural lands derived from satellite images. The tutorial content is segregated in four thematic chapters, which are designed to be used as stand-alone units: Monitoring Crop Status, Crop Yield Estimation, Crop Identification, and Precision Agriculture.

At the initial stages, information and images were collected from within MAICh, collaborating partners of the SEOS consortium, and third sources outside the consortium. Satellite image providers were contacted and permission was received for the use of imagery within the SEOS framework. In particular, for high spatial resolution satellite images which are usually strongly protected by copyrights, special agreements were made with the image providers. The collected material was used to cover the foreseen thematic areas in the description of work, and four chapters were formed covering the topic of the use of remote sensing and geo-information in agriculture (Monitoring Crop Status, Crop Yield Estimation, Crop Identification and Precision Agriculture). Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is also available in Dutch, French, German, Greek and Arabic.



Introductory page of Tutorial 4

Tutorial 5: Land Cover/Landuse Change and Land Consumption

The aim of the tutorial is to build awareness for the problems of land cover/ land use change and land consumption in example areas with the help of satellite images in different landscape zones. An understanding for the local and global causes of land cover/ land use change should be created through using satellite images and interactive learning modules. The users should then be able to evaluate the ecological and economical consequences of land cover/ land use changes and possible solutions for a sustainable use of areas.

Altogether there are four chapters, the first about global land use changes. The second chapter focuses on land use change and land consumption regarding urbanisation processes, the third chapter focuses on land use changes in relation to syndromes of global change (like depletion of natural resources). The last chapter is about land use change caused by mass tourism. All four chapters are available in English and German language with accompanying additional materials and worksheets. The tutorial has been tested with success in different schools and in teacher trainings. Teachers' and students' feedback comments have already been used to fine-tune the module contents and presentation. Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is also available in Dutch, and Arabic and soon to be translated into French and Greek.

Introductory page of Tutorial 5

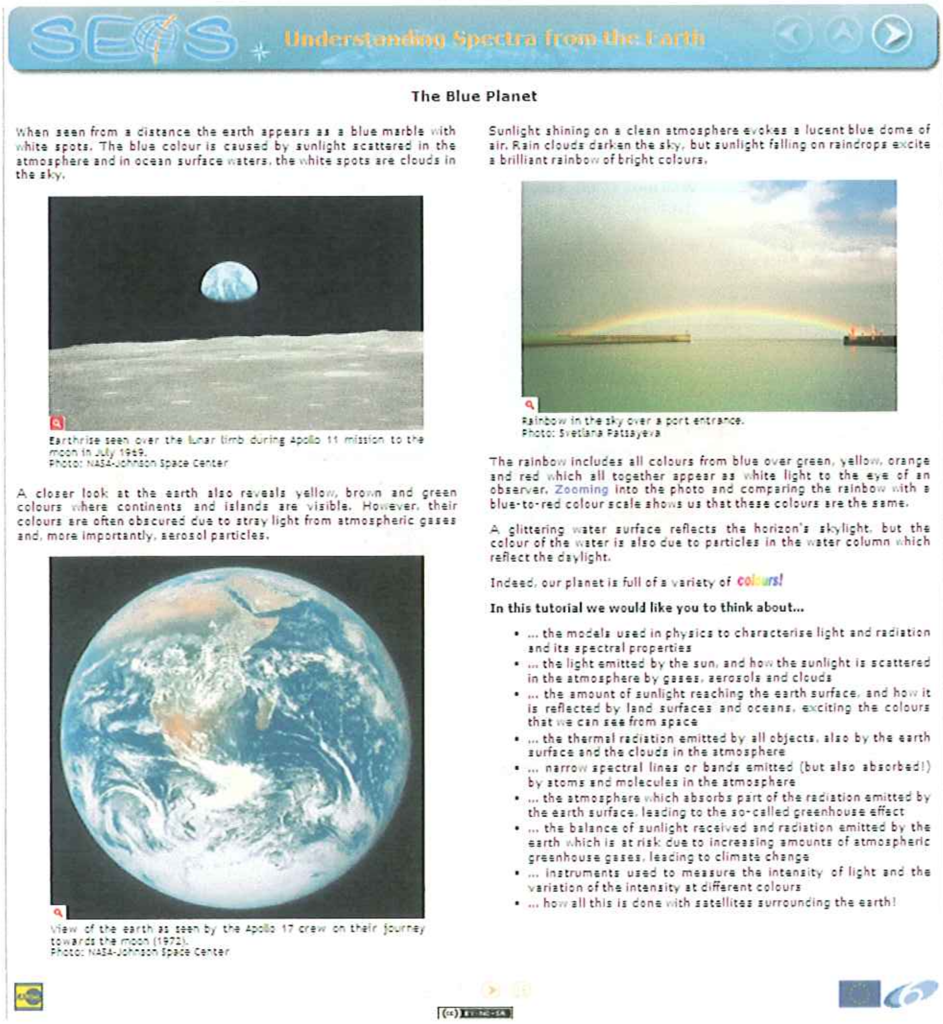
Tutorial 6: Understanding Spectra from the Earth

The tutorial is primarily intended for physics courses on optics and on spectra of light. Several elements are suitable for courses in biology (e.g. on photosynthesis) and chemistry (e.g. atomic line spectra). It focuses on the fundamental properties of light and radiation and their interaction with matter, which are elements of the physics curriculum at all high schools. It also covers the basic physical elements of earth observation from space, and thus aims at reaching a profound understanding of the physical background of most other tutorials to be realized.

The tutorial includes pages on the physical characteristics of radiation, electromagnetic waves and photons, on spectral lines and thermal emission, on radiation detection and spectroscopy.

The tutorial provides detailed information on the nature of light and the physical models which have been created on electromagnetic waves and photons. It explains the methods of signal detection and spectroscopy, with emphasis on examples from the field of remote sensing. It thus gives also the background information on physics for other geography- and biology-related tutorials. Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is also available in Dutch, French, German, Greek and Arabic.



Introductory page of Tutorial 6

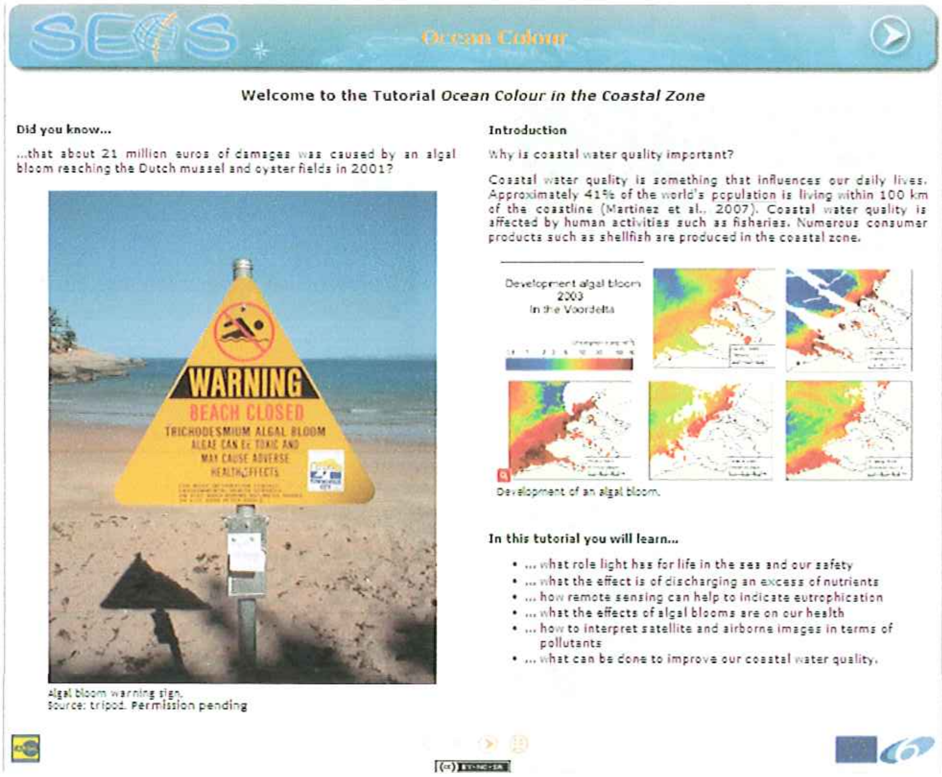
Tutorial 7: Ocean Colour in the Coastal Zone

The objective of the tutorial is to make the student aware of the fact that coastal areas are extremely productive waters with an ecosystem that is strongly influenced by human activities. From an educational point of view, it is interesting to demonstrate that European coastal waters are frequently observed from space and that satellite data observe the effect of human activities (river-run-off, eutrophication). In order to understand the information, the student will get an introduction to simple physical relations between light, attenuation, turbidity and light availability for photosynthesis.

The tutorial is divided into three main topics namely: Light and life, Ecosystems, and Eutrophication and Health, which can be linked to curricula in physics and biology

Each chapter is designed to be used individually and follows a predominantly linear structure, which can be followed by the navigation link icons on the top and bottom of the screen. Some terms within the text appear as hyperlinks that lead to definitions of those terms in the common glossary. Explanatory pop-up boxes and answers to questions in pop-up boxes are implemented, following the suggestion made by the teachers that student are "mainly looking for features that move or are interactive".

The tutorial will soon be translated into Dutch, French, German, Greek and Arabic.



Introductory page of Tutorial 7

Tutorial 8: Currents in the Oceans Measured from Space

This tutorial aims at an understanding of the physical principles that drive the global system of surface and deep ocean currents, and how our understanding of ocean circulation may be improved by measuring sea surface topography using satellite altimeters. The tutorial also aims to increase awareness of the role of ocean currents in transporting heat from the equator to the poles, and how cold and warm currents influence our climate by affecting temperature and rainfall in different climate zones.

Although the main relevance of this tutorial is in physics education, it is also relevant to biological and environmental sciences. The main aim is to show how basic physical principles may be used to describe and understand the ocean currents and their effect on marine life, human activities and the Earth's climate system.

The tutorial describes the main ocean currents, and explains the physical principles behind the wind-driven surface currents and the global system of deep and surface currents, known as the thermohaline circulation because it is driven by the sinking of cold (thermo), salty (haline) water at high latitudes. It shows how currents may be studied form space using satellite altimetry, and how this is related to global patterns of sea surface temperature and marine plant productivity.

Through exercises and examples using meteorological measurements (temperature and rainfall statistics) and satellite images (sea surface temperature, altimetry, ocean colour, global vegetation indices) students may to see for themselves how warm and cold surface currents influence regional climate across the world by affecting temperature and rainfall patterns in different climate zones.

The tutorial shows how ocean circulation and its effect on Earth's climate system may be explained by the physical properties of seawater, such as density, temperature, salinity, latent and specific heat, and transitions between the three phases - gas (water vapour), liquid water and solid (snow, ice).

The tutorial is also available in German and soon to be translated into Dutch, French Greek and Arabic.

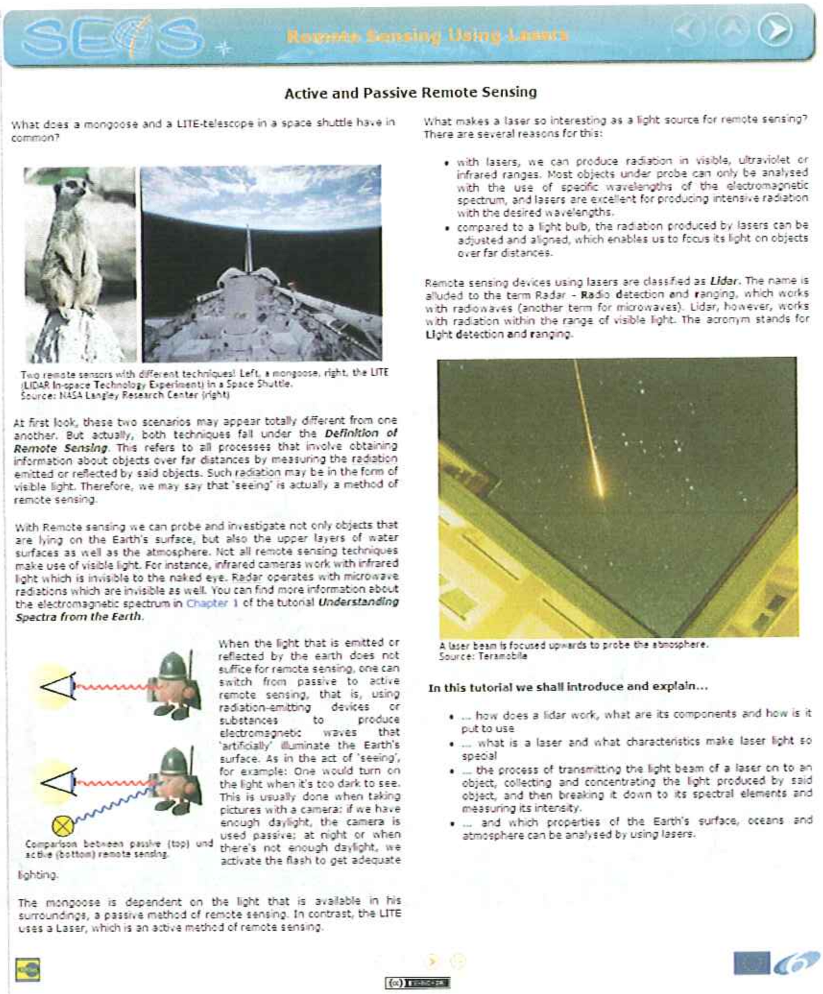
Opening page of Tutorial 8

Tutorial 9: Remote Sensing using Lasers

The tutorial is primarily intended for use in physics courses on optics, to make the students familiar with lasers as modern light sources, the physics behind laser light generation, and the applications of laser-based analytical methods in environmental science and monitoring. It can also be used in chemistry courses in the context of atomic and molecular absorption spectroscopy, fluorescence analysis and Raman spectroscopy, and in biology courses in the context of vegetation analysis using absorption and fluorescence properties of plant pigments like chlorophyll *a*. Several supplements explain the physics of laser light generation, and propagation through the atmosphere and oceans, with advanced calculus, which makes the tutorial also interesting for mathematics courses in the context of differentiation and integration, exponential functions, etc.

The tutorial includes chapters on the physics of lasers and laser radiation, on optical instruments for light collection and detection, and on the lidar principles with applications in the atmosphere and ocean. Besides the text and images, one finds additional information and questions in drop-down boxes. There are also supplement pages which include more theoretical contributions for an understanding of laser principles and laser beam propagation. Moreover, each chapter contains worksheets for studies in class or as homework.

The tutorial is also available in German and soon to be translated into Dutch, French Greek and Arabic.


Remote Sensing Using Lasers

Active and Passive Remote Sensing

What does a mongoose and a LITE-telescope in a space shuttle have in common?

Two remote sensors with different techniques! Left, a mongoose, right, the LITE (LIDAR In-space Technology Experiment) in a Space Shuttle.
Source: NASA Langley Research Center (right)

At first look, these two scenarios may appear totally different from one another. But actually, both techniques fall under the ***Definition of Remote Sensing***. This refers to all processes that involve obtaining information about objects over far distances by measuring the radiation emitted or reflected by said objects. Such radiation may be in the form of visible light. Therefore, we may say that 'seeing' is actually a method of remote sensing.

With Remote sensing we can probe and investigate not only objects that are lying on the Earth's surface, but also the upper layers of water surfaces as well as the atmosphere. Not all remote sensing techniques make use of visible light. For instance, infrared cameras work with infrared light which is invisible to the naked eye. Radar operates with microwave radiations which are invisible as well. You can find more information about the electromagnetic spectrum in Chapter 1 of the tutorial ***Understanding Spectra from the Earth***.

Comparison between passive (top) und active (bottom) remote sensing.

When the light that is emitted or reflected by the earth does not suffice for remote sensing, one can switch from passive to active remote sensing, that is, using radiation-emitting devices or substances to produce electromagnetic waves that 'artificially' illuminate the Earth's surface. As in the act of 'seeing', for example: One would turn on the light when it's too dark to see. This is usually done when taking pictures with a camera: if we have enough daylight, the camera is used passive; at night or when there's not enough daylight, we activate the flash to get adequate lighting.

The mongoose is dependent on the light that is available in his surroundings, a passive method of remote sensing. In contrast, the LITE uses a Laser, which is an active method of remote sensing.

What makes a laser so interesting as a light source for remote sensing? There are several reasons for this:

- with lasers, we can produce radiation in visible, ultraviolet or infrared ranges. Most objects under probe can only be analysed with the use of specific wavelengths of the electromagnetic spectrum, and lasers are excellent for producing intensive radiation with the desired wavelengths.
- compared to a light bulb, the radiation produced by lasers can be adjusted and aligned, which enables us to focus its light on objects over far distances.

Remote sensing devices using lasers are classified as ***Lidar***. The name is alluded to the term Radar - **Ra**dio **d**etection **a**nd **r**anging, which works with radiowaves (another term for microwaves). Lidar, however, works with radiation within the range of visible light. The acronym stands for **Li**ght **d**etection **a**nd **r**anging.

A laser beam is focused upwards to probe the atmosphere.
Source: Teramobile

In this tutorial we shall introduce and explain...

- ... how does a lidar work, what are its components and how is it put to use
- ... what is a laser and what characteristics make laser light so special
- ... the process of transmitting the light beam of a laser on to an object, collecting and concentrating the light produced by said object, and then breaking it down to its spectral elements and measuring its intensity.
- ... and which properties of the Earth's surface, oceans and atmosphere can be analysed by using lasers.

Introductory page of Tutorial 9

Tutorial 10: 3D Models based upon Stereoscopic Data

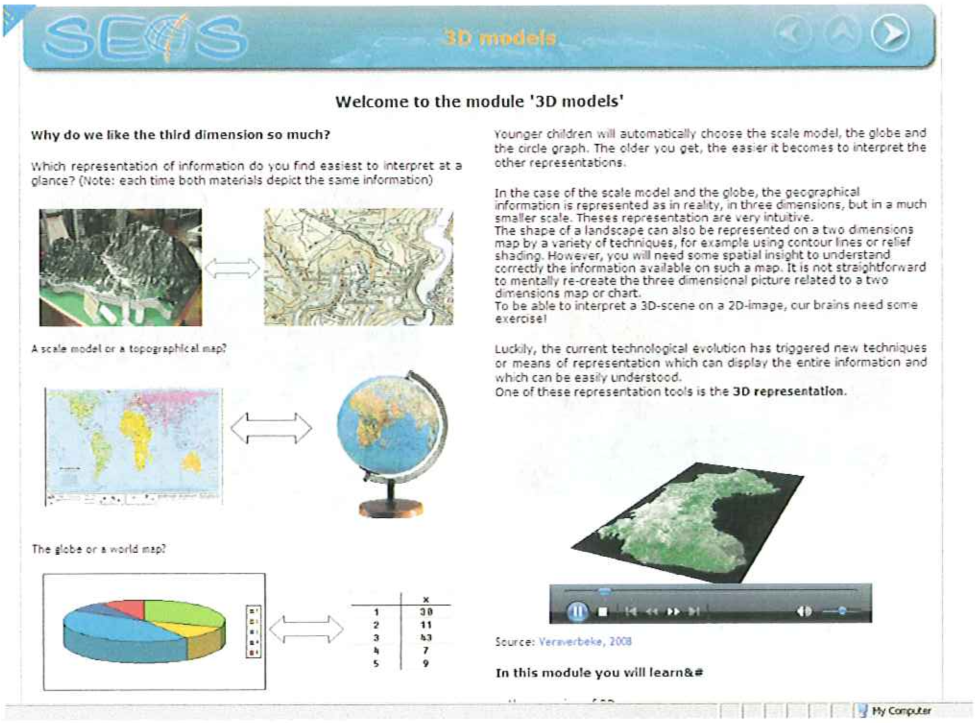
It is important that high schools students realize that 3D information is essential when working with remote sensing images. This tutorial intends to teach high school students the concept of image displacement and the elementary difference between geo-referencing and orthorectification. The relation between the scale and the resolution of an image is illustrated.

The goal of the tutorial is to give an illustration of different applications of 3D. To be able to understand these applications, a chapter explains the elementary principles (like parallax, stereovision, etc.. For students who are not familiar with 3D, an introduction chapter explains this basic information in an easy way (i.e. 'what is meant by 3D?). Additionally, some extra pages emphasize certain aspects which can be taught in mathematics or physics classes ('How to calculate height out of a relief displacement?').

The tutorial includes some nice animations (for example a fly over, the process of orthorectification...) which make the whole more attractive. There are also practical applications available, for example: 'how to make your own 3D glasses?'. Exercises (with worksheets) serve to better comprehend the theoretical pages ('Worksheet: Fly over'). Some worksheets are added where pupils get more practical exercises ('How to make your own camera obscura?', 'How to make your own 3D glasses?'). To deepen the knowledge, some chapters have additional pages that provide more information about a subject that is not fully explained in the chapter itself (for example: 'Stereovison: it can go wrong!', 'Stereopairs'...).

The pupils can navigate through the whole tutorial by clicking on arrows, going to the contents table, clicking on highlighted words in the text or with in-depth information.

The tutorial is also available in German and Dutch and soon to be translated into French Greek and Arabic.



Introductory page of Tutorial 10

Tutorial 11: Natural Resources Management

This tutorial aims to (a) promote the understanding of the trainees on matters of geographic information, spatial and temporal variability of natural resources, (b) demonstrate the way geographical information is collected, analysed and utilised for Natural Resources Management, and (c) enhance the trainee's ability to combine remote sensing and geo-information technologies in a range of applications on environmental issues.

The tutorial informs interested actors (from high school pupils to professionals) about the applications and solutions provided by Remote Sensing on a range of environmental issues. It demonstrates management tools and methodologies that combine past knowledge preserved through maps and data in databases with the spatial and temporal variability of natural resources as derived from satellite images. The tutorial content is segregated in five thematic chapters, which are designed to be used as stand-alone units: Soil degradation, Water resources management, Sustainable forest management, Waste management, and Urban planning.

Each chapter is designed to be used individually and follows a predominantly linear structure, which can be followed by the navigation link icons on the top left of the screen. However, many terms within the text appear as hyperlinks that lead to definitions of those terms in the common glossary or to further information regarding that topic in the form of supplementary web pages. Explanatory and summary boxes, small exercises, and pop up boxes appear throughout the pages, in order to increase the trainee's interest, support teachers, and enhance the learning procedure. In addition to the regular tutorial pages, the teachers and trainees have access to exercises of variable length that can either be used in the classroom during the lesson, or used as homework assignments by the teachers or stand alone training.

The tutorial is also available in Dutch, Greek and Arabic and soon to be translated into French and German.

Introductory page of Tutorial 11

Tutorial 12: Marine Pollution

This tutorial aims at an understanding of the impacts of pollutants on the oceans, and in particular the coastal zones, and their surveillance with remote sensing. While the monitoring of trace metals and organic chemicals which reach the ocean via atmospheric deposition, riverine inputs and waste-water discharges necessitates sophisticated analytical methods in the laboratory, spillages of oil, oil-products and some chemicals can be detected with remote sensing using aircraft and satellites. These spillages occur as a result of accidents at sea, but also due to controlled - and often illegal - discharges.

The tutorial covers the following topics:

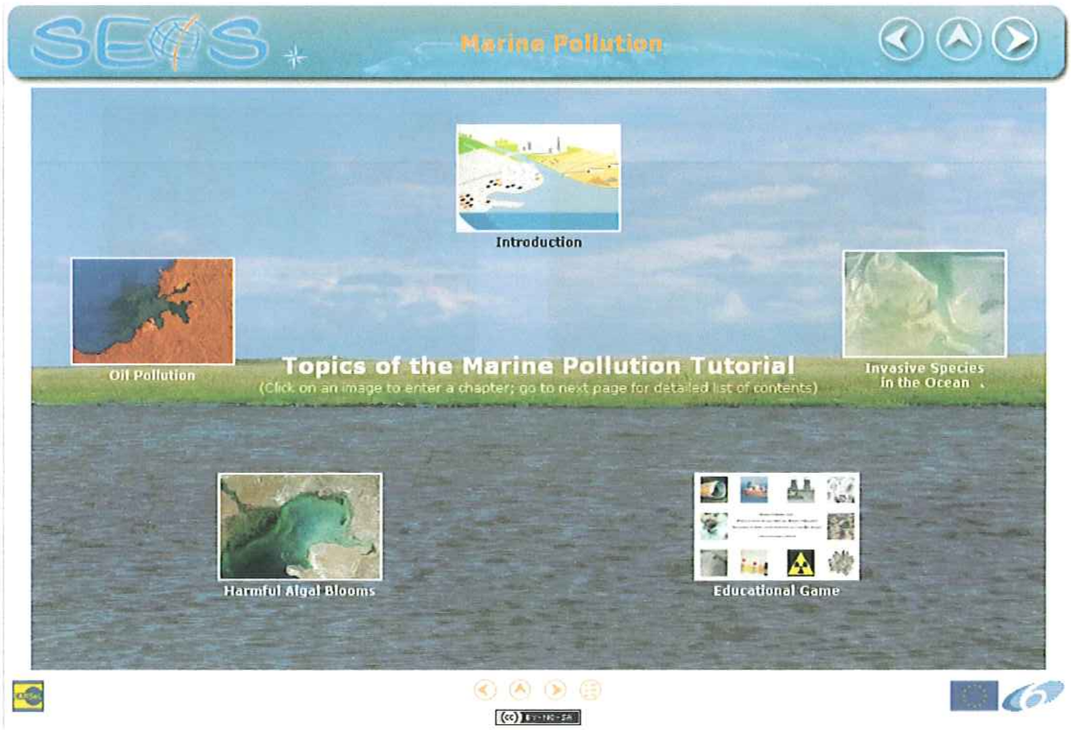
1) Oil and chemical pollutants: physical and chemical properties, behaviour in seawater/on the sea surface, typical scenarios of pollutant discharges

2) Instruments: microwave sensors - Radar, microwave radiometry; optical (UV/IR) radiometry, laser fluorosensor; strengths and weaknesses of the different sensors

3) Methods: Radar, microwave emission radiometry, UV/IR reflectance radiometry, laser-induced fluorescence

4) Airborne applications: examples of sensor suites used for airborne surveillance - SLAR, SAR, UV/IR, optical, laser fluorosensor, video/photos; how RS sensors may be used with GIS and oil spill trajectory models.

The tutorial is also available in Dutch, French, German and Greek and soon to be translated into Arabic.



Opening page of Tutorial 12

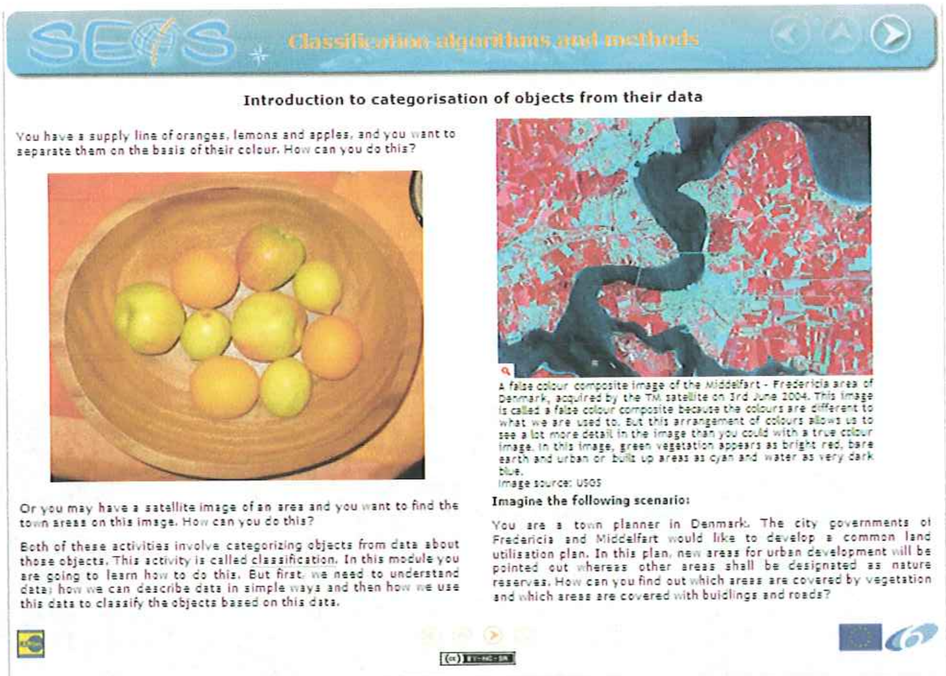
Tutorial 13: Classification Algorithms and Methods

The tutorial aims to impart the concepts and principles of image classification using parametric and non-parametric methods, to teach the practices of image classification, including strategies that can be used to improve classification accuracy, and to inform students on sources of error in image classification and methods of conducting accuracy assessment of image classification results.

The tutorial is composed of six chapters. The first chapter gives an introduction to the concepts of classification and a very short introduction into the basics of visual recognition and sensing. Chapter 2 gives an introduction to the basic mathematical methods like probability, probability density functions like scatter plots. Chapter 3 explains more thoroughly the meaning and significance of Classification. Chapter 4 deals with the Minimum Distance Classifier, and Chapter 5 with the Maximum Likelihood Classifier. Errors and Costs in Classification are dealt with in Chapter 6.

The tutorial is pepped up with colourful satellite images, as well as simple to difficult mathematical exercises. Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is available in the English version. Translations in Dutch, French, German, Greek and Arabic shall be available after project end.



Introductory page of Tutorial 13

Tutorial 14: Modelling of Environmental Processes

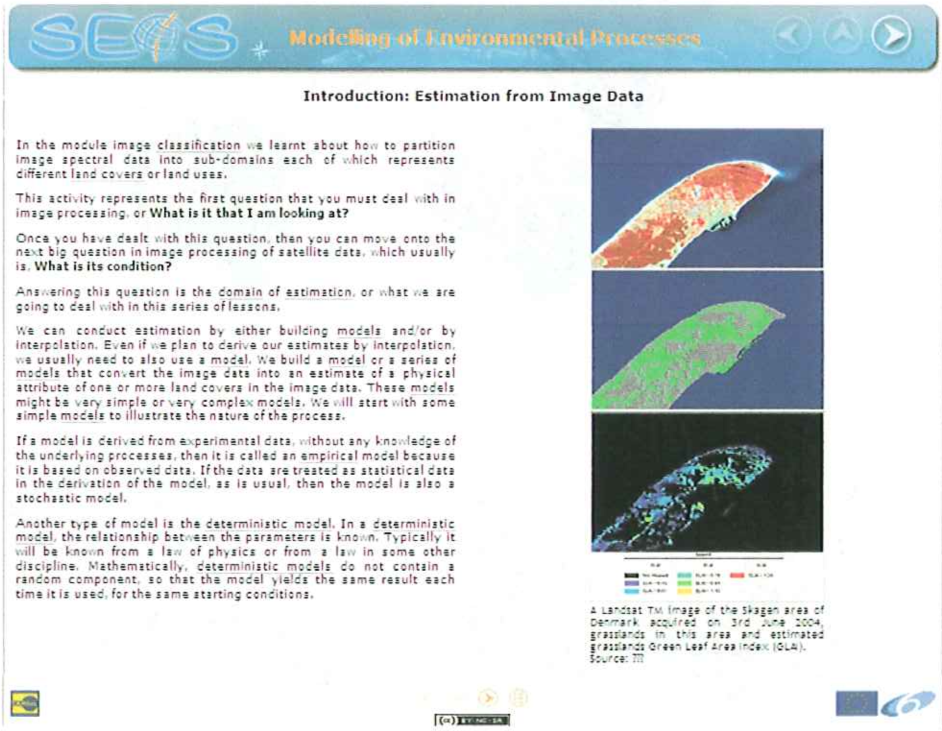
The tutorial aims to teach students the principles of modeling aspects of the physical environment using statistically and deterministically based models applied as static and event based (cellular automata and agent based) models, to provide students with the tools to build simple models using both approaches, so as to understand the attributes of the various methods of model building and hence the role of remote sensing and modeling in understanding the nature of the dynamic environment.

The tutorial consists of seven chapters dealing with the topics:

a) Linear Empirical regression Models
b) Method of Least Squares in Regression
c) Interpretation of Linear Regression Models
d) The Quality of Regression Equation
e) Implementation Using Image Data
f) Samples and Populations
g) Stochastic and Deterministic Models

The tutorial is pepped up with colourful satellite images, as well as simple to difficult mathematical exercises. Navigation features like arrows, in-depth and marked words help the pupils to go easily through the whole tutorial.

The tutorial is available in the English version. Translations in Dutch, French, German, Greek and Arabic shall be available after project end.



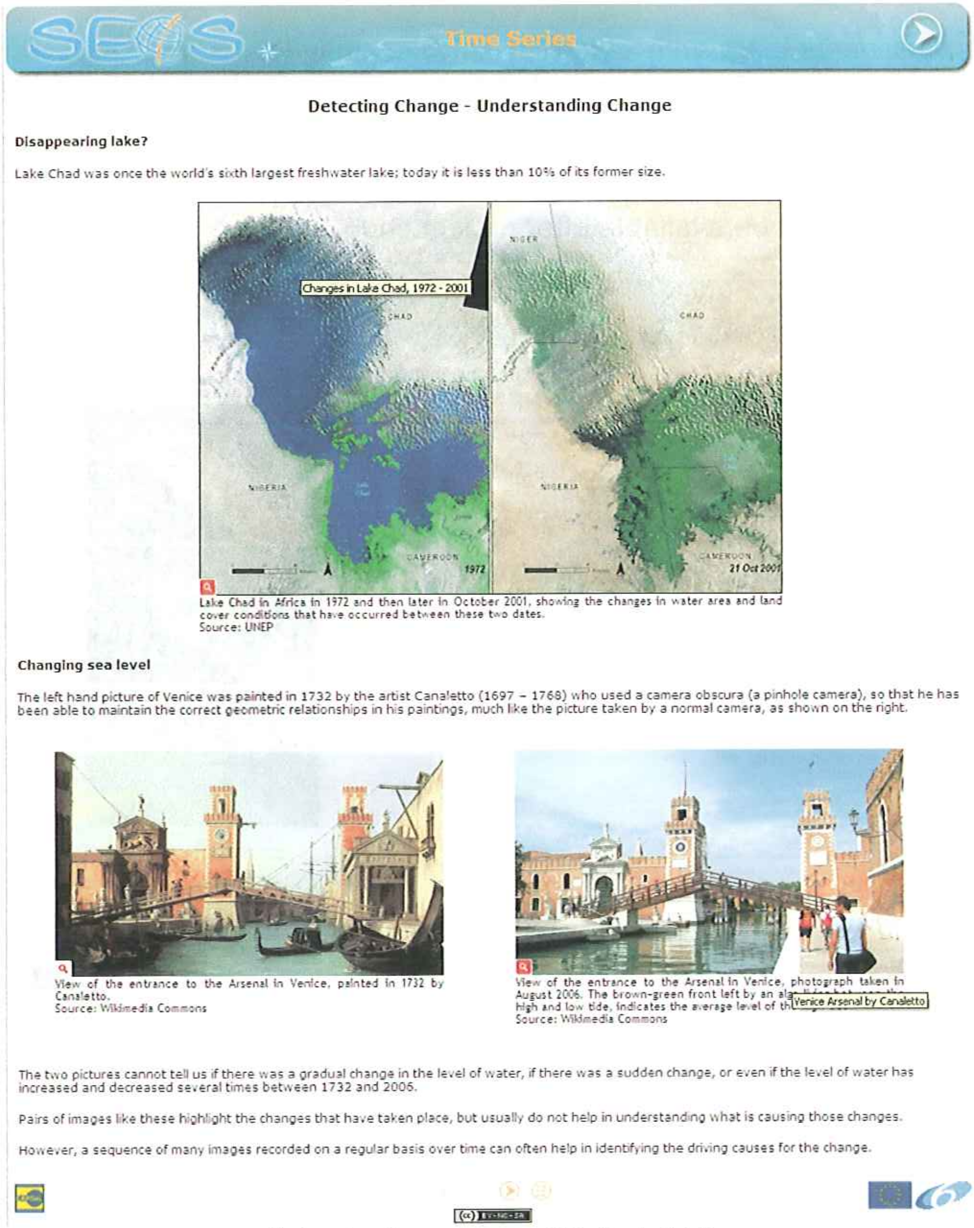
Introductory page of Tutorial 14

Tutorial 15: Time Series Analysis

The tutorial is primarily intended to introduce students to time series data and the relevance of time series to understanding dynamic processes in the environment. It is used in mathematics courses and covers the curriculum on statistics, stochastics and probabilities. It can also be used in physics courses in the field of interpreting experimental errors, identification of variabilities and trends, correlation analysis, and similar topics.

The tutorial includes pages on the concept of time series, with emphasis on time series data taken at fixed positions and on the basic elements of their analysis. This concept is studied in more detail with multiyear datasets from the Wadden Sea, to develop the mathematical tools of time series analysis such as the data centroid, linear regression using least squares, and the interpretation of findings obtained with regression analysis. These concepts are further studied with examples on atmospheric CO_2, on plant phenology on land, on sea ice in the Arctic, and on plankton blooms in the oceans.

The tutorial is also available in German and soon to be translated into Dutch, French Greek and Arabic.



Introductory page of Tutorial 15

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