The EARSeL Remote Sensing Academy

1. Background

Remote sensing of the Earth covers many topics significant for all natural science disciplines at school and university. Prominent examples are atmospheric and oceanic circulation, which depend on physical forces, vegetation on land and in the oceans as well as physical and chemical conditions driving biological productivity which are of interest in biology, botany and geography. They are important, particularly over time, for understanding the relationship between vegetation resources and their driving forces as well as for assessing the impact of climate change and other factors on vegetative growth and on biodiversity. Relevant examples in chemistry are the atmospheric trace gases and their reactions, for example freons, and their interaction with ozone, and the impact of atmospheric pollutants (e.g., the sources and effects of greenhouse gases) as well as oceanic pollutants (e.g., hydrocarbons from oil spillages). Remote sensing also assists to better understand the ecosystems on Earth and to survey their exploitation for humankind, for example the availability of clean water, agricultural products, fishes for food, timber, etc.

Hence, remote sensing is a highly important tool for understanding the natural world, as much as for understanding the human impact, and to relate the observed changes to economic, social, and physical driving forces.

Technical aspects are also relevant, such as the generation and detection of microwave and laser radiation, reflectance properties of materials at different wavelengths, methods of instrument design and data transmission, the creation of mathematical and statistical tools and methods for data analysis, and the role of models in understanding the environment.

These themes, which are but a few examples from a much wider range of relevant subjects, are currently investigated in great detail using remote sensing. Satellite imagery and data derived from satellite sensors are available from studies of local, regional and even large scale phenomena, thus allowing the demonstration of the relationships between local and global scales. Remote sensing data are used for attempting to explaining actual conditions on Earth. But they also provide information for outlining methods for the prediction of future developments – e.g., of the climate system – by using models.

2. Objective

EARSeL's Special Interest Group on Education and Training has great interest in advancing the use of remote sensing through education and training. The SIG therefore encourages the exchange of education and training experts and the promotion of the results of EARSeL's scientific activities to the general public. With this aim, the SIG initiates and establishes the

EARSeL Remote Sensing Academy (ERSA).

This initiative aims at topics which are beyond the typical activities of EARSeL's Special Interest Groups through the creation of educational material for different school and university levels in natural sciences, mathematics and engineering, and for authorities responsible for monitoring and surveillance of the environment. EARSeL members from other SIGs are requested to contribute with their specific expertise in the methods and results of remote sensing. External funding for ERSA through joint projects shall be an element to provide the resources for achieving this output-oriented programme.

3. Topical Framework: Education and Training

An understanding of the basic science behind remote sensing is essential not only in order that students can appreciate the wide range of applications in the natural world, but also for

operators to make the most sensible use of the techniques availabe – the students of today are the users of tomorrow.

For these reasons, ERSA shall be primarily engaged in science education and training with an emphasis on remote sensing methods and results, and will make available products in the following areas.

a) Education and Training for university students

Educational material shall be created and provided for students in various disciplines:

- in physics and engineering,
  with contents on physics fundamentals focusing on radiation and radiative transfer, and on remote sensing principles and technologies
- in biology, geography and other geosciences,
- with contents on remote sensing applications and results.

These tutorials shall be realised in the form of websites and other documents available through the internet.

A novel approach of distant learning shall comprise

- internet-based teaching modules

offered by ERSA members. Lecture series held by experts from EARSeL member universities shall be made available to registered users through the internet. Besides lectures, these courses shall include interactive tutorials and exercises that allow for the supervised training of students.[1] Students passing the final exam may receive a certificate documenting the topics and credits attained *via* the distant-learning modules according to internationally accepted standards.

b) Remote Sensing for use in school at different levels

Teaching science in schools is not always straightforward. The students are confronted with a series of formulas and theories that generally are difficult to relate to the day-to-day life of students. Most of the students then arrive at the erroneous conclusion that all the topics taught in science are of importance mainly for future researchers; not being relevant to their daily life.

A programme of teaching units shall therefore be created for teachers and students, comprised of eLearning tutorials and worksheets for hands-on experiments and homework. Remote sensing shall be used to shed light on the relevance of natural science for a better understanding of the natural world. In order to have good acceptance the educational material shall focus on core topics in science education, in agreement with the curricula from elementary to high school wherever possible. It shall use remote sensing imagery to assist the students in understanding how Earth Observation form space is beneficial for society by improving knowledge of our planet.

Tutorials for use in high school shall cover many disciplines such as physics, mathematics, biology, geography and engineering, and focus on the interdisciplinary character of remote sensing.[2] The aim is to achieve scientific literacy, in line with the key scientific education standards. ERSA will therefore closely cooperate with teaching institutions engaged in environmental education.

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[1] Several universities provided pioneering contributions to this method of distant teaching, see, e.g., http://www.academicearth.org/, https://www.edx.org/courses, https://www.coursera.org/. Contributions in geosciences and remote sensing are not yet available.

[2] EARSeL's SEOS tutorials, http://lms.seos-project.eu, could be a primary source for creating ERSA Tutorials for science education in high schools

Teaching material for use in elementary and middle school shall be created with the objective of motivating children about environmental topics at an early stage of their education. This subject necessarily requires active involvement of teachers from such schools, as well as educational experts from pedagogical universities.

To begin with, these tutorials will be realised in the English language, later on to be translated into other languages by ERSA members.

c) Training material for governmental organisations and authorities

Today, environmental agencies have an increasing need of specific expertise in understanding remote sensing products. For example, this concerns authorities involved in response of environmental hazards, in safety and emergency management, in atmospheric and maritime surveillance, to name but a few.

There are two major needs:

- to have access to timely and accurate data
- to be able to convert such data into information.

In order to meet these requirements, several programmes have been developed for making available such services, e.g., Global Monitoring for Environment and Safety (Copernicus)[3], the Group on Earth Observation System of Systems (GEOSS)[4], and the International Charter *Space and Major Disasters*[5]. Apart from such transnational initiatives, numerous state agencies are responsible for surveillance and monitoring within the national responsibility areas.

Operational procedures in use at these agencies often include remote sensing data which are available to the operators in the form of higher-level products. While these products generally meet the requirements of a rapid reaction in cases of emergencies, their use would often benefit from a deeper understanding of the methods applied to the original data for deriving such products: learning about the physics behind remotely sensed data would be desirable.

These links which connect physics of remotely sensed information and the operationally optimised products can be directly derived from ERSA's educational material for universities and high schools. It shall be modified where necessary to meet the requirements of providing training materials for end-users of remotely sensed information at governmental agencies. Among many others, relevant examples are tutorials with topics on land use and land cover, natural hazards, human impact to the environment, ocean currents and marine pollution. Methodological tutorials related to environmental modelling, image classification, and topographic mapping are also of much interest in this context.

The use of training materials shall be supported by forums for the exchange of information between users at agencies and ERSA experts.

d) Organisation of educational workshops and summer schools

ERSA will organise on a regular basis the following events:

- ERSA Workshops on Remote Sensing in Education and Training
- ERSA Remote Sensing Summer Schools,

both on topics which may vary from one event to the next, in regard to remote sensing methods (e.g. hyperspectral, radar, …), subject of interest (e.g., land surface,

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3 http://copernicus.eu/

4 http://www.earthobservations.org/index.shtml

5 http://www.disasterscharter.org/home

atmosphere and ocean, heritage, hazards, etc.), and the targeted group (e.g., university, specific school level, administrative authorities).

It is also expected that the proposed joint workshops will substantially support the financial income of ERSA, thus supporting the cost of providing the above-mentioned internet-based services free of charge.

e) Information of the public on the various aspects of Earth observation

There is a common topic that all humans find motivating and interesting: the understanding of our planet earth, looking at our planet from space and finally the fascinating aspects of outer space. Remote sensing can be a vehicle to better teach science and to attract humans to be interested in science.

Indeed, space is a motivating example for explaining the relevance of science with concrete and practical examples and to raise awareness for the environment.

It is therefore recommended that ERSA will make available the results of Earth Observation to the public by means of articles

- in newspapers on specific topics in cases of actual events like for example the impact of active volcanoes on land and in the atmosphere, the impact of floods in coastal zones, etc.
- on methods and exemplary results of remote sensing in popular science magazines and science pages of newspapers, in the form of review-like articles. A regular column where a series of subjects in Earth Observation from space are presented on a monthly basis would be an even better opportunity to promote the relevance of remote sensing to the public.

f) The provision of tools and standards for routine processing of satellite data

Open access to well-established data processing procedures available in member laboratories shall be provided for other ERSA members. This might include also ground truth procedures for data validation. The goal is to harmonise the processing of satellite imagery for an easier exchange of data, thus improving cooperation between members.

4. Organisation and Budget

ERSA will be an activity of the Special Interest Group on Education and Training through members engaged in the SIG. Contributions from other EARSeL SIGs and member laboratories are very much encouraged.

The SIG chairmen will jointly organise and coordinate the activities of ERSA. Statutes may be drafted and submitted to the EARSeL Boards at a later stage when ERSA will be operational. Until then the EARSeL statutes and regulations apply to all activities of ERSA.

ERSA Workshops and Summer Schools are financed by registration fees of participants and through sponsorships.

Costs for realising educational material etc. are financed by income from ERSA events, by sponsorship and external funding via projects where ERSA is involved.

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