# Tangible Results of the IRSEL Project

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***Abstract*— The objective of the IRSEL project was to develop an innovative learning platform, a LMS in the field of Remote Sensing Applications for Asian countries, China and Thailand. Beyond establishing the LMS at each Asian university, a Knowledge Pool of high-level e-Learning teaching materials for a wider scientific and engineering community has been developed, furthermore workshops, trainings for the teaching staff and a summer school for selected students has been organized. The LMS installed at 4 Asian universities serves the practical applicability of increasingly higher resolution Remote Sensing data coming from more and more sources for wide range of disciplines (including different tasks of Environmental protection, Agriculture, Forestry and fishery, Physical sciences, Engineering and engineering trades, Transport services, Security services). All intellectual products of the project are available via internet for the whole Remote Sensing society at large, while the full feature is hosted at the Thai and Chinese partners and will be involved in their higher education activity.**

***Keywords— Remote Sensing applications, e-learning, LMS***

## I. INTRODUCTION

The EU space strategy according to [1] says "The Commission's aim is to optimise the benefits that space brings to society and the wider EU economy. Achieving this means boosting demand among public and private users, facilitating access to and use of space data, and stimulating the development and use of innovative downstream applications." The demand is in line with the practice observed in the field of Remote Sensing (RS), which has wide range of potential applications unused [2].

The Erasmus+ Capacity Building for Higher Education Key Action 2 project titled Innovation on Remote Sensing Education and Learning (abbreviated as IRSEL) has been conducted for the period 15 October 2017 to 14 October 2020. The wider objective of the IRSEL project was to develop an innovative learning platform, a Learning Management System (LMS) for Asian countries, China and Thailand, which already have relevant activity in the field of RS. Though the content of the implemented LMS does not correspond to any level of tertiary level education, it is basically developed for meeting from BSc to MSc level of RS related disciplines.

More specifically, the following activities were planned and completed: 1) establishing a LMS at each of participating Asian universities, 2) creating a Knowledge Pool of high level e-Learning teaching materials for a wider scientific and engineering community, and 3) organizing workshops, trainings and a summer school for the students, teaching and the administration staff.

Specific Project Objectives of the IRSEL project has been:

1) To ensure researchers and academic staff in RS and geospatial sciences for studies integrated into world-wide sustainability academia (research) community

2) To strengthen and integrate RS and geospatial science into Multi-Inter-Trans-Cross-Disciplinary sustainability studies and research of Socio-Ecological Systems

3) To enhance the role of Asian institutions in socio-ecological systems studies and researches for the benefit of Asian region

4) To promote internationalization on the relevant knowledge areas

5) To enhance international cooperation between EU and Asian universities and research institutes

The LMS hosts 20 newly developed modules on Remote Sensing in the curricula of participating universities, improving the quality of higher education, delivering a background for studying the practical use of the Remote Sensing techniques. This would by time enhance the practical use of Remote Sensing on a wide range of applications serving the labour market and society. The competences and skills in the participating Higher Education Institutions (HEIs) will be developed using these learning modules. The developed LMS at 4 Asian universities will serve the practical applicability of Remote Sensing data for wide range of disciplines (including different tasks of Environmental protection, Agriculture, Forestry and fishery, Physical sciences, Engineering and engineering trades, Transport services, Security services). The

aim of the LMS is to foster the uptake of Remote Sensing applications to boost the benefits that Earth Observation (EO) brings to society and the wider economy. Society will benefit from the improved contacts between research and application for sustainable development.

Now the IRSEL project has reached its end. Instead of focusing on the project activities in general, this paper focuses only on those tangible results, which can openly be used by the international RS society. For up-to-date information on the IRSEL project, you may visit the official website at http://irsel.eu/, c.f. the QR code in Figure 1.

The project has been implemented in an international cooperation of 8 higher education institutions additionally to the 6 associated partners. The list of the involved institutions is summarized in Table I.

TABLE I. THE CONSORTIUM

| **Partners** | | |
|---|---|---|
| ***HEI*** | ***abbr.*** | ***Country*** |
| Obuda University | OU | Hungary |
| University of Natural Resources and Life Sciences | BOKU | Austria |
| Jagiellonian University | JU | Poland |
| University of Twente | ITC | the Netherlands |
| Fujian Normal University | FNU | China |
| Yunnan Normal University | YNNU | China |
| Asian Institute of Technology | AIT | Thailand |
| Khon Kaen University | KKU | Thailand |
| **Associated partners** | | |
| ***HEI*** | ***abbr.*** | ***Country*** |
| Government Office of the Capital City Budapest, Department of Geodesy, Remote Sensing and Land Offices[1] | BFKH-FTFF | Hungary |
| Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Science | MTA RCAE | Hungary |
| Yunnan Hanzhe Technology Co. Ltd. | - | China |
| Southwest Forestry University | SWFU | China |
| Mahasarakham University | MSU | Thailand |
| Thammasat University | TU | Thailand |

## II. KNOWLEDGE CENTRES AND KNOWLEDGE POOL

A key outcome of the IRSEL project was the development of 4 Knowledge Centres (KC) hosting LMS at each Asian partner Universities. Beyond the hardware and software demands, also some equipment for data acquisition is included in the KCs.

The LMS is host on the well-known open-source learning platform, the Moodle. The core material of the hosted knowledge pool is the 20 learning modules, additionally, freely accessible research and teaching materials, and scientific publications developed within the frame of this project, c.f. [3]-[10] are included.

[1] Now it is merged to Lechner Knowledge Centre.

Fig. 1. QR code of the irsel.eu webpage

By the end of the project, the content of the KCs is identical at each Asian partners. By time, Asian partners should modify, extend and update the content, including additional knowledge pool. It can be extended with the translation of the modules to local (Chinese or Thai) languages, additional Remote Sensing software and Remote Sensing data.

Generally, the knowledge pool hosted on the LMS will be involved at different levels of the education of the Asian partners, including distance and blended learning forms as well. For supporting the use of the LMS for self-study, a learning guide is provided. Similarly, for boosting the use of LMS for teaching, a teaching guide is also delivered.

A major part of the equipment purchase budget of the IRSEL project was dedicated to establishing the hardware and software demand of the knowledge pool. Beyond the hardware, software and data demands, also tools for data acquisition were invested, as no Remote Sensing application can be performed without acquiring data. Without the sake of completeness, the equipment park for data acquisition contains laser scanner, multispectral UAV, camera, spectroradiometer, plant canopy analyser.

Fig. 2. QR code of the registration webpage

Though the learning materials has been developed primarily for the benefit of the Chinese and Thai partner universities, according to the open access policy of the project, learning materials are also made available for the international RS society. After a registration at https://lms.irsel.eu/ website, you can get an access to download the learning modules in readable form. The downloadable content can be used offline, while the full feature, applying innovative tools in the learning material is available only on the Moodle platform of Asian partners.

## III. Learning Material Development

As the e-Learning material content of the Learning Management System is the intellectual output of the IRSEL project, which can be accessed by the RS community, in this chapter we provide a review of the 20 modules.

Prior to the learning material development, the Needs Analysis was done. As a result, we've created a Needs Analysis Report. It is a document describing detailed needs and expectations from Asian Remote Sensing Society. The report contains results of needs analysis questionnaires, summarize the recommendations according to local demands, and list the targeted stakeholders and respondents from China and Thailand. The report provides necessary information for module development for the IRSEL project.

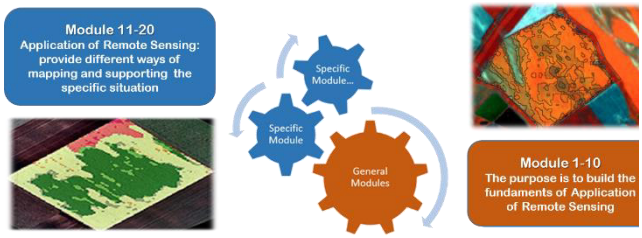


Fig. 3. Structure of the Learning Materials

The learning materials can be divided into two parts: the first 10 modules provide the fundamental knowledge on Remote Sensing at appr. BSc level, while the last 10 modules deals with actual Remote Sensing applications at appr. MSc level (Fig. 2). The actual course specifications are detailed below:

M1 Physical Principles of Remote Sensing: providing students with physical principles of Remote Sensing, the tool to obtain information on the earth from deci-meter level to km level locally and globally, as well as basic RS image processing techniques and skills. The main focus remains on theories and laws on nature of light, its interactions with the atmosphere and earth surface. Additionally, this module focuses on introducing spectrometer, their types, applications and approach to conduct laboratory experiments.

M2 Data Acquisition, Sensors and Platforms (passive sensing): The module provides an overview of different sensors and platforms for the acquisition of passive EO data with emphasis on satellites. EO data, and subsequently the sensors, can be characterized based on the different types of resolutions (spatial, spectral, temporal, radiometric). The main platforms - such as unmanned aerial vehicles (UAV), airplane, and satellite - are presented. Further, the data acquisition process and the different types of sensors (frame cameras, scanners) will be analysed.

M3 Data Acquisition, Sensors and Platforms (active sensing): This module aims at introducing basic and applications of active remote sensing. It covers the basics of imaging system and polarmetric of radar. The differences in type of sensor and availability of spaceborne and airborne sensor. The characteristics of scattering and reflection of microwave energy in various type of surface. An Introduction to Lidar system concepts. The exercises and case studies allow students to explore a range of practical techniques.

M4 Airborne Photogrammetry Remote Sensing Simulation: Understand and master the definition and classification of aerial photogrammetry and Remote Sensing; understand the mission, history and current status of aerial photogrammetry and Remote Sensing; master and thoroughly understand the basic theoretical basis for aerial photogrammetry. Through the study of this course, students are required to understand the whole process of photogrammetry operations, and they can analyse and interpret the aerial photogrammetry process from theory and practice and provide a theoretical basis for solving practical problems.

M5 Digital Image Processing I.: This module aims at introducing basic and advanced techniques of digital image processing. It covers the fundamental concepts required to understand and apply commonly used and more advanced algorithms for pre-processing of remotely sensed data, image manipulation, characterization, segmentation and feature extraction in direct space.

M6 Digital Image Processing II. / Image Classification and Interpretation: This module aims at introducing basic and advanced techniques of digital image processing. It covers the fundamental concepts required to understand and apply commonly used and more advanced algorithms for classification of remotely sensed data. It focuses on an image classification knowledge, techniques and skills for getting information from imagery and ability to solve complex tasks based on Remote Sensing. Emphasis is placed on gaining a practical understanding of the principles behind each technique and a consideration of their appropriateness in different applications. (For an example see Fig. 4)

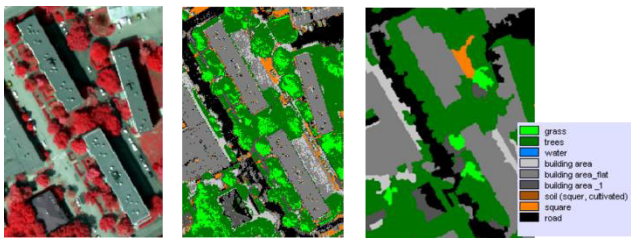


Fig. 4. Pixel and object approach for land cover classification (example)

M7 Available Software Applied in Remote Sensing: This module aims at introducing software tools available for applications in Remote Sensing. RS software landscape will be introduced and their practical methodologies of using this software for real-world problem solving will be explored. Some selected fully-fledged software packages including proprietary and free and open source will be used for image processing, analysis and visualization processes or for information extraction.

M8 Land Change Detection: This module aims at introducing concepts of land change and how basic and advanced techniques of digital change detection can be applied to detect and monitor changes on the land surface. It builds on fundamental concepts related to principles of Remote Sensing and basics of image processing and extends knowledge and skills of students into a temporal dimension. Topics are illustrated with examples and case studies supported by remotely sensed and ancillary data.

M9 Terrain modelling and analysis: introducing concepts of digital elevation models, and how basic and advanced techniques can be applied to analyse and visualize terrain and surface. It builds on fundamental concepts related to principles of photogrammetry, Remote Sensing, and image processing, and extends knowledge and skills of students into a third dimension. (For an example see Fig. 5)

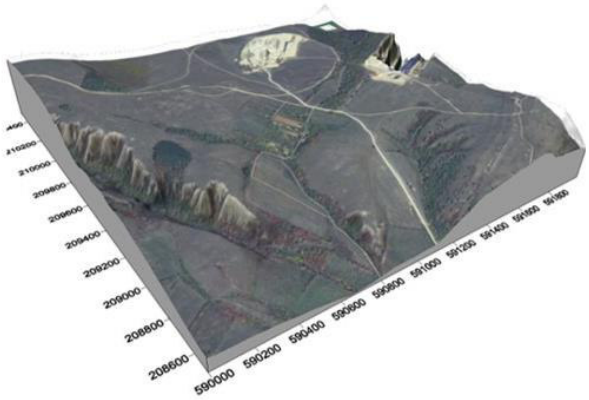


Fig. 5. An orthophoto projected onto a LIDAR-borne terrain model

M10 Remote Sensing and Geographical Information Systems (GIS): aims at the basic of geographic information system (GIS) and data type for integrated with Remote Sensing data. The integration between GIS and Remote Sensing data for data acquisition, analysed, presentation. Technology trends in Remote Sensing and GIS in the future.

M11 Application of Remote Sensing in Agriculture: This module aims at providing the principles, potentials and challenges of Earth observation technologies in the context of crop type mapping, change detection and, more generally, crop condition monitoring. It combines theoretical and practical sessions. The scope of the practical (computer-based laboratory exercises) is to consolidate the theory, to learn & train practical skills and to apply problem-solving methodologies to real-life examples. The main focus lies on the added values of multi-spectral data to retrieve crop bio-physical indicators and the use of multi-temporal data to study the changes and evolution of these indicators over time.

M12 Vegetation mapping and monitoring: providing students with knowledge of satellite Remote Sensing processing techniques and analysis for vegetation mapping and monitoring. Derived products of vegetation index, water stress etc. are generated to track the length of growing season, vegetation health and anomalies.

M13 Application of Remote Sensing (optical satellite data) in Forestry: This module presents different application possibilities of Remote Sensing in forestry. The main focus remains on tree species classification on different levels of detail. Additional contents are biomass / growing stock estimation and change detection applications for forest monitoring. Starting with the presentation of existing and free available data products the module provides some basics about different (active and passive) Remote Sensing data and analysis techniques.

M14 Monitoring the environment by using of RS: This module aims at introducing RS methods of mapping, monitoring and modelling of the resources for management of the environment and solving environmental problems. It will help learners to understand the methods of analysing environmental problems using RS tools for identification and application of possible solutions to support decision making.

M15 Application of Remotes Sensing in Water Management: In this module the theoretical background of the different water budget components is discussed. For each of the components the role of Earth observation is highlighted. To assess the water balance component, you need data. Data can be obtained from the ground and/or from satellite observations and/or already available satellite products. This module explains how to gather and combine data from these two sources, and where applicable, it refers to procedures already included in linked courses.

M16 Oceans/See and Coastal Monitoring: The main objective of the module is to give an overview about Earth observation solutions related to ocean and coastal monitoring. After a generic overview, which covers all application fields, some aspects will be described in detail, including water quality and sea surface monitoring and coastal processes monitoring.

M17 Remote Sensing in Archaeology: This module aims at providing students with knowledge of airborne and terrestrial Remote Sensing in archaeology in order to perform archaeological site detection and identification. It covers the fundamental concepts for data pre-processing and analysis of the multi various airborne and terrestrial Remote Sensing to derive an integrated archaeological mapping and interpretation of detected structure and features. (For an example see Fig. 6)

Fig. 6. Example for using orthophoto of an archeologic application in Székesfehérvár

M18 Application of (optical) Remote Sensing in Urban Environment: providing the principles, potentials and challenges of Earth Observation technologies in the context of land cover mapping, monitoring and change detection within urban environment. The scope of the practical (computer-based laboratory exercises) is to consolidate the theory, to learn and train practical skills and to apply problem-solving methodologies to real-life examples. The main focus lies on the added values of multi-spectral data to retrieve vegetation bio-physical indicators and the use of multi-temporal data to study the changes and evolution of these indicators over time. (For an example see Fig. 7)

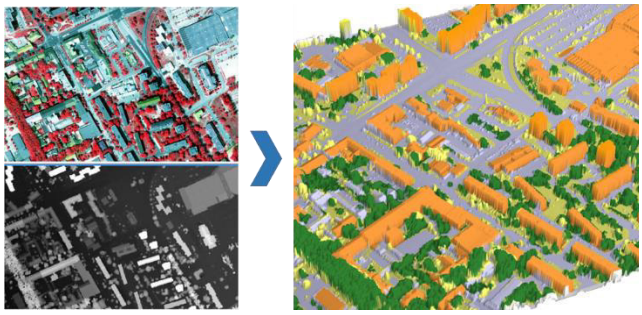

Fig. 7. Example for land cover mapping by OBIA

M19 Disaster Monitoring: This module aims at introducing the benefit of satellite images to monitoring disaster as flood, drought, tsunami, Hurricanes, earthquake, pollution. The data selection for analysed and detected each kind of disaster. The exercises and case studies allow students to explore a range of practical techniques.

M20 Weather and climate monitoring with Remote Sensing: introducing basics of satellite meteorology and climatology, principles of data processing and analyses. The main focus remains on particular spectral channels applications and the interpretation of processed weather and climate information. The module content will give also a broad overview of satellite weather and climate data records and databases as well as data integration towards assessing and monitoring climate change.

## IV. Summary

The IRSEL project has aimed to develop an innovative learning platform, a Learning Management System for China and Thailand in the field of Remote Sensing applications. More specifically, a LMS at each of participating Asian universities has been established, a Knowledge Pool of high level e-Learning teaching materials for a wider scientific and engineering community has been created, finally, workshops, trainings and a summer school for the teaching and the administration staff has been organized.

The project has involved equipping people with the skills, experience and motivation to plan and develop complex educational materials. The project breaks down the traditional educational scheme what contribute to sustainability of results. It promotes (a) multi-method approaches: learning materials (modules), tutorials, webinars, meetings, etc., (b) critical, analytical and integrative thinking, (c) problem solving and research capability, (d) creative and innovative, (e) global and locally relevant information.

It has focused on the use of partnerships to build networks (knowledge platforms) and relationships, also has improved the communication between different sectors of discipline. The outcomes foreseen go in line with needs of educational and research institutions as well. In addition to the tangible results there are many areas of exploitation, such as cooperation in academic sector to offer new e-Learning approaches, also cooperation with geospatial industry to offer new innovative business products, furthermore the benefit of the society due to the improved contacts between research and application for sustainable development.

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## Legal Notice



## References

[1] European Commission: “Communication From The Commission To The European Parliament”, The Council, The European Economic And Social Committee And The Committee Of The Regions, Space Strategy For Europe, Com(2016) 705 Final, Brussels, 26.10.2016, p. 13.

[2] Ferrari, A., Cachia, R. & Punie, Y. 2009. Innovation and creativity in education and training in the EU member states: fostering creative learning and supporting innovative teaching. Luxembourg: European Communities. European Commission Joint Research Centre, JR 52374.

[3] Shifaw, E., Sha, J.M., Li, X.M., Shang, J.L., Bao, Z.C.: "Remote sensing and GIS-based analysis of urban dynamics and modelling of its drivers, the case of Pingtan, China", Environment Development and Sustainability 22(10), 2018, DOI: 10.1007/s10668-018-0283-z

[4] Shifaw, E., Sha, J.M., Li, X.M., Bao, Z.C., Ji, J.W., Chen, B.C.: "Spatiotemporal analysis of vegetation cover (1984–2017) and modelling of its change drivers, the case of Pingtan Island, China", Modeling Earth Systems and Environment 4(2), 2018, p. 1-19, DOI: 10.1007/s40808-018-0473-6

[5] Bao, Z.C., Sondago, T.H., Shifaw, E., Li, X.M., Sha, J.M.: "Monitoring of beach litter by automatic interpretation of unmanned aerial vehicle images using the segmentation threshold method", Marine Pollution Bulletin 137, 2018, p. 388-398, DOI: 10.1016/j.marpolbul.2018.08.009

[6] Mansberger, R., Bauer, T., Immitzer, M., Vuolo, F.: "Bildungsprojekte im Fachbereich Photogrammetrie, Fernerkundung und GIS: Herausforderungen, Chancen und Grenzen", Dreiländertagung der DGPF, der OVG und der SGPF in Wien, Österreich – Publikationen der DGPF, Band 28, 2019, p. 256-269

[7] Shifaw, E., Sha, J.M., Li, X.M., Bao, Z.C., Zhou, Z.L.: "An insight into land-cover changes and their impacts on ecosystem services before and after the implementation of a comprehensive experimental zone plan in Pingtan island, China", Land Use Policy 82, 2109, p. 631-642

[8] Lin, X., Su, Y.C., Shang, J.L., Sha, J.M., Li, X.M., Sun, Y.Y., Ji, J.W., Jin, B.: "Geographically Weighted Regression Effects on Soil Zinc Content Hyperspectral Modeling by Applying the Fractional-Order Differential", Remote Sensing 11(6), 2019, p. 636, DOI: 10.3390/rs11060636

[9] Shifaw, E., Sha, J.M., Li, X.M., Bao, Z.C., Bahir, A.L., Belete, M., Ji, J.W., Su, Y.C., Addis, A.K.: "Farmland dynamics in Pingtan, China: understanding its transition, landscape structure and driving factors", Environmental Earth Sciences 78(17), 2019, DOI: 10.1007/s12665-019-8537-0

[10] Verőné Wojtaszek, M., Balázsik, V., Földváry, L., Márkus, B.: “IRSEL: Innovation on Remote Sensing Education and Learning”, Proceedings of the H-SPACE 2020 Conference, Budapest, 26-27 February, 2020, in press.