Diaľkový prieskum Zeme misiami ESA

Earth observation with ESA missions

K. Pukanská, K. Bartoš, Ľ. Kseňak

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FUNDED BY THE SLOVAK REPUBLIC THROUGH AN ESA CONTRACT UNDER THE PECS
(PLAN FOR EUROPEAN COOPERATING STATES)

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O projekte

Výzva:	ESA AO/1-10044/19/NL/SC Invitation to Tender for the Fifth Call for Outline Proposals under the Plan for European Cooperating States (PECS) in Slovakia, 12/2019
Názov projektu:	University Course EO with ESA missions
Číslo projektu:	4000133959/21/NL/SC
Typ aktivity:	Vzdelávacia aktivita, E
Trvanie projektu:	18 mesiacov
Výška dotácie:	28 480,- €
Začiatok projektu:	01.03.2021
Koniec projektu:	31.08.2022

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Projektový zámer

- Zapojiť FBERG TUKE a ÚGKaGIS do medzinárodného edukačného projektu
- Získať záujem študentov Technickej univerzity v Košiciach o diaľkový prieskum Zeme pomocou satelitných technológií a nástrojov, ktoré ESA ponúka
- Rozšíriť okruh potenciálnych užívateľov satelitných dát na Slovensku
- Zvýrazniť voľný a otvorený prístup k satelitných dátam a softvérovým možnostiam pre študentov
- Výmena poznatkov a skúseností medzi fakultami TUKE v oblasti diaľkového prieskumu Zeme
- Prispieť k modernizácii vzdelávacieho procesu a implementácii nástrojov DPZ na vzdelávacích činnostiach
- Zamerať sa na konkrétne medzery na trhu pri spracovaní satelitných snímok ESA

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Požiadavky projektu

1. Vytvorenie informačného listu predmetu „DPZ misiami ESA“, schváleného garantom štúdia
2. Vytvorenie predmetu „DPZ misiami ESA“ – zapísaného v zozname študijných predmetov v LS 2021/2022
3. Postavenie predmetu pre II. st. VŠ štúdia v odbore IGaKN, v 2. semestri
4. Záväznosť predmetu „voliteľný - V“, 4 kreditový
5. Dĺžka kurzu 1 semester/ 13 týždňov
6. Rozsah štúdia 12 prednášok 2 hod a cvičenia 2hod
7. Počas štúdia sa musí absolvovať exkurzia
8. Ukončenie predmetu je skúškou a záverečným testom
9. Zriadenie web stránky so všetkými edukačnými materiálmi, ktoré budú voľne prístupné

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ANNEX 6 – THE COURSE SYLLABUS

SYLLABUS	
University: Technical University of Košice	
Faculty: Faculty of Mining, Ecology, Process Control and Geotechnologies	
Department: Institute of Geodesy and Geographical Information Systems	
Course Number:	**Course Name:** Earth Observation with ESA missions
Type, scope and method of learning activities: **Course Type:** Lectures, Practical exercises **Recommended scope of the course content (in hours):** Full-time study (hours per week): 2 hours of lectures / 2 hours of practical exercises per week **Study Method:** Attendance Method	
Number of credits: 4	
Recommended semester of study: Summer Term (ST)	

Semester	Study programme
1st year ST	Engineering Surveying and Real Estate Register (IGaKN_Ing_D_Sk)

Level of study: 2nd level of higher education / Master form of study

Prerequisites:

Course completion requirements:
Assessment and completion of the course: *Credit test, Excursion, Final test.*
Continuous assessment: Student passes the continuous assessment and receives credits when he or she meets the requirement to obtain at least 16% out of 30%. *Credit test, Assignments, Excursion.*
Final assessment: Student passes the final assessment and passes the examination when he or she meets the requirement to obtain at least 36% out of 70%. *Final test.*
Overall assessment: Overall assessment is the sum of the assessments obtained by students in the assessment period. The overall result is determined in accordance with the internal regulations of the Technical University in Košice.

Learning outcomes:
Successful graduates of this course should acquire deeper knowledge about ESA space activities and its satellite missions. They will be able to download, process, and interpret satellite data from free and open access Sentinel-1 and Sentinel-2 (and possibly Sentinel-3) missions in various practical tasks. Students should also gain knowledge about ESA third party missions and the use of its data, while being aware of its advantages and disadvantages.

Brief course content:
The course content will consist of the following topics:

	Lectures	Practical Exercises
1	ESA and its space activities, Earth Observation – past, current and future missions, Free and open access to Sentinel missions' data, Scientific results of products from Sentinel missions' data and third party missions	Free and open access to Sentinel missions data, Scientific results of products from Sentinel missions data and third party missions
2	Electromagnetic Radiation – its properties and interaction with the environment	Water bodies detection using ESA satellite Sentinel 2
3	Optical remote sensing: Defining an image; defining reflectance; spectral, spatial, and radiometric resolutions; sensors and platforms; resampling	Water bodies detection using ESA satellite Sentinel 1
4	Digital image analyses - Image pre-processing, Image enhancement	Mapping forest fires using ESA satellite data S1/S2
5	Digital image analyses – Image classification	Mapping deforestation using ESA satellite missions S1/S2
6	Basics of Radar Remote Sensing	Mapping vegetation using ESA satellite missions - land cover/land use S1/S2

Obsahová náplň predmetu

- IL predmetu
- Zriadenie web stránky k predmetu s dostupnosťou všetkých študijných materiálov v SJ a AJ verzii
- https://eo-esa.fberg.tuke.sk/
- https://eo-esa.fberg.tuke.sk/en/home/
- Vytvorenie prednášok a návodov na cvičenia v digitálnej forme, zverejnených na web stránke
- Napísanie VŠ učebnice v slovenskom a čiastočnej aj v anglickom jazyku
- Vytvorenie dátových sád na cvičenia a sady priebežných testov a záverečných testov predmetu

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Výsledky vzdelávania

Úspešní absolventi tohto predmetu získajú hlbšie znalosti o ESA vesmírnych aktivitách a ich satelitných misiách.

Budú schopní získavať, spracovávať a interpretovať satelitné dáta z voľne dostupných zdrojov misií Sentinel-1 a Sentinel-2 a Sentinel – 3 v rôznych praktických úlohách.

Študenti taktiež získajú znalosti o iných zdrojoch satelitných misií v rámci ESA third party missions a ich použití.

V 1. roku zavedenia predmetu bolo 20 študentov, kt. ukončili predmet skúškou

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Obsahová náplň prednášok

https://eo-esa.fberg.tuke.sk/prednasky/
https://eo-esa.fberg.tuke.sk/en/lectures/

- **ESA a jej vesmírne aktivity,** open access k dátam zo satelitných misií Sentinel Hub (EO browser, 3rd party missions)
- **Elektromagnetické žiarenie**
- **Optický diaľkový prieskum Zeme –** snímka, odrazivosť, senzory, platformy
- **Digitálne snímkové analýzy** – preprocessing, vylepšenie obrazu, klasifikácie
- **Základy radarového DPZ**
- **SAR aplikácie**
- **Aplikácie DPZ** – krajinná pokrývka, geologické a banské účely, lesnícke účely, mapovanie vody, snehu a ľadu, ochrana životného prostredia, geohazardov a prírodných fenoménov

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Obsahová náplň cvičení

https://eo-esa.fberg.tuke.sk/navody-na-cvicenia/
https://eo-esa.fberg.tuke.sk/en/tutorials-for-exercises/

- Otvorený prístup k dátam z portálu Copernicus Open Access Hub
- Detekcia vodných plôch použitím satelitov ESA
- Detekcia aktívnych požiarov použitím družice Sentinel – 3
- Mapovanie odlesnenia použitím ESA satelitov
- Detekcia nerastných surovín použitím družice Sentinel – 2
- InSAR pre detekciu, mapovanie a monitorovanie živelných pohrôm
- Mapovanie teplotných ostrovov pomocou družice Sentinel – 3
- Aplikácia dát Sentinel v platforme Google Earth Engine

Dialkový prieskum Zeme misiami ESA

Web stránka

FBERG esa Home About the Project Lectures Tutorials for Exercises About the Course Study of Geodesy

Earth Observation with ESA missions

is a university course is developed in cooperation with European Space Agency ESA within the 5th project call of the PECS programme (Plan for European Cooperating States)

Lectures
Course lectures about ESA missions, satellite images processing, and its use in geosciences

Exercises
Practical exercises about satellite images processing in SNAP software enviroment

About the Course
All practical information about the course and requirements of its completion

WHAT WE DO

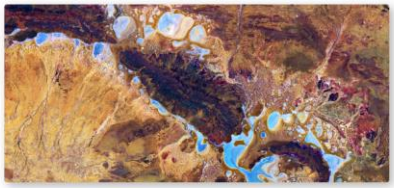
We educate new users of wide range of ESA products in Earth observation

About the project

DESCRIPTION OF THE PROJECT

Earth Observations with ESA mission

is a project realised by the contract No.4000133959/21/NL/SC between the European Space Agency ESA, ESTEC Institution – The European Space Research and Technology Centre, and the Technical University of Košice, Faculty of mining, ecology, process control and geotechnologies, within the 5th project call of the PECS programme – Plan for European Cooperating States.



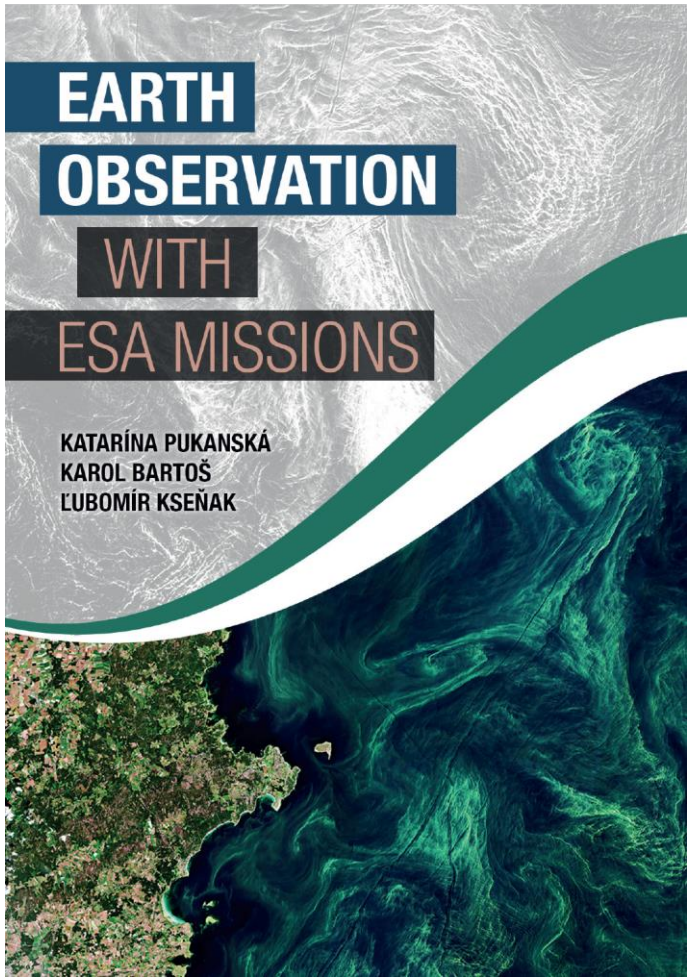
INTENTION OF THE PROJECT

1. Acquire the interest of university students in the exploration of the Earth using satellite technologies and tools offered by ESA

2. Support the development of space technology capabilities – produce the users of data

Dialkový prieskum Zeme misiami ESA

Vysokoškolská učebnica



Diaľkový prieskum Zeme misiami ESA

Vysokoškolská učebnica

Content

The Autors

Katarína Pukanská works as an associate professor at the ÚGKaGIS, FBERG, TUKE. At the Faculty of BERG, TU Košice, she leads lectures and exercises in subjects Remote Sensing, Photogrammetry I., II. and Space Geodesy. She specialises in laser scanning and digital photogrammetry in creating spatial models of surface and underground objects, digital terrain models, mapping, and using these methods in special industrial applications.

Karol Bartoš works as an assistant professor at ÚGKaGIS, FBERG, TU Košice. He leads the subject Surveying at the Faculty of Civil Engineering, and exercises in subjects Photogrammetry I. and Surveying I. In his professional activities, he specialises in digital photogrammetry technologies, terrestrial laser scanning and remote sensing, and their use in the creation of spatial models of underground and surface objects, mapping of natural and anthropogenic objects and phenomena.

Ľubomír Kseňak He is an assistant professor at ÚGKaGIS, FBERG, TU Košice. He leads exercises from Spherical Geodesy, Remote Sensing, Surveying in Underground Spaces, and Field Exercises from Surveying. As part of his research activities, he deals with the issue of obtaining and processing data from remote sensing, specialising in various types of satellite data, while in this area, he has completed several foreign trainings and courses.

Predhovor

Preface

University textbook Earth Observation with ESA Missions is a textbook written primarily for students of the Faculty of Mining, Ecology, Process Control and Geotechnologies, the Technical University of Košice, in the field of study geodesy and geoinformatics. The textbook reflects the current needs and possibilities of education in these disciplines in higher education studies of the 1st and 2nd level of higher education. Within the preparation of the equivalent study subject, freely accessible lectures and tutorials for exercises are also prepared, which were created for the field of study Engineering Surveying and Cadastre of Real Estate in the 2nd level of higher education.
The course has been developed in the framework of the international project entitled University Course Earth Observation with ESA Missions within the framework of the activity Plan for European Cooperating States (PECS) launched by the European Space Agency ESA under the fifth call, Part E - Educational Activities. The PECS activity is aimed at the development of projects by research and commercial entities of the applicant country for membership of the European Space Agency in several areas: Flight Hardware, Preparatory Activities, Research and Development Activities, Space Applications, Products and Services and Educational Activities. The main objective of this course is to teach university students in the field of remote sensing, but more importantly, to get them interested in working in this field. The course curriculum allows students to acquire the latest knowledge in the use of space technologies offered by ESA and prepare them for future professional careers in these fields.
The curriculum consists of 12 chapters, introducing ESA's historical, current, and planned Earth observation missions, online access to these data, and third-party data. The following chapters present the theory of electromagnetic radiation, its physical principles and interaction with the environment, and its use in optical and radar DPZ. A separate chapter covers image processing and enhancement, image analysis and classification needed for object detection. Two chapters are devoted to radar DPZ - fundamentals and SAR applications. A large part of the textbook consists of the use of data acquired primarily by ESA missions in areas such as land cover mapping, geological and mining mapping, forestry, water, snow and ice mapping, and use in monitoring and mapping natural disasters.
The text of the book is prepared in a combination of Slovak and English, with chapter titles, abstracts and figure titles in English.
All the materials produced to support this course - the undergraduate textbook, lectures and tutorials - are available on the website created for this purpose https://eo-esa.fberg.tuke.sk.
We believe that the prepared textbook and other supporting materials will be a useful and beneficial learning tool for students and possibly other practitioners.

Authors

1 ESA and its space activities

The history of the European Space Agency began many years ago. After World War II, many European scientists left Western Europe and decided to pursue scientific careers in the US or the Soviet Union, as they saw more potential in working with the superpowers. In 1958, two prominent members of the Western European scientific community -Pierre Auger and Edoardo Amaldi proposed to European governments to set up a purely scientific joint organisation for space research along the lines of CERN.
In 1960, scientists from 10 European countries of the "Groupe d'etudes europeen pour la Collaboration dans le domaine des recherches spatiales" (GEERS) formed a commission to decide on the possibilities of European cooperation in space. In 1962, two agencies were created: the European Launch Development Organisation (ELDO) and the European Space Research Organisation (ESRO) to develop spacecraft. In 1975, ESA in its present form was created by the merger of ELDO and ESRO. It has 10 founding members: Belgium, Germany, Denmark, France, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.
Since 2008, ESA has become a fully responsible partner in the operation and exploitation of the ISS and therefore has the right to fly its own astronauts on long-term missions as members of the ISS resident crew.
As ESA is involved in many activities, not only in remote sensing but also in planetary missions, and participates in the International Space Station ISS operation, it is challenging to mention all the activities fully.
This chapter is devoted to the characteristics of past, present and future ESA Earth observation satellite missions. It also includes information on the basic types of images and data from each mission, as well as how to access these data and data from third-party missions.

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Vysokoškolská učebnica

1 ESA, Earth Observation, Data Access

1.2.1.4. GOCE satellite

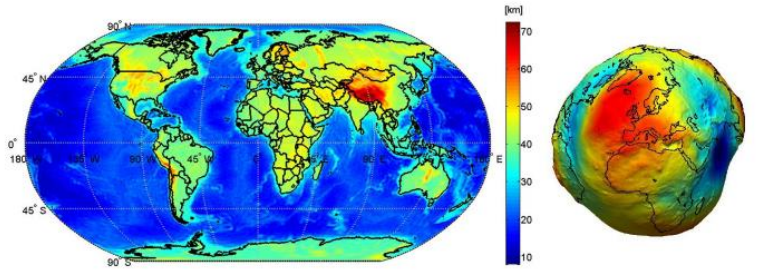
Tretí z radu satelitov pozorujúcich Zem bol satelit GOC
Explorer, Obr.1.3), ktorý pracoval od roku 2009 do
gravitačné pole Zeme a modelovať geoid s veľmi vy
obežnej dráhe iba 224 km. Vysoko presný gravitačn
získal informácie o vnútornej štruktúre Zeme, ako aj
oceánov.

Obr. 1.3 *GOCE družica.*
Fig. 1.3 *GOCE satellite.*
Source: earth.esa.int/eogateway/missions/goce

Gravitačná mapa a model geoidu poskytli použí
definované dátové produkty, ktoré sú nápomocné
širokom rade disciplín. Hoci sa jeho let skončil, mn
využíva na zlepšenie nášho chápania geodézie, geofyz
oceánografie, hladiny morí, dynamiky ľadu a vnútra Z

Vedecké ciele misie boli:

1 ESA, Earth Observation, Data Access



Obr. 1.4 *Rozloženie globálnej Mohorovičićovej plochy diskontinuity a tvar geoidu získaný na základe misie GOCE.*
Fig. 1.4 *Distribution of the global Mohorovičić discontinuity surface and the shape of the geoid obtained from the GOCE mission.*
Source: ©GEMMA project; ©ESA

GOCE niesol senzory:

EGG The Electrostatic Gravity Gradiometer, ktorý meral stacionárne gravitačné pole a gravitačné anomálie s vysokým priestorovým rozlíšením a vysokou presnosťou

SSTI The Satellite to Satellite Tracking Instrument

STR The Star Trackers

MGM 3-osí magnetometer

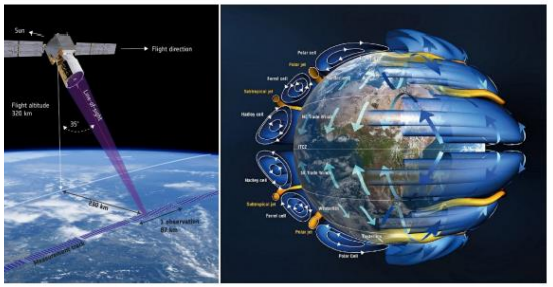
LRR The Laser Retroreflector pre satelitnú službu laserových meraní

1.2.2. Current ESA Earth Observation missions

Aktuálne pracujúce misie dialkového prieskumu Zeme sú Aeolus, Cloudsat, Sentinel,1,2,3, 5P a SWARM. V Tab. 1.2 sú uvedené bližšie technické špecifikácie týchto misií.

Tab. 1.2 *Technické parametre aktuálnych misií.*
Tab. 1.2 *Technical parameters of current missions.*

1 ESA, Earth Observation, Data Access



a Aeolus a monitoring globálnej atmosféry.
us mission and monitoring of global atmosphere.
A/ATG medialab; directory.eoportal.org/web/eoportal/satellite-missions/a/aeolus

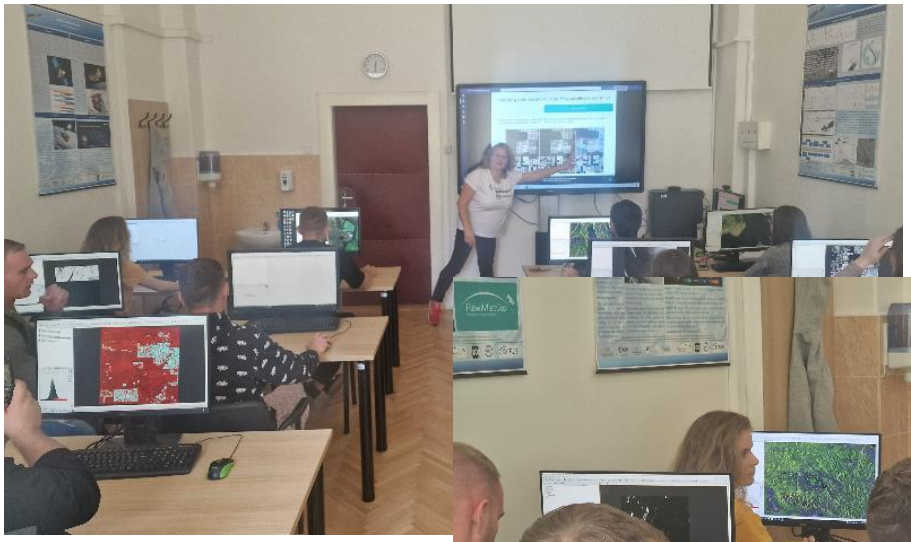
1.2.2.2. Cryosat-2 mission

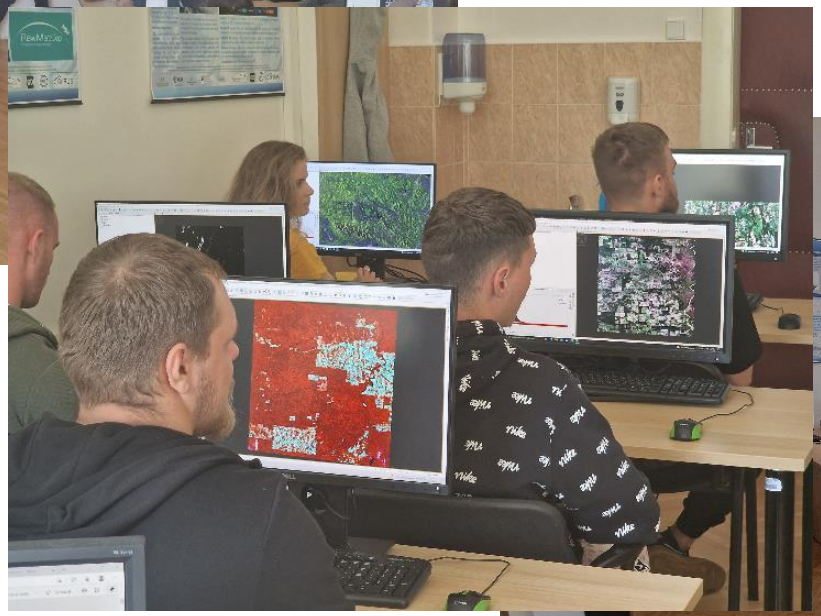
Earth Explorer Cryosat (Obr. 1.8) je zameraná na meranie hrúbky polárneho ľadu a hrúbky kontinentálnych ľadovcových štítov, ktoré pokrývajú Grónsko a . Jeho hlavným užitočným zaťažením je interferometrický radarový výškomer je navrhnutý pre meranie ľadu, pričom meria zmeny na okrajoch rozsiahlych ítov a plávajúceho ľadu v polárnych oceánoch. Zároveň je špeciálne navrhnutý ovanie najdynamickejších úsekov kryosféry Zeme. Pôvodný satelit Cryosat-1 arte v roku 2005.

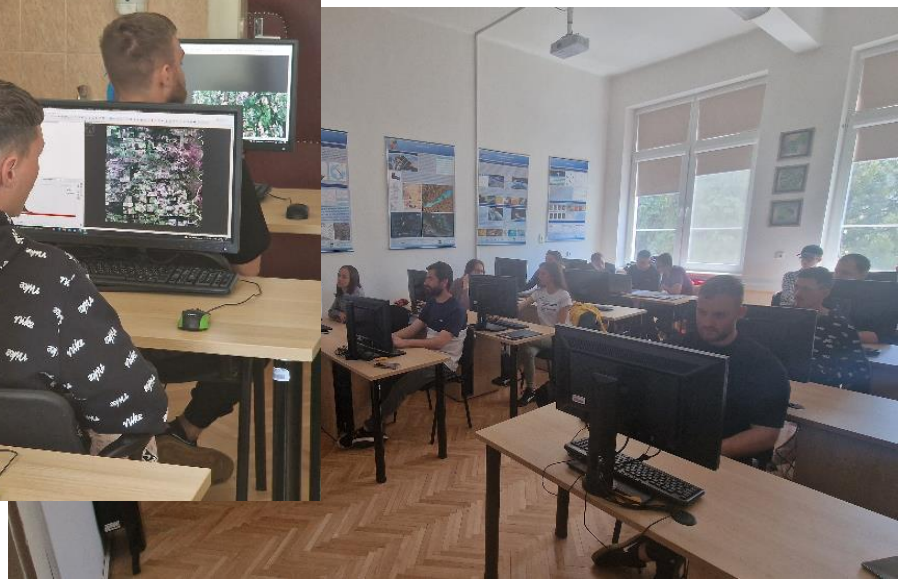
ouží syntetické apertúrne radarové a interferometrické techniky zo ich zobrazovacích radarových misií, aby zlepšila svoju presnosť na drsných adových vrstiev a morského ľadu v polárnych vodách. Meria „voľný bok" – rozdiel vo výške medzi morským ľadom a priľahlou vodou – ako aj nadmorskú výšku ľadovej pokrývky, pričom sleduje zmeny hrúbky ľadu.

Dialkový prieskum Zeme misiami ESA

Implementácia projektu







Výučby sa zúčastnilo **22 študentov**, pričom 20-ti ukončili predmet skúškou

Dialkový prieskum Zeme misiami ESA

Exkurzia

Národné lesnícke centrum vo Zvolene
SAŽP v Banskej Bystrici

Diaľkový prieskum Zeme misiami ESA

Exkurzia

Prednášky v NLC:

Radar a kvantifikácia drevnej biomasy na nelesných pozemkoch (Sentinel-1) - Dr. Ing. Tomáš Bucha, Mgr. Ivan Barka, PhD.

Satelitné sledovanie fenologických prejavov lesných drevín v kontexte klimatickej zmeny (MODIS) - Dr. Ing. Tomáš Bucha

Sledovanie stavu lesa pomocou satelitných snímok Sentinel-2 - Mgr. Ivan Barka, PhD.

3D CT skener drevnej guľatiny - Ing. Tomáš Gergeľ, PhD.

Prednášky na SAŽP:

Programy ESA a Copernicus na Slovensku - Mgr. Peter Pastorek, MŽP SR

CLC a CLC+ a jeho spracovanie na Slovensku - Mgr. Ľuboš Balážovič, PhD.

Ukážky používanej techniky a DPZ vybavenia na SAŽP - Mgr. Ľ. Balážovič, PhD.

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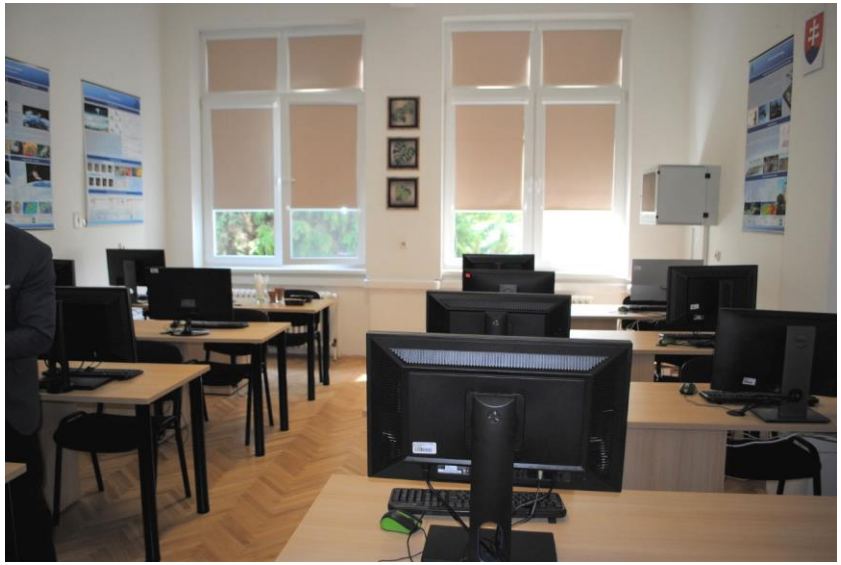
Následná spolupráca

Projekt KEGA na zriadenie učebne:

Vedecké a edukačné centrum pre dialkový prieskum Zeme so zameraním na využívanie e-learningových prístupov vo vzdelávaní (004TUKE-4/2019)

Dotácia: 48 184€



Multimediálne prvky učebne

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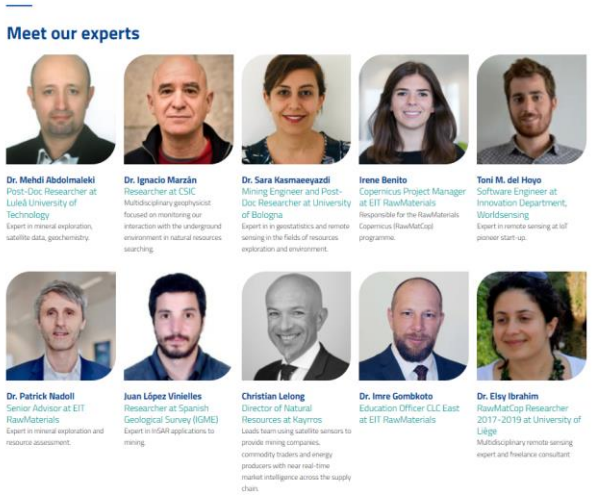
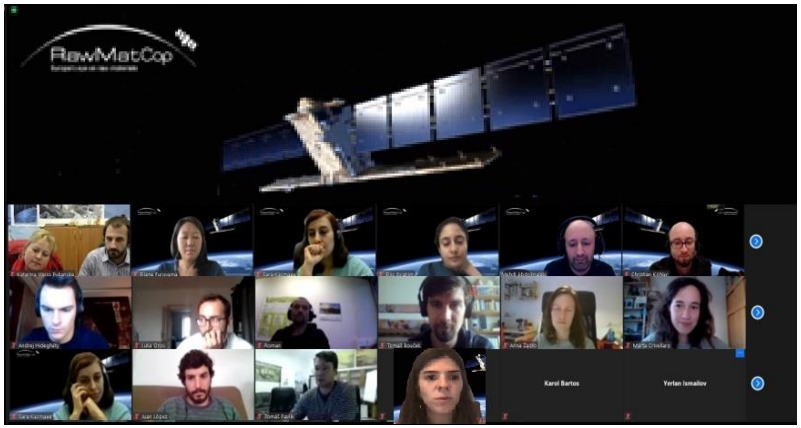
EIT RawMatCop

Oblasti prednášok školenia:

- Prieskum nerastov a mapovanie ložísk nerastných surovín
- Monitorovanie banskej činnosti vrátane odpadového hospodárstva
- Monitorovanie vplyvov na životné prostredie
- Detekcia vody.





Ďakujem za pozornosť!

katarina.pukanska@tuke.sk

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