With the support of the Erasmus+ Programme of the European Union Sector Skills Alliances N° 591991-EPP-1-2017-1-IT-EPPKA2-SSA-B

D5.3 – Integrated Application

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Work package / Task:

WP5 - Testing and validating the strategy bases on case-based learning in 3 sub-sectors

T5.3 – Integrated Application

Short Description:

This deliverable describes the training actions within the “Integrated Application” subsector. All training actions are case-based learning.

Keywords:

Body of Knowledge; Integrated Application; case-based Learning Scenario; Training Action; Earth Observation

Dissemination Level		
PU	Public	X
RE	Restricted to other programme participants (including Commission services and project reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

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Revision History:

Revision	Date	Author(s)	Status	Description
1.0	25/02/2022	Gabriele Leoni Luca Guerrieri Daniele Spizzichino Federica Ferrigno Francesco Menniti	Ready for the QA	
2.0	26/03/2022	Gabriele Leoni Luca Guerrieri Daniele Spizzichino Federica Ferrigno Francesco Menniti		Final version

Executive Summary

This report summarizes the activities carried out in the “Task 5.3 - Integrated Application” of the EO4GEO Project. Nine Training Actions of different typologies, i.e. webinar, workshop, course and project work, were realized during the two-year activity, dealing with themes of the EO*GI subsector Integrated Application and more than 500 attendees were involved.

Each Training Action followed a problem-based approach, starting from a real use case (Scenario) and addressing the solution, through a BPMN, by identifying the relevant actors (profiles) and skills needed (curricula). By this approach, the Training Actions made wide use of and tested the project tools (BoK, CD Tool, Training Material) demonstrating how to implement them, in a dynamic learning environment, for the development of skills at different level of expertise.

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Acronyms

Acronym	Description
AI	Artificial Intelligence
AP	Associated Partners
BoK	Body of Knowledge
BPMN	Business Process Model and Notation
CAP	Common Agricultural Policy
CDT	Curriculum Design Tool
CNR-IREA	Consiglio Nazionale delle Ricerche – Istituto per il Rilevamento Elettromagnetico dell'Ambiente
CS	Citizen Science
DEM	Digital Elevation Model
EACEA	Education, Audio-visual, Culture Executive Agency
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit System for Vocational Education and Training
EO	Earth Observation
EO*GI	EO and GI sectors
EQF	European Qualifications Framework
ESA	European Space Agency
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
GEOF	University of Zagreb – Faculty of Geodesy
GI	Geographic Information
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
GPS	Global positioning System
ICT	Information Computer Technology
IoT	Internet of Things
InSAR	SAR Interferometry
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale
INSPIRE	Infrastructure for Spatial Information in Europe
KU-Leuven	Katholieke Universiteit Leuven
LIDAR	Light Detection and Ranging
LRA	Local and Regional Authorities
MOOC / OOC	Massive Open Online Course / Open Online Course
NDVI	Normalized Difference Vegetation Index
OBIA	Object-based Image Analysis
OGC	Open Geographical Consortium
PLUS	Paris-Lodron-Universität Salzburg
PSI	Persistent Scatterer Interferometry
Q&A	Question & Answer
ROSA	Romanian space Agency
SAR	Synthetic Aperture Radar
SNAP	Sentinel Application Platform
TA	Training Action
TM	Training Material
UJI	Universitat Jaume I
VET	Vocational Education and Training
WP	Work Package

Glossary

- **Bloom's Taxonomy** is a classification of thinking or cognitive skills, which is often used in the design of educational, training and learning processes, and especially in the definition of learning outcomes. Bloom's Taxonomy consist of six levels of thinking skills, ranged from lower order thinking skills to higher order thinking skills
- **Blueprint** refers to the systematic definition of EO*GI content for the purpose of creating curricula with validity evidence.
- **Body of Knowledge (BoK)** is the complete set of concepts and relations between them, that make up a professional domain, (in this case EO*GI BoK) and the related learning outcomes as defined by the relevant learned society or a professional association.
- A **Course** is a unit of teaching, a set of lectures or a plan of study on a particular subject, usually leading to an exam or qualification. This unit can be used for teaching theoretical as well as practical content; depending on the specific subject of the course and its theoretical or practical nature the assessment of learners is done with an exam or through the assessment of assignments.
- **European Credit Transfer and Accumulation System (ECTS)** is a credit system designed to make it easier for students to move between different countries.
- **European Qualifications Framework (EQF)** descriptor is defined by 8 levels of descriptors that indicates at that level the learning outcomes relevant to qualifications in any system of qualifications.
- **European Skills, Competences, Qualifications and Occupations (ESCO)** is the multilingual classification of European Skills, Competences, Qualifications and Occupations.
- **Geographic Information (GI)** is the data of a geographic location combined with non-spatial information (e.g. statistical data) and their representation as a map.
- **Knowledge** means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.
- **Learning outcome:** Learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process. In EO4GEO They are described in terms of Knowledge and Skills.
  They should be characterized by:
  - A time frame
  - A performer
  - An action verb (observable and measurable)

  In EO4GEO it has been agreed that learning outcomes are formulated as verb + knowledge-based statement (example: at the end of the course (time frame) the student (performer) is able to work (Verb) theoretically and practically in the processes of disaster management (knowledge-based statement)).
- A **Lecture** is a formal talk or practical exercise on a serious subject intended to display information or teach people about a particular subject (also known as lessons or classes).
- **Massive Open Online Courses (MOOC)** are free online courses available and provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale

- A **Module** is a collection of courses grouped because courses are run over the same year or semester, or tackle the same topic. (Source: CDT)
- **Skill** means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive or practical skills.
- **Training** is the organized activity aimed at transmitting and receiving information and/or instructions to improve the recipient's (learner, trainee) knowledge and/or skill. Methods of imparting training are, for example, **on-the-job training** (development through performance), **case-based methods** (analysis of an actual situation), **knowledge-based methods** (lectures, seminars, workshops). (Adapted from Talloo, 2007 and Business Dictionary)

1. Introduction

1.1. EO4GEO project

EO4GEO is an **Erasmus+ Sector Skills Alliance** gathering **25 partners from 13 EU countries**, most of which are part of the **Copernicus Academy Network**. Be they from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sector. The project is also supported by a strong group of Associated Partners mostly consisting of associations or networks active in space/geospatial domain. The project started on January 1st, 2018, upon approval by the EU Education, Audiovisual and Culture Executive Agency (EACEA) and runs over four years.

EO4GEO **aims to help bridging the skills gap in the space/geospatial sector** by creating a strong alliance of players from the sector/community reinforcing the existing ecosystem and **fostering the uptake and integration of space/geospatial data and services**. EO4GEO works in a **multi- and interdisciplinary** way and applies innovative solutions for its education and training actions including: case-based and collaborative learning scenarios; learning-while-doing in a living lab environment; on-the-job training; co-creation of knowledge, skills and competencies; etc.

EO4GEO defines a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT).

The strategy is implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts; developing and integrating a dynamic collaborative platform with associated tools; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes and conducting a series of training actions for a selected set of scenario's in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally a long-term Action Plan will be developed and endorsed to roll-out and sustain the proposed solutions

For more information on the project please visit http://www.eo4geo.eu/about-eo4geo/.

1.2. Objectives of the Work Package

The scope of work package 5 is testing and validating the (EO4GEO) strategy based on case-based learning scenarios in three sub sectors. The **three sub sectors** are **"Integrated Applications", "Smart Cities" and "Climate Change"**.

The work package specifies curricula based on case-based scenarios for the sub-sectors, and tests and validates them in concrete training actions. These training actions included on-the-job training like webinars and workshops but also (academic-) courses and summer schools. In this context remote sensing and related techniques were considered as supporting or horizontal competencies needed for conducting the case-based scenarios. The training actions were prepared in detail by mixed task forces. Each training action is complete in terms of learning objectives and content and thus is independent. This assures that in a single training action a complete lesson is learnt, and well-defined learning outcomes are achieved. Nonetheless, the different training actions are part of learning paths that link them to related training actions. Trainees can choose a learning path that guides them through training actions that are relevant for their interests.
For each sub-sector, a taskforce of at least three partners with relevant expertise were designing the training actions applicable on national and transnational levels and involving multiple subjects. The space/geospatial sector and the education/training providers work closely together to prepare, conduct, and evaluate the training actions. Testing and validation were performed by involving the education/training providers, the space/geospatial industry and public sector players, the end-users of the Alliance and other relevant stakeholders.

Case-based learning
Case-based learning starts from 'real-world' problems or scenarios, rather than from the 'solutions' or supporting technologies. Training action participants learn to analyze a problem, explore how GI and EO techniques can be used for a solution and more particularly how Copernicus data and information can help in the particular case. This approach allows demonstrating how to support different users and different types of usage. The selection, acquisition, and preparation of the GI and EO data, their (pre)processing and integration, and their transformation into information readily usable for problem-solving are important parts of the teaching/learning process.

1.3. Objectives of the Task

Integrated applications usually focus on multi-faceted, on multi-sector and on cross-border challenges, coming from environmental changes and causing an impact on human settlements and activities or vice versa. Monitoring and analyzing such relations and developments is a key action in order to reduce risks and to plan resilient cities. To produce an integrated application, skills from different sectors have to work together and bring together all the data and information relevant to the case. This is the typical approach of the EO*GI specialists that need to integrate Copernicus data (remote and in situ) and services with that coming from other systems such as INSPIRE, statistical data cubes, national infrastructures, planning departments of cities, etc. Integrated applications are often necessary also to access data, to 'mine' and process them and present them in a way they are understandable for decision makers and stakeholders involved in the process.

Different learning scenarios have been chosen for this sub-sector for which a few relevant occupational profiles required to support the process and its sub-processes are needed. For these profiles a typical learning path has been designed with the curricula designed in previous steps of the Project. To design the scenarios the following steps have been followed:

- Identify the components of interdisciplinary and intersectoral scenarios respecting the related policies and regulations.
- Assess the requirements for integrating data and information from various sources by exploring Copernicus and INSPIRE infrastructures.
- Select appropriate curricula and training methods to address the specific nature and skills needs of the community to be involved.
- Decide on the format of training actions.
- Advertise the training action(s) to attract participants from the respective communities (per discipline, sectorial, pan-European).
- Implement the Training Actions with the objective to provide best-practice examples.

The integrated applications team consists of consortium partners active in this field, complemented by other education/training providers, private companies interested in this kind of developments, associated partners, etc. The training actions are open for the broader Copernicus community.

1.4. Purpose and structure of the document

This document reports the selection path of the Learning Scenarios for the Training Actions (TA), conducted in the EO4GEO Project's Task 5.3 - Integrated Applications, that derive from the EO*GI skill analysis and are built on the training support tools from the previous phases of the Project (EO4GEO Tools, BPMN modeling). Then the TA are described in their content and realization, and their impact are assessed in order to evaluate the effectiveness. Finally, some conclusions are drawn to address next Project's phases.

2. Methodology

2.1. A common storyline - The EO4GEO training approach

The skills strategy of the GI and EO sector has been established and followed by the development of an EO*GI Body of Knowledge (BoK). Beyond comprising a common vocabulary for the GI and EO sector, the BoK provides a structured overview of the related necessary skills for the EO*GI workforce to do business.

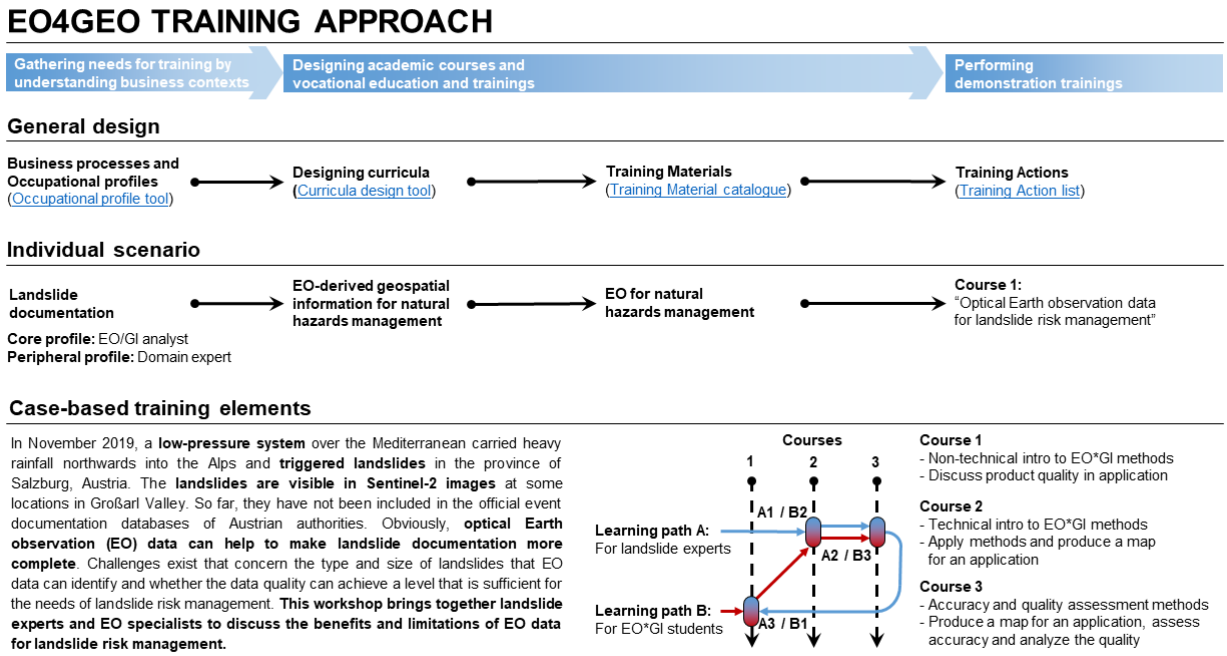

Fig. 1: The EO4GEO Training Approach - A skills strategy for the GI and EO sector.

A need for training occurs where there is a gap between the demand of competences for certain business processes that cannot be met by the members of the workforce. Therefore, the gathering of needs for training requires an understanding of the business processes and the involved occupational profiles that define the skill requirements. Curricula related to business processes and occupation profiles relevant to Copernicus were created which led to tailored training material for the EO*GI sector. The training actions were then used to test the material, the integrated platform of collaborative tools being developed and of the curricula supporting Copernicus within the EO4GEO training approach.

2.2. Integrated Application case-based Learning Scenario

The Training Actions for the sub-sector Integrated Application have been selected starting from use-cases chosen by project partners during previous phases; these use-cases have been developed and described following the Business Process Model and Notation BPMN (The use cases are described more in detail in D 4.1 - Identifying business processes and occupational profiles).

At the beginning, four learning scenarios were chosen, each of them representing an Application Domain. Each scenario is characterized by a relevant component of EO*GI data and services' application and by a sound integration of multidisciplinary competences and skills. During the Task, some partners proposed additional topics, even with different competences, so the range was enlarged to offer a wider perspective on the potential applications. All case-based learning scenarios have been evaluated in terms of contents and disciplines and finally some of them have been selected to provide a balanced project's training offer.

The selected themes for the Integrated Application sub-sector have been grouped in six different Application Domains as in the Table listed below:

APPLICATION DOMAIN	acronym
Agro-Monitoring System	AMS
Ground Motion	GM
Geohazard Zoning	GZ
Land Change Detection	LCD
Machine Learning	ML
Citizen Science	CS

For each Application Domain, at least one use-case, modeled through BPMN, became one Learning Scenario, to be developed into a Training Action. The value and applicability of scenarios have been analyzed by sub-sector's experts. Learning scenarios concern practical implementation of natural phenomena management (i.e. landslides) or human activities (i.e. farming, land use change) for which the application of EO*GI data and services is a decisive contribution towards the solution of a real issue.

Following project directions and project meeting agreement and decisions (Task 5.1 - Developing a method for designing case-based scenario's for 3 sub-sectors) the training offer is articulated in different types, target groups and expertise levels (EQF level), in order to reach and to involve as many relevant actors and stakeholders as possible. The Training Actions show the project tools exploitation aimed at solving real problems depicted by scenarios.

Finally, nine Learning Scenarios have been realized, reaching a total number of 573 participants. The following table summarizes general information on different learning scenarios conducted by Organizer Partners as Training Actions for the sub-sector Integrated Application.

Table 1. Overview of Training Actions of the Integrated Application sub-sector.

Organizer	Learning Scenario	Application Domain	Date	n. of participants	Implementation
UJI	Observing from space. Agriculture and environment	AMS	18/11/2020	31	Webinar
Planetek	The rise of Artificial Intelligence for Earth Observation	ML	02/03/2021	275	Webinar
PLUS	Optical Earth observation data for landslide risk management	GZ	15/04/2021	22	Workshop
CNR-IREA	A new Common Agricultural Policy (CAP) based on Copernicus program and EO4GEO tools	AMS	28/04/2021	80	Webinar
ROSA	Change detection using EO data	LCD	03/05/2021 14/12/2021	10 15	Academic course
GEOF	Fast disaster response – satellite technologies for surface displacement monitoring	GM	12-14/07/2021	77	Webinar
ISPRA	Landslide affecting Cultural Heritage sites - Roman Thermae of Baia	GM	from December 2021	13	OOC
KU-Leuven	Development of a citizen science project within the MyGardenLab environment	CS	February-November 2022	5	Webinar and Project work
IGEA	Data-driven platform for efficient farm management combining EO, IoT and GIS data	AMS	08/03/2022	45	Webinar

A brief description of the Learning Scenarios, highlighting relevant topics and context of application, is reported in the following paragraphs.

Observing from space. Agriculture and environment

http://www.eo4geo.eu/training/observando-desde-el-espacio-agricultura-y-medio-ambiente/

This training is addressed to non-experts in EO and environmental modelling, but for people in charge of developing and implementing a Geoportal providing products to monitor crops or for precision agriculture. The learner will understand how to create a geoportal that allows users to select different products (vegetation, NDVI…), to compare products from different dates covering the same area, to see the evolution (in graphic format) of the area and to identify the value at an individual pixel over time (NDVI, biomass, leaf area index, etc.).

The rise of Artificial Intelligence for Earth Observation

http://www.eo4geo.eu/training/the-rise-of-artificial-intelligence-for-earth-observation/

The webinar addresses the use of AI algorithms in the EO applications.
Participants become more familiar with AI concepts, from machine to deep learning, from unsupervised to supervised methods. Furthermore, applications in objects detection are demonstrated such as semantic segmentation, classification, clustering and data augmentation.

The basic idea of AI algorithms is presented (random forest, Multi-Layer Perceptron, Convolutional Neural Networks and Generative Adversarial Networks) and how they are useful in the EO applications.
The webinar is mainly addressed to non-technical and all AI researchers, EO experts, GIS technicians, and technology enthusiasts are invited.

Optical Earth observation data for landslide risk management

http://www.eo4geo.eu/training/optical-earth-observation-data-for-landslide-risk-management/

Mountainous regions are particularly prone to alpine geohazards like landslides. Landslides occur every year and cause significant damages. Therefore, a sound basis of landslide information is necessary to support tasks of landslide mitigation, preparedness, response and recovery, e.g. hazard zone planning or eligibility checking for insurance claims. In the last couple of decades, public authorities performed systematic acquisition of information about alpine geohazards and enabled a better understanding of the hazard and the risk.
Earth observation (EO) data and innovative processing methods such as object-based image analysis (OBIA) provide the opportunity to produce landslide maps. A landslide documentation service for inventory updates after triggering events is described, that produces EO-derived landslide information enhanced with in-situ verification.

A new Common Agricultural Policy (CAP) based on Copernicus program and EO4GEO tools

http://www.eo4geo.eu/training-actions/common-agriculture-policy-copernicus-webinar/

The webinar has the overall objective to promote the EO4GEO sector skills alliance and its tools towards the European Regions, their Citizens and Universities but also to get their views on the initiative. The aims of the webinar are:

- to raise awareness on the importance of new European instruments for Earth Observation and management;
- to raise awareness on the EO4GEO initiative: Introduction of EO4GEO Sector Skills Alliance to the regional ecosystem;
- to promote the EO4GEO tools to Regions, Farmers' Organizations and Citizens;
- to gather input and feed-back from the regional/farmer community/citizen on the adequacy of the tools proposed;
- to enhance interregional collaboration;
- to improve connections within the European initiatives and EO4GEO community.

Change detection using EO data

http://www.eo4geo.eu/training/change-detection-using-eo-data/

One of the main objectives of GMES (Global Monitoring for Environment and Security) was to provide timely and effective services to support the environmental monitoring and security, as required by the political programs in this field. Monitoring land use is a complex task given the resources involved and the demands coming from different areas: soil, water, agriculture, forests, ecology, energy and utilities, urban development, recreation, transport and communications infrastructure. In this respect, first initiatives aim to create prototype services for monitoring land use,

taking into account the requirements for integrating this type of national services with similar European ones. In order to achieve this goal, the most technically mature resources are used to create basic services and conditions for the development of derived services for monitoring land use, according to the specific requirements identified at different levels.

Fast disaster response – satellite technologies for surface displacement monitoring

http://www.eo4geo.eu/training/fast-disaster-response-satellite-technologies-for-surface-displacement-monitoring/

Croatia was in 2020 hit by two damaging earthquakes. The first one hit the town of Zagreb on March 22nd with a magnitude equal to 5.5, and the second one on December 29th hit the area of Banija (epicenter near town of Petrinja) with the magnitude equal to 6.2. Both earthquakes resulted in severe damages and human losses. Already after the Zagreb earthquake a great need for spatial interpretation of the event and its aftermath has been recognized. Therefore, after the earthquake in Petrinja, a quick reaction of geodetic experts followed, using modern satellite and geoinformation (GI) technologies to provide information on the aftermath of the earthquake.
The workshop provided an overview of the usage of EO, GNSS and GIS technology in case of catastrophic earthquakes and information which can be gained from those technologies to provide information about the behavior and displacements caused by the earthquake and providing support to rescue services and delivering information to the general population.
The workshop includes theory and practice about InSAR and GNSS technology and targets geo-professionals and researchers who are interested in disaster risk reduction and management of catastrophic events.

Landslide affecting Cultural Heritage sites - Roman Thermae of Baia

http://www.eo4geo.eu/training/landslide-affecting-cultural-heritage-sites/

The Baia Archaeological Park is located in Bacoli municipality (Naples), close by the Phlegrean Fields caldera, a unique example of volcanic-related subsidence with unrest cycles characterized by intense ground uplift and down lift.
The site is located exactly along the inner side of the western sector of the volcanic building of Baia. The particular location of the site, along the steep internal slopes of the volcano, required a strong control over the area development with massive terracing works. The instability phenomena seem to be related to the very high acclivity values of the top sector of the slope favoring the activation of modest collapse phenomena as well as by ordinary management and maintenance of the area (e.g. invasive vegetation, absence of drainage systems).
Preliminary InSAR analyses were performed exploiting ERS and COSMO Sky-Med datasets; the first dataset shows ground lowering phenomena, highlighting that subsidence affected the areas close to Phlegrean Fields during that period (1993 – 2003). The deformation rates (5-10 mm/yr) recorded in the investigated time interval are consistent with the general down lift cycle, while time series show some small uplift events. InSAR data processing takes into consideration ERS and COSMO Sky-Med datasets and the most recent SENTINEL-1 data, allowing trainees to assess the instability phenomena evolution of the area in a recent time interval.
The Open Online Course (OOC) leads the student through the case, following a multidisciplinary approach to understand causes and effects of land processes that, over the centuries, shaped this

peculiar human environment, with the aim to plan a proper and sustainable monitoring and conservation plan.

Development of a citizen science project within the MijnTuinlab (MyGardenLab) environment

In Flanders, 9% of the territory is occupied by private gardens (11% by woods, 3% natural reserves). It is clear that private gardens can have an important influence on biodiversity, water management, air quality etc. In relation to these problems, citizens often ask the question “how can I contribute?” to a solution. Private gardens can be part of the answer. With small actions in the garden, people can have an important influence.
However, little is known about those private gardens. Therefore, KU-Leuven together with Kenniscentrum Tuin+ and Natuurpunt created the MijnTuinlab (MyGardenLab) citizen science platform. The main goal of this platform is to increase awareness about gardens and their role in improving our local environment. Data collected from citizens (garden owners) can be combined with other (geospatial) data (Copernicus, INSPIRE...) to study different aspects of the Flanders garden complex. The platform can be used by researchers to launch new projects and as such to build a common knowledge pool on the Flemish garden complex.
In this project work, participants build and execute a MyGardenLab project, from brainstorming on ideas, working out the details, developing the technical implementation over communicating and launching the project to processing the results. The aim is to develop a project where citizen data is combined with EO and INSPIRE data to investigate (a specific aspect of) the influence of private gardens in cities. A different option is to port a project developed for Flanders to another region or country.
Participants learn about the different aspects of citizen science and implement web technologies (e.g. OGC web services/API features), database technology, data integration and EO analysis. They not only cover the technological aspects but also work on the communication towards citizens (e.g. a webinar about the project for citizens) and dissemination of the results.
The different EQF levels cover material for citizens (EQF 2) over implementation (EQF 4) to project development and analyzing results (EQF up to 6).[1]

Data-driven platform for efficient farm management combining EO, IoT and GIS data

http://www.eo4geo.eu/training/data-driven-platform-for-efficient-farm-management-combining-eo-iot-and-gis-data/

This webinar addresses specialists for agricultural management and business planning familiar with the standard planning calculations. The webinar presents and discusses the research approach and preliminary results from the Ekogen project. Recently the FARM MANAGER platform has been largely upgraded with the integration of three type of data to increase the quality of calculations and to support better planning and managing of farms: GIS data (like land cadaster, digital orthophoto, agricultural units), EO data (Copernicus Sentinel), IoT data (on-field sensors).
The webinar presents:

[1] Due to different circumstances (mainly technically) the project work itself was not yet executed. The preparation of the training and project work have been done and it is expected that the project work itself will now take place in Autumn 2022.

- the technological aspect, including main building blocks used for data integration from relatively diverse types of data sources;
- the advantages and new features of business planning and management in farming.

3. Results

3.1. Project Tool implementation

The design of the Training Actions was based on the selected Integrated Application scenarios, using EO4GEO tools, such as the Body of Knowledge (BoK) and the Curriculum Design Tool (CDT), also to practically demonstrate their usefulness and capacity.

Each TA follows a logical schema that, starting from a real use-case, identify its solution's workflow (BPMN). Then the process' components are explained by knowledge concepts (BoK), thus leading trainees to recognize and use well known elements. Particularly this knowledge link is provided by the Curriculum Design Tool, that indicates the logical path to acquire the right skills to execute the task drawn in the scenario.

The Table below indicates, for each Training Action of the Integrated Application sub-sector, the relevant Body of Knowledge (BoK) concepts, the expertise level referred to the EQF system, the ECTS provided (where it is possible) and the Target Group addressed by the Training Action, as stated in the D5.1 "Case-based learning scenarios for three sub-sectors", i.e. Core-, Managerial-, Peripheral- and Complementary-Profiles.

Training Action	BoK Concepts	EQF level	ECTS	Target group
Observing from space. Agriculture and environment	[CF1-1B] What is Geographic Information Science and Technology [IP3-1-2-3] Normalized Difference Vegetation Index (NDVI) [PS1-2] Passive vs. active sensors [TA11-1] Users in managed living resources [TA12-5] EO for sustainable agriculture & food production [TA13-4-1] Monitor crops [IP3-1-1-2]	6	0.5	CorP
The rise of Artificial Intelligence for Earth Observation	[AM8] Geostatistics [CV2] Data considerations [CV6] Usability [CF5] Elements of geographic information [GS3] Use of geospatial information [TA3] Land Monitoring	6		CorP

Training Action	BoK Concepts	EQF level	ECTS	Target group
Optical Earth observation data for landslide risk management	[TA13-3-4] Forecast and assess landslides [PS1-7] Optical spectrometers [PS3-4] Properties of digital imagery [PS3-4-4] Temporal resolution [IP3-13-1] Elements (cues) of interpretation [IP4-3-3] Capability to resolve anything, [IP3-11] Time series analysis [IP3-1-2-3] Normalized Difference Vegetation Index (NDVI) [AM4-4] Neighborhood analysis [AM5-2] Kernels and density estimation, [IP3-4] Image classification [IP3-7] Object-based image analysis (OBIA) [IP4-2] Product quality [TA11-3-4] Users in transport & logistics [AM5-7] Multi-criteria evaluation [AM7] Spatial statistics [AM4-3] Overlay.	4	0.5	ManP
A new Common Agricultural Policy (CAP) based on Copernicus program and EO4GEO tools	[IP] Image processing and analysis [IP3] Normalized Difference Vegetation Index (NDVI) [IP3-11] Time series analysis [CF] Conceptual Foundations [DM1] Foundations for Data Modelling Storage and Exploitation [GS3-4] Use of geospatial information in agricultural issues	3		ManP CorP PerP
Change detection using EO data	[GIST] Geographic Information Science and Technology [IP1] Image pre-processing [GD] Geospatial Data [GD2] Data Collection [GD2-2] Remote sensing [GD11-3] Algorithms and processing Change detection	7	6	PerP
Fast disaster response – satellite technologies for surface displacement monitoring	[DM1] Foundations for Data Modelling Storage and Exploitation [GS3-4] Use of geospatial information in environmental issues [TA12] EO for societal and environmental challenges	6 - 7		
Landslide affecting Cultural Heritage sites - Roman Thermae of Baia	[GIST] Geographic Information Science and Technology [IP1] Image pre-processing [IP1-5] Interferometry [CV] Cartography and Visualization [PS] Platforms, sensors, and digital imagery [PS1-1] History of Remote Sensing Sensors [PS1-3] Active Sensors [PS1-3-4-1] Radar Scatterometers [GD] Geospatial Data [GD2] Data Collection [GD2-2] Remote sensing [GD11] Satellite and shipboard remote sensing [GD11-4] Ground verification and accuracy assessment [GD11-3] Algorithms and processing	7	13	ManP CorP PerP

Training Action	BoK Concepts	EQF level	ECTS	Target group
Development of a citizen science project within the MyGardenLab environment	[AM4] Basic analytical operations [WB1-4] OGC web services [WB5-1] Integrating data from OGC web services [DA3-4] WebGIS, SDI services, map services [GS4] Geospatial citizenship	2 - 6		PerP CorP
Data-driven platform for efficient farm management combining EO, IoT and GIS data	[CF1-1b] What is Geographic Information Science and Technology [GS3-4] Use of geospatial information in environmental issues [TA11-1-1] Users in agriculture [AM7-4] Global measures of spatial association"	5 - 7		CorP

3.2. Learning Objectives of Scenarios

While different case-based learning scenarios require some initial and fundamental knowledge, ensured by the use of proposed Training Material, the Training Actions aim at increasing the development of new skills, as needed by new challenges in the integration of EO*GI data and services.
These new skills have been identified, for each TA, by the following Learning Objectives.

Observing from space. Agriculture and environment

- Discover the value of GIS;
- Appraise the basics of Remote Sensing for agriculture;
- Illustrate the use of satellite imagery to create vegetation indexes;
- Discuss the role of satellite imagery for agriculture monitoring.

The rise of Artificial Intelligence for Earth Observation

- Demonstrate existing EO technologies and data to collect spatial soil, canopy, and crop data Collect Spatial/temporal data.
- Apply satellite-derived and ground-based data into usable viticulture information.
- Analyze relationships from sensors and mapping to the vineyard for practical applications.

Optical Earth observation data for landslide risk management

- Identify different types of optical EO satellite images and related processing methods that are capable of extracting landslide information.
- Find what kind of landslide information the optical satellite images can provide.
- Compare the quality of landslide information to the needs of landslide risk management.
- Discuss the suitability of EO-derived landslide information for landslide documentation.
- Identify the requirements of geohazard zoning in hiking trail management.
- Determine the meaning of landslide susceptibility and its GIS-based statistical modelling methods.
- Compare the quality of landslide susceptibility maps to the needs of hiking trail management.
- Discuss the suitability of landslide susceptibility maps for geohazard zoning.

A new Common Agricultural Policy (CAP) based on Copernicus program and EO4GEO tools

The EU Commission has indeed encouraged Member States for the use of Earth Observation (EO) technologies, especially for monitoring in a continuous way the correct payment of all declared areas for aid. So, the objectives of this TA are:

- to promote the new opportunities offered by the Copernicus Programme in dealing with the Common Agriculture Policy;
- participants will be also addressed on how to use EO*GI in the agricultural domain, exploiting the opportunity to access to free training data.

Change detection using EO data

- To conduct research and development activities for gradually achieving a scientific, technological, and socio-economic state where the necessary information for coverage and land use, as required in the various policies, are constantly updated and accessible.
- To select and develop the most appropriate procedures for the permanent collection and analysis of user requirements in order to facilitate the design, implementation and validation of basic services relevant for monitoring land use.
- To provide the tools and services needed to manage spatial remote sensing data or data collected in the field and ancillary data required to generate information about coverage and land use, as they are required for users who implement policies related to land use monitoring.

Fast disaster response – satellite technologies for surface displacement monitoring

- To get familiar with usage of EO*GI in case of disasters.
- To explain why should professional EO*GI society be fast.
- To identify on which aspects special attention should be paid.

Landslide affecting Cultural Heritage sites - Roman Thermae of Baia

- To spread and encourage the use of satellite radar data for deformation analyses, not only in geological and environmental applications but also in the management and conservation of built heritage in cultural sites.
- To promote a simple and easy-to-use methodology to exploit Persistent Scatterer Interferometry (PSI) data related to the Roman Thermae of Baia.
- To deal with PSI processing in order to perform PS spatial and velocity analysis focused on the detection of historical and recent deformation.

Development of a citizen science project within the MijnTuinlab (MyGardenLab) environment

- Find how Citizens can contribute to the European Green Deal.
- Practically set up a geospatial web server and develop a client linking to it.
- Analyze data available through INSPIRE and Copernicus and evaluate their relevance for a certain use case.
- Translate an environmental problem to a citizen science project.
- Explain the problem in a language understandable for citizens.

Data-driven platform for efficient farm management combining EO, IoT and GIS data

- Explain the background of Farm Manager platform;
- Show the structure and content of Farm Management Planning Calculation Catalogue;
- Show IT architecture of development of server infrastructure and services;
- Identify data types used for increasing the efficiency of business planning (GIS, EO, IoT);
- Identify different economical parameters;
- Find new functionalities of Farm manager;
- Explain what kind of information the open spatial data services can provide;
- Improving the efficiency of farm production.

3.3. Training Actions implementation

Training Actions have strongly benefit from Training Material developed in previous phases of the EO4GEO project (WP4 - Designing GI and EO curricula in support of Copernicus), and by interacting with previous tasks to address the creation of new contents according to skills needed by scenarios. More training resources, from official providers of data, services and education in the EO*GI sector (ESA, Copernicus, EO-College), were used in order to complete the training offer.

Training Actions organizers, belonging to different sectors (e.g. academia, private companies, research institutes), have involved external contributors and experts (from public and private sector) as well as local administrators and stakeholders for the definition of content and training's presentations.

Involved Target Groups are of Core Profiles (CorP, e.g. students, academics, data experts), Managerial Profiles (ManP, e.g. data experts, local managers, decision makers) and Peripheral Profiles (PerP, e.g. city planners, public authorities, managers, decision makers) (see D5.1). All TA were designed with the aim to address a wider range of profiles and target groups, with EQF levels ranging from 2 to 7.

Every TA has been based on real use cases and its execution involves many expertise with different level of competences: according to each Application Domain, topics have been discussed by experts from farming sector or earth scientists, land and urban planning experts, local administrators and civic groups as users of services.

Almost all TA were conducted by one main teacher expert of the subject, belonging to a project partner. Other tutors and application domain experts, even from other administrations or companies, supported the main trainer for particular tasks and to explain specific subtopics. The only exception concerns the OOC, which, due to the wide and multifaceted topic (landslide hazard monitoring on cultural heritage), has been created by the Task leader (ISPRA Geological Survey of Italy) with an important contribution of the local archeological authority (Parco Archeologico dei Campi Flegrei) and the local research institute (INGV-Osservatorio Vesuviano). For this complex TA more training materials were also collected from valuable external resources.

Though initially the Task selected many different TA types (theses, internships, project works, academic courses, workshops, webinars and MOOCs) training in presence became not feasible in the project temporal window due to the pandemic. Thus, trainings requiring physical presence at work, such as theses and internships were excluded; the courses were held online and the workshops were transformed into webinars. Finally, were held 6 webinars, 2 courses (1 academic course and 1 OOC), 1 workshop and 1 project work.

The total amount of ECTS of the sub-sector is 20. It comes mostly from the courses, even because webinars, almost all lasting one hour, are hard to be evaluated in terms of training credits.

4. Discussion

The integration of Training Material, both from the project and from other sources, helped to increase the potential of the Training Actions and to build an updated and dynamic learning environment.

All TA involved more than 550 participants, largely exceeding the initial target. This result seems to be very important, since the terms of participation to events changed completely due to the pandemic and consequent lockdown, in the early stages of the Task.

The Task paid great attention to involve participants by remote interaction (e.g. polls, Q&A sessions and questionnaires), presenting practical examples in a simple way and making training material available to a general public.

Thanks to the adoption of alternative solutions, the target of extending more users' skills rather than the basic transfer of knowledge has been reached. This clearly results from the evaluation questionnaires that for the self-assessment of skill growth item reports values above 85% for all TA.

The change in TA format, from physical to online events, affected the resource allocation in two ways:

- a cost reduction for the organization and logistic with respect to events in presence;
- an effort's increase of organizers for the dissemination, participants registration and implementation of the online platform of the events.

However, the implementation of webinar led to a better dissemination of TA, allowing to easily reach a wider group of interested people. The webinar organization committed more than usual the workshop chairman that, due to the availability of free online platforms, had to manage directly every phase of the event (i.e. dissemination, registration, access management, etc.). On the other hand, the easier management of events has encouraged partners to propose more TA in additional fields, that increased both the quantity and the quality of the project's training offer. Private partners too, beside the academic ones, took benefit of the increased visibility of their expertise.

Despite the increased commitment, all partners ensured a high-quality level both in the content's creation and in the management of TA. Indeed, the online format of TA resulted more friendly for

participants and the open access availability of the Moodle platform for the contents storage and maintenance led to the use of resources from a broader audience than the one initially foreseen.

Conversely, the lack of face-to-face relations between trainees and tutors made very difficult the evaluation of learning. The interaction via Q&A does not seem to have compensated the lack of physical meetings.

The workflow provided for the creation of TA led to a valuable increase of the training's quality, allowing participants to easily discern the application context, the logical workflow (BPMN modeling, Curriculum Design Tool), the tools (BoK), the roles (Occupation Profile Tool) and the expected results in terms of new skills.

5. Conclusions

Results obtained in the Integrated Application sub-sector overcame the expectations, both in terms of quality of the training offer and in number of participants to Training Actions.

All Task partners conducted at least one TA and cooperated to the others by sharing good practices and with practical support. Challenges from the pandemic have been faced and tackled with sense of initiative and cooperation. New opportunities have arisen from the better use of online resources (e.g. with webinars).

The availability of the partners and the coordination of the various TAs allowed to reach a high-quality training offer, as highlighted by the results of the evaluation questionnaires.

For the growth of personal skills, target users of TA seem to prefer short events with low interaction, such as webinar, rather than structured courses requiring stepwise approach and self-assessment tests. This constraint might be reduced, hopefully totally overcome, with face-to-face training sessions, as experienced by summer school events.

The added value of TA of the EO4GEO project is that they take advantage of an "ecosystem" where each actor (teacher, student, manager or stakeholder) can find a reliable and dynamic tool to frame, design and exploit an appropriate learning path to match any request with the right skills.