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

D 5.4 –Smart Cities

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Work package / Task:

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

T5.4 – Smart cities

Short Description:

This deliverable describes the training actions withing the Smart cities subsector. All training actions are built upon the concept of case-based learning.

Keywords:

Case-based learning; Smart cities; Climate adaption; Body of Knowledge (BoK); learning outcome, EO

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
0.1	28/02/2022	Sara Wiman Greger Lindeberg	Draft	Initial version
0.2	22/03/2022	Sara Wiman Greger Lindeberg	Draft	Second version with added content
1.0	11/04/2022	Sara Wiman Greger Lindeberg	Ready for the QA	Complete version
2.0	04/05/2022	Sara Wiman Greger Lindeberg		Final version after comments by QA team

Executive Summary

This report presents the methodology for developing training actions as well as the results and the training actions performed within the Smart cities' subsector. Based on the selection of case-based learning scenarios presented in D5.1, a series of training actions (TA) were conducted during 2021 and 2022. The content and structure of these TA's are described here together with results from the assessment and evaluation.

The TA's have all been produced following a methodology, developed within the EO4GEO project, consisting of a series of steps from case idea to implemented training. These steps include investigation of what knowledge and skills are needed to meet future requirements by stakeholders and community. The results of the process are a series of curricula (WP4) related to business processes and occupational profiles relevant to Copernicus. These curricula were used as a basis for developing case-based scenarios that were tested and assessed in concrete training actions.

For WP5.4 the methodology is as follows:

1. Select relevant cases for teaching topics related to Smart Cities issues
2. Develop Business Process Models (BPMN) of each case to visualize all components involved.
3. Collect data and knowledge to cover the components that form a case
4. Package the relevant components into training material
5. Perform training activities

Some of the main conclusions are that the timing of the training events is important and so is the advertisement to reach the intended audience. The EO4GEO process of building training actions based on real-world cases was successful, although the process could benefit from a more agile workflow, during a shorter timeframe. Also some guidelines concerning the European standards are needed especially for those training providers that are not academic institutes.

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Acronyms

Acronym	Description
ARD	Analysis Ready Data
BoK	Body of Knowledge
BPMN	Business Process Model and Notation
CAMS	Copernicus Atmosphere Monitoring Service
CEMS	Copernicus Emergency Management Service
CLMS	Copernicus Land Monitoring Service
CMEMS	Copernicus Marine Environment Monitoring Service
C3S	Copernicus Climate Change Service
EC	European Commission
EO	Earth Observation (incl. Meteorology)
EO*GI	EO and GI sectors
ESA	European Space Agency
EQF	European Qualifications Framework
ETU	Education and Training Unit
EU	European Union
GI	Geographical Information
GEE	Google Earth Engine
GIS	Geographical Information System
HR	High Resolution EO data
LTB	Living TextBook
TIRS	Thermal Infrared Sensor
VET	Vocational Education and Training
WP	Work Package

Glossary

- **Bloom's Taxonomy** is a classification of thinking or cognitive skills, 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, ranging from lower order to higher order thinking skills
- **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.
- **Competence** means the proven ability to use knowledge, skills as well as personal, social, and methodological abilities in work or study situations and in professional and/or personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.
- The term **Earth Observation (EO)** related services is taken to mean any geo-spatial information service activity which in some way involves data coming from EO satellites (including meteorological satellites). An EO satellite is any satellite with one or more sensors that measure parameters coming from the earth's surface or atmosphere. The involvement may be direct, for example processing or distributing imagery or indirect, for example consultancy based around knowledge of the imagery or its use. It starts from the point where imagery is transmitted to the ground, including reception and processing of imagery but does not include construction of ground stations or the satellites delivering the data. Note that it includes all geo-spatial information services activities where satellite EO data has been used and so extends to downstream information processing of geospatial information where data being used has been derived from EO imagery and imagery combined with other data types.
- **European Qualifications Framework (EQF)** descriptor is defined by 8 levels of descriptors that indicate at each level the learning outcomes relevant to qualifications in any system of qualifications.
- **Geographical Information (GI)** is the data of a geographic location combined with non-spatial information (e.g. statistical data) and their representation as a map.
- **Geographical Information System (GIS)** is a computerized tool designed for storing, analysing and consulting data where geographic location is an important characteristic or critical to the analysis.
- **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** is the process by which an individual assimilates information, ideas and values and thus acquires knowledge, know-how, skills and/or competences. (Source: Cedefop, 2008) Learning occurs through **teaching** (from the perspective of a teacher, facilitator) **/ learning** (from the perspective of learner, trainee) or other activities such as reading, reflecting, practising, networking, discussing, problem solving etc. It may take place in formal (in an organised and structured environment), non-formal (embedded in planned activities not explicitly designated as learning) or informal (resulting from daily activities) settings. (adapted from Cedefop, 2008)

- **Learning outcomes:** Learning outcomes are statements of what a learner knows, understands and is capable of on completion of a learning process. In EO4GEO Learning outcomes described in terms of Knowledge and Skills.

  Outcomes 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)).
- **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 may include 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 BusinessDictionary)

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 disciplines. 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 analyse 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 to demonstrate 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*

Smart Cities is in this context focused on the use of EO and GI data and algorithms to meet the needs of growing cities. There are numerous challenges to be met by planners on regional, and municipal levels, including:

- Urban heat effects. Exploitation and densification of cities change the local climate in cities, which impacts on the health of the population
- Urban and peri-urban green structure. The green areas in cities are providing important ecosystem services to the population. It is especially important to monitor and map these structures to maintain and develop ecosystem services.
- Impervious surfaces. The share of impervious surfaces in the city has a strong impact on the generation of stormwater, especially in situations of extreme precipitation events

The Smart Cities training initiative provide training, materials, and real-world cases for the training of GI-professionals, architects, and planners on different levels. The WP5.4 Smart Cities have been accomplished by a few partners active in this field. The training actions were for the broader Copernicus community. The task consisted of the following activities:

- Identification of the components of interdisciplinary and inter sectorial scenarios (i.e., urban planning, demography, urban ecology, energy supply)
- Based on the methodology established in T5.1, assess the requirements for integrating data and information from various sources (i.e., urban footprint, human settlements, census data, energy statistics) by exploring Copernicus and INSPIRE infrastructure (i.e., Copernicus Land Monitoring Service (CLMS). Urban Atlas, traffic information)

Originally mapping urban sprawl and monitoring city growth, was an objective of the task. This is not included in the deliverables per se, even if the methods presented in the training actions may well be used for this purpose as well. The reason for not including urban sprawl in the training initiatives was a lesser interest from stakeholders, and that this type of analysis can be achieved with the help of the concepts and techniques that we present in our other training actions within Smart cities.

Due to the covid pandemic a slight change in how the training actions were conducted was needed. Instead of live presentation and live workshop for the training action *Smart cities, UHI and urban green* we were forced to execute them online Since many of the training actions in WP 5.4 were planned as webinars at an early stage this didn't affect the planning too much.

The case studies within Smart cities sub sector focus on how efficient planning can make cities more resilient and adaptable to e.g. climate change and extreme weather events. Careful planning and nature-based solutions can help to enhance and reinforce ecosystem services in the city. Together this may shape future cities and make them more attractive and sustainable. The use of GI and EO data are of crucial importance for analysing and assessing many important values in the city. As an example, vegetation indices derived from EO-data can be used to measure and evaluate the amount of green spaces in the city, a key indicator of many ecosystem services.

Urbanization is a prevailing trend, and many cities are expanding rapidly, sometimes at the expense of green spaces, resulting in loss of important ecosystem services. EO and GI data can help to keep track of change in land-cover and land-use, making it easier for planners to make the right decisions. In the training actions we use a variety of data sources and methods to accomplish this by e.g. screening for vulnerable areas, analysing effects on ecosystem services and human well-being, assessing accessibility to green spaces, identifying areas prone to flooding, as well as identifying areas important for interception, infiltration and groundwater recharge. Three scenarios were selected of which all are connected to strengthen urban resilience and sustainability, with an apparent connection to both subsectors Climate change and Integrated applications. These scenarios also illustrate the need of spatial data and analysis in an obvious way.

1.4. Purpose of the document

The purpose of this document is to describe the process of developing the Smart cities´ training activities based on the Business Process models. Another objective is to describe and evaluate the actual training actions that have been conducted within the task.

1.5. Structure of the report

This report is divided in several chapters starting with *Methodology*, describing the workflow for decision on TA's and how they are developed. Following, a chapter on *Results*, describing the structure, design and content as well as learning outcomes of each TA implemented. In the end of the Results chapter are the evaluations of the TA's. Finally, a *Discussion and Conclusions* part, where concluding aspects of the project are elaborated in more detail.

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.

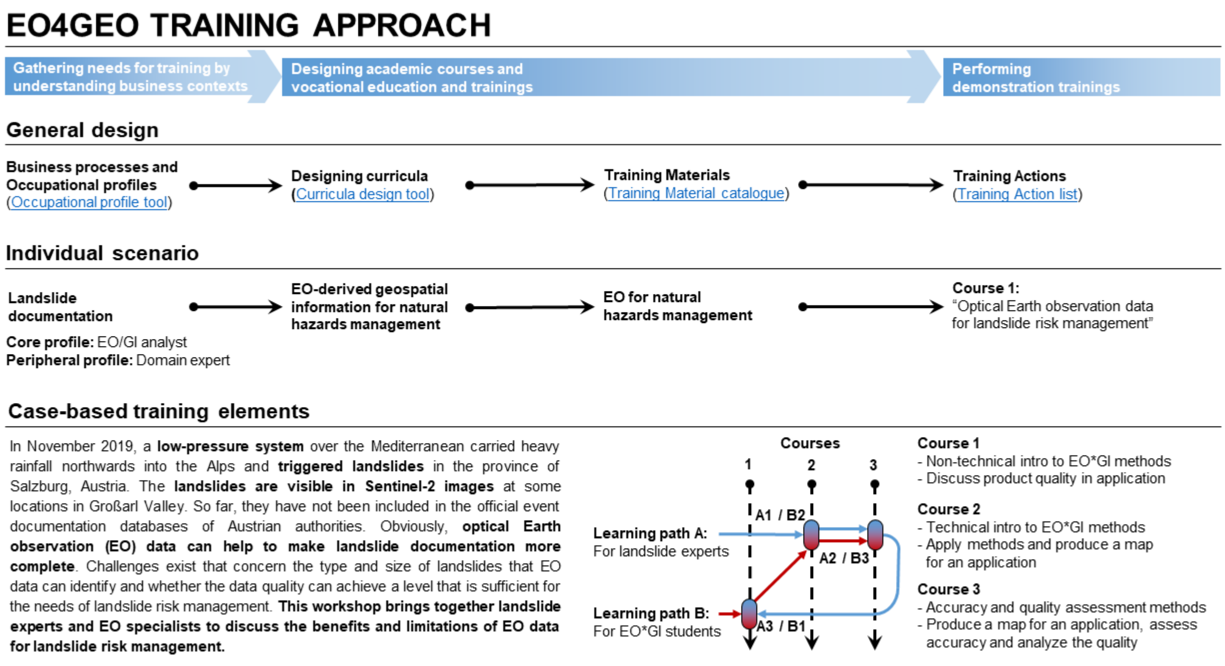

Figure 1 The EO4GEO Training Approach - A skills strategy for the GI and EO sector

A need for training occurs where there is a gap between the demand in certain business processes and their occupational profiles 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. Designs of curricula related to business processes and occupation profiles relevant to Copernicus were created which led to specific training material for the EO/GI sector. The training actions were used to test the material and the development of an integrated platform of collaborative tools and of curricula in support of Copernicus within the EO4GEO training approach.

2.2. Development of the training actions

The development of training actions within the Smart Cities sub-sector started based on the results of the BPMN's, which were developed in T4.3. The BPMN's defined the following:

- Primary user of the product or service produced
- Primary goal of the user (what kind of problem should must be solved)
- Main data sources and providers
- Description of the Business process
- Condition before and after service or product has been used

Using the BPMN's, cases were elaborated in more detail so that the following information could be derived:

- Required data
  - EO data
  - GIS data
  - Ancillary data (e.g., census data, case specific data)
- Required tools or functions
- Suitable study area

For the real-world examples, the interest from certain stakeholders was taken into consideration. To accommodate the specific requirements of each training action was material was compiled from numerous sources, among which includes:

- EO4GEO training material catalogue
- Copernicus land cover services
- Sentinel data hub
- Material produced in-house by EO4GEO partners
- Review of relevant scientific literature

The training material produced for the training actions in Smart cities consists of a theoretical part, and a more 'hands-on' part describing the process of conducting the analysis for each specific case.

2.3. Workflow

The workflow for developing the training actions has followed a common procedure, consisting of:

- Collection of ideas for problem-based cases, answering questions:

- What is the problem?
- What is the strategy for solution?
- What are the objectives of the selected strategy?

• Development of the cases using Business Process Models, BPM visualising processes, data and analyses involved. To be finally selected, a case must:

- Be user driven
- Provide a solution
- Have EO data and methods as an important part of the solution

• Adapting the case for a learning environment involves some balancing between generic and real case.

Examples for a problem-based approach on how to discuss the questions, for two topics, are given below:

1. Urban Heat Islands

What is the problem?

Urban heat is a growing problem in many cities and causes heat stress and discomfort for the urban population, drought and deterioration of ecosystems and increasing energy consumption. Urban heat is driven by a range of factors, e.g. climate, city morphology and texture. Therefore, it is also possible to mitigate heat effects through different measures, for example by increasing the share of green spaces.

What is a strategy for solution?

Through analysis of different datasets, it is important to delineate local hot spots and by this be able to assess where different measures can be most effective. In this specific case we use EO-derived surface temperature maps together with GIS-data in order exemplify how it can be used as a decision basis in planning situations.

What are the objectives of the selected strategy?

Demonstrate how standard EO technologies and data can help the assessment of heat issues in an urban planning context. By demonstrating a real-world case this training action will provide a basic understanding of the urban heat issue and how EO-data can be used in the context of planning.

2. Evaluation and planning of urban green structures – problem-based approach

What is the problem?

Ecosystem services in a city are functions that improves the environment for the inhabitants in numerous ways. These services are provided by the green infrastructure in the city. Different activities in the city's green structure can affect these services positively or negatively. Therefore, there is a need to monitor the urban green structure to assess the potential impact of future actions e.g., densification or different planning strategies.

What is a strategy for solution?

The training action will provide a background on urban ecosystem services. We will demonstrate how EO-derived products can be used to monitor the quality of the urban green structure, and how an assessment of ecosystem services can be done. This will also be done showing a real-world case where green structure and ecosystem services are mapped within a municipal project.

What are the objectives of the selected strategy?

Demonstrate how standard EO technologies and data can help the assessment of urban green structure and ecosystem services. By demonstrating a real-world case this training action will give a basic understanding of ecosystem services and how EO-data can be used in the context of mapping and monitoring these.

3. Results

The main result of this task are the training actions with corresponding training materials. The training material produced within the project is re-useable and could also be used in future EO training activites. For this reason the material can be found at the EO4GEO website (http://www.eo4geo.eu/training-material-catalogue/). In total 4 webinars, 1 workshop and 1 project work were held within the task. Table 1 shows a compilation of the training actions, while Table 2 describe the training material produced within T5.4.

Table 1 Training actions held within Smart cities

Training action	Organizing partner(s)	Abbreviation	Date	No of participants
Webinar: Identification of local heat islands to support city planning	GIB, EPSIT, GISIG	UHI	2021-02-03	82
Webinar: Evaluation and planning of urban green structures	GIB	Urban GI	2021-06-08 2021-09-08	21 14
Webinar: Smart cities, UHI and urban green (preparing for workshop), Swedish	GIB	Smart cities, webinar	2021-10-05	10
Workshop: Smart cities, UHI and urban green (WS with a technical focus and more hands-on work), Swedish	GIB	Smart cities, workshop	2021-10-08	8
Project work: Improving sustainability of cities to storm and water	GIB	Skyfall	Dec 2021 – Feb 2022	1

Table 2 Training material produced within Smart cities

Training material	Organizing partner(s)	Type of content
Identification of local heat islands to support city planning	GIB, EPSIT, SpaSe, GEOF	Presentation material, Reveal JS
Evaluation and planning of urban green structures	GIB, GEOF, UNEP-GRID, EPSIT	Presentation material, PPT
Smart cities, UHI and urban green (preparing for workshop), Swedish	GIB, GEOF, UNEP-GRID, EPSIT	Presentation material, PPT
Smart cities, UHI and urban green (WS with a technical focus and more hands on work), Swedish	GIB	Presentation material (PPT), EO imagery, Raster data, vector data, workshop instructions, data documentation (.docx)
Improving sustainability of cities to storm and water	GIB	EO imagery, Raster data, vector data, Report

3.1. *Structure, Design and Content of Training Actions*

In general, the EO4GEO webinars followed this structure:

1. Introduction of the EO4GEO project: the context, the vision, the mission, the partnership, the project outcomes (this introduction should be the same for all the webinars). Estimated time: 3 minutes. Required training material: max 3 slides.
2. Webinar introduction: Content index. Estimated time: 3 minutes. Required training material: max 3 slides.
3. Training unit(s): Estimated time: 30 minutes. Required training material: max 30 slides, which include a practical case.
4. Sli.do polls. Estimated time: 5 minutes. Required training material: short guidelines on how to design the polls.
5. Q&A session: Estimated time: 15 minutes (including questions).

Except from 3 webinars also a workshop and a project work were provided within the Smart Cities sub-sector. To present this in a readable and comparable way they are all summarized in Table 3 according to structure of each TA, the design and content included in the presentation, workshop, or project work. There is also a list of BoK concepts valid for each TA.

Table 3 Compilation of TA's within WP5.4 according to structure, design and content and links to relevant BoK concepts for each TA.

Training actions		
UHI	Structure	Divided into 6 major parts: Introduction of the EO4GEO project, the concept of Urban heat islands, background on satellite sensor spectral information, background on vegetation indices and thermal infrared sensors, practical examples of using thermal infrared sensor data for UHI mapping,
	Design and content	Presentation of Thermal infrared time series, calibrated to surface temperatures, e.g. 5-year maximum summer temperature. Discuss how different urban planning principles can affect microclimate, and how green structure and water surfaces have a cooling effect. Discuss how nature-based solutions in planning can have a positive impact on the microclimate. Content was also compiled from the following EO4GEO lectures; 1. Urban Heat Islands – Basic GIS knowledge, vector and raster data (University of Zagreb). 2. Urban Heat Islands – Understanding the concept of EO time series (University of Zagreb)
	BoK concepts	[PS2-2-2-3-2-4-8] Landsat-8, [PS2-2-2-3-2-4-20] Sentinel-3, [PP1-6-5] Thermal infrared radiation transfer in the atmosphere, [IP3-11] Time

		series analysis,
Urban GI	Structure	Divided into 5 main parts: Introduction of the EO4GEO project, background, description of concepts, case examples, polls and ending discussion with Q/A
	Design and content	Presentation of PowerPoint slides in online Teams meeting. Interaction with participants via polls during the presentation. Ending discussion and Q/A. Topics: - Introduction of EO4GEO - Concepts of green infrastructure and ecosystem services - Ecosystem services from urban trees - EO data and methodology supporting green infrastructure - Case – planning challenges - Case presentation
	BoK concepts	PS3-4] Properties of digital imagery, [PS2-2-2-3-2-4-19] Sentinel-2, [CF4-4b] Categories, [CV2] Data considerations, [CV3] Design principles, [CV6] Usability,
Smart cities, webinar	Structure	Divided into 5 main parts: Introduction of the EO4GEO project, background and description of concepts, case presentation, ending Q/A
	Design and content	Presentation of PowerPoint slides in online Teams meeting. Participants have the possibility to interact during the presentation. Ending discussion and Q/A. Content: - EO-derived data and satellite sensors – background - Urban Heat Islands – temperature from satellite - Urban green infrastructure and ecosystem services
	BoK concepts	[PS3-4] Properties of digital imagery, [PS2-2-2-3-2-4-19] Sentinel-2, [CF4-4b] Categories, [CV2] Data considerations, [CV3] Design principles, [CV6] Usability,
Smart cities, workshop	Structure	Case and task presentation, data download, hands-on work on own computer.
	Design and content	The workshop was held online. Sample data and instruction was provided to the participants in advance. A more detailed plan can be found in Appendix 1. - Introduction: ecosystem services provided by urban greenery and trees - Compute EST values - Access to green areas (population, statistics) - Presentation of remote sensing derived land cover maps - Access maps - Green infrastructure, creating habitat network for forest birds - Perform analysis for a specific specie - How to introduce green areas and trees at early stages of the planning process - Prepare maps and report

		according to the above subjects, for a specific plan
	BoK concepts	[PS3-4] Properties of digital imagery, [PS2-2-2-3-2-4-19] Sentinel-2, [IP1] Image pre-processing, [IP3-1] Band maths, [CF4-4b] Categories, [CV2] Data considerations, [CV3] Design principles, [CV6] Usability,
Skyfall	Structure	This TA is divided into three main parts. The first is doing a literature review on historical cloudbursts in the region of interest. Second part covers data review, data ingestion and preparation of EO and GIS data. Third section consist of the real-world case complemented with an analysis section
	Design and content	The project is designed to describe in text and maps how EO and Copernicus data can be used to model urban hydrology, with special focus on flooding caused by cloudbursts. By visualization of land-use change and calculation of runoff in two real-world cases, changes in the basis for the hydrological models are described. Together with the literature on cloudburst rainfall, discussion and results shows the value of high-quality satellite derivatives to monitor and calculate changing urban hydrology.
	BoK concepts	[PS3-4] Properties of digital imagery, [PS2-2-2-3-2-4-19] Sentinel-2, [CF4-4b] Categories, [CV2] Data considerations, [CV3] Design principles, [CV6] Usability

3.2. Learning Outcomes

Training action	**Learning outcomes**
UHI	Understand the importance of identifying UHIs in a spatial planning context. Understand how EO surface temperature time series can support identification of UHIs. Understand how to EO surface temperature time series can be interpreted to identify UHIs. Understand how to derive maps from EO surface temperature data, to be integrated with other relevant information related to UHI identification in a spatial planning context. Understand how information derived from EO surface temperature data can be integrated with other relevant information related to UHI identification in a spatial planning context. Understand the limitations of the EO surface temperature data due to the spatial resolution.

Urban GI	Understanding about different data sources and analyses available for in spatial planning context. Understand the importance of the resolution of the data. Understand the limitations of the “green values” data Applying the knowledge of how the data can be useful in a planning context. Understand how to acquire data on urban greenery using remote sensing methods. Understand how the data acquired can be used to improve urban greenery management, especially in the context of climate change adaption. Understand how EO-data in combination with other remote sensing data can contribute to the assessment of ecosystem services.
Smart cities, webinar	Introduction to workshop. Corresponding learning outcome as former webinars on UHI and Urban GI.
Smart cities, workshop	Applying search for data sources - where to find relevant geodata, and how to access it Applying data pre-processing - how to pre-process data to use it for further analysis (includes transformations, reformatting, and harmonisation) Analyse data using remote sensing methods. Understand how the data acquired can be used to improve urban greenery management, especially in the context of climate change adaption. Understand how EO-data in combination with other remote sensing data can contribute to the assessment of ecosystem services, values, overlay analysis, buffer analysis, vegetation indexes etc. Illustrate and visualize data and analysis results in a pedagogic manner Creating a report - technical and non-technical, communicating results to e.g. city planners or managers
Skyfall	Select geodata to screen urban areas for the sensitivity to heavy rainfall events Application of data management - how to handle large amounts of geodata effectively Applying search for data sources - where to find relevant geodata, and how to access it Application of data pre-processing - how to pre-process data to use it for further analysis (includes transformations, reformatting, and harmonisation) Analysis - using software for e.g. delineating catchments, rainfall analysis and delineated catchment areas Applying data visualisation - visualise data and analysis results in a pedagogic manner Creating a report - technical and non-technical, communicating results to e.g. city planners or managers

3.3. Evaluation of training actions

The TA:s within Smart cities were followed by questionnaires for the evaluation. These were elaborated within WP 5.6 and distributed to all participants. Roughly 20% of the participants answered the questionnaires in total.

3.3.1. UHI

The questionnaires contained both qualitative (free text) and quantitative questions. Figure 2 shows the results from the quantitative questions which were graded from 1-5 (very poor to very good) as mean values. Overall, the results are above average and only two questions out of 15 had an average score below 4. Highest scores were related to the organisation of the webinar, and lowest scores related to the content. Below are a few of the free text quotes from the question "What did you most like about the training?".

- "The case-based learning method"
- "The quality of theory and case study"
- "Presentation covered the most important topics, was clear"

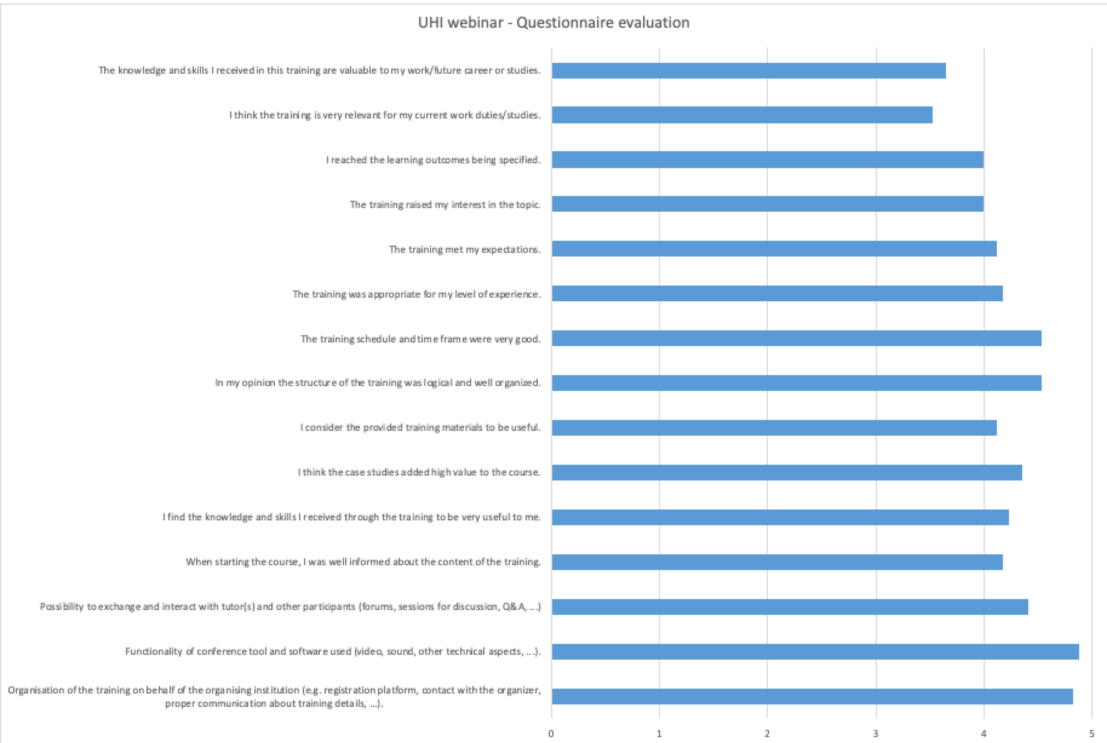

Figure 2 Result from UHI webinar questionnaire

3.3.2. Urban GI

Figure 3 is showing the quantitative results from the GI webinar. Questions are a little bit different from the UHI webinar, but essentially similar. Scores are also here above average, with highest scores (c. 4.5) related to questions regarding the organisation of the webinar. Lowest scores (c. 3.7) were related to questions about time, software, and services needed to complete the tasks. A few free text quotes from the question; “What is your motivation to take part in this training?”

- “The topic seemed interesting”
- “An interest in working more with satellite data”
- “EO4GEO partner, interested in urban greenery”
- “Increased knowledge, updated information”

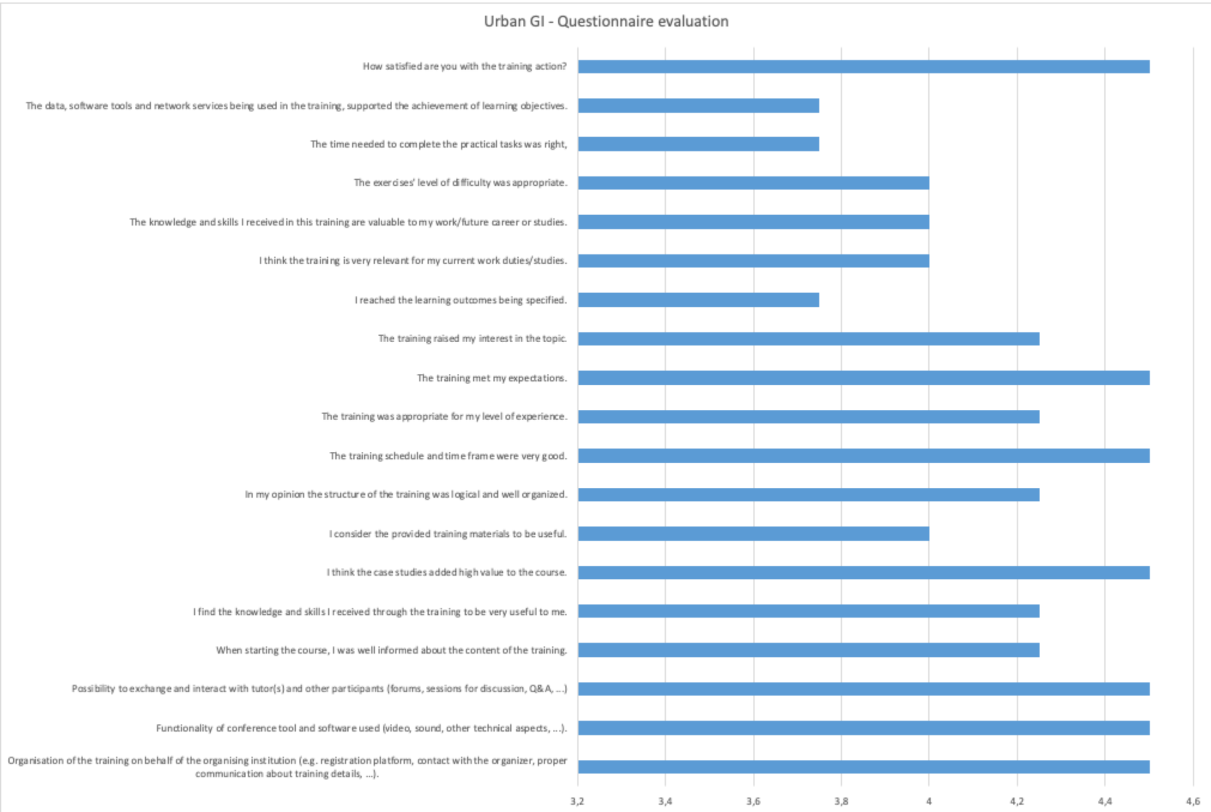

Figure 3 Result from the Urban GI webinar questionnaire

3.3.3. Smart cities

In Figure 4 the combined results from the webinar and workshop are shown. Results are overall a little bit lower than the other TA:s. The only question below average (c 2.7) is related to time needed to complete the tasks. On the other hand highest scores are related to content and value of the TA. Below are a few reactions on the question “What can be improved regarding structure, format and material?”.

- Nothing specific that I can think of, maybe images that are easier to understand and follow.
- Maybe a little more focus on a single topic. Everything was interesting, but I did get a little short on time
- Having a list of tasks or expected objectives to follow during the allocated practical time of the workshop.
- The practical process of performing the urban heat mapping could have been more elaborated (Translated from Swedish)

Figure 4 Result from the Smart cities webinar and workshop

3.3.4. Skyfall

The project work was evaluated by the student. A written evaluation can be found I Appendix 1.

3.3.5. European Credit system

The credit system used within EO4GEO, for calculation of reached knowledge, is the European Credit System (ECTS). 60 ECTS corresponds to one year of study).

The number of credits reached within the Smart Cities work package is estimated to 32,85 ECTS for all participants together, with the first webinar and the project work Skyfall both reaching a bit more than 12 ECTS each. The first webinar had many participants during a short time (webinar) while the project work involved one student for a longer time.

4. Discussion and Conclusions

The number of participants varied markedly in the Smart cities training actions. There are various reasons for this. The first webinar addressing Urban heat Islands attracted more participants than the following training actions. The tutors believe that the main reasons are as follows.

- It was a joint action between two partners, GIB and EPSIT. Both partners promoted the training action in their respective networks
- The subjects Urban heat and climate adaption are prioritized on the agenda of many cities all over Europe, and thus there is a need for information on possible solutions
- It was the first training action within the EO4GEO project and therefore stakeholders following the project may have been more inclined to participate
- The webinar was promoted approximately 2 months in advance

Main reasons for the relative moderate response on the following webinars

- The webinars were promoted by only one partner, GIB, whose network consists mostly of Swedes.
- The time for the next webinar was at the beginning of June, which clashed with other events such as the last week before the summer holidays, school graduations etc.
- The supply of webinars has increased during the pandemic. There have been many opportunities to listen to presentations on green infrastructure

We summarize our experience from the different training actions in this list, which can be considered to cover most of our thoughts:

- EO4GEO generic training material is very good but additional case-oriented material must be produced to tie the presentation together

- If the goal is to reach a large audience, the timing of events is important, so that it is not conflicting with for example public holidays or coincides with other similar events
- The events should be timely and concise! Less is more (and can sometimes stimulate interaction/questions)
- Divide the webinar into smaller sections and use short breaks
- Polls can be used to get to know the audience
- Use of English language is obviously slowing us down
- Preparation is important (e.g., Technique, Polls etc)
- Learning from the participants/audience is important – feedback during the TA may be more important
- Hard to get a relevant discussion or interaction with the participants in large groups (>10 people)
- Finding ways to stimulate interaction during webinars

We believe that the content and structure of the training actions are relevant to the objectives stated in chapter 1. They are still valid and can be used as a basis for future training actions within this field, perhaps with some local examples added for the learners to recognise.

When it comes to the evaluation of the training actions some very broad conclusions can be made. It seems that most respondents are quite satisfied with the organisation and the technical features of the webinars. In the UHI webinar, lowest scores are recognised in questions regarding the relevance of the subject, in relation to the work/studies of the respondent. This may be interpreted that the webinar did not attract the right target group. Or alternatively that the approach is novel and considered untested in the line of work of the participants. The evaluation of combined webinar and workshop TA, Smart cities, reveals that the time to complete the tasks was an issue. This tells us that online workshops may require more time than live workshops where it is easier to reach out to the tutor for help. Also, the teacher can swich faster between participants. We used separate digital “breakout rooms” when helping workshop participants, which worked quite well, but more time for each participant may have been needed. Overall, the total average of all questions in the Smart cities combined webinar and workshop was 3.8, a little lower than the two preceding webinars (c. 4.2). This may indicate that more effort must be put into TA:s with workshop character, since these places higher demands on both student skills and available time for support by the tutor. Originally, the workshop was planned as a live event, but the conversion to online event would demand more time to execute the training action properly.

It is also obvious that the variation of computer and GIS skills among the students is a challenge when conducting a workshop. Students with poorly developed skills may impede the learning process and the transferring of skills. This may indicate that a skill test or questionnaire would be suitable to help putting together homogenous student groups. Otherwise, the workshop form is effective for transferring technical skills both from the tutor to the student and between students. It is our belief that it is important for students to work practically with data and analyses to increase motivation and develop skills. Therefore, it may be important for the future to develop training actions with a significant share of exercises including problem-solving and “hands on” work for the students.

The main conclusions of this task may be summarised as follows

- The EO4GEO method of developing training actions consists of the sequence “specifying business processes – specifying curricula – develop learning material – develop training action”. The method worked well, and it is the impression of the tutors that the method is effective and efficient even if it is a bit static in its nature. A way to overcome this is to shorten the development time, and perhaps adopt a more agile workflow.

- There is a large variation in the number of participants attending the training actions. It seems that webinar was the most popular format, perhaps due to the simplicity to attend. Other important factors having an impact on the number of participants are the advertisements carried out and the timing of the event.

- The project has an ambition to promote the usage of European training standards, such as ECTS/ECVET, EQF and EQAVET. Since most training providers preparing the training events do not have training provision as their main business, the knowledge about these European training standards have been limited. The credit systems (ECTS/ECVET) are occasional used as well as the system for education levels (EQF) and standards for specifying learning outcomes. The Quality Assurance procedures at the course level, described in EQAVET, are however incorporated in the standardised course evaluation forms, being used in all training actions. The conclusion is therefore that the usage of these European standards must be embedded in general guidelines, especially if less experienced training providers are involved.

5. Appendix 1 Quality assessment Skyfall

5.1. Project summary

The project is one of the deliverables withing the sub-sector smart cities, within WP5. Presented here are practical examples of using remote sensing and CLCR data for urban hydrological modelling. Cases and problems presented here are typical to a developing city, increasing densification induce a stress on the urban hydrology, sometimes with flooding of specific areas. The report also shows that with the right data and models, we can also predict or estimate the impact of cloudbursts or intense rainfall. From this study, it can also be concluded that it would be a great advantage to produce landcover products specifically for hydrological modelling. Available products have a wider scope and must be adapted to serve this specific use.

5.2. Problem-based approach

We have adopted a problem-based approach for the project based upon the following questions;

What is the problem?
What is a strategy for solution?
What are the objectives of the selected strategy?

5.3. Learning process

The following chapter describes the learning process from the students' perspective

5.3.1. Learning objectives

- Conduct a literature review on cloudbursts, and statistical measures on these events
- Applying EO and geodata for screening urban areas and the sensitivity to heavy rainfall events / flash floods.
- Using different tools to process and analyse large amounts of geodata effectively.
- Visualisation and communication of results.

5.3.2. Description of learning process

When it comes to the use of geodata, I learned how to apply geodata from Copernicus Land Monitoring Service to land cover change analysis by using the Urban Atlas portal to identify reasonably large and new exploited areas from the past fifteen years.

In terms of literature study, I developed my skills in finding relevant literature for the report, particularly literature referent to typical precipitation values and return time of cloudburst events, preventive measures that can be taken to mitigate damages to infrastructure, and the high reparation costs of cloudburst damage

Working on this report was also a way to apply my previous knowledge of remote sensing, by means of interpreting data collected by other entities (particularly satellite data) and cross-analyse them to better understand the reality.

I deepened my knowledge of hydrological processes, which was more limited prior to this report. In particular the relation between precipitation and runoff, and how that relation (coefficient) depends on the type of land cover.

This report also made me think of the best way to visualise the data, as how it is visualised depends on the context of the study and its objectives. It is important that all the necessary information is conveyed in a clear and simple visual manner, so that the reader easily understands the results.

5.3.3. Learning outcomes

The EO and geodata used for screening urban areas and their sensitivity to cloudburst events was sufficient for the stipulated analysis. This data will be useful for other projects in the future, as the data is of easy access and in most cases free.

The different tools used to process and analyse the data (ex: GIS, Urban Atlas) proved to be efficient and I even learned how to use new tools for geographical analysis.

In terms of visualisation and communication of results, they turned out better than what was envisioned, given the limitations of the data.

5.3.4. Lessons learned

Regarding other approaches to the project, one possibility would be to include more study areas (possibly from different cities), especially areas next to or near meteorological stations or data collection points of pluvial data. This would allow for a more comprehensive comparison and analysis of cloudburst events if time availability allows it. Another more comprehensive approach would be to create a higher resolution land cover dataset for the study areas at the start of the study period. Due to the lower resolution of the earlier land cover dataset used in this report, one could reclassify the older dataset with the newer dataset classes using spectral data from the start of the study period. This approach would depend on time availability, as it is a time-consuming process and requires a lot of processing capacity.