D4.2 ONLINE CATALOGUE COLLECTING ALL TRAINING MATERIALS DEVELOPED IN THE PROEJCT

Document Author(s)	Mariana Belgiu, Yolla Al Asmar, Raian Maretto Vargas (Twente University)
Document Contributor(s)	Panagiotis Partsinevelos, Christina Brempou, Georgia Skiniti, Stavroula Panagiotidou (Technical University of Crete), Heidi Thiemann (Space Skills Alliance)

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Abstract

Task 4200 focuses on the revision, development, and quality assurance of training materials addressing skills shortages in Earth Observation (EO) and GNSS-related domains. The task covers the development of Massive Open Online Courses (MOOCs) and a dedicated webinar series aligned with the needs of the European downstream space sector. A structured methodology was applied to identify skills gaps through the analysis of industry surveys, the ASTRAIOS Knowledge Catalogue, scientific publication trends, and existing European Space Agency training offerings. This multi-source analysis highlighted several underrepresented but high-demand knowledge domains, including geospatial data analytics, machine learning, agricultural applications, land and climate monitoring, and GNSS-based technologies. Based on these findings, Task 4200 delivered a portfolio of training resources consisting of one comprehensive MOOC on Earth Observation and Machine Learning for Agricultural Applications, multiple MOOCs addressing GNSS-related topics, and a series of expert-led webinars covering interdisciplinary downstream applications. The training materials were designed in alignment with the ASTRAIOS pedagogical framework and mapped to European Qualification Framework (EQF) levels 6 and 7. A structured internal quality assessment was conducted, with consortium members acting as course participants to evaluate the content against predefined criteria covering content quality, learning outcomes, pedagogical coherence, and presentation standards. The assessment confirmed the robustness and readiness of the materials and informed targeted refinements. Overall, Task 4200 contributes to ASTRAIOS objectives by delivering high-quality, modular, and policy-aligned educational resources that support capacity building in the European EO and GNSS downstream sectors.

Keywords: MOOCs, webinars, training, GNSS, Earth Observation, Artificial Intelligence, agriculture

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1 INTRODUCTION

1.1 ASTRAIOS Project overview

The **ASTRAIOS project** aims to strengthen the European space ecosystem by bridging the gap between education, research, and industry. It focuses on aligning space-related training and educational initiatives with the current and emerging needs of the labor market.

Through collaboration among academic institutions, industry stakeholders, and European space agencies, ASTRAIOS seeks to enhance the availability, accessibility, and relevance of training materials that equip learners with the skills required for the rapidly evolving downstream space segment. The project supports the European Union's vision for a competitive, innovative, and sustainable space economy by fostering capacity building and skills development aligned with programs such as **Copernicus** and **Galileo**.

1.2 Objective of Task 4200

Task 4200-Educational Material for EO and PNT related Jobs focuses on the improvement of existing training resources and the development of new educational materials for users in the EO/Copernicus and Galileo downstream sectors.

The overarching objective of this task is to address the existing mismatch between the supply of educational and training courses and the demand for skilled professionals in the European space domain. The task aims to deliver high-quality, accessible, and modular learning resources — including Massive Open Online Courses (MOOCs) and webinars — that respond directly to the skills gaps identified within the sector.

1.3 Purpose of the document

The purpose of this document is to present the methodology, structure, and content developed under Task 4200 of the ASTRAIOS project. It outlines the approach used for identifying skills gaps, the design and implementation of training materials (with a focus on MOOCs and webinars), and the alignment of these resources with the European Qualification Framework (EQF).

Furthermore, the document provides an overview of the thematic coverage, learning outcomes, and pedagogical design of each MOOC, including those related to Earth Observation and Machine Learning for Agricultural Applications and GNSS-based technologies. It also describes the hosting platform, licensing terms, and assessment strategies applied to ensure the quality and sustainability of the educational content.

1.4 Structure of the report

This report is organized into the following main sections:

- Section 1 – Introduction: Presents the background of the ASTRAIOS project, the objectives of Task 4200, and the purpose and structure of this document.

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- Section 2 – Methodology: Describes the approach for developing the training materials, including the identification of skills gaps, content creation process, and pedagogical framework for MOOCs and webinars.
- Section 3 – MOOC on Earth Observation and Machine Learning for Agricultural Applications: Provides a detailed overview of the course design, syllabus, and learning objectives.
- Section 4 – MOOCs Related to GNSS: Outlines the content, structure, and objectives of the MOOCs developed for GNSS topics.
- Section 5 – Webinars: Summarizes the topics, presenters, and hosting approach for the webinar series.
- Section 6 – Discussion and Conclusions: Presents key findings, lessons learned, and recommendations for future educational initiatives under ASTRAIOS.
- Appendix 1 – Feedback Forms: Includes participant feedback forms used for evaluating the MOOCs and webinars.

2 METHODOLOGY

2.1 General overview of the training content

2.1.1 Skill gaps overview

The identification of skills gaps has been based on a multi-source analytical approach that combines data from online survey, industry surveys, knowledge catalogues, scientific trends, and educational resources:

i. Design and publish an online survey to identify future skills gaps related to EO and PNT
ii. Review of existing surveys: we have examined the key sectoral studies such as the EARSC Industry Survey (Europe) and the Space Sector Skills Survey 2023 (UK) to identify critical and emerging skills currently in demand within the space and Earth observation sectors.
iii. Evaluation of underrepresented knowledge areas: we have analyzed the ASTRAIOS Catalogue to detect knowledge domains and competencies that are underrepresented or insufficiently covered.
iv. Analysis of application trends: we have reviewed publications from scientific repositories to identify rapidly growing application areas and the corresponding skill sets needed to support these technological and research developments.
v. Assessment of ESA MOOCs: we have examined the ESA's Massive Open Online Courses (MOOCs) related to Copernicus Thematic Areas to assess how well current training offerings align with industry needs and where additional capacity-building may be required.

2.1.2 Online Survey Skill gaps

To identify skill gaps, a short online survey was prepared to collect information and expand the geographic coverage and diversity of responses. The survey maintained participant anonymity, collecting no personal data. It consisted of seven questions: the first three gathered demographic information (country, background, and gender); two focused on the skills and knowledge necessary for effectively using Earth Observation (EO) and PNT data and services (GNSS) to address global challenges ; one addressed application domains that could make greater use of EO and PNT; and the final question explored skills gaps and future needs in the downstream sector.

The survey was built and later distributed on the EUSurvey. The EUSurvey is a web application created and managed by the Directorate-General for Informatics of the European Commission, herein after known as "DIGIT" (https://ec.europa.eu/eusurvey/home/tos). The complete survey, including all sets of questions and answers, can be found in Appendix B. The survey was shared on the ASTRAIOS Social Media channels and distributed at the 2024 IEEE International Geoscience and Remote Sensing Symposium, held from July 7 to 12, 2024, in Athens, Greece.

Eleven responses were received, with three excluded as they fell outside the study area. The analysis is therefore based on eight valid responses, mostly male, from Europe, primarily the Netherlands,

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with one from the United Kingdom. Respondents reported backgrounds mainly in EO, remote

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sensing, SAR/radar technologies, data science, machine learning, forestry, and space-related fields. Key skills for effective use of EO data included mainly remote sensing, programming, data analysis, physics and mathematics, image analysis, SAR, GIS, and communication as a soft skill. Responses related to PNT/GNSS were more limited or uncertain, indicating a need to strengthen skills in programming, GIS, EO, and communication. Application domains expected to benefit most from EO and PNT data include environmental studies, agriculture and forestry, and urban planning, with fewer mentions of policy making, emergency response, finance, and glaciology. Across responses, commonly identified skills gaps and future priorities in the downstream sector included advanced coding and geo-data engineering, experiment design and validation, deeper conceptual understanding, and strong communication skills.

Despite the limited responses, the survey provides a general indication of skill needs and gaps in the EO and PNT downstream sector. Strong technical skills and communication are essential, while gaps remain in key technical and domain-specific competencies related to EO and PNT applications, which mostly were covered in both the webinars series and the developed MOOCs,

2.1.3 Skill gaps related to Earth Observation

Review of existing skills and industry surveys: a foundational step in selecting topics was to review existing surveys that summarise current skills demand and trends within the Earth observation and space sectors. To ensure that the ASTRAIOS training materials respond to real and documented labour-market needs, a comprehensive review of key European and international skills surveys, sectoral reports, and training catalogues was conducted. The consulted sources include:

- Space Sector Skills Survey 2023 (UK)
- EO4GEO Skills and Education Strategy (Europe)
- EARSC Industry Survey (Europe)
- AGI Skills Report 2023 (UK)
- Demand for Geospatial Skills – Job Advert Analysis (UK)
- Space/Geoinformation Sector Skills Strategy Report (Europe)
- giCASES Project Outputs on Geospatial Competences (Europe)
- Space Training Catalogue (UK/Europe)

Together, these reports provide a comprehensive overview of current skills gaps, future skills demand, and training provision across the space and geospatial downstream sectors.

Key Findings from the Consulted Surveys and Reports: The Space Sector Skills Survey 2023 (UK) identifies Artificial Intelligence (AI) and Machine Learning (ML) as the most critical skills gap across the sector. AI/ML skills are reported as lacking by 41% of the current workforce, 52% of job applicants, and are expected to be required by 70% of the future workforce. Closely related skills such as data analysis and modelling and data processing and manipulation also rank consistently among the most significant gaps and future needs. The AGI Skills Report 2023 (UK) confirms this trend, showing that the highest demand in the geospatial sector is for core data skills, including data analysis, processing,

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visualisation, and manipulation, while less data-centric skills (e.g. ethics or people management) are in comparatively lower demand.

At the European level, the EARSC Industry Survey reports that 77% of companies face difficulties in recruiting skilled staff, particularly due to shortages in EO-specific expertise, programming and development, analytical methods, data management, visualisation and cartography, and the integration of space-based and ground-based data. Companies also cite limited EO training availability in some countries and a lack of experienced professionals.

The Space/Geoinformation Sector Skills Strategy Report (Europe) further highlights demand for skills in EO*GI data handling, analytical methods, programming, extraction and transformation of geospatial data, interpretation and quality assessment of EO data, and advanced visualisation techniques. The report also stresses growing needs in data science, computer science, AI and machine learning, and the use of UAVs and advanced visualisation for decision-making.

Insights from EO4GEO emphasise that, alongside technical expertise, transversal and soft skills are essential to address future societal challenges. The report underlines the importance of data-centred curricula covering the full data lifecycle, as well as multidisciplinary and socio-cultural competences.

Findings from giCASES demonstrate that higher-education institutions are expected to deliver a broad competence mix, including cartography and visualisation, spatial data analysis and modelling, programming and application development, thematic domain knowledge, academic skills, workplace competences, and non-technical aspects such as legal, economic, and organisational knowledge.

An analysis of job advertisements and demand for geospatial skills (UK) confirms the need for hybrid professional profiles combining EO, GIS, and data analytics with programming and software skills. High demand is observed for GIS, remote sensing, mapping, land surveying, as well as tools and skills such as Python, SQL, software development, data management, and visualisation.

Finally, the Space Training Catalogue (UK/Europe) was reviewed to assess existing training provision. While it shows a wide range of available courses, gaps remain in integrated, application-driven training that combines EO, AI, and sector-specific use cases, particularly in agriculture, climate monitoring, and downstream services.

Implications for ASTRAIOS raining Design: These surveys consistently emphasize the growing importance of data science and AI in conjunction with remote sensing, and highlight the demand for professionals capable of applying these competencies to solve real-world problems, including those in agriculture and land monitoring. This demand highlights the importance of prioritising learning content that integrates EO and machine learning skills with application-oriented problem solving.

Evaluation of underrepresented knowledge areas in the ASTRAIOS Catalogue: in parallel to external skills surveys, an internal review of the ASTRAIOS Knowledge Catalogue was conducted to identify

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gaps and underrepresented areas. The goal was to ensure that training content fills gaps rather than

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duplicating existing material. The top 15 knowledge domains represented in the courses available in the ASTRAIOS web catalogue are represented in Figures 1 andFigure 1 Figure 2.

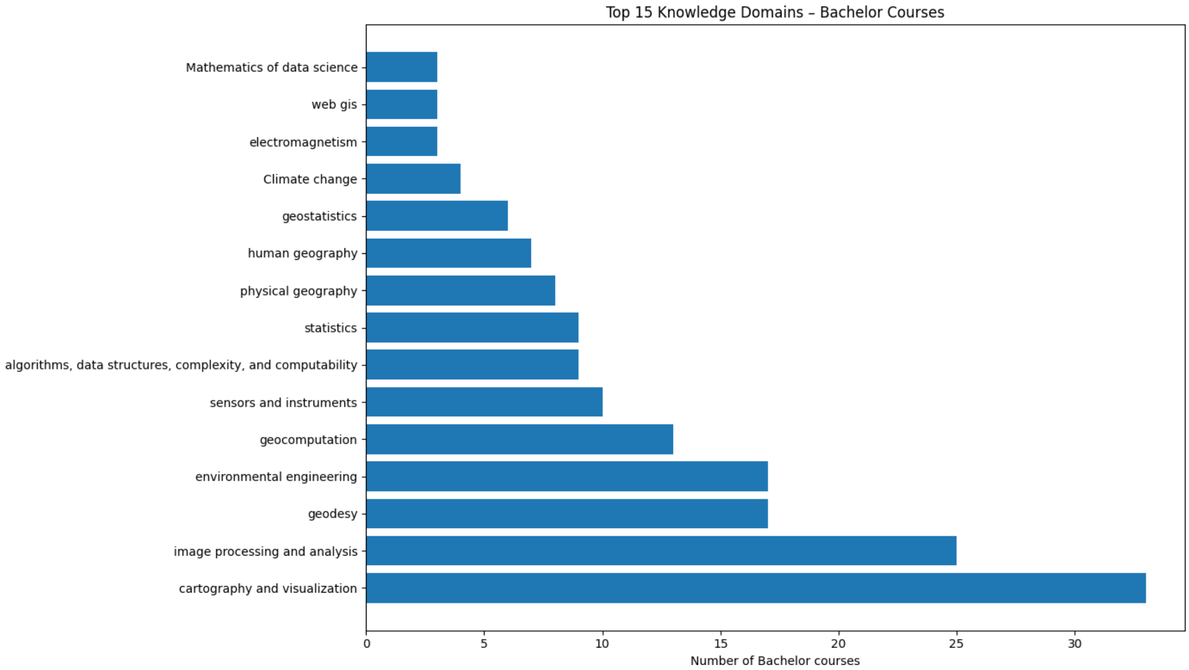

Figure 1: Top knowledge domains covered by the bachelor courses available in the ASTRAIOS database

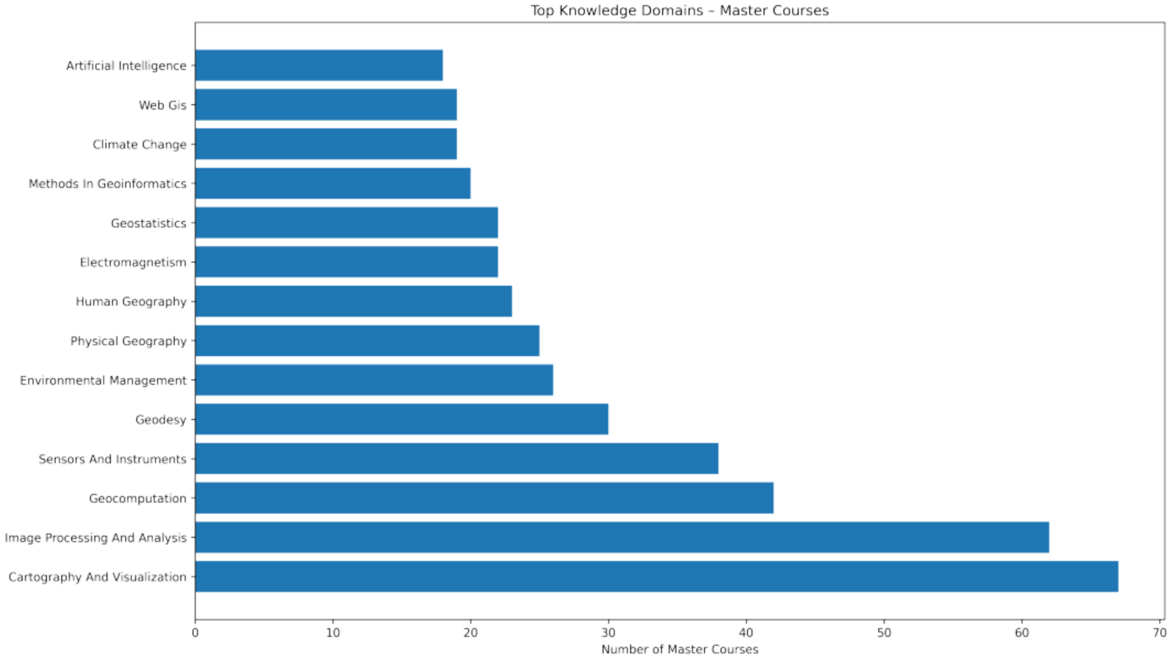

Figure 2: Top knowledge domains covered by the MSc courses available in the ASTRAIOS database.

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Based on this analysis, we realized that domain domains including: Image Processing And Analysis, Geocomputation, Land Monitoring, Environmental Engineering, Disaster Management, Metrology And Calibration, Physical Geography, Satellite Navigation And Positioning (GPS, Galileo, GLONASS, BEIDO), Artificial Intelligence, Agriculture Monitoring, Climate Change, Atmospheric Monitoring, Human Geography, Electromagnetism.

Artificial Intelligence (AI) was included as a key knowledge domain due to its growing strategic importance within Earth observation, geospatial analysis, and environmental monitoring. AI techniques—such as machine learning, deep learning, and automated pattern recognition—are increasingly essential for processing large volumes of satellite, sensor, and geospatial data, enabling more accurate, timely, and scalable analysis across domains such as land monitoring, climate change assessment, disaster management, and environmental engineering. In addition, the EU's RAISE initiative (the Resource for Artificial Intelligence Science in Europe) highlights the strategic importance of AI in EU by establishing a virtual institute to pool computational resources, data, talent, and funding to accelerate frontier research using AI across disciplines, from climate science to geospatial analysis. This initiative aligns with broader EU competitiveness frameworks aimed at reinforcing Europe's leadership in AI and scientific excellence.

Including Artificial Intelligence as a knowledge domain therefore ensures alignment with European policy priorities, supports the development of future-ready skills, and reinforces the interdisciplinary connection between digital technologies, environmental sciences, and space applications.

The identification of these gaps was instrumental in shaping both webinar topics and the structure of the developed MOOCs, ensuring they address specific knowledge gaps in the catalogue and align with stakeholders' needs.

Analysis of application and research trends from scientific repositories: to ground topic identification in cutting-edge scientific evidence, trends in research applications were analysed using scientific repositories (e.g., Scopus) in Earth observation and machine learning. Analysis of recent research demonstrates the rapid evolution and breadth of EO–ML applications as depicted in Figures Figure 3 and Figure 4.

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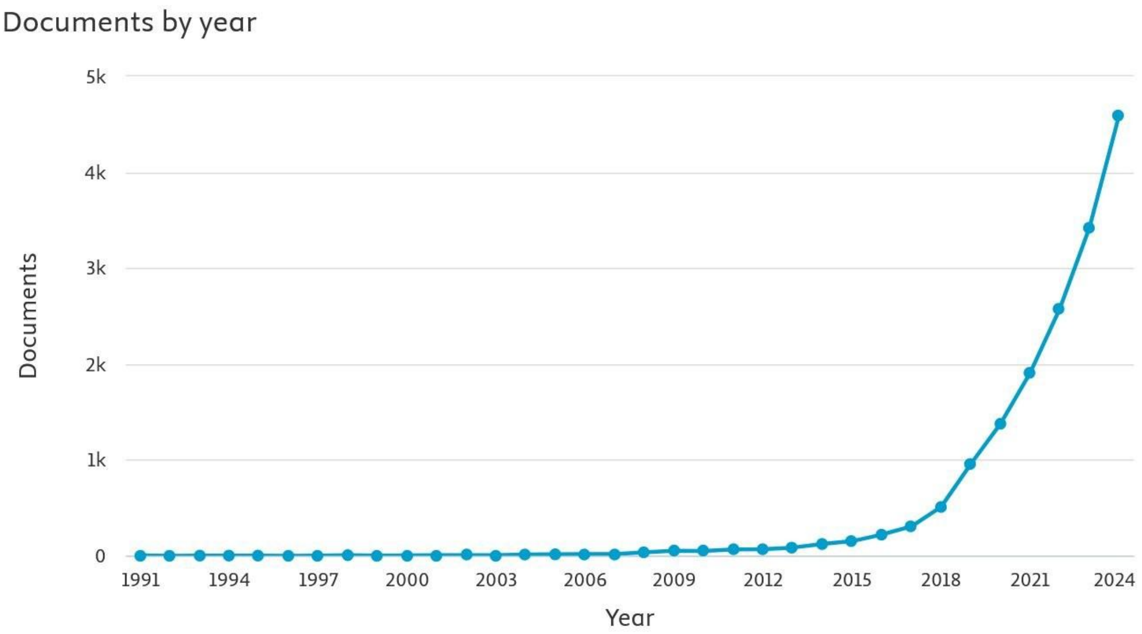

Figure 3: AI trends in the scientific repositories (Scopus). Keywords used: machine learning AND remote sensing or Earth Observation

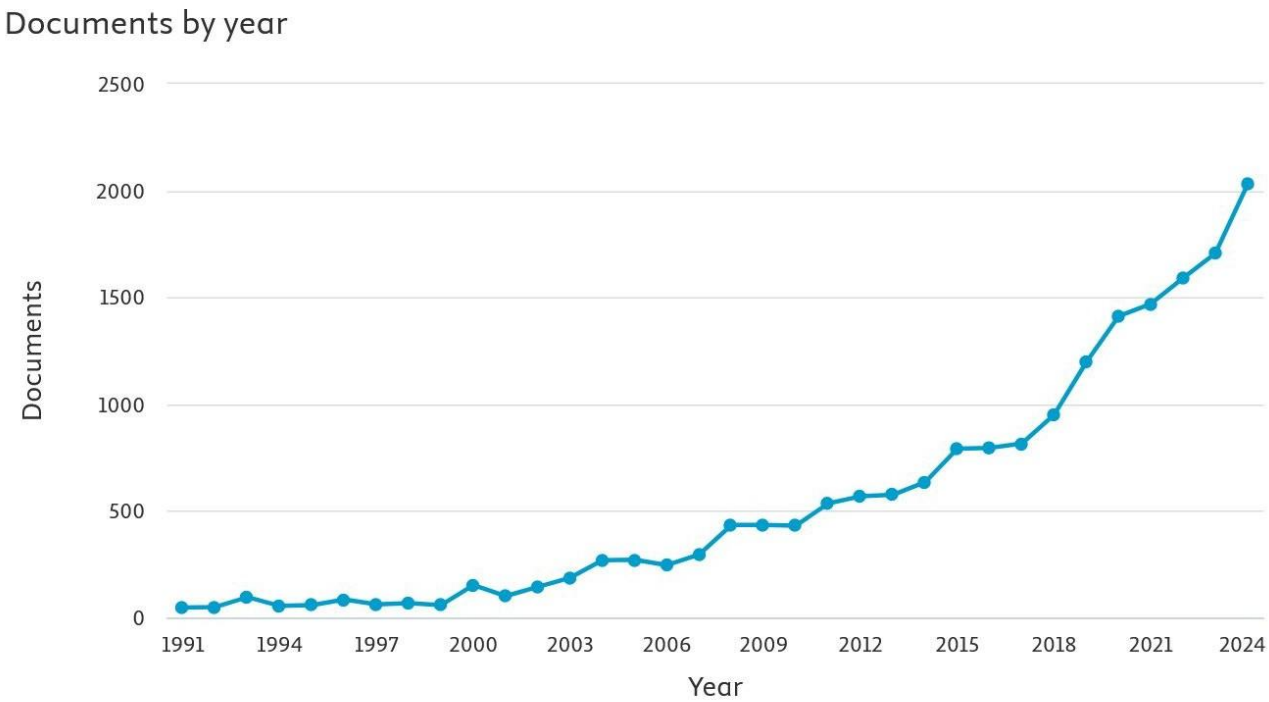

Figure 4: agriculture trends in the scientific repositories (Scopus). Keywords used: agriculture AND remote sensing or Earth Observation

Assessment of ESA MOOCs and EO Training Materials: As part of the selection process, existing ESA MOOCs and capacity-building materials related to Earth observation and Copernicus thematic areas were assessed. This evaluation aimed to ensure the ASTRAIOS MOOC would be complementary rather than duplicative, and that it would align with broader educational offerings while addressing specific gaps in skills training.

ESA's portfolio of MOOCs includes a range of courses spanning foundational EO knowledge to advanced technology trend presented in Table 1.

Table 1 : MOOCs and courses offered by the European Space Agency (ESA) mapped to the knowledge areas and knowledge domains defined by the ASTRAIOS team in WP1000

Course / MOOC Title	Main Focus	Mapped Knowledge Area(s)	Mapped Knowledge Domain(s)
Copernicus MOOC	Copernicus data and services, EO-enabled applications, service development	Remote Sensing; Geographic Information Science; Environmental sciences; Computer Science	Land monitoring; Marine monitoring; Atmospheric Monitoring; Web GIS; Data management
Earth Observation from Space: The Optical View	Optical Earth observation fundamentals, sensors, data and applications	Remote Sensing; Physics; Environmental sciences	Sensors and instruments; Image processing and analysis; Land monitoring; Atmospheric Monitoring
Monitoring Climate from Space	Climate change monitoring using satellite Earth observation	Climate Science; Environmental sciences; Remote Sensing	Climate change; Atmospheric Monitoring; Land monitoring; Marine monitoring
Earth Observation from Space: The Atmosphere	Atmospheric remote sensing, air quality and atmospheric composition	Atmospheric Science; Environmental sciences; Remote Sensing	Atmospheric Monitoring; Climate change; Environmental engineering
Earth Observation from Space: The Cryosphere	Cryosphere monitoring, glaciers and polar regions using EO	Climate Science; Geography; Remote Sensing	Climate change; Physical geography; Land monitoring
Space for International Development Assistance	Use of Earth observation for development and humanitarian applications	Environmental sciences; Geography; Economics	Disaster management; Human Geography; Land monitoring
Land in Focus – Remote Sensing Fundamentals	Land surface monitoring, EO basics and applied remote sensing	Remote Sensing; Geography; Environmental sciences	Land monitoring; Image processing and analysis; Physical geography

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EO Open Data Science: Cubes & Clouds	EO data cubes, cloud-based processing and open data science	Computer Science; Remote Sensing; Mathematics	Data management; Data mining; Geocomputation; Software development

This assessment confirmed that while ESA offers high-quality foundational and thematic training, there was no dedicated, comprehensive course that integrates machine learning with EO applications specifically targeted to agriculture and food systems. Therefore, the ASTRAIOS MOOC fills a critical niche by combining domain knowledge and modern analytical techniques.

2.1.4 Skill gaps related to GNSS

Despite the critical importance of GNSS for applications ranging from autonomous systems to geospatial services, there is currently no dedicated, large-scale survey explicitly tracking GNSS-specific skills gaps. Major sector reports, including the UK Space Sector Skills Survey 2023, EO4GEO Sector Skills Strategy, EARSC Industry Survey, giCASES, and AGI Skills Report, either focus on broader space and geospatial competencies or on Earth observation and geospatial workflows, leaving GNSS expertise largely under-recognized in formal workforce assessments. Nevertheless, indirect evidence from these surveys highlights shortages in related technical areas such as software development, data analysis, systems engineering, and radio frequency/telecommunications, which are foundational for GNSS systems and applications.

The only direct evidence of a GNSS-specific skills shortage comes from the SmartSat Space Industry Skills Gap Analysis in Australia, which identifies high-precision GNSS data processing as a high-intensity shortage area (SmartSat CRC, 2021). This suggests that while GNSS is critical to many operational and research domains, expertise in advanced services, precise positioning, and resilient navigation is not sufficiently available in the current workforce.

Academic literature highlights that GNSS education at the university level often lacks comprehensive curricula aligned with PNT application requirements, practical innovation capacity, and up-to-date teaching platforms, pointing to an educational gap in GNSS competency development for the workforce [4].

Additionally, emerging studies propose pedagogical reforms leveraging technologies such as Generative AI to address instructional limitations, indicating a need for modernization of GNSS training approaches [5]. Expert commentary also notes the scarcity of formal GNSS programmes and industry-academic integration, and international bodies recommend structured training pathways to build capacity, reinforcing the view that GNSS skills development is insufficiently supported by current education frameworks [6].

Market and industry trends indicate that the demand for specialized GNSS skills is growing rapidly. GNSS underpins a wide range of high-value applications in autonomous systems, precision

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agriculture, geospatial analytics, and transportation, yet formal training pathways and workforce

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development programs remain limited. This combination of recognized technical shortages, absence of GNSS-focused surveys, and rapidly evolving application requirements underscores the urgent need for targeted, advanced GNSS education and professional training, positioning initiatives like the present courses to fill a critical gap in the sector

Specifically, The 2024 EUSPA EO & GNSS Market Report projects that the GNSS market will more than double in value from approximately €260 billion in 2023 to nearly €580 billion by 2033, with diversified adoption across sectors such as automotive, agriculture, infrastructure, aviation, and emergency management. This expansion across 15 distinct market segments reflects a rapidly growing reliance on GNSS capabilities across both mass-market and professional domains, implying a rising demand for a workforce equipped with advanced GNSS system understanding and integration skills. While the report focuses on market dynamics and applications, it underscores an implicit need for specialised competencies that existing education and training pathways may currently under-service.

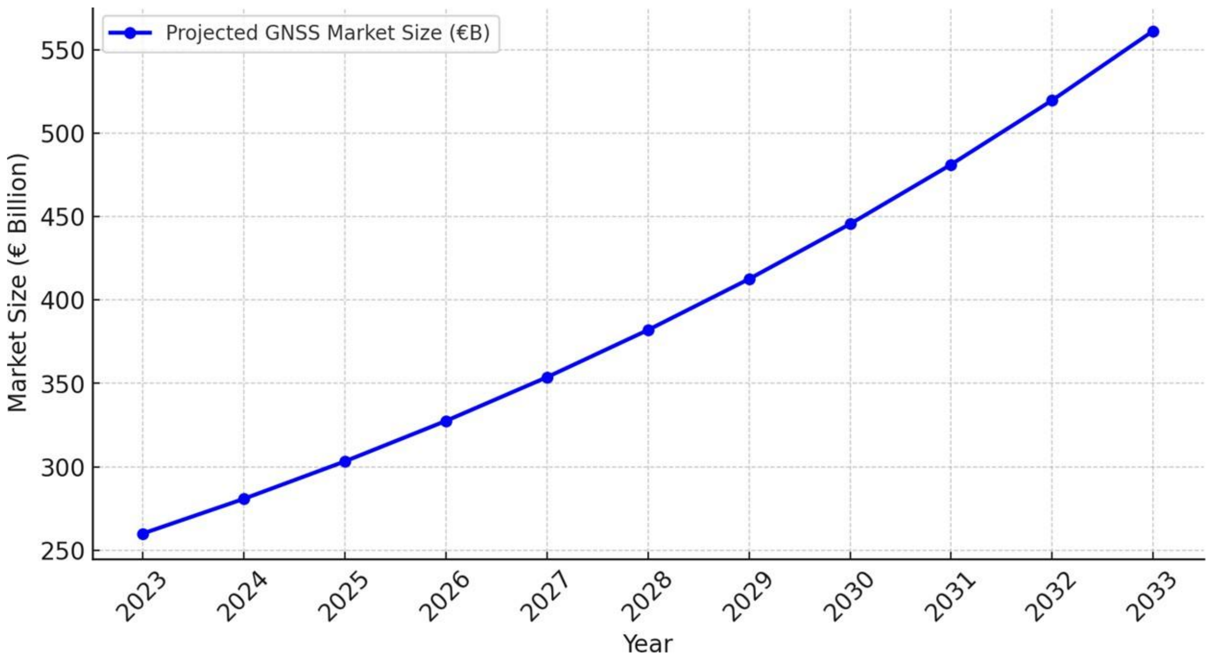

Figure 5: GNSS downstream market, EUSPA Report on GNSS Market Growth.

Finally, a targeted review of publications indexed in Scopus was conducted. Using keywords such as Drones OR Drone OR UAV AND Global Navigation Satellite System OR GNSS, reveals a rapidly expanding body of literature that spans multiple disciplines, including aerospace engineering, geospatial sciences, robotics, and Earth observation.

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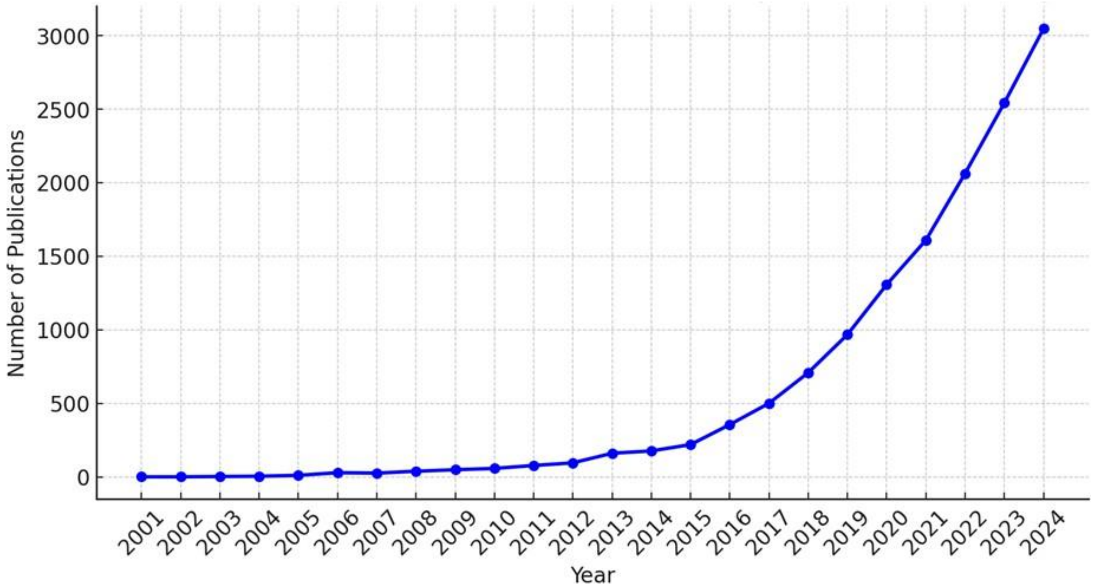

Figure 6: Scopus trends using keywords: Drones OR Drone OR UAV AND Global Navigation Satellite System OR GNSS

Also using keywords like smartphone OR smart-phone OR smartphones OR "smart phone" AND Global Navigation Satellite System OR GNSS, captures recent research on the integration of GNSS with smartphones, highlighting advances in positioning accuracy, location-based services, and mobile sensing applications. The resulting literature reflects the rapid growth of this field and provides insight into emerging technological trends.

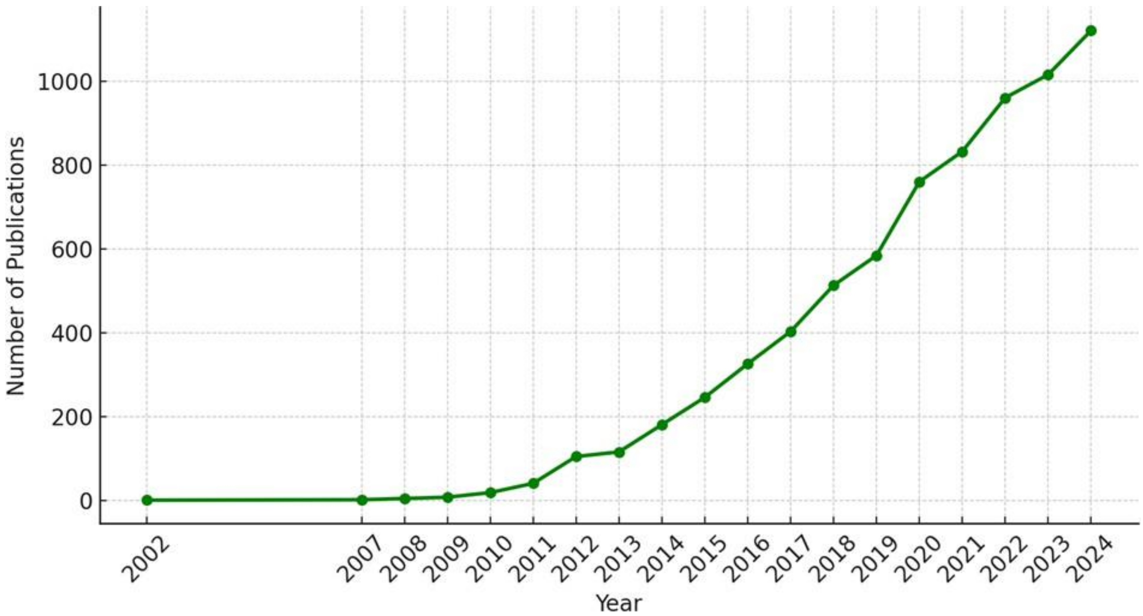

Figure 7: Scopus trends using keywords: smartphone OR smart-phone OR smartphones OR smart phone AND Global Navigation Satellite System OR GNSS

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Using the keywords GNSS OR Global Navigation Satellite System AND Climate Monitoring OR Climate search, captures recent research on the use of GNSS technologies for monitoring and studying climate-related phenomena, including atmospheric water vapor estimation, weather prediction, and environmental monitoring. The resulting literature highlights the growing application of GNSS in climate science.

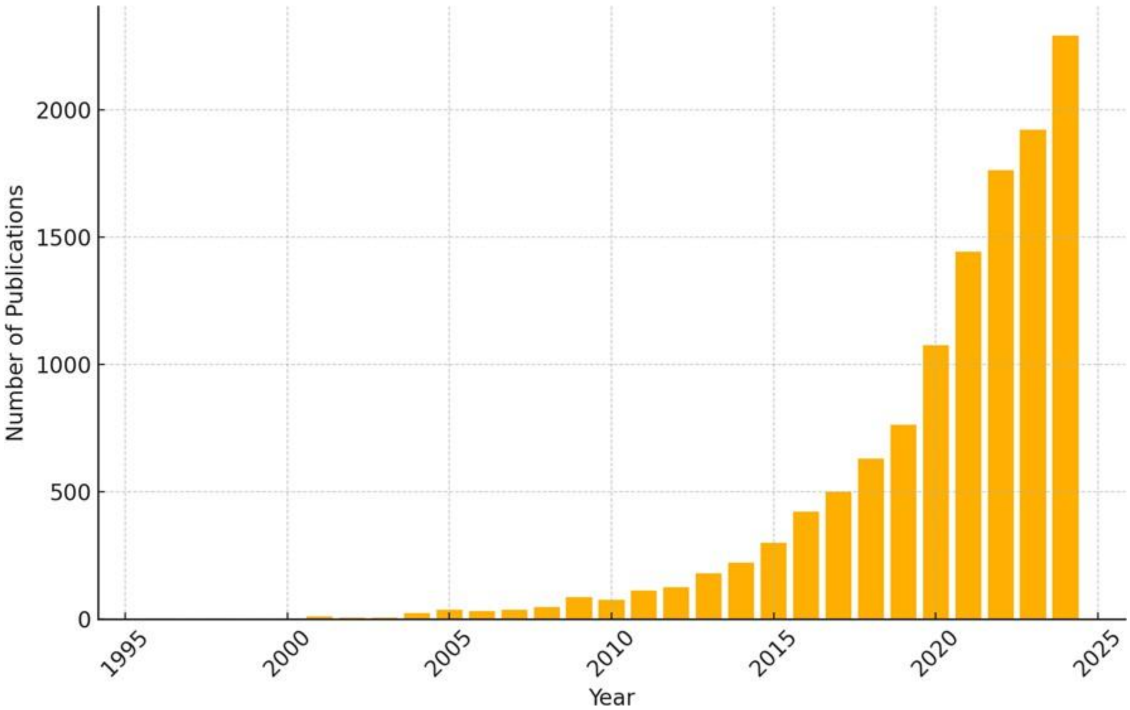

Figure 8: Scopus trends using keywords: GNSS OR Global Navigation Satellite System AND Climate Monitoring OR Climate

Searching with keywords GNSS OR Global Navigation Satellite System AND Natural Hazards OR Natural Hazard, captured a growing volume of scientific research in the field, as seen in Figure 9.

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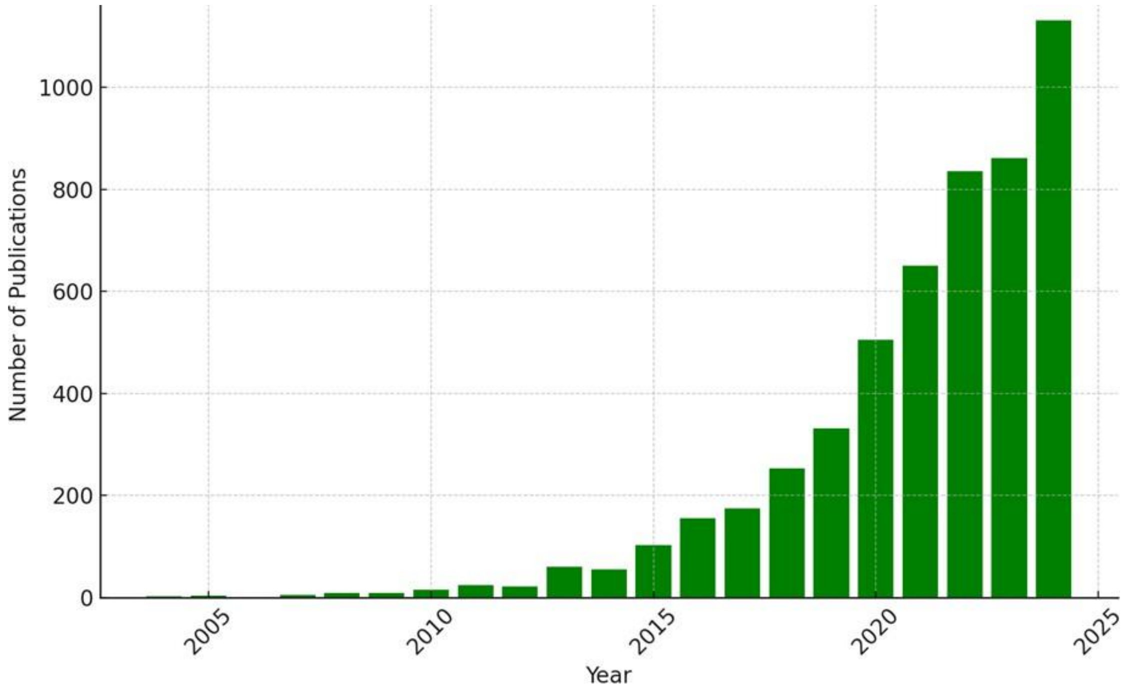

Figure 9: Scopus trends using keywords: GNSS OR Global Navigation Satellite System AND Natural Hazards OR Natural Hazard

ESA GNSS and Space Training Opportunities

A review of training opportunities offered by the **European Space Agency (ESA)** was conducted to assess the current educational landscape in GNSS and related space technologies. ESA Academy provides a range of courses and workshops for students, early career researchers, and professionals, covering topics such as satellite navigation, space systems engineering, satellite communications, CubeSat design, and space weather. Among these, the **Navigation Training Course** and the ESA GNSS Data Processing Book represent the most direct offerings related to GNSS, providing foundational knowledge on system architecture, signal processing, positioning techniques, and practical exercises. While these courses build essential expertise, advanced and application-oriented GNSS topics—such as high-accuracy services, GNSS-denied navigation, and UAV integration—are not yet fully addressed within the existing ESA curriculum

Table 2: ESA training opportunities

Training /Material	**Focus**	**Direct GNSS Relevance**	**Link**
Navigation Training Course	Satellite navigation & Galileo	High	https://www.esa.int/Education/ESA_Academy/Navigation_Training_Course_now_open_for_application2

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Satellite Communication Systems	Satellite communications	Medium	https://www.esa.int/Education/ESA_Academy/Satellite_Communication_Systems_Training_Course_open_for_application2
Concurrent Engineering Workshop	**Systems engineering**	**Medium**	**https://www.esa.int/Education/ESA_Academy/Training_Future_Opportunities**
CubeSat Hands-On Training	Small satellite systems	**Low-Medium**	https://www.esa.int/Education/ESA_Academy/Training_Future_Opportunities
Space Weather Training	Space environment impacts	Medium	https://www.esa.int/Education/ESA_Academy/Training_Future_Opportunities
Space Standards Training	Engineering standards	Low-Medium	https://www.esa.int/Education/ESA_Academy/Training_Future_Opportunities
ESA GNSS Data Processing Book	Self-learning GNSS processing	High	https://gssc.esa.int/navipedia/index.php/GNSS%3ATools?utm_source

Table 2 illustrates the breadth of ESA training opportunities and highlights those most directly relevant to GNSS. While ESA provides foundational and complementary knowledge across multiple domains, there remains a gap in **advanced, application-oriented GNSS training**.

The **MOOC on Advanced GNSS Applications and Services** directly addresses this gap, offering a structured, in-depth learning pathway that extends beyond the fundamentals. It covers high-precision positioning, resilient navigation strategies, and integration with autonomous systems such as UAVs and mobile platforms. By providing accessible, application-focused content, the MOOC enhances professional readiness and develops specialized competencies increasingly demanded in both European and global GNSS markets. In this way, it complements ESA's initiatives and provides a **critical bridge between foundational knowledge and emerging industry requirements**.

2.1.5 Thematic coverage of training material

This section provides an overview of the thematic coverage of the training materials developed by the ASTRAIOS team related to the downstream applications, with a specific focus on the knowledge areas and knowledge domains defined by the ASTRAIOS team in Work Package 1000 (WP1000). The

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analysis demonstrates how the webinar series and the dedicated MOOC collectively address a broad

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and interdisciplinary set of competencies spanning Earth Observation (EO), geospatial sciences, data analytics, and application-driven domains relevant to sustainability and societal challenges.

The thematic coverage of the webinars has been assessed by mapping each webinar to the ASTRAIOS Knowledge Areas and Knowledge Domains, ensuring consistency with the taxonomy established in WP1 (Table 3). This mapping highlights the breadth of expertise addressed by the training activities and supports transparency in how the learning content contributes to the project's overall capacity-building objectives

Table 3 Knowledge areas and knowledge domains defined by ASTRAIOS team in WP 1 covered by the webinars

Webinar Title	Knowledge Area(s)	Knowledge Domain(s)
GeoXR: Its Characteristics and Uses	Geographic Information Science; Remote Sensing; Computer Science	Image processing and analysis; Geocomputation
Uncontrolled Illegal Mining and Garimpo in the Brazilian Amazon	Environmental sciences; Geology; Geography	Land monitoring; Environmental engineering; Disaster management;
Geodetic Reference Systems and their applications	Geography; Physics; Metrology	Metrology and calibration; Physical geography; Satellite navigation and positioning (GPS, Galileo, GLONASS, BEIDO)
Machine Learning and Earth Observation for the Sustainable Development Goals – Focus on SDG 2 and 11	Remote Sensing; Computer Science; Agriculture science; Environmental sciences	Artificial intelligence; Agriculture monitoring; Land monitoring; Climate change
Artificial Intelligence for Integrating Multiple Types of Remote Sensing Data for Sustainability Applications	Remote Sensing; Computer Science; Environmental sciences	Artificial intelligence; Image processing and analysis; Environmental engineering
Monitoring Rangeland Carrying Capacity with Earth Observation	Agriculture science; Environmental sciences; Remote Sensing	Agriculture monitoring; Land monitoring; Climate change
Monitoring Air Quality from Space	Atmospheric Science; Environmental sciences; Remote Sensing	Atmospheric Monitoring; Climate change; Environmental engineering
Promoting Disaster Preparedness and Resilience by Co-developing Stakeholder Support Tools for Managing the Systemic Risk of Compounding Disasters and the Role of EO	Environmental sciences; Geography; Remote Sensing	Disaster management; Land monitoring; Environmental engineering
From Space to Place: Mapping Inequalities in Complex Urban Spaces by Combining Earth	Geography; Computer Science; Environmental sciences	Human Geography; Artificial intelligence; Land monitoring

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Observation, AI, and Citizen Science		
Earth Observation and Geospatial Data for Digital Twins: Global Perspectives for Sustainable Development	Geographic Information Science; Remote Sensing; Computer Science	Geocomputation; Image processing and analysis;
From Space to Sustainability: Using EO and Geospatial Data for ESG Reporting	Environmental sciences; Economics; Geography	Environmental engineering
Space Geodetic Techniques for Remote Sensing the Ionosphere and Natural Hazard Detection	Physics; Atmospheric Science; Remote Sensing	Electromagnetism; Atmospheric Monitoring; Disaster management
Large-Scale Glacier Monitoring with Earth Observation and Deep Learning	Climate Science; Remote Sensing; Computer Science	Climate change; Artificial intelligence; Land monitoring

Coverage of the MOOC on EO and Machine Learning for agricultural applications

In addition to the webinar series, the training portfolio includes one dedicated MOOC on the use of Earth Observation and machine learning for agricultural applications. This MOOC complements the webinar content by providing a structured and in-depth learning pathway that integrates EO data, machine learning methods, and real-world agricultural use cases. Agriculture plays a central role in addressing some of the European Union's most pressing challenges, including food security, climate change mitigation and adaptation, biodiversity protection, and sustainable land management. The transition towards more sustainable and resilient agri-food systems is a core objective of the EU Farm to Fork Strategy, which emphasizes the need to reduce environmental impacts, optimize the use of natural resources, and strengthen the economic viability of farming. Achieving these goals increasingly depends on the availability of high-quality data, advanced monitoring capabilities, and **skilled professionals** who can translate scientific and technological innovation into practical agricultural solutions.

Earth Observation (EO) is a key enabler of this transition. Satellite-based EO provides continuous, large-scale, and objective information on agricultural land, crop conditions, soil moisture, water availability, and land-use dynamics. Through the **Copernicus programme**, the EU delivers free and open data and services that directly support agricultural monitoring across thematic areas such as land, climate change, atmosphere, and emergency management. These capabilities are essential for precision agriculture, compliance with environmental and agricultural policies, risk management, and the assessment of climate impacts on farming systems. Education and training in EO therefore play a crucial role in ensuring that agricultural stakeholders can fully exploit these European data infrastructures. AI further transforms agriculture by enabling the efficient and intelligent exploitation of EO data. AI techniques such as machine learning, deep learning, and automated image analysis make it possible to process vast volumes of satellite and sensor data and convert them into actionable insights for farmers, policymakers, and agri-food businesses. When combined with EO, AI supports applications such as crop type classification, yield forecasting, early detection of stress and disease, optimization of irrigation and fertilization, and rapid assessment of extreme events [1, 2, 3].

Integrating AI into agricultural education strengthens the connection between digital innovation and

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Earth observation, ensuring that future professionals are equipped to develop data-driven, sustainable, and resilient agricultural systems in line with EU policy priorities.

The MOOC primarily addresses the following knowledge areas: Remote Sensing, Computer Science, Agriculture Science, and Environmental Sciences. At the level of knowledge domains, it focuses on Artificial intelligence, Agriculture monitoring, Land monitoring, and Image processing and analysis. By doing so, the MOOC strengthens the project's coverage of data-driven agricultural monitoring and decision-support applications, reinforcing key skills identified as critical in both research and industry.

Overall, the thematic coverage of the training materials demonstrates a balanced and interdisciplinary approach, combining foundational EO and geospatial competencies with advanced data analytics, machine learning, and application-specific domains. The webinars and the agriculture-focused MOOC jointly ensure comprehensive coverage of the knowledge areas and domains defined by the ASTRAIOS team in WP1, supporting the objectives of capacity building, skills development, and long-term impact.

The training portfolio includes one comprehensive MOOC titled: **Global Navigation Satellite Systems (GNSS) Applications and Capabilities**, which is structured around **six complementary modules** that together address both the **foundations and advanced applications of Global Navigation Satellite Systems (GNSS)**. The MOOC is designed to provide learners with a coherent overview of how GNSS technologies, services, and methodologies support a wide range of scientific, societal, and industrial use cases, while also highlighting current challenges and emerging directions in the field.

The first module serves as an essential introduction to Galileo Services, situating the European Global Navigation Satellite System (GNSS) within the broader context of the global navigation landscape. It emphasizes the unique value-added services that Galileo provides, highlighting how these services enhance accuracy, reliability, security, and public safety in modern positioning applications. Learners are guided through key service offerings, including the High Accuracy Service (HAS), which delivers centimetre-level precision for professional and mass-market users; the Public Regulated Service (PRS), designed for governmental and critical infrastructure applications requiring robust, encrypted access; and the Search and Rescue (SAR) service, which improves emergency response capabilities by enabling faster detection and location of distress signals. Additionally, the module explores OSNMA (Open Service Navigation Message Authentication), which ensures the integrity of GNSS signals against spoofing, as well as Galileo's emergency warning functionalities that provide timely alerts in crisis situations. By combining these topics, the module establishes a service-oriented perspective on GNSS, demonstrating how Galileo contributes to resilient and trustworthy Positioning, Navigation, and Timing (PNT) solutions across civilian, commercial, and governmental domains.

Building on this foundation, the **GNSS for Essential Climate Variable Monitoring** module explores how GNSS observations contribute to climate science and environmental monitoring. Essential Climate Variables (ECVs) such as sea level, ocean surface temperature, and soil moisture are primarily monitored via remote sensing, with satellite altimetry being one of the most powerful tools. However, altimetric measurements are highly sensitive to atmospheric effects, which can introduce significant errors. GNSS provides essential corrections for the troposphere and ionosphere, directly improving altimetry precision and enabling robust long-term climate monitoring. The course guides

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learners through the physical processes affecting microwave signals, the correction techniques

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enabled by GNSS, and the synergy between GNSS and traditional altimetry. It also introduces GNSS Reflectometry (GNSS-R), an emerging technique that acts as a new form of altimetry, highlighting the expanding role of GNSS in the future of ECV observation and climate research.

The **GNSS-denied Environments and Drones** module shifts the focus from traditional GNSS-based navigation to the operational and technological challenges faced when GNSS signals are unavailable, unreliable, or deliberately jammed. Learners explore how autonomous aerial systems, including drones, maintain precise navigation and situational awareness in these challenging conditions. The module introduces a range of complementary technologies, including inertial navigation systems (INS), which use accelerometers and gyroscopes to estimate position and orientation independently of satellites, as well as alternative sensors such as LiDAR, radar, visual odometry, and magnetometers. The concept of sensor fusion is emphasized, showing how combining multiple data sources through advanced algorithms enhances robustness and accuracy. Additionally, the module presents AI-supported localisation and mapping techniques, including simultaneous localization and mapping (SLAM), that allow drones to navigate complex environments autonomously. By the end of the module, learners gain a comprehensive understanding of navigation strategies that extend beyond conventional satellite-based positioning, equipping them with the skills to design resilient and intelligent autonomous systems capable of operating in GNSS-denied scenarios.

The **Gaps in GNSS education** module provides an integrative and application-oriented treatment of Global Navigation Satellite Systems, designed to bridge classical GNSS instruction with the evolving demands of modern navigation, Earth observation, and space systems. It establishes a solid foundation in GNSS principles, including signal structures, satellite constellations, receiver technologies, and fundamental positioning methods, and extends these concepts to higher-precision techniques such as Precise Point Positioning (PPP) and the modelling and mitigation of dominant error sources, including atmospheric effects, multipath, and geometry-related limitations. Particular emphasis is placed on GNSS performance under constrained or degraded conditions—such as urban, indoor, underground, space, and interference-prone environments—introducing learners to multi-sensor integration, resilient PNT concepts, signal authentication, and cybersecurity considerations. The module further broadens the educational scope by addressing GNSS applications in space and Earth science, including space missions, radio occultation, reflectometry, space weather monitoring, and Essential Climate Variable (ECV) monitoring, highlighting the evolution of GNSS from a navigation utility into a versatile scientific and operational instrument.

The **Natural hazard detection using space geodetic techniques** module focuses on the role of GNSS and related geodetic methods in monitoring geophysical processes associated with earthquakes, volcanic activity, landslides, and other natural hazards. This module demonstrates how high-precision positioning contributes to risk assessment, early warning, and disaster preparedness.

Finally, the module on **Centimeter-level position accuracy using smartphones** addresses recent advances in mass-market GNSS capabilities. It examines how multi-frequency GNSS, precise positioning techniques, and improved receiver technologies are enabling high-accuracy positioning on consumer devices, opening new possibilities for applications in mobility, mapping, and location-based services.

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Taken together, the six modules form a **balanced and interdisciplinary MOOC** that connects GNSS services, scientific applications, technological innovation, and educational challenges. The course strengthens the overall training portfolio by addressing GNSS from multiple perspectives, supporting capacity building and skills development across research, industry, and the public sector, while ensuring coherence with the broader objectives of the project.

2.1.6 Language of the training material

All training materials developed and delivered within the ASTRAIOS project are provided in English, which serves as the primary working language of the project. The use of English ensures broad accessibility and inclusiveness, enabling participation from an international and multidisciplinary audience, including researchers, students, professionals, and policy stakeholders across Europe and beyond.

The webinars hosted on the ASTRAIOS website are delivered in English, with all presentation slides, spoken content, and accompanying materials prepared accordingly. Where recordings are made available, they are presented in English to maintain consistency between live and asynchronous learning formats.

Similarly, the MOOCs are fully developed in English. This includes video lectures, written learning practicals, quizzes. The choice of English aligns with the language standards of the hosting platform and facilitates wide dissemination and reuse of the training content. The use of a single common language across all training materials ensures coherence, supports knowledge exchange among participants from different countries, and maximizes the potential impact and sustainability of the training activities. Where appropriate, technical terminology is clearly explained to accommodate learners with diverse backgrounds and varying levels of prior expertise.

2.1.7 Platform for hosting the training materials

The training activities developed by the ASTRAIOS team are delivered through a combination of complementary online platforms, selected to ensure accessibility, scalability, and long-term sustainability of the project's educational outputs. In particular, the hosting strategy distinguishes between **webinar-based training activities**, which are hosted on the ASTRAIOS website (see Figure 10) and on ASTRAIOS YouTube channel, and **MOOCs**, which will hosted on the FutureLearn platform. This approach allows the ASTRAIOS team to address the needs of different audiences while ensuring high-quality learning experiences. The MOOCs lectures/modules are currently available on: https://www.astraios.eu/moocs-in-eo-gnss.

ASTRAIOS website: All webinars developed and delivered by the ASTRAIOS team are hosted on the official ASTRAIOS website and can be accessed at: https://www.astraios.eu/webinars. Besides that, the recordings of all webinars is hosted on ASTRAIOS YouTube channel. The ASTRAIOS website functions as a central and project-owned hub for the dissemination of webinar-based training materials. It provides open access to recorded content, allowing participants to engage with the materials asynchronously. This flexibility is particularly important for reaching a diverse audience across different countries, time zones, and professional backgrounds. Each webinar is presented on a dedicated webpage that includes essential contextual information such as the title, topic, speakers, and a brief description of the learning objectives. Importantly, access to webinar materials does not require user registration, which lowers participation barriers and aligns with open science and open education principles. The ASTRAIOS team retains full control over content management, updates, and long-term availability, ensuring that webinar materials remain accessible beyond the duration of individual training events.

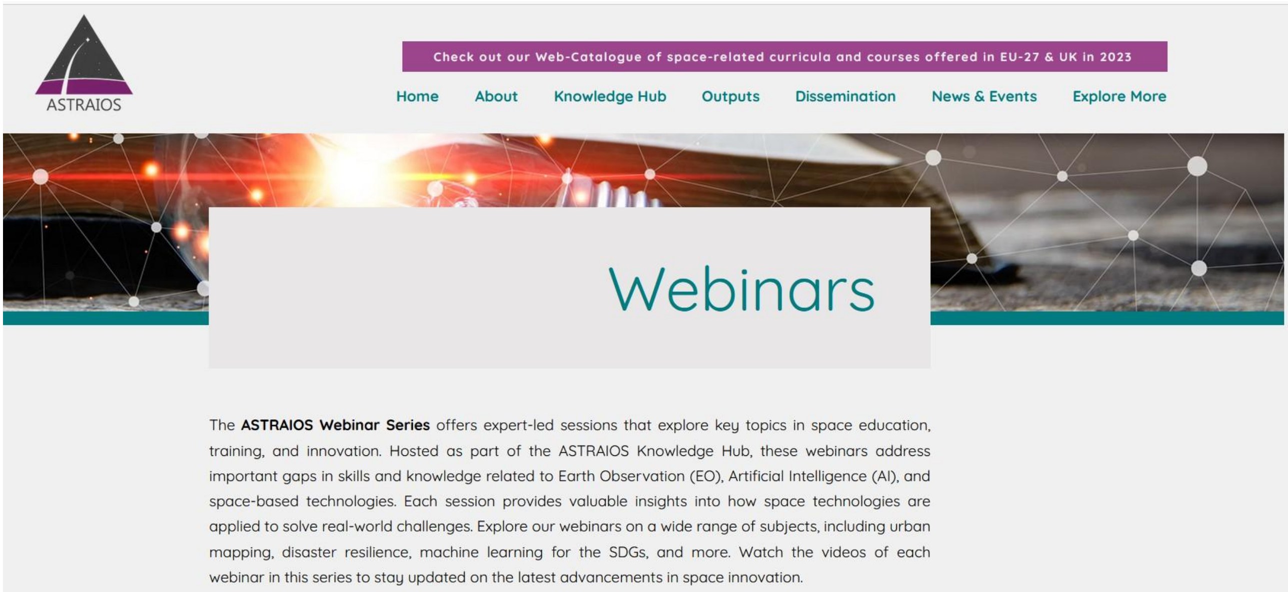

Figure 10: ASTRAIOS website hosting the webinars.

FutureLearn Platform: in addition to webinars, the ASTRAIOS team develops more comprehensive training materials in the form of MOOCs. These courses will be hosted on the FutureLearn platform, a well-established and internationally recognized provider of online learning. Discussions between the ASTRAIOS team and FutureLearn began several months ago, and we received preliminary confirmation of their interest based on the description of the proposed training content. However, due to unforeseen changes on their side, access to the platform is still pending, which is necessary to proceed with uploading the training materials that have already been developed. In parallel, alternative options are being considered should this process not move forward as anticipated (see the ASTRAIOS website as an alternative to host the MOOCs: https://www.astraios.eu/moocs-in-eo-gnss).

The FutureLearn platform enables the ASTRAIOS team to deliver structured learning pathways, with content organized into clearly defined weeks and learning activities. MOOCs combine multiple content formats, including short video lectures, written materials, interactive quizzes, and discussion forums. This variety supports different learning styles and encourages active participation and peer-to-peer learning. FutureLearn also provides built-in tools for learner engagement, progress tracking, and assessment. Participants can monitor their own learning progress, reflect on course materials, and interact with other learners and educators through moderated discussions. For the ASTRAIOS team, the platform offers analytical insights into learner engagement and completion rates, supporting evaluation of training reach and impact. A further advantage of FutureLearn is its strong commitment to accessibility and inclusive design. The platform supports subtitles, transcripts, and flexible pacing, ensuring that MOOCs developed by the ASTRAIOS team are accessible to learners with different needs and levels of prior knowledge.

By combining the ASTRAIOS website for webinars with the FutureLearn platform for MOOCs, the ASTRAIOS team adopts a complementary and strategic hosting approach. Webinars provide targeted, expert-led training and timely dissemination of knowledge, while MOOCs offer in-depth, self-paced learning opportunities. Together, these platforms maximize the visibility, accessibility, and long-term impact of the ASTRAIOS team's training materials, supporting effective capacity building and knowledge transfer across a broad audience.

2.2 Development of the MOOC: approach overview

The MOOC development process followed within ASTRAIOS is structured into five main phases, ensuring pedagogical quality, and relevance (Figure 11):

- MOOC design: this phase defined the overall structure of the course, including learning objectives, target audience, and alignment with the European Qualification Framework (EQF). Key knowledge areas and domains are selected based on identified skills gaps, and the course syllabus is designed to balance theoretical foundations with practical applications.
- MOOC development: during this phase, the training content was created and implemented. This includes the preparation of lecture materials, video recordings, practical exercises, quizzes, and supporting resources. To ensure consistency and clarity across all course components, presentation and exercise templates were prepared for use in all lectures and exercises, following defined rules for font type and size. For lecture materials, the font should align with the template, with a recommended minimum size of 30 pt; headings should be bold and larger than body text, and all text should be left-aligned. Each slide should present only one main idea, embedded videos should not exceed 12 minutes, and only publicly available figures should be used. Pedagogical guidelines and quality standards defined by the ASTRAIOS framework are applied to ensure consistency and clarity across all course components.
- MOOC assessment: the developed MOOCs underwent a structured internal content-focused evaluation. Consortium members assess the materials against predefined criteria covering content quality, learning outcomes, pedagogical coherence, presentation, and compliance aspects. The aim is to ensure the robustness and readiness of the training materials.
- MOOC updating: based on the outcomes of the assessment, targeted updates and refinements were implemented. These may include clarifying learning outcomes, improving visuals or examples, or updating content to reflect current scientific and technological developments.
- MOOC sharing: in the final phase, the MOOCs are made available through selected online platforms to ensure broad accessibility and long-term impact. The courses are shared under

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open licensing terms, facilitating reuse, dissemination, and integration into higher-education and professional training contexts.

Each MOOC is structured to provide a comprehensive and engaging learning experience. It typically includes several key components designed to support both conceptual understanding and practical skill development.

- Topic introduction: Each course begins with a short video or written overview that introduces the subject matter and outlines the main learning objectives.
- Learning materials: Participants are provided with a combination of video lectures and recommended readings that cover the theoretical foundations and practical applications of the topic.
- Practicals: To reinforce learning, the courses include hands-on exercises such as interactive coding activities, often implemented through *R programming language* and *Jupyter Notebooks*. These tasks allow learners to apply concepts directly in a practical context.
- Interactive elements: quizzes and other interactive features are integrated throughout the MOOC to keep learners engaged and to check understanding of key concepts.

The assessment strategy focuses primarily on *formative assessment*, using quizzes to provide continuous feedback and monitor learners' progress throughout the course.

Additionally, the ASTRAIOS Team has developed clear guidelines for preparing PowerPoint presentations and video recordings, ensuring that all course materials maintain a consistent quality and presentation style.

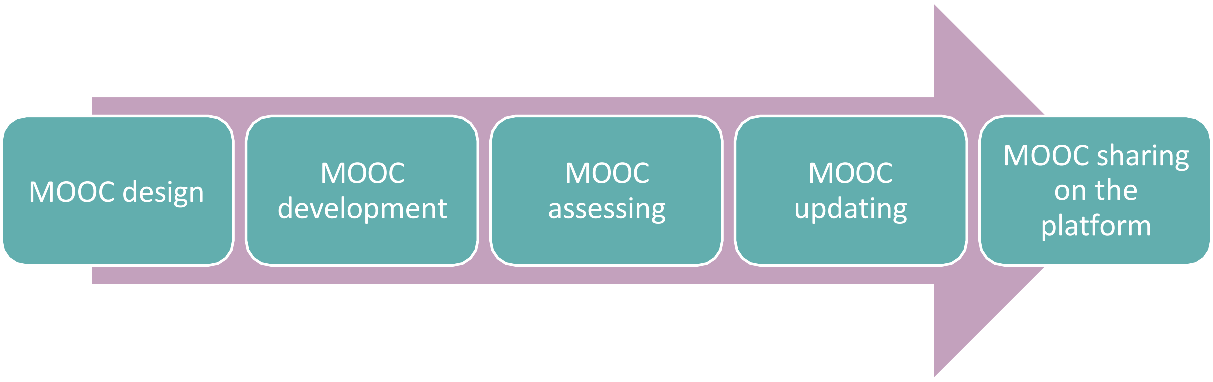

Figure 11: Steps involved in developing the ASTRAIOS MOOCs.

The video production instructions are provided below:

Content creation:

- Keep videos short and focused (ideally max 15 minutes per video, split by chapters).
- Use high-quality visuals, animations, and audio.

- Share all the materials used in the lecture (slides, script, video, audio…)
- When mistakes are made, please note the timecode to simplify editing cuts.
- Respect the graphical charter when creating the slides.

Below are some recommendations for creating the course slides:

- Safe zone: keep a safe zone in the slides to accommodate the speaker's webcam in picture-in-picture (PIP) mode and avoid placing content behind it.
- The safe zone should have a 16:9 ratio (standard) and occupy 15% of the slide area.
- In general, this zone should be placed in the top-right corner.
- Logo Placement: Place the ASTRAIOS logo aligned with the bottom-right corner, with 50% opacity, to ensure better visibility of the content.

2.3 MOOC on Earth Observation data and Machine learning for agriculture applications

2.3.1 MOOC design:

EQF (European Qualification Framework): Master level (level 7) and Bachelor level (level 6)

Duration: 140 hours

Learning outcomes:

1) Understand the basics of Earth Observation (EO) data and machine learning, particularly for agricultural applications
2) Identify key geospatial challenges and link them to appropriate EO sensor technologies and data.
3) Apply machine learning and deep learning concepts to agricultural data analysis using EO data.
4) Develop data-driven solutions for various agricultural tasks, such as crop mapping, yield estimation, and nutrient monitoring.

Course syllabus, lesson learning objectives, quiz titles and practicals are presented in the sections below.

2.3.2 MOOC development: overview modules’ content and learning objectives

Module 1: General introduction to Earth Observation data and machine learning for agriculture applications

Introduced concepts: food production data-opportunities and challenges, EO technologies development, machine learning developments, earth Observation and machine learning for agriculture applications

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By the end of this lecture, learners should be able to:

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- Understand how Earth Observation data and machine learning can be applied to food production and nutrition analysis.
- Recognize how EO–ML methods scale from farm-level to national and global assessments.
- Appreciate the role of data, modelling pipelines, and spatial analysis in supporting food security and nutrition policy.

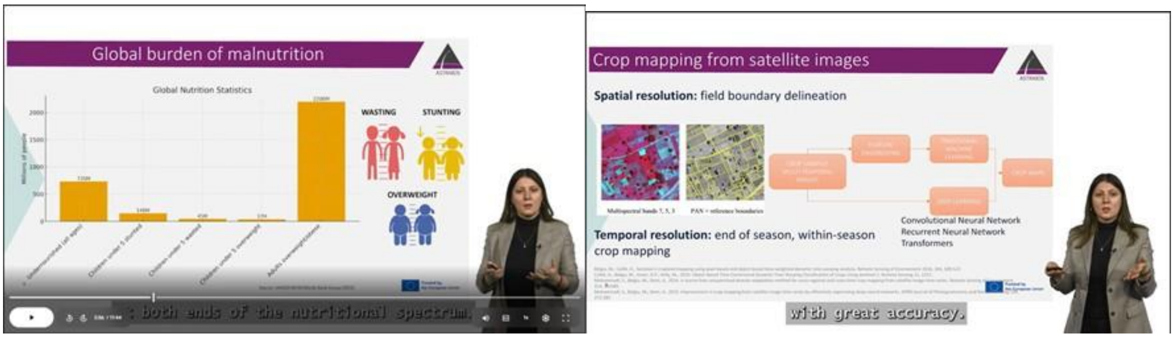

Figure 12: Module 1. EO data and machine learning for agriculture applications- Presentations and videos samples

Module 2: Linking Geospatial Challenges to EO Sensors

Introduced concepts: Earth Observation (EO) with examples of current EO missions, the importance of spatial data in solving environmental challenges. the principles of space-based data acquisition, including satellite orbits, sensor types, and electromagnetic radiation, and the 4 key resolution properties of EO optical imaging sensors with two EO main sensor limitations. Transform geospatial challenges into EO-Based Solutions by applying a 4 steps approach supported by a practical example.

By the end of this lecture, learners should be able to:

- Understand the role Earth Observation missions and the spatial data in addressing environmental challenges
- Describe the principles of space-based data acquisition and understand the fundamental characteristics of space EO sensors with focus on optical imaging sensors
- Reflect on two main limitations associated with the use of space EO sensors.
- Apply a 4-step systematic approach to transform a geospatial challenge into an EO-based solution

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Figure 13 *:* Module 2. Linking Geospatial Challenges to EO Sensors- Presentations and videos samples

Module 3: General introduction to machine learning

Introduced concepts: What is Machine Learning - Historic Perspective; How do we make machines learn (Introduces KNN); Why machine learning; types of classifiers; Concept of Feature/attribute; Feature/attribute space and impact of data representation, ML as an optimization problem; Generalization and overfitting; Maximum Likelihood classification or SVM.

By the end of this lecture, learners should be able to:

- Understand what Machine Learning is and what are the main concepts behind it
- Explain how we can make algorithms learn from data
- Describe what is a feature and feature space and the importance of feature representation
- Understand the differences among supervised and unsupervised classifiers
- Explain the concepts behind the Support Vector Machine classifier and how does its algorithm work

Figure 14: Module 3. General introduction to machine learning - Presentations and videos samples

Module 4: Earth Observation and machine learning for crop mapping

Introduced concepts: EO and ML for crop mapping; Ensemble learning: bagging; Decision trees; Random- Forest introduction; Random Forest hyperparameters; Random Forest for crop mapping

By the end of this lecture, learners should be able to:

- Understand crop mapping workflows using EO and ML.

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- Explain key methodological choices such as class definitions, labeling, and sampling.
- Apply and compare ensemble learning approaches, including Random Forest, for land cover and crop classification.

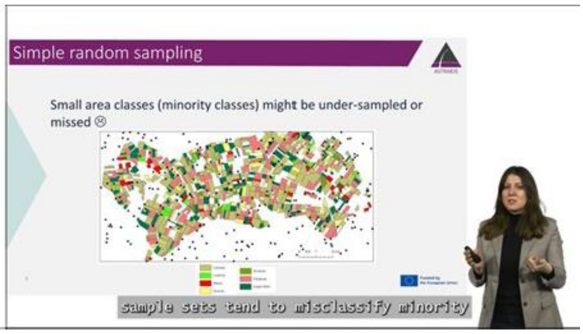


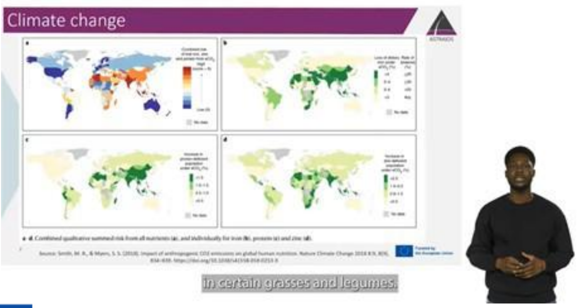
Figure 15*:* Module 4 Earth Observation and machine learning for crop mapping - Presentations and videos sample

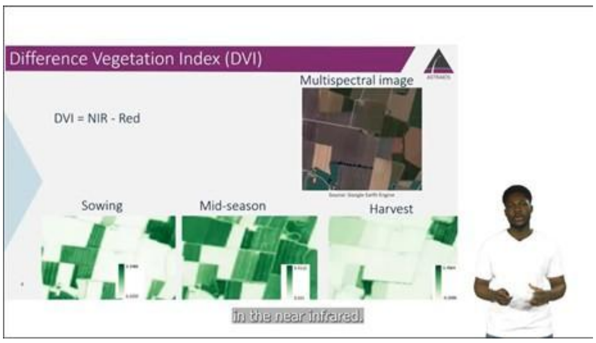
Module 5: Geospatial and earth observation data acquisition and processing for crop grain nutrient estimation

Introduced concepts: Micronutrient deficiency aka hidden hunger; Role of EO and spatial data to map and monitor crop nutrients; Spectral indices for crop nutrients- NDVI and other indices; Data preprocessing (noise reduction, radiometric and geometric corrections, and atmospheric correction)

After completing this lecture, students will be able to:

- Describe the role of geospatial and Earth observation data in mapping and monitoring crop nutrient status at field and regional scales.
- Identify and interpret spectral indices used for crop nutrient assessment, including NDVI and other relevant vegetation indices.
- Understand the principles of EO data preprocessing, including noise reduction, radiometric correction, geometric correction, and atmospheric correction.
- Apply basic preprocessing workflows to EO datasets in preparation for crop nutrient analysis.
- Critically assess the impact of data quality and preprocessing choices on the reliability of





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crop nutrient estimation results.

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Figure 16: Module 5 Geospatial and EO data acquisition and processing for crop grain nutrient estimation - Presentations and videos sample

Module 6: Geospatial data, Earth Observation and machine learning for crop grain nutrient estimation

Introduced concepts: Data extraction and cleaning; Feature reduction general introduction; Feature reduction general introduction: methods and examples; imbalance dataset in machine learning; Strategies for splitting training and testing sample sets; Grain nutrient estimation using Random Forest; Random Forest hyperparameter fine tuning; Assessing the nutrient estimation results: plots + Variable importance; Variable importance and PDPs and SHAP

After completing this lecture, students will be able to:

- Extract and clean geospatial and EO-derived datasets for use in machine learning-based crop nutrient estimation.
- Explain the purpose of feature reduction and describe common feature reduction methods used in geospatial and agricultural data analysis.
- Recognize and address imbalanced datasets in agricultural machine learning applications.
- Design appropriate strategies for splitting data into training and testing sets, ensuring robust model evaluation.
- Implement Random Forest models for crop grain nutrient estimation using EO and spatial features.
- Perform hyperparameter tuning of Random Forest models to improve prediction accuracy and model robustness.
- Evaluate model performance using appropriate validation metrics and interpret the results in an agricultural and environmental context.
- Understand the strengths and limitations of machine learning approaches for crop nutrient estimation using EO data.

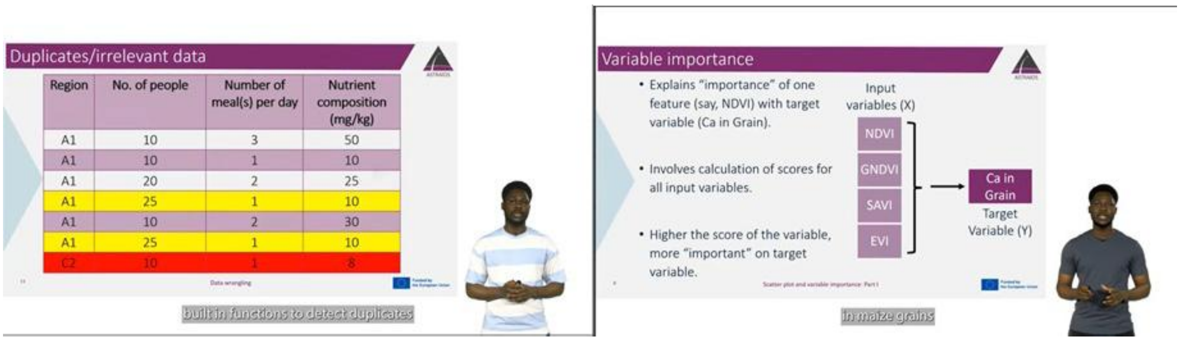

Figure 17: Module 6 Geospatial data, Earth Observation and machine learning for crop grain nutrient estimation- Presentations and videos sample

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Module 7: General Introduction to Deep Learning

Introduced concepts: What is Deep Learning (general description); Basic concepts on Deep Learning Types of networks and classification tasks; What is a Convolutional neural network; Components of a CNN; Main Architectures; What is a Recurrent Neural Network; Main Architectures; LSTM; Regularization; Classification workflow

By the end of this lecture, learners should be able to:

- Explain what an Artificial Neuron is and how it works
- Explain what an Artificial Neuron Network is
- Describe how the backpropagation algorithm works
- Explain what Convolutional Neural Networks are and how they can be used in Remote Sensing Applications
- Explain what Fully Convolutional Networks are and how they can be used in Remote Sensing Applications
- Explain Recurrent Neural Networks are and how they can be used in Remote Sensing Applications

Figure 18*:* Module 7 General Introduction to Deep Learning - Presentations and videos sample

2.3.3 Collecting feedback and improving the MOOC content

The revision and development of the training materials were carried out through a coordinated process involving consortium partners from both academia and industry, ensuring scientific quality, practical relevance, and alignment with project objectives.

The developed MOOCs underwent a structured quality assessment of the course content, conducted internally by designated consortium experts. The assessment was conducted as a content-focused review, with consortium members acting as course participants and evaluating the completeness, coherence, and overall quality of the training materials. The evaluation followed a predefined set of criteria covering appearance and form, content quality, clarity and alignment of learning outcomes. The outcomes of this assessment informed refinements and confirmed the overall robustness, consistency, and suitability of the MOOCs for higher-education (EQF 6 and 7) and professional training contexts.

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Table 4 : Criteria used to assess the MOOC content (the evaluation forms are attached at the end of the deliverable document)

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.			
Are all visuals, figures, and text clear, readable, and in the correct resolution?			
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?			
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.			
Do the slides give a professional impression?			
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			
The title accurately reflects the content of the material.			
The learning outcomes are clearly articulated, easy to understand, and aligned with the overall goals of the course.			
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.			
The content reflect current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.			
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.			
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.			
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?			
Are practical examples or case studies provided to illustrate the material effectively?			
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?			
The content matches the learning outcomes.			
Is the content properly cited and compliant with copyright laws?			
Does the content use only authorized materials and appropriately credit sources?			

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On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			
Do you have any general recommendations for improvements?			

2.4 MOOCs related to GNSS

2.4.1 MOOCs overview and design

The Technical University of Crete team (SenseLab) has developed the MOOC: **Global Navigation Satellite Systems (GNSS) Applications and Capabilities**. The course is comprised of six modules:

1. Galileo Services
2. GNSS for Essential Climate Variable Monitoring
3. GNSS-denied environments & drones
4. Gaps in GNSS education
5. Natural hazard detection using space geodetic techniques
6. Centimeter-Level Position Accuracy Using Smartphones

This MOOC provides a comprehensive introduction to modern Global Navigation Satellite Systems (GNSS) and space-geodetic techniques. Learners progress from the fundamentals of Galileo and multi-GNSS services through advanced signal processing, high-precision positioning and software-defined receivers, to applied topics such as environmental and climate monitoring, resilient drone navigation in GNSS-denied environments and natural-hazard detection. Each module combines short lectures with exercises and case studies to build practical understanding.

The Global Navigation Satellite Systems (GNSS) Applications and Capabilities course explains how multi-constellation, multi-frequency and AI-enhanced methods improve positioning, navigation and timing; how GNSS observations support essential climate variable monitoring and atmospheric corrections; how sensor fusion and alternative PNT methods enable autonomous operation without GNSS; and how space-geodetic observations reveal signals from natural hazards. It is designed at an intermediate–advanced level for students, professionals and educators who wish to update or broaden their knowledge of GNSS and its applications.

The course is delivered through a carefully designed learning pathway comprising 42 presentations and accompanying video lectures, complemented by self-assessment exercises and quizzes that support active learning and continuous knowledge evaluation.

EQF (European Qualification Framework): Master level (level 7) and Bachelor level (level 6)

Duration: 8 weeks

2.4.2 MOOC developments: overview modules' content and learning objectives

As described above there were six topics which were discussed in detail. The first topic:

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Module 1: Galileo Services

Global Navigation Satellite Systems (GNSS) have become a critical backbone of modern society, enabling precise positioning, navigation, and timing across a wide range of civil, commercial, and governmental applications. Among these systems, Galileo, the European Union's global navigation satellite system, stands out for its civilian governance, service guarantees, and innovative service portfolio. This topic introduces the core principles of GNSS before focusing on Galileo's unique value-added services, including the High Accuracy Service (HAS), the Public Regulated Service (PRS), Search and Rescue (SAR) services with the Return Link Service (RLS), Open Service Navigation Message Authentication (OSNMA), and the Emergency Warning Satellite Service (EWSS). Through this course, learners will gain a structured understanding of how Galileo enhances accuracy, security, resilience, and public safety, and how its services support emerging applications, critical infrastructures, and crisis-response capabilities at European and global scales.

By the end of this module, learners will be able to:

- Define Global Navigation Satellite Systems (GNSS) and explain their role in delivering Positioning, Navigation, and Timing (PNT) services.
- Describe the historical evolution of satellite navigation systems and distinguish between the main global GNSS constellations (GPS, GLONASS, BeiDou, and Galileo).
- Identify key application domains of GNSS technologies, including transportation, aviation, maritime, surveying, agriculture, telecommunications, emergency management, and critical infrastructures.
- Explain the concept and operational principles of the Galileo High Accuracy Service (HAS) and differentiate it from standard GNSS positioning solutions.
- Describe the HAS system architecture, including the flow of information from reference stations through processing centres to Galileo satellites and end users.
- Recognize the main service features of HAS, such as real-time Precise Point Positioning (PPP), satellite-based correction delivery, global coverage, and free access.
- Explain the phased implementation of HAS and assess its relevance for service reliability, scalability, and future evolution.
- Define the Galileo Public Regulated Service (PRS) and explain its purpose as a secure and resilient GNSS service for authorised users.
- Describe the security and robustness features of PRS, including encrypted signals, controlled access, authentication mechanisms, and resistance to jamming and spoofing.
- Identify authorised PRS user groups and outline operational and access-control processes at national and international levels.
- Explain the principles of the Cospas-Sarsat Programme and describe Galileo's contribution to global Search and Rescue (SAR) operations within the MEOSAR system.
- Describe the functionality and benefits of the Forward Link Service (FLS) and the Return Link Service (RLS), including reduced detection times and improved user reassurance.

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- Explain the threat of GNSS spoofing and recognize the vulnerabilities of unauthenticated navigation messages.
- Describe the purpose and operation of Galileo Open Service Navigation Message Authentication (OSNMA).
- Explain how OSNMA complements PRS within the broader GNSS security ecosystem.
- Describe the need for a satellite-based emergency warning service and explain the operational concept and public-safety benefits of the Galileo Emergency Warning Satellite Service (EWSS).
- Assess how Galileo services collectively contribute to resilient PNT, public safety, emergency response, and European strategic autonomy

This module is comprised of **six (6)** presentations and videos, titled: **i)** Galileo Services introduction, **ii)** Galileo High Accuracy Service (HAS), **iii)** Galileo Public Regulated Service (PRS), **iv)** Galileo Search and Rescue Service (SAR), **v)** Galileo Open Service Navigation Message Authentication (ONSMA) and **vi)** Galileo Emergency Warning Satellite Service (EWSS). The module's guidelines and assessment exercises were also prepared.

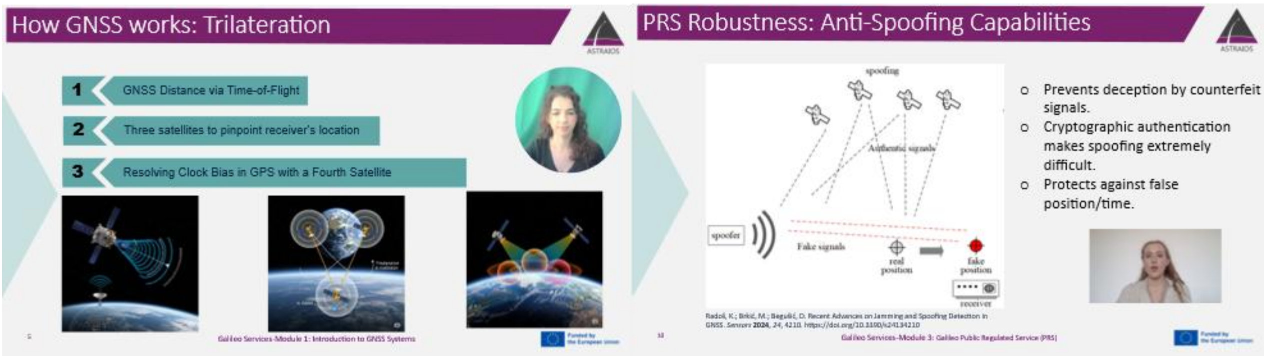

Figure 19: Module 1. Galileo Services-Presentations and videos samples.

Module 2: GNSS for Essential Climate Monitoring

Reliable climate monitoring relies on long-term, accurate, and globally consistent observations of the Earth system. Global Navigation Satellite Systems (GNSS), originally developed for positioning and navigation, have emerged as powerful and independent tools for observing Essential Climate Variables (ECVs) across the atmosphere, oceans, and land surfaces. This topic introduces the principles of GNSS-based remote sensing techniques—such as GNSS Radio Occultation, GNSS Reflectometry, and tropospheric delay estimation—and explains how they contribute to monitoring key climate indicators including atmospheric temperature and humidity, sea level, soil moisture, snow and ice, and land deformation. By combining theoretical foundations with real-world applications, the course highlights the unique strengths of GNSS for climate science, its role in complementing other Earth Observation systems, and its growing importance for climate services, early warning systems, and evidence-based climate policy.

By the end of this module, learners will be able to:

- Describe the composition and layers of Earth's atmosphere relevant to satellite altimetry.
- Present the working principle of GNSS for positioning.
- Focus on the additional applications of GNSS on other satellites and ground stations.
- Explain the fundamental principle of satellite altimetry and its operating frequencies.
- Differentiate between atmospheric absorption and refraction and their impacts on altimeter signals.
- Distinguish between non-dispersive and dispersive atmospheric media.
- Identify the two main components of the tropospheric delay: the dry and wet delays.
- Explain the physical origin and typical magnitudes of the dry and wet tropospheric delays.
- Describe how the dry tropospheric delay is estimated using GNSS and numerical weather prediction models.
- Understand the role of Microwave Radiometers (MWRs) in comparison to GNSS in estimating the wet tropospheric delay.
- Provide details about the total tropospheric delay that can be estimated using GNSS receivers.
- Explain the composition of the ionosphere and its effect on altimetry signals.
- Understand why the ionospheric delay is dispersive and its relationship to Total Electron Content (TEC).
- Describe how dual-frequency altimeters utilize the dispersive property to correct for the ionospheric delay.
- Explain how the same approach for estimating ionospheric effects is a well-established methodology in GNSS.
- Discuss the impact of the solar cycle on the ionosphere and its implications for altimetry corrections.
- Identify GNSS for ionospheric corrections, especially for single-frequency missions.
- Apply basic calculations for altimeter range and ionospheric delay in practical exercises.
- Synthesize knowledge of all atmospheric corrections and the importance of GNSS in ECVs reliable monitoring.
- Present the new technique of GNSS-R and realise its role as a standalone ECVs monitoring method.

This module comprises of **eight (8)** presentations and videos titled: **i)** Introduction to ECVs and GNSS, **ii)** Atmospheric Absorption and Refractive Index on Microwaves, **iii)** Wet and Dry Delays on Satellite Signals, **iv)** GNSS for Tropospheric Delays Estimation, **v)** Ionospheric Propagation Effects on Satellite Signals, **vi)** Dual Frequency Approach for Ionospheric Correction, **vii)** The Solar Cycle and Ionospheric Scaling, **viii)** The Road ahead GNSS Altimetry and ECV Monitoring.

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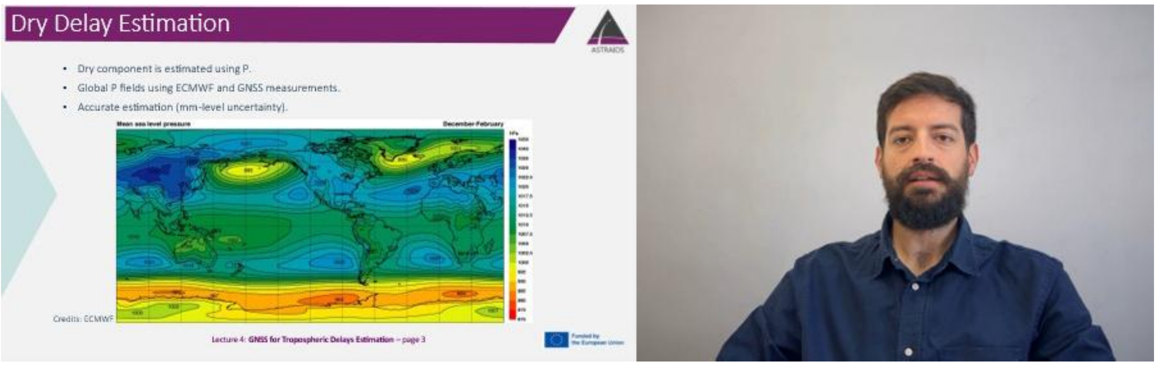

Figure 20: Module 2. GNSS for Essential Climate Variable monitoring-Presentations and video samples.

Module 3: GNSS Denied Environments

Autonomous systems such as drones increasingly operate in environments where Global Navigation Satellite System (GNSS) signals are unavailable, degraded, or deliberately disrupted. Urban canyons, indoor spaces, forests, underground facilities, and contested or hostile environments pose significant challenges to reliable positioning and navigation. This topic introduces the principles, technologies, and methodologies that enable robust navigation in GNSS-denied environments, with a focus on unmanned aerial systems (UAS). Learners will explore inertial navigation, alternative sensing modalities, sensor fusion, and advanced techniques such as SLAM and artificial intelligence, gaining a structured understanding of how modern autonomous platforms maintain situational awareness, localisation, and autonomy when GNSS cannot be relied upon.

By the end of this module, learners will be able to:

- Describe the basic architecture of a UAV, including frame, propulsion, power, control, navigation, and payload systems
- Explain the role of the flight controller and navigation subsystem in drone operation the physical, environmental, and intentional causes of GNSS signal loss or degradation.
- Understand what an Inertial Navigation System (INS) is and how it operate
- Identify the core components of an INS, including the Inertial Measurement Unit (IMU) and navigation computer
- Explain the operating principles and limitations of accelerometers, gyroscopes, and magnetometers
- Describe how position, velocity, and orientation are estimated through inertial integration
- Recognize error sources such as bias, noise, and drift Sensor Fusion
- Explain why sensor fusion is required for reliable drone navigation
- Describe how combining multiple sensors improves accuracy and robustness
- Recognize common sensor fusion strategies used in UAVs GNSS-Denied Environments
- Define GNSS-denied and GNSS-degraded environments

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- Identify the main causes of GNSS denial, including signal obstruction, multipath, jamming, and spoofing
- Understand the operational risks and challenges associated with GNSS-denied navigation, alternative Navigation Technologies
- Understand the principles of LiDAR-based navigation and SLAM
- Explain how Radar can support navigation in adverse weather and low-visibility conditions
- Describe the role and limitations of acoustic sensors for close-range awareness
- Comprehend the concept of star-based navigation for aerial platforms
- Understand shadow matching as a localization method in urban environments
- Explain photo-navigation and terrain/image matching techniques (VIDAR-like approaches)
- Understand the role of Machine Learning in autonomous navigation
- Explain how deep learning and CNN-based perception systems enable environment understanding
- Comprehend the fundamentals of Reinforcement Learning (RL) for decision-making and path planning
- Identify the key components of an RL system: Agent, Environment, State, Action, and Reward
- Discuss challenges and future directions in AI-driven navigation systems

This module is comprised of **seven (7)** presentations and videos, titled: **i)** Introduction to GNSS denied Environments**, ii)** Drones Basics, **iii)** Anatomy of a Drone, **iv)** Inertial Navigation Systems (INS) and Inertial Measurement Units (IMUs), **v)** Technologies and their use in drones for mapping and navigation, **vi)** Drones2GNSS Accuracy from the Sky, **vii)** Testing, Validation, and Future Directions.

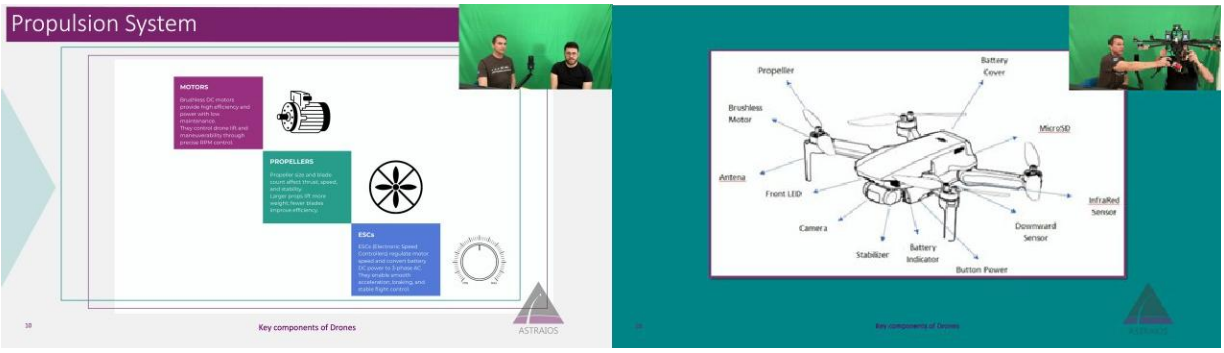

Figure 21: Module 3 GNSS Denied Environments- Presentations and video samples.

Module 4: Gaps in GNSS education

Global Navigation Satellite Systems (GNSS) underpin a wide range of critical services, from precise positioning and timing to Earth observation, scientific research, and emerging space applications. As GNSS technologies evolve beyond single-constellation positioning, users increasingly rely on multi-GNSS interoperability, advanced signal processing, high-precision techniques, and resilient

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Positioning, Navigation, and Timing (PNT) solutions capable of operating in challenging

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environments. This course provides a comprehensive overview of modern GNSS systems, signals, and services, covering multi-GNSS architectures, signal structures, Software-Defined Radio (SDR)-based signal processing, high-accuracy positioning methods, error sources and mitigation strategies, and resilience against interference and spoofing. It further explores GNSS applications beyond Earth, the integration of machine learning and sensor fusion, the role of GNSS in Earth observation and environmental monitoring, and the broader economic, regulatory, and policy landscape. Through a combination of theory, real-world examples, and field-testing perspectives, the course equips learners with the knowledge required to understand current GNSS capabilities, assess emerging trends, and engage with future developments in resilient and autonomous PNT.

By the end of this module, learners will be able to:

- Explain the structure and operation of multi-constellation GNSS, including signal generation, transmission, reception, and positioning principles
- Distinguish between navigation-grade and geodetic-grade GNSS processing techniques, including Single Point Positioning, differential methods, and Precise Point Positioning
- Model and quantify major GNSS error sources, including ionospheric and tropospheric delays, satellite orbit and clock errors, multipath, and receiver noise
- Analyze the impact of satellite geometry and constellation configuration on positioning accuracy using DOP metrics and mission-planning tools
- Process real GNSS observation data using open-source software and evaluate positioning performance through statistical and graphical analysis
- Assess GNSS performance in harsh or degraded environments and explain the need for multi-sensor fusion and alternative PNT strategies
- Describe GNSS applications in space missions, including orbit determination, inter-satellite networking, lunar navigation, and deep-space support techniques
- Explain the role of GNSS in Earth observation and climate science, including radio occultation, reflectometry, and space weather monitoring
- Identify emerging trends in GNSS innovation, such as onboard autonomy, signal authentication, cybersecurity, and resilient PNT architectures
- Apply a systems-engineering perspective to GNSS-based solutions, recognizing trade-offs between accuracy, robustness, autonomy, and operational constraints.

The module comprises of **ten (10)** presentations and videos, titled: **i)** Multi-GNSS Integration and Interoperability, **ii)** Advanced GNSS Signal Processing & Software-Defined GNSS, **iii)** High-Precision GNSS Techniques, **iv)** GNSS in Urban & Harsh Environments, **v)** GNSS Cybersecurity & Signal Authentication, **vi)** GNSS for Space Applications, **vii)** AI & Machine Learning in GNSS, **viii)** GNSS for Earth Observation, **ix)** GNSS Business, Policy and Spectrum Regulation, **x)** Hands-on GNSS Field Testing & Industry Collaboration

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Figure 22: Module 4. Gaps in GNSS education-Presentations and videos samples.

Module 5: Natural hazard detection using space Geodetic techniques

Space geodesy provides a powerful framework for observing the Earth system and its dynamic interactions with the atmosphere and ionosphere. By exploiting satellite-based measurement techniques such as GNSS, Satellite Laser Ranging (SLR), DORIS, VLBI, and satellite altimetry, space geodesy enables precise monitoring of signal propagation effects that are strongly influenced by atmospheric and ionospheric conditions. This module introduces the fundamental principles of geodesy and space geodesy before examining how electromagnetic signals interact with the troposphere and ionosphere, leading to measurable delays, refraction effects, and plasma-related disturbances. It further explores how natural hazards and extreme events—including earthquakes, tsunamis, thunderstorms, and volcanic eruptions—generate atmospheric and ionospheric waves that can be remotely sensed from space. Through theoretical foundations, observational techniques, and real-world case studies such as the 2011 Tohoku earthquake, learners will gain insight into how space geodetic observations contribute to Earth system science, natural hazard monitoring, and emerging early warning and sensing capabilities.

By the end of this module, learners will be able to:

- Explain the fundamental principles of geodesy and space geodesy and classify the main space geodetic techniques.
- Describe the key characteristics and operational principles of major space geodetic systems, including GNSS, Satellite Laser Ranging (SLR), and DORIS.
- Describe the structure of the Earth's atmosphere and distinguish between its main layers relevant to space geodetic measurements.
- Explain the physical principles governing signal propagation in the troposphere, including refraction, propagation delay, and the separation of wet and dry delay components.
- Describe how the tropospheric refractive index is integrated along the signal path and define the concept of Zenith Total Delay (ZTD).
- Explain the fundamental properties of the ionosphere and describe how electromagnetic signals propagate through ionospheric plasma.
- Distinguish between group and phase velocities and explain their relevance to ionospheric signal delays.

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- Explain how different space geodetic techniques probe and sense the ionosphere, including GNSS, satellite altimetry, VLBI, and Low Earth Orbit (LEO) missions.
- Describe the principles of GNSS remote sensing of the ionosphere, including Total Electron Content (TEC) estimation.
- Explain the origin, characteristics, and classification of ionospheric irregularities and their impact on space-based measurements.
- Describe the generation and propagation of atmospheric waves, including gravity waves and acoustic waves, and explain the concept of vertical coupling between the troposphere and ionosphere.
- Explain how natural hazards, such as earthquakes, tsunamis, thunderstorms, and volcanic eruptions, generate Ionospheric Gravity Waves (IGWs) and Ionospheric Acoustic Waves (IAWs).
- Describe the physical principles of tsunami generation and compare different techniques used for tsunami detection, including space-based approaches.
- Analyse real-world case studies, such as the 2011 Tohoku earthquake, to assess the ionospheric signatures of large geophysical events.
- Explain how ionospheric observations can support alternative and complementary approaches for tsunami detection, including those related to volcanic eruptions
- Describe the physical processes associated with thunderstorms and volcanic eruptions and explain their effects on the ionosphere.
- Identify methods for detecting IGWs and IAWs generated by severe weather and volcanic activity using space geodetic observations.

The module comprises of **eight (8)** presentations and videos, titled: **i)** Space Geodesy**, ii)** The troposphere, **iii)** The Ionosphere Part 1**, iv)** The ionosphere Part 2**, v)** Ionosphere irregularities**, vi)** Natural Hazards**, vii)** Detecting Natural Hazards Part 1, **viii)** Detecting Natural Hazards, Part 2.

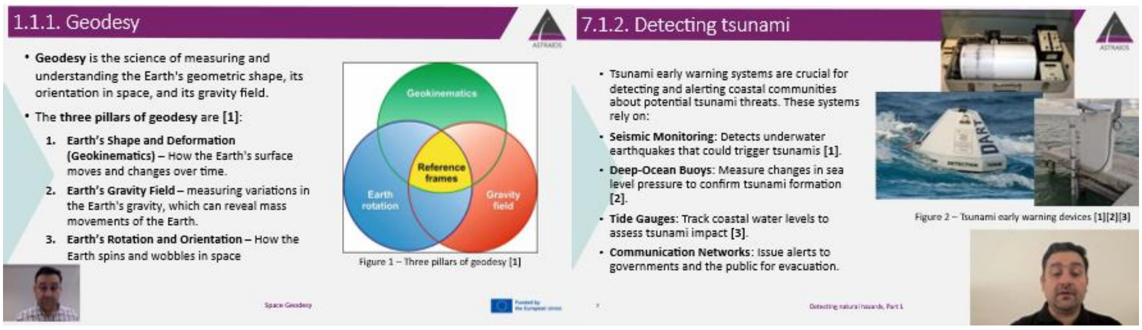

Figure 23: Module 5. Natural hazard detection using Space geodetic techniques- Presentations and videos samples.

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Module 6: Smartphone centimeter level positioning

The widespread availability of smartphones equipped with multi-constellation GNSS receivers and embedded sensors has transformed personal devices into powerful platforms for positioning and navigation. While traditional smartphone positioning has been limited to meter-level accuracy, recent advances in raw GNSS measurements, carrier-phase access, multi-GNSS support, and sensor integration now enable centimeter-level positioning under suitable conditions. This module introduces the fundamental principles of GNSS positioning before focusing on smartphone-based implementations, including GNSS observables, positioning models, and both point and relative positioning techniques. It examines the unique characteristics and limitations of smartphone sensors, the evolution of Android GNSS capabilities, and the challenges of achieving high accuracy in diverse environments. Through practical positioning workflows, scenario-based analyses, and emerging approaches such as AI-assisted data integration, learners will gain a comprehensive understanding of how high-precision GNSS techniques can be adapted to mass-market devices and applied in real-world urban, rural, and complex environments.

By the end of this module learners will be able to:

- Explain the basic principles of GNSS positioning and identify the main global GNSS constellations relevant to smartphone navigation.
- Describe GNSS observables (code and carrier phase) and distinguish between point and relative positioning techniques used for high-accuracy applications.
- Explain how modern smartphones perform GNSS positioning and recognize the evolution of smartphone GNSS capabilities and sensor access.
- Identify the main smartphone positioning sensors (GNSS, inertial, Wi-Fi, cellular) and recognize their limitations and error sources.
- Describe standard smartphone positioning workflows, including Single Point Positioning (SPP) and Real-Time Kinematic (RTK) approaches.
- Assess the challenges of achieving centimeter-level accuracy in urban, rural, and complex environments.
- Explain how sensor fusion and AI-based methods can improve the accuracy and robustness of smartphone positioning solutions.

This module comprises of **three (3)** presentations and videos, titled: **i)** Positioning using GNSS, **ii)** Smartphone positioning, **iii)** High Accuracy Smartphone Positioning Using GNSS.

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Figure 24: Module 6. Smartphone centimeter level positioning.

2.4.3 Evaluation and update of the MOOCs content

The assessment of the MOOC materials followed the same structured and consistent evaluation process described in section 2.3.3. For each module, a representative—either from other organization in the consortium or from the same organization—completed the evaluation form (Table 4) to provide focused and coherent feedback. All modules followed this procedure to ensure consistency across the deliverable. Comments and suggestions from the evaluation forms were directly addressed and incorporated into the materials, contributing to improved quality of the final products. The evaluation involved individuals from diverse organizations, representing perspectives from education, technical institutions, and the private sector.

The evaluation forms can be found in Appendix B.

2.5 Webinars

2.5.1 General information

To address the identified gaps, the team organized a dedicated webinar series to build skills and knowledge for the Copernicus (EO) and Galileo (PNT) downstream sectors.

Experts lead the webinars, covering foundational concepts and applied use cases to show how EO, AI, and space-based technologies translate into practical solutions. The series emphasizes real-world applications, fosters capacity building, and engages participants through interactive discussions and Q&A sessions.

Most webinars were scheduled every two weeks at a consistent CET/CEST time, making the series easy to follow and allowing participants to plan and engage regularly. We have completed and published 14 webinars in total. Table 5 shows the complete list of the webinars series and a summary of each topic, including the presenter is described in section 9.1.2.

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Table 5: List of all the webinars in the series

No.	Dates	Presenter	Title of the Webinar
1	7-2-2025	Paulo Raposo	GeoXR: Its Characteristics and Uses
2	14.05.2025	Luiz Cortinhas	Uncontrolled Illegal Mining and Garimpo in the Brazilian Amazon
3	16.05.2025	Dimitris Ampatzidis	Geodetic Reference Systems and their Applications
4	11.06.2025	Claudio Persello	Machine Learning and Earth Observation for the Sustainable Development Goals – Focus on SDG 2 and 11
5	25.06.2025	Raian Vargas Maretto	Artificial Intelligence for integrating multiple types of Remote Sensing data for Sustainability applications
6	09.07.2025	Michael Marshall	Monitoring Rangeland Carrying Capacity with Earth Observation
7	20.08.2025	Marloes Penning de Vries	Monitoring air quality from space
8	03.09.2025	Funda Atun	Promoting disaster preparedness and resilience by co-developing stakeholder support tools for managing the systemic risk of compounding disasters and the role EO
9	17.09.2025	Monika Kuffer	From Space to Place: Mapping Inequalities in Complex Urban Spaces by combining Earth Observation, AI, and Citizen Science
10	01.10.2025	Mila Koeva	Earth Observation and Geospatial Data for Digital Twins: Global Perspectives for Sustainable Development
11	15.10.2025	Stavroula Panagiotidou	From Space to Sustainability: Using EO and Geospatial Data for ESG Reporting
12	29.10.2025	Mahdi Alzadeh	Space Geodetic Techniques for Remote Sensing the Ionosphere and Natural Hazard Detection
13	12.11.2025	Konstantin Maslov	Large-Scale Glacier Monitoring with Earth Observation and Deep Learning
14	10.12.2025	Konstantinos Kokolakis	The Multifaceted Role of GNSS in ECV Monitoring with Satellite Altimetry

The webinars were promoted using multiple channels to reach the largest and most diverse audience possible.

- For each webinar, a dedicated email template was prepared and shared with the consortium for wide circulation through mass mailing.
- The webinars were actively promoted at least five days in advance on ASTRAIOS social media

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platforms, including LinkedIn (with over 400 followers) and X, and were subsequently

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reposted by the ASTRAIOS consortium, whose most members have more than 300 followers. Figure 25 illustrates Webinar 14 as an example of an advertisement template used for LinkedIn webinar promotion.

- Several webinars were also advertised on the LinkedIn page of the Faculty of Geo-Information Science and Earth Observation (ITC) at the University of Twente, which reaches over 46,000 followers.

Most webinars were also shared on the Digital EU Space Ecosystem Platform, to further extending their reach to the European space community.

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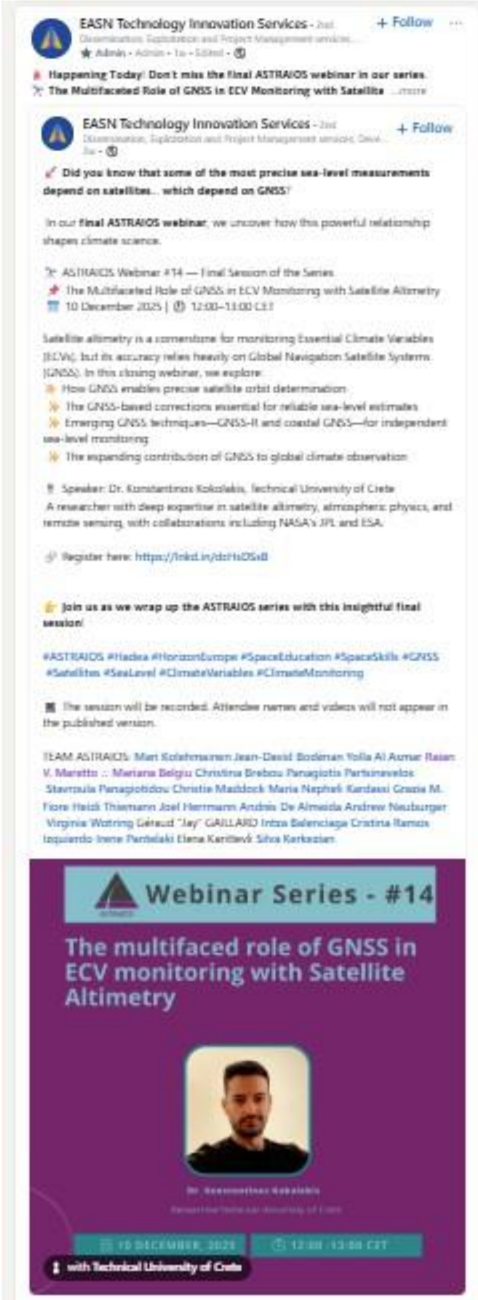

Figure 25: Example of a LinkedIn advertisement template for webinar promotion.

The webinars attracted a varied audience, with participation interests and levels differing across sessions. All webinars were recorded to ensure that the content remained accessible beyond the live sessions. The recordings were disseminated through multiple platforms to reach a broader audience, including the ASTRAIOS Knowledge Hub and the project's YouTube channel.

The webinars achieved strong participant engagement overall, with LinkedIn proving more effective than X in reaching and engaging audiences from the space sector. Across LinkedIn, a total of 623 likes were recorded, with an average of 45 likes per webinar. Webinar 4 on *Machine Learning and Earth*

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Observation for the Sustainable Development Goals received the highest engagement with 110 likes,

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followed by webinars 9 ,8 and 11. Engagement levels were influenced by several factors, including LinkedIn's algorithm, seasonal variations such as summer breaks, the number of reposts by partners or speakers, and the overall attractiveness of the webinar topic to the audience, with highly technical topics attracting less attention than the more applied ones.

Website analytics further demonstrate the impact of the dissemination efforts. The ASTRAIOS website recorded 251 page views on the Knowledge Hub and 105 page views on the webinar's pages. Together, the webinars summed 314 attendants and 393 registrations, with an average of 23 attendants and 28 registrations per webinar. The registration page of the webinars accounted a total of 890 viewers, with an average of 64 viewer per registration page. Webinar 5 had the highest number of attendants (44) and webinar #3 had the highest number of registrations (75). On the project's YouTube channel, the recorded webinars accumulated approximately 477 views in total, with an average of 35 views per webinar. Webinar 4, with the highest number of likes also had the maximum views, reaching 80, followed by webinars 5, 11 and 3.

Together, the ASTRAIOS Knowledge Hub and YouTube channel act as complementary dissemination platforms. They ensure that the webinar content remains accessible beyond the project's lifetime, allowing the material to continue reaching new audiences over time.

2.5.2 Summary of each topic and presenter, number of attendees

Webinar Series No 1: GeoXR: Its Characteristics and Uses

This webinar discussed the use of mixed reality (XR) technologies in geospatial data analysis, visualization, and management. GeoXR offers an intuitive modality for viewing and interacting with geospatial data because both XR and geography are intrinsically spatial; XR allows for 3D, immersive cartography and information visualization, as well as relatively natural interaction modalities using hand gestures and embodied movement. This webinar will discuss present and future possible applications of GeoXR technology and the skills and resources necessary to engage with them, using examples of studies from the Faculty ITC, University of Twente.

Presenter: Dr. Paulo Raposo, Assistant Professor, Faculty ITC, University of Twente

Attendants alive: 22; Visualizations on YouTube on 23-Dec-2025: 29

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Webinar Series No 2: Uncontrolled Illegal Mining and Garimpo in the Brazilian Amazon

This webinar discussed the application of Deep Learning, particularly U-shaped CNNs, offers powerful tools for remote sensing change detection. This presentation demonstrates an automatic U-Net based methodology to detect and map industrial and artisanal mining areas in Brazil using 37 years (1985-2022) of annual Landsat mosaics. Spatially validated by specialists, the U-Net achieved an average 99% overall accuracy and 91% for producer and user accuracies. Results reveal a tenfold increase in mining area to 4500 km², with artisanal mining showing the largest proportional growth. here is also presented the modified U-Net by reducing the number of trainable parameters by 30%. The proposed methodology effectively provides accurate and current mining data for environmental management and territorial planning.

Presenter: Dr. Luiz Cortinhas, CTO at Solved Geoinformation Solutions

Attendants alive: 28; Visualizations on YouTube on 23-Dec-2025: 46

Webinar Series No 3: Geodetic Reference Systems and their applications

The webinar focused on the description of the geodetic reference systems in terms of their theoretical background, their construction and their contribution in a wide range of applications. The audience will take some fundamental knowledge for the necessity of the geodetic reference systems, the sophisticated methodology of how they are established and how the geodetic reference systems play crucial role in a huge variety of daily practice for many users. The core of the webinar is the description of International Terrestrial Reference Systems (ITRS) and its realization, called International Terrestrial Reference Frame (ITRF). In addition, there was some discussion on the regional Terrestrial Reference Systems, such as the European (ETRS89).

Presenter: Professor Dimitris Ampatzidis, Assitant Professor, International University of Thessaloniki

Attendants alive: 42; Visualizations on YouTube on 23-Dec-2025: 51

Webinar Series No 4: Machine Learning and Earth Observation for the Sustainable Development Goals – Focus on SDG 2 and 11

This webinar discussed the integration of machine learning and Earth observation (EO) technologies for advancing the reporting and development towards the United Nations Sustainable Development Goals (SDGs). The webinar showcased cutting-edge research and practical applications that directly support SDG Target 2.3 (doubling the productivity and incomes of small-scale food producers) and SDG Target 11.1 (ensuring access to adequate, safe, and affordable housing). We explored deep learning methodologies for delineating agricultural field boundaries to support the mapping of smallholder farms in Africa and Southeast Asia—an essential step in enabling data-driven agricultural monitoring and policy. Additionally, we will highlight recent developments in EO-based approaches for identifying and characterizing deprived urban areas (commonly referred to as informal settlements or slums), which are critical for tracking progress on Indicator 11.1.1.

Presenter: Prof. Claudio Persello, Adjunct Professor, Faculty ITC, University of Twente.

Attendants alive: 33; Visualizations on YouTube on 23-Dec-2025: 83

Webinar series No 5: Artificial Intelligence for integrating multiple types of Remote Sensing data for Sustainability applications

This webinar discussed the use of AI for combining different types of Remote sensing data on a large scale to monitor Earth's surface, providing insights into environmental, urban, and socio-economic changes, and supporting the development towards the Sustainable Development Goals (SDGs). In recent years, advancements in Artificial Intelligence, particularly Deep Learning (DL), have significantly enhanced the analysis and interpretation of remote sensing data, enabling the development of fully automated systems for diverse applications. In the context of environmental conservation, we have developed DL models for mapping deforestation, moving forward in the direction of developing an automated near-real-time deforestation detection system. Additionally, AI-powered techniques have enabled accurate estimation of aboveground biomass, which can contribute to more effective carbon stock assessment and climate change mitigation strategies. We have also developed a tool for detecting illegal mining activities in the whole Brazilian territory, mappping deprived urban areas, among others. Despite these advancements, integrating AI into remote sensing applications comes with significant challenges. Besides discussing some of those applications, we will raise and discuss some of the current major challenges in the field.

Presenter: Dr. Raian Vargas Maretto, Assistant Professor, Faculty ITC, University of Twente

Attendants alive: 44; Visualizations on YouTube on 23-Dec-2025: 77

Webinar Series No 6: Monitoring Rangeland Carrying Capacity with Earth Observation

This webinar discussed how overgrazing degrades grasslands and how Earth Observation (EO) can help manage rangeland sustainability. It introduced the concept of carrying capacity—the maximum number of animals a rangeland can support without ecological damage—in the context of the Noy-Meir grazing model. Noy-Meir is the foundation of modern grazing-system models. While modern grazing-system models capture complex ecological interactions, they are often too detailed for regional application. The talk highlights the potential of EO tools, including vegetation indices, production efficiency models (e.g., Sentinel-3 dry matter productivity), and machine learning, to monitor biomass and estimate carrying capacity at larger scales. The ESA LUISA project demonstrates how EO enables data-driven rangeland management decisions by tracking forage availability, productivity,

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and livestock density across Africa. The presentation concludes that while EO offers scalable

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solutions, limitations remain, such as lacking species-level forage detail and the exclusion of shrubland dynamics.

Presenter: Dr. Michael Marshall, Associate Professor, Faculty ITC, University of Twente

Attendants alive: 8; Visualizations on YouTube on 23-Dec-2025: 37

Webinar Series No 7: Monitoring Air Quality from Space

This webinar discussed air quality: what does it encompass, what are the main sources of pollution and how does it affect health? Different types of air quality measurements will be demonstrated, from ground-based stations to satellite-borne instruments. And finally, some applications of satellite-based air quality monitoring will be presented. Air pollution is one of the major environmental factors affecting humans, yet the associated health effects often appear gradually over a long time period. For this reason, air pollution is known as the “silent killer”, affecting almost every single human on the planet – particularly children. Keeping a close eye on air quality is an important step towards cleaner air, as major sources can be identified and targeted for action to mitigate pollution. Moreover, spatial, temporal, and weather-dependent patterns may be examined and used to develop local adaptation strategies.

Presenter: Dr. Marloes Penning de Vries, Assistant Professor, Faculty ITC, University of Twente

Attendants alive: 15; Visualizations on YouTube on 23-Dec-2025: 33

Webinar Series No 8: Promoting disaster preparedness and resilience by co-developing stakeholder support tools for managing the systemic risk of compounding disasters and the role EO

This webinar discussed the developments and outcomes of the PARATUS project. PARATUS is a Horizon Europe-funded project that aims to increase the preparedness of first and second responders in the face of multi-hazard events and to reduce the risks related to impacts on various sectors that result from complex disasters. The outcome is to develop a cloud-based Online Service Platform that offers support in reducing dynamic risk scenarios and systemic vulnerability caused by multi-hazard disasters. In order to achieve these objectives, the project team performs in-depth assessments of complex interactions between hazards and their resulting impacts in various sectors, as well as analyses the current risk situation and studies how alternative future scenarios could change multi-hazard impact chains. Based on this analysis, scenarios of multi-hazard impacts will be co-designed with stakeholders and developed in four case study areas (including the Caribbean, Romania, Istanbul, and Alpine areas).

Presenter: Dr. Funda Atun, Associate Professor, Faculty ITC, University of Twente

Attendants alive: 22; Visualizations on YouTube on 23-Dec-2025: 17

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Webinar Series No 9: From Space to Place: Mapping Inequalities in Complex Urban Spaces by combining Earth Observation, AI, and Citizen Science

This discussed the methodological innovations that advance our understanding of the morphology, patterns, and dynamics of urban areas through the combination of quantitative and qualitative approaches. The specific focus was on technological advances in Earth Observation, Artificial Intelligence, participatory mapping, and citizen science. Rapid urbanization is reshaping cities worldwide, producing complex urban spaces where opportunities and vulnerabilities meet. While cities generate economic growth, innovation, and access to services, they also reveal stark spatial inequalities, particularly in access to housing, infrastructure, and basic services. These inequalities are most visible in Low- and Middle-Income Countries (LMIC). The accelerating environmental challenges, including air pollution, heat stress, flooding, and other climate-related hazards, further compound social and economic divides, threatening the quality of urban life and the sustainability of urban development. Geospatial data can be efficiently combined with locally grounded knowledge to better capture urban inequalities and access gaps. By integrating methodological innovations with socio-spatial perspectives, this talk seeks to provide an overview of how actionable insights can be generated to inform policies for inclusive, resilient, and sustainable cities.

Presenter: Prof. Dr. Monika Kuffer, Professor of Sustainability of Rural-Urban Systems at the University of Twente

Attendants alive: 24; Visualizations on YouTube on 23-Dec-2025: 13

Webinar Series No 10: Earth Observation and Geospatial Data for Digital Twins: Global Perspectives for Sustainable Development

This webinar discussed the use of Digital Twins on Earth Observation applications. Digital Twins are transforming the way we address global challenges such as climate change, disaster risk reduction, sustainable land use, and infrastructure management. Their effectiveness depends on combining Earth Observation (EO), IoT-enabled near-real-time and real-time data, and geospatial datasets into interoperable, scalable systems. This webinarshows how such data integration enables advanced visualization, simulation, and predictive analytics that can be applied at local, regional, and global levels. By bridging EO, IoT, and AI-powered methods, Digital Twins can provide actionable insights for diverse stakeholders, from city planners and policymakers to global organizations. Examples from ongoing research and applications worldwide will highlight pathways to ensure Digital Twins are inclusive, open, and impactful—delivering evidence-based decision support for a more resilient and sustainable future.

Presenter: Dr. Mila Koeva, Vice Dean of Research and Senior Associate Professor at the Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente

Attendants alive: 35; Visualizations on YouTube on 23-Dec-2025: 21

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Webinar Series No 11: From Space to Sustainability: Using EO and Geospatial Data for ESG Reporting

This webinar explored how Earth Observation (EO) and geospatial data are transforming the way we monitor sustainability in the mining and energy sectors. By integrating satellite imagery, atmospheric and thermal data with geospatial analytics and machine learning, it becomes possible to identify key environmental and social impacts, such as deforestation, emissions, and land-use change, with greater accuracy and transparency. The session highlights how EO-obtained insights can enhance Environmental, Social, and Governance (ESG) reporting by providing verifiable, data-driven evidence that supports compliance with the EU Corporate Sustainability Reporting Directive (CSRD) and contributes to the UN Sustainable Development Goals (SDGs). Participants had a chance to discover how EO and geospatial intelligence can support evidence-based decision-making, enhance accountability, and contribute to a more transparent and sustainable financial and industrial ecosystem.

Presenter: Stavroula Panagiotidou, PhD Candidate at the Technical University of Crete

Attendants alive: 9; Visualizations on YouTube on 23-Dec-2025: 63

Webinar Series No 12: Space Geodetic Techniques for Remote Sensing the Ionosphere and Natural Hazard Detection

For space geodetic techniques, such as Global Navigation Satellite Systems (GNSS), Very Long Baseline Interferometry (VLBI), satellite altimetry missions, and Low Earth Orbit (LEO) satellites, which operate in microwave band, the ionosphere is a dispersive medium. Thus, signals traveling through this medium are in the first approximation affected proportionally to the inverse of the square of their frequencies. This effect enables us to gain information about the parameters of the ionosphere in terms of total electron content (TEC) or the electron density from measurements of such techniques.

The occurrence of some natural hazards in the lower part of the atmosphere, the troposphere, may lead to creation of some energetic waves such as Internal Gravity Waves (IGWs), or acoustic waves. These waves transfer energy from the lower troposphere to upper layers, and to the ionosphere. When these waves reach the ionosphere, they create significant variations the ionospheric TEC and electron density. Tsunamis, volcanic eruptions, typhoons, strong thunderstorms, and heavy rainfalls are among the natural hazards that create such energetic waves.

Tsunami waves and IGWs are known to have similar characteristics such as horizontal speed, frequency, and arrival time. The IGWs horizontal velocity component and the tsunami’s velocity are more or less the same, but the vertical component of the IGWs velocity increases rapidly with the increase in the altitude, therefore the effect of the IGWs propagation through the bottom-side

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ionosphere, which is manifested as ionospheric irregularities, can be detected by the GNSS ground stations in the region of the tsunami, earlier than the tsunami itself.

In the event of a volcanic eruption, IGWs originating from the volcano spread in a cone-shaped pattern. They can be detected earlier than tsunami waves reaching the tide gauges or DART buoys. In the occurrence of typhoon, the vertical and horizontal phase velocities of IGWs are maximum at the eye of the typhoon. These velocities decrease as the IGWs propagate helically on the ocean's surface. When these waves reach land, their vertical and horizontal phase velocities increase, likely due to lower viscosity. In the instance of strong thunderstorms, the activity of acoustic and gravity waves in the ionosphere increases dramatically. Most IGWs are observed during thunderstorms, as well as one to two hours after.

All these phenomena are detectable in the form of IGWs/acoustic waves several minutes to a few hours earlier than current early warning detection systems.

Presenter: Dr. Mahdi Alizadeh, Assistant Professor at KNToosi University of Technology

Attendants alive: 10; Visualizations on YouTube on 23-Dec-2025: 20

Webinar Series No 13: Large-Scale Glacier Monitoring with Earth Observation and Deep Learning

This webinar discussed the use of Deep Learning and Earth Observation Data for mapping and monitoring Glaciers on a global scale. Glaciers are an essential climate variable due to their high sensitivity to temperature and precipitation fluctuations. Their monitoring is crucial for understanding climate change, local hydrology and related hazards. This webinar introduces how Earth Observation, climate data and Deep Learning (DL) enable large-scale monitoring of two critical glacier parameters—area and surface mass balance (SMB). Modern computer vision models allow glacier area mapping with quality comparable to human experts using both optical and Synthetic Aperture Radar imagery. They also enable mapping of different glacier surface types, which can be linked to in-situ SMB measurements. Finally, these mapping products can be assimilated into a physics-aware DL framework to infer SMB in an interpretable manner. This integration of satellite data and AI brings us closer to continuous, global and physically consistent glacier monitoring, making an essential step toward understanding and adapting to our changing climate.

Presenter: Konstantin A. Maslov, PhD Candidate, Faculty ITC, University of Twente

Attendants alive: 5; Visualizations on YouTube on 23-Dec-2025: 22

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Webinar Series No 14: The Multifaceted Role of GNSS in ECV Monitoring with Satellite Altimetry

Satellite altimetry is one of the primary techniques used to monitor Essential Climate Variables (ECVs), providing crucial information on sea level, wind speed, ocean currents, and other oceanographic parameters. However, to ensure that these measurements are accurate and meaningful, satellite altimetry depends on Global Navigation Satellite Systems (GNSS) in several ways. First, GNSS plays a fundamental role in determining the satellite's precise orbit, which is essential for locating the altimeter relative to Earth. Accurate orbital parameters directly influence the quality of the altimetric height measurements. In addition, the main observable of satellite altimetry—the range between the satellite and the sea surface—relies on several geophysical and instrumental corrections derived from GNSS-based products, helping achieve reliable sea-level estimates.

Furthermore, recent advances in GNSS technology have expanded its role beyond supporting satellite altimetry. Both satellite-based and ground-based GNSS applications, including GNSS reflectometry (GNSS-R) and coastal GNSS stations, can independently estimate sea level, providing complementary observations for climate monitoring.

Attendants alive: 13; Visualizations on YouTube on 23-Dec-2025: 21

2.5.3 Presentation of the ASTRAIOS website hosting the webinars

All webinars are hosted on the ASTRAIOS project website within the Knowledge Hub on a dedicated, user-friendly page. The page lists all webinars with their titles and presenters, ordered from the most recent to the oldest. Each entry includes a direct link to the webinar page, which opens the recorded session in a new webpage for convenient viewing. A screenshot of the webinar page is shown in Figure 26, and the link to the webinar page is provided in the report.

In addition, the recorded webinars are published on the ASTRAIOS YouTube channel alongside other project outputs. The channel displays content in order from the most recent uploads, while also offering other viewing options such as most popular, oldest, and standard search to help users locate specific webinars. A screenshot of the ASTRAIOS YouTube channel is provided in Figure 27, and the link to the channel is also included in the report.

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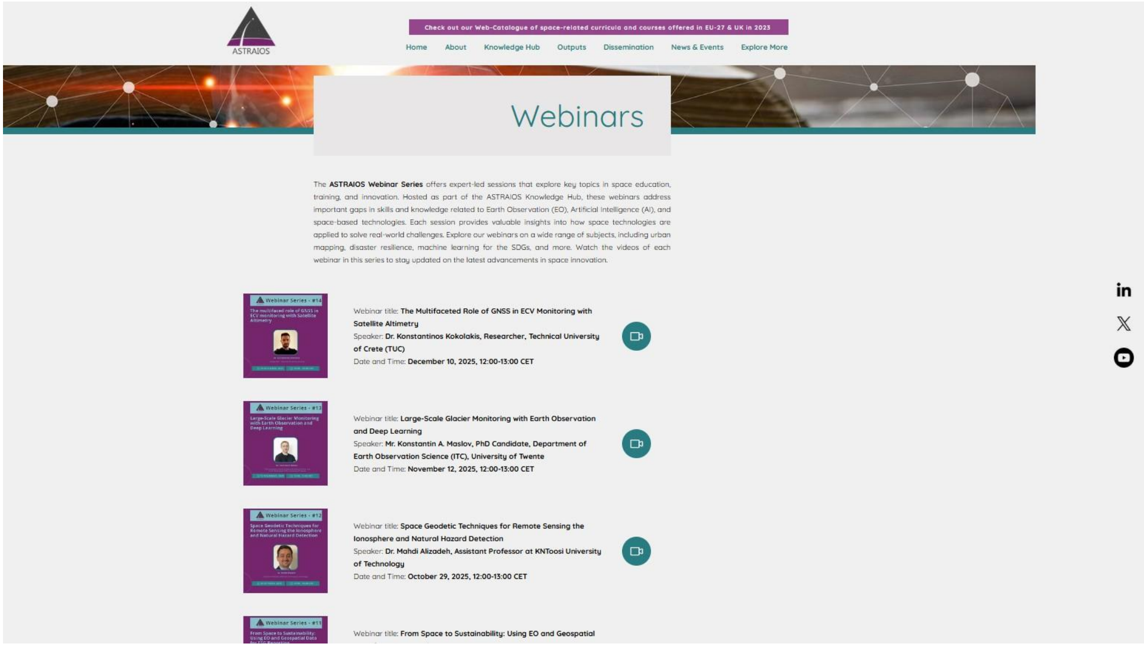

Figure 26: ASTRAIOS Knowledge Hub showing webinars page arranged from newest to oldest.

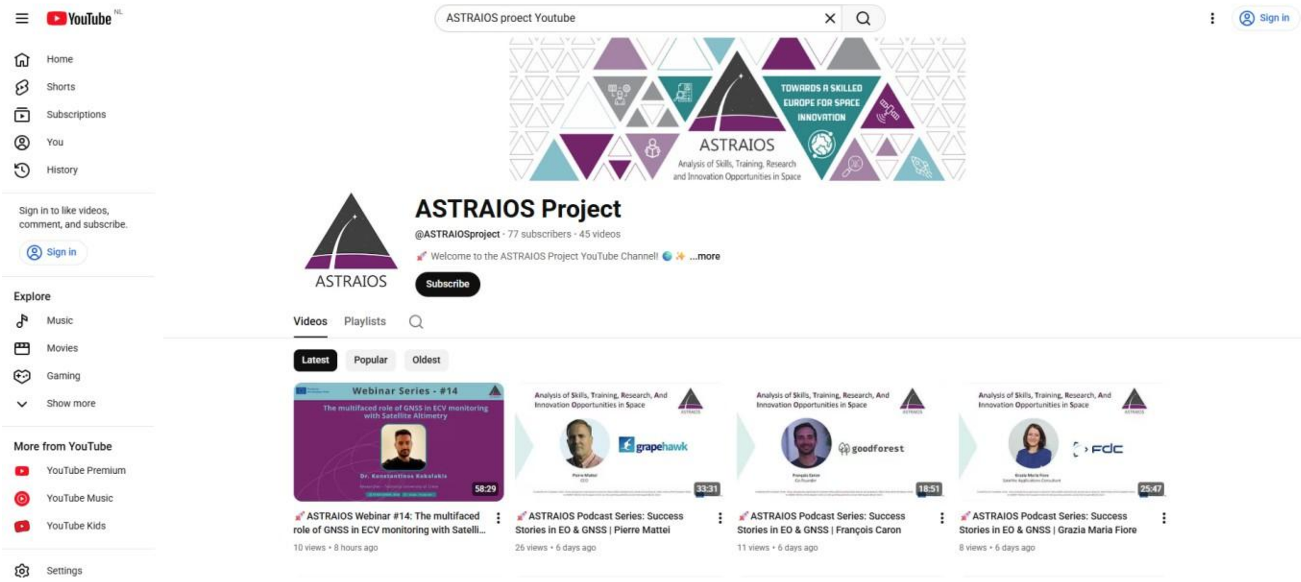

Figure 27: ASTRAIOS YouTube channel showing the recorded webinars and project outputs.

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3 DISCUSSION AND CONCLUSIONS

The work carried out under Task 4200 demonstrates how targeted educational interventions can effectively address skills gaps in the European downstream space sector, particularly in EO and Positioning, Navigation and Timing (PNT/GNSS) domains. By combining a structured skills gap analysis with the development of modular and accessible training materials, the task contributes directly to ASTRAIOS' objective of strengthening the link between education, research, and industry needs.

A key strength of the approach lies in the multi-source methodology used to identify skills gaps. The integration of skill gaps and industry surveys, the ASTRAIOS Knowledge Catalogue, scientific publication trends, and existing ESA training offerings provided a robust evidence base for prioritising knowledge areas and domains. This ensured that the developed training materials were not duplicative of existing resources, but instead targeted underrepresented and high-demand competencies, such as geospatial data analytics, machine learning, agricultural EO applications, land and climate monitoring, and GNSS-based technologies. The consistency observed between industry demand signals and research trends further confirms the relevance of these choices.

The resulting portfolio of training materials reflects a balanced and complementary structure. With a total of 314 attendants distributed across the whole series, and approximately 480 views on the YouTube channel (until 23rd of December, 2025), the webinar series has enabled rapid dissemination of expert knowledge and facilitated exposure to a broad range of interdisciplinary downstream applications, whereas the MOOCs provided a more structured and in-depth learning pathway. The MOOC on Earth Observation and Machine Learning for Agricultural Applications addresses a clearly identified gap in existing European training offerings. While several high-quality ESA MOOCs cover foundational EO concepts and thematic Copernicus areas, none provide a comprehensive integration of EO data, machine learning techniques, and agriculture-focused use cases. The ASTRAIOS MOOC therefore fills a critical niche by linking technological methods to real-world challenges related to food security, sustainability, and land management, in line with EU priorities such as the Farm to Fork Strategy and the European Green Deal.

The development of the MOOC on **Global Navigation Satellite Systems (GNSS) Applications and Capabilities** responds to a recognized shortfall in European training programs. Existing courses, while effective in introducing core GNSS concepts, rarely provide structured pathways connecting advanced positioning techniques, resilient navigation, and practical implementation in real-world contexts such as autonomous systems or environmental monitoring. This course offers a targeted application-oriented curriculum and supports the development of specialized skills that that are increasingly demanded in research and industry. Its focus aligns with European priorities, including the **EU Space Programme**, the **Digital Europe Strategy**, and broader objectives for technological innovation and digital sovereignty, helping ensure that workforce capabilities keep pace with evolving GNSS applications and societal needs.

The alignment of all training materials with the ASTRAIOS pedagogical framework and the European Qualification Framework (EQF) levels 6 and 7 further strengthens their relevance and usability in higher-education and professional training contexts. This alignment supports transparency regarding learning outcomes and facilitates potential reuse or integration of the materials into formal curricula, lifelong learning programmes, or industry-led training initiatives.

Quality assurance was addressed through a structured internal content-focused evaluation, in which consortium members acted as course participants and reviewed the training materials against predefined criteria. This assessment provided a systematic and expert-based review of content quality, coherence, learning outcomes, and presentation standards. This approach is appropriate at the development stage and ensured that the materials reached a level of maturity and robustness suitable for wider deployment. The assessment outcomes informed targeted refinements and confirmed the overall readiness of the training portfolio.

At the same time, some limitations should be acknowledged. While the materials are designed to be modular and adaptable, their long-term impact will depend on sustained dissemination, updates to reflect technological advances, and continued alignment with evolving industry needs.

In conclusion, Task 4200 makes a substantial contribution to the ASTRAIOS project by delivering high-quality, modular, and policy-aligned educational resources that address critical skills gaps in the European EO and GNSS downstream sectors. The combination of evidence-based topic selection, structured pedagogical design, and internal quality assessment provides a strong foundation for future capacity-building activities. These results demonstrate the potential of ASTRAIOS training materials to support workforce development, foster innovation, and enhance Europe’s competitiveness in space-based and data-driven applications.

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APPENDIX A – ASTRAIOS SURVEY ON FUTURE SKILLS GAPS

Fields marked with * are mandatory.

Disclaimer
The European Commission is not responsible for the content of questionnaires created using the EUSurvey service - it remains the sole responsibility of the form creator and manager. The use of EUSurvey service does not imply a recommendation or endorsement, by the European Commission, of the views expressed within them.

Anonymous mode
The anonymous option has been activated. As a result, your contribution to this survey will be anonymous as the system will not save any personal data such as your IP address.

Introduction

ASTRAIOS project aims at providing an exhaustive view and understanding of the current and future offer of Space curricula and **courses in the EU-27 and the UK**. https://www.astraios.eu/

- -

Q1: Please specify **the country** in which your organization is located.

Q2: Please summarize **your background** using just 2-3 keywords?

Q3 Which **gender** do you identify as?

- F
- M
- X
- Prefer not to say

Q4: What specific **skills and knowledge** are necessary for effectively using **Earth Observation data and services** to address today's global challenges?

Q5: What specific **skills and knowledge** are necessary for effectively using **Positioning, Navigation and Timing PNT data and services (GNSS)** to address today's global challenges?

Q6: Which **application domains** can or should make greater use of Earth Observation data and services, including PNT?

Q7: Which **skills** do you find most **lacking, in need of improvement, or increasingly important** for the future in the downstream sector?

Disclaimer!

The survey is designed to maintain the anonymity of participants. All the data provided will be handled confidentially, and the information will be published in an aggregated form that does not trace to individual entries. The analysis does not

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include any personal data.

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Completed

Your answers have been submitted successfully. Thank you a lot for your contribution.

Table 6: Results collected in the Survey on Future Skill Gaps.

Alias	fbe457e1-d486-4591-d59d-bc900369941b					
Export Date	22-12-2025 13:40					
Q1:Please specify the country in which your organization is located.	**Q2: Please summarize your background using just 2-3 keywords?**	**Q3 Which gender do you identify as?**	**Q4: What specific skills and knowledge are necessary for effectively using Earth Observation data and services to address today's global challenges?**	**Q5: What specific skills and knowledge are necessary for effectively using Positioning, Navigation and Timing (PNT) data and services (GNSS) to address today's global challenges?**	**Q6: Which application domains can or should make greater use of Earth Observation data and services, including PNT?**	**Q7: Which skills do you find most lacking, in need of improvement, or increasingly important for the future in the downstream sector?**
Finland	SAR Remote Sensing	M	Physics, programming	Physics	Policy making	
Netherlands	Sar	M	Sar	Eo	Environmental studies	Deep understanding of the concept and coding capabilities
netherlands	Radar, forest, change	F	Programming skills, communication skills	Programminf skills		
The Netherlands	Lidar, forestry, satellite	M	Knowledge of remote sensing, image analysis and processing	GIS, programming, communication skills	Forestry, agriculture, urban planning	Communication skills

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Netherlands	Remote Sensing	M	remote sensing, gis, data analysis, sales		agriculture, environment, water, urban	geo-data engineering skills
The Netherlands	Machine learning	M	Remote sensing, statistics, data analysis		Glaciology, forestry	Experiment design, validation protocols
Austria	Remote sensing, data science, computer vision	M	Math and programing for data science	Famikiarity with the devices plus science behind it	Emergency response	
UK	Space situational awareness	F	Not sure	Not sure	Finance	coding skills, GIS skills, ability to talk to clients

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APPENDIX B – MOOC EVALUATION FORMS

The evaluation forms follow the same order as the modules of the two MOOCs described in this document. Table 7 presents the number of evaluation forms and the corresponding evaluated modules.

Table 7: Number of evaluation forms and the corresponding evaluated modules.

Number	Name of the MOOC	Number and Name of the Module
Training Material Evaluation 1	Earth Observation data and Machine learning for agriculture applications	Module 1: General introduction to Earth Observation data and machine learning for agriculture applications
Training Material Evaluation 2	Earth Observation data and Machine learning for agriculture applications	Module 2: Linking Geospatial Challenges to EO Sensors
Training Material Evaluation 3	Earth Observation data and Machine learning for agriculture applications	Module 3: General introduction to machine learning
Training Material Evaluation 4	Earth Observation data and Machine learning for agriculture applications	Module 4: Earth Observation and machine learning for crop mapping
Training Material Evaluation 5	Earth Observation data and Machine learning for agriculture applications	Module 5: Geospatial and earth observation data acquisition and processing for crop grain nutrient estimation
Training Material Evaluation 6	Earth Observation data and Machine learning for agriculture applications	Module 6: Geospatial data, Earth Observation and machine learning for crop grain nutrient estimation
Training Material Evaluation 7	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 1: Galileo Services
Training Material Evaluation 8	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 2: GNSS for Essential Climate Variable Monitoring
Training Material Evaluation 9	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 3: GNSS-denied environments & drones
Training Material Evaluation 10	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 4: . Gaps in GNSS education

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Training Material Evaluation 11	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 5: Natural hazard detection using space geodetic techniques-ppts 1 to 6
Training Material Evaluation 12	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 5: Natural hazard detection using space geodetic techniques ppts 6 to 8
Training Material Evaluation 13	Global Navigation Satellite Systems (GNSS) Applications and Capabilities	Module 6: Centimeter-Level Position Accuracy Using Smartphones

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Training Material Evaluation 1

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is December 2, 2025. The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Michael Marshall, ITC
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.		*Slide 7, 9 and 10 there are minor typoes*	*Clear structure, consistent layout, professional design*
Are all visuals, figures, and text clear, readable and in the correct resolution?	*x*		*Figures and diagrams are readable and well-scaled.*
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*x*		*Visuals align well with EO and ML concepts.*
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	x		*Content progresses from concepts to applications smoothly.*
Do the slides give a professional impression?	*x*		*Slides meet academic and professional standards.*

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Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			*NA*
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	x		Title accurately represents lecture scope.
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	X		Learning objectives are clearly stated and aligned.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	X		Objectives are specific, measurable, and appropriate
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	x		Content is scientifically sound and well referenced.
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	x		
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	X		
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?	x		Appropriate for Bachelor/Master level learners.
Are practical examples or case studies provided to illustrate the material effectively?	x		Includes real-world EO and agriculture examples.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		x	
The content matches the learning outcomes.	x		Strong alignment observed.
Is the content properly cited and compliant with copyright laws?	x		

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Does the content use only authorised materials and appropriately credit sources?	x		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	1		
Do you have any general recommendations for improvements?			Consider adding optional hands-on datasets for practice.

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Training Material Evaluation 2

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is December 2, 2025. The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Mariana Belgiu, ITC
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.	x		*Several typos and spacing issues (e.g., asses → assess, shooter → shorter, inconsistent spacing). Needs proofreading.*
Are all visuals, figures, and text clear, readable and in the correct resolution?	x		*Mostly readable, but some slides are text-heavy (e.g., Accessibility issues slide in EO Sensors) and could be split.*
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	x		*Visuals are relevant (orbits, EM spectrum), but some only have source credits without explanatory captions (e.g., AI-generated EO sensor images).*

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The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	x		*Clear flow from basics → sensors → applications (especially strong in 4-step approach deck).*
Do the slides give a professional impression?	*x*		*Slides meet academic and professional standards.*
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			*Standardize fonts, spacing, bullet styles*
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	x		Title matches well (missions, sensors, EO-based solutions).
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	X		Clear and aligned, e.g., "describe principles of space-based data acquisition," but mostly use verbs like understand.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	X		Objectives are specific, measurable, and appropriate
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	x		Content is scientifically sound and well referenced.
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	x		
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	X		
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?	x		Appropriate for Bachelor/Master level learners.

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Are practical examples or case studies provided to illustrate the material effectively?	x		Good examples (land cover, crop health)
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		x	
The content matches the learning outcomes.	x		Yes, workflow and examples directly support outcomes.
Is the content properly cited and compliant with copyright laws?	x		Many sources credited (ESA, USGS), but some refs incomplete (e.g., “Year”)
Does the content use only authorised materials and appropriately credit sources?	x		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	1		
Do you have any general recommendations for improvements?	x		standardize references and captions.

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Grant Agreement No: 101082636

Training Material Evaluation 3

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is [4th of July 2025]. The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Reham, University of Strathclyde
Would you like to provide your evaluation anonymously? YES/NO:	No

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.			
Are all visuals, figures, and text clear, readable and in the correct resolution?	*Yes*		
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*Yes*		
The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	Yes		
Do the slides give a professional impression?	*Yes*		
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			**Module_3**[illegible] Slide 9: th[illegible] is overlapped, make it hard to rea[illegible] ***raian*** *2025-08-07 11:27:32* --- Fixed! **Module_3_video_2_How_ML_works:** Slide 6: Grammar error
Content			

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Grant Agreement No: 101082636

When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	Yes		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	Yes		
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	Yes		
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	Yes		
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	Yes		
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.		No	**Module_3_video_3_types_classifiers: Slide 9:** N... in detail.
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?	Yes		
Are practical examples or case studies provided to illustrate the material effectively?		No	I suggest ... various fo... images.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?			
The content matches the learning outcomes.	Yes		
Is the content properly cited and compliant with copyright laws?	Yes		
Does the content use only authorised materials and appropriately credit sources?	Yes		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	2		
Do you have any general recommendations for improvements?			**Module_3**... suggest re... Section 1: “Why do we need Mac...

raian
2025-08-07 11:28:00

It's because the detailed explanation will be given by talking. I use the images as triggers for that.

raian
2025-08-07 11:28:55

This will be done through the practices. I prefered including simpler didactic examples in the videos only, so they don't become too long.

raian
2025-08-07 11:29:16

Great suggestion! Done!

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			“Background Information” or “Setting the Context” **Module_3** I suggest Nearest N Video 2 s introductio in Video 3 **General**: related to

raian
2025-08-07 11:30:11

I think this inversion would make it a bit harder to understand. Because the idea there is also explaining how ML

raian
2025-08-07 12:08:55

I thought about adding that in the mooc page. Is that ok?

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Training Material Evaluation 4

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is December 2, 2025. The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Michael Marshall, ITC
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.		*Minor typos in the learning objectives*	*Clear structure, consistent layout, professional design. The slides are visually consistent and professionally formatted. However, some slides are relatively dense, and reducing text or splitting complex figures across multiple slides could improve readability and learner focus.*
Are all visuals, figures, and text clear, readable and in the correct resolution?	*x*		*Most visuals are clear and well presented. In a few cases, plots and maps would benefit*

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			from larger fonts or clearer legends to improve interpretability, especially for learners viewing the content on smaller screens.
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*x*		*The visuals correctly represent EO and machine learning concepts. Nonetheless, adding more annotated examples (e.g. highlighting key classification errors or decision boundaries) would strengthen conceptual understanding.*
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	x		*The lecture follows a logical progression from theory to application. A clearer signposting of transitions between methodological steps (e.g. from data preparation to modelling and validation) would further improve flow.*
Do the slides give a professional impression?	*x*		*The lecture meets academic and professional standards. Minor refinements to slide density and visual balance would further enhance the overall presentation quality.*
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			*NA*
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality.			

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We encouragedetailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	x		The title accurately reflects the scope and focus of the lecture on crop mapping using EO and machine learning.
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	X		Learning outcomes are clearly stated and relevant. Some outcomes could be made more explicit regarding expected analytical depth, particularly for interpretation of classification results
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	X		The learning outcomes are generally specific and achievable. They could be strengthened by including clearer performance indicators (e.g. “evaluate classification accuracy using standard metrics”).
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	x		The lecture reflects current practices in EO-based crop mapping, including the use of ensemble learning. Brief references to emerging approaches (e.g. deep learning-based crop mapping) could further enhance currency.
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	x		The content is scientifically accurate and consistent with current literature. No major conceptual or factual issues were identified.

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If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	X		Key concepts are covered in sufficient depth for the intended EQF level. However, additional discussion on limitations, uncertainty sources, and generalisation issues would strengthen critical understanding
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?	x		The content is appropriate for both EQF 6 and EQF 7. For EQF 7 learners, deeper discussion of model assumptions and uncertainty analysis could be added as optional advanced material.
Are practical examples or case studies provided to illustrate the material effectively?	x		Practical examples are included and relevant. The lecture would benefit from a more explicit end-to-end case study that connects data acquisition, preprocessing, modelling, validation, and interpretation in one workflow.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		x	
The content matches the learning outcomes.	x		The content aligns well with the stated learning outcomes. Strengthening the validation and interpretation

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			components would further improve this alignment.
Is the content properly cited and compliant with copyright laws?	x		The content appears compliant with copyright and citation requirements. All figures and sources are appropriately referenced.
Does the content use only authorised materials and appropriately credit sources?	x		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	1		The lecture is of high quality, well structured, and relevant. The identified points relate mainly to depth, clarity, and enhancement rather than deficiencies.
Do you have any general recommendations for improvements?			Consider adding short visual summaries for complex concepts (e.g. class imbalance, validation metrics), expanding discussion on uncertainty and scale effects, and including optional advanced material or datasets for hands-on practice.

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Training Material Evaluation 5

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 5/12/2024 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Yolla Al Asmar – ITC- University of Twente
Would you like to provide your evaluation anonymously? YES/NO:	Yes

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.	*Yes*		*Some slides have so much text. It needs to be divided into multiple slides.*
Are all visuals, figures, and text clear, readable and in the correct resolution?		*No*	*Some texts are small. Please enlarge as recommended – minimum. size 30pt*
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?		*No*	*Some figures can be added to improve understanding, so not only a general figure, such as a map showing the output of the vegetation index. Some figures can be directly related to the text, and additional short*

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			captions can be added to enhance understanding.
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	Yes		Each presentation has slides for content overview, learning outcomes, and a summary at the end. Besides, the presentations are divided into individual sections. The content begins with an introduction and proceeds to provide more details related to the topic.
Do the slides give a professional impression?	*Yes*		
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?		*No*	
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	Yes		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.		No	Some learning outcomes are generic and can be better defined /more specific.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.		No	Same as the previous comment
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	Yes		To the best of my knowledge
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	Yes		To the best of my knowledge
If not, would you suggest any corrections?		No	

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The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	Yes	No	The topics began with a general introduction and progressed to more in-depth knowledge, helping the audience gain a general understanding and factual information related to the more technical parts. Some variables were mentioned, but need to be explained.
If not, which key concepts should be further detailed?			NA
Is the indicated EQF-level appropriate for the intended audience?			Bachelor's and master's level
Are practical examples or case studies provided to illustrate the material effectively?	Yes		
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?	Yes		Some variables were mentioned, but need to be explained.
The content matches the learning outcomes.	Yes		
Is the content properly cited and compliant with copyright laws?	No		Some images miss proper citation and need to be updated.
Does the content use only authorised materials and appropriately credit sources?		No	Some are missing and need to be updated.
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			1
Do you have any general recommendations for improvements?		No	

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Analysis of Skills, Training, Research, And Innovation Opportunities in Space

Training Material Evaluation 6

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 10/12/2024 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Yolla Al Asmar – ITC- University of Twente
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.	*Yes*		*Slides have so much text. It needs to be divided into multiple slides. The footnote of the slide in some presentations is missing. Some figures are small and would be better enlarged.*
Are all visuals, figures, and text clear, readable and in the correct resolution?		*No*	*Some texts are small. Please enlarge as recommended – minimum. size 30pt Some figures and tables are small and better to be enlarged/added to a separate slide*

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Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*Yes*		
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	Yes		Each presentation has slides for content overview, learning outcomes, and a summary at the end. Besides, the presentations are divided into individual sections.
Do the slides give a professional impression?	*Yes*		
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?		*No*	
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	Yes		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.		No	Some learning outcomes are not very specific / need to be improved.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.		No	Same as the previous comment
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	Yes		To the best of my knowledge
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	Yes		To the best of my knowledge
If not, would you suggest any corrections?		No	
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.			Yes, but still, a relevant background is needed, as not all concepts are explained in detail.
If not, which key concepts should be further detailed?			NA

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Is the indicated EQF-level appropriate for the intended audience?			Bachelor's and master's level
Are practical examples or case studies provided to illustrate the material effectively?	Yes		
Is there anything missing that you consider important that should be added or elaborated upon in future revisions?		No	
The content matches the learning outcomes.	Yes		
Is the content properly cited and compliant with copyright laws?	No		Mostly yes, but some images and texts miss proper citation and need to be updated.
Does the content use only authorised materials and appropriately credit sources?	Yes		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			2
Do you have any general recommendations for improvements?		No	

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Training Material Evaluation 7

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 4th of July The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Irene Pantelaki, Elena Karittevli & Silva Kerkezian EASN-TIS
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.	•		- Video 5 – Slide 3: 'Neual' instead of 'Neural' FIXED - Video 5 – Slide 17: 'Shor—term' instead of 'Short-term' FIXED
Are all visuals, figures, and text clear, readable and in the correct resolution?	•		All videos use clear fonts and legible layouts. Figures are readable and consistent .
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?			- Video 4 – Slide 11: Source cited, but no visual caption explaining figure *Text is in the top left of the slide: Dilates the*

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			convolutional filter (sparse filter)
The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	●		Excellent flow across all five presentations: - Video 1: Introduces perceptrons to backpropagation -Video 2 :bridges the basics with more advanced topics by defining deep learning and explaining its relationship to machine learning - Video 3-4: Move from CNNs to FCNs - Video 5: Adds temporal modeling with RNNs and LSTMs
Do the slides give a professional impression?	●		Consistent branding, design, and spacing throughout.
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?	●		Minor suggestion: Add uniform captions It could be helpful to include a final slide at the end of Video 5 (RNN & LSTM) that presents a simple comparative overview of all the models introduced in Module 8, such as the Perceptron, MLP, CNN, FCN, RNN, and LSTM. This comparison could summarise key aspects such as: - Core use cases (e.g., image classification, sequence modelling) - Strengths and limitations

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			- When each model is typically preferred in practice DONE
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	•		Each video title (e.g., 'What is Deep Learning', 'CNN', 'RNN and LSTM') is well aligned with the video's scope and content.
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	•		Learning objectives are listed at the start of each video and reflect the skills developed throughout the presentation.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	•		While the learning outcomes are specific and relevant, they could be slightly refined to be more measurable and time-bound. Including success criteria or expected learner actions would help. They were defined in the Understand level of the bloom taxonomy, that's why I kept on the "explain" level
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	•		The material reflects state-of-the-art practices, covering CNNs, FCNs, LSTMs,

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			and referencing architectures such as DeepLab and U-Net. Transformers are also briefly mentioned.
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	•		The concepts are technically sound and consistent with current literature. No factual inaccuracies were identified.
If not, would you suggest any corrections?			-
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	•		The module covers foundational and advanced concepts (e.g. perceptron, backpropagation, CNNs, RNNs) with helpful visual explanations.
If not, which key concepts should be further detailed?			-
Is the indicated EQF-level appropriate for the intended audience?	•		The content appears well-suited for EQF level. While the module is presented as an introduction to deep learning, it assumes familiarity with basic machine learning principles, such as classification tasks, loss functions, and model training. Since these topics are already covered earlier in the Module 3 this approach is fully justified and supports a more in-depth exploration of deep learning concepts
Are practical examples or case studies provided to illustrate the material effectively?	•		Practical examples are indeed included, particularly in relation to

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			remote sensing applications. For instance, Video 3- Slide 28 presents a full CNN workflow for land use/cover mapping, and Video 5- Slide 24 describes the use of LSTM in processing time-series satellite imagery. These use cases are helpful and contextually relevant. It might be beneficial, however, to gently expand the scope by including brief references to other domains, such as NLP or medical imaging, to illustrate how deep learning models generalise across fields. This would provide learners with a broader view of potential applications. This would make the videos much longer. That's why I kept the focus on Remote Sensing only. I will include in the reading material.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?			For future revisions, it could be helpful to include a final comparison slide that summarises the key differences and typical use cases of all models presented (Perceptron, MLP, CNN, FCN, RNN,

			LSTM). Additionally, adding brief recap questions or reflective prompts at the end of each video may support deeper understanding and encourage active learner engagement. Will be included in the reading material and practice.
The content matches the learning outcomes.	•		The material is well aligned with the stated objectives of each presentation.
Is the content properly cited and compliant with copyright laws?	•		
Does the content use only authorised materials and appropriately credit sources?	•		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			1 – The content is high quality, informative, and structured, with minor editorial and enhancement opportunities.
Do you have any general recommendations for improvements?	•		Some suggestions mentioned above are: refining the learning outcomes to be more measurable, adding brief recap questions at the end of each video, and including a final comparison slide summarising the key models presented. These additions could enhance clarity and engagement, though the overall structure and content are already of high quality and well-

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			aligned with the module's objectives.

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Training Material Evaluation 7

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 31/11/25 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Tehnical University of Crete
Would you like to provide your evaluation anonymously? YES/NO:	YES

Evaluation Criterion	Yes	No	Remarks
Please list any errors you find on the slides, including grammar, typos, or issues with images.			*Module 1. Introduction to GNSS systems: Objectives are missing Module 2. Galileo Services: slide 5 add reference to image Slide 8 correct numbering in phases Module 4. Add logos on first slide Module 5. Galileo PRS: add logos on first slide, correct slide 13- is should be "prepare for Module 6" not 7*
Are all visuals, figures, and text clear, readable and in the correct resolution?	*x*		

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Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	x		
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	x		Generally, yes
Do the slides give a professional impression?	x		
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			
The title accurately reflects the content of the material.	x		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	x		
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	x		
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	x		
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	x		To my understanding of the subject yes
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	x		
If not, which key concepts should be further detailed?	x		
Is the indicated EQF-level appropriate for the intended audience?	x		
Are practical examples or case studies provided to illustrate the material effectively?	x		
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		x	
The content matches the learning outcomes.	x		
Is the content properly cited and compliant with copyright laws?	x		
Does the content use only authorised materials and appropriately credit sources?	x		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			2

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Do you have any general recommendations for improvements?		x	

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Training Material Evaluation 8

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 15/10/25 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Tehnical University of Crete
Would you like to provide your evaluation anonymously? YES/NO:	YES

Evaluation Criterion	Yes	No	Remarks
Please list any errors you find on the slides, including grammar, typos, or issues with images.			*Presentation 1, slide 6: add reference for image Presentation 3, slide 3: is scheme in scale? Same for slides 5, 6, 7, 8 Presentation 4, slide 6,7 are schemes in scale? (same comment for schemes-have to define)*
Are all visuals, figures, and text clear, readable and in the correct resolution?	*x*		
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*x*		
The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	x		
Do the slides give a professional impression?	*x*		

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Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			
The title accurately reflects the content of the material.	x		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	x		
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	x		
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	x		
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	x		
If not, would you suggest any corrections?	x		
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	x		
If not, which key concepts should be further detailed?	x		
Is the indicated EQF-level appropriate for the intended audience?	x		
Are practical examples or case studies provided to illustrate the material effectively?	x		
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		x	
The content matches the learning outcomes.	x		
Is the content properly cited and compliant with copyright laws?	x		
Does the content use only authorised materials and appropriately credit sources?	x		
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			2
Do you have any general recommendations for improvements?		x	

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Grant Agreement No: 101082636

Analysis of Skills, Training, Research, And Innovation Opportunities in Space

Training Material Evaluation 9

Please complete the following questionnaire and send it to cbrempou@tuc.gr The deadline for submission is 28/7/25 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Grazia Fiore, FDC
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Please list any errors you find on the slides, including grammar, typos, or issues with images.	• *PPT 1. Introduction, slide 2. Some headers in the slides are missing from index:* *3. Why does GNSS fail? (slide 7)* *6. The Role of GNSS in Drone Autonomy (slide 12)* *7. Why is Backup No Longer Optional? (slide 13)* *8. Beyond GNSS: What's Next (slide 14)* • *PPT 1. Introduction, slide 3. GNSS "are" (instead of "is")* • *PPT 1. Introduction, slide 7: "Why GNSS Fails?" should be "Why does GNSS fail?"* • *PPT 1. Introduction, slide 7: In the graph, all entries in bullet points should start with a capital letter. No commas in bullet points* • *PPT 1. Introduction, slide 11: "GPS" should be "GNSS"*		

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	• *PPT 1. Introduction, slide 12: A logo seems to be missing from the white circle* • *PPT 1. Introduction, slide 13: The title should be "Why Is Backup No Longer Optional?"* • *PPT 1. Introduction, slide 13: A space is missing between "zones.These" in the point 2.* • *PPT 1. Introduction, slide 13: In point 2 "Urban centers" should be "Urban centres* • *PPT 1. Introduction, slide 13: In point 3, eliminate comma between «drone» and «inability»* • *PPT 1. Introduction, slide 14: Localization and localize should be "localisation" and "localise"* • *PPT 1. Introduction, slide 14: This part should be called "Discaimer" since we do not thank institutions like in an acknowledgment* • *PPT 2. Drones, Slide 3: "GPS" should be "GNSS"* • *PPT 2. Drones, Slide 7: "Staying" with capital letter* • *PPT 2. Drones, Slide 7: "Stabilisation" with "s"* • *PPT 2. Drones, Slide 9: "Stabilise" with "s"* • *PPT 2. Drones, Slide 9: "IMU + GPS" should be "IMU + GNSS"* • *PPT 2. Drones, Slide 10: "GPS" should be "GNSS"* • *PPT 2. Drones, Slide 10: space after bullet points is needed.* • *PPT 2. Drones, Slide 12: In 3, "It detects" should be "They detect".* • *PPT 2. Drones, Slide 12: In 2 and 5, "GPS" should be "GNSS"* • *PPT 2. Drones, Slide 13: "GPS" should be "GNSS"* • *PPT 2. Drones, Slide 14: There is a net on the image (copyrighted image?)* • *PPT 2. Drones, Slide 18: "GPS" should be "GNSS"*

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	• *PPT 2. Drones, Slide 19: The contacts box should be filled in or removed.* *PPT 3 "Drones components" has same contents of PPT 2 starting from slide 3* • *PPT4: In the footer, there is an extra space between "Navigation" and "Systems". The fonts of the titles of the slides are different.* • *PPT4, Slide 2: This lesson does not have slides corresponding to the titles of the sections in the index (like in lesson 2). The title and/or the titles of the sections on the slides need to be reviewed.* • *PPT4, Slide 7: "computer" is in italics. "Initialization" should be "Initialisation". Is the image source needed?* • *PPT4, Slide 8: Is the image source needed?* • *PPT4, Slide 9: "measures" should be "measure". In "What They Enable", "they" should be in small caps.* • *PPT4, Slide 10: In "What They Enable", "they" should be in small caps. There should be no dots after sentences in bullet points. "Stabilize" should be "Stabilise".* • *PPT4, Slide 11: In "What They Enable", "they" should be in small caps.* • *PPT4, Slide 14: "Stabilization" should be "Stabilisation".* • *PPT4, Slide 15: "Localization" should be "Localisation".* • *PPT4, Slide 18: "Disclaimer" instead of "Acknowledgement" ?* *Is Lesson 5 missing?* • *PPT6: The fonts of the titles of the slides are different in some slides.* • *PPT6, Slide 3: "Localization" should be "localisation"*

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	• *PPT6, Slide 9: add space after b in "b)Relative speed"* • *PPT6, Slide 13: need to add picture credits?* • *PPT6, Slide 13: replace "GPS-jammed" with "GNSS-jammed". The text in the pink box on the left is difficult to read. In the pink box on the right "defense" should be "defence"* • *PPT6, Slide 15: "localization" should be "localisation". The verbs in the pink box on the left should be third person singular. The last parenthesis has to be closed.* • *PPT6, Slide 17: "localize" and "localization" should be "localise" and "localisation".* • *PPT6, Slide 18: add contacts?* • *PPT6, Slide 19: "Disclaimer" instead of "Acknowledgement"?* • *PPT7, Slide 3: The learning objectives here are those of the first lesson* • *PPT7, Slide 5: Should the title read "Challenges" instead of "Challenge"? Are picture credits needed?* • *PPT7, Slide 6: Are picture credits needed? "Capitalize" should be "capitalise"* • *PPT7, Slide 9: Delete commas after sentences in bullet points* • *PPT7, Slide 12: Picture credits needed?* • *PPT7, Slide 15: Some texts in the graph have bullet points* • *PPT7, Slide 18: Do we need an image or an explanation since the term "barometer" is used here for the first time in this lesson?* • *PPT7, Slide 19: add contacts?* • *PPT7, Slide 20: "Disclaimer" instead of "Acknowledgement"?* • *PPT8: The fonts of the titles of the slides are different in some slides.*

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	• *PPT8: There is only one slide with the title of the chapter in the PPT. Others shall be added.* • *PPT8, Slide 3: "utilising" instead of "utilizing"* • *PPT8, Slide 5: "localisation" instead of "localization"* • *PPT8, Slide 6: "GNSS" instead of "GPS"?* • *PPT8, Slide 7: "generalising" instead of "generalizing"?* • *PPT8, Slide 8: "specialised" instead of "specialized" and "recognise" instead of "recognize"* • *PPT8, Slide 9: in subtitle, substitute ";" with ":". Adjust slide title's font.* • *PPT8, Slide 11: Adjust slide title's font.* • *PPT8, Slide 12: Verify UK English consistency* • *PPT8, Slide 15: The text in the pink box on the left needs to be better spaced* • *PPT8, Slide 18: "Disclaimer" instead of "Acknowledgement"?*
Are all visuals, figures, and text clear, readable and in the correct resolution?	*Slide 15 of PPT 2 (Drones basics) is not very clear.*
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*Yes*
The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	Yes
Do the slides give a professional impression?	*Yes*
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?	*The second PPT includes slides with the titles of the chapters, while the first PPT does not have them. Might be worth harmonising.* *formatting could be improved in some slides containing boxes.* *Uk English should be used in all contents.*

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The title accurately reflects the content of the material.	Mostly yes (see comments in first pages)		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	Yes		
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	Yes		
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.			
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.			
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	Yes		
If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?			
Are practical examples or case studies provided to illustrate the material effectively?			
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?			
The content matches the learning outcomes.			
Is the content properly cited and compliant with copyright laws?			

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Does the content use only authorised materials and appropriately credit sources?			
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	2		
Do you have any general recommendations for improvements?			

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Training Material Evaluation 10

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 8/7/2025 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Yolla Al Asmar – ITC- University of Twente
Would you like to provide your evaluation anonymously? YES/NO:	Yes

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.		*No*	
Are all visuals, figures, and text clear, readable and in the correct resolution?	*Yes*		
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	*Yes*		*No caption- but the pictures can be directly related to the text*
The content is presented in an organized and logical manner, which facilitates comprehension and a smooth learning progression.	Yes		An introduction and summary at the beginning and the end of each presentation help to improve understanding.
Do the slides give a professional impression?	*Yes*		
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?	*Yes*		*Please update the thank you slide (last slide) – information about the university developed the slides should be there*

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			and not information related to the Twente University- please use the Twente University as an example and follow.
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	Yes		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.		No	There are no learning outcomes specified on the slides. Please add them as part of the introduction page of the MOOC
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.			Same as previous comment
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	Yes		
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	Yes		As far as
If not, would you suggest any corrections?		No	
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	Yes		Some presentations provided highly technical, in-depth information, while others focused more on general knowledge, depending on the topic. This mix of depth was valuable in addressing the needs of audiences with varying levels of expertise.
If not, which key concepts should be further detailed?			NA

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Is the indicated EQF-level appropriate for the intended audience?			Not specified- please indicate the EQF-level in the introduction page of this MOOC.
Are practical examples or case studies provided to illustrate the material effectively?			Not explicitly available for this topic.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?	Yes		Some abbreviations are not explicitly explained in the slides, although they are mentioned during the presentation. This can sometimes make it difficult to follow, for example, PDOP, IMUs, LiDAR, NMEA, RINEX, and RTCM,LEO,MEOGEO. Including a list of abbreviations in the module introduction could significantly enhance understanding. Additionally, providing a glossary with definitions or referring to an existing one would be very helpful for learners(if possible).
The content matches the learning outcomes.			Cannot be decided at this point
Is the content properly cited and compliant with copyright laws?	Yes		The links to the sources of the images used are available. However, proper citations can be enhanced when possible. Presentation 01- missing image reference of slide 16 Presentation 04- missing image reference of slide 18
Does the content use only authorised materials and appropriately credit sources?	Yes		

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On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	1		The MOOC spans basic to more in-depth knowledge, targeting different participants and filling gaps in GNSS education.
Do you have any general recommendations for improvements?		No	

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Analysis of Skills, Training, Research, And Innovation Opportunities in Space

Training Material Evaluation 11

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 15/7/25 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.	
Evaluator name and organisation:	Cristina Ramos Izquierdo (AZO) Intza Balenciaga (AZO)
Would you like to provide your evaluation anonymously? YES/NO:	No

Evaluation Criterion	Yes	No	Remarks
Please list any errors you find on the slides, including grammar, typos, or issues with images.	*X*		Overall (all ppt) feedback: We suggest using Irish English instead of US English as one of the EU official languages. We´re not sure who this presentation is targeted at, but at first instance, it looks very scientific, quite hard to digest the information for non-technical viewers/listeners. We encourage you to provide contact details in the last slide (thank you) in case the audience wants to get back to you for questions/further info. Review you start all bullet points in capital or lower case – there´s inconsistency.

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			V01 Slide 6: vector names are incorrect, they repeat rj three times when describing the different elements of the formula. When explaining the GNSS, Galileo, as the EU´s GNSS, should be listed first and not last. We suggest adding an image to represent Galileo to further promote it (same way as you did with GPS). V02 Slide 8 is unclear – is it finished? Also, the writing is too small – please make it bigger. Kindly ensure all images in Slides 7-15 are visible. V03 Slide 4: bullet points 3-5 seem to be copy pasted without editing the formatting. Please ensure they all have the same format. Check the images are visible in Slides 6-9 and 12-16. V04 Slide 4: bullet points 2-4 should have same format as bullet point 1. Check if the figures are visible in Slides 5 and 9. V05 Slides 4-7 and 9: there´s too much text – no one will read it but the presenter. Consider reducing the texts and putting main ideas to then elaborate it verbally. Check if the figure is visible in Slide 12.
Are all visuals, figures, and text clear, readable and in the correct resolution?	X		All visuals and figures are clear, but the ones pointed out in the previous row.
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	X		Overall, yes, but please check what we mention in first row for individual cases.
The content is presented in an organized and logical manner, which facilitates comprehension and smooth learning progression.	X		Generally speaking, yes, but we´d recommend adding numbers to each section to improve and clarify the progression of topics throughout the presentation.
Do the slides give a professional impression?	X		Check the first box to review those sentences that need to be bigger or

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			should be formatted to follow consistency.
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?			Content overview slides contain different color in some presentations, some all black letters (slide 2 in V01, V02, V03, V04) other black and blue (slide 2 V05), it is recommended to us the same color coded for all presentations.
The title accurately reflects the content of the material.	X		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.		X	We believe the target audience should be clearly indicated in the first presentation to avoid misunderstandings. For non-technical partners, the information is not easy to digest. Images help but the texts and formulas are not easy to follow. Perhaps a "learning outcomes" slide should be added after the title slide for each presentation.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.		X	Cannot be evaluated since learning outcomes are missing.
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	X		According to our understanding, we affirmatively support this; however, as a project funded by the EU, we advocate for prioritising the promotion of EU technology and services, and whenever feasible, encourage their use (for instance, GPS compared to Galileo).
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	X		Within our understanding, yes!
If not, would you suggest any corrections?			
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	X		Theoretical explanations are well covered overall presentations; however, we suggest adding a clearer connection with hazard detection in presentations V01, V02, V03, V04, and V05 that would help make the content more engaging and relevant for the audience.

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If not, which key concepts should be further detailed?			
Is the indicated EQF-level appropriate for the intended audience?	X		The material appears to be appropriately aligned with EQF levels 5-6 (upper undergraduate to early postgraduate).
Are practical examples or case studies provided to illustrate the material effectively?	X		Some case studies are provided, but several presentations lack explicit practical examples. We encourage using real case studies as much as possible, preferably with illustrations.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?	X		Absence of learning outcomes slides, as well as additional practical examples with illustrations.
The content matches the learning outcomes.		X	Missing. This should be explicitly added at the beginning of each presentation.
Is the content properly cited and compliant with copyright laws?	X		References are included, so we do hope all material indicated is one by one referenced.
Does the content use only authorised materials and appropriately credit sources?	X		To the best of our understanding, the content consists of authorised material; however, we recommend verifying the licenses for any images that may need it.
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	2		
Do you have any general recommendations for improvements?	X		It is advisable to include summary slides at the conclusion of presentations. If the format permits, consider incorporating interactive elements or basic animations to enhance audience engagement. Additionally, a Q&A slide may be included to provide a safe space for inquiries and contact information should be presented at the end of every presentation.

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Training Material Evaluation 12

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 15th of July The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Irene Pantelaki, Elena Karittevli & Silva Kerkezian- EASN-TIS
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.			Minor formatting inconsistencies in **V06 slide 11**, where the figure uses a different font style, and in **V08** (**Slides 10, 17, and 19**), where multiple font types appear within the same slide.
Are all visuals, figures, and text clear, readable and in the correct resolution?	•		In general, visuals and text are clear and readable. **V08 (Slides 9 and 17)** include photos that could be improved in terms of image quality.
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	•		All visuals and figures accurately represent the key concepts discussed in the presentations.

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The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	•		All presentations (V06, V07, V08) follow a clear and structured sequence. Each part builds logically upon the previous one, aiding comprehension.
Do the slides give a professional impression?	•		Yes, the slides are well-structured, visually consistent, and professionally designed across all three presentations.
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?	•		The slides are overall clear and professional. As mentioned above, a minor note: maintaining consistent font usage across all three presentations would enhance visual coherence and overall polish.
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	•		Each presentation title clearly describes the topic covered.
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	•		The learning objectives are clearly conveyed through the structure and flow of each presentation, making the content easy to follow and aligned with the course goals.
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	•		The content is well-structured and clearly delivered. Including a brief summary or reflection slide at the end of each presentation could further support understanding and help learners consolidate key points.

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The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	•		The structure and flow of each presentation suggest clear learning intentions.
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	•		The content is correct, clear, and includes up-to-date and reliable information with no errors found.
If not, would you suggest any corrections?			-
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	•		The key topics and concepts are well covered and explained with sufficient depth to support learner understanding.
If not, which key concepts should be further detailed?			-
Is the indicated EQF-level appropriate for the intended audience?	•		The content fits EQF Level, suitable for advanced undergraduate or postgraduate learners.
Are practical examples or case studies provided to illustrate the material effectively?	•		Practical examples and case studies are effectively used across the presentations. For instance, in V07, the 2011 Tohoku Earthquake and Tsunami is used to illustrate the devastating impact of seismic activity, including data on magnitude, tsunami height, and casualties. Similarly, in V08, the 2022 Tonga–Hunga Haʻapai volcanic eruption is presented, highlighting its explosivity, the generation of atmospheric waves, and the resulting tsunami. These examples help connect the theoretical content with real-world applications.
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		•	-

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The content matches the learning outcomes.			The material is coherent and clearly aligned with the intended learning goals.
Is the content properly cited and compliant with copyright laws?	•		-
Does the content use only authorised materials and appropriately credit sources?	•		All materials appear to be properly sourced and attributed.
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?			**1** – The material is high-quality, relevant, and well-presented.
Do you have any general recommendations for improvements?	•		As mentioned above, **adding recap** or **reflection slides** at the end of each presentation would enhance learner engagement and help reinforce key concepts.

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Analysis of Skills, Training, Research, And Innovation Opportunities in Space

Training Material Evaluation 13

Please complete the following questionnaire and send it to m.h.stroeven@utwente.nl The deadline for submission is 10/10/2025 The deadline to send back this evaluation is two weeks after the receiving date While none of the questions are strictly mandatory, we kindly ask you to answer as many as possible. Your responses will be shared with the authors of the training materials and will serve as a basis for future revisions and updates.

Evaluator name and organisation:	Achilleas Tripolitsiotis, Technical University of Crete
Would you like to provide your evaluation anonymously? YES/NO:	NO

Evaluation Criterion	Yes	No	Remarks
Appearance and form			
Please list any errors you find on the slides, including grammar, typos, or issues with images.			V01: correct fonts size- there are inconsistencies (Same for VO2 and VO3) V02: check numbering for pictures V03: missing lecture objectives
Are all visuals, figures, and text clear, readable and in the correct resolution?	**X**		They could be better for V01, V02 and V03
Do the visuals and figures accurately represent the concepts being taught and include a proper caption?	X		-
The content is presented in an organszed and logical manner, which facilitates comprehension and a smooth learning progression.	X		-

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Do the slides give a professional impression?	X		-
Do you have any additional feedback or comments regarding the appearance and formatting of the slides?	X		-
Content When reviewing the training material, please focus on content-related aspects, such as accuracy, relevance, and overall quality. We encourage detailed feedback rather than simple YES/NO answers. Please share your thoughts, impressions, and opinions to help us understand your perspective more deeply. Your insights will be valuable in improving the content of the training material.			
The title accurately reflects the content of the material.	X		
The learning outcomes are clearly articulated, easy to understand and aligned with the overall goals of the course.	X		
The learning outcomes are specific, measurable, achievable, relevant, and time-bound (SMART), providing clear guidance on what participants are expected to achieve.	X		
The content reflects current trends, practices, and advancements in the field, ensuring the relevance and currency of participant learning experiences.	X		
The content is accurate, contains up-to-date and credible information, free from factual and conceptual errors.	X		No error was detected.
If not, would you suggest any corrections?	X		-
The key topics, themes, and concepts are comprehensive and explained in sufficient depth.	X		.
If not, which key concepts should be further detailed?	X		-
Is the indicated EQF-level appropriate for the intended audience?	X		-
Are practical examples or case studies provided to illustrate the material effectively?	X		
Is there anything missing that you consider as important that should be added or elaborated upon in future revisions?		X	-
The content matches the learning outcomes.			-

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Is the content properly cited and compliant with copyright laws?	X		--
Does the content use only authorised materials and appropriately credit sources?	X		-
On a scale from 1 to 5 (1 = very good; 5 = poor), how would you rate the evaluated lecture/training material?	X		-
Do you have any general recommendations for improvements?	X		-

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