EO4GEO – Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake

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Space / Geospatial Sector Skills Strategy

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WP1 - Preparing the Space/Geospatial Sector Skills Strategy

T1.5 - Space/Geospatial Sector Skills Strategy

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EO4GEO – Towards an innovative strategy
for skills development and capacity building in
the space geo-information sector supporting
Copernicus User Uptake

This document presents the strategic views under the Space/Geospatial Sector Skills Strategy. It proposes a concrete vision, mission and goals that will be used in the definition of a long-term action plan (LTAP) to address short- and medium-term skills needs in the areas of skills, knowledge and competences. Specific actions to be taken by a diverse group of stakeholders will be described, in order to establish an ongoing dialogue between the EO4GEO partnership, external stakeholders and entities within the EU directories (specially the European Commission DG on Employment, Social Affairs and Inclusion (DG-EMPL) and DG Internal Market, Industry, Entrepreneurship and SMEs (DG-GROW)) and Member States through their Ministers of Education. In this report, a first version of the strategy is outlined, aiming to reduce the gap and eliminate the mismatch between the supply of and the demand for education/training in the Earth Observation (EO) and Geographic Information (GI) sector taking into account wider technological, societal and policy developments. The LTAP which will be created based on the Sector Skills Strategy recommendations outlined within, and discussions stemming from, will then be updated as appropriate to take account of lessons learnt throughout the EO4GEO project, open discussions with stakeholders and also future technological, societal and policy developments.

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

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0.1	1st March 2019	Miguel-Lago, M. (EARSC) with contributions from Climate-KIC (Bansal, R.; Ramirez, K.), CNR-IREA (Gomarasca, M.), EARSC (Donnelly, R.), EPSIT (Martirano, G.), GISIC (Carbonaro, M.; Gorni, S.; Molina, R.; Saio, G.), KU Leuven [De Brito, M.; Vancauwenberghe, G.; Vandenbroucke, D.], PLUS (Ferber, N.; Hofer, B.; Lang, S., Spatial Services (Zeil, P.), UNIBAS (Satriano, V.; Scanniello, G.; Tramutoli, V.)	1st Version including all EO4GEO and external contributions.	Draft of the deliverable including a reviewed version of the strategic views by external stakeholders (EC-DG-GROW, ESA, GEO secretariat, Industry represented by EARSC BoD). This version includes an overview of the project, but it is also the document which will guide the sector skills strategy in the long term. Document integrated reviewed by EO4GEO partners and stakeholders.
1.0	12th March 2019	Miguel-Lago, M. (EARSC)	Version included internal EARSC review.	Version for Quality Assurance (QA).
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2.0	30th April 2019	Miguel-Lago, M. (EARSC), Vandenbroucke, D. (KU Leuven)	Final version	Approved by Steering Committee

Executive Summary

> EO4GEO – "Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake"

The Earth Observation (EO)[1] and Geographic Information (GI)[2] sectors (referred to in this document collectively as the EO/GI sector) are of strategic importance with their great potential to support many European, national and sub-national policy domains. However, due to the large amount of data made available and accessible through data and information infrastructures at various levels, the uptake of existing data and services is not being fully exploited and their integration in added value services for governments, businesses and citizens could be improved. Studies from the Organisation for Economic Co-operation and Development (OECD)[3] and the European Parliament (EP)[4] revealed that the lack of specialized technical and scientific skills[5], knowledge and competences, hinders this uptake by private companies and other actors. Furthermore, there is a gap between the offerings of academic and vocational education and training (VET)[6] at both universities and private institutions, and the specifics needs to make this uptake happen seamlessly.

The needs of the industry are constantly evolving. Helping the EO/GI Sector to find workers with the right skills and ensuring that they acquire the competences they need to find jobs is key to sector economic innovation, growth and competitiveness. To that end, the Erasmus+[7] project EO4GEO[8], funded by the Education, Audio-visual and Culture Executive Agency from the

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[1] Earth Observation (EO) collects information about the Earth – the land, the sea and the atmosphere – using sensors carried on satellites, aircraft, ships, buoys floating on the ocean, and thousands of weather stations around the world

[2] Geographic information (GI) is information related to geographic locations, often in combination with non-spatial information (e.g. ownership of land, amount of soil contaminations etc). Geographic information may be visualised by a map.

[3] Small Businesses, Job creation and growth, OECD / OECD (2018), Education at a Glance 2018: OECD Indicators, OECD Publishing, Paris / OECD (2018), Job Creation and Local Economic Development 2018: Preparing for the Future of Work, OECD Publishing, Paris,

[4] Space Market Uptake in Europe - European Parliament
(http://www.europarl.europa.eu/RegData/etudes/STUD/2016/569984/IPOL_STU(2016)569984_EN.pdf)

5 While addressing skills within this document, the sectors "skills strategy" is referred to "skills, knowledge and competences"

[6] Vocational Education and Training (VET): VET is a key element of lifelong learning systems equipping people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labour market.

[7] Erasmus+: EU's programme to support education, training, youth and sport in Europe.

[8] EO4GEO project (www.eo4geo.eu): An innovative strategy for skills development and capacity building in the EO/GI field

European Union (EACEA)[9] under the Blueprint for Sectoral Cooperation on Skills[10] scheme, is proposing skills development recommendations, preparing and taking actions for education and training that will unleash students' and workers' potential to be the EO/GI sector innovators of tomorrow and the EO/GI adopters in other industry end-user sectors (agriculture, energy, transport, local government, maritime, etc.). Particularly the latter benefit is important to create the conditions for integrating EO/GI data management[11] into other sectors and allow the EO/GI sector to make a step-change in mass-market uptake of these services. EO4GEO builds on the New Skills Agenda for Europe[12] which is designed to improve the quality and relevance of skills in order to meet the needs of a rapidly changing society and increase the mutual understanding of skills and qualifications in the European labour market. Moreover, the EO4GEO project objectives align with the spirit of the Copernicus Programme[13] for the establishment of a European capacity development for Earth observation, including geospatial data, tools and services, putting the users in the driver seat. The project also supports full and open access to EO data, information and knowledge as a crucial element for better understanding social, economic and environmental challenges. This includes full access to all the training resources and tools developed throughout the project and made available to the public through the EO4GEO project website.

The activities developed under EO4GEO will enrich the European Skills Panorama[14], with the goal of **defining a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training**. This **Sector Skills Strategy (SSS)** will serve as basis for the **development of the Long-Term Action Plan (LTAP)** which will be updated

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9 Education, Audiovisual and Culture Executive Agency from the European Union (EACEA) is an agency of the European Union located in Brussels, Belgium. It manages parts of the Union's programs in education, culture, and audiovisual fields.

10 Blueprint for Sectoral Cooperation on Skills: a new framework for strategic cooperation in a given economic sector between key stakeholders

[11] EO/GI data products and associated services

[12] the New Skills Agenda for Europe proposed 10 actions to make the right training, skills and support available to people in the EU [Upskilling Pathways: New Opportunities for Adults, 2) European Qualifications Framework, 3) Digital Skills and Jobs Coalition, 4) Blueprint for Sectoral Cooperation on Skills5) EU Skills Profile Tool Kit for Third-Country Nationals, 6) Vocational education and training (VET), 7) Key competences, 8) Europass, 9) Graduate Tracking, 10) Analysing and sharing of best practice on the movement of highly skilled or qualified people between countries (brain flows)]

[13] European Copernicus Programme: Copernicus is the European Union's Earth Observation Programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers information services based on satellite Earth Observation and in situ (non-space) data.

[14] Skills Panorama, Skills Panorama aims to foster the development or improvement of skill needs assessment and anticipation

as appropriate to take account of lessons learnt throughout the EO4GEO project. The SSS already took into account the skills assessment[15] conducted as part of the EO4GEO project which helped to identify existing and anticipated gaps and shortages, and to plot a path towards understanding skills mismatches. The skills development requirements are driven by considering the adoption of the new enabling technologies, the evolving sector context, and the continuous need for underpinning core social skills such as curiosity, imagination, resilience, respect and self-regulation. Cross-cutting skills required to support the adoption of new technologies such as broader management, business and technical abilities are needed to encourage the uptake of new skills and ideas.

The **Sector Skills Strategy** will be revisited within the EO4GEO project under the activities leading to the definition of the Long-Term Action Plan (LTAP). This Sector Skills Strategy document provides a strategic framework that seeks to secure long term provision of required skills through establishment of an open and ongoing dialogue between businesses and training providers allowing evolving skills requirements to be identified and delivered well beyond the timeframe of the project.

From Vision to Action

The **VISION of the Sector Skills Strategy** is to foster the growth of the European EO/GI sector ensuring a workforce with the **right skills, in the right place, at the right time.** The **MISSION of the Sector Skills Strategy** is to ensure the strategic cooperation among stakeholders on skills development in the EO/GI sector (Sector Skills Alliance[16]). This cooperation will support growth, diversity, and flexibility of the sector by providing harmonized and improved educational offers at a range of different learning levels including VET and academic training and the development of new occupational profiles for the EO/GI sector.

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15 Skills assessment done under EO4GEO: D 1.5–Skills shortages, gaps and mismatches between supply and (future) demand
http://www.eo4geo.eu/download/eo4geo_d1-5-skills-shortages-gaps-and-mismatches-between-supply-and-future-demand_v2-0/?wpdmdl=3473

[16] Sector Skills Alliance: Sector Skills Alliances (SSAs) are designed to tackle skills, aligning vocational education and training (VET) systems with labour market needs. More info.

The EO4GEO project, as a Blueprint, helps people and the EO/GI sector to grasp new opportunities for innovation, growth and jobs. The proposed vision and mission recommend the upskilling of the workforce, driving innovation and growth in the EO/GI sector. EO4GEO will focus on curation, co-creation, co-production and delivery of knowledge with partners to develop Europe's human capital for innovation for end users of space-derived-data based applications. These skills will make workers more adaptable to changes and EO4GEO, by operating as an "observatory for skills development", will identify those threats, challenges and opportunities of the sector.

By adopting a forward-looking perspective, the following **GOALS** have been identified for the successful implementation of the Sector Skills Strategy. These goals might not be fully reached during the EO4GEO project but are recommended to be followed up as part of the LTAP:

- A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established.
- A political commitment at EU level (DG-GROW[17] and DG-EMPL[18]) to stimulate innovative skills development policies is ensured.
- A coordinated effort to improve competitiveness[19] and to penetrate other sectors through market intelligence across stakeholders is created.
- The EO/GI awareness of and engagement with "end user" sectors is improved leading to increased uptake of Copernicus data and information services.
- Harmonised curricula and training offers (including workforce mobility) at pan-European but also international[20] levels are improved and developed.
- A standard for describing key qualifications is promoted.
- The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported.

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[17] DG Internal Market, Industry, Entrepreneurship and SMEs (DG-GROW)

[18] European Commission DG on Employment, Social Affairs and Inclusion (DG-EMPL)

[19] Space Strategy for Europe: Foster a globally competitive and innovative European Space Sector (https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-705-F1-EN-MAIN.PDF)

[20] Internationalization, strengthening Europe's as a global actor and promoting international cooperation. Copernicus as a global best practice and accepted standard internationally

- Skills needs are mapped to better define teaching supply, with a focus on flexible learning pathways.

The activities proposed and being implemented by EO4GEO partners aim to bridge the gap between supply and demand of education, training and skills, which will be done through a better understanding of the skills required for the successful advancement of the EO/GI sector. Consequently, the strategy is implemented through several **EO4GEO actions** to realise the goals: the development and maintenance of an ontology-based **Body of Knowledge** (BoK) for the sector; the set-up of a dynamic **collaborative platform** with associated tools; the design and development of a series of **curricula** and a portfolio of **training modules** directly usable in the context of Copernicus; the organisation of a series of **training actions** for a selected set of scenarios in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally, a **Long-Term Action Plan** (LTAP) will be developed and endorsed by the broader education/training and space/geospatial industry as well as the Copernicus programme. The **sustainability plan** will also be developed in order to sustain the proposed solutions beyond the duration of the project, indicating possible sources of funding. Table 1 provides the different phases of the EO4GEO project which consist of the following major milestones (revisions between brackets):

Table 1- EO4GEO Milestones and expected data

Milestone	Expected data
Sector Skills Strategy	April 2019
Revised and extended BoK for GI and EO	June 2019, December 2019, and June 2020, 2021
Collaborative platform	December 2019, (June 2020)
Curricula designed	June 2020
Training actions for 3 sub-sectors conducted	February 2021
Long-term Action Plan	October 2021

Providing well justified elements to the strategic goals, EO4GEO will provide answers on the focus of the strategy (**what**)**, who** should be involved, **how** we develop the actions and **when** these will be implemented (during EO4GEO or planned for the LTAP):

WHAT will be achieved: EO4GEO reviews and monitors the skills needed by the sector and develop the strategy to address these needs, both through nurturing the development of skills and through attracting skilled staff into the sector. EO4GEO targets skills beyond the technical context, whilst understanding how to foster the development of the sector and ensuring the improvement of workforce with the "right skills, in the right place, at the right time". Innovation and entrepreneurial soft skills[21] are also required to skill up EO/GI users to maximise the benefits to society of these technologies.

Following the rapid evolution of the EO/GI and associated sectoral technologies and related innovations[22], the vocational education and training (VET) in the sector is usually based on specific courses that can be used to respond to "just in time" needs and which can change very quickly over time. While a skills strategy for higher education should address much more emerging (but generic) skill needs (e.g., adding a geospatial dimension to digital era, circular economy, interconnected systems, etc.) more than capabilities devoted to solving a specific problem.

The preparatory strategy anticipates the sector's skills development and growth opportunities. Based on its sector global competitive position and market development, the strategy foresees the skills that will prepare the sector best for future success. There is a need to link the strategy with policy initiatives at national and European level, improving the better integration of EO/GI education and training; stakeholders' input to the definition of learning outcomes, the emergence of new occupational profiles in the EO/GI sector and the recognition of skills, knowledge and competences.

During the project surveys, the following main skills sets were considered as relevant to the EO/GI sector: space/geospatial data skills, analytical methods, visualization and cartography, programming and development, data capture and management, EO/GI and society, computing resources and platforms, organizational and institutional aspects. During the curricula development phase, the project will also explore how statistical methods, big data analytics, new technologies such as machine learning, artificial intelligence, and changes referring to sustainable development

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[21] defined by CEDEFOP: Entrepreneurial skills - Skills Panorama

(https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/focus-entrepreneurial-skills)

[22] Evolution of the sector innovations: Modernising vocational education and training – ResearchGate

or social science, will create an impact on the evolution of the job profiles. The ability to combine and process sensor data; satellite and non-satellite EO data (other platforms such UAVs, aerial, etc.), GI, and in-situ data is one of the most important elements for sector success. It will generate massive information flows for a wide range of user communities in the coming years.

WHO should be involved: The EO4GEO team will create the strategy which is targeted at the EO/GI ecosystem including the policy makers (both at EU and national level). EO4GEO intends that policy makers use the sector skills strategy to draft future work programmes on skills development. EO/GI stakeholders in the public domain will be better prepared to specify actions with regards to skills; academy, research and companies will be more aware of collaboration developing the skills workforce. EO4GEO has been working to map the EO/GI education and training landscape, with the identification of around a thousand different education and training resources. Now, the next step will be the re-use of these resources in the context of the training actions. For doing so, the learning outcomes for particular scenarios should be developed as part of a systematic curricula design process. Skills development is only possible through collaborative governance in the public and private sector, helping to increase and develop both the existing and future workforce in the sector. Stakeholders will focus on tackling the skills challenges and building agreement on what actions need to be taken and by whom.

HOW we develop the actions: The sector skills strategy encourages and supports the use of EO/GI but specially the Copernicus programme as an inspiring context for learning across different learning levels. This ensures that supporting materials on careers (job profile specifications inside of the workforce, work experience or internships) are accessible and will enforce implementation of wider outreach programmes to improve awareness and engagement.

Sector growth relies on skills formation and skills deepening. The EO/GI sector is progressively entering in other industry markets hence is mainly looking for specific combinations or configurations of skills. In terms of skills requirements this means an ever-evolving and expanding list of skills combinations to suit the needs of various sectors. Identifying the most needed configurations of skills, including both domain specific and more general – soft-skills (leadership, flexibility, creative thinking, decision making, adaptability conflict resolution…etc.) – will be an ongoing challenge that is crucial to the success not only of the EO/GI sector but all of those sectors

which it does and will support. We propose a grouping of these skills around the EO/GI-based skills to make this list manageable. Based on the results and views collected during previous EO4GEO activities[23] concerning the demand for EO/GI education and training and priority occupational profiles[24], three main profiles were identified as starting point for analysis: EO/GI developers, EO/GI data analysts and EO/GI specialist and project managers. These profiles provide a new dimension to the discussion. The collection and analysis of job advertisements[25] provides valuable input to the revision of existing European Skills, Competences, Qualifications and Occupations (ESCO) profiles related to the EO/GI domain. This input consists of new and/or redefined profiles, skills sets and underlying skills. The Body of Knowledge (BoK) will be an important tool enabling and supporting this analysis, defining the core concepts in the EO/GI domain. These concepts could be translated into skills demanded by the EO/GI sector as well as into learning objectives addressed by education and training. In this way, the BoK is crucial for establishing a link between the Supply of and the Demand for EO/GI skills.

WHEN these will be implemented: EO4GEO is considered to be in this document as the Alliance developing the sector skills strategy. Throughout the duration of the project, EO4GEO will realise the vision to foster the development of the European EO/GI sector, ensuring the workforce is supplied with the "right skills, in the right place at the right time". The preparatory strategy (EO4GEO D.1.6) provides information about the initial steps and activities associated with the development of a LTAP which will be prepared throughout the lifespan of the project. EO4GEO defined key profiles as configurations of skills that are at present not sufficiently recognized. The sector is more and more incorporating new digital capabilities e.g. IT technologies, advanced algorithms, machine learning, deep learning, artificial intelligence, imagery features from new satellite constellations (pixel size, revisit time, wavelength, geographical area, etc.) and multi-source solutions, generating the information flows for a wider range of final user communities. Although some progress has been made in exploring the impact of these new technologies, still a lot needs to be done in order to fully understand the EO/GI skills mismatch.

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[23] Deliverable EO4GEO_D1.3 – Demand for space-geospatial education and training and priority occupational profiles

[24] Occupational profiles identify the skill levels required for an occupation across jobs, companies, or industries. Occupational profiles are created by summarizing a set of related job profiles (link)

[25] The collection and analysis of job advertisements: A review of research methodology

In 2018, EO4GEO has been involved in gathering the necessary elements for building the Sector Skills Strategy. It should be flexible in order to take advantage of rapidly changing technology & societal environments, market change and the experience from the stakeholders, to make employees more resilient and able to adapt to changes in the competitive work environment. This document will be used to frame discussions between different communities around the skills scheme and how we can achieve a long-term sustainable plan. It introduces possible long-term actions from the perspective of the future governance, sustainability, potential mainstreaming and operational maintenance. It also provides a baseline for elaboration of the Long-Term Action Plan that will promote the effective cross-fertilisation of EO4GEO activities and links to another EC programmes.

A tool-box for action is presented as a tool to help the sector to identify appropriate tools to optimise industry relationships concerning skills development. It takes into account the goals and promotes cross-fertilisation with industry under three main areas: industry & innovation (productivity, support and leadership); quality (recruitment and employ engagement); and access (education & training).

Table of Contents

EO4GEO – Towards an innovative
strategy for skills development and
capacity building in the space geo-
information sector supporting Copernicus
User Uptake

List of Tables

List of Figures

List of Annexes

ANNEX 1	References
ANNEX 2	EO4GEO activities Gantt Chart
ANNEX 3	SWOT Analysis of the Goals
ANNEX 4	Timeframe and indication of progress
ANNEX 5	National exercises on Vocational Educational Training (VET)
ANNEX 6	Exercises on professional profiles (DACUM)

Acronyms

Acronym	Description
BoK	Body of Knowledge
DoW / DoU	Description of Work / Document of Understanding
DG-EMPL	DG for employment, social affairs and inclusion
DG-GROW	DG Internal Market, Industry, Entrepreneurship and SMEs
EC	European Commission
EACEA	Education, Audio-visual, Culture Executive Agency
EARSC	European Association of Remote Sensing Companies
EO	Earth Observation (inc. Meteorology)
EO/GI	EO and GI sectors
EU	European Union
EQAR	European Quality Assurance Reference
EQAVET	European Quality Assurance Reference Framework for VET
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GI	Geographic Information
GISIG	Geographic Information System International Group
IP	Intellectual Property
LRA	Local and Regional Authorities
NEREUS	Network of European Regions Using Space Technologies
OECD	Organisation for Economic Co-operation and Development
R&D	Research & Development
STEAM	Science, Technology, Engineering, Arts and Mathematics
SSC	Sector Skills Council
SSS	Sector Skills Strategy
VET	Vocational and Educational Training

Glossary

Note: Some elements from the glossary have been extracted from Deliverable D.1.5 (Assessing the skills shortages, gaps and mismatches between supply and demand).

- **Blueprint** refers to the systematic definition of EO/GI content for the purpose of creating curricula with validity evidence.

- **Body of Knowledge (BoK)** is the complete set of concepts and relations between them, that make up a professional domain, (in this case EO/GI BoK) and the related learning outcomes as defined by the relevant learned society or a professional association.

- **Competence** means the proven ability to use knowledge, skills and personal, social and methodological abilities in work or study situations and in professional and/or personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.

- **European Credit Transfer and Accumulation System (ECTS)** is a credit system designed to make it easier for students to move between different countries.

- **European Association of Remote Sensing Companies (EARSC)** is the European organization which (on a non-profit basis) promotes the use of Earth Observation technology and especially the companies in Europe which offer EO-related products and services.

- **Education, Audiovisual and Culture Executive Agency (EACEA)** manages funding for education, culture, audiovisual, sport, citizenship and volunteering.

- **European Centre for the Development of Vocational Training (CEDEFOP)** is one of the EU's decentralised agencies. Founded in 1975 and based in Greece since 1995, it supports development of European vocational education and training (VET) policies and contributes to their implementation.

- **European Credit System for Vocational Education and Training (ECVET)** have common instruments helping individuals in transfer, recognition and accumulation of their assessed learning outcomes, to achieve a qualification or to take part in lifelong learning.

- The term **Earth Observation (EO) related services** is taken to mean any geo-spatial information service activity which in some way involves data coming from EO satellites (including meteorological satellites) i.e. any satellite with one or more sensors that measure parameters coming from the earth's surface or atmosphere. The involvement may be direct i.e. processing or distributing imagery or indirect i.e. consultancy based around knowledge of the imagery or its use. It starts from the point where imagery is transmitted to the ground, so it does include reception and processing of imagery but does not include construction of ground stations or the satellites delivering the data. Note that it includes all geo-spatial

information services activities where satellite EO data has been used and so extends to downstream information processing of geospatial information where data being used has been derived from EO imagery possibly in combination with other data types.

- **EQAVET** (**The European Quality Assurance in Vocational Education and Training**) is a framework designed to promote better vocational education and training by providing VET providers with common tools for the management of quality. EQAVET is a community of practice that promotes European collaboration in developing and improving quality assurance in VET (EQAVET, 2018).

- **European Qualifications Framework (EQF)** descriptor is defined by 8 levels of descriptors that indicates at that level the learning outcomes relevant to qualifications in any system of qualifications.

- **European Skills, Competences, Qualifications and Occupations (ESCO)** is the multilingual classification of European Skills, Competences, Qualifications and Occupations.

- **Geographic Information (GI)** is the data of a geographic location combined with non-spatial information (e.g. statistical data) and their representation as a map.

- **Geographic information: Need to Know (GI-N2K)** is a project under the Lifelong Learning Programme Erasmus of the EU that aimed to improve the way in which future GI professionals are prepared for the labour market so that the GI sector in general can evolve in a dynamic and innovative way.

- **Geographic Information System (GIS)** is a computerized tool designed for storing, analysing and consulting data where geographic location is an important characteristic or critical to the analysis.

- **Knowledge** means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.

- Coherent strategy and a detailed **Long-Term Action Plan** will be developed and endorsed by the space/geospatial and education/training communities. The project will not be considered as a one snapshot trial or implementation, but rather as a mechanism that will be multiplied in the long-term in a systematic way. Therefore, it is based on the strategy developed and the experience gained in the implementation phase including a coherent Governance Model and financial sustainability, and that will guarantee the roll-out and multiplication of the approach and results.

- The specific EO4GEO objectives are to define a **Long-Term and Sustainable Plan** for education and training strategy, to define an ontology based Body of Knowledge for the sector, to design a series of curricula for different type of occupational profiles in the sector, to develop and integrate a dynamic learning platform, to design, develop and conduct a series of training actions for three of the priority Copernicus areas and to develop a long-term and sustainable exploitation plan.

- **Organisation for Economic Co-operation and Development (OECD)**, aims to is to promote policies that will improve the economic and social well-being of people around the world.

- **Open Geospatial Consortium (OGC)** is an international industry consortium of over 530 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards.

- **Quality assurance** in VET is a key priority at EU level to promote increased transparency of VET policy developments between Member States, thereby enhancing mutual trust, mobility of workers and learners, and lifelong learning.

- **Sector Skills Alliance** (SSAs) are designed to tackle skills, aligning vocational education and training (VET) systems with labour market needs. This is done by: (i) modernising VET by adapting to skills needs and integrating work-based learning, (ii) strengthening the exchange of knowledge and best practices, (iii) improving labour market mobility, (iv) increasing the recognition of qualifications. More info.

- **Sector Skills Strategy** (SSS) offers a mechanism to focus comprehensively on workforce skills, from entry level to advanced, required in the space/geospatial sector. The Sector Skills strategy is informed by data, research, analysis and consultation at a regional and national level and are planned to be European-focused and it aims at tackling skills gaps with regard to one or more occupational profiles.

- **Soft Skills** are a combination of people skills, social skills, communication skills, character or personality traits, attitudes, career attributes, social intelligence and emotional intelligence quotients, among others, that enable people to navigate their environment, work well with others, perform well, and achieve their goals with complementing hard skills (wikipedia).

- **Skills** means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive or practical skills.

- **Vocational and Educational training (VET) projects** are helping to make vocational education and training better and more attractive to learners.

1. Introduction

Chapter 1 is the **Introductory** chapter including a section describing some preparatory questions on **where we are now, where we want to be, and determining how we get there** introducing the work to be done as part of the preliminary activities under the sector skills strategy. It also proposes a **Methodology** for building the Sector Skills Strategy.

1.1.   Overview EO4GEO

EO4GEO is an Erasmus+ Sector Skills Alliance gathering 26 partners from 13 EU countries, most of which are part of the Copernicus Academy Network. Be they from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sectors. The project is also supported by a strong group of Associated Partners mostly consisting of associations or networks active in space/geospatial ecosystem. The project started on January 1st, 2018, upon approval by the EU Education, Audio-visual and Culture Executive Agency (EACEA) and runs over four years.

ERASMUS+ Sector Skills Alliances aim to tackle skills gaps with regard to one or more occupational profiles in a specific sector. They shall cover a coherent and comprehensive set of activities and outputs as relevant for the sector concerned. EO4GEO was promoted under Lot 3 of the 2017 ERASMUS+ Call for Sector Skills Alliances for implementing a new strategic approach ("**Blueprint**") to sectoral cooperation on skills (sectoral skills strategy).

The sector «**Space Data (geo-information)**» is in fact among the first six pilot sectors selected in the «**Blueprint for sectoral cooperation on skills**»[26] and is linked to the **Copernicus Building Skills Action**, aiming to:
- increase the number of people able to access and use Copernicus data and information (basic users and/or advanced/innovative users of Copernicus);
- increase the supply of skills to stimulate the growth of geospatial-related jobs in Europe.

This directly supports and contributes to the implementation of the **Space Strategy for Europe** (COM (2016))[27] having, among its objectives:

- to maximize the benefits of space for society and the EU economy by encouraging the **uptake of space** services and data;
- supporting research and innovation and development of skills, with explicit reference to the **New Skills Agenda for Europe**, the inclusion of **space/Earth observation in the Blueprint** and the launch of a **dedicated sector skills alliance.**

EO4GEO is therefore "*the*" Blueprint project for developing the sectoral skills strategy in the space/geospatial field, as firstly drafted in this report.

1.2.   EO4GEO Objectives

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

1. to define a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training, taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT);
2. to define an ontology-based Body of Knowledge (BoK) for the space/geospatial sector based on previous efforts, by mobilizing an extended network of domain experts in a collaborative environment;
3. to develop and integrate a dynamic platform with associated tools that allows:
   a. a collaborative method for integrating new concepts (theories, methods, technologies …) and updating existing concepts of a BoK for Geo-information (GI) and Earth Observation (EO);

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[26] Blueprint for sectoral cooperation on skills, European Union, 2017

[27] Space Strategy for Europe (COM (2016)): Communication from the Commission to the European Parliament, the Council, the European Economic and social Committee and the Committee of the Regions

b. the design of curricula for (academic and) Vocational Educational Training (VET) direct access, not only to the training materials, but also to space and geospatial data, case-based learning scenario's, self-tests and other relevant materials;

4. to design and develop a series of curricula for different types of occupational profiles in the sector, making use of the BoK and taking into account the identified needs, and to develop a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programs;

5. to design, develop and conduct a series of training actions for a selected set of scenarios for three sub-sectors - integrated applications, smart cities and climate change – supported by remote sensing and geospatial technology in order to test and validate the approach, the platform, the designed curricula and developed training modules;

6. to develop and endorse a long-term Action Plan based on the strategy developed and the experience gained in the implementation phase including: a Governance Model and Structure; a Business Plan to become financially sustainable; a plan for mainstreaming, promoting and multiplying the approach in other sub-sectors; and a plan to roll-out the technical solutions developed.

1.3.   *Preparatory Sector Skills Strategy*

A strategy may be defined as "a long-range plan for achieving something or reaching a goal" (Cambridge English Dictionary). This means that the strategy also need to specify the goals it is addressing. The objective of this report is to describe a preparatory space/geospatial sector skills strategy where special attention is paid to

- Observed mismatches between supply and (future) demand for space/geospatial education and training
- The proposed approach to bridge the gaps
- A detailed description of the concrete actions to be implemented
- First ideas for a long-term approach

According to the Document of Work (DoW) this report aims to make the strategy more explicitly in terms of: the qualifications that should be developed and promoted; the required provision of VET

(content- and format-wise); potential cases to be developed in the project and possibly also beyond the project lifetime; the different options and priorities for the occupational profiles and how they can be linked to European Skills, Competences, Qualifications and Occupations (ESCO)[28], the European Skills Panorama and other competence frameworks. This deliverable will summarize the findings of previous work assessing the skills shortages, gaps, and mismatches between supply and (future) demand and propose a clear set of possible strategic actions and how they will be implemented, tested and validated during the project. This will include the development of a BoK with all the relevant concepts (theories, methods, processes, technologies …), the design of VET curricula, the development of new and improvement of existing curricula and training material, etc. Work Package 1 (Preparing the Space/Geospatial Sector Skills Strategy) will form the basis of the implementation phase [(WP2 (Developing and operationalizing a Body of Knowledge for GI and EO), WP3 (Integrated platform of collaborative tools), WP4 (Design and development of curricula in support of Copernicus) and WP5 (Testing and validating the 3 sub-sectors: integrated applications, smart-cities and climate change)] and the long - term Action Plan (WP6).

Figure 1 presents the key elements of the Strategy (preparatory sector skills strategy), interactions with other project work packages and how those should be revised within the EO4GEO project but also in the Long-Term Action Plan (LTAP).

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[28] ESCO European Skills, Competences, Qualifications and Occupations
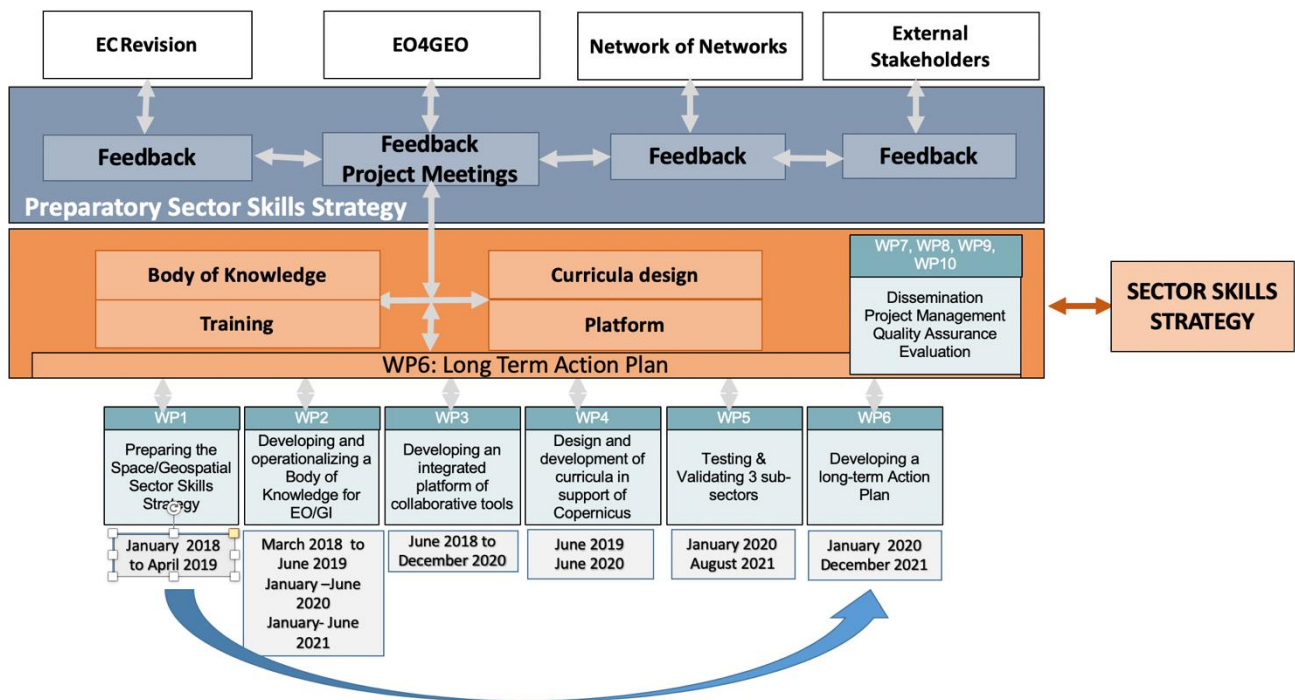
Figure 1: Sector Skills Strategy and its relationship with EO4GEO WPs

EO4GEO will follow an approach in different phases: the preparation phase (WP1), the implementation phase (WP2, WP3, WP4, WP5), a dissemination and exploitation phase (WP6, WP7), the Management and Quality Assurance (WP8, WP9), and the Evaluation phase (WP10). Based on these phases 10 work packages have been defined:

-In **WP1** (**Preparing the Space/Geospatial Sector Skills Strategy**), an in-depth assessment of the supply and demand for skills in the space/geospatial sector is carried out based on desktop studies, surveys and in-depth interviews. It takes into account technological and non-technological trends and developments, a watch (dashboard) will be set-up.

-In **WP2** (**Developing and operationalizing a Body of Knowledge for EO/GI**), the existing BoK for GI S&T is revised and extended to the Earth Observation field following an ontology-based approach based on agreed concepts in the community (mobilising a network of experts in the field).

-**WP3** (**Developing an integrated platform for collaborative tools**) assesses different existing collaborative platforms and tools from the GI-N2K, Copernicus/ESA initiatives, analyse specific requirements and improve the existing platform and tools. Additional tools are prepared to support the development of job/occupational profiles and learning paths.

-In **WP4** (**Designing EO and GI curricula in support of Copernicus**) , a series of curricula are designed based on the analysis of business processes and related occupational profiles making use of the above mentioned tools, and a portfolio of training material is developed to be used and tested in the validation phase.

-**WP5** (**Testing and validating the strategy bases on case-based learning scenarios**) brings the results of WP2, WP3 and WP4 together and use the curricula, the material and method in several case-based learning scenarios for 3 sub-sectors: integrated applications, smart cities and climate change.

-In **WP6** (**Developing a Long-term Action Plan**), the results of the testing and validation are taken into account to develop an integrated long- term Action Plan (LTAP) including a Governance model and Structure, a Business Plan including costs and potential revenues, an approach for mainstreaming and multiplication, and a roll-out plan for the different components (platform, content ...).

-**WP7** (**Capacity building and dissemination**) will focus on the dissemination of the results, including a series of high-level seminars. **WP8** (**Management**), **WP9** (**Quality Assurance**) and **WP10** (**Evaluation**) will steer the project implementation and evaluation.

The outputs and outcomes of this preparatory work package (WP1) will form the foundation for the implementation stage (WP2, WP3, WP4 and WP5) which will detail and test & validate the chosen approach, and for the space/geospatial Sector Skills Action Plan which will be one of the main outputs of the project. A Gannt Chart representing the project activities is in Annex 2.

The task 1.5 under WP1 (Defining a GI and EO sector skills strategy) and represented in figure 1 as the preparatory sector skills strategy included the following activities:

- Description of the major conclusions from the workshop on "Assessing the skills shortages, gaps and mismatches between supply and (future) demand" held in Patras, December 2018 with feedback from the community regarding how the gaps can be bridged and mismatches be resolved;
- Defining a series of strategic actions that will be implemented, tested and validated during the project;
- Identifying a series of potential actions that will not be implemented, tested and validated in the project life - time, but could/should be implemented, tested and validated in the medium - or long - term;

- Define the methodology that will be applied to implement, test and validate the proposed strategic actions (BoK, curricula design including definition of learning outcomes, the multi - partner/multi - sector/multi - disciplinary approach, …);
- Preparation of the "Space/geospatial Sector Skills Strategy" document with several feedback cycles among the space/geospatial and education/training communities.

This report is edited in a collaborative way with key partners from work package 1 (WP1), but also relevant organizations of the consortium involved in the long-term action plan. The report was closely reviewed by all EO4GEO partners, associated members and other stakeholders establishing a first strong and collaborative action within the Alliance for the Sector Skills Strategy.

1.4.   Methodology to build the Strategy

In this section, the methodology of the current preparatory work for the Sector Strategy is presented and discussed. The methodology proposed allows to draft a meaningful long-term sustainable plan for the development of the Strategy. The success will come from the joint project implementation by partners, together with the associate members building the Sector Skills Alliance, and its integration with an actionable Long-Term Action Plan (LTAP). Their participatory approach network provides continuous opportunities to foster understanding between EO and GI communities, strengthening the "geo-information" / "geospatial" sector.

Figure 2 shows the strategy development methodology [multi-partner (EO4GEO partners), multi-sector and multi-disciplinary] EO/GI and "end users", who in fact pull the information and services, and iterations with the project and independent validation.
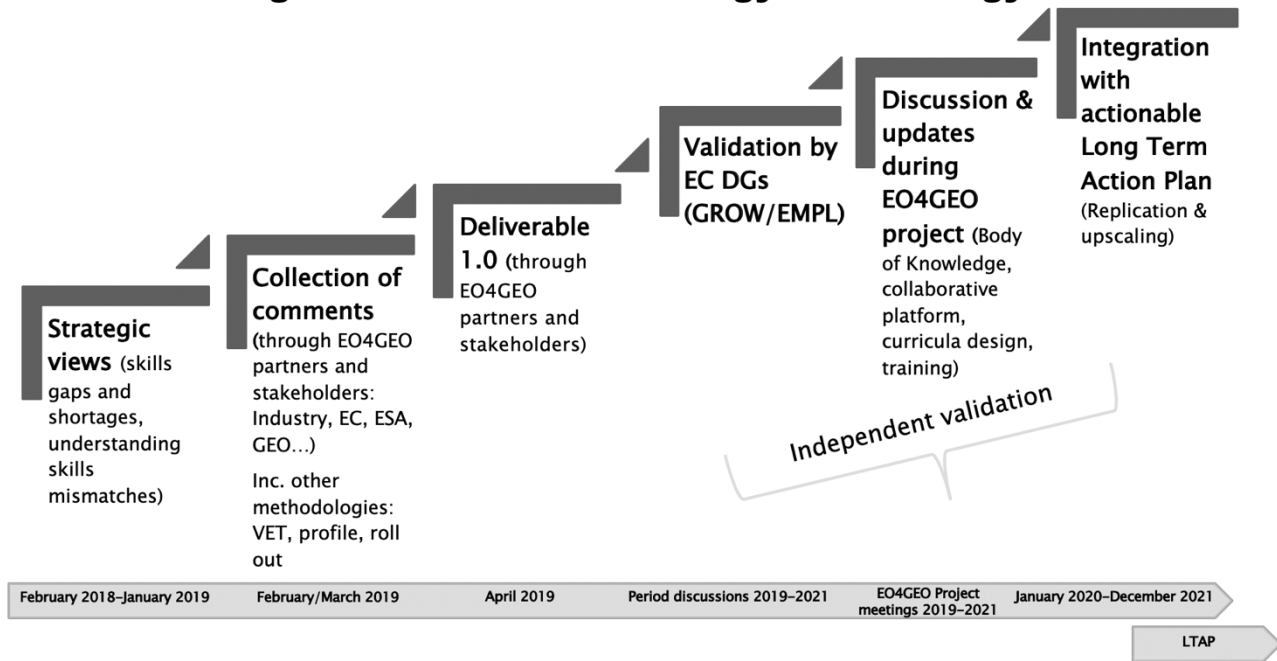
Figure 2: Methodology for the Sector Skills Strategy

An important step in this preliminary process to build the strategy is the analysis of the current skills on the supply and demand sides. This assessment helps to identify existing and anticipated skills gaps and shortages, and to plot a path towards understanding skills mismatches. The skills needs will be driven by the adoption of the new enabling technologies, the evolving industrial context, and the continuing need for underpinning core societal skills[29] (such as communication). Cross-cutting skills required to support the adoption of new technologies, such as appropriate management, business and technical practices, are needed to encourage the take-up of new skills ideas. Thanks to the EO4GEO actions in the next years, this strategic approach presents a guiding document for an actionable long-term action plan enabling the involved actors to take meaningful steps towards maximising relevant skills development within the sector and reaping the benefits from the resulting improvements to business practices and efficiencies.

This preliminary strategy is a living document which will continue to form the basis of ongoing discussions with stakeholders and to incorporate ongoing sector evolution. It brings elements to start thinking and discussing about the possible long-term actions from the perspective of the future governance, sustainability, potential mainstream and operational maintenance. Promoting

the effective cross-fertilisation with stakeholders and existing activities in the skills domain is a key activity and different project meetings, but also an external workshop, will present the strategy giving the opportunity for a consensual discussion. To complement the work done during the first year of the project, we have proposed a brainstorming to the partners on the following questions (where are we now? where do we want to be? and how can we get there?). All these strategic questions will be revisited during the project meetings.

Table 2: Preparatory questions to build the strategy

Where are we now?	Where do we want to be?	How can we get there?
How do we analyse the EO/GI sector market from the skills perspective? What is the current state-of-play with regards to EO/GI Sector Skills in Europe? What is the current situation on VET? Which are the problems and obstacles? Who are the key stakeholders? Are the existing collaborations operational? What occupations and skills are in high demand? What challenges the sector is still facing? What is the footprint of the existing skills activities? What are the changes in the way certain occupational profiles are working today?	What are the essentials of the EO/GI Sector Skills Strategy? How do we create strong partnerships and knowledge transfer? How do we monitor and evaluate progress? What is the future we are trying to shape and what is the role of the Sector Skills Strategy? Where do we want to direct investment to? How can we model work processes in which EO/GI skills are needed? How do we forecast requirements of unknown skills?	How do we win sector support? What forces are driving change? How do we align Skills Strategies to industry needs and public priorities? How to bridge horizontal and vertical skill-sets? How do we bring this at national level? What are the possible sources to leverage sustainability funding? Which actions shall we undertake as an EO/GI community to support the Sector Skills Strategy? Which collaborative activities shall we carry out to achieve the desired future we envisage for the skills sector? How do we develop a Sector Skills Strategy that works? How can we design curricula from the Copernicus user uptake perspective instead of from the data producer perspective? How to harmonize the language (EO/GI, academia/industry)? How to update and harmonize the VET and academic offer across EU countries? (e.g., to increase remote sensing in the bachelor's degree courses, to favour application approach) How to adapt the existing training opportunities to the new occupational profiles: EO/GI developer, EO/GI data analyst, EO/GI project manager? How to learn from other continents? How do we inspire the next generations to develop an interest in EO and GI? How do we showcase EO/GI as an exciting, vibrant

		sector that students and undergraduates will see as an attractive career choice? How do we ensure a solid base of STEM skills (Science, Technology, Engineering, Mathematics) in students when they leave school?

We can seek partially evidence-backed answers to some of these questions in this deliverable. After each question it is indicated where it has been elaborated in the document.

- o What is the current state-of-play with regards to EO/GI Sector Skills in Europe? Chapter 2 of this report deals with the analysis of current status related to the EO/GI education and training landscape and understanding the demand for EO/GI skills.
- o Who are the key stakeholders? Chapter 5: Recommendations for the LTAP > WHO: main actors.
- o What is the future we are trying to shape and what is the role of the Sector Skills Strategy? Chapter 5: Recommendations for the LTAP.
- o Which actions shall we undertake as an EO/GI community to support the Sector Skills Strategy? Chapter 5: Recommendations for the LTAP > Implication on Governance.
- o Which actions shall we undertake as an EO/GI community to support the Sector Skills Strategy? Chapter 5: Recommendations for the LTAP > Implication on Governance.
- o Which collaborative activities shall we carry out to achieve the desired future we envisage for the skills sector? Chapter 5: Recommendations for the LTAP > Implication on Governance and LTAP Implementation.
- o How do we develop a Sector Skills Strategy that works? Chapter 3: Strategic Objectives.
- o How to harmonize the language (EO/GI, academia/industry)? Chapter 4 > EO4GEO Operational Objectives > BoK.

Though not all these questions have/will have an answer or full answer in this preparatory work, but this exercise supports the process to build the long-term action plan.

1.5. Structure of the document

This document **outlines a range of preparatory measures to deliver the Sector Skills Strategy** and requires actions involving many stakeholders, those in the public but also in the private sector, all working towards a common goal looking at where the sector wants to go in the future and providing indications to resources, assets, and actors to get there (as suggested by P. van der

Heiden (2015)[30]). Overall the wider objective of the EO4GEO project is to develop a long-term and sustainable sectoral skills strategy.

This strategy should be considered as a "live" document and it is structured so that the different chapters fall under **six** main phases. For each of these phases we have taken into account potential longer-term perspectives.

- **Executive Summary** provides the strategic views under the Space/Geospatial Sector Skills Strategy. It proposes a concrete vision, mission, goals that will be used as preparatory work for the definition of the long-term action plan (LTAP) which will guide specific actions to be taken by a diverse group of stakeholders.
- **Chapter 1** is the **Introductory** chapter including a section describing some preparatory questions on where we are now, where we want to be, and determining how we get there, introducing the work to be done as part of the preliminary activities under the sector skills strategy. It also proposes a **Methodology** for building the strategy.
- **Chapter 2** outlines the **strategic objectives** of the **Sector Skills Strategy** such as the **Vision, Mission** and **Goals**. It provides the mission as a general statement of how the strategy will contribute to the vision. The required objectives on what needs to be accomplished to implement the strategy are also addressed. Overall, this section of the preparatory strategy contains practical actions to achieve the vision in the short term (EO4GEO project duration), but also in the long-term action plan (LTAP). The chapter also presents the impact, the fit with the European Skills Panorama, the regional roll-out and the quality assurance aspects of the training.
- **Chapter 3** describes the **"Analysis of the current status",** the evaluation of the "Guiding Principles" concerning the integrated analysis of both the demand and supply of skills for the EO/GI sector. It[31] by bringing those previous projects tasks results together, with the goal to identify shortages, gaps and mismatches. It describes methodologies to be applied during the course of the EO4GEO project in the context of the Vocational Education and Training (VET) but also an exercise on professional profiles. It also presents an exercise on the EO/GI value chain.

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[30] The role of education and training in absorptive capacity of international technology transfer in the aerospace sector

[31] Supply and Demand surveys (http://www.eo4geo.eu/surveys/)

- **Chapter 4** guides us through an introductory **methodology** to be applied for the **Operational objectives** of the EO4GEO project; the BoK, the integrated platform of collaborative tools, the development of the curricula support and the organisation (and validation) of a series of training actions for a selected set of scenarios on the three identified sub-sectors.

- **Chapter 5** present the first **Recommendations** and **Risks associated** to the **Long-Term Action Plan.** The implication of Governance structures, including the main actors, the business plan, maintenance and the industry connection are described. The risk associated on how to measure progress within the EO4GEO project duration but also some proposals for the LTAP are presented. It also elaborates on the **Marketing and Outreach** activities around the Strategy. The overall perspective is to promote the EO4GEO strategy for skills development in different contexts, towards the target groups addressed by the project dissemination.

- **Chapter 6** focus on the **Conclusions** describing the main aspects for the Sector Skills Strategy (SSS) including the Sector Skills Alliance that will improve the EO/GI sector in terms of relevance of workforce provision.

- **Annexes**, including the references, glossary, the National exercises on Vocational Educational Training (VET) and the exercise on the professional profiles (DACUM workshops).
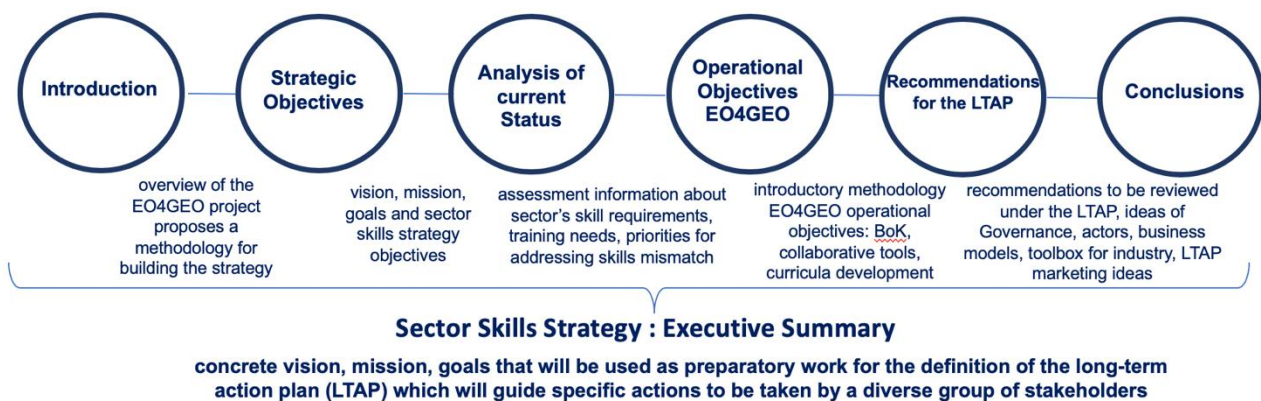
Figure 3: Chapter liaison

This **introductory chapter** presents the framework of the deliverable "Space/Geospatial **Sector Skills Strategy (SSS)"**. In presents the overview of the EO4GEO project and its context showing the preparatory work filling the gap between the supply of and demand for space/geospatial education and training taking into account the current and expected

technological and non-technological developments in the space/geospatial and related sectors. It also introduces the strategy within the full context of EO4GEO providing a summary of all the chapters.

Process to build the Strategy

The methodology offers a mechanism to focus on workforce development for the EO/GI sector. Furthermore, some questions to be answered throughout the EO4GEO project are presented: What are the essentials of the Sector Skills Strategy? Who are the key stakeholders? Why is it necessary to create the Alliance? What are sources to leverage funding to implement the strategy? and How do we monitor and evaluate progress?...

The sector skills strategy presents future activities at Regional level working across boundaries including some national exercises incorporating a methodology to research the situation of vocational training programmes in the EO/GI domain in some European countries. This bottom-up initiative contributes to the strategy development and will form the basis of further discussions within the EO4GEO project.

2. Strategic Objectives for the Sector Skills Strategy (SSS)

Chapter 2 outlines the strategic objectives for the **Sector Skills Strategy** (**SSS**) such as the **vision, mission** and **goals**. It provides the mission as a general statement of how the strategy will contribute to the vision. The required **objectives** on what needs to be accomplished to implement the strategy are also addressed. Overall, this section of the sector skills strategy contains practical actions to achieve the vision in the short term (EO4GEO project duration and connected through the EO4GEO project objectives), but also in the long-term action plan (LTAP).

The chapter also presents the fit with the European Skills Panorama and the quality assurance aspects of the training.

2.1.   Vision (SSS)

The vision statement looks forward and creates a mental image on what EO4GEO wishes to achieve expressing the need for skills for the EO/GI sector to achieve its maximum impact.

The **VISION** of the Sector Skills Strategy is to foster the growth of the European EO/GI sector ensuring a workforce with the right skills, in the right place, at the right time.

The ambition is to maximise the potential of the skills to meet demand and to drive the growth of the EO/GI sector through innovation and flexibility. The vision requires a systematic approach for identifying the skills and competences required to meet the sector's challenges. It follows the Skills Strategy Action Report from OECD which provides countries with a framework to achieve this shared vision of: "Better Skills, Better Jobs, Better Lives" but also fits with the Skills Panorama (See Section 5.4) which turns the labour market data into accurate and timely intelligence to offer new insights into skill needs in the European Union.

2.2. Mission (SSS)

The mission statement describes how we intend to contribute to the vision and serves to communicate purpose and direction.

The **MISSION** is to ensure a strategic cooperation among stakeholders on skills development in the EO/GI sector (Sector Skills Alliance). This cooperation will support growth, diversity, and flexibility by providing harmonized and improved educational offers across different learning levels including VET (vocational / professional training) and academic [high school education, university (graduate, postgraduate)] training and the development of new occupational profiles for the EO/GI sector.

The Copernicus Building Skills action aims to increase the supply of skills to stimulate the growth of geospatial-related jobs in Europe. The proposed mission will leverage the sector skills by ensuring political commitment and coordinating with different stakeholders for the implementation phase and effective policy measures at EU level. These measures will help to increase the number of people able to access, understand and use Copernicus data and information.

This directly supports and contributes to the implementation of the Space Strategy for Europe (COM(2016)) having, among its objectives:
- to maximize the benefits of space for society and the EU economy by encouraging the uptake of space services and data;

- to support research and innovation and development of skills, with explicit reference to the New Skills Agenda for Europe, the inclusion of space/Earth observation in the Blueprint and the launch of a dedicated sector skills alliance (which led to the approval of EO4GEO within ERASMUS+).

In this framework, the following European Commission policy priorities have been identified to be addressed by EO4GEO activities:

- Skilling people through space data and applications covering the entire value chain to enable innovation in different downstream sectors, since it has been assessed that there is a need to create a dedicated education path which is truly interdisciplinary for people's education. Moreover matching job profiles needed in the future, it is important to enable soft skills from the early education steps and in vocational education for students at high schools and university (training) and workers (re-training). A key challenge for industry is that there are not enough students considering EO/GI as a career choice from the outset;
- To pursue a mutual recognition of job profiles and skills from national education systems and labour markets (different sectors) actors (SMEs, Industry, Public Authorities). Currently, some actors are aware of their need to receive the right offer of skilled people to face innovation strategies led by Copernicus paradigm shifts (space 4.0 revolution, AI and other technologies), but struggle to find suitable skilled staff. Actions are needed to help developing and foster EO/GI skills in the end-user sectors (agriculture, energy, transport, local government, etc.) as this is where the "pull" for Copernicus information/services eventually comes from;
- Qualifications and certifications can be a driver to skills' development and mutual recognition, supporting the Copernicus Users Uptake Strategy. To pave the way for this long term objective, the ESCO classification is being taken into due account to align the set of tools EO4GEO will develop with the ESCO available tools and to further cooperate to feed ESCO with skills, occupational profiles and qualifications EO4GEO will identify for the space/geospatial sector.

2.3.   Goals (SSS)

EO4GEO proposes first guidelines of a "European Sector Skills Alliance" to operate as a "Leadership" for EO/GI skills development in Europe which provides insight and intelligence on the

demand/offer of the sector but also developing skills. With this mission in mind, the EO4GEO Consortium will harmonize and give recommendations and develop material (when needed) on EO/GI training courses and programs at different levels such as VET, graduate and postgraduate levels directly linked and adapted to the European classification of Skills, Competences, Occupations and Qualifications (ESCO) occupational profiles. To accomplish this, the following Sector Skills Strategy goals (core, specific targets to achieve the vision) and long-term goals (LTG designated for the LTAP) have been grouped in five different aspects that should be covered in the skills strategy. These goals will not be fully reached during the EO4GEO project but recommended to be follow up during the LTAP. The LTGs definition help to categorise the (core) SSS goals. The table 3 represents the skills aspects, goals and the long terms goals.

Table 3: Skills aspects, goals and Long-Term goals (LTG)

Skills aspects	Skills assessment & intelligence	Skills recognition & transferability	Skills development	Collaboration	Outreach & awareness raising
Long Term Goals (LTG)	Qualifications[32] of the existing workforce are properly described and compared with current and future demands.	Qualifications are recognised in other countries and can be transferred between universities and other training providers.	There is a sufficient amount of education and training being provided by universities and VET providers and political commitment to stimulate skills development policies	The stakeholders are collaborating in an efficient and effective manner.	Existing and potentially new stakeholders are aware of and contributes to the skills development.
SSS Goals (core)	-A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created. -Skills needs are mapped to better refine teaching supply, with a focus on flexible learning paths.	- A standard for describing key qualifications is developed.	-The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported. -Political commitment at EU level (DG-GROW & DG-EMPL) to stimulate innovative skills development policies is ensured. -Harmonised curricula, mobility activities and training offers at pan-	-A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established.	-The EO/GI awareness of and engagement with "end user" sectors is improved leading to increased uptake of Copernicus data and information services.

[32] Qualifications term includes knowledge, skills and competences.

			European level are developed and implemented.		

2.4. Objectives (SSS)

The **objectives** to achieve the strategic goals under the **Sector Skills Strategy (SSS)** and the **Long-Term Action Plan** have been defined in the tables 4 and 5 (Identification of goals and objectives). The objectives registered as **(⇛)** perform as EO4GEO objectives under the EO4GEO Work Plan (Table 4) while the rest of actions will be considered for the LTAP discussions (Table 5).

Table 4: Identification of goals and objectives by skills aspects (EO4GEO)

Skills aspects LTGs SSS Goals	Skills assessment & intelligence	Skills recognition & transferability	Skills development	Collaboration	Outreach & awareness raising
	Qualifications of the existing workforce are properly described and compared with current and future demands. *(Understand skills needs)*	Qualifications are recognised in other countries and can be transferred between universities and other training providers. *(Skills leverage through transferability)*	There is a sufficient amount of education and training being provided by universities and VET providers and political commitment to stimulate skills development policies. *(Skills leverage through training and education)*	The stakeholders are collaborating in an efficient and effective manner. *(Promote collaboration between academic, industry, government and end user sector)*	Existing and potentially new stakeholders are aware of and contributes to the skills development. *(Promote the use of (G)EO in teaching, learning and innovation)*
A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created	(⇛) A review and monitoring program (methodology on how to assess demand/supply) will be implemented, providing a detailed insight in the current supply of and the requirements for education/training in the EO/GI sector. (Review and monitor the skills needed by the sector understanding the collective impact) (EO4GEO Work Plan)				
	(⇛) A technology and non-technology watch that permanently monitors, analyses and publishes the developments and trends in the space/geospatial and related				

	sectors, and in society at large (EO4GEO Work Plan> Proposal for LTAP))				
Skills needs are mapped to better refine teaching supply, with a focus on flexible learning pathways	**(⇒) A commonly agreed Body of Knowledge describing an ontology for the space/geospatial domain that can be permanently updated by making use of a set of collaborative tools in a collaborative platform (EO4GEO Work Plan)**		**(⇒) A series of curricula carefully designed, discussed and agreed upon within the space/geospatial community, based on the modelling of a series of work processes, linked to a series of occupational profiles in the sector making use of the BoK for GI and EO and other competency frameworks (EO4GEO Work Plan)**		
The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported			**(⇒) A series of training actions for different scenarios in the sub-sectors 'integrated applications', 'smart cities' and 'climate change' including group work and internships making use of collaborative methods and tools (EO4GEO Work**		

				Plan)	
Political commitment at EU level (DG-GROW & DG-EMPL) to stimulate innovative skills development policies is ensured				-Coordination with the Commission services for the implementation phase and effective policy measures **(by EC-DG GROW)**	
Harmonized curricula and training offers (including workforce mobility) at pan-European but also international levels are improved and developed					
A standard for describing key qualifications is promoted					
A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established				(⇛) **Create an operational Sector Skills Alliance enforced by of a 'Network-of-Networks'** (interested in skills development). Those partners could be part of the academic, research, industry, decision-making actors including the EC) but	

					also end user sectors. EO4GEO is interacting with the Copernicus academy, Copernicus relays, ESA academy, EUMETSAT, EEAs, etc). Establish links with EiroForum. Explore uptake with other market sectors **(EO4GEO Work Plan)**	
The EO/GI awareness of and engagement with "end user" sectors is improved leading to increase uptake to Copernicus data and information services	**(⇒) Further develop/improve mapping of EO/GI education and training landscape, with strong focus on learning objectives (EO4GEO Work Plan)**					**(⇒) High level capacity building event (EO4GEO Work Plan)**

Table 5: Identification of goals and objectives by skills aspects (LTAP)

Goals / Skills aspects	Skills assessment & intelligence	Skills recognition & transferability	Skills development	Collaboration	Outreach & awareness raising
	(Understand skills needs)	*(Skills leverage through transferability)*	*(Skills leverage through training and education)*	*(Promote collaboration between academic, industry, government and end user sector)*	*(Promote the use of (G)EO in teaching, learning and innovation)*
A coordinated effort to face competitiveness and diversify market intelligence across stakeholders is created					

Skills needs are mapped to better refine teaching supply, with a focus on flexible learning pathways		-Recognition in the European Skills / Competences, qualifications and Occupations (ESCO classification). EO/Geospatial VET courses are offered within all national VET systems and directly linked to ESCO occupational profiles (skills, competences, occupations, qualifications)	Support quality assurance procedures through skills development by raising standards and responsiveness in education and training provision. Quality assurance procedures will act as driver for the mutual recognition on occupational profiles and skills, between education system, labour markets and users		
		-EO/GI VET courses are offered within all national VET systems and directly linked to ESCO occupational profiles Recognition and validation of non-formal learning			
The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported			Provide a mechanism for the upskilling of the existing scientific workforce (Support Continuing Professional Development (CPD) and Wider Learning Opportunities...)	Promote the engagement of professionals in the sector "updating" and "upscaling". Build and update the transferable skills base	Encourage and support the use of EO/GI as an inspiring context for learning across different learning levels (inc. academic (HE, Universities and VET education). Inspire younger children to focus on STEM/STEAM skills and to see EO/GI as an attractive career choice. Start cultivating their interest in EO/GI from school stage

Political commitment at EU level (DG-GROW & DG-EMPL) to stimulate innovative skills development policies is ensured			Stabilize funding for skills policy and resolve funding challenges (Regional Sectoral Skills investment plans for EO/GI sector)	-Mutual recognition of job profiles & skills between national education systems and the labour market (consisting of different sectors) **(by EC-DG GROW)**	
Curricula design and training offer (including workforce mobility) at pan-European but also international levels improved and developed		-Facilitate transferability between public and private organizations - Facilitate transferability of students between academic institutions in different countries	-Transferability of skills among groups of sectors must be enhanced, with mobility schemes and European credit system for vocational education and training (ECVET) as potential enablers. -Acknowledge EO/Geospatial courses in national VET systems. Develop pan-European training modules and collaboration agreements for countries not having sufficient VET training resources in the field.		
A standard for describing key qualifications is promoted					
A strategic collaboration between the skills alliance,					

private sector, government and "end user" sectors is established					
The EO/GI awareness of and engagement with "end user" sectors is improved leading to increase uptake to Copernicus data and information services			-Ensure occupations and occupational profiles are currently included/defined in ESCO	Closer working with VET and higher education (Enhance responsiveness of initial and continuing VET and HE)	-Develop and implement wider outreach programmes to improve awareness and engagement with the ERASMUS+ programmes
			-Secure and embed vocational skills in the workforce (promote vocational pathways (VET) on an equal footing with academic routes, ensure visibility of progression routes...). Support the design and delivery of transnational vocational training content, as well as teaching and training methodologies for European professional core profile. Bring links with Smart Specialization Strategies at regional level	-Collaboration also needs to extend out to the "end user" sectors (agriculture, automotive, energy, local government etc.) as these sectors are the "consumers" of EO/GI information, so they generate the pull that leads to increased uptake of Copernicus data and information services. Without this, our EO/GI sector is having to "push" its technology towards these sectors.	-Develops connexion with the STEAM education (science, technology, engineering, arts and mathematics)
			-Ensure that support materials on careers are accessible, including job profile specifications, work		-Build awareness of EO/GI sector skills objectives (i.e. particular focus on digital skills, green skills and sustainable development)

			experience, internships and information on jobs		

EO4GEO is a 4-year project running from January 2018 to December 2021. The **timeframe and measuring progress** are proposed in Annex 5 and it is represented by a table which captures actions and engagement with representative stakeholders. The timeframe will be revisited in WP6, under the Long-Term Action Plan.

2.5. *Feed the European Skills Panorama*

The Skills Panorama portal is an initiative of the European Commission to improve transparency on the European labour market by providing online access to data and research findings on skills and labour market prospects at both national and European level. In the Skills Panorama, quantitative and qualitative information on sectoral skills are included through:

● Resources: updated information with key pieces from various sources (for example EO4GEO deliverables for WP1), including sectoral skills-relevant reports.
● Analytical Highlights: concise reports on selected topics (e.g. sectors, occupations and countries) providing intelligence on demand, supply and trends in skills and related areas
● Indicators: computed using European and widely accepted sources (i.e. Eurostat Labour Force Survey, the European Centre for the Development of Vocational training (Cedefop) forecast, EACEA call for proposals[33]…)

In the Guidelines for Applicants for Sector Skills Alliance, the need to provide a detailed assessment of the current and anticipated skills shortages, gaps and mismatches in the sector, as well as the need for the review of occupational profiles was clearly mentioned, together with the request of delivering all relevant EU and/or country level qualitative evidence and quantitative data in open data format, using CEDEFOP´s Practical Framework for including sectoral skills evidence in the Skills Panorama[34].

Accordingly, in the work plan of EO4GEO the commitment to use the Collected sectoral skills evidence to feed the European Skills Panorama is stated, also mentioning that both reports D1.5

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[33] Call for Proposals – EACEA 04/2017, KA 2 – Cooperation for Innovation and Exchange of Good Practices, Sector Skills Alliances Applicants' Guidelines

[34] Skills Panorama (2018). Practical Framework for including sectoral skills evidence in the Skills Panorama

"Skills shortages, gaps and mismatches between supply and (future) demand" and D1.6 "Space/geospatial Sector Skills Strategy" would have been prepared in suitable way to feed the European Skills Panorama.

EO4GEO D1.5 is suitable for submission to the Skills Panorama team to allow to decide if and in which way the results will be uploaded on their Platform, together with former deliverables D1.1 "Current supply of space/geospatial education and training" and D1.3 "Demand for space/geospatial education and training and priority occupational profiles". This because they all contain (or refer to) data which are collected and provided in formats that enable further and comparative analysis between sectoral studies, which is a condition necessary to feed the Skills Panorama. The deliverables and the corresponding web links are being therefore provided to the Skills Panorama team for their examination, including raw data in standard format, record of original tables/figures and, when applicable, metadata. As specified in the Practical Framework, the deliverables will be released in MS Word document format to allow the development/update of analytical highlights. Whenever missing, the contact information will be also included.

Additionally, all above reports contains the methodology followed, since this can help Skills Panorama[35] experts understand the "itinerary" of data formation (type of survey, representativeness of sample, soundness of research methods used etc.) and compare and match it to results from other reports, also promoting comparative analysis among different sectoral skills work. The feedback from Skills Panorama experts on the deliverables released so far within the EO4GEO skills intelligence will be of great value to better tune the applied methodology and enforce it in view of its replicability within and beyond the project (both from a geographical and temporal perspective).

For instance, in the Practical Framework it is recommended to have a substantial part dedicated to country/regional analysis of the topic, based either on national or EU data sources (i.e. highlighting differences between countries/regions). This is in line with the main guidelines the project is drafting within the Sectoral Skills Strategy, where a major role is given to a regional rollout, also with the identification and involvement of key players at a national / regional and even local level.

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[35] Practical Framework Annex I "Key principles for planning, developing and carrying out a sectoral skills study applied by Cedefop"

We refer to the Practical Framework and its Annex I "Key principles for planning, developing and carrying out a sectoral skills study applied by Cedefop" for further detailed guidelines to perform sectoral skills studies, which should be detailed in the methodology for up-dating and replicating those studies along time as part of the sectoral skills strategy.

This section provided a first view on how to link the project outputs to the ESCO occupational profiles in terms of training provision and formats while section T4.1 in the project will identify the business processes and occupational profiles. These occupational profiles should then be described in a way that is compliant with EQF.

2.6.   Quality Assurance

The EO4GEO project has no ambitions to change or improve the quality assurance practices at an academic, nor at the VET-system level (often national).

As a first objective, it is expected that the EO4GEO project will propose new curricula to be implemented, for instance as new study programs at CVET (Continuous VET) levels or university levels. In case of new VET programs, the sector skills strategy should assume that these new programs will be implemented according to the national legislations for VET education. As expressed in the EO4GEO Deliverable 9.2 (Defining the Quality Assessment approach for VET related activities), in cases where companies or other entities within the space/geospatial sector will provide formal vocational training, they must establish appropriate Quality Assurance (QA) routines according to their national regulations. Another possible solution for the companies may be to carry out the training as a contractor of an accredited VET provider.

A second objective is to specify the processes for assuring that the curriculum and the learning material, are aligned with the European Qualification Framework (EQF). By doing so, future certification will be possible. ESCO is a multilingual classification system for European skills, competences, qualifications and occupations. It is expected that the project will revise and update the existing ESCO occupational profiles. These job profiles should then be described in a way that is compliant with the EQF. The EQF is also used for specifying learning outcomes, both at a program level and at a module level. The qualifications defined in the curricula design phase should be based on the qualifications identified in the work process assessement.

A third objective is to analyse the ECVET principles and give recommendations about their applicability for the EO4GEO project: 1) ECVET units are components of qualifications, consisting of a coherent set of knowledge, skills and competence that can be assessed and validated with a number of associated ECVET points 2) ECVET partnership is an instrument used for transfer and accumulation of learning outcomes 3) ECVET points provide complementary information about qualifications and units in numerical form.

Outcome: Strategic Objectives

This chapter presents a reflexion on the Strategic views. It gives direction creating the path on what EO4GEO wishes to achieve in the long-term action plan **(fostering the growth of the European EO/GI sector ensuring the development of workforce with the right skills, in the right place, at the right time)**. We describe our contribution to it on what we are intending to do supporting the vision serving to present this route **(ensuring the strategic cooperation with stakeholders on skills development in the EO/GI sector (Sector Skills Alliance))**.

The importance of a comprehensive approach to the sector strategy and the curriculum development is that it results in the creation of a robust set of goals obtained by partners and external stakeholders' consensus. Those have been grouped in five different aspects covering the skills **assessment** (coordinated effort for market intelligence & skills mapping), **recognition** (EO/GI as inspiring and innovative context), **development** (political commitment & curricula design), **collaboration** (strategic collaboration & cooperation) and **awareness** (engagement with users). Such a blueprint may then serve as a powerful cornerstone for subsequent steps of the EO4GEO Project and the skills development.

This chapter also provides a description of the process on how the sector skills development will be reflected and become available for use under the **EU Skills Panorama** is provided. The Skills Panorama portal turns labour market data into useful, accurate and timely intelligence that helps policy-makers in making their decisions on skills and jobs in Europe.

Main recommendations from the deliverable "Defining the **quality assessment** approach for VET related activities" have been addressed. This section is tackling procedures how to deal with European initiatives like ECVET, EQAVET and EQF.

3. Analysis of current status

Chapter 3 describes the **"Analysis of the current status",** the evaluation of the "Guiding Principles" concerning the integrated analysis of both the demand and supply of skills for the EO/GI sector. It deals with the mismatches and how to bridge the identified gaps. It involves the assessment of the collection of information about the sector's skill requirements and training needs and incorporates elements of analysis of both the demand and supply surveys[36] by bringing those previous projects tasks results together, with the goal to identify shortages, gaps and mismatches. It describes methodologies to be applied during the course of the EO4GEO project in the context of the Vocational Education and Training (VET) but also an exercise on professional profiles. It also presents an exercise based on the EO/GI value chain.

The importance of equipping people with the right skills for today and tomorrow's jobs in the EO/GI sector was expressed in previous deliverables. An integrated analysis of the demand for and supply of geospatial education and training was undertaken in the European GI-N2K project and revealed some important gaps in the education and training offer. The 2016 study on the socio-economic impact of Copernicus[37] concluded that one of the main threats of Copernicus user uptake is the lack of appropriate skills. The EP study on space market[38] highlighted that a lack of specialized technical and scientific skills could prevent private enterprises from exploiting opportunities in space data and was a barrier for the development of the EO/GI data market.

As part of the preparation of the skills strategy for the EO/GI sector, several additional surveys have been undertaken in the context of EO4GEO. These include surveys of both the demand for and supply of EO/GI education in Europe as well as an analysis of key trends and challenges related to the EO/GI sector. The results and findings of these studies help to better understand the current status of the sector, as well as the main challenges that have to be addressed in terms of skills needs and skills development.

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[36] Supply and Demand surveys (http://www.eo4geo.eu/surveys/)
[37] Study to examine the socio-economic impact of Copernicus in the EU

[38] Space market uptake in Europe

3.1. The EO/GI education and training landscape

The EO4GEO Supply Study[39] provided a mapping and investigation of the current supply of training and education in the domain of EO. Since the GI-N2K project investigated the GI part of the sector, the focus of the EO4GEO supply study was on the EO part. The results and findings of this study, which was based on a survey among education and training providers, in combination with a systematic web investigation of education and training resources available online, provided a picture of the current EO education and training landscape. The survey led to the identification of more than 230 EO/GI training and education resources. The identified training and education resources could be divided into three main categories: academic courses and lectures at Master level (EQ7), academic courses and lectures at Bachelor level (European qualifications framework)[40] (EQF5/6) and vocational training modules and packages (EQF 4). EO/GI education and training are mainly provided by education and research institutions, but also private companies and public administrations are active in the provision of training and education on EO/GI.

With regard to the application fields as identified in the EARSC Taxonomy for the EO Services Market[41], education and training is provided on all six application fields, but especially the field of Land Services is dominant in the current education and training offer. Around 60% of the identified training and education resources make use of one or more of the Copernicus Services[42], with the Copernicus Land Monitoring Service (CLMS) being the most often used service.

In terms of the scope and content of EO/GI training and education, a distinction can be made between two main groups of education and training resources, i.e. education and training on remote sensing education and education and training on GI and geomatics. At present, there are very few education and training resources covering both remote sensing and geomatics in an integrated manner. When focusing on remote sensing education in particular, a further distinction

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[39] EO4GEO Supply Study (http://www.eo4geo.eu/download/eo4geo_d1-1_current-supply-of-space-geospatial-education-and-training_v2-0/?wpdmdl=3192)

[40] European qualifications framework is a common European reference framework whose purpose is to make qualifications more readable and understandable across different countries and systems

[41] EARSC Taxonomy for the EO Services Market

[42] Copernicus services (https://www.copernicus.eu/en/services): Atmosphere, marine, Land, Climate Change, Security, Emergency

was made between basic resources, advanced resources and domain specific resources. Basic education and training resources on remote sensing[43] mainly deal with the basic theoretical, methodological and technological principles of remote sensing, covering topics such as the physical principles, main platforms, types of sensors, data acquisition techniques. Advanced training and education in remote sensing consist of highly specialized resources, often dealing with a particular remote sensing method[44] or technology[45]. Domain specific resources, which are often targeted at professionals or experts, provide introductory knowledge on remote sensing in a specific domain or fields and strongly focus on practical applications and the use of remote sensing data in decision making in a particular domain. The users of EO/GI data and services are present in many industries, each with very specific needs. Examples of such sectors are spatial planning, agriculture, urban development, coastal and marine management, mining, fisheries and aquaculture.

Important pillars in the current EO training and education landscape are the training and education sites provided by the European Commission (Copernicus education)[46], and key organizations or associations such as the European Space Agency (ESA)[47], the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)[48], the Network of European Regions Using Space Technologies (NEREUS)[49], the European Association of Remote Sensing Laboratories (EARSeL)[50] and various others. Several successful examples are outlined below.

The Copernicus program itself made available around 130 training videos via the official Copernicus YouTube channel, of which many are devoted to foster user uptake regarding the use of Copernicus data (with information on how to access and process Copernicus data and how to use the Copernicus Services for specific applications/case studies). Another key component of the

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[43] Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area

[44] Remote Sensing methods are analysis of image data that comes from one or more remote sensor types (i.e. ocean colour)

[45] Remote sensing data collection technology can be passive or active. Passive sensors (e.g., spectral imagers) detect natural radiation that is emitted or reflected by the object or area being observed. In active remote sensing (e.g., radar) energy is emitted and the resultant signal that is reflected back is measured)) (i.e inSAR)

[46] European Commission (Copernicus education) and Copernicus YouTube channel, Copernicus Training and Information Sessions

[47] European Space Agency (ESA)

[48] European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

[49] Network of European Regions Using Space Technologies (NEREUS)

[50] European Association of Remote Sensing Laboratories (EARSeL)

Copernicus training offer are the Copernicus Training and Information Sessions organized in the different Member States, that aim to promote awareness of the many uses of Copernicus data and information.

The European Space Agency established a training and education portal to provide information about their education activities, and enables access to all the resources produced. ESA provides a large and diverse collection of education resources, including the ESA MOOCs, the LearnEO! project, the EO Education for Schools resources and various other – more advanced - training courses (e.g. Dragon Training, Tiger Training, Advanced EO Training). ESA also provides a comprehensive hands-on training service as part of the RUS (Research and User Support for Sentinel Core products) Service, which aims to promote the uptake of Copernicus data and to support the scaling up of R&D activities with Copernicus data. The RUS Training platform provides easy access to face-to-face training sessions, online webinars and e-learning courses. Via the European Space Education Resource Office (ESERO), ESA also aims to support the primary and secondary education community in Europe. ESERO offers a series of national or regional training sessions for both primary and secondary school teachers, as part of continual professional development qualifications.

Additionally, EUMETSAT, hosts a Training Library with several online training modules. NEREUS developed an online tool called the NEREUS e-catalogue, an open and up-to-date inventory of training courses performed in the space domain in the NEREUS network regions. The 2017-18 edition of the catalogue contains information on 368 courses provided by European universities. EARSeL regularly organizes summer schools and workshops on key topics in the EO/GI domain. These are just some examples of the wide variety of EO/GI education and training resources provided by actors in the field, and many other resources and initiatives exist.

Adding the EO/GI education and training resources provided by these organizations and associations to the resources identified in the survey, EO4GEO was very successful in mapping the EO/GI education and training landscape, with the identification of more than 1000 different education and training resources on EO/GI. The main challenge now is to further investigate the content of each of these sources to better understand which topics they address and which skills they aim to develop.

More info Deliverable EO4GEO_D1.1_Current supply of space-geospatial education and training

3.2. Understanding the demand for EO/GI skills

The EO4GEO Demand Study[51] aimed to better understand the demands of current workforce in the EO/GI sector and to highlight skills required in this sector in the near future. The study consisted of several components, of which the part on the demand of skills in the EO/GI sector can be considered as the main pillar. Between April and July 2018, this survey on skills and occupations was completed by 176 respondents, from different European countries and types of organizations (public sector, SMEs, education and training providers, etc.). While the first part of the survey focused on the organization of the respondents and their own job and expertise, the second part looked at the most needed EO/GI job profiles and the knowledge, skills and competencies relevant and needed for these profiles. Especially the answers provided to this second part provide valuable information on the skills and occupational profiles required by the EO/GI sector.

With regard to the most important and valuable skills, several highly relevant skills sets were identified. In general, data skills were given the highest importance across all answers provided to the survey. Other skill sets were considered important by most of the respondents and they included analytical methods, visualization and cartography, programming and development. Differences were also found in the skills ratings across types of organization, with, for instance, large companies putting most emphasis on programming and development-related skills. Other skill sets, such as computing resources and platforms, were generally considered to be less relevant by the respondents. However, this does not reduce the importance of the related skills, but it could indicate that there might be fewer profiles with these specific skills (a growing role on the processing capabilities in the production of EO services). When looking at the specific skills, most of them could be identified and considered to be relevant and require a high level of expertise. These include the extraction, transformation and loading of EO/GI data, the interpretation of EO/GI data, geo-referencing and resampling data and the evaluation of data quality. Besides these domain-specific skills, also the importance of transferable skills, such as communication skills, networking skills, an independent and proactive working attitude and the willingness to re-skill and enter new thematic fields, was highlighted several times.

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[51] EO4GEO_D1.3 – Demand for space-geospatial education and training and priority occupational profiles

For the analysis of the demand for skills and profiles in the EO/GI sector, the results and findings of the EO4GEO Demand survey were completed with a series of discussions and in-depth interviews with both industrial and public sector actors in the domain. Based on the results of both the interviews and the survey, three main occupational profiles were identified, which already linked occupations with required skills: *1. **EO/GI developer (master level)**, a technically oriented master level EO/GI graduate, that is especially proficient in data related skills and has programming and development skills, but also requires additional skills in analytical methods, visualization, data capture and management required for the development of EO/GI products and services; 2. **EO/GI data analyst (master level),** an analysis oriented master level EO/GI graduate that is highly proficient in space/geospatial data skills and analytical methods, complemented by skills in visualization, programming and development and data capture and management; and 3. **EO/GI specialist (project manager)**, a PhD level EO/GI graduate that is highly proficient not only in the tasks of the analysis and technically oriented master but also proficient in the skills of EO/GI and society, computing resources and platforms, and organizational and institutional aspects. These – new – occupational profiles all express the increased relevance of the integrated development of space/geospatial occupational profiles.

Another approach to better understand and gain insight in the profiles and skills currently required in the EO/GI job market is the investigation of existing job advertisements in the domain of earth observation and geo-information. Job advertisements are a rich source of information about skills needs and can be used to get more insight in sector-specific requirements or competencies related to a specific occupation. Based on an analysis of advertisements for jobs in the EO/GI sector, several main occupational profiles in the sector could be identified, including more traditional profiles such as cartographers and remote sensing experts, but also various types of GIS related profiles, such as developers, (data) specialists, analysts and technicians. With regard to the skills that are demanded by the EO/GI job market, the results of the job advertisements analysis confirmed the importance of recognizing 'Programming and development' as a key EO/GI skill sets, alongside other skills sets such as 'Analytical Methods', 'Data Capture' and 'Visualization and Cartography'.

The results of the EO4GEO Demand Study and the complementary job advertisement analysis both reveal new skills and skills sets that should be covered in EO/GI training and education. In addition to this, they also demonstrate the need to rethink and revise the EO/GI related occupations and skills as currently included in ESCO, the European multilingual classification of

Skills, Competences, Qualifications and Occupations. ESCO, which is an important element in the achievement of the objectives of the New Skills Agenda for Europe, provides a common reference terminology for describing, identifying and classifying skills, competences, qualifications and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. ESCO currently contains three occupations related to the EO/GI domain: geographic information system specialist, remote sensing technician and cartographer. For each of these profiles, a set of essential and optimal skills was defined. In total 50 different EO/GI skills were defined, including skills that are seen as relevant to all three EO/GI profiles such as applying digital mapping, collecting data using GPS, compiling GIS-data, executing analytical mathematical calculations, creating GIS reports, creating thematic maps, using digital illustration techniques and using geographic information systems. The EO4GEO Demand Study and job advertisement analysis showed the need to include new and updated occupational profiles as well as new skills.

While the focus of the EO4GEO Demand Study and related initiatives was mainly on expert profiles and expert skills in the EO/GI domain itself, it is important to also recognize the need to provide people in other domains with the right skills and competencies. This especially applies to various types of users of EO/GI data, including professional users but also end-users, with very specific skills needs.

More info Deliverable EO4GEO_D1.3 – Demand for space-geospatial education and training and priority occupational profiles

3.3. Anticipating future skills needs

EO/GI training and education will only be relevant and effective in case it also takes into consideration the key trends and challenges related or relevant to the domain. These trends and challenges will determine the future need for knowledge and skills. Skills anticipation, i.e. identifying future skills needs and preparing to meet them, means that relevant trends and challenges are monitored and further explored.

Therefore, it is essential to recognize and well understand main trends and changes in the EO sector and its value chain, which can be divided into three major components: upstream, midstream and downstream. These three components or sub-sectors are constantly evolving. Both

the upstream sector, i.e. the (space) infrastructure with its massive increase in EO sensors and satellites, and the midstream/downstream sector, i.e. the ground segment plus value-added services are experiencing significant changes. Space infrastructure is gradually growing, comprising huge, multi-national missions like the Sentinel satellites family, and commercial satellites with increasing spatial resolution, acquisition frequencies as well as micro satellites for near-individual, or solitary use. The ground segment faces rather disruptive changes in the way data storing and access is organised, in particular for Sentinel data which is granted to be full, free and open, and thus increasingly offered as a platform-as-a-service (PaaS). The new paradigm of big EO data ("bring the users to the data") has led to a tendency towards the provision of analysis-ready data (ARD) in central data infrastructures, and also to an increasing cloud-based processing and information extraction (Information as a Service, INFOaaS). The various implementations of DIAS (data & information access service), are examples that integrate both services to some degree. The value-adding industry ("downstream sector") is supposed to benefit enormously from the given data and service infrastructure. These technical achievements need to be ultimately translated into users speak, i.e. the language potential users and customers including the non-EO industry are able to understand and perceive technical achievements as related to the challenges they typically face.

The fact that the EO/GI undergoes a considerable change is documented by recent studies. Important to notice is that many of the trends that are transforming or at least influencing the EO/GI sector are not unique to the sector but can be seen as broader technological and societal trends. Among the key technologies and technological trends that (will) have an impact on the EO/GI sector are the cloud computing (and the fog & the edge), big data, the internet of things, artificial intelligence, blockchain, augmented reality, drones, SmallSats and future CubeSats. Also, broader societal developments such as the rise of the circular economy and the data economy, citizen science and citizen observatories are relevant to the EO/GI sector and its value chain. The 2030 Agenda for Sustainable Development and the creation of the new set of Sustainable Development Goals is just one of the many policy initiatives with a strong relevance to the EO/GI sector.

Setting up a trend watch system for the EO/GI sector should allow to forecast, monitor and investigate future trends and developments that are relevant to the sector, and support decision making on sectoral education and training. An illustration of this is the OGC Technology Trends process, which uses information from a wide variety of sources to identify technology trends, assess their relevance and impact to the geospatial industry, and define future actions to the identified trends. The EO/GI sector should learn from this and similar examples and collaborate

with actors involved in these initiatives for the creation of an EO/GI Trends Watch, in which also non-technological trends and developments are addressed.

> More info EO4GEO_D1.4 - Trends and challenges in the space/geospatial sector

3.4.   Priorities for addressing the skills mismatch

The preparation and execution of these studies on both the demand for and supply of EO/GI education in Europe and on key trends and developments in or related to the EO/GI sector, has allowed the identification of the main challenges that have to be addressed in the EO/GI Sector Skills Strategy. At least five key challenges can be identified:

1. *A more detailed and continuous **monitoring and investigation of the** EO/G**I** education and training landscape, which consists of various types of resources provided by many different actors in the domain.* With the identification of around thousand different education and training resources, EO4GEO already provided a major step in mapping the current supply of EO/GI education and training. Particular effort should be done to also include professional and vocational training on EO/GI in this mapping and investigation of EO/GI education and training landscape. A crucial next step is the investigation of the scope of content of each of these resources, which means that information on the learning objectives of these resources should be collected and analysed in a structured and systematic manner. This should especially lead to more insight in and better understanding of the extent to which and the ways in which EO and GI already are addressed in an integrated manner in particular courses or programs.

2. *Investigating and **mapping the skills needs of the EO/GI Sector** combining information from various sources.* During the preparation of this sector skills strategy, different methods have been applied to collect information on skills needed by the EO/GI sector. A survey among people active in the sector, in-depth interviews with employers and an analysis of job advertisements all helped to better understand the sector skills needs. Ideally, also EO/GI skills in other sectors and in society in general should be investigated. Especially the skills needed for using EO/GI data are important and should be further explored, knowing that different users – expert users versus professional users versus end users – probably will have different skills needs. Continuing these efforts to monitor and investigate the skills

needs and exploring new approaches and methods is crucial, as skills needs are changing rapidly.

3. ***Developing a common vocabulary for describing skills needs and skills supply****.* Skills gaps and mismatches are about imbalances between the supply of skills and demand for skills. Detecting these imbalances means that a comparison is made between the skills developed and supplied by the current EO/GI education and training offer and the skills needed by the EO/GI job market. Such a comparison is only possible with the use of a common vocabulary for the description of skills needs and skills already supplied. The development of the EO/GI Body of Knowledge, by defining core concepts in the EO/GI domain, will enable and support the comparison and analysis of supply and demand;

4. **EO/GI** ***training and education should meet current and future skills needs***. The skills needed by the EO/GI job market should be central in the design and implementation of EO/GI education and training. There already is a large supply of EO/GI education and training in Europe, consisting of various programs and courses at master level and bachelor level, vocational education initiatives and actions, different types of online courses and programs, etc. The challenge is to think about best ways to improve existing education and training and to add new elements to the existing education and training offer. Especially the integration of EO and GI in single courses, both in academic education and vocational training should be considered.

5. ***Building further on existing initiatives and collaborating with leading actors****.* The EO/GI sector is characterised by a wide variety of training and education resources and initiatives, involving many different types of actors and organizations. Many different initiatives also exist for the collection, description and analysis of occupations, skills, education and training resources and technological trends. Many of these resources and initiatives have been identified and investigated in the preparation of this strategy. It is essential for the EO/GI sector to learn from these and, if possible, to build further on the work that has been done and the initiatives that have been put in place.

The table 6 identifies the five challenges under the skills mismatch and their relationship with the operational objectives under EO4GEO but also under the LTG. These challenges reflect their connexion with skills assessment and intelligence, skills development and collaboration.

Table 6: Skills mismatch priorities and identification of strategy objectives

Skills aspects & Long-Term Goals	EO4GEO priorities related to skills	Identification of EO4GEO objectives by skills aspects

mismatch		
Skills assessment & Intelligence Qualifications of the existing workforce are properly described and compared with current and future demands.	**monitoring and investigation of the EO/GI education and training landscape**	(⇛) Further develop/improve **mapping of EO/GI education and training landscape**, with strong focus on learning objectives (EO4GEO Work Plan> Proposal for LTAP)
	mapping the skills needs of the EO/GI Sector	(⇛) A technology and non-technology watch that permanently **monitors, analyses and publishes the developments and trends in the space/geospatial and related sectors**, and in society at large (D.1.4. introduced the technology and non-technology watch that the implementation could be part of the LTAP, therefore within the project follow up activities);
	developing a common vocabulary for describing skills needs and skills supply	(⇛) A commonly agreed **Body of Knowledge describing an ontology for the space/geospatial domain** that can be permanently updated by making use of a set of collaborative tools in a collaborative platform (EO4GEO Work Plan);
Skills development There is a sufficient amount of education and training being provided by universities and VET providers and political commitment to stimulate skills development policies.	**meeting current and future skills needs through EO/GI training and education**	(⇛) A **series of curricula**[52] carefully designed, discussed and agreed upon within the space/geospatial community, linked to a series of occupational profiles in the sector making use of the BoK for GI and EO and other competency frameworks (EO4GEO Work Plan) (⇛) A review and monitoring program will be implemented, providing a **detailed insight in the current supply of and the requirements for education/training** in the EO/GI sector;
Collaboration The stakeholders are collaborating in an efficient and effective manner.	**building further on existing initiatives and collaborating with leading actors**	(⇛) Create an **operational Sector Skills Alliance enforced by of a 'Network-of-Networks'** (interested in skills development). Those partners could be part of the academic, research, industry, decision-making actors including the EC) but also end user sector. EO4GEO is interacting with the Copernicus academy, Copernicus relays, ESA academy, EUMETSAT, EEAs, etc). Explore uptake with other market sectors (EO4GEO Work Plan).

3.5.   *EO industry value chain*

This section describes the EO value chain. According EARSC´s report for the NextGEOSS[53] project, the strategic environment for the Earth Observation (EO) services industry sector evolves
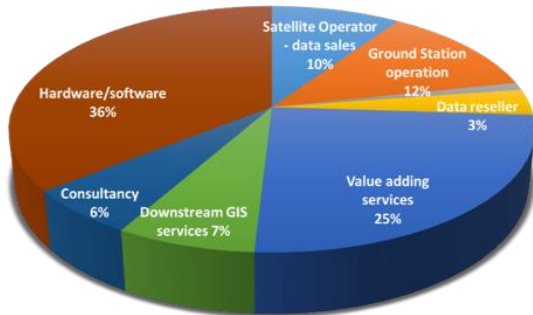
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[52] EO4GEO will develop and implement systematic approach to curriculum development in the domain of EO/GI, by taking into consideration key business processes and occupational profiles in the domain. During the project life time, 15 curricula will be developed that include adaptations of existing courses as well as the development of new courses.

[53] NextGEOSS is a centralised European Earth observation data hub and platform

rapidly with the strong development of acquisition capability, online platforms to access data, infrastructure and new services. Platforms have different positioning, focusing on accessing the data, attracting developers or providing sales channels. The development in ICT, artificial intelligence and robotics, just to mention some of these technological trends, are also impacting the GI sector which generates new conditions for employment and have unpredictable impacts on job creation. Although such technological evolution is not new, the risk lies on how the sector identifies and addresses these new challenges and opportunities. However, in all senses we need to see it as an opportunity for economic growth and development. The rapid rise of the on-demand data and the spread of platforms is a concrete impact which is reflected in the value chain. Starting with the ground station activity collecting raw data from satellites, up to the geospatial information, the value-chain for EO services is broad even if it does not take into account the satellite manufacturing. EARSC Surveys[54] performed in 2012, 2014 and 2016 indicates some changes in the value chain (Figure 3: Comparison of EO downstream activities).

Split of activities based on 2016 revenues   Activity Split (Combination: 2012, 2014, 2016)
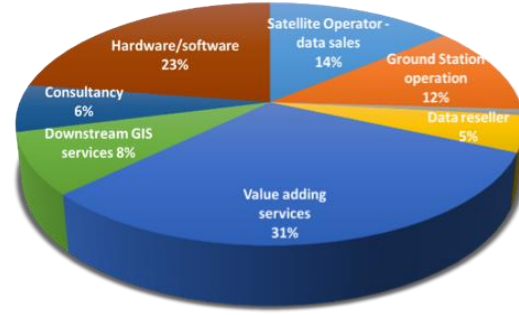

Figure 4: Comparison EO downstream activities evolution

Whereas Consultancy, Downstream GIS, and Ground station operation are stable, Hardware/software and Value adding services present significant variation of respectively +12% and -6%. This indicates a growing role of processing capabilities in the production of EO services. These variations will be analysed in the next EARSC survey for 2019.

The identification of available data, the acquisition of the proper data, the storage of large volumes of data, the processing capabilities have constraints and there may have been barriers for the use of the EO products or services. Nowadays, ICT standards and the open data policy contribute to

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[54]EARSC Industry Survey (http://earsc.org/news/results-eo-industry-survey-september-2017)

the emergence of digital platforms, offering a new approach to ease the adoption of EO products or services. Platforms have different positioning, focusing on the access to data, EO tools, IT services, promotion and, or, sales which are aligned with the different tiers of the EO ecosystems and are considered tools to create bridges between a product or service and a customer, allowing to improve awareness on EO/GI capabilities, providing example or case stories and potentially interacting with the platform up to become a selling point. The reflection on the value chain provides some generic thoughts on the evolution of the sector and the need of new skills. Figure 4 shows the tiers of the EO ecosystem and related platforms while Figure 5 shows the Copernicus Support Ecosystem (copyright EvenFlow).
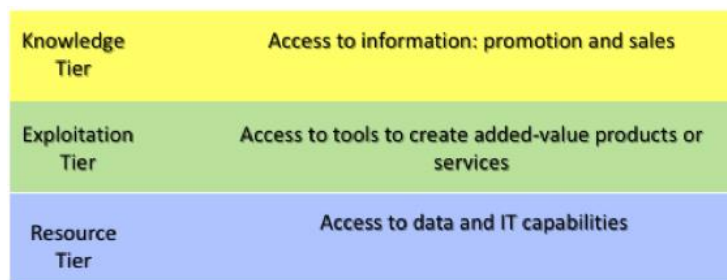

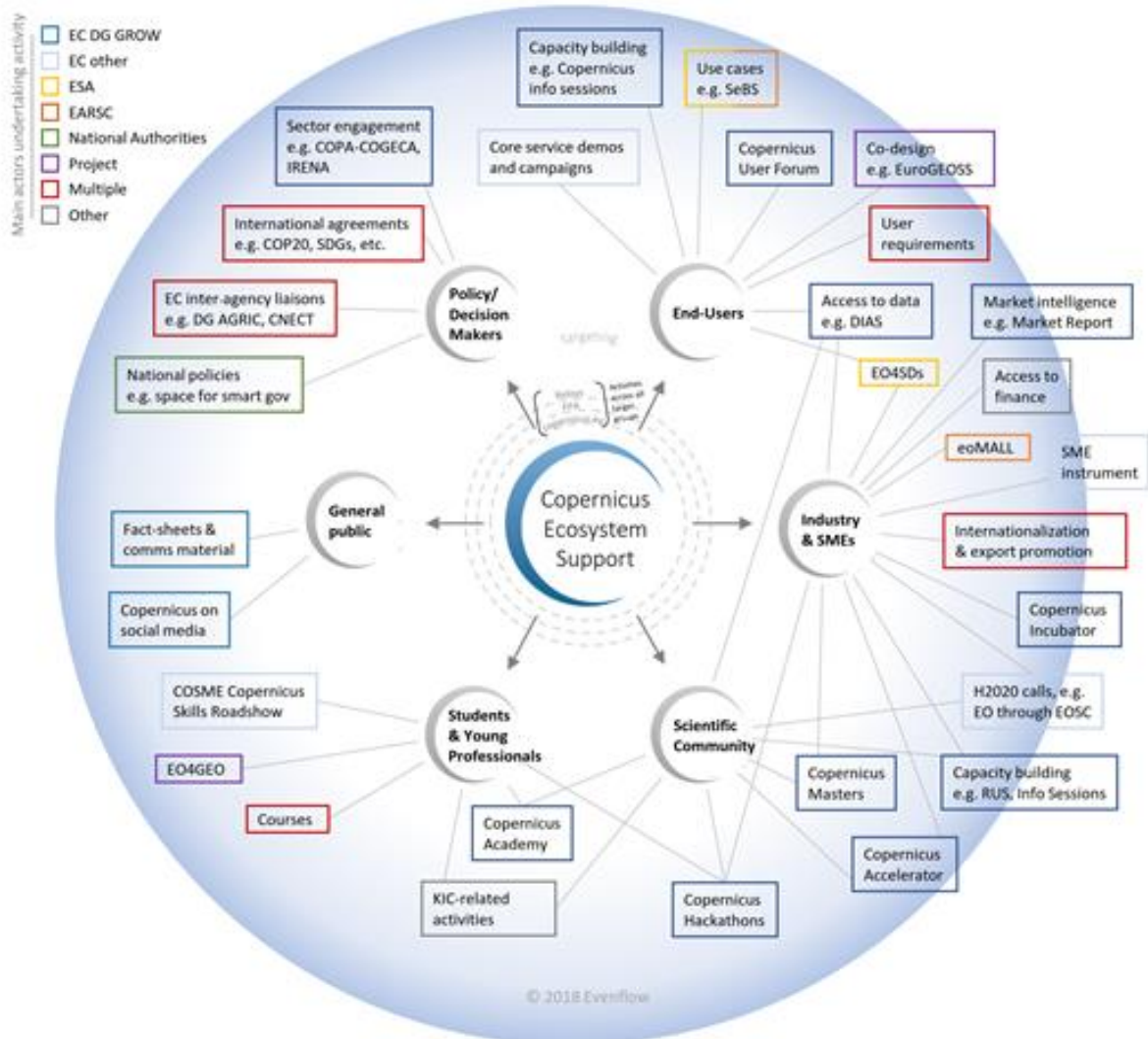Figure 5: Tiers of the EO/GI ecosystem

Figure 6: Copernicus Support Ecosystem

EO is traditionally a bespoke market (B2B) where a customer needs a tailored product or service. Its production therefore requires human actions or intelligence. Due to numerous improvements (e.g. processing capabilities, understanding of customers' needs, companies' Research & Development (R&D), some parts of the processing can be automated opening new business opportunities.

The development of cloud capabilities offers new perspectives to overcome local IT limitations (compute, storage, database, networking and content delivery, ...). Some platforms provide a single-entry point to diverse tools to handle the data prior use (e.g. format conversion, sub-setting, band extraction), to complement a dataset (e.g. overpass prediction times, satellite tasking) or to process data locally or remotely. In the short term, companies consider that sales of tailored

bespoke services/products could slightly decrease compensated by the sale of standardized pre-developed products (e.g. land cover maps) or ready to interpret/analyse data for advanced users who will create added value products/services for diverse thematic or markets. These products, called intermediate services, can be orthorectified imagery or data cubes, Digital Elevation Model or Digital Terrain Models. Consequently, the value chain has evolved very rapidly, see Figure 6 on the future EO services value chain where new and innovative satellite operators are entering the market, new data sources are emerging - including unmanned aircraft systems (UAS) and crowd or citizen sources using mobile technologies - and large IT companies. All leading to many more potential opportunities to exploit it.
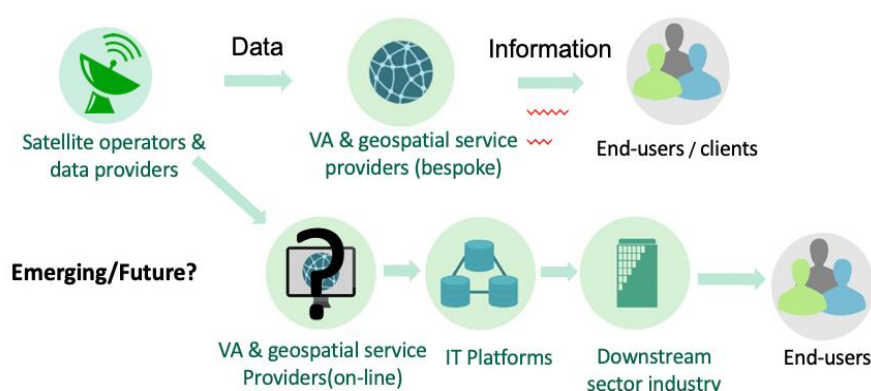

Figure 7: Changes in the EO/GI value chain

The GI value chain should be considered in future EO4GEO future activities such as WP6 (Developing a Long-Term Action Plan).

Outcome: Analysis of current status

Several outputs and outcomes were generated in the first 12 months of the EO4GEO project. Two surveys were conducted to assess the supply and demand of education and training in the space & geospatial field, complemented by a desktop research and in-depth interviews. The **EO4GEO Supply Study** [EO4GEO D.1.1] aimed to gain insight in the current offer of EO/GI education and training in Europe by identifying existing courses, lectures, workshops and other education and training initiatives in the sector. The **EO4GEO Demand Study** [EO4GEO D.1.3] aimed to gain insight in the current demand for EO/GI skills and occupational profiles by further investigating the content of those resources. An initial set of eight skills sets was further explored; space/geospatial data skills, analytical methods, visualization and cartography, programming and

development, data capture and management, EO/GI and society, computing resources and platforms, organizational and institutional aspects. In addition to this, the study also aimed at better understanding the different occupational profiles in the sector and three main profiles were defined: EO/GI developers, EO/GI data analysts and EO/GI specialist and project managers. The corresponding reports (accessible at project publications link) provide an in-depth insight in the provision of academic and vocational training offered throughout Europe and the need for (new) occupational profiles.

In order to be able to anticipate to skills needs, it is essential to better understand and gain insights into the skills that are needed to embrace those trends and developments that will or could be relevant to the EO/GI domain, consequently the **technology and societal trends and challenges** [EO4GEO D.1.4] report, highlights the dynamic and continuous changing sector. In this context, the foundation has been laid to have a structured and long-lasting cooperation with the Open Geospatial Consortium (OGC) and its members to monitor and take into account future trends in the space & geospatial sector.

EO provides access to data in innovative, accessible and user-friendly ways, as well as providing information and services which are integrated into recurrent GI processes. In doing so, the industry is gradually moving toward analytics as a service demonstrating EO/GI capabilities, developing consistent production workflow as well as the adoption and acceptance of users to modify and modernize their processes of using EO services.

Five **challenges** have been identified:

1) monitoring and investigation of the EO/GI education and training landscape

2) mapping the skills needs of the EO/GI Sector

3) Developing a common vocabulary for describing skills needs and skills supply

4) EO/GI training and education should meet current and future skills needs

5) Building further on existing initiatives and collaborating with leading actors.

The chapter also analysed the actual **EO value chain** based on the work done under NextGEOSS project. The GI value chain should be considered in future EO4GEO future activities such WP6 (Developing a Long-Term Action Plan).

The work done in WP1 (Preparatory Sector Skills Strategy) during the first year provided the necessary input to define a first version of the strategy based on the current state of affairs.

4. EO4GEO Operational Objectives

Chapter 4 guides us through an introductory **methodology** to be applied for the **operational objectives** of the EO4GEO project: the Body of Knowledge, the integrated platform of collaborative tools, the development of the curricula support and the organisation (and validation) of training actions suitable for a selected set of scenarios on the three identified sub-sectors. It briefly describes the actions that will be implemented, tested and validated in the project. It is not the intention under this chapter to describe the activities that will be performed nor indicates it suggestions for the work plan.

To expand on the Skills Strategy, we present the operational EO4GEO activities as key elements of the Strategy and how these activities should be taken into account in the Long-Term Action Plan (LTAP): The Body of Knowledge (BoK), the Platform for collaborative tools, the Development of Curricula and the Test and validation in other sub-sectors. The following sections describe the methodology of these activities and also indicate their revision within the project duration (short/long term) indicating some challenges / or testing the approach.

4.1.   Developing and operationalizing an EO/GI Body of Knowledge

WP2 (Developing and operationalizing an EO/GI Body of Knowledge (BoK)) builds upon the output and outcomes of WP1, including the results of the skills needs assessment and the outcomes from the trends and challenges analysis. The resulting BoK will form the basis for the design of the curricula (WP4). Existing tools will be improved, while new tools will be developed as part of activities in WP3 (Developing an integrated collaborative platform) to expand, maintain and exploit the BoK.

In WP2 a BoK for EO and GI will be developed and operationalized. This work builds on the results from the GI-N2K project[55] that resulted in a BoK for GIS&T. The network of experts will be a continuous process during the project to allow as many people as possible to be involved, and to actively search for experts in domains or concepts not yet covered by the current network. Using a

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[55] the GI-N2K project (Geographic information : Need to Know) aims to improve the way in which future GI professionals are prepared for the labor market so that the GI sector in general can evolve in a dynamic and innovative way.

revised and fine-tuned ontology-based approach these experts will clean-up and update the existing BoK and extend it with EO concepts.

In parallel the content of the current GI-N2K BoK was explored and analysed as preparation for the update and maintenance of the BoK. Missing EO/Copernicus related concepts were identified and used to define possible working groups for the extension of the existing BoK with these new concepts. The workflow to seamlessly integrate these new concepts in the existing BoK was also elaborated.

4.2.   Developing an integrated platform of collaborative tools

WP3 (Developing an integrated platform of collaborative tools) will make use of existing evidence on the needs for particular tools (functions) that has already been collected in other initiatives, in the action plans of the Copernicus Academy members and Copernicus relays, and in the survey on the demand for education and training in the GI and EO sector that was conducted as part of WP1. Although there exist already clear ideas on specific interests such as the development of a dedicated tool for defining job/expert or occupational profiles.

One of the EO4GEO goals, as well as WP3 main activity, is the creation of a EO4GEO collaborative platform based on the combination of existing components and platforms and the development of new components and tools. To this aim, a methodology has been tailored that supports the project partners in; collection and selection of requirements (both functional and non-functional), development and reuse of existing components/platforms, and implementation of new components/tools. The process underlying this methodology is depicted in Figure 7 by means of a Unified Modelling Language (UML) Activity Diagram with Object Flow, where ellipses represent the phases of the methodology, while rectangles represent the artefact consumed/produced by these phases.
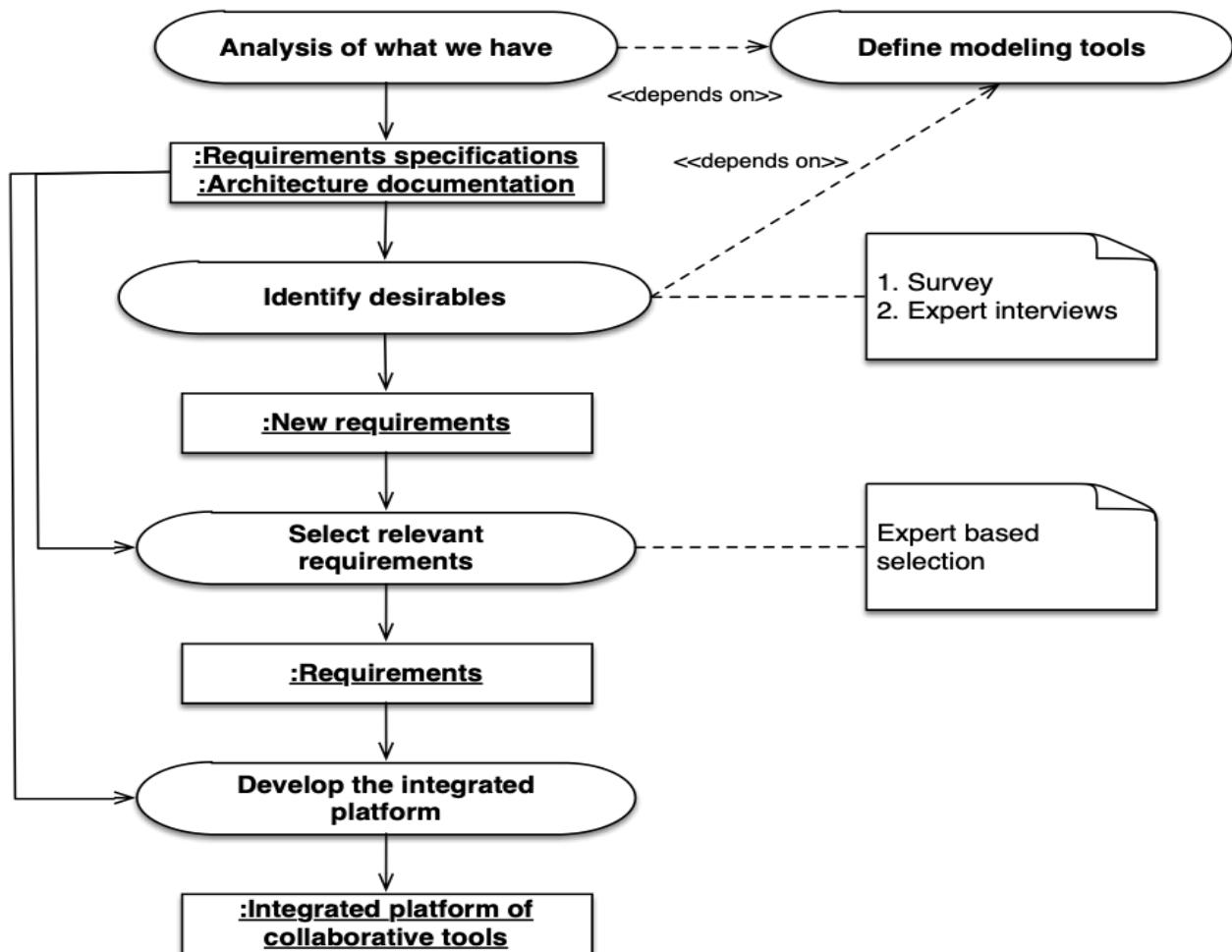
Figure 8: Process outline: Adopted methodology for the development of the integrated platform of collaborative tools

Before analysing the existing and available components/platforms, there is an initial phase (**Analysis of what we have**) in which EO4GEO had to define modelling tools to describe requirements (**Define modelling tools**) and desirable functionalities (**Identify desirables**). To this end, EO4GEO opted for Use Case modelling that was properly adapted to better handle the problem at hand. This represents the standard of our project for modelling functional requirements. This represents also the standard in software industry and will be used in EO4GEO to model functional requirements. Use cases are easy to understand for people without specific technical knowledge because they allow describing a given functionality in terms of interactions between the end-user and the system.

The phase **Analysis of what we have** also aimed to reverse engineer the software architecture of existing platforms. The identification of desirable functionalities not present in the existing components/platforms (**Identify desirables**) is a critical phase of the methodology and involves

experts who, to this aim, are invited to fill-in a survey and to participate in interviews. It is worth mentioning that not all the desirable functionalities will necessarily be implemented in the integrated platform of collaborative tools, but only the most important/useful ones will be selected (**Select relevant requirements**). What is important or useful is not easy to establish and for this reason a selection-based process is used guided by experts of the problem domain.

In the last phase (**Develop the integrated platform)** the new requirements identified in the previous phases will be implemented and then integrated in the existing components/platforms. Currently, the WP3 partners are defying the prototypes of the user interfaces (through mockups) of the most important/useful requirements. The next actions are concerned to the definition of all mockups and their validation among the project partners. A requirement could be implemented as it has been described in the mockups, removed, or modified. Requirement modifications can be in terms of: layout of the user interfaces and interactions between end-users and platform. To implement these requirements it has been decided to use the agile methodology SCRUM[56]. The implementation of all the new requirements will be possible through the use of the architectural models previously recovered and documented.

The platform, so developed, will be tested during existing academic courses (e.g. at UNIBAS) and/or summer schools organized by EO4GEO partners. In the long-term strategy a common European platform supporting education (at all levels) in the EO/GI field should be envisaged allowing extensions and/or updating by all the registered contributors. Also, in this case a panel of academic experts and EO/GI users should be committed to verify, and guarantee during the time, the quality of EDU contents made available in the platform.

4.3.   Design & development of curricula in support of Copernicus

This work package will rely on the BoK for GI and EO (WP2: Developing and operationalizing a Body of Knowledge for EO/GI) to populate the curricula by making use of the revised and extended tools (WP3: Developing an integrated platform of collaborative tools). The business processes and related occupational profiles will be modelled by adopting the BPMN standards.

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[56]SCRUM,is focused on improving the profession of software delivery and that drives everything we do.

The designed curricula and the training materials will form the basis for the testing and validation phase (WP5: Testing and validating the strategy bases on case-based learning in 3 sub-sectors) which will focus on the education and training for some selected scenarios for three sub-domains: smart cities, integrated applications and climate change. Some training modules/courses will be relevant for all three sub- sectors, e.g. those related to basic techniques in remote sensing and soft skills.

EO4GEO aims at providing a systematic approach to curriculum development on various levels of the European Qualification Framework (EQF) by taking business processes and occupational profiles into consideration. During the project life time, 15 curricula will be developed that include adaptations of existing courses as well as the development of new courses. **The specific target of curriculum development is to overcome the identified skill gaps and to prepare the future workforce of the evolving EO/GI market**. The tool used for curriculum development is the Curriculum Design tool (CDT), developed in the GI-N2K project and to be re-used and extended in EO4GEO.

In order to meet the implicit challenge of curriculum development for a future workforce, an analysis of key work (or business) processes (as an extension of the previous findings) was initiated: selected partners carried out an exercise on future occupational profiles (DACUM). The work processes consisting of different types of activities carried out by different occupational profiles (see Annex 7) will be analysed in order to find overlaps and divergence in skills, knowledge and competencies. Identified work processes (T4.1) and their related workflows will offer in-depth information on the skills gap and future requirements of EO and related curricula (T4.2). The selected work processes will related to the sub-sectors for which scenarios will be developed in WP5.

The curriculum design process builds on input from various sources that are meant to assure a forward-looking perspective of the curricula and subsequently course material:
- WP1 surveys on the demand and supply of education in the EO/GI sector and the analysis of gaps between supply and demand;
- Information on existing VET curricula in EO4GEO partner countries (Annex 6: National exercises on Vocational Educational Training (VET));
- An analysis of (changing) occupational profiles by EO4GEO project partners (Annex 7: Exercises on professional profiles (DACUM);

- Technological trends as identified in the technology watch.

In addition, the improvement of existing and the development of new training material (T4.3) will be supported by the outcomes of (i) an analysis of vocational training programmes on existing VET curricula in the EO/GI domain in the partner countries and (ii) the results of the supply survey (T1.1.).

The integration of a work-based learning concept in connection with a case-based learning approach (WP5) is envisaged. In order to foster case-based and work-based learning a mobility programme (T4.4) i.e. internships/placements will be developed.

The collected inputs are expected to be geared towards sector needs without neglecting any relevant conceptual foundations outlined in the BoK. The systematic approach to curriculum development used in the EO4GEO project can be repeated at later stages during the project or after the project lifetime in order to establish up-to-date training programmes.

The European Qualification Framework (EQF) is also used for specifying learning outcomes, as well at a program level as at a module level. The qualifications specified in the occupational profiles specified in D4.1 "Business processes and occupational profiles" should match the qualifications specified by the learning outcomes of the curricula in D4.2 "EO and related curricula". This may also support the development of a validation process.

It is an ambition of the EO4GEO project that the required competences should be based on EQF levels and thus enhancing the relationship between ESCO and EQF. This means that we need a method where we can go from process descriptions to occupational profiles in a structured manner.

Concerning ECVET:

- ECVET units are components of qualifications, consisting of a coherent set of knowledge, skills and competence that can be assessed and validated with a number of associated ECVET points. In the EO4GEO project, a unit may be implemented by the courses specified in the curricula (T4.2 "Design of EO and related curricula").

- ECVET points provide complementary information about qualifications and units in numerical form. A convention is used according to which 60 ECVET points are allocated to the learning outcomes expected to be achieved in a year of formal full time VET. It is

proposed that the courses specified in the EO4GEO curricula are quantified using ECVET points.

- To support the mobility of learner's goal, the usage of learning agreements should be taken into consideration in task 4.4 "Development of a mobility programme" and its deliverable D4.5 "Mobility Vademecum".

4.4. Testing and validating 3 sub-sectors: integrated applications, smart cities and climate change

While WP4 designs a series of curricula related to business processes and occupation profiles relevant to Copernicus, WP5 is aiming at using these curricula for developing case-based scenarios for 3 sub-sectors, and testing and validating them in concrete training actions (including on-the-job training and summer schools). The feedback on the testing and validation during the training actions will provide the necessary input to help defining the Action Plan (WP6). The results will also be presented during dissemination events (WP7).

To adequately test and validate that EO4GEO's curricula indeed facilitate achieving the mission to enable 'right skills, in the right place, in the right time', real-world scenarios will be developed for the three sub-sectors – integrated applications, smart cities, and climate change monitoring & adaptation. The training measures are built on case-based learning concepts which start from problems rather than from the 'solutions' or supporting technologies. Participants learn to analyse a problem, explore how GI and EO techniques can be used to find solutions and more particularly how Copernicus data and information can help in the specific case. This approach allows demonstrating how complex infrastructures can support different users and different types of usage, rather than focusing on the mere set-up and maintenance of the infrastructures themselves. The selection, acquisition and preparation of the GI and EO data, their (pre)processing and integration, and their transformation into information readily usable for problem-solving will be an important part of the teaching/learning process.

The design of the scenarios needs to take into account the active involvement of the EO/GI profiles which resulted from the demand survey - developers, data analysts/specialists, and project

managers. Each of those will require different/complementary skills related to the relevant sections of the EO/GI BoK.

The testing and validation are performed by involving the education/training providers, the space/geospatial industry and public sector players, the end-users of the Alliance and other relevant stakeholders. For each sub-sector there will be a task-force of at least three partners that are working in these fields. The actions will be national and transnational, involving multiple disciplines. Also, the space/geospatial sector and the education/training providers will work closely together to prepare, conduct and evaluate the training actions.

The feedback on the testing and validation during the training actions will provide the necessary input to help defining the Action Plan (WP6). The results will also be presented during dissemination events (WP7).

During the definition of the Quality Assessment approach to VET related activities (D.9.2.: Quality assessment of VET related activities) some recommendations were indicated for the training actions (T5.3 (Integrated Applications), T5.4 (Smart Cities) and T5.5 (Climate Change Monitoring and adaptation)):

- Responsibilities in quality management and development have been explicitly allocated
- There is an early involvement of staff in planning, including quality development
- VET providers plan cooperative initiatives with other VET providers
- The relevant stakeholders participate in the process of analysing local needs
- VET providers have an explicit and transparent quality assurance system in place
- Resources are appropriately internally aligned/ assigned with a view to achieving the targets set in the implementation plans
- Relevant and inclusive partnerships are explicitly supported to implement the actions planned
- The strategic plan for staff competence development specifies the need for training for teachers and trainers
- Staff undertake regular training and develop cooperation with relevant external stakeholders to support capacity building and quality improvement, and to enhance performance

- Self-assessment/self-evaluation is periodically carried out under national and regional regulations/frameworks or at the initiative of VET providers
- Evaluation and review include adequate and effective mechanisms to involve internal and external stakeholders
- Early warning systems are implemented
- Procedures on feedback and review are part of a strategic learning process in the organisation

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Outcome: Operational Objectives

Chapter 4 deals with the activities carried out in WP2 to WP5. This chapter introduce the actions that will be implemented, tested and validated in the project. There is not expected dedicated clarifications nor deviations from the work plan.

-Work started in the **Body of Knowledge (BoK)** (WP2 - Developing and operationalizing a BoK for EO and GI). The way an ontology-based BoK will be developed and maintained was assessed, discussed and decided upon. The procedures were set-up and described to populate and maintain the BoK for EO and GI and several existing tools were tested. It was decided to organise the work by setting-up 7 Working Groups.

-Regarding the **platform(s) and tools** (WP3 - Developing an integrated platform of collaborative tools), a detailed analysis has been carried out to identify and describe existing open and closed-source platforms and tools to populate, manage and use the BoK; to organise and manage training materials and training actions; and to access, process and use geospatial and Copernicus data and services in the context of learning activities. In addition, an internal user requirements analysis with regard to the different EO4GEO activities was carried out and documented in work package.

-The specific target of **curriculum development** is to overcome identified skill gaps and to prepare the future workforce of the evolving EO/GI market. The WP4 (Design and development of the curricula in support of Copernicus) will describe methodology to achieve new or adaptation of curricula.

-The development of curricular objectives is an important step in curriculum development. The section on **Testing and validating sub-sectors** (WP5) should outline an innovative and comprehensive approach to the development by consensus of curriculum content based on three sub-sectors**.**

Several recommendations are given concerning how to deal with ECVET (European Credit

5. Recommendations for the Long-Term Action Plan

Chapter 5 presents the first **Recommendations** and **Risks associated** to the **Long-Term Action Plan.** The implication of Governance structures, including the main actors, the business plan, maintenance and the industry connection are described. The risk associated on how to measure progress within the EO4GEO project duration but also some proposals for the LTAP are presented. The section also elaborates on the **Marketing and Outreach** activities around the Strategy.

The strategic plan presented in chapter 3 (Strategic views) captures our preliminary outlook for EO/GI over the next years, the associated skills issues and priorities, and the solutions EO4GEO will deliver. The document also references further areas for delivery addressed by organizations working in partnership and by stakeholders through the skills agreement.

5.1. Structure of Governance

EO4GEO has adopted a rather direct approach to embrace the Sector Skills Strategy defining in very clear terms (who) should be involved, (what) should they focus on, (how) shall they go about implementing these actions and in which timeframes (when).

5.1.1. Who: Main actors

Considering the International Labour Organization (ILO)[57] studies on skills development, as skills needs change, people and their employers (workers) will require different sets of skills over time. In addition at considering the supply of new entrants (students) to the labour force with required skills, sectoral approaches (made by industry) look at what must be done to develop the skills of existing

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[57] International labour Organization (ILO)

workers in the sector to allow businesses to perform well and keep people's skills up-to-date; skills must be updated and upgraded. To do this, the right systems must be developed and regulated (by EC and Members States) within businesses (industry) and in collaboration between businesses and educational and training providers. In developing a sectoral approach EO4GEO wants to work with existing educational and training institutions where feasible. The sector skills strategy approach can help in the development of new competency standards which would be the basis for new, up-to-date and more efficient EO/GI curricula. The strategy identified the following stakeholders:

The **European Commission** should stimulate innovative skills development policies (stabilize funding and policy to build EO/GI skills throughout the education system). The EC is working through a number of frameworks and procedures aiming to harmonise the Vocational Educational Training (VET) coordinated actions, government-subsidised training market arrangements and the effective operation of public providers. The EC will have the responsibility of provide funding for supporting skills delivery and workforce development under ERASMUS+ which will increase the interest in EO/GI learning and understanding. Entities within the EU directories (specially the European Commission DG on Employment, Social Affairs and Inclusion (DG-EMPL) and DG Internal Market, Industry, Entrepreneurship and SMEs (DG-GROW) are to be highlighted.

The **Members States**, through their ministries of education, labour or social affairs normally deal with different aspects of career guidance on science and technology are those expected to provide leadership in the development of policy, programmes, supervision of materials, organization structure for delivery, and procedures for evaluation. Following UNESCO's [58] recommendations, the Government support for guidance is important because the economic growth is based increasingly on the availability of highly skilled workers and the technical and vocational education and training are very important means to developing a skilled labour force. The National governments could set policy directions providing sectoral education and National VET programmes and services and determining national skills priorities therefore promoting EO/GI career development concepts into academic subjects. The EO/GI national approach is important. It will enable the country and its national sector to focus on developing the specific skills needed to maintain and improve the national sector productivity and competitiveness. Governments should

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[58] UNESCO's Strategies for Vocational Guidance in the Twenty-first Century

promote the STEAM education[59], attracting young people to the sector but also young professionals to better understand the capabilities of the EO/GI sector.

EO4GEO partners are responsible for the Sector Skills Strategy, requiring engagement with industry, academy, research and ultimately with end market users through to seek advice on skills needs, workforce planning and traineeship system. EO4GEO will support the development and provision of methods and materials for guidance and will propose more comprehensive and better ways of conducting EO/GI skills development in academia and VET. EO4GEO monitors and responds to emerging skills needs. The LTAP will propose the development of a skill monitoring mechanism.

The **industry** is interested in relevant training that delivers a productive and highly skilled workforce. It provides the elements to monitor the market to ensure areas of emerging / demand are. Facilitate collaboration between providers to deliver optimum quality across specialisms. Partnership with industry is fundamental to achieve the monitoring and responding to emerging skills needs. Industry should provide a mechanism for the upskilling of the existing workforce.

Training providers will build training programmes but also handle the training and learning development. They should design and implement a record keeping system in compliance with the **ECVET** (European Credit System for Vocational Education and Training), **EQF** (European Qualification Framework) and **EQAVET** (The European Quality Assurance in Vocational Education and Training) requirements. They will be also assessing the skills and knowledge determining what training is needed to grow and retain these skills (build and understand the transferable skills base in the workforce). Providers should engage with **STEAM** education securing capacity and capability of the teaching workforce.

Universities and other **Higher Education establishments** play a special role in the skills development. The greatest difference is the (relative) sovereignty of such academic institutions, and – as a consequence – the greater responsibility Universities may have in foreseeing and

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[59] STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking

taking up societal and technical trends (also as a competitive measure), independently from governmental, political guidelines.

Workers and Students which access a VET or academic education (HE, graduate, postgraduate) and careers services that help them pursue opportunities important to the skills force in the sector and its growth and innovation. Not being the scope of this project, we strongly remark that students in high school, junior college or just starting university (12-18 years old) need to be addressed through dedicated actions to stimulate career choices in the LTAP, as this is where the talent pool for the next decade will come from.

5.1.2. What: Business plan

The activities in the action plan need to be supported by an appropriate business plan. These will be analysed at WP6 under the Long-Term Action Plan. While the LTAP is primarily used for implementing and managing the strategic direction, the Business plan[60] will be used to initially discuss the sustainability of the LTAP, seek for funding, assess viability via direct operations.

The efforts related to developing a Business plan aim to ensure the longevity of the Sector Skills Alliance[61] from an economic and financial perspective. It indicates the resources needed. The business models currently adopted by the individual partners of the Alliance will be analysed, to jointly identify possible conflicts with the economic and financial sustainability of the whole Alliance and the related solutions will be adopted. The heterogeneity of the economic nature of the partners (public education/research, government, private commercial, private no-profit, associations) will represent a strength rather than a weakness, because it will facilitate consideration of the plurality of interests coming from the many economic sectors involved. Focus will be given to identification of the possible revenue streams, e.g. from funded projects/initiatives (e.g. Erasmus+, COSME, Structural Funds), to membership fees and sale of services, as well as possible financing by the space/geospatial industry. Complementarily, the structure and the quantification of the costs for long-term operations of the Alliance will be analysed.

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[60]The activities in the Long-term action plan (includes an outline of goals, objectives, measurements, action steps and responsibilities for each step) are supported by the called "business plan"
[61] Sector Skills Alliance's aim at tackling skills gaps with regard to one or more occupational profiles in a specific sector.

Activities associated with the development of a business plan include:

- Identify different potential business models for the long-term financial sustainability of the Alliance and its activities;
- Consider organisations aspects such as different types of legal entities, operational management and exploitation of IPR assets;
- Conduct a series of interviews among the partners and other representatives from the space/geospatial sector to identify the interest/possibility for long-term financial contributions;
- Collect information on the management, operational and maintenance costs and of the costs for a full roll-out of all the components of the sector skills alliance (maintaining the BoK, the platform and the tools; continuous update of curricula and adding courses/training modules)
- Comparative analysis of existing solutions (competitors and existing similar productions/solutions);
- Define clear value propositions based on the outcomes of the project. In other words, explain how EO4GEO solutions solve end-user's needs or improves their situation.

5.1.3. When: Long-Term roll-out maintenance plan

The roll-out and maintenance plan of the project will focus on the way the components of the education/training space/geospatial ecosystem that were developed, tested and validated during the lifespan of the project can be rolled-out and maintained in the long-term. This task deals with the technical aspects and the content of the ecosystem (BoK, platform & tools, curricula, training materials and other elements developed during the project). These activities are complemented and supported by the development of suitable governance, business and mainstreaming models.

This task (6.4. Defining the long-term roll-out and maintenance plan) will analyse how the current trends can be embedded in the roll-out phase of the project. It will also assess the prospective viewpoints of a long-term roll out and maintenance plan. The challenge is to build products/solutions which are capable of attracting motivated end users continuously. This goal can be obtained not by using traditional practices but by defining metric achievements.

The following aspects will be considered for an effective maintenance plan:

- **maintenance policy**: highest-level description, typically applies to the entire proposal/project analysing the several components to be covered (e.g. collaborative platform);
- **maintenance strategy**: next level down, typically reviewed and updated every year and adapted to the progress;
- **maintenance program**: applies to the space/geospatial sectors education/training system, describes the total maintenance requirements for that system;
- **maintenance checklist**: list of maintenance tasks (preventive or predictive) typically derived through some form of analysis, that can be also generated automatically at a predetermined frequency;

5.1.4. How: Tool-box for actions and its relationship with industry skills development

The tool-box for actions (Table 7, 8 and 9) presented in this section takes into account baseline elements presented in the preparatory strategy (goals) and promotes cross-fertilisation with industry and existing EO4GEO activities in the skills domain. It proposes priority actions under three main industry areas of interest for skills development (industry & innovation, quality system and access, participation and collaboration). Those should be consider under the LTAP. Table 7 provides the relationship with the strategic goals, industry areas considering skills development and some of the EO4GEO main objectives.

Table 7: Skills aspects and its relationship Industry areas

Industry areas	Skills aspects and LTGs	EO4GEO objectives
Industry and Innovation	-Skills assessment & intelligence (Qualifications of the existing workforce are properly described and compared with current and future demands)	Strategic collaboration between the Skills Alliance, private sector, government and "end user" to support the skills strategy and advance the sector growth
A quality system for education and training (based on best practises)	-Skills development (There is a sufficient amount of education and training being provided by universities and VET providers) -Skills recognition & transferability (Qualifications are recognised in other countries and can be transferred between universities and other training providers)	Key building blocks of a quality system which includes, a common Body of Knowledge to better understand communities, skills program design, training packages and accredited courses and regulation

Access, participation and collaboration	-Collaboration (The stakeholders are collaborating in an efficient and effective manner) -Outreach & awareness raising (Existing and potentially new stakeholders are aware of and contributes to the skills development)	Have access to skilling path ways that enhance employability

Table 8 represents the industry areas and value with the strategic goals. Building on these EO4GEO works across the stakeholders to deliver a range of sector specific solutions: For example, the industry priorities on **productivity** represent longer term aspirations to increase the sector's competitiveness, supporting employers through upskilling and improved levels of competence and efficiency. The priorities under **support** will be based on skills needs in response to increasing demands of industry and potential new markets opening up. The elements under **leadership** reflect on the direction for the EO/GI sector on key skills issues addressing an integrated approach and influencing in policy. The essentials on **recruitment** will keep talented skills workforce flowing**.** The **engagement** understand skills needs and shape solutions accordingly and finally the **education & training** will work with academia, VET and other providers to ensure strengthen the skills development and deliver the right skills, right place and right time.

The table also sets out some of the priorities in terms of which activities will be addressed as part of the Sector Skills core actions following the industry perspective and their language (productivity, support, leadership, recruitment, employer engagement and education & training). These elements could be part of the Long-Term Strategy in line with the EO4GEO project and what is expected from other stakeholders across the industry at European level.

Examples of the activities EO4GEO will be undertaking will contribute to addressing a number of the sector skills challenges identified, demonstrating the potential role of the Alliance on industry skills issues.

Table 8: Industry action areas and its relationship with the Sector Strategy Goals

Areas	Industry & Innovation			Quality System		Access & Participation
Actions on	Productivity	Support	Leadership	Recruitment	Employer engagement	Education & training
SSS Goals	A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created	-The EO/GI awareness of and engagement with "end user" sectors is improved leading to increased uptake of Copernicus data and information services -Harmonised curricula design and training offers (including workforce mobility) at pan-European but also international level is improved and developed	-A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established -A political commitment at EU level (DG-GROW and DG-EMPL) to stimulate innovative skills development policies is ensured	-The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported -A standard for describing key qualifications is promoted.		Skills needs are mapped to better refine teaching supply with a focus on flexible learning pathways is addressed
LTGs	Qualifications of the existing workforce are properly described and compared with current and future demands.	-Existing and potentially new stakeholders are aware of and contributes to the skills -There is a sufficient amount of education and training being provided by universities and VET providers.	-The stakeholders are collaborating in an efficient and effective manner. -There is a sufficient amount of education and training being provided by universities and VET providers.	-There is a sufficient amount of education and training being provided by universities and VET providers. - Qualifications are recognised in other countries and can be transferred between universities and other training providers.		Qualifications of the existing workforce are properly described and compared with current and future demands.
Value for industry	supporting competitiveness	supporting sector future skills needs	providing sector leadership on skills & training for employers	keeping the pipeline of talent flowing	recognizing and responding to skills needs	working with providers to deliver right skills

Industry perception	-qualifying the workforce, upskilling workers training and increase effectiveness -improve competence -understanding & addressing employers business skills need -mapping skills with profiles	-building knowledge on industry future skills and translating into solutions -working in partnership with industry to maximize influence over policy and funding for future skills	-working with representative bodies (such trade unions, employers, politicians) to develop an integrated approach -leveraging success stories to influence policy -understanding leadership and management skills needs	-influencing academic but also VET curriculum and supporting partnership with stakeholders -providing information, advice and guidance on qualifications and careers to potential recruitments, early stage students, even at secondary school level to attract new talents to our sectoral field	-promoting the benefits on investing in training and development -diagnosing skills needs -extending awareness on skills	-understanding of skills provision to influence funding decisions -ensure current and future skills needs are met through the supply of sufficient, affordable and quality provision -developing qualification/ validation and accreditation /certification schemes, build confidence

Outcome: Implication on Governance

Who: The strategy identified the following actors: European Commission (DG-GROW and DG-EMPL), Members States (through Ministries of Education labour or social affairs dealing with career guidance), industry, training providers and students.

What: The business plan aims to ensure the longevity of the Sector Skills Alliance from an economic and financial perspective.

When: The Long-term roll-out maintenance plan will focus on the way the components of the EO/GI education/training ecosystem were developed, tested and validated and how could be maintained in the long-term.

How: The tool-box for actions and industry relationship takes into account the goals and promotes cross-fertilisation with industry under three main areas: industry & innovation, quality, and access.

5.2.   Mainstreaming, impact, multiplication approach

The Long-Term Action Plan will be supported by an outreach strategy targeting wider stakeholders including society, policy makers, business and international stakeholders. Initial scoping and feasibility with partners and external stakeholders and a detailed implementation plan will be put together to ensure the widest impact. The work will be developed with the following impact framework and guided by a detailed communication and internationalisation strategy.
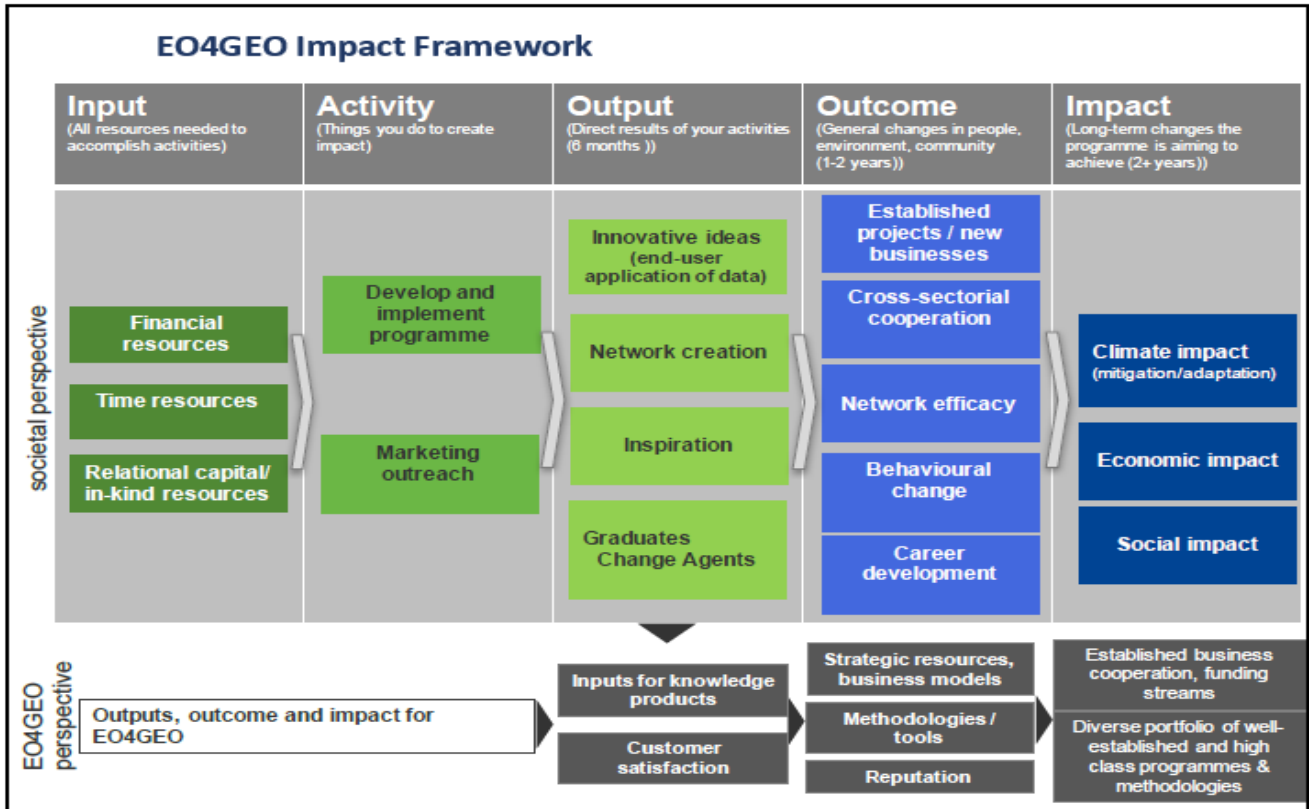
Figure 9: Process outline of the adopted methodology for the development of the integrated platform of collaborative tools

The work undertaken for the long-term sustainability plan will provide replicable frameworks which build capacity in specialised technical and scientific domains. This will also create awareness of both the availability and the potential applications based on what has been done during the testing and validation of the strategy, including the case-based learning scenarios in 3 sub-sectors (integrated applications, smart cities and climate change). They present an opportunity to consolidate across various space-related service streams, end user applications and through the upstream, midstream and downstream space value chain. There will be an opportunity to bring the non-space sector to these initial initiatives of EO4GEO, this will be done by targeting sectors that can readily benefit from the project results.

EO4GEO will target educational and training opportunities to develop competences and skills by ensuring a structured and integrated approach, centred on the access and use of existing training material and information products accessible through the online platform (learning platform under WP3). These aspects are to be considered within EO4GEO but also during the LTAP.

EO4GEO will target skills beyond the technical context, whilst receiving support services (under WP6) to foster entrepreneurial thinking to generate commercially relevant outcome. Innovation and entrepreneurial soft skills are also part of the gap to fill to skill up space/geospatial users. EO4GEO will propose a centre of excellence in EO/GI education and training - a community led by the EO4GEO Alliance that will spearhead the Space Skills education strategy taking the advantage of the Alumni creating a network of agents for the geospatial community.

Objectives and approach;

- Driving marketing and outreach campaign for maximising impact;
- To engage with new global partners for increasing cross-fertilisation of 'space' innovation;
- To encourage citizen engagement and raise awareness both at national and global level;
- Engagement of local students, entrepreneurs and innovators;
- Forge strong links between local businesses, academia and public bodies;
- Setting up adapted targeted marketing strategy with multiple communication channels including social media, crowdsourcing ideas, website, communication collaterals will be developed to maximise the outreach and impact;
- Incorporate data analytics to all outreach and marketing channels for knowledge management.

5.3.   LTAP implementation

Regarding the Long-Term Action Plan (LTAP), it should be stressed that this will be developed together with the space/geospatial community (EO4GEO partners such academia, research, industry and stakeholders consulted in ESA, DG-GROW, GEO secretariat or companies) and endorsed during a final conference in 2021. This will make the long-term implementation and sustainability more stable/formal and will create trust among all the stakeholders and is an indication of the recognition by the broader community. All the questions concerning future activities will be analysed including the accreditation and/or certification which should be further discussed when developing the LTAP.

In case new VET programs are proposed, the sector skills strategy recommends that these new programs will be implemented according to the national legislations for VET education. To be recognised as an accredited VET provider, the training provider must comply with the QA routines as specified in the respective national legislation. It may also be considered to extend the EARSC

certification scheme[62] by introducing EQAVET descriptors and indicators for educational services. This may also be seen as a complementary path for training providers not aiming to enter the national accreditation processes.

A set of recommendations provided by stakeholders (such industry consulted or ESA) for the LTAP are proposed to be performed after the project ends to complement the work done during EO4GEO:

- Continue to review and monitor the skills needed by the sector and help develop the strategy to address these needs;
- Work with those responsible for the development of training to ensure that materials on training are easily accessible;
- Develop and implement wider outreach programmes to improve awareness and engagement with the other EU programmes;
- Encourage and support the use of EO/GI as an inspiring context for learning across all age groups;

Table 10 presents those recommendations and the relation with the Sector Skills Strategy (Goals and LTGs), the EO4GEO objectives and the follow up after EO4GEO:

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[62] EARSC certification scheme (http://earsc.org/certification):The goal is to help companies offer a more professional service, to assure customers that the EO service supplier offers products and services of quality and to help reduce the procurement costs by standardising products across suppliers.

Table 9: Value for development the sector skills strategy

Skills aspects	Strategy Goals	EO4GEO objectives	Strategy Long Term Goals	Follow up after EO4GEO
Skills assessment & intelligence	A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created	(⇒) A review and monitoring program will be implemented, providing a detailed insight in the current supply of and the requirements for education/training in the EO/GI sector. (Review and monitor the skills needed by the sector understanding the collective impact) (EO4GEO Work Plan) (⇒) A technology and non-technology watch that permanently monitors, analyses and publishes the developments and trends in the space/geospatial and related sectors, and in society at large (EO4GEO Work Plan)	Qualifications of the existing workforce are properly described and compared with current and future demands.	**Continue to review and monitor the skills needed by the sector and help develop the strategy to address these needs**, both through nurturing the development of skills and through attracting skilled staff into the sector; an analysis of the gaps between the required skills and the present offer and future evolution of such gaps; - a survey of the present offer in terms of EO/GI skills from universities all over Europe and/or other training facilities (ITC, EC, Copernicus Academies, ESA Academy, ESA trainings/MOOCs, EUMETSAT training, etc); - periodical survey leading, ideally, to an (almost) exhaustive list of all those professional occupations in Europe requiring or getting benefit from EO/GI skills; - an analysis of how such needs may evolve in the next 10 years, taking into account technological challenges but also factors such as political/ societal/ economic, environmental forecast such global change, climate change, etc;
Skills development & Collaboration	-Skills needs are mapped to better refine teaching supply, with a focus on flexible learning pathways -A strategic collaboration between the skills alliance, private sector, government	(⇒) A series of curricula carefully designed, discussed and agreed upon within the space/geospatial community, linked to a series of occupational profiles in the sector making use of the BoK for GI and EO and other competency frameworks (EO4GEO Work Plan) (⇒) A commonly agreed Body of Knowledge	-Qualifications of the existing workforce are properly described and compared with current and future demands. -The stakeholders are collaborating in an	**Work with those responsible for the development of training to ensure that materials on training are easily accessible**, including profile specifications, work experience, internships and information on jobs; Curricula, training strategies / new training concepts & tools;

		efficient and effective manner. - Qualifications are recognised in other countries and can be transferred between universities and other training providers.	
and "end user" sectors is established - Harmonised curricula, mobility activities and training offers at pan-European level are developed and implemented. - A standard for describing key qualifications is promoted.	describing an ontology for the space/geospatial domain that can be permanently updated by making use of a set of collaborative tools in a collaborative platform (EO4GEO Work Plan) (⇒) Create an operational Sector Skills Alliance enforced by of a 'Network-of-Networks' (interested in skills development). Those partners could be part of the academic, research, industry, decision-making actors including the EC) but also end user sectors. EO4GEO is interacting with the Copernicus academy, Copernicus relays, ESA academy, EUMETSAT, EEAs, etc). Establish links with EiroForum. Explore uptake with other market sectors (EO4GEO Work Plan)		
Skills assessment & intelligence Collaboration	-The EO/GI awareness of and engagement with "end user" sectors is improved leading to increase uptake to Copernicus data and information services -Political commitment at EU level (DG-GROW & DG-EMPL) to stimulate innovative skills development policies is ensured	(⇒) Further develop/improve mapping of EO/GI education and training landscape, with strong focus on learning objectives (EO4GEO Work Plan) -Coordination with the Commission services for the implementation phase and effective policy measures (by EC-DG GROW)	Existing and potentially new stakeholders are aware of and contributes to the skills development.	-**Develop and implement wider outreach programmes to improve awareness and engagement with the other EU programmes**, such ERASMUS+, VET programmes, maybe organising an EO/GI skills annual conference. - **Encourage and support the use of EO/GI as an inspiring context for learning across all age groups**, but with emphasis on: - supporting non-specialist teachers in the use of EO/GI in teaching; - improving the quality and availability of teaching materials using EO/GI across the academic curriculum and VET education; - engaging students through the use of EO/GI and maintaining and developing the interest of the most enthusiastic students by providing suitable opportunities.

5.4. Marketing & Outreach

In order to build a long-term and sustainable strategy to fill the gap between the supply of and demand for space/geospatial education and training, several actions have been foreseen which imply a progressive strategy to foster the visibility of the project itself in order to engage with specific target audiences. These activities include the definition of an overall approach to Communication and Dissemination, with capacity-building activities as a key element for the dissemination of the project results and community engagement.

Community-building and consolidation is fundamental for pursuing the longer-term objectives i.e. the sustainability of the project outcomes after its conclusion. This particular item of the strategy will be developed in close relationship with partners of the project working on developing the long-term action plan of the project. The basis for such sustainability will start from the beginning of the project with the awareness raising activities and be consolidated throughout the project.

Marketing and outreach activities aim to:

- Raising awareness on the uses of EO/GI data and information with special emphasis on the engagement of "end users";
- Attracting new stakeholders interested in using EO / GI data;
- Establishing strategic collaboration between the skills alliance, private sector, government and "end user" sectors;
- Building capacity to foster user uptake of Copernicus-based products and services in three sub sectors;
- Consolidating the EO4GEO community to build a sustainable long-term strategy;
- Reaching out to the selected and profiled target groups and raise their awareness and understanding on the uses of EO/GI data and information;
- Fostering the dialogue between the training/education and the space/geospatial sector and help to build a community;
- Building a strong EO4GEO brand which will contribute to the overall Copernicus brand identity and strengthen the recognition of the long-term Action Plan;
- Identifying and establish potential collaboration mechanisms between the education/training and the space/geospatial industry;

● Securing political commitment at EU level (DG-GROW and DG-EMPL) to stimulate the implementation of innovative skills development policies;

The overall perspective is to promote the EO4GEO strategy for skills development in different contexts, towards the target groups addressed by the project dissemination. This will be done by matching the specific skills and knowledge needed for the implementation of the Space Strategy with the needs of the sectors.

This is a horizontally supporting activity that is planned along the whole project duration. It is crucial as it ensures that the specific objectives and deliverables of the project have an effective outreach during the project life-time. It requires that the consortium partners provide input for profiling the target groups and contribute to the dissemination activities in order to maximise outreach.

Outcome: Recommendations for the Long-Term Action Plan (LTAP)

-**Implications of Governance**: Governance is to define more clearly the knowledge, skills and behaviours needed to implement the vision to foster the growth of the European EO/GI sector ensuring the development of workforce with the **"right skills, in the right place, in the right time"**

-The mainstream, impact, **multiplication approach** will be supported by a strategy of outreach to wider stakeholders. The activities will provide replicable frameworks and create awareness.

-When developing a LTAP, the analysis of the **strategy implementation** should be analysed ensuring the attainment of the strategic objectives.

- The section also introduces activities to approach the communication and dissemination aspects but also the project activities including capacity-building as a key element for the dissemination of the project results and community engagement. The overall perspective is to promote the EO4GEO strategy for skills development in different contexts, towards the target groups addressed by the project dissemination.

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6. Conclusions

> **Chapter 7** focus on the **Conclusions** describing the main aspects for the Sector Skills Strategy that will improve the EO/GI sector in terms of relevance of workforce provision.

The EO/GI sector is following new processes and business models driven by disrupting technologies such as internet of things (IoT), artificial intelligence (AI), cloud, wireless and broadband, big data, etc. Although at the same time, it also provides an integrated framework to the combined capabilities with other technologies such positioning, spatial analytics, 3D scanning, etc. and further augmented by facilitators such as standards, open data and interconnected systems and processes such as business intelligence, digital engineering and workflow automation. Having all these new technological opportunities and challenges, the EO/GI sector is preparing the path to deliver solutions through other platforms that were not previously considered such as apps, cloud computing and other technology platforms which give added value to the services and an uptake for the user.

The strategy of the European Commission is to foster the use of Copernicus data and information and thus to stimulate the development of innovative downstream applications. In order to ensure that programmes related to EO/GI deliver its benefits according to the set expectations, it is essential to deploy an effective Sector Skills Strategy (SSS) for stimulating the uptake of this data, services and information. A skilled and educated workforce will enable the sector to attract high value, innovative and knowledge-based businesses and adapt more readily to the challenging technological environment that the EO/GI sector is experimenting. The Erasmus+ EO4GEO project is working collaboratively on the "Space/Geospatial Sector Skills Strategy" and increasingly together with other associated partners leveraging influence about the skills intelligence. The needs of the sector are constantly evolving; therefore, the skills strategy needs to be responsive to the rapid changes in the industry and employment. EO4GEO built this strategy with a concrete vision, mission and goals that will be used as a basis for the definition of a long -term action plan (LTAP).

Its VISION is to foster the growth of the European EO/GI sector ensuring the development of workforce with the "right skills, in the right place, at the right time" and the MISSION is to ensure a strategic cooperation among stakeholders on skills development in the EO/GI sector (Sector Skills Alliance). This cooperation will support growth, diversity, and flexibility of the sector by providing harmonized and improved educational offers across different learning levels including VET and academic training and the development of new occupational profiles for the EO/GI sector.

By adopting a forward-looking perspective, the following GOALS have been identified for the successful implementation of the skills strategy:

- A strategic collaboration between the skills alliance, private sector and government and "end user" sectors is established.
- A political commitment at EU level (DG-GROW and DG-EMPL) to stimulate innovative skills development policies is ensured.
- A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created.
- The EO/GI awareness of and engagement with "end user" sectors is improved leading to increased uptake of Copernicus data and information services.
- Harmonised curricula and training offers (including workforce mobility) at pan-European but also international levels are improved and developed.
- A standard for describing key qualifications is promoted.
- The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported.
- Skills needs are mapped to better refine teaching supply, with a focus on flexible learning pathways.

The main objective of EO4GEO is to help bridge the skills gap between supply and demand of education and training in the EO/GI sector by reinforcing the existing ecosystem and fostering the uptake and integration of EO/GI data and services in end-user applications. Hence, the proposed Strategy is clear and concrete (how, when, what and by whom), with the definition of activities, timelines within the EO4GEO project duration and milestones planned for the Long-Term Action Plan. Such actions are:

- Continue to review and monitor the skills needed by the sector and help develop the strategy to address these needs;
- Work with those responsible for the development of training to ensure that materials on training are easily accessible;
- Develop and implement wider outreach programmes to improve awareness and engagement with the other EU programmes;
- Encourage and support the use of EO/GI as an inspiring context for learning across all age groups;

This strategy will be used in the definition of a long-term action plan (LTAP) to address short- and medium-term skills needs in the areas of skills, knowledge and competences. This document will

set the wheels in motion, for discussion within the EO4GEO partners but also stakeholders (public authorities, policy makers, industry, training providers) who can actually will implement it (under the LTAP) and guarantee its impact.

Annexes

Annex 1: References

[1] Earth Observation (EO) collects information about the Earth – the land, the sea and the atmosphere – using sensors carried on satellites, aircraft, ships, buoys floating on the ocean, and thousands of weather stations around the world

[2] Geographic information (GI) is information related to geographic locations, often in combination with non-spatial information (e.g. ownership of land, amount of soil contaminations etc). Geographic information may be visualised by a map.

[3] Small Businesses, Job creation and growth, OECD / OECD (2018), Education at a Glance 2018: OECD Indicators, OECD Publishing, Paris / OECD (2018), Job Creation and Local Economic Development 2018: Preparing for the Future of Work, OECD Publishing, Paris,

[4] Space Market Uptake in Europe - European Parliament

[5] The sectors Skills strategy is referred to skills, knowledge and competences

[6] Vocational Education and Training (VET): VET is a key element of lifelong learning systems equipping people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labour market.

[7] Erasmus+: EU's programme to support education, training, youth and sport in Europe.

[8] EO4GEO project (www.eo4geo.eu): An innovative strategy for skills development and capacity building in the EO/GI field

[9] Education, Audiovisual and Culture Executive Agency from the European Union (EACEA)

[10] Blueprint for Sectoral Cooperation on Skills: a new framework for strategic cooperation in a given economic sector between key stakeholders

[11] EO/GI data products and associated services

[12] the New Skills Agenda for Europe proposed 10 actions to make the right training, skills and support available to people in the EU [Upskilling Pathways: New Opportunities for Adults, 2) European Qualifications Framework, 3) Digital Skills and Jobs Coalition, 4) Blueprint for Sectoral Cooperation on Skills5) EU Skills Profile Tool Kit for Third-Country Nationals, 6) Vocational education and training (VET), 7) Key competences, 8) Europass, 9) Graduate Tracking, 10) Analysing and sharing of best practice on brain flows]

[13] European Copernicus Programme: Copernicus is the European Union's Earth Observation Programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers information services based on satellite Earth Observation and in situ (non-space) data.

[14] Skills Panorama, Skills Panorama aims to foster the development or improvement of skill needs assessment and anticipation

[15] Skills assessment done under EO4GEO: D 1.5–Skills shortages, gaps and mismatches between supply and (future) demand
http://www.eo4geo.eu/download/eo4geo_d1-5-skills-shortages-gaps-and-mismatches-between-supply-and-future-demand_v2-0/?wpdmdl=3473

[16] Sector Skills Alliance: Sector Skills Alliances (SSAs) are designed to tackle skills, aligning vocational education and training (VET) systems with labour market needs. More info.

[17] DG Internal Market, Industry, Entrepreneurship and SMEs (DG-GROW)

[18] European Commission DG on Employment, Social Affairs and Inclusion (DG-EMPL)

[19] Space Strategy for Europe: Foster a globally competitive and innovative European Space Sector

[20] Internationalization, strengthening Europe's as a global actor and promoting international cooperation. Copernicus as a global best practice and accepted standard internationally

[21] defined by CEDEFOP: Entrepreneurial skills - Skills Panorama

[22] Evolution of the sector innovations: Modernising vocational education and training – ResearchGate)

[23] Deliverable EO4GEO_D1.3 – Demand for space-geospatial education and training and priority occupational profiles

[24] Occupational profiles identify the skill levels required for an occupation across jobs, companies, or industries. Occupational profiles are created by summarizing a set of related job profiles (link)

[25] The collection and analysis of job advertisements: A review of research methodology

[26] Blueprint for sectoral cooperation on skills, European Union, 2017

[27] Space Strategy for Europe (COM (2016)): Communication from the Commission to the European Parliament, the Council, the European Economic and social Committee and the Committee of the Regions

[28] ESCO European Skills, Competences, Qualifications and Occupations

[29] The core social skills are competences used to select effective communication channels to interact with others.

[30] The role of education and training in absorptive capacity of international technology transfer in the aerospace sector

[31] Supply and Demand surveys (http://www.eo4geo.eu/surveys/)

[32] Qualifications term includes knowledge, skills and competences.

[33] Call for Proposals – EACEA 04/2017, KA 2 – Cooperation for Innovation and Exchange of Good Practices, Sector Skills Alliances Applicants' Guidelines

[34] Skills Panorama (2018). Practical Framework for including sectoral skills evidence in the Skills Panorama

[35] Practical Framework Annex I "Key principles for planning, developing and carrying out a sectoral skills study applied by Cedefop"

[36] Supply and Demand surveys (http://www.eo4geo.eu/surveys/)

[37] Study to examine the socio-economic impact of Copernicus in the EU

[38] Space market uptake in Europe

[39] EO4GEO Supply Study (http://www.eo4geo.eu/download/eo4geo_d1-1_current-supply-of-space-geospatial-education-and-training_v2-0/?wpdmdl=3192)

[40] European qualifications framework is a common European reference framework whose purpose is to make qualifications more readable and understandable across different countries and systems

[41] EARSC Taxonomy for the EO Services Market

[42] Copernicus services (https://www.copernicus.eu/en/services): Atmosphere, marine, Land, Climate Change, Security, Emergency

[43] Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area

[44] Remote Sensing methods are analysis of image data that comes from one or more remote sensor types (i.e. ocean colour)

[45] Remote sensing data collection technology can be passive or active. Passive sensors (e.g., spectral imagers) detect natural radiation that is emitted or reflected by the object or area being observed. In active remote sensing (e.g., radar) energy is emitted and the resultant signal that is reflected back is measured)) (i.e inSAR)

[46] European Commission (Copernicus education) and Copernicus YouTube channel, Copernicus Training and Information Sessions

[47] European Space Agency (ESA)

[48] European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

[49] Network of European Regions Using Space Technologies (NEREUS)

[50] European Association of Remote Sensing Laboratories (EARSeL)

[51] EO4GEO_D1.3 – Demand for space-geospatial education and training and priority occupational profiles

[52] EO4GEO will develop and implement systematic approach to curriculum development in the domain of EO/GI, by taking into consideration key business processes and occupational profiles in the domain. During the project life time, 15 curricula will be developed that include adaptations of existing courses as well as the development of new courses.

[53] NextGEOSS is a centralised European Earth observation data hub and platform

[54] EARSC Industry Survey (http://earsc.org/news/results-eo-industry-survey-september-2017)

[55] the GI-N2K project (Geographic information : Need to Know) aims to improve the way in which future GI professionals are prepared for the labor market so that the GI sector in general can evolve in a dynamic and innovative way.

[56] SCRUM,is focused on improving the profession of software delivery and that drives everything we do.

[57] International labour Organization (ILO)

[58] UNESCO's Strategies for Vocational Guidance in the Twenty-first Century

[59] STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking

[60] The activities in the Long-term action plan (includes an outline of goals, objectives, measurements, action steps and responsibilities for each step) are supported by the called "business plan"

[61] Sector Skills Alliance's aim at tackling skills gaps with regard to one or more occupational profiles in a specific sector.

[62] EARSC certification scheme (http://earsc.org/certification):The goal is to help companies offer a more professional service, to assure customers that the EO service supplier offers products and services of quality and to help reduce the procurement costs by standardising products across suppliers.

[63] Hofer B., Lang S., Ferber N. (2019 to appear) Future Occupational Profiles in Earth Observation and Geoinformation - Scenarios Resulting from Changing Workflows. In: Kyriakidis P., Hadjimitsis D., Skarlatos D., Mansourian A. (eds.) Geospatial Technologies for Local and Regional Development. AGILE 2019. Lecture Notes in Geoinformation and Cartography, Springer.

Annex 2: EO4GEO activities presented in Gantt Chart

Figure 10: Gantt Chart

Annex 3: SWOT Analysis of the Goals

A SWOT analysis is a well-known strategic planning tool to discover weaknesses and strengths able to identify both potential opportunities and threats. This preliminary SWOT exercise characterise some of the proposed goal assessments. The analysis will be reviewed in the LTAP deliverable.

Table 10: SWOT analysis of the goals

Assessment Goal: A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established	
Strength ● partnerships ● commitment & leadership ● stakeholder´s capacities	**Weakness** ● dialogue mechanisms
Opportunity ● European & regional framework discussions ● policy engagement at EU level	**Threat** ● motivation ● competing with other networks

Assessment Goal: A political commitment at EU level (DG-GROW and DG-EMPL) to stimulate innovative skills development policies is ensured.	
Strength ● policy understanding through EC engagement ● engage closely other stakeholders and influence actively	**Weakness** ● formal process to influence skills policy
Opportunity ● leverage a shared position ● stabilize funding lines ● coordination with EC-DG-GROW	**Threat** ● skills policy coherency ● coordination with national investment plans

Assessment Goal: A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across stakeholders is created.	
Strength ● monitoring programme providing insight supply/demand ● technology watch	**Weakness** ● bring common voice of experts
Opportunity ● EO4GEO interact with stakeholders	**Threat** ● reach of internal assessment reports validation ● exploitation of opportunities

Assessment Goal: The EO/GI awareness of and engagement with "end user" sectors is improved leading to increased uptake of Copernicus data and information services.	

Strength	Weakness
- develop map of education & training - improve awareness & outreach - think skills/competences within EO4GEO - build awareness of EO/GI sector skills objectives	- mechanism to ensure links are made - ensure updated map of skills development
Opportunity	**Threat**
- European & regional frameworks - ensure profiles are included in ESCO - support design of VET content - closer working with VET and HE	- participation in ERASMUS+, STEAM Meetings - embed VET in the workforce

Assessment Goal: The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported	
Strength	**Weakness**
- promote uptake of EO/G services and data in response of skills needs - advocate the engagement of professionals (academia, research, industry and EC institutions) - scenarios development	involvement of actors
Opportunity	**Threat**
- support the integration of EO/GI capacities - facilitate transferability - EO/GI as inspiring context for learning	common mechanism for upskilling

Assessment Goal: Skills needs are mapped to better refine teaching supply, with a focus on flexible learning pathways	
Strength	**Weakness**
- support quality approaches - acceptance Body of Knowledge by EO/G experts	expert's motivation
Opportunity	**Threat**
- curriculum planning - recognition in the European Skills competences (ESCO) and Skills Panorama	- quality assurance processes accepted - engagement with other platforms

Assessment Goal: Harmonised curricula and training offers (including workforce mobility) at pan-European but also international levels are improved and developed. A standard for describing key qualifications is promoted.	
Strength	**Weakness**
- innovation - highly skilled - quality	- curricula too stretched - communication plans

Opportunity	Threat
● mobility & internationalisation ● networking ● learn new skills	● lack external funding

Annex 4: Timeframe and indication of progress

The Sector Skills Alliance works with the academia, research and industry to ensure the sector has the rights skills. Each partner brings knowledge and expertise across the range of activities recognizing the different needs and engaging employers and learners in training. Using the "observatory" as "skills intelligence" gained through the proposed EO4GEO strategic plan, we might provide some lines of future sector employment and training requirements and agree with industry the priorities for action. The measuring progress below is proposed to be captured as a means to engage the representative bodies; professional and public organizations.

EO4GEO is a 4 years project. The duration period is from January 2018 to December 2021. The time-frame indicates the period of time where EO4GEO project will make advancements on the defined objectives and actions to undertake and achieve the goals while LTAP contemplates the Long-Term Action Plan (after the project duration). Overall the full accomplishment of the goals is projected for the LTAP. The timeframe will be revisited in the WP6. Bold characters heading by an arrow (⇛) indicate the EO4GEO objectives defined in the Work Plan and within the lifetime of the project.

Table 11: Observatory of the indicators measuring progress

Goals (targets)	Objectives (means)	Timeframe	Indicators of progress
A strategic collaboration between the skills alliance, private sector, government and "end user" sectors is established	(⇒) **Create an operational Sector Skills Alliance enforced by of a 'Network-of-Networks'** (interested in skills development). Those partners could be part of the academic, research, industry and decision-making actors including the EC). EO4GEO is interacting with the Copernicus academy, Copernicus relays, ESA academy, EUMETSAT, EEAs, etc). Establish links with EiroForum. Explore uptake with other market sectors **(EO4GEO Work Plan)**	EO4GEO LTAP	(⇒) **Alliance website visitors (EO4GEO-KPI)** (helping to engage the community). (Making network of experts more visible) -Stakeholder engagement & partnerships (via Network of Networks with associated partners) including National & Regional engagement that will continue to operate, also after the life-time of the project. Measures by n. letter of interest or MoU signed with organizations. N. of Advisory Board members engagement in short/long term
Political commitment at EU level (DG-GROW & DG-EMPL) to stimulate innovative skills development policies is ensured	Stabilize funding for skills policy and resolve funding challenges (Regional Sectoral Skills investment plans for EO/GI sector)	LTAP	-EO4GEO follow up: partners commitment for 2/3 years engagement after the project completion -N. Stakeholders influencing skills policy & funding -Creating a "skill working group" (active participants)
	Mutual recognition of job profiles & skills between national education systems and the labour market (consisting of different sectors) **(by EC-DG GROW)**	LTAP	-Engagement with National education system -Engagement with other sectors > Transferability of skills among groups of sectors
	Coordination with the Commission services for the implementation phase and effective policy measures **(by EC-DG GROW)**	EO4GEO	-Regular engagement with EC Directorates. N. dedicated meeting with EC -Reinforce and complement the Skills in the Space Strategy document with EO4GEO Sector Skills Strategy elements
A coordinated effort to improve competitiveness and penetrate other sectors through market intelligence across	(⇒) **A review and monitoring program will be implemented, providing a detailed insight in the current supply of and the requirements for education/training in the EO/GI sector.** (Review and monitor the skills needed by the sector understanding the collective impact) **(EO4GEO Work Plan)**	EO4GEO	-Sector skills assessment reports which understand the collective EO/GI sector impact on skills (2 surveys (demand/supply) have been developed and EO4GEO will consider how/when/which conditions those that can be repeated & improved over time. (⇒) **N. participants in the surveys on supply and demand (EO4GEO-KPI)**

stakeholders is created.	(⇒) **A technology and non-technology watch that permanently monitors, analyses and publishes the developments and trends in the space/geospatial and related sectors, and in society at large (EO4GEO Work Plan)**	EO4GEO LTAP	(⇒) **Develop skills monitoring mechanism (**suggested name following CEDEFOP as **"Observatory")** to respond to emerging skills needs (identification of future trends and opportunities as part of skills anticipation > the observatory's goal is to measure and identify skill shortages). -Educational, technical staff and market experts to be asked to underline business concepts that can achieve interest, considering the specific market conditions of each country -Each EO4GEO partner, specially the industrial ones, will identify how to exploit the project outcomes to leverage further business opportunities (e.g. through dedicated training actions or technical consultancy) after a proper assessment of the market needs and trends (technology and non-technology watch).These will be channelled to appropriate innovation frameworks and incubation across the partner ecosystem to ensure maximum impact both nationally and a at regional levels.
The EO/GI awareness of and engagement with "end user" sectors is improved leading to increase uptake to Copernicus data and information services	(⇒) **Further develop/improve mapping of EO/GI education and training landscape, with strong focus on learning objectives (EO4GEO Work Plan)**	EO4GEO LTAP	-Ensure links with the skills development observatory by inserting a map of stakeholders (actual DB of demand offer). Maintenance and update of catalogue of training resources resulted from online sources
	Develop and implement wider outreach programmes to improve awareness and engagement with the ERASMUS+ programmes	LTAP	-ERASMUS+ connexion with EO/G in their title
	Develops connexion with the STEAM education (science, technology, engineering, arts and mathematics)	LTAP	-Meetings where skills development is presented including an inclusive approach in STEAM careers (also consider rates of gender balance)
	Ensure occupations and occupational profiles are currently included/defined in ESCO	EO4GEO	-Rethink skills/competences as currently included/defined in ESCO and make proposals for new ones to include (feed ESCO)

	Secure and embed vocational skills in the workforce (promote vocational pathways (VET) on an equal footing with academic routes, ensure visibility of progression routes...). Support the design and delivery of transnational vocational training content, as well as teaching and training methodologies for European professional core profile. Bring links with Smart Specialization Strategies at regional level	LTAP	-Surveys occupational coverage in the academic but also VET framework (VET demand/offer, % qualification at ESCO profile
	Closer working with VET and higher education (Enhance responsiveness of initial and continuing VET and HE)	LTAP	-Identification of EO/GI educational and outreach material provided at higher education level
	Build awareness of EO/GI sector skills objectives (i.e particular focus on digital skills, green skills and sustainable development)	EO4GEO	-Sharing success stories. Simplifying utility and value of geospatial knowledge for consumers become determining factor for successful (G)EO business -Stakeholders influencing on sector skills awareness (n. workshops)
	Ensure that support materials on careers are accessible, including job profile specifications, work experience, internships and information on jobs	EO4GEO LTAP	-Collaboration with employers' representatives, trade unions, career centres, orientation services at universities and VET institutions on skills development (i.e. develop a magazine dedicated to sector skills "eo Skills mag")
	(⇛) High level capacity building event (EO4GEO Work Plan)	EO4GEO	(⇛) N. participants in the event
	Collaboration also needs to extend out to the "end user" sectors (agriculture, automotive, energy, local government etc.) as these sectors are the "consumers" of EO/GI information, so they generate the pull that leads to increased uptake of Copernicus data and information services. Without this, our EO/GI sector is having to "push" its technology towards these sectors	LTAP	-Engagement with other sectors and communities. Organization of industry forums with other sectors.
Harmonised curricula design and training offers (including workforce	Facilitate transferability of skills between public and private organizations	LTAP	-Memorandum of Understanding (MoUs) between public and industry promoted by the Sector Skills Alliance (i.e, secondment positions at national level, mapping agreements established between Universities and companies at regional level...)

mobility) at pan-European but also international level is improved and developed. - A standard for describing key qualifications is promoted.	Transferability of skills among groups of sectors must be enhanced, with mobility schemes and European credit system for vocational education and training (ECVET) as potential enablers.	LTAP	-Application of ECVET approach (establish a framework curricula with the ECVET approach)
	Acknowledge EO/Geospatial courses in national VET systems. Develop pan-European training modules and collaboration agreements for countries not having sufficient VET training resources in the field.	LTAP	-Revision of VET systems (n. agreements in countries)
The use of EO/GI services as an inspiring and innovative context for learning across all age groups and value chains is encouraged and supported **(by EC-DG GROW)**	Promote the engagement of professionals in the sector "updating" and "upscaling". Build and update the transferable skills base	LTAP	-Number of industry representatives participating in the Alliance -Increase employer participation (increase numbers of employers taking a role in developing skills for the workplace)
	Provide a mechanism for the upskilling of the existing scientific workforce (Support Continuing Professional Development (CPD) and Wider Learning Opportunities...)	LTAP	-Number training activities/organization for attracting skilled staff into the sector. -N. of "best practises for upskilling" > endorsement of these programs by trade unions and/or employer representatives.
	Encourage and support the use of EO/GI as an inspiring context for learning across different learning levels (inc. academic (HE, Universities and VET education). Inspire younger children to focus on STEM skills and to see EO/GI as an attractive career choice. Start cultivating their interest in EO/GI from school stage	LTAP	-Acknowledge EO/GI courses in national VET systems. Develop pan-European training modules and collaboration agreements for countries not having sufficient VET training resources in the field -National (Regional) plans reviewed against the skills strategy -Evolution of the VET exercise
	(⇒) **A series of training actions for different scenarios** in the sub-sectors 'integrated applications', 'smart cities' and climate change' including group work and internships making use of collaborative methods and tools **(EO4GEO Work Plan)**	EO4GEO	(⇒) **Number of participants in the training actions (EO4GEO-KPI)**
Skills needs are mapped to better refine teaching	Support quality approaches through skills development by raising standards and responsiveness in education and training provision. Driver for the mutual	EO4GEO	-Develop quality assurance (validation> accreditation) -Qualifications developed in line with future skills needs (developing & maintaining

	recognition on occupational profiles and skills, between education system, labour markets and users		standards, secure capacity and capability...)
supply, with a focus on flexible learning pathways	(⇒) **A commonly agreed Body of Knowledge describing an ontology for the space/geospatial domain that can be permanently updated by making use of a set of collaborative tools in a collaborative platform (EO4GEO Work Plan)**	EO4GEO LTAP	(⇒) **Number of experts contributing to the BoK revision and extension (engagement with partners through w/gs) (EO4GEO-KPI)** (Making network of experts more visible)**.** -Collaborative platform hosting for 2/3 years after the end of the contractual period and engagement through the Copernicus Data and Information Access Services (DIAS) gallery on Education & Training, the eoMALL gallery on Education & Training or the European Open Science Cloud (EOSC) (⇒) **Users in the collaborative platform (EO4GEO-KPI).** - Set-up a mechanism to collect continuously user requirements (number users). Evaluate open platform
	(⇒) **A series of curricula carefully designed, discussed and agreed upon within the space/geospatial community, linked to a series of occupational profiles in the sector making use of the BoK for GI and EO and other competency frameworks (EO4GEO Work Plan)**	EO4GEO	(⇒) **Number of curricula designed (EO4GEO-KPI)** (contributing to the European policies on education and training by enhancing creativity and innovation at all levels of education and training)
	Recognition in the European Skills / Competences, qualifications and Occupations (ESCO classification). EO/Geospatial VET courses are offered within all national VET systems and directly linked to ESCO occupational profiles (skills, competences, occupations, qualifications)	EO4GEO	-A portfolio of VET training modules based on existing training materials or newly developed ones and a case-based learning method that is applicable for different scenarios and in any sub-sector of the space/geospatial domain. (⇒) **Number of participants in the training actions (**according the work plan, the format of the training actions will be decided in WP5) **(EO4GEO-KPI)** -Exercise VET methodology repeated in year 2 and year 4. (partners research the situation of vocational training programmes in the EO/GI domain in their countries. This bottom-up initiative contributes to the strategy development and is supposed to concretize further discussions within the project)
	-EO/GI VET courses are offered within all national VET systems and directly	LTAP	-N courses year

	linked to ESCO occupational profiles		

Annex 5: National exercises on Vocational Educational Training (VET)

The survey on demand and supply showed little evidence of the existence, benefits, and needs of VET curricula in the high-skill EO/GI sector, as of today. Most respondents of the demand survey held a Master or PhD degree and most courses reported in the training supply survey where academic courses. This finding is in contrast to the objective of assuring workforce across the whole educational spectrum. In order to complete and 'objectivize' the picture on VET programmes in EO4GEO partner countries, it was decided to take a bottom-up approach and research existing VET programmes relevant in the EO/GI sector. This section is presenting the methodology for the VET exercises which will be extended in WP4 (Designing EO/GI curricula in support of Copernicus)

Among the EO4GEO partnership, which is comprised of partners from 13 European countries, seven existing VET programmes in the EO/GI sector were identified (Table 10). Given the names of the VET programmes, they seem to lean towards the GI part of the sector; EO specific skill, knowledge and competencies are only implicitly addressed. Despite the fragmentary nature of this bottom-up analysis, the impression from the demand and supply surveys of an underrepresentation of VET programmes in the EO/GI sector could be confirmed. The insights on the current availability of VET programmes in the sector across Europe will be considered when developing curricula for the sector.

Table 12: VET programmes in the EO/GI sector

VET Programme	VET Programme Name	Country	Prerequisites	Duration	Link to source of information
Geoinformation Technician	Geoinformations-technikerIn	Austria	Completion of 9 years of compulsory school education	3 years	https://www.berufslexikon.at/berufe/3359-GeoinformationstechnikerIn/
Geodesy and geoinformation technician	Tehničar geodezije i geoinformatike	Croatia	Completion of 8 years of compulsory school education.	4 years	https://narodne-novine.nn.hr/clanci/sluzbeni/2017_08_79_1966.html
Geomatics	Geomatiker/	Germany	Completion of 9/10 years of	3 years	https://berufenet.arbeit

Technician	Geomatikerin		compulsory school education		sagentur.de/berufenet/faces/index?path=null/kurzbeschreibung&dkz=77494
Assistant - Geovisualization	Assistent/in - Geovisualisierung	Germany	Completion of 10 years of compulsory school education	3 years	https://berufenet.arbeitsagentur.de/berufenet/faces/index?path=null/suchergebnisse/kurzbeschreibung/informationsquellen&dkz=28630
Professional course GIS technician.	Curso de Técnico de Sistemas de Informação Geográfica	Portugal	Completion of 9 years of compulsory school education	3 years	http://www.epcg.pt/home/cursos-profissionais/sistemas-de-informacao-geografica
Advanced usage of GIS	Avancerad GIS-användare	Sweden	Completion of 9 years of compulsory school education. Grade E (Pass) in English and Swedish.	1 year	https://www.yrkeshogskolan.se/hitta-utbildning/sok/utbildning/?id=5942
Mobile systems and GI Technologies	Mobila system och GIT	Sweden	Completion of 9 years of compulsory school education. Grade E (Pass) in English, Swedish and Computer Technology.	2 years	https://www.yrkeshogskolan.se/hitta-utbildning/sok/utbildning/?id=5950

Annex 6: Exercises on changing occupational profiles (DACUM)

In accordance with the goal to involve stakeholders in the development of revised training and educational programmes, it is essential to consider needs of the market. These needs have been assessed by the demand survey. To deepen the findings of the demand survey regarding occupational profiles that are requested by the market and the tasks that these profiles subsume, it was decided to analyse occupational profiles in detail. The term occupational profile refers to the description of duties and tasks of an employee.

The description of duties and tasks provides the basis for an analysis of effects of ongoing technological trends in the EO/GI sector on these tasks. An analysis of changing occupational profiles has the potential to ground EO4GEO curricula in what the market requires today and in mid-term to prepare curricula for training the 'workforce of tomorrow'. The methodology to analyse changing occupational profiles has been proposed and tested by Hofer et al[63].

The methodology is an expert-based approach to describe occupational profiles according to the 'develop a curriculum (DACUM) method'. The aim of DACUM is to analyse a job and to derive duties and tasks as well as required technical skills and personal traits in recurring discussion rounds. The discussions involve experts in the field who reach consensus on the job profile during the discussion process. Based on the occupational profile created in the DACUM workshop, the tasks are marked with a specific skill level, whereby transversal skills, technical skills and competencies are differentiated. The third step of the exercise is the identification of trends related to a specific occupation and the illustration of the effects of trends on tasks.

Based on the proposed methodology, ten EO4GEO partners participated in an exercise on changing occupational profiles (as of February 26, 2019). The provided descriptions of occupational profiles that are relevant in their organisation (Table 11) and the profiles including identified trends are listed below (Figures 10 to 19).

Table 13: Descriptions of occupational profiles

	Occupational Profile	Identified trends	Type of Organisation	EO4GEO Partner
1	**Remote Sensing Specialist**	Analysis ready data; automation of image analysis; Platform as a service; Information as a service	University	PLUS
2	**Remote Sensing Specialist / Researcher in a Private R&D organization**	Analysis ready data; automation of image analysis; Platform as a service; Information as a service	Private research institute	VRI IES

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[63] Hofer B., Lang S., Ferber N. (2019 to appear) Future Occupational Profiles in Earth Observation and Geoinformation - Scenarios Resulting from Changing Workflows. In: Kyriakidis P., Hadjimitsis D., Skarlatos D., Mansourian A. (eds.) Geospatial Technologies for Local and Regional Development. AGILE 2019. Lecture Notes in Geoinformation and Cartography, Springer.

3	**GIS Developer**	Platform as a service; information as a service	SME	GIB
4	**Senior Remote Sensing and GIS Consultant**	Analysis ready data; automation of image analysis; Platform as a service; Information as a service	SME	GIB
5	**Remote Sensing Researcher**	-	Research institute	IGIK
6	**Remote Sensing Specialist**	-	Research institute	IGIK
7	**Remote Sensing Technician**	-	Research institute	IGIK
8	**Sales of EO Data and Services**	Subscription sale; automation; new commercial channels	SME	Planetek
9	**Remote Sensing Researcher for Atmospheric Sciences**	Analysis ready data; automation of image analysis; Platform as a service; Information as a service	University	UPAT
10	**Remote Sensing Scientist**	Platform as a service; analysis ready data; multidimensional data analysis; citizen science; open science	University	FSU
11	**Data manager**	Broad data standardisation; Automation of maintenance of data; Platform as a service; Information as a service	SME	UNEP-Grid
12	**Educator**	Platform as a service; Information as a service	SME	UNEP-Grid
13	**Business Analyst**	Analysis ready data; automation of procedures, Standardisation of datasets, information as a service	SME	IGEA
14	**Geomatics Expert**	Videometric photogrammetry; Virtual Reality; Decision Support Systems (DSS); Cloud Computing; Big Data; Artificial Intelligence (AI); 3D and 4D analysis	Public body	CNR-IREA

The profiles indicate the breadth of tasks covered in the EO/GI sector as well as different areas of specialisation. Their detailed analysis will highlight:

- tasks for which current workforce might require retraining because of changes affecting the tasks.
- combinations of tasks (mostly requiring technical skills) that might be suitable for VET profiles.
- Input for the development of curricula for preparing the workforce of tomorrow.

Figure 11: Trend mapping for the workflow of a Remote Sensing Specialist conducted by PLUS

Figure 12: Trend mapping for the workflow of a Remote Sensing Specialist / Researcher in a Private R&D organization conducted by VRI IES

Duties	Tasks									
Project planning	Identify project idea and objectives	Identification of project work packages and deliverables	Study of existing capabilities	Definition of required data	Definition of methodology	Project proposal creation				
Manage projects		Prepare progress reports	Prepare deliverables							
Data acquisition	Define parameters for airborne missions	Define sensor configuration	Create site maps	Search for satellite data provider services	Download of satellite data	Examine the data quality	Trouble shoot issues with data or data acquisition			
Ground-truth and validation data	Preparation of validation and sampling plan	Preparation of equipment	Conduct in-situ measurements	Organize acquired data	Collect GPS coordinates of sampling points	Archive database management				
Data processing	PosNavProcessing (processing of aircraft positional data)	Airborne data pre-processing (radiometric correction, geometric correction, coregistration)		Atmospheric correction for airborne data	Atmospheric correction for satellite data	SAR data preprocessing (calibration, multilooking, filtering, terrain correction, coregistration, interferometry)	Multisensor data fusion	Data enhancement or filtering	Creation of data mosaics	Generate LiDAR derived proucts (DSM,DTM, nDSM, aspect ratio, slope)
Data processing (cont.)		Creation of difference images	Creation of remote sensing index layers	Prepare reference data for classification	Perform machine learning based classification	Image transformation (e.g. PCA, MNF)	Extract areas of interest (masking or clipping)	Prepared script implementation for processing and pre-processing steps	Reprojection	Thresholding
Data analysis	Visual interpretation	Normalization of data sets	Modelling analysis	Compare in-situ data with remote sensing data	Regression and correlation analysis	Time series analysis	Evaluation of trends in data	Spectral analysis	Statistical parameters of data set (min, max, mean, median, various percentile, standard deviation etc.)	
Accuracy assesment	Correlation with validation dataset	Confusion matrix	Classification accuracy estimation (users, producers, overall, kappa value)	End-user feedback	RMSE evaluation					
Development of end-products	Data post-processing	Prepartion of the visual material (maps, charts, tables, videos)	Prepare reports, methodology, documentation of the end product	Product desription						
Research and Development	Following the latest advances in the field	Test latest methods and technicues on various data sets	Examining the possibilities of new data sets (different satellite platforms)	Examining and testing new tools for data processing and analysis	Developing new automated workflows	Development of new algorithms				
Professional Development	Presentation of the results	Participating in webinars	Attending conferences	Development of proffesional skills (online courses, examination of available information)	Reading Remote Sensing related publications	Take part in creating scientific publications				
Data management	Processed data storage on the server	Data base fusion	Optimization of storage space							
Communication	Reporting on ongoing activities	Discussing the results with the colegues	Communication with product end-users							

Change of Workflow

- Analysis ready data
- Automation of image analysis
- Platform as a service
- Information as a service

Figure 13: Trend mapping for the workflow of a GIS Developer conducted by GIB
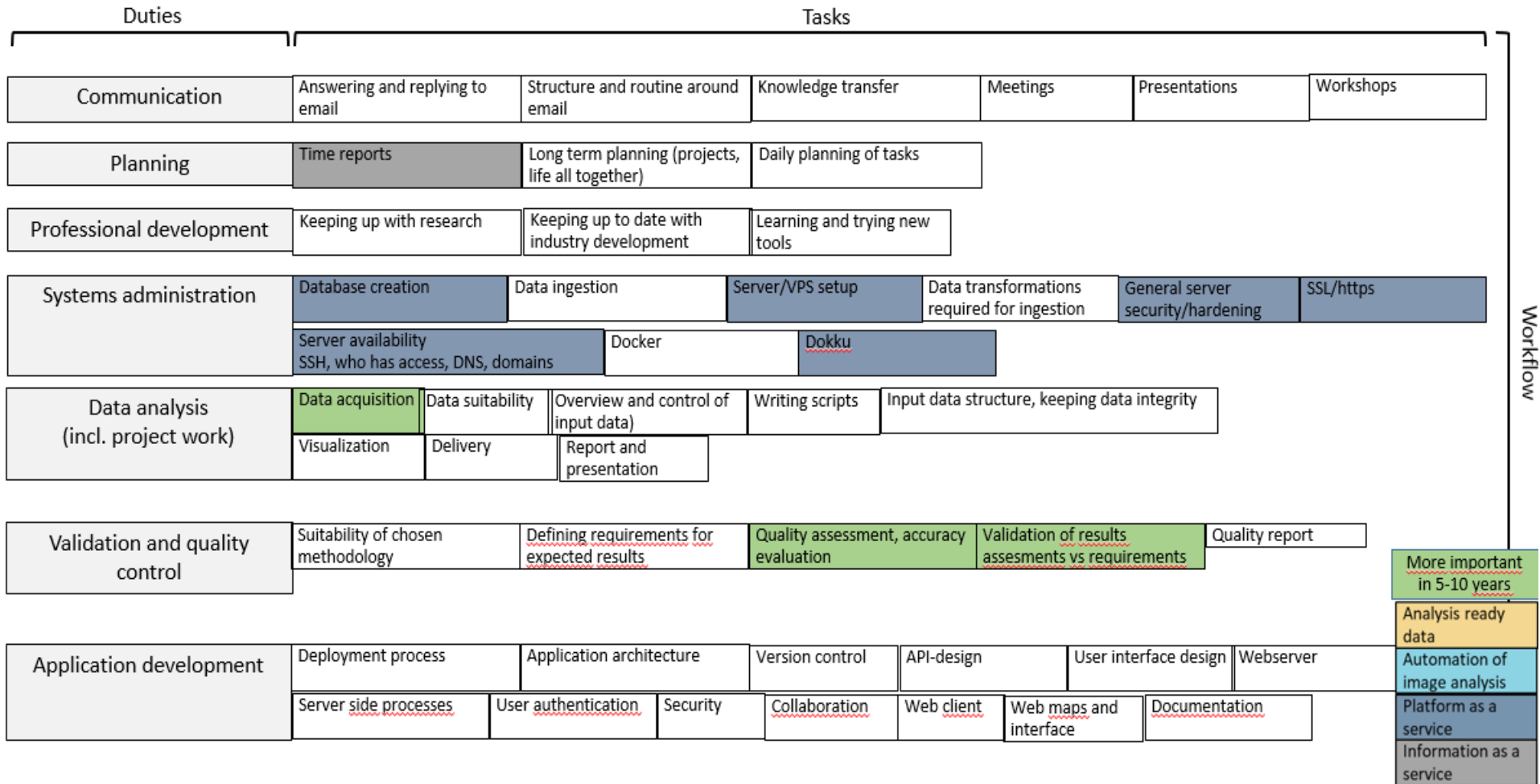
Figure 14: Trend mapping for the workflow of a Remote Sensing and GIS consultant conducted by GIB
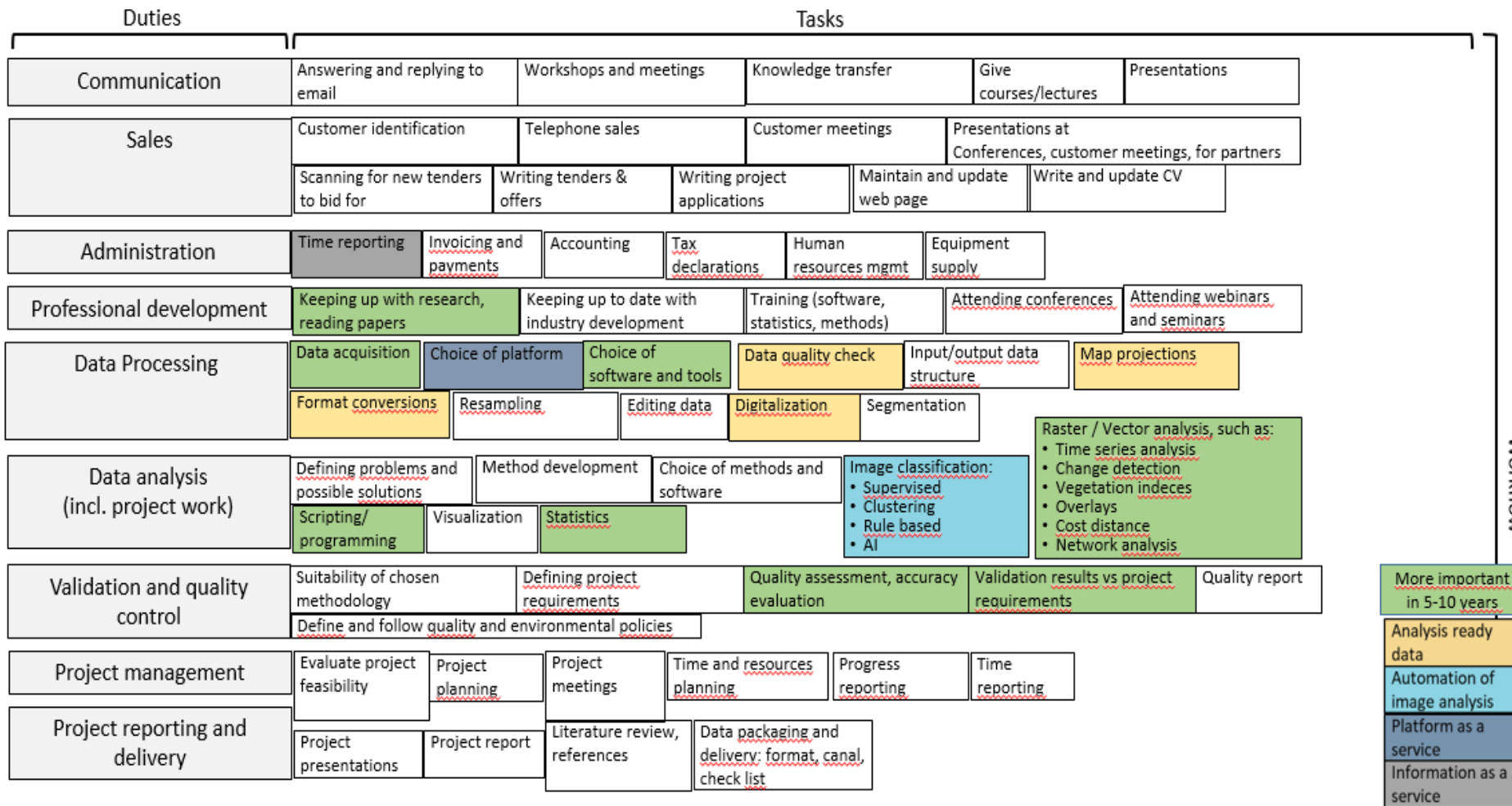
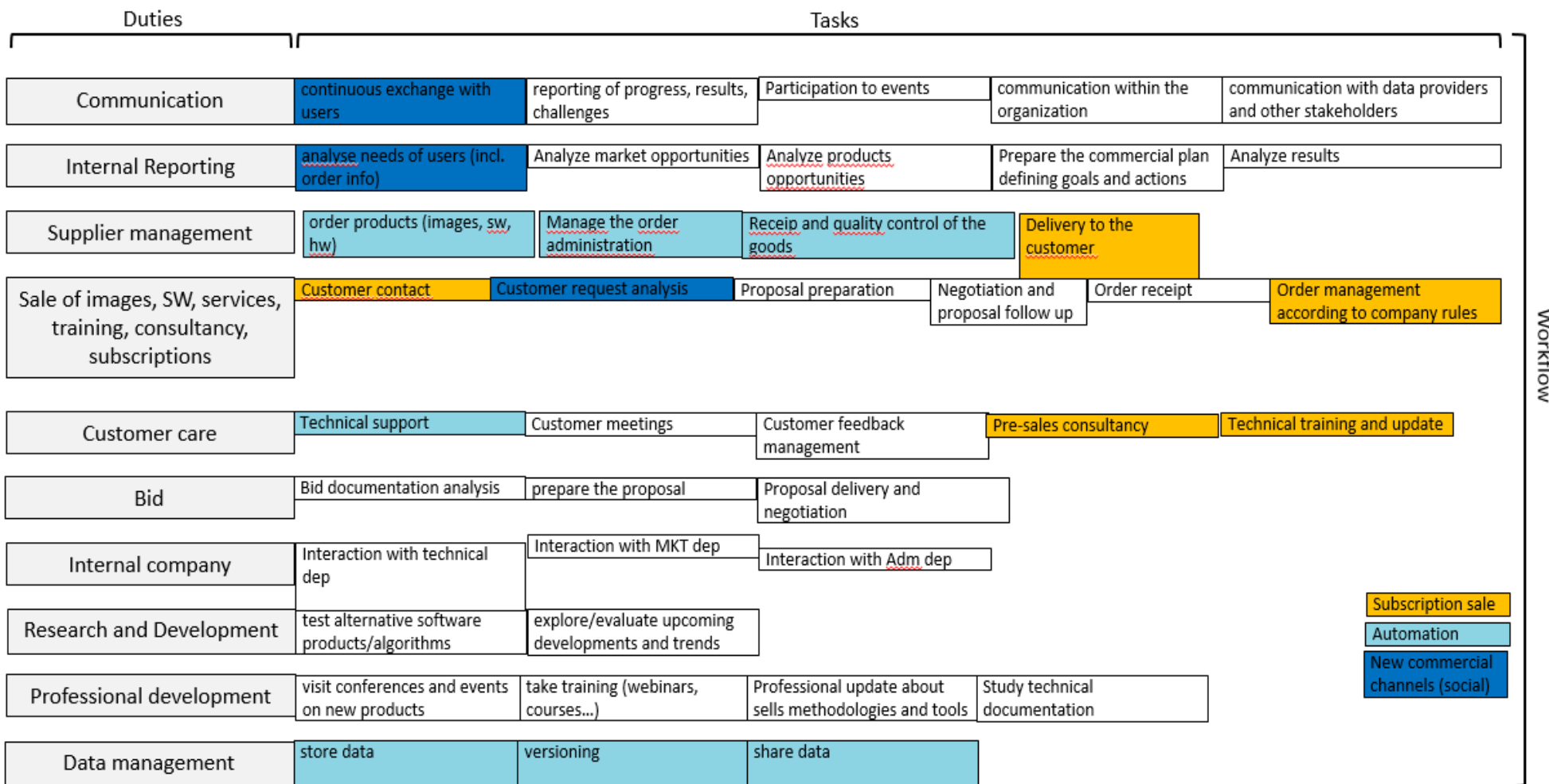Figure 15: Trend mapping for the workflow of a Sales of EO Data and Services conducted by Planetek

Figure 16: Trend mapping for the workflow of a Remote Sensing Researcher for Atmospheric Sciences conducted by UPAT
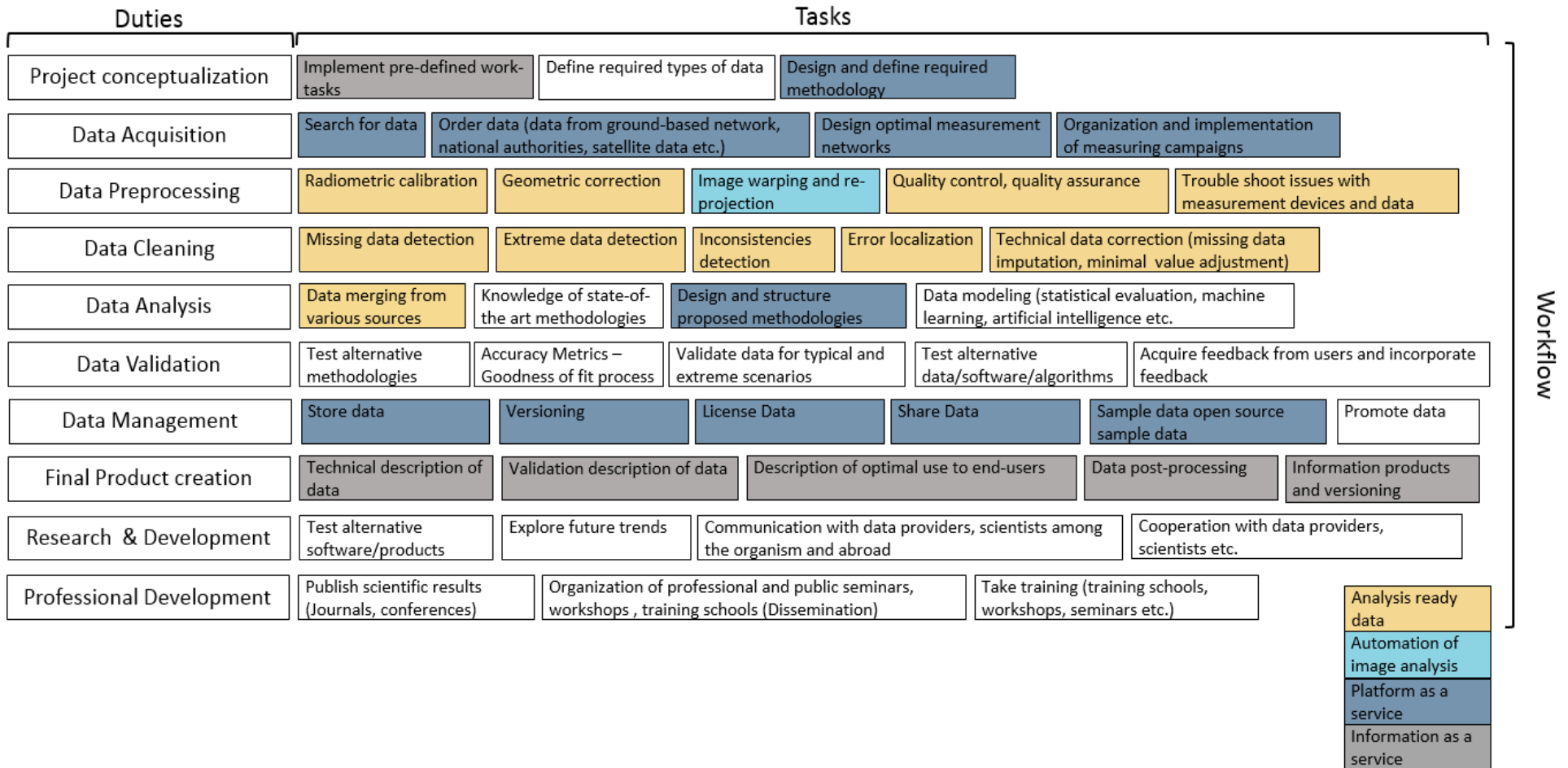
Figure 17: Trend mapping for the workflow of a Remote Sensing Scientist conducted by FSU
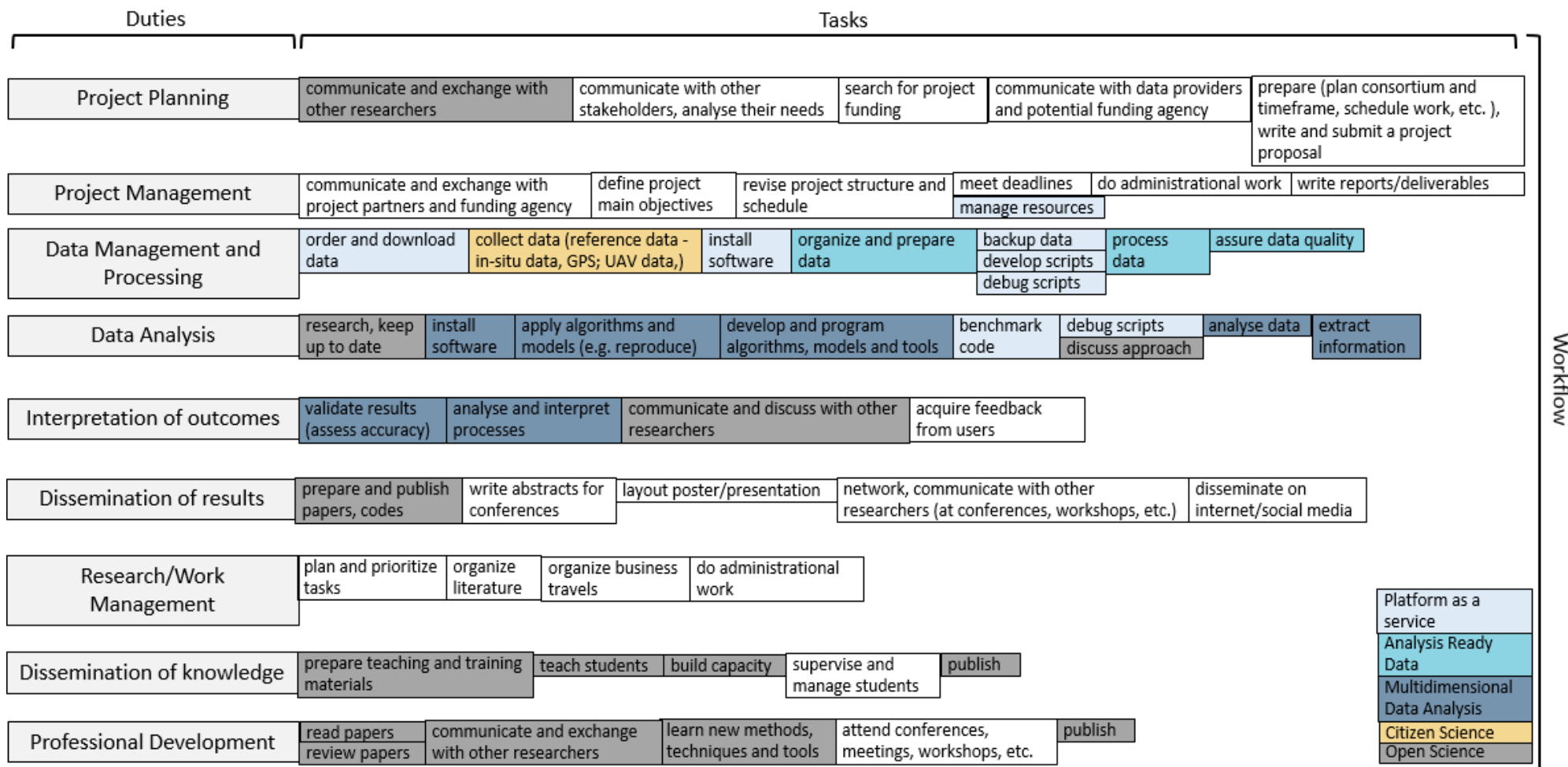
Figure 18: Trend mapping for the workflow of a Data manager conducted by UNEP-GRID
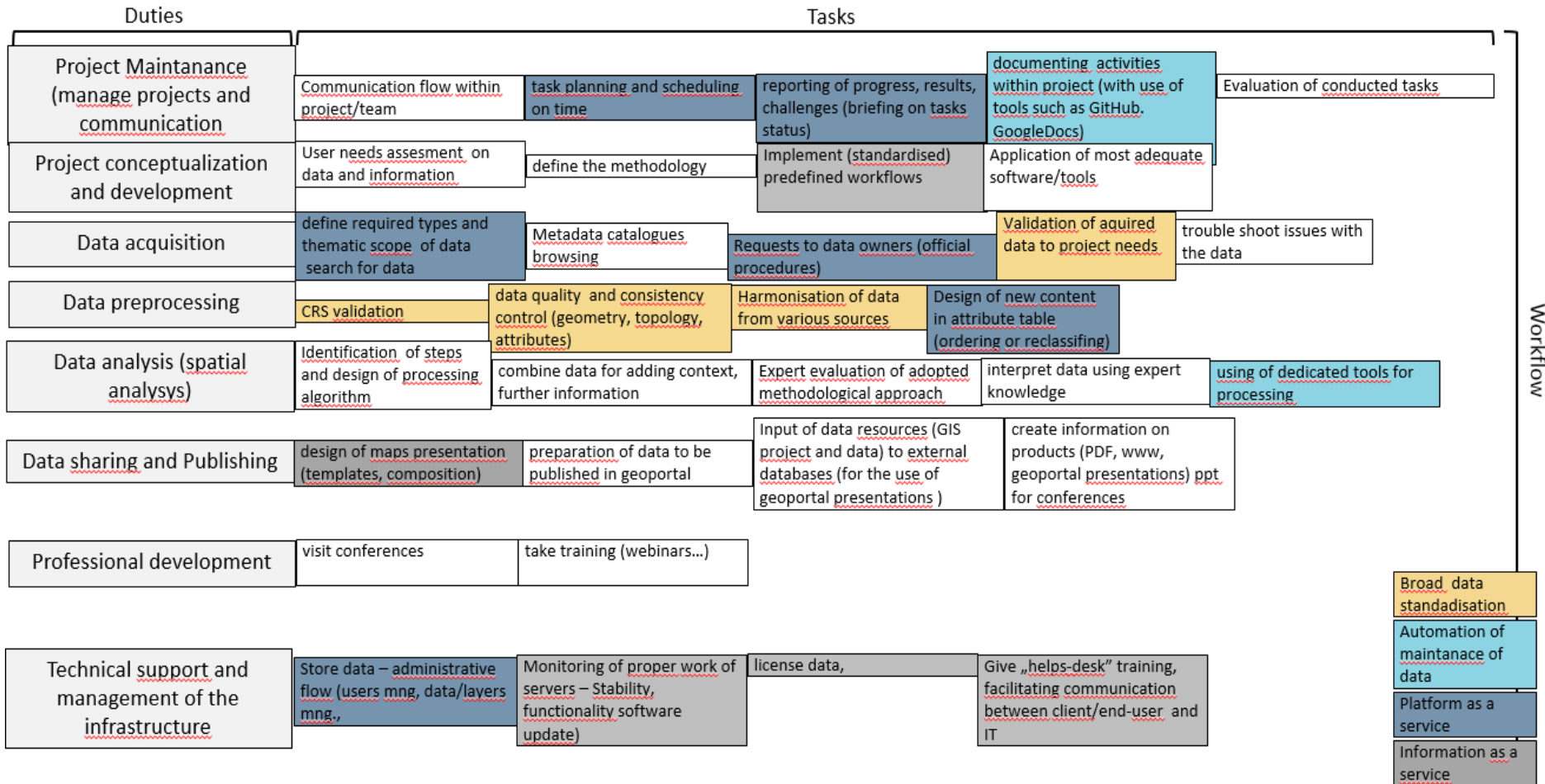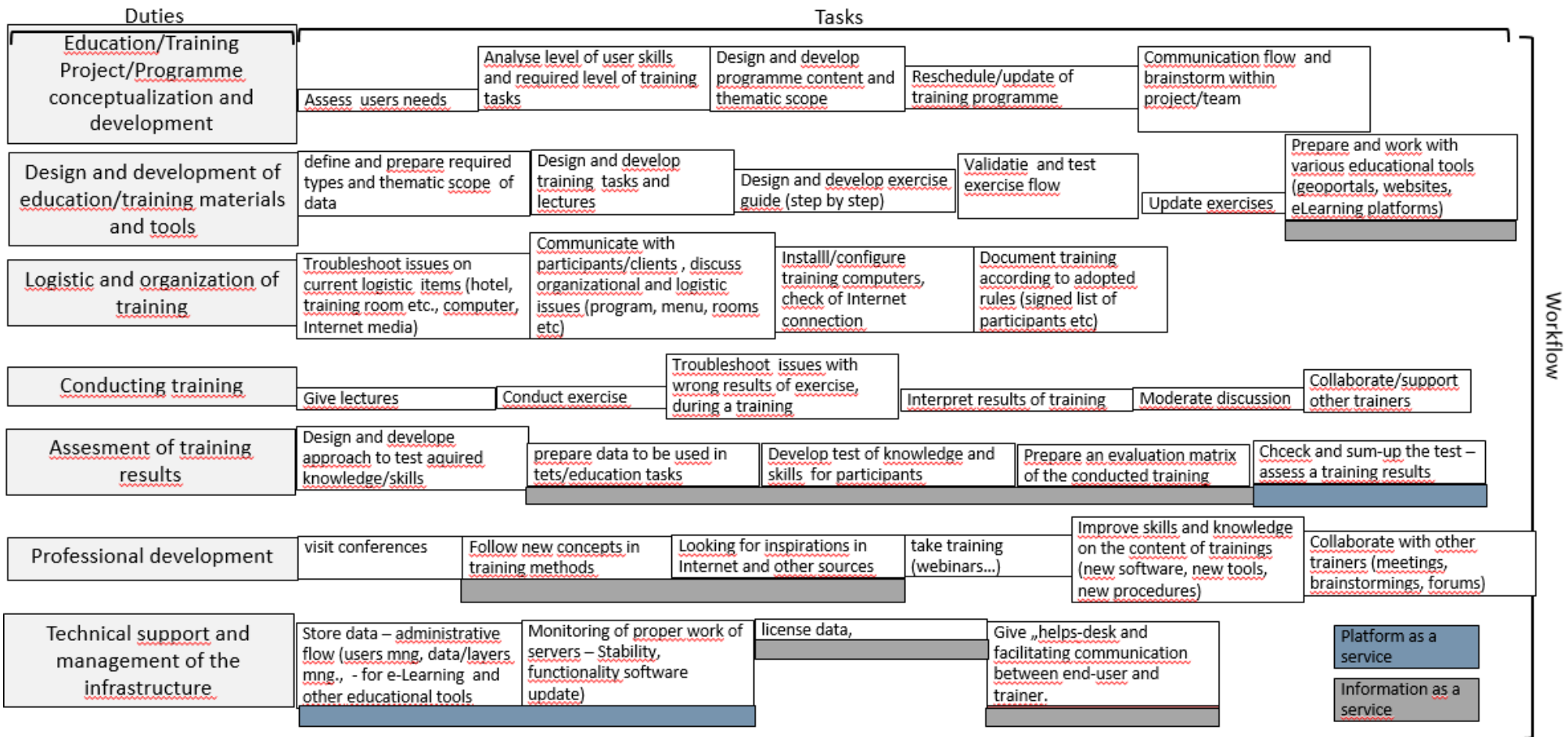
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Figure 19: Trend mapping for the workflow of an Educator conducted by UNEP-GRID

Duties | **Tasks** | **Workflow**

Education/Training Project/Programme conceptualization and development
- Assess users needs
- Analyse level of user skills and required level of training tasks
- Design and develop programme content and thematic scope
- Reschedule/update of training programme
- Communication flow and brainstorm within project/team

Design and development of education/training materials and tools
- define and prepare required types and thematic scope of data
- Design and develop training tasks and lectures
- Design and develop exercise guide (step by step)
- Validatie and test exercise flow
- Update exercises
- Prepare and work with various educational tools (geoportals, websites, eLearning platforms)

Logistic and organization of training
- Troubleshoot issues on current logistic items (hotel, training room etc., computer, Internet media)
- Communicate with participants/clients, discuss organizational and logistic issues (program, menu, rooms etc)
- Installl/configure training computers, check of Internet connection
- Document training according to adopted rules (signed list of participants etc)

Conducting training
- Give lectures
- Conduct exercise
- Troubleshoot issues with wrong results of exercise, during a training
- Interpret results of training
- Moderate discussion
- Collaborate/support other trainers

Assesment of training results
- Design and develope approach to test aquired knowledge/skills
- prepare data to be used in tets/education tasks
- Develop test of knowledge and skills for participants
- Prepare an evaluation matrix of the conducted training
- Chceck and sum-up the test – assess a training results

Professional development
- visit conferences
- Follow new concepts in training methods
- Looking for inspirations in Internet and other sources
- take training (webinars...)
- Improve skills and knowledge on the content of trainings (new software, new tools, new procedures)
- Collaborate with other trainers (meetings, brainstormings, forums)

Technical support and management of the infrastructure
- Store data – administrative flow (users mng, data/layers mng., - for e-Learning and other educational tools
- Monitoring of proper work of servers – Stability, functionality software update)
- license data,
- Give „helps-desk and facilitating communication between end-user and trainer.
- Platform as a service
- Information as a service

Figure 20: Trend mapping for the workflow of a Business Analyst conducted by IGEA

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