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D 1.3 – Demand for space/geospatial education and training and priority occupational profiles

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Work package / Task:

WP1 - Preparing the Space/Geospatial Sector Skills Strategy

T1.2 - Identifying the current demand for GI and EO skills and occupational profiles

Short Description:

Public report (Deliverable 1.3) summarizing the work on Task 1.2 - the identification of demand for skills, competences and knowledge in the space/geospatial sector. It covers an analysis of related studies, a survey among employers and employees on requested job profiles semi-structured interviews with market representatives carried out to obtain complementary, qualitative information to the survey. .

Keywords:

Space/geospatial education and training; demand survey; EO/GI skills; Copernicus

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

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2.0	12.12.2018	PLUS	Final version	Submitted version including all comments from QA
2.1	04.06.2019	PLUS	Final version	Integration of Technical Progress Report comments, list of acronyms and glossary

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Acronyms

Acronym	Description
AFIGEO	Association française pour l'information géographique
AGILE	Association of Geographic Information Laboratories in Europe
ARD	Analysis ready data
BoK	Body of Knowledge
CEO	Chief Executive Officer
DACUM	Develop A CurriculUM (DACUM) approach
DIAS	Data & information access service
EACEA	Education, Audio-visual, Culture Executive Agency
EARSC	European Association of Remote Sensing Companies
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit System for Vocational Education and Training
EO	Earth Observation (inc. Meteorology)
EO/GI	EO and GI sectors
EQAVET	European Quality Assurance Reference Framework for VET
EQF	European Qualifications Framework
ESA	European Space Agency
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
FP7	7th Framework Programme for Research and Technological Development
Geo-ICT	Geographic Information and communication technologies
GI	Geographic Information
GIS	Geographic Information System
GIS&T BoK	Geographic Information Science & Technology Body of Knowledge
GNSS	Global Navigation Satellite System
ICT	Information and communication technology
INSPIRE	Infrastructure for Spatial Information in Europe
INFOaaS	Information as a service
ISCO	International Standard Classification of Occupations
LLP	Lifelong Learning Programme

LRA	Local and Regional Authorities
MOOC	Massive Open Online Course
NEREUS	Network of European Regions Using Space Technologies
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OSP	Occupational Skill Profiles
PaaS	Platform as a Service
R&D	Research & Development
RS	Remote sensing
RUS	Research and User Support (for Sentinel Core products)
SAR	Synthetic Aperture Radar
SME	Small and Medium Enterprises
UAV	Unmanned aerial vehicle
UCGIS	University Consortium for Geographic Information Science
URL	Uniform Resource Locator
VAS	Value added Services
VET	Vocational Education and Training
WP	Work Package

Glossary

- **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.
- **Earth Observation (EO) related services** is 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.
- **European Credit Transfer and Accumulation System (ECTS)** is a credit system designed to make it easier for students to move between different countries.
- **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.
- **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.
- **Information and communication technologies (ICT)** are the infrastructure and components that enable modern computing.
- 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.
- **Massive Open Online Courses (MOOC)** are free online courses available and provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale

- **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.
- **Research and User Support (RUS)** is a Copernicus Service portal, the RUS Service is the "New Expert Service for Sentinel Users" funded by the European Commission, managed by the European Space Agency, and operated by CS SI and its partners.
- **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.
- **Small and medium-sized enterprises (SMEs)** are enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.
- **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.
- **Unmanned aerial vehicle (UAV)**, commonly known as a drone, is an aircraft without a human pilot aboard.
- **Vocational Education and Training (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.

1. Introduction

EO4GEO is an Erasmus+ Sector Skills Alliance gathering 26 partners from 13 EU countries. Given the focus of EO4GEO, most of the partners are part of the Copernicus Academy Network, represent academia, the public and private sectors and are all active in education and training 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, Audiovisual and Culture Executive Agency (EACEA) and runs over four years.

EO4GEO aims to help bridging the skills gap in the space/geospatial sector by creating a strong alliance of players from the sector/community reinforcing the existing ecosystem and fostering the uptake and integration of space/geospatial data and services. EO4GEO will work in a multi- and interdisciplinary way and 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; the co-creation of knowledge, skills and competencies; etc.

EO4GEO will 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). The strategy will be implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts; developing and integrating a dynamic collaborative platform with associated tools; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes and conducting a series of training actions for a selected set of scenario's in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally a long-term Action Plan will be developed and endorsed to roll-out and sustain the proposed solutions

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

1.1. Objectives of the demand analysis

The present report is a result from work package 1 (WP1): Preparing the space/geospatial sector skill strategy. In WP1, the supply and demand of education and skills, gaps between supply and demand and trends in the space/geospatial sector are analysed to provide the foundation for the development of a sector skills strategy. This deliverable D1.3 focuses specifically on Task T1.2 of WP1, which is assessing the demand for space/geospatial education and training and priority occupational profiles. As such, it is input for the analysis of the gap between supply of education and training (T1.1) and the respective demand and additionally provides input for the strategy development (T1.5) in WP1. In the broader project context, some results of D1.3, the demand for space/geospatial education and training and priority occupational profiles, might further feed into and inform the work in work packages 2 (WP2) on the development of one Body of Knowledge (BoK) integrating Earth observation and GIS&T related knowledge, skills and competencies. The development of curricula and training material in WP4, the design of GI and EO curricula in support of Copernicus, as well as the development of a long-term action plan (WP6) will also build on requirements of the workforce in the space/geospatial sector.

1.2. Methodology and Document Structure

The activities carried out in task T1.2 of WP1, preparing the space/geospatial sector skill strategy, followed a specific methodology in order to achieve the targeted analysis of identifying the current demand of EO/GI skills and occupational profiles. Figure 1 provides an overview on the methodology of T1.2. The starting point is an analysis of related studies and previous assessments of the EO/GI workforce. In addition, three project activities contribute an up-to-date view on the demanded EO/GI skills and profiles. These activities include the EO4GEO demand survey, semi-structured interviews and a dedicated workshop with EO/GI professionals for a discussion of intermediate findings. These activities provide the basis for a discussion of relevant professional profiles as well as topics that might have to be included in the EO/GI body of knowledge.

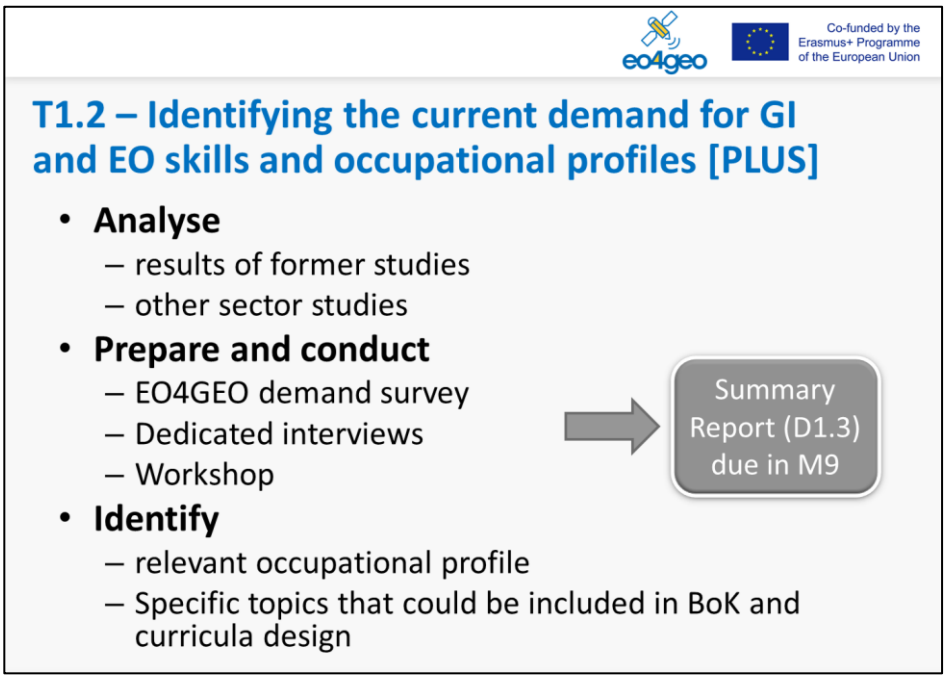

Figure 1. Methodology of the Task T1.2 of WP1.

The methodology related to the given task is represented in the structure of this document:

- Section 2 presents an analysis of previous studies that characterize the EO/GI market, its workforce and contributions regarding the development of sector skill strategies.
- Section 3 introduces the objectives and implementation of the EO4GEO demand survey. The report then analyses the results of a survey on demand for space/geospatial skills and occupational profiles based on
- Section 4 reports on the results of the survey. These results are covering 175 valid responses that were received until July 28, 2018 (the total amount of responses is 196 responses until September 10, 2018). The objective of this section is to provide the results without their discussion (which follows in section 6)
- Section 5 comprises the design and results from the semi-structured interviews that were held with 30 EO/GI sector representatives. The semi-structured interviews take into account recommendations provided on the first insights of the survey during the related workshop.
- Section 6 is the discussion section that provides an interpretation of the results of the survey and the interviews and argues for occupational profiles that result from the demand analysis.

- Section 7 includes a summary and outlook of the work on T1.2.

Preliminary results of the *demand survey* have been discussed with representatives of industry, public administration, universities and the European Commission in panels and breakout sessions during a workshop held in May 2018. The presentation of the workshop is not part of this deliverable; the workshop report D1.2 is published on the project website http://www.eo4geo.eu/publications/.

The expected contributions of this report are the identification of (1) EO/GI sector-specific knowledge, skills and competencies for a growing market and related methodological concerns, (2) potential high-priority profiles that can guide curriculum development in a later phase of the project, and (3) emerging topics to be included in a combined EO/GI BoK. The identification of priority profiles includes the opportunities of vocational training (VET) profiles, which hardly exist for the sector at hand.

2. Background and related studies

Space is considered one of the key strategic and economic sectors for many countries in the world, with an increasing role of private actors (OECD 2005) and the evolution of a distinct space economy. The sustainability of the Copernicus programme – the conjoint Earth observation (EO) programme by the European Commission (EC) and the Eureopan Space Agency (ESA) – strongly depends on a vibrant commercial European EO economy with a strong uptake by its sectors and, in particular, the users. The EARSC Report on the state and health of the European EO Service Industry, conducted in 2013, 2015 and 2016, provides insights into EO service companies such as data suppliers, value-adding and GIS companies as well as consultants. The survey results (EARSC 2017) show that the EO service industry landscape is very fragmented and consists mostly of micro companies (66%), followed by small (30%), medium (3%) and large companies (1%). The distribution of employees shows also that small (43%) and medium sized (26%) companies employ almost 70% of the employees in the sector. The EO value chain can be segmented in the upstream, midstream and downstream (sub-)sector (Figure 2). This value chain is constantly evolving. Both the upstream sector, i.e. the (space) infrastructure with its massive

increase in EO sensors/satellites, and the midstream/downstream sector, i.e. the ground segment plus value-added services, experience 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 discruptive 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") (Sudmanns et al. 2018), has led to provide analysis-ready data (ARD) increasingly 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 enourmously from the given data and service infrastructure. These technical achievements need to be ultimatiely 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.

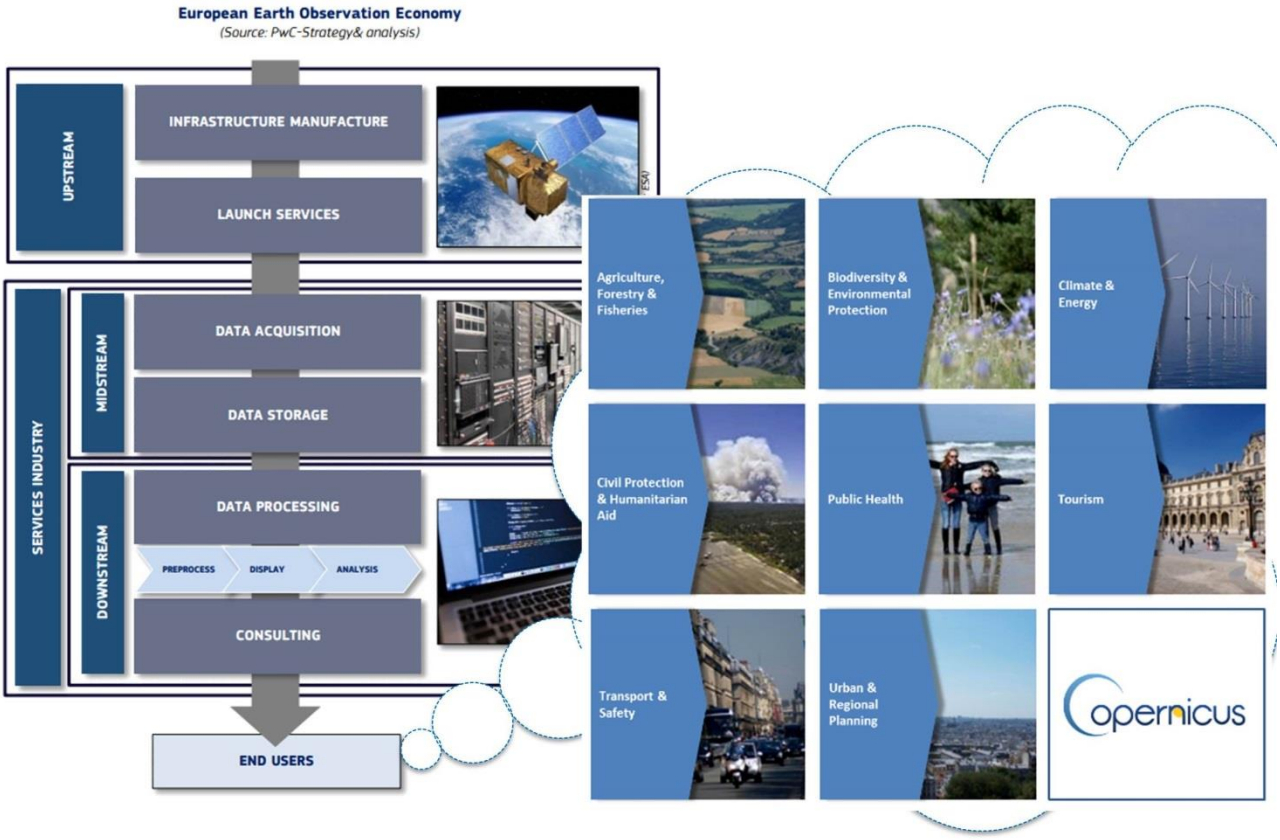

Figure 2. European Earth Observation Economy (EC 2016), complemented by Copernicus promotion material (compilation by PLUS. (see text for further explanation)

The fact that the market undergoes a considerable change is documented by recent studies. The existing interdependence of data economy and the EO/GI sector underlies key drivers of change, including the following (O'Sullivan, Wise, and Mathieu 2018):

- Rise of the platforms: leveraging cloud computing infrastructure and stimulating applications development.
- Data as a service: user manages the application; everything else is delivered as a service.
- Open data policies: demand from users and government policies changing towards improved access to data and tools.
- New business models: people can easily gain access to and use a multitude of data analysis services quickly.
- Sensor use growing: IoT and sensors intelligently working at the edge of networks, complementarity of space-borne and terrestrial data.
- Crowdsourcing: citizen science platforms and their commercial capability.

- Disruptive innovation: introduces a new value proposition. They either create new markets or reshape existing ones.

The project 'EO4GEO - Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake' is situated in the context of the changing EO/GI sectors. The specific project context and the contributions of this report are outlined in the subsequent sections.

The EC's Blueprint for sectoral cooperation on skills aims at meeting the future challenges in the space data (geoinformation) sector (European Commission 2017), among others, EO4GEO is the dedicated sector skills alliance for space/Earth observation EC 2017), among others. EO4GEO is the dedicated sector skills alliance for the space/geospatial sector gathering key stakeholders from industry, research, universities and public authorities to tackle new skills requirements in the sector.

Following the EU Space strategy [COM(2016) 705 final], the Commission is strengthening activities and projects to promote space in education and sciences. In the longer term, the Commission will encourage the uptake of space solutions through standardisation measures and roadmaps so that to open up space to non-space entrants and non-space industries (D'Oleire-Oltmanns et al. 2018). In the communication on "Rethinking education" [COM(2012) 669 final], the European Commission stresses that investment in education and training for skills development is essential to boost growth and competitiveness. In the long-term, skills and fitting occupational profiles can trigger innovation and growth, move production up the value chain, stimulate the concentration of higher level skills in the EU and shape the future labour market.

Occupational Skill Profiles (OSP) (see Figure 3) are job descriptions summarizing essential characteristics of a given job. It includes 'the level of education and training (and hence the complexity of occupation), the field of education and training and other main and supplementary requirements concerning knowledge, skills, competence, interests and values (Cedefop 2013). OSPs have been developed to analyse, project and forecast skills needs.

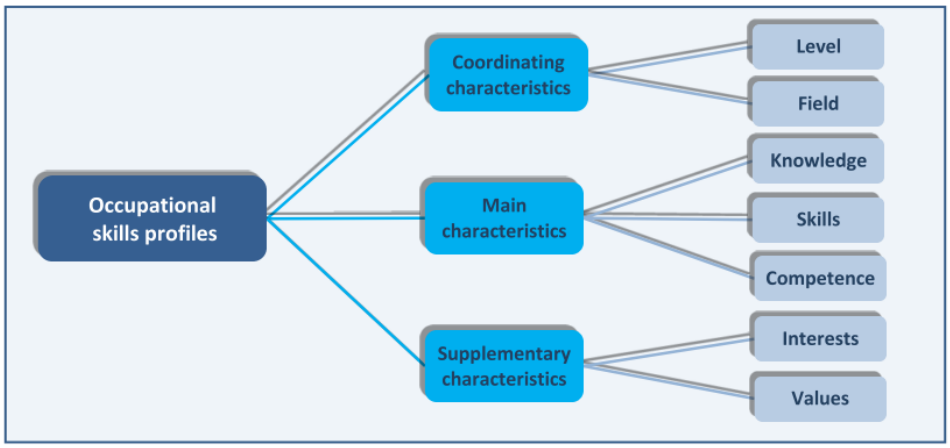

Figure 3. Occupational skills profile: main dimensions (Cedefop 2013)

The term occupation refers by the International Standard Classification of Occupations (ISCO-08)[1]

'*… to the kind of work performed in a job. The concept of occupation is defined as a "set of jobs whose main tasks and duties are characterized by high degree of similarity". A person may be associated with an occupation through the main job currently held, a second job, a future job or a job previously held*.' (International Labour Office 2012).

Already defined occupational profiles in the EO/GI sector are listed in the European Skills/Competences, qualifications and Occupations (ESCO) framework[2]. The ESCO framework lists occupations profiles defined by the International Standard Classification of Occupations (ISCO-08) indicating ten main groups (see Figure 4) which are defined by the two skill dimensions namely skill level and skill specialization. A skill level (1-4) is specified as the complexity and range of tasks and duties to be performed and skill specialization is the field of knowledge required as well as tools and machinery used, materials worked on or with or the kinds of goods and services produced (International Labour Office 2012).

[1] http://www.ilo.org/public/english/bureau/stat/isco/isco08/
[2] https://ec.europa.eu/esco/portal/skill

ISCO-08 major groups	Skill level
1 Managers	3 + 4
2 Professionals	4
3 Technicians and Associate Professionals	3
4 Clerical Support Workers	2
5 Services and Sales Workers	
6 Skilled Agricultural, Forestry and Fishery Workers	
7 Craft and Related Trades Workers	
8 Plant and Machine Operators, and Assemblers	
9 Elementary Occupations	1
0 Armed Forces Occupations	1 + 2 + 4

Figure 4. ISCO-08 major groups to skill levels (International Labour Office 2012)

For example, in group 3 'technicians and associate professionals' the occupational profile of a remote sensing technician is described as followed:

'*Remote sensing technicians collect airborne data. They utilise equipment aimed for the collection of data and determination of geographical points in order to help in a variety of operations such as land conservation, urban planning, and military operations*.´ (European Commission 2018).

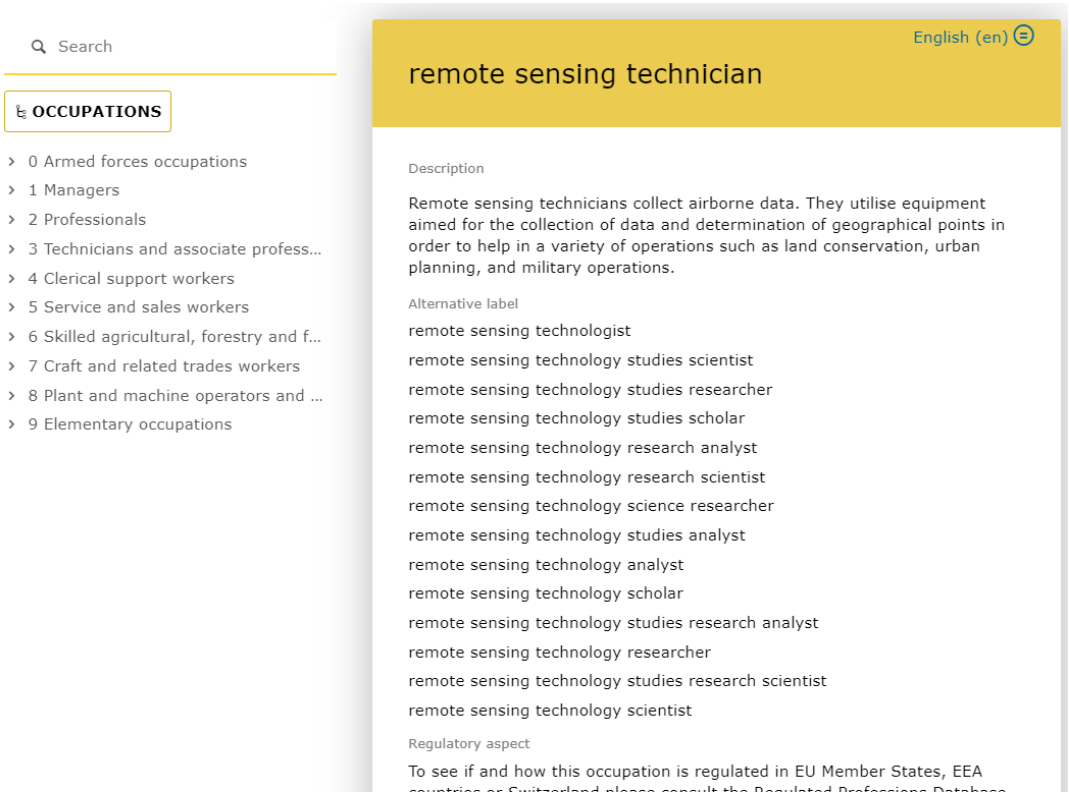

Figure 5. ESCO profile for Remote Sensing Technician (EUROPEAN COMMISSION 2018)

The ESCO framework includes two occupational profiles relevant for the space/geospatial sector: the **remote sensing technician** (see Figure 5) as described above and the **geographic information system specialist**. These profiles are described with essential skills and competencies, essential knowledge and various optional skills. The listed elements draw a general picture of what remote sensing technicians and GIS specialists need to know and tasks they need to be able to perform. Profiles for future workforce on the space/geospatial market as assessed in this report need to be characterized in more detail.

The terms skills, competencies and knowledge as used in ESCO profiles are defined as follows (EUROPEAN COMMISSION 2017):

- “Knowledge is defined as the outcome of the assimilation of information through learning. It represents the body of facts, principles, theories and practices related to a field of work or study.

- Skills indicate the ability to apply knowledge and use know-how to complete tasks and solve problems.
- Competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development."

Vice versa, ESCO collects skills and allows queries about the assignment of these to specific occupations. Interestingly, the skill "have spatial awareness" is assigned to a range of occupations dealing with piloting and logistics, but (currently) not to the aforementioned two occupational profiles.

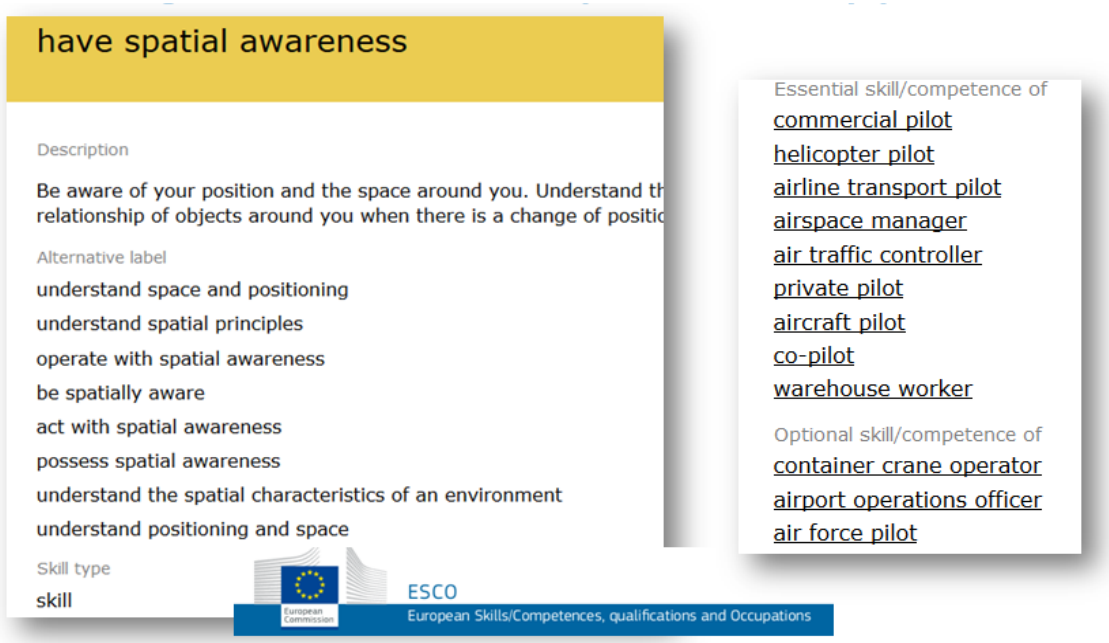

Figure 6. The skill "have spatial awareness" as defined by ESCO

Several studies investigated required education for building-up the workforce for the EO/GI market:

In context of the LLP-ERASMUS project GI-N2K[3] the workforce demands to shape GIS&T education in the future were discussed. The GI-N2K project aimed at aligning the Geoinformation

[3] http://www.gi-n2k.eu/the-project/

Science & Technology (GIS&T) Body of Knowledge (BoK)[4] to market demands with regard to knowledge and skills with training offers in the GIS&T sector. The project consortia conducted a European wide survey to assess the demand and concluded that three main topics need to be addressed in an update of the GIS&T BoK. The first topic would be the "shift from primary data acquisition to the handling of highly abundant spatial data". The second topic to be addressed would be "a lack of competences in programming and application development. The third topic is the "poor coverage of web-related aspects" (Wallentin, Hofer, and Traun 2015).

In the context of the FP7 project smeSpire[5] the market potential for Geo-ICT SMEs in relation to INSPIRE was assessed. The study deals with the market comprising of small and medium sized Geo-ICT companies and how they (might) contribute to the INSPIRE directive. The focus was on the opportunities of SMEs in the Geo-ICT sector to provide services to public authorities offering skill sets seldom found in public authorities. The study provided a detailed description of the European Geo-ICT market. Geo-ICT in regarding to the study was limited to GIS/geo-location activities of ICT companies, which comprise approximately 1-2% of the ICT sector. The Project developed training packages based on vocational training curricula, a best practice catalogue as well as a network of SMEs and other institutional stakeholders. Another output was to create business models enabling companies to convert technological innovation to economic value (Cipriano, Easton, and Roglia 2013).

[4] http://www.gi-n2k.eu/wp-content/uploads/2014/01/UCGIS_GISandT_BoK_DigReIssue2012.pdf
[5] http://www.smespire.eu/project-overview/

3. Survey on demand for Space/Geospatial skills and occupational profiles

In order to have a representative insight into the current demand for space/geospatial skills and occupational profiles in Europe, one of the most important sources of information is the users, employers and educators in that field. They have long-term experience in different types of organisations, such as private companies, educational organizations and public authorities on the one hand. They have developed strategies for upcoming challenges emerging in latest developed services where traditional and/or well-known (business) approaches are not applicable anymore on the other hand. Hence, their input, ideas and - simply spoken - wishes help to outline the current state on demand for space/geospatial Education and Training in Europe and beyond.

3.1. Design of the Demand Survey

In view of technological changes that transform workflows in the EO/GI sector (see work Planetek (2018)), the objective of the survey is the investigation which sector specific skills are required on the market and might be emerging skills to be contained in an EO/GI BoK. Information on required skills and their levels allows an informed design of curricula and trainings that make the future workforce fit for the market. Furthermore, findings from the survey support the identification of newly arising occupational profiles. This in return enables also a strengthening of the academic/educational offers and adapting those if necessary. Hence, existing curricula may be updated and extended, intermediate ways to educate staff may be enforced, such as Vocational Educational Training (VET) measures and, if identified as necessary, further approaches for future education in the space/geospatial domain may be discussed and conceptualized.

In order to achieve these objectives, the online survey aimed at receiving firstly information about the skills and expertise of the respondents in order to assess the current workforce and requirements of organizations. Secondly, the survey aimed at collecting characterizations of occupational profiles of employers that currently searched for by organizations. The resulting survey is structured into three sections (see Figure 7 for an overview on the structure and Annex 1 for the full survey), which are shortly described below.

Figure 7. Structure of the demand for EO/GI survey at a glance (D'Oleire-Oltmanns et al. 2018).

In the first section of the survey, the respondents provided **information about their organization**. This included type and size, the availability of training measures for employees, and the top three professional EO/GI related skills that employees need. Furthermore, the respondents ranked according to their experience whether applicants for vacancies typically fulfil the required skills. The next questions in the first section of the survey concerned the **respondents' own expertise**. This included their highest level of education, the name of their current position/job profile, the EO/GI related profile to which it belongs best, the Copernicus application domains that their work relates to and three tasks with specific relation to EO/GI that their professional work requires them to perform frequently.

In the second section of the survey, the respondents gave **information about the most needed EO/GI related job position/occupational profile** in the organization and the skills that are required to be successful in that job position. The answers included the name of the most needed position, the disciplines where applicants come from and the highest level of education of that occupational profile. Moreover, the survey presented eight different EO/GI related skill sets to the respondent (in the language of a BoK, skill sets can be understood as knowledge areas). The skill sets/knowledge areas were:

- Space/geospatial data

- Data capture and management
- Analytical methods
- Programming and development
- Computing resources and platforms
- Visualization and Cartography
- Organizational and institutional issues
- EO/GI and society

The upcoming section below provides more details on defining EO/GI related skill sets. Within each skill set, the respondents identified specifically relevant skills and rated the level of expertise that an applicant requires in that skill. This was compulsory for three of the listed skills; the eight skill sets listed between five and fourteen skills and the option to specify other relevant skills. After the level of expertise rating within each skill set, the respondent rated the overall relevance of the specific skill set with a value in the range from 1 to 6. In addition to the rating of the EO/GI related skills, the respondent could select one or more transferable and soft skills that would complement the competencies of an applicant. Finally, the respondent linked one or more application domains the occupational profile relates to, based on a provided list of application domains.

The third and last section of the survey let the respondent provide their contact information if they were interested in more information about the EO4GEO project or if they would agree to engage in the demand survey by a qualitative interview.

The questionnaire design for section 2 was mostly concerned with providing the respondents with EO/GI related skill sets that cover the main tasks in the space/geospatial sector. They shall enable each respondent to provide an individual selection and rating of EO/GI related skills for a specific occupational profile.

The eight skill sets in the questionnaire are predominantly based on the GIS&T BoK[6] and provide a slight recombination of knowledge areas in order to limit the number of skill sets presented to the respondents. Besides the UCGIS BoK, the BoK resulting from the GI-N2K project has also been considered in the derivation of skills sets[7]; as some of the knowledge areas in the GI-N2K BoK

[6] https://www.ucgis.org/gis-t-body-of-knowledge
[7] http://gin2k.bigknowledge.net/bokwiki/bokwiki.html

have an explicit reference to GIS in the title, these labels were not reused in the context of EO/GI related skill sets.

The knowledge area 'foundational concepts' was not included as a separate skill set as concepts of spatial data need to be known to implement solutions accordingly. The skill sets were introduced with a list of skills related to each subject. As the focus of the survey is not on GIS&T alone, but on space/geospatial data, methods and solutions, it was required to include Earth observation skills in the list of skills. The skills were derived based on the identified skills in previous studies (EARSC 2015; Rip, Wallentin, and Lammeren 2014) and in discussions with EO specialists. The listed skills are only exemplary and the work on an EO/GI BoK during the project has the potential to improve the foundation on which a skill assessment can be based.

The survey had to fulfil certain general requirements to allow respondents to understand the structure of the questionnaire on this complex subject and to answer appropriately in a limited timeframe. There was a series of feedback rounds in the project consortium to assure a clear structure of the survey and unambiguous questions. The majority of the questions are multiple-choice questions, intended to reduce the respondents' time efforts to complete the survey.

3.2. Survey implementation and distribution

The online survey (see Annex 1 for its structure) was implemented and carried out via the platform EUSurvey[8]. The European Commission (EC) provides this platform without any further costs for the user and enables the distribution of the created survey via a simple URL. This allows reaching a maximum of respondents having the possibility to provide their insights without any greater technological effort. Having in mind sensitive network structures or restricted communication guidelines from companies it is especially helpful to apply such a free and transparent tool. The affiliation to the European Union is an asset in the context of this project co-funded by the Erasmus+ Programme and supporting the Copernicus User Uptake.

In the survey, one section enabled the respondent to choose freely on the provision of information on her/his personal background as well as contact information. In addition, the respondents were

[8] https://ec.europa.eu/eusurvey/home/welcome

invited to indicate via a checkbox to accept being contacted. These steps were implemented to consider the guidelines regarding data protection.

The survey has been created in English language. The distribution took place through all partners and multiple mailing lists such as the Copernicus network, the AGILE community, social media outlets (twitter, facebook etc.) of partners and many more to reach a representative number of responses. To even further expand the range of the survey, AFIGEO has in addition implemented a translated version of the questionnaire in French. As of now there are three replies from France that could be considered.

The survey is up and running since April 2018 with an preliminary end date in June 2018. The project partners supported by the steering committee decided in the meantime to leave the survey up and running for the whole duration of the project.

3.3. Results of the survey

The analysis of the survey results is based on a total of 176 respondents; these responses were received until end of July 2018, which represents the cut-off date for the analysis presented in this report. Out of the 176 responses, 175 provided sufficiently complete questionnaires; these 175 questionnaires form the basis of the following analysis. The main distribution area for the survey was Europe. Figure 8 presents an overview of 25 the countries where the responses originated.

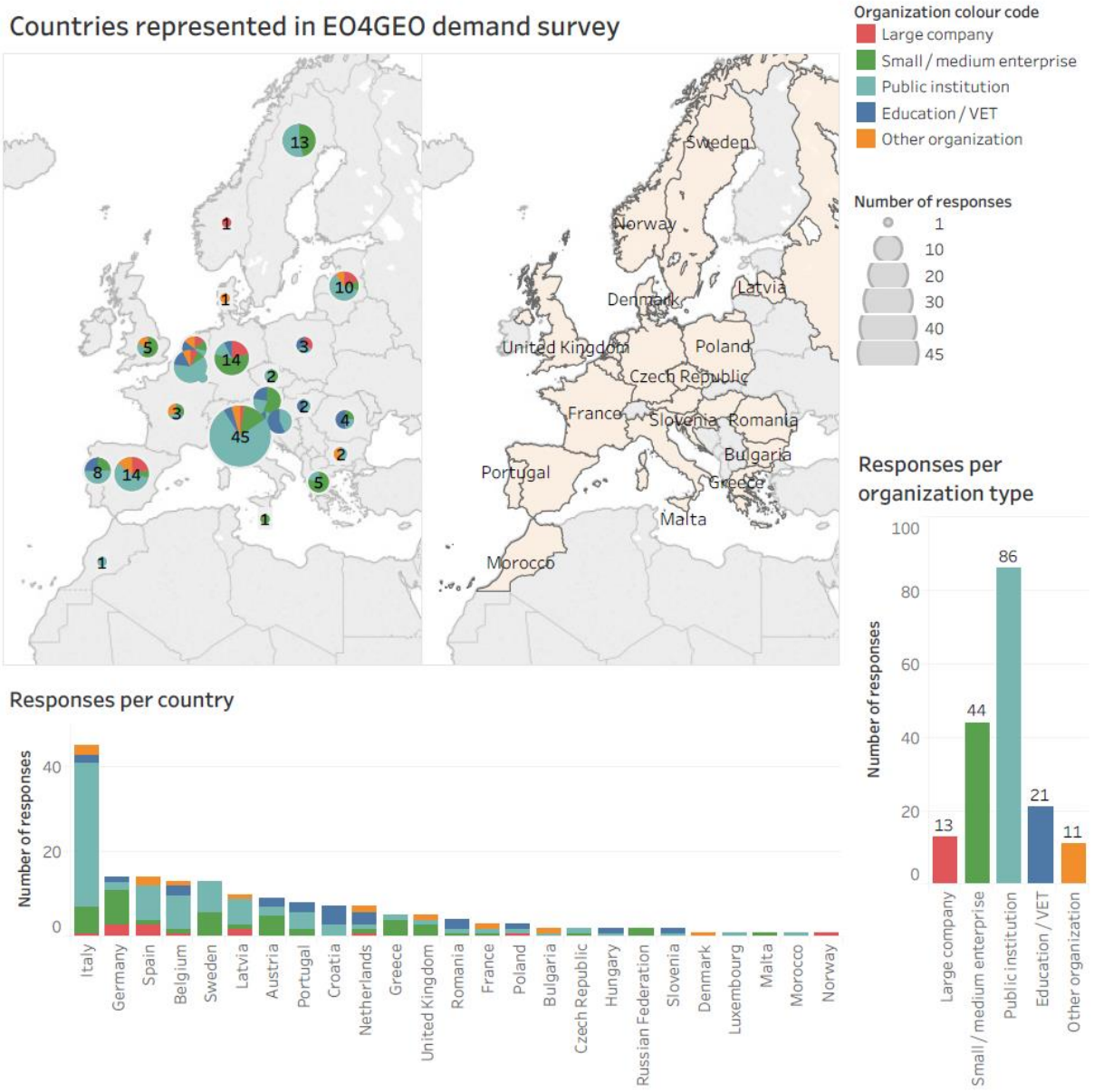

Figure 8. Number of responses per country and organization type [9].

Responses originated from almost all countries of the European Union, with the strongest representation within the 13 countries where the EO4GEO Sector Skill Alliance has its 26 partners,

[9] The interactive version of the diagram can be viewed here: https://public.tableau.com/views/EO4GEO_Demand_Survey_Part1_Overview_FA/MapDashboard?:embed=y&:display_count=yes&publish=yes

specifically Italy (7 partners). The countries of the 27 associated partners of EO4GEO were covered, when excluding international organizations and partners outside of Europe. The EU countries not covered are Ireland, Finland, Estonia, Lithuania, Slovakia, and Cyprus. No partners from these countries were part of the EO4GEO Sector Skill Alliance or of its associated partners, which may be a reason why no response returned from these countries. In addition, some responses came from outside of the EU, i.e. the United States, the Russian Federation, and Morocco. With a target amount of 200 responses, the survey did not aim on distinguishing the EO/GI demand between countries. The majority of European countries is represented, indicating a sufficient coverage of the survey's target region so that the subsequent analysis can provide answers about the entire European market.

Figure 8 shows the number of answers per organization type. The respondents answered about their organization type in more detail, but we aggregated all provided types into five general categories.

- "Large company"
- "Small / medium enterprise (SME)"
- "Public institution" (summarizing "Public body", "International organisation", "International organisation of European interest")
- "Education/VET" (summarizing "Secondary or Higher education establishment", "Vocational education and training provider")
- "Other organization" (summarizing "Non-profit", "Legal person / Individual professionals'", "Other").

The majority of responses originated from public institutions. In the private sector, more responses were receivd from SMEs than from large companies. A considerable amount of responses to the demand survey came from Education/VET.

Figure 9 illustrates the training measures supported by organizations. There was no particular preference for training measures from the organisation type Education/VET, other. Large companies, SMEs, and public institutions prefer in-house trainings, external workshops and distance learning

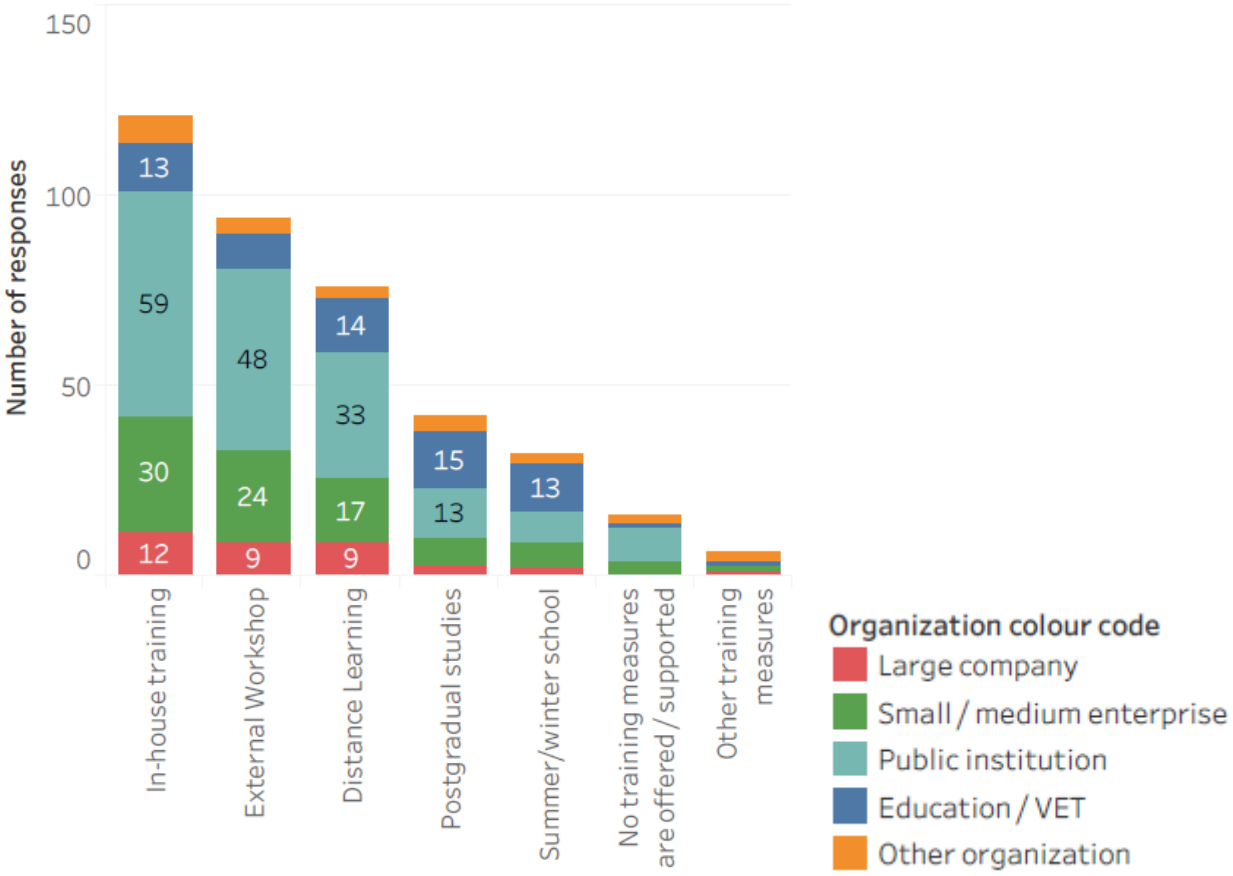

Figure 9. Preferred types of training measures within the organization.

The low number of organizations that offer/support no training measures reflects the high awareness within the EO/GI industry that continued training is a requirement.

The survey respondents generally have a high degree of education with the vast majority having a Master or even a PhD (Figure 10). This corresponds to previous assessments of the space/geospatial sector (EARSC 2015).

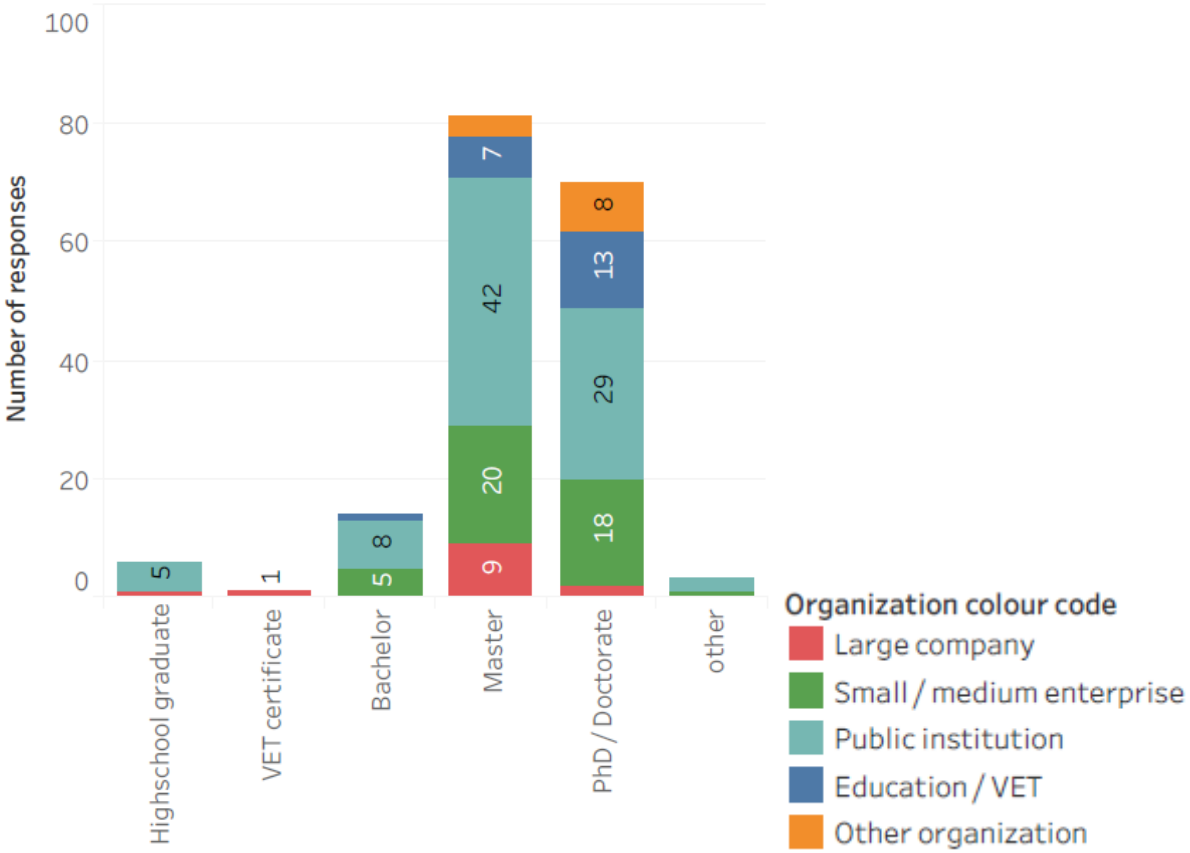

Figure 10. Highest degree of education of respondent.

The survey sought responses from people working in the field of EO/GI. Figure 11 shows that most of the responses came from people that are directly involved with EO/GI data/services. About half of the people declared themselves as EO/GI data/service expert (analyst, researcher, and educator).

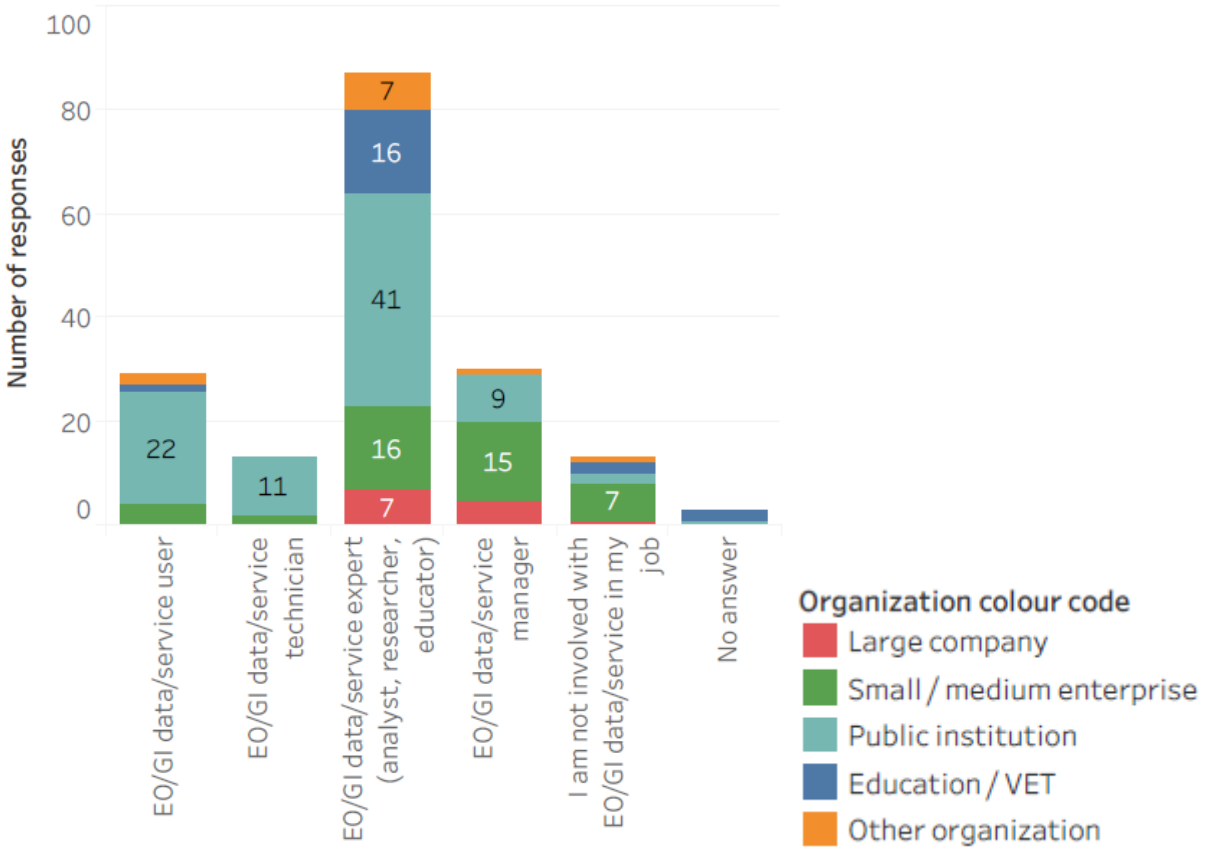

Figure 11. EO/GI profile related to the position of the respondent.

Figure 12 shows the relation of the respondent's position to the Copernicus services by selecting one or more services. The respondents use all Copernicus services. The most relevant Copernicus services are "Land Services", "Disaster & Geohazards", and "Built Environment & Human Factors".

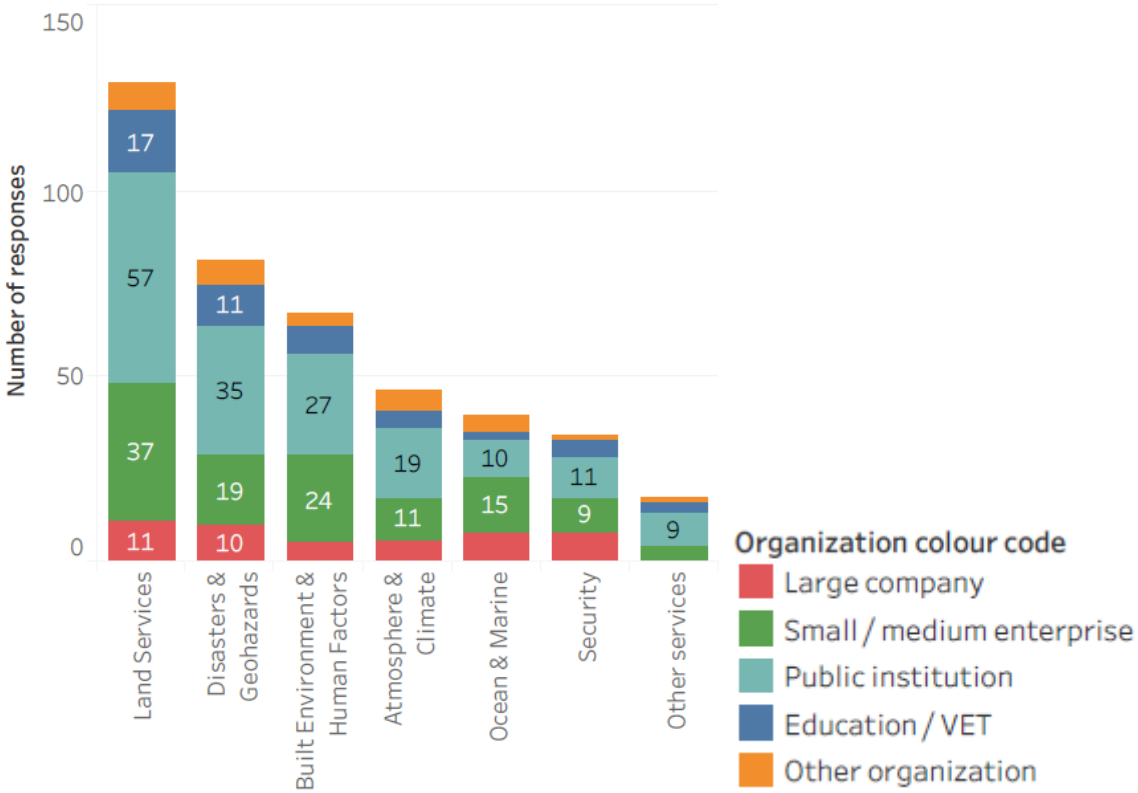

Figure 12. Copernicus services that the respondents' work relates to.

The second section of the survey focused on the specification of the most needed position in the respondents' organization. The specification of occupational profiles based on skill set ratings provide the core resource acquired by the survey. In the following, we describe the results related to the identified profiles

Figure 13 illustrates a first indication that indicates a mismatch between required and offered skills by the applicants.

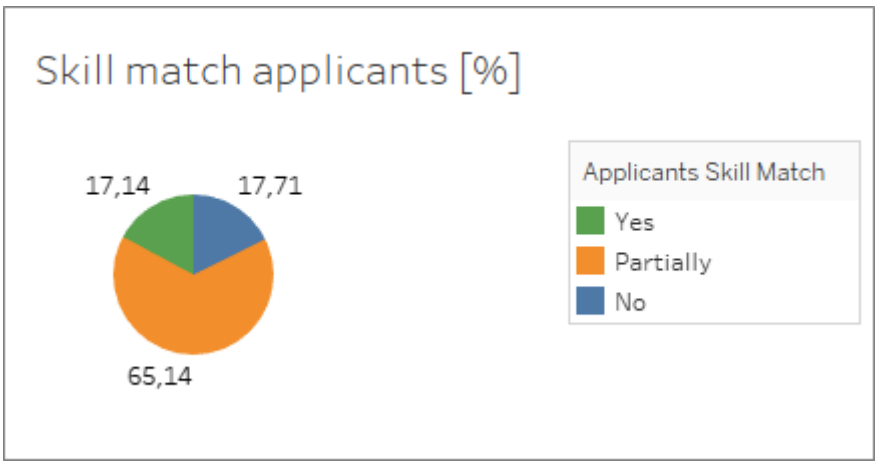

Figure 13. Showing how well the applicants do match with the required skills. Only slight over 17% do match, the vast majority with over 65% only matches partially and remaining ~18% do not match with the required skills.

The matrix in Figure 14 provides an overview on the labels for the most needed position. We grouped the answers into one categorization of the role/function that the position fulfils and a second categorization that identifies the field of expertise for the position. Finally, we sorted the categories that the highest number of responses appears in the top left corner with decreasing numbers to the right and to the bottom of the matrix. The first six rows represent half of the provided answers.

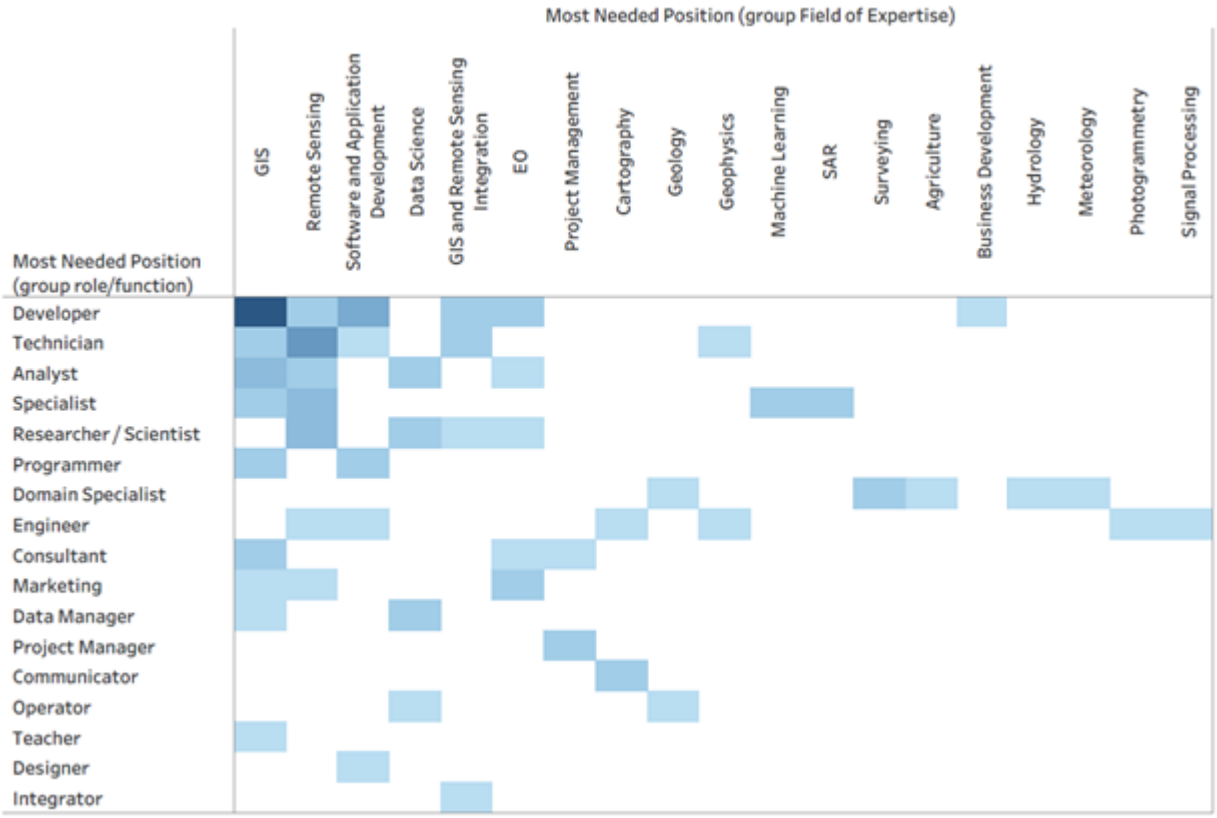

Figure 14. Most needed position categorized by role/function and by field of expertise. [10]

The positions “GIS developer” and “Remote Sensing technician” have been mentioned most often (these two terms had been mentioned as examples in the description of the question). Common fields of expertise were “GIS”, “Remote Sensing”, “Software and Application Development”, “Data Science”, “GIS and Remote Sensing Integration” and “EO”. The most common roles/functions were “Developer”, “Technician”, “Analyst”, “Specialist”, and “Researcher / Scientist”. The other elements in the matrix show is the large diversity existing for both in definitions of the role/function and in identifying the field of expertise for the most needed position of organizations in the EO/GI domain. Figure 15 illustrates the fields of expertise in a word cloud. The font size represents the relative number of responses per category.

[10] The interactive version of the matrix displays a tooltip per matrix cell with number of responses and a position name example. It can be viewed here: https://public.tableau.com/views/EO4GEO_Demand_Survey_Part3_MNP_FA/MostNeededPositionMatrixrolefunctionandfieldofexpertise?:embed=y&:display_count=yes&publish=yes

Figure 15. Fields of expertise of the most needed position.

Figure 16 illustrates the disciplines where suitable applicants have been trained (multiple choices were possible). Geoinformatics and Remote Sensing are highest ranked, followed by Cartography, Computer Science, Data Science and Environmental Science. As expected, Economics is the least mentioned discipline.

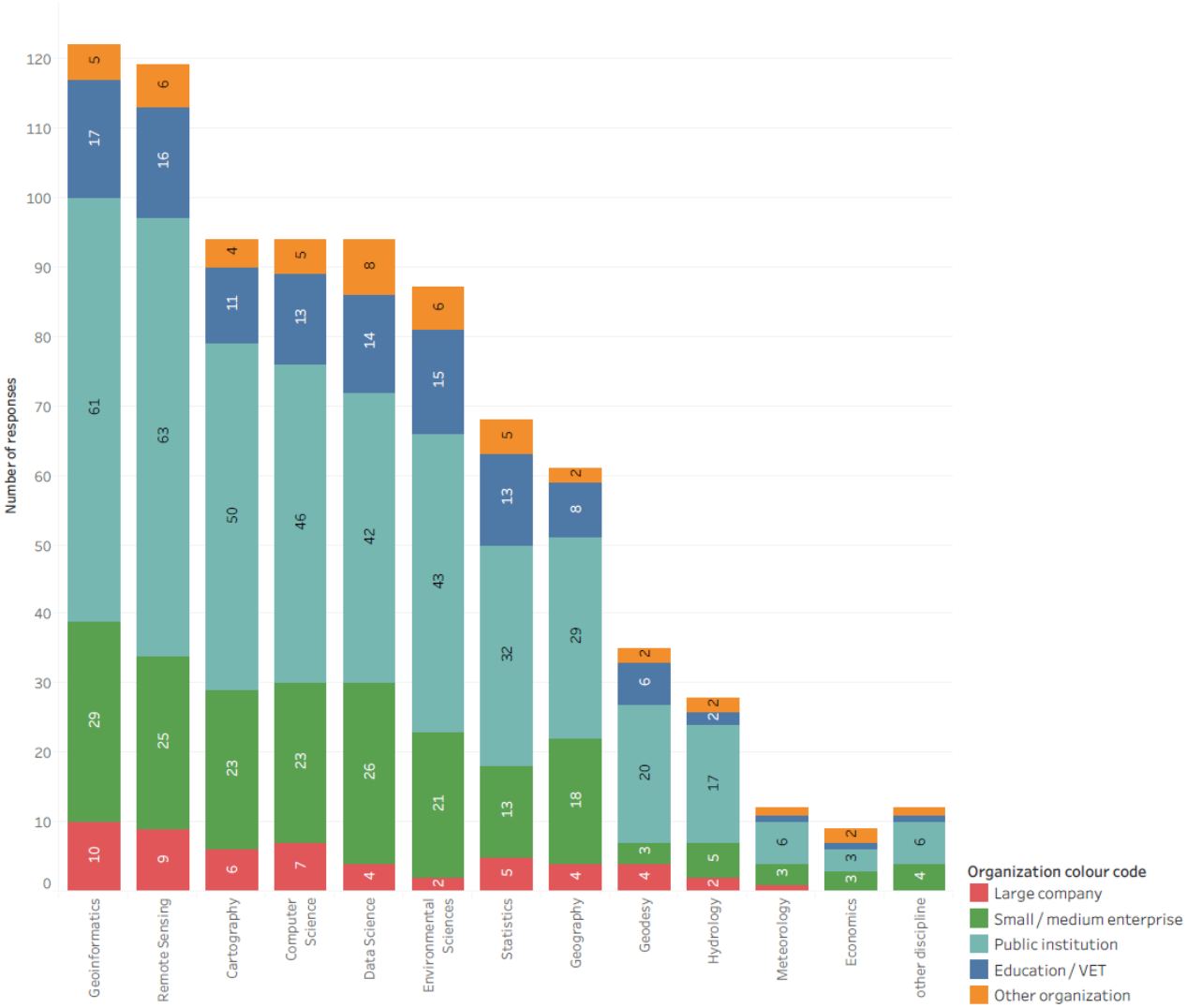

Figure 16. Disciplines in which suitable applicants for the respective position have been trained.

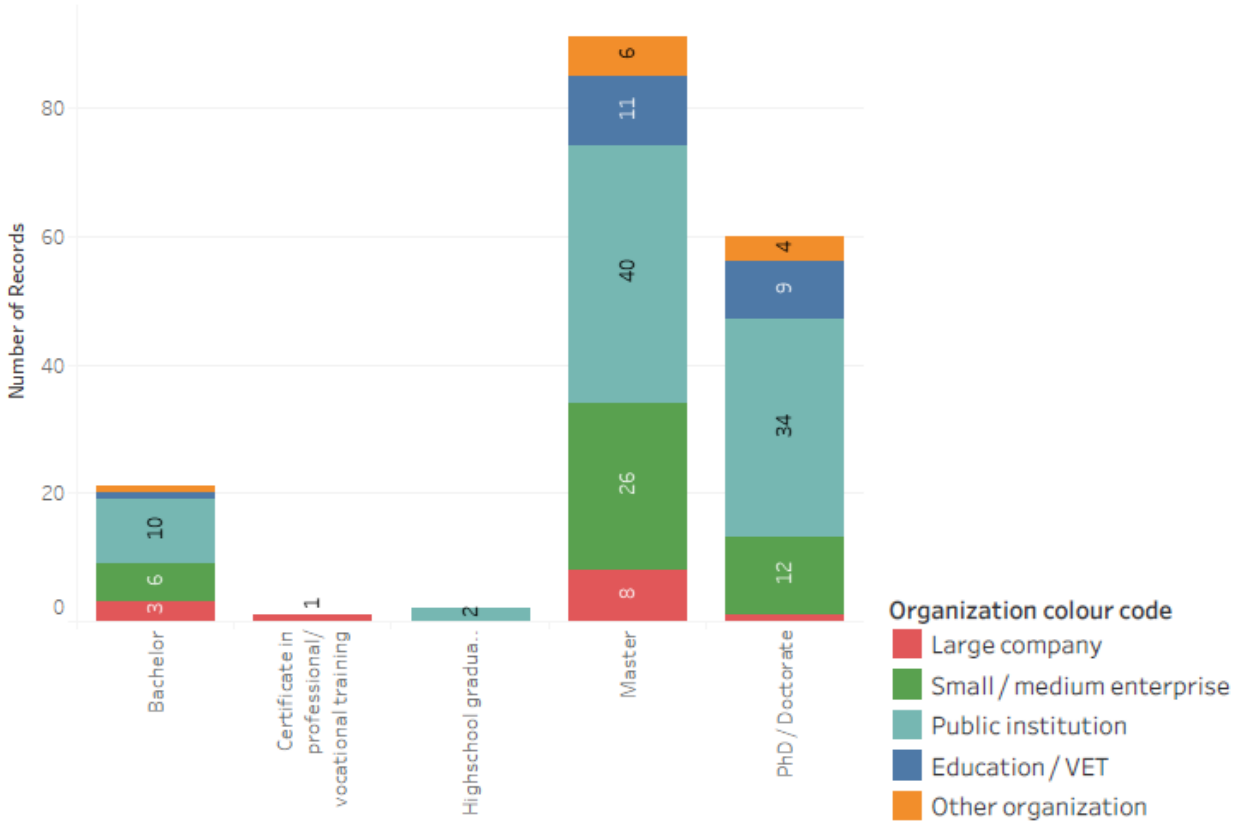

Figure 17. Highest level of education as requested for potential applicants.

Figure 17 illustrates the required level of education. This reflects the educational level of the current workforce.

The respondents were asked to provide more detailed information about EO/GI skills organized in 8 different skill sets. These skill sets are

- Space/Geospatial Data skills
- Visualization and Cartography
- Analytical Methods
- Programming and Development
- Data Capture and Management
- EO/GI and Society
- Computing Resources and Platforms
- Organizational and Institutional aspects

As a first task, the respondents had to rate the overall relevance of each skill set on a scale between 1 and 6. Figure 18 illustrates the overall relevance per skill set (in percent of votes within the skill set).

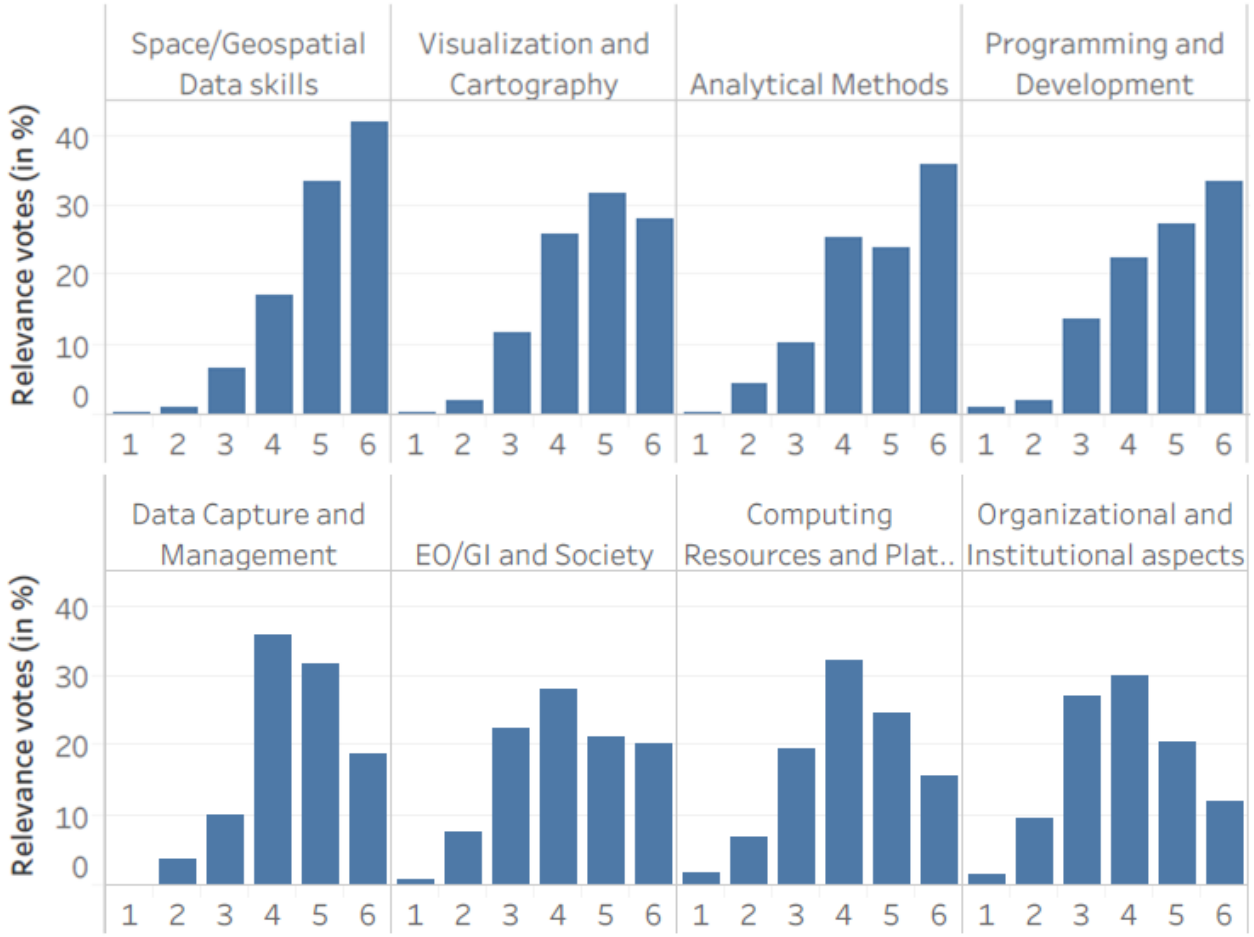

Figure 18. Histograms of overall relevance of the EO/GI skill sets.

This shows that each skill set histogram has a different distribution of votes. The highest mean vote goes to Space/Geospatial Data skills. For a better across comparison between skill sets, Figure 19 shows the rating of the overall relevance of the different skill sets. The boxes outline half a standard deviation above and below the mean rated value.

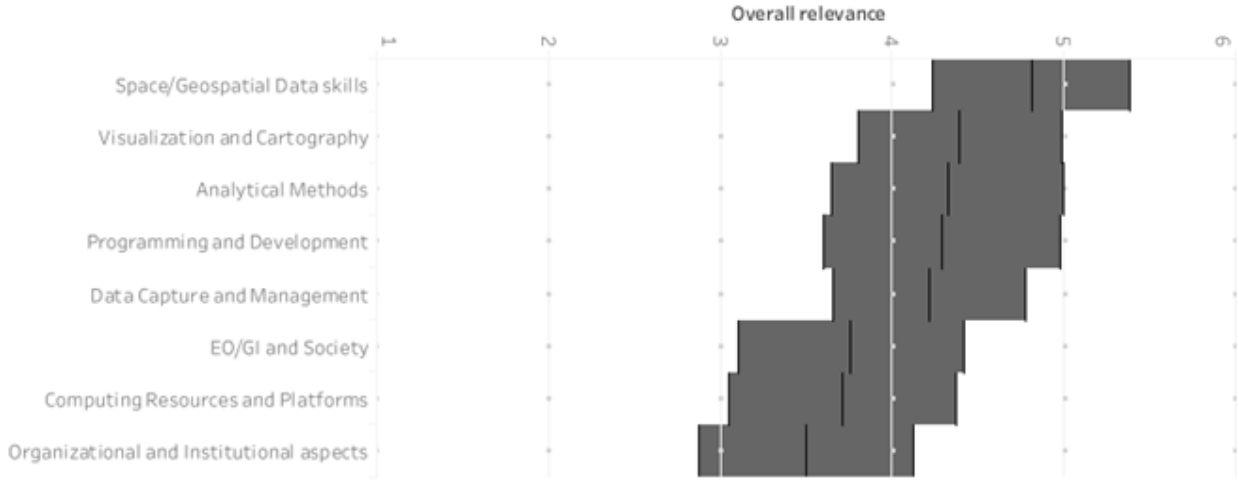

Figure 19. The overall relevance of the EO/GI skill sets, ordered by mean relevance rating

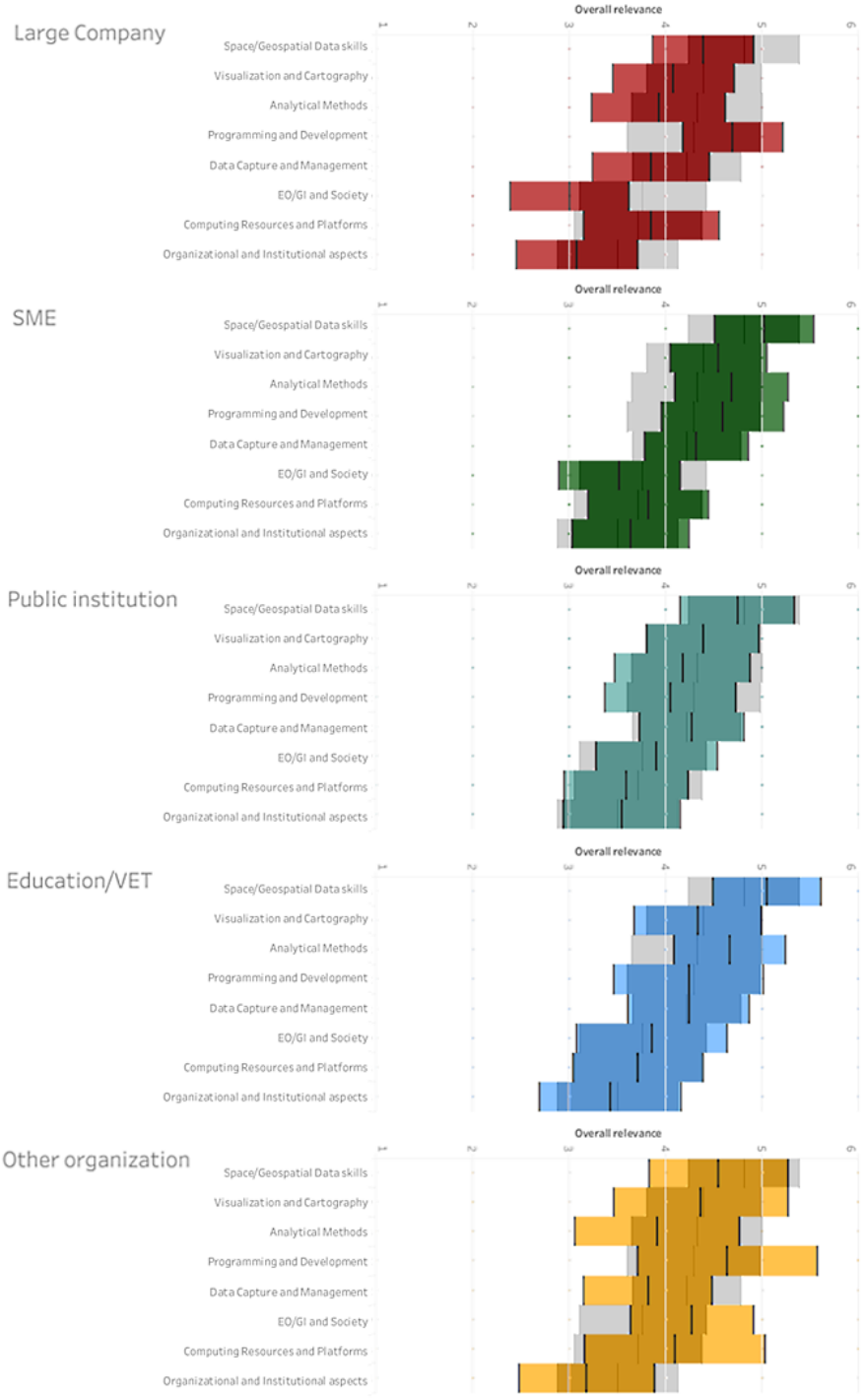

Figure 20. The overall relevance of the EO/GI skill sets per organization type.

The ordering of skill sets according to their relevance for different organisation types already provides input for the derivation of priority occupational profiles (see Figure 20). In order to deepen the analysis, a cluster analysis based on the overall relevance ratings of the eight EO/GI skill sets grouped similar responses into four clusters. The k-means clustering according to the deterministic Lloyd's algorithm (Tableau 2018) was used to calculate the clusters. Having generated the clusters aimed at identifying different high priority profiles. We analysed different numbers of clusters. Different optimization algorithms suggested using between two and three clusters. The choice of four clusters proved to be the most valuable for interpretation. Figure 21 illustrates the rating of the overall relevance of the different skill sets for each cluster. In addition, Figure 21 presents a pie chart for each cluster differentiating the educational levels of occupational profiles present within that cluster. The size of the pie charts represents the number of responses assigned per cluster.

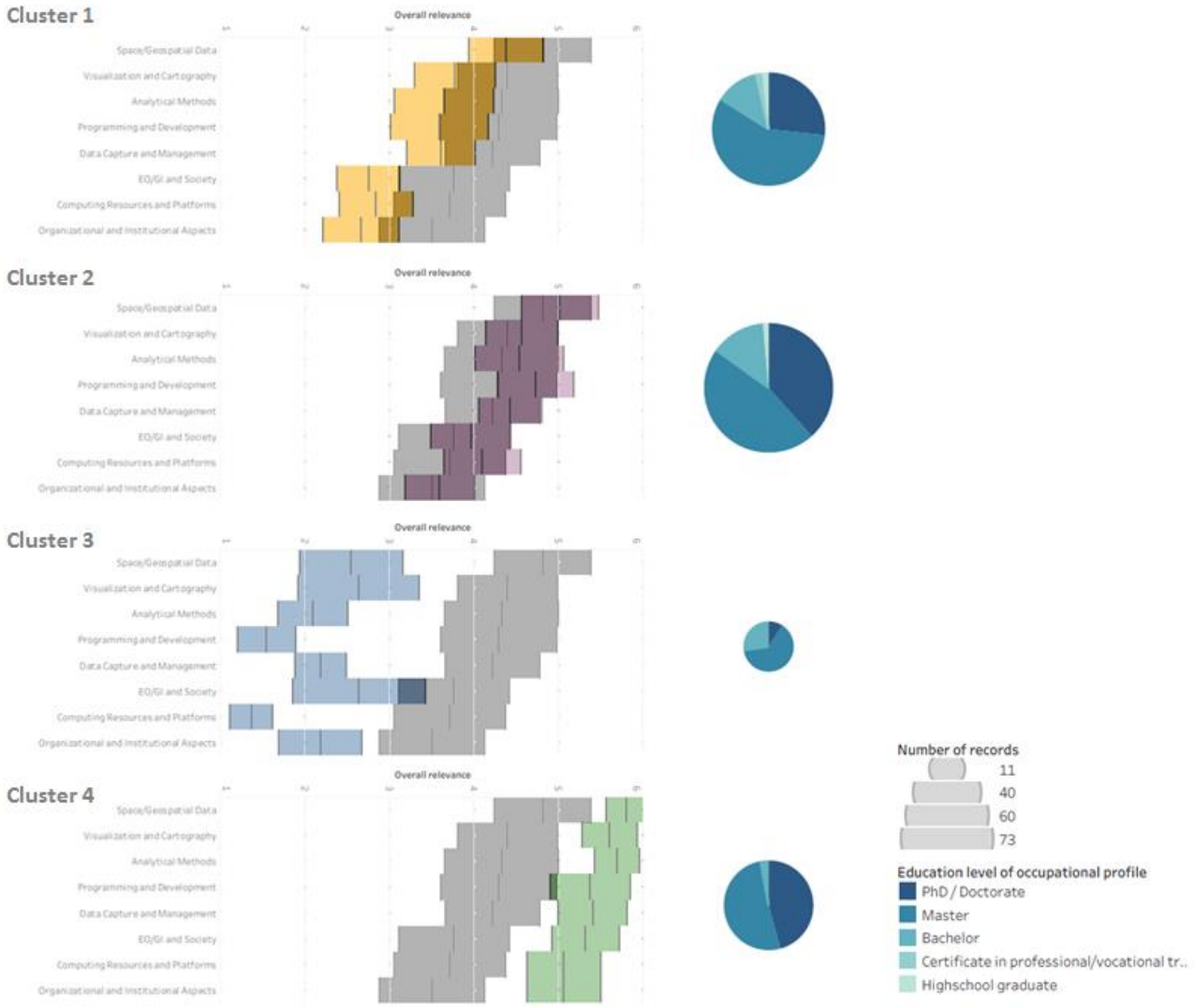

Figure 21. Distribution of overall relevance ratings within the clusters and pie charts differentiating the educational levels of occupational profiles present within each cluster, scaled by the number of responses assigned to each cluster.

Cluster 3 consists of only 11 responses that consider the skill sets generally of low relevance. Therefore, we excluded cluster 3 from any further analysis. Within the remaining clusters 1, 2 and 4, the skill set Space/Geospatial Data has the highest rating. At a first glance, cluster 1 groups low relevance ratings, cluster 2 groups medium relevance ratings and cluster 4 shows high relevance ratings as expected for cluster analysis. This corresponds with the education level where cluster 1 contains the lowest share of occupational profiles with a PhD, cluster 2 contains a larger share of

occupational profiles with a PhD, and cluster 4 contains the highest share of occupational profiles with a PhD and almost no occupational profiles without at least an education level of Master. Nevertheless, a large within-heterogeneity is present in all clusters.

Investigating the single profiles specified by the respondents reveals a similar high diversity of ratings as indicated by the standard deviations in the previous plots. First, there is a considerable discrepancy between ratings specified for the same occupations as indicated by the provided name (see Figure 22 and Figure 23). Secondly, similar ratings of skills sets may be specified by different absolute values of the provided 1 to 6 scale and in addition characterize different occupations (see Figure 23 and Figure 24).

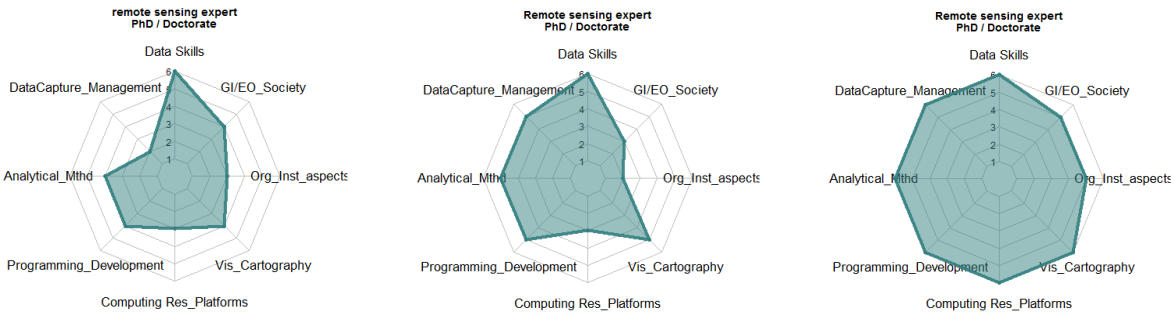

Figure 22. Three specific ratings of skill sets for remote sensing experts on PhD level as provided by survey participants.

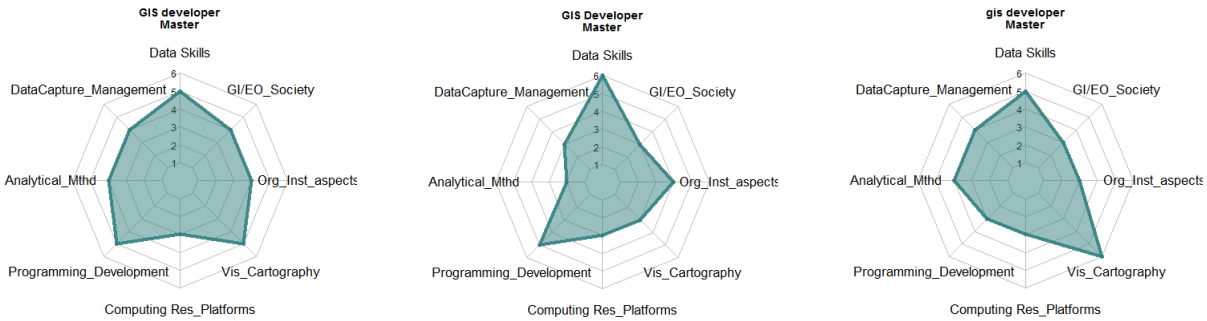

Figure 23. Three specific skill ratings for GIS developers on master level as provided by distinct respondents of the survey.

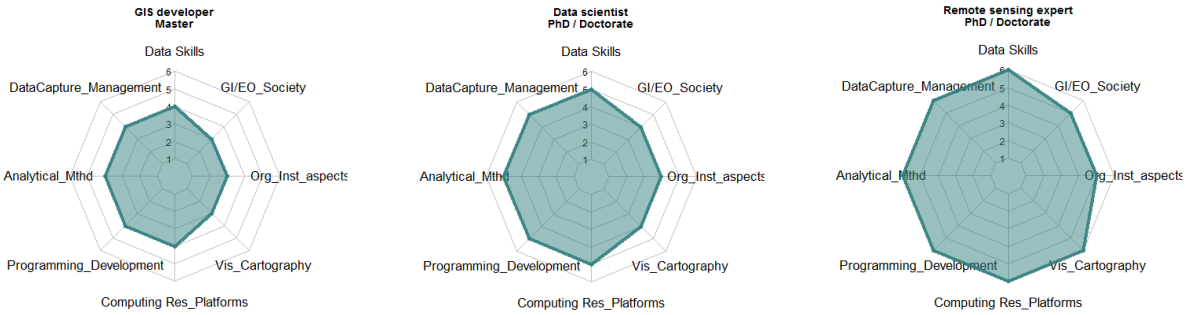

Figure 24. Similar profiles with differing absolute ratings and differing labels.

Besides the analysis of occupational profiles, the survey had the objective to identify skills relevant for an EO/GI BoK. Addressing this objective, we analysed the ratings of skills listed in each skill set. Within each of the eight skill sets, the respondents identified the three most relevant skills and rated their level of expertise an applicant requires. The possible levels of expertise were “basic”, “intermediate”, “expert”, and “n/a” for considering a skill as not relevant. For each skill that (i.e. “basic”, “intermediate”, “expert”) we calculated an index value by assigning a weight for each skill level and calculating the average. We assigned weights as follows:

- “Basic“ → 33
- “Intermediate” → 66
- “Expert” → 100

Figure 25 through Figure 28 present the rating of skills in each skill set for the four most important skill sets, i.e. Space/Geospatial Data Skills, Visualization and Cartography, Analytical Methods and Programming and Development (Diagrams for the remaining skill sets are provided in Annex 2 Skill ratings).

The average weights within each skill set show a similarity to the overall relevance rating of the skill sets. For example, the highest average weight, 82.34 for the skill “Extraction, transformation and loading EO/GI data”, is part of the skill set with the highest overall relevance Space/Geospatial Data Skills.

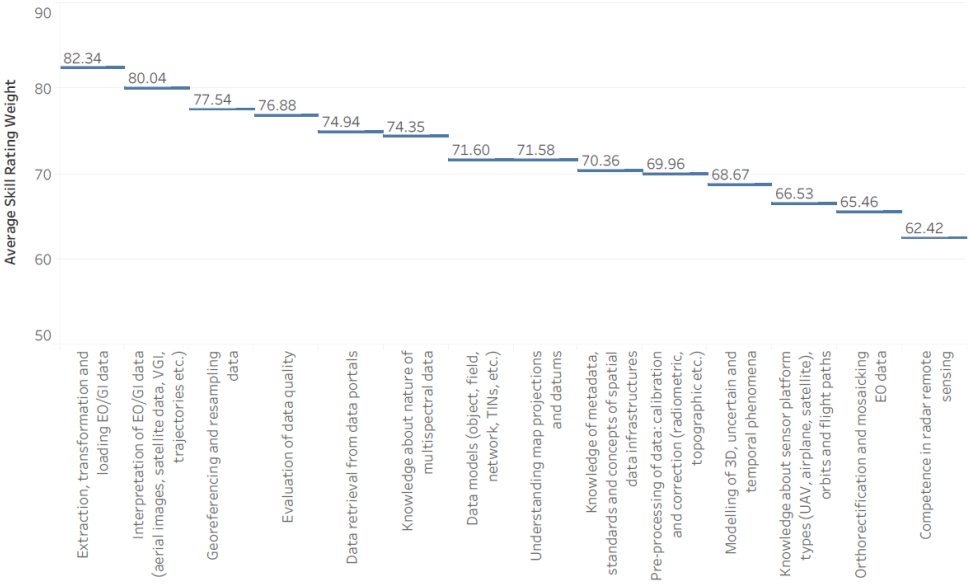

Figure 25. Skill rating for Space/Geospatial Data Skills. [11]

[11] Skill ratings for all other skill sets can be viewed in the following tableau workbook: https://public.tableau.com/views/EO4GEO_Demand_survey_Part5_SkillSets_Details/DashboardSpace?:embed=y&:display_count=yes

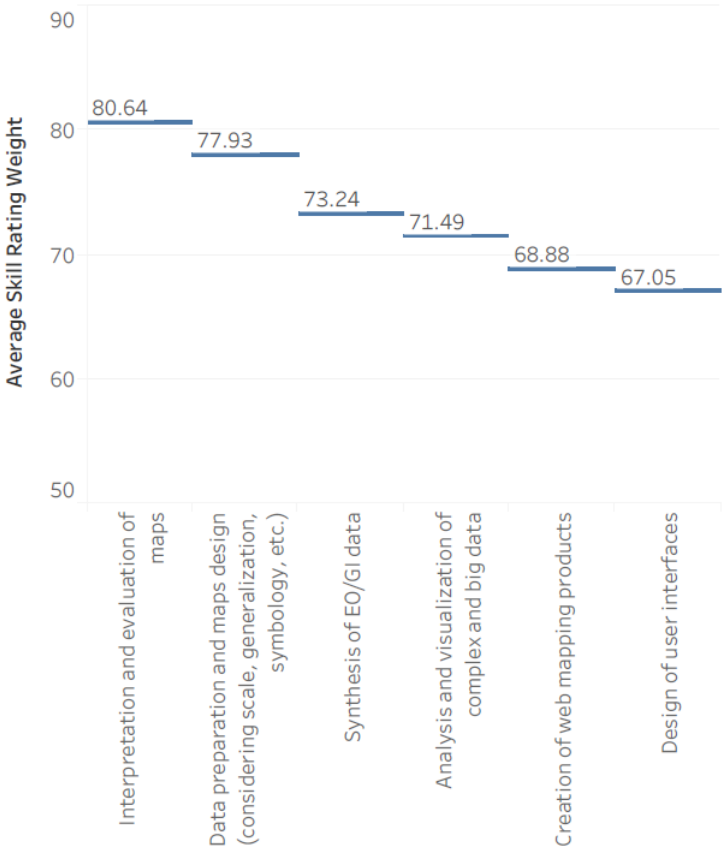

Figure 26. Skill rating for Visualization and Cartography.

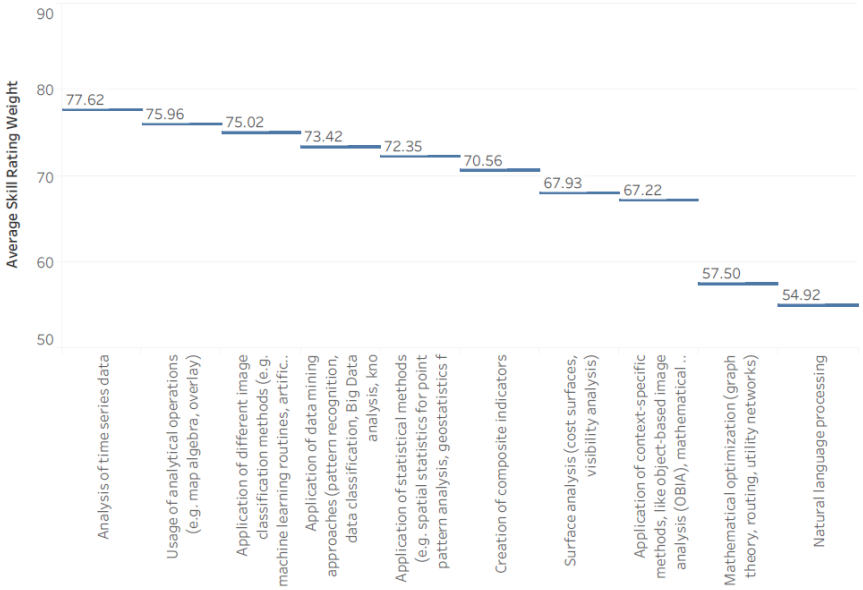

Figure 27. Skill rating for Analytical Methods.

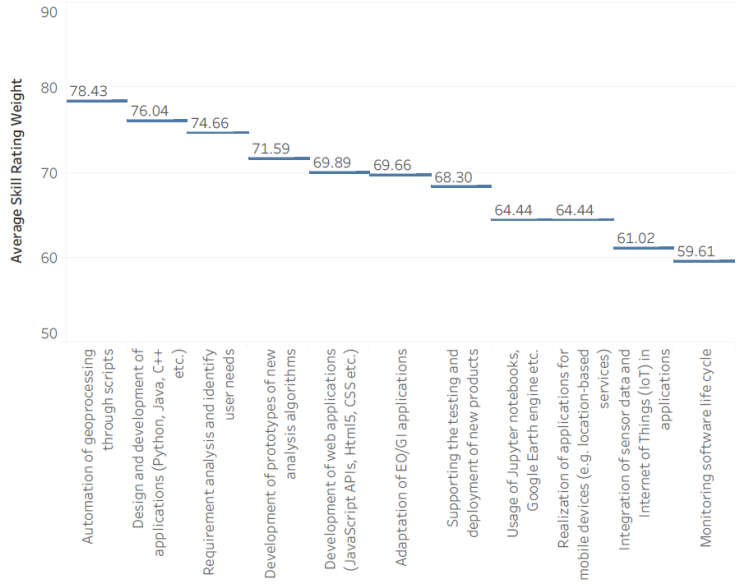

Figure 28. Skill rating for Programming and Development.

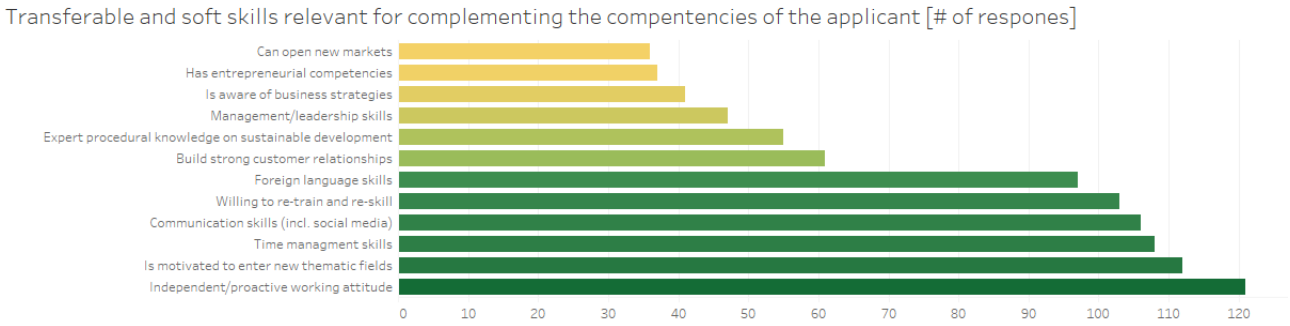

Figure 29. *Transferable and soft skills being considered relevant for complementing the competencies of the applicant (ranked by number of responses).*

Next to the technical and methodological competencies of applicants, there has also been a range of transferable and soft skills required relevant by the respondents. Figure 29 illustrates the numbers of responses per skill. The skill with the most responses is *"independent/proactive working attitude"* followed by "is motivated to enter new thematic fields". Skills on place three to five comprise time management, communication skills, willingness to re-train, and re-skill.

3.4. Conclusion

The outcomes from the demand survey indicate that there is still a continuous demand on well-trained applicants also in the future. Referring to Figure 21, the three identified clusters contain low, medium, and high relevance for the respective skill sets which corresponds to the respective education level requested from respondents for each of the clusters. Having set high relevance to the majority of the skill sets also the expected educational level is located at the level of at least a master or even PhD. This means that with the increased relevance for a broad variety of skill sets there is a need for an expert being able to handle also a broad range of tasks, different aspects, and team members. This is seen in contrast to a highly professionalized niche expert. Nevertheless, a large within-heterogeneity is present in all clusters which becomes even clearer when seeing the responses for the identical named profile but the variety of skill set rating (see *Figure 22* and *Figure 23*). The identified palette of soft skills (see *Figure 29*) complement the image of a somehow universal expert being seeked for.

4. Semi-structured Interviews among Industrial and Public Sector Players

4.1. Design of the semi-structured interview questionnaire

The activities foreseen in the task description for task 1.2 included the acquisition of interviews among industrial and the public sector players to collect more focused input regarding the demand for education and training and to complement the outcomes of the demand survey. Furthermore, research on occupational profiles makes it essential to shed a light on skills, tasks and workflows. According to the feedback on the intermediate results of the quantitative survey presented at the workshop on demand for space/geospatial education and training in May 2018 in Castellon (see deliverable D1.2), a qualitative semi-structured interview guideline was developed. A semi-structured interview is a qualitative data collection strategy through a set of pre-defined topics but open ended questions (Given, 2008).

At the workshop, the intermediate results of the quantitative demand survey were discussed with stakeholders representing the geospatial industry and small and medium sized enterprises as well as public bodies. On this occasion, representatives of the industry indicated that there “is a need of building bridges between vertical and horizontal or transversal skills” (M. Gould, ESRI) and that the current GIS&T Body of knowledge is not representing those links. The qualitative semi-structured questionnaire stimulated the interviewee to talk about business activities and customers as well as about tasks and workflows and about workforce development. See Annex 3 Topic List semi-structured interviews for the topic list used during the semi-structured interviews.

Additionally to the Workshop results, an expert interview with Jochen Albrecht was conducted. Dr Albrecht is Professor for Computational and Theoretical Geography at Hunter College and an expert for curriculum development, whose research was foundational to the development of a national certification program for GIS Managers and its accreditation in the United States (URISA 2017) . He gave advice and insights concerning the business vs. educational perspective as well as towards the assessment of workflows and the structure of work in organizations. Discussion with Mr Albrecht also focussed on how knowledge on tasks and workflows, which is mostly tacit knowledge, can be compiled through semi-structured interviews. Mr Albrecht recommended orientating on the Develop A CurriculUM (DACUM) approach, which assumes expert workers to be

the best source for task analysis for a structured analysis of occupations. Following DACUM any occupation can be efficiently described in terms of duties, tasks, knowledge, skills and traits (Collum 1999, Johnson 2010).

The distribution of responds to the quantitative survey as an important aspect of the intermediate results was taken into account. At intermediate stage of the inquiry period, we have received many responses from representatives of public bodies. Therefore, we focussed the qualitative interviews mostly on representatives from business and industry. Nevertheless, we also interviewed representatives from public bodies to be able to confirm our intermediate assumptions for this group of stakeholder.

The semi-structured interview questionnaire consisted of a set of topics that provide a general guideline for the interviewer during the interview. The interviewer took the provided questions more as a stimulus for opening up a discussion with the interviewee rather than following a straightforward question and answer format. The interviewer could adapt the set of questions for fitting the needs of the interview situation and the abilities of the interviewee to answer the questions. The structure of the semi-structured interview guideline was dedicated to three main topics:

1) (business) activities & customers
2) tasks & workflows and
3) workforce development.

The first question ‘Could you please briefly describe the main (business) activities of the enterprise/organization you are working for?’ stimulated to talk about the main (business) activities of the enterprise or organization the interviewee was working with which the business model could be fairly described.

The second question lead the interviewee to talk about its customers or contracting authorities and the third question investigated which EO related customer requests are most frequent. Based on these three questions we were able to categorize answers of different stakeholder groups appropriately and were able to clarify any differences or similarities concerning the subsequent questions on tasks & workflows as well as on workforce development.

The second part of the semi-structured interview questionnaire was dedicated to EO related tasks and workflows in the organization, describing (*Question 4*) which tasks are most relevant for an EO-related service request. This question was relevant for understanding existing workflows in the

respective institution and how much time administrational, technical and customer related work consumes to complete an EO-related customer requests.

The next question (*Question 5*) stimulated to talk about predefined workflows and their relevance for the work in the organization.

Question 6 relates to the structure of responsibilities and the flexibility of tasks. The question *'who is responsible for service requests*' (*Question 6*) inquired the interviewee to talk about the mixture of tasks related to technical work, project management related tasks and organizational responsibilities to handle a service request.

The next question (*Question 7*) inquired if the organization uses Copernicus data or services. This connected the interviewee to the overall aim of the EO4GEO project, which is to foster user uptake of Copernicus data and services bridging the skills gap between supply and demand of education and training. Using Copernicus data and services can emphasize assumptions on knowledge about Copernicus services and data.

The third part of the semi-structured interview questionnaire focussed on workforce development and training measures taking into account the specific situation of different stakeholders. The question on the limitations to handle service requests (Question 8) lead over to the workforce development. This question should lead the interviewee to talk about future business drivers and the demand of skills in the organization.

The following question (*Question 9*) asked to describe '*in which areas of business activities staff needs training'* and to describe the ideal training for the organization.

Finally, we asked if training measures are foreseen and if the company or organization provides staff with opportunities for professional development i.e. in-house or external training and which training events were attended lately (*Questions 10-12*).

We collected also general information such as the name of the interviewee and the position as well as the experience in the EO/GI sector in years for a profound context the subsequent analysis was based on. Additionally, we asked for the type of organization i.e. large company, SME or public body as well as the name in the organization.

4.2. Interviewed actors and analysis approach

PLUS, the task leader for Task 1.2 shared the qualitative (semi-structured) questionnaire (see Annex 3 Topic List semi-structured interviews) with selected EO4GEO project partners. This should extend the geographical spread of the qualitative interview results. Benefits of this strategy were that some partners who attended conferences could interview representatives of the target groups face to face at international events. Furthermore, partners got in contact with interview partners within their close environment. This ensured receiving more detailed information during the interviews, because already established contacts can ensure trustworthiness and facilitate scheduling and interview conduction.

The selected EO4GEO partners were asked to find at least one interview partner from SMEs and larger companies but also from public bodies. Interviewing people with different positions and roles in the same organization was encouraged. The interview time was scheduled for a duration between 20-30 minutes and could easily be done via telephone, skype or face to face over a coffee break. The interview protocols were returned via e-mail to the task leader of task1.2.

In total, 30 interviews with representatives from 10 different countries (from Austria, Germany, Italy, Greece, UK, France, Belgium, Poland, Latvia and Canada) were conducted. The interviewees consisted of representatives from SMEs (13), large companies (8), public bodies (7) and NGOs (1).

The job experiences of the interviewees were rather diverse with an average of 14 years of experience in the EO/GI sector. The position of the interviewed comprised CEOs, Head of Division and Management with over 20 years of experience to Technicians, Remote Sensing Specialists and Project Managers with less than 5 years of experience. 13 interviewees had more than 10 years of experience and 5 had less than 5 years of experience in the sector.

The analysis of the interviews is based on qualitative content analysis (Mayring 2014).

For the analysis, we used the software MaxQDA aiming at handling the interview data in a structured way and developing coding with an inductive approach during the analysis process. The text material was marked with the relevant categorization (see Annex 3 Coding results semi-structured interviews for the full list of coding results for the semi-structured interviews). Derived results and more significant material is described in detail in the following chapter.

4.3. Results of the semi-structured interviews

The following paragraphs summarize the results of the qualitative interviews. The interview guideline was focussing on three main topics namely *(business) activities*, *tasks & workflows* and *workforce development*. The following paragraphs provide an overview for each of these topics.

(Business) activities

The first question '*Could you please briefly describe the main (business) activities of the enterprise/organization you are working for*?' stimulated the interviewee to talk about the business model the company or institution is creating value with. The business activities mentioned by respondents cover a wide range of activities mostly of the downstream sector of the earth observation value chain (see Figure 30).

Specifically the interviewees of large companies mentioned software development as one of their main business activities providing standard product solutions for specific purposes and customers (vertical market such as defense, agriculture, oil and gas etc.) but also for a wide range of customers (software development - horizontal market) (Denis et al. 2017). Interviewees of large companies are also active in data pre-processing and data distribution as well as in consulting and as service provider. The vertical integration of services is mentioned by large companies (I_3, I_14). Nevertheless, interviewees working for a medium sized company (I12 & I13 same company) mentioned that the vertical integration was initiated after the company had grown. One interviewee from a large company (I_15) gave insights in the business structure bridging business activities in the upstream, midstream and downstream of the earth observation value chain. Those activities include the engineering of space and airborne sensors for data capture and communication technologies, developing solutions for the transfer of data and additionally the development of image processing software.

Small and medium enterprises are mostly active in value-added services (VAS) and niche markets with specializations in thematic or geographic fields (see Denis et al. 2017: 425). Most of the interviewees mentioned product development, i.e. customized workflow and application development as well as development of information products based on satellite data. The SME respondents also mentioned consulting as one of their main business activities.

Interviewees from public bodies came from public institutions connecting upstream, midstream and downstream, such as a national space agency (I_06) with a strong interest in strategy and policy as well as research and regional governments with a focus on civil protection and regional planning (I_20/21, I_16). In addition, research institutions with a strong interest in either a thematic field such as forest management (I_29,) or disaster management (I_08) have been under the respondents. Respondents from regional development agencies (I_17a/b) showed a strong interest in networking activities with a focus on regional stakeholders.

Figure 30. Business activities of SMEs, large companies and public bodies referring to question 1.

Tasks & workflows

The assessment showed stakeholders to have diverging practices concerning tasks and workflows and the internal organization of work. During the interviews, we investigated the organization of relevant administrational, technical and customer related work around an EO-related customer request. Since we interviewed companies of different sizes and with different business models, the compilation of the interview results provided quite diverse answers (see Table 4.1).

In medium sized and larger companies specific duties are handled by staff responsible for a specific task and a specific part of the overall workflow. The division of tasks in larger companies was assumed being fragmented. We also assumed that it is more likely in small and medium sized organizations that work is processed by one or maximum two team members with diverging duties. Duties in SMEs are more diverse and require a more generalist occupational profile including duties such as project planning and management as well as the execution of tasks, concerning data acquisition, processing and analysis. One respondent from a large company (I_26) differentiated responsibilities with five separate occupational profiles, namely:

- Space Application and Services Division Manager – search for new EO business opportunities
- Geoinformation Project Manager – managing of GIS&EO projects
- Sales Specialist – first contact with potential customers (mainly EO data and services sales)
- GIS&EO specialist (creating new EO services concepts, development of EO services & products, data acquisition etc.)
- IT team (programmers with geoinformation skills) – support and development of EO applications/software/web services etc.

An interviewee from a SME (I_27) differentiates four different occupational profiles:

- Director / owner of the company – responsible for sales, customer relationship building and networking; identification of customer needs;
- Remote sensing specialists / senior researchers – responsible for customer requirement definition and designing of data acquisition, data quality control, and data analysis; communication with the customer about the final deliverables;
- Remote sensing specialists / research technicians – responsible for data pre-processing;
- Remote sensing technician – responsible for obtaining of flight permissions, data acquisition, operation of remote sensing technologies;

Nevertheless, one respondent from a large company (I_11) stood out in describing the organizational structure unlike the structure of other large companies. Here, we find the responsibilities not strictly separated. The company hires preferably generalists with high flexibility

and openness in their work attitude. The respondent expects professional staff to have - besides technical skills - especially interpersonal communication skills and to be able to communicate equally well with customers and colleagues.

We found some interesting insights concerning the changes of tasks and workflows in that sense, more ‘time was spent on meta-level and that processing gets less’ (I_09). As a new trend, a respondent mentioned also that clients require more monitoring concepts and that self-contained pieces of work are no longer requested, but that work is getting more operational (I_09).

Another interviewee mentioned that ‘more programming skills are required’ (I_25) and that technological changes such as the ‘use of cloud technologies’ (I_25) will increase.

The organization of work is an indicator for horizontal skills as well as the flexibility and fragmentation of activities and workflows. The fragmentation of activities is underpinned by the use of new methods and technologies such as cloud computing. One interviewee from a large company (I_03) expects ‘a shift of classical remote skills (seen as a future), and in future will more turn into programming, cloud computing, harvesting, understanding computing systems’.

Using standardized workflows for creating standardized products (I_14, I24) is more common at larger companies. SMEs mostly offer specialized services where “many of the services provided by the company are customized to a particular client and do not have a recurring character”(I_27).

The interviewees also commented on possible limitations. For respondents from SMEs, limitations mostly occur in terms of company size and capacity. Smaller companies operate in very specific business areas and diversification of products to niche services and complex solutions was mentioned as business strategy (I_27)

‘With the growing competition and increasing number of players in the EO sector, the company is thinking a lot about the development of niche services and more complex solutions that require a multi-disciplinary knowledge base and would be based on multiple data sources (ground data, drones, IoT, satellite data, citizen science etc.).’

Table 4.1. Examples for EO tasks and workflows with time spent for different duties in %.

Large company	**SME**
I_26 data gathering - 10% * data processing & service development - 60% * project management - 15% * customer communication - 15% * informing the customer about EO services & opportunities takes a long time * collecting customer requirements - determining his needs takes a long time * programming of data acquisition consume less time * development of EO services (including dedicated processing algorithms) takes a long time * collaborate with other consultants	I_27 Definition of customer requirements (communication with the customer) – 30% * Planning of data acquisition campaigns (project management) – 20% * Data acquisition in proper way and appropriate weather conditions (preparation and operation of remote sensing technologies on board the aircraft) – 10%; * Data processing and analysis (use of existing software products as well as development and improvement of data classification algorithms) – 40%.
I_14 Person responsible for data processing 80-90% working with software and 10-20% quality control * Divided responsibilities * customer/client contact less	I_10 Example given: Sentinel 2 data workflow * Specifications/Concept – new development or use of former development * Feasibility and costs * Development, set-up, test of workflow * Presentation to the customer * Iteration process until the customer is satisfied * 20% concept * 50% development * 30% optimization and quality control

Workforce demand and training

The third part of the semi-structured interview questionnaire investigated workforce development and training measures. It took into account the specific situation of different stakeholders.

Accordingly, in this section we provide details on the answers about future workforce development and the demand of skills in the organization.

The different stakeholders have diverging opinions on workforce and workforce development in the EO sector. The future demand for specific skills and competences is dependent on size, business model and level of vertical integration of the company.

Some companies provided very specific answers indicating that 'some academic staff is over-educated, in particular at large projects with high operational share, technicians would be more suitable' (I_04) and that in 'small projects academics are better suited' because they are able to solve new challenges (I_04). Respondents from SMEs (I_09, I_28) and large companies (I_03) prefer applicants with an MSc degree and mention that there is no PhD degree necessary for the tasks and duties in their organization. Nevertheless, in the opinion of some respondent experts at BSc level with some years of work experience are also suitable for working at SMEs (I_25, I_1, I_2).

When it comes to specific skills, one interviewee (I_19) provided specific information on ‚recruiting experts of data management, data analysis and big data in general'.

As mentioned before (see under tasks & workflows), besides technical skills, work attitude and willingness to learn as well as other transversal skills are very important in every kind of organization. Interviewees (I_03) generally value cross-cultural competence, time allocation, project management, communication, flexibility and motivation as well as the absence of frustration. An interviewee from a company (I_18) specialized in business development described apart from soft skills also cross-sectoral skills such as logical thinking, digital literacy skills, logical reading and analytical skills as well as the ability to synthesize. Moreover, interviewees addressed interpersonal skills such as communication skills several times.

Different stakeholders mentioned several times cloud computing as a future driver. Nevertheless, currently emotional and legal barriers prevail customers from using cloud solutions so it is still a difficult topic especially for bigger companies (I_11). Up until now, mostly smaller companies prefer integrated software solutions (I_11). Emerging topics apart from cloud solutions are drones, big data, and artificial intelligence (AI).

The interviewee (I_11), a big software distributor and developer, indicated that Copernicus is not a big topic in contact with customers yet, and is more or less an exotic topic covered by universities. Nevertheless, almost all of the interviewees use Sentinel data or Copernicus services.

We also asked if companies and organizations support training measures and if they either prefer in-house or external trainings.

A respondent from an SME (I_27) stated as for the current preferred training measures the following:

Preparation for (the) future is happening through attendance of international conferences, workshops, participation in international projects (EU funded projects) where there is an opportunity to learn from others, visit partner organizations. `

Most of the respondents want trainings to be explicitly practice-oriented (I_1, I_10 etc.). Furthermore, respondents mentioned due to the limited time (preferably 2-3 hours) available for trainings and the course being available online and if possible on demand (I_10, I_14) was preferred. Some interviewees are available for trainings and workshops that last for one to two days (I_01). Mostly, larger companies offer in-house trainings or organized external training providers offer workshops at the premises of the companies (I_11, I_03, I_04, I_05). In smaller but also in medium companies internal training is offered in formal technical meetings (I_14) were experienced technicians presenting their work to colleagues or informal ways such as helping colleagues with problems (I_14, I_12, I_13).

Training is needed (I_10 SME) in cloud solutions, ICT in general, online process developments, big data analysis (technical possibilities to effectively incorporate Copernicus data, diversity on platforms to access data/information, for SME little information how it is possible to efficiently integrate data in company workflows. The interviewee also mentioned that he has the impression that small companies hardly get the latest data. He stated a need of information on development tools general and specifically and overview which tools are available from ESA and EU. Other interviewees differentiated in trainings for project management and social media (I_12, I_01, I_27). On top of the most wanted technical trainings was IT skills in general and programming (I_04, I_12, I_13, I_14, I_25, I_29), and databases (I_01, I_11, I_12, I_13)) mentioned. Sector specific training

is needed for Sentinel data processing, TomoSAR data (I_25, I_26) and Radar data processing (I_16).

4.4. Conclusion

The outcomes of the semi-structured interviews suggest that statements made by the interviewees are very much depending on the type of organisation they are referring to. Small and medium sized companies demand personnel with generalist knowledge and a horizontal skillset with a strong commitment to work in a service related environment being able to communicate equally well with clients and colleagues. On the other side we have large companies with a verticalized organisational structure having staff working on fragmented tasks and workflows being specialists with fewer contacts to clients. Nevertheless the structure of work is changing; with the rise of new technologies such as cloud computing and machine learning, priorities may shift to the meta-level focusing more on methodological and conceptual tasks. Demand for knowledge and skills to handle the automation of tasks will also change the organisation of work and the structure of organisations. Being able to bridge horizontal and vertical skillsets will be of future concern for all types of organisations.

5. Resulting Occupational Profiles in the EO/GI sector

5.1. Representativeness of the demand analysis

The definition of occupational profiles by (Cedefop 2013) differentiates the three components of (1) field and level, (2) knowledge, skills and competencies, and (3) interest and value. The survey had a focus on (technical) skills rather than knowledge and competencies relevant for a successful career in the EO/GI sector. This perspective is complemented with input provided by discussions and interviews with sector representatives (Aguilar Moreno, Hofer, and Lang 2018). In addition, the respondents provided feedback on transversal and soft skills being relevant to complement the competencies from applicants (see Figure 9). Sector representatives from different types of organizations emphasized the importance of personal traits and motivation of individuals. In some conversations motivation, communication skills and willingness to learn and grow seemed even

more important than the subject of formal training programmes did. This might link to the importance of customer relationships, consulting and networking in jobs across organisation types on the one hand and to the difference between theoretical education at universities and practical reality on the other hand. Occupational profiles for the EO/GI market need to combine transferable skills and technical and domain-oriented skills. Which domain-oriented skills stand out according to the survey is elaborated below.

We want to emphasize again that we carried out the survey in a community of (known) networks. From that perspective, the responses tend to reflect the opinions of representatives who are active in the field since a long time. Thus, a more 'traditional' view on the matter is created than potential newcomers (so-called non-space entrants or non-space industries) may have (see Figure 31). While also spin-off companies and start-ups are included in the group of recipients, the number of unconventional views from outside the remote sensing community is limited. What is also greatly underrepresented is the (unknowingly large) group of potential users outside the known communities (indicated as the 'Universe'), including expert users from other industries who may use EO/GI data but perceive it not different to other input layers and information sources. In a dedicated session on "Future EO & the Space Economy" at this year's ESA's Φ-Week, this problem was pointedly phrased as "*We don't even know what we don't know from [non-EO] industry*". Another illustrative metaphor was used by a representative from the Oil & Gas sector who compared the EO community as a "*choir, which keeps on practicing for itself not being aware there might be an audience out there*".

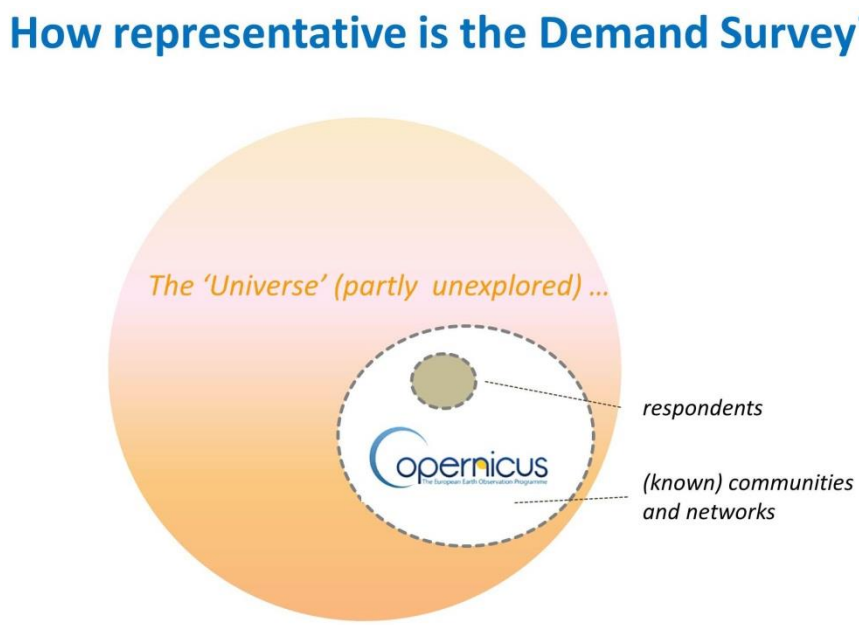

Figure 31. The respondents of the Demand Survey are mainly from within the GI/EO community with a certain legacy in the field of remote sensing. The 'universe' of potential users and future actors is greatly unexplored as yet.

All this may have implications on the formation of profiles, which are mostly conceptualised based on existing ones by adapting a certain part of the profile or adding specific skills to them. The example of the "GIS and Remote Sensing integrator" demonstrates the need for a transition without a clear picture of the actual new requirements.

When talking about the formation of priority profiles, these profiles need a name. As the ESCO classification of occupations suggests, there are a series of alternative labels for, e.g., GIS specialists: GIS technician, GIS consultant, GIS analyst, GIS application specialist, GIS. There are no common labels used neither in relation to GIS nor to remote sensing. Interestingly, the labels "GIS and Remote Sensing developer", "GIS and Remote Sensing technician" and "GIS and Remote Sensing integrator" were used several times for denominating profiles in the survey. This suggests a high relevance of the integrated development of space/geospatial occupational profiles as addressed in the EO4GEO project.

The occupational profiles specified by respondents of the survey are virtually all requesting a master level (52%) or PhD level (34%). Only three profiles have been described for people who are high school graduates or have a vocational training degree. These figures correspond to the

characterization of current workforce that indicates that 85% have a master or PhD degree themselves. The strong emphasis of highly trained workers explains the complexity of tasks of EO/GI specialists. Given the EU initiatives to foster VET programmes (SWD(2012) 375 final; EC 2017) in technical disciplines like the EO/GI sector represents a challenge not only for the design of such training programmes, but also for the successful employment of such individuals in organisations.

The heterogeneity of the 175 occupational profiles collected in the survey is an issue regarding the identification of high priority profiles. There seems to be an agreement that the level of education should be at master or PhD level. The specific relevance of skills, however, depends on factors like the type and size of organisations, the business processes and the specific tasks of an individual.

When looking into an aggregated assessment of the specific profiles, the skill set that stands out most is space/geospatial data. The importance of space/geospatial data skills has also been named by large company representative Mike Gould in the related workshop, how requested a data oriented curriculum with high practical skills (Aguilar Moreno, Hofer, and Lang 2018). Data related skills are leading the order of skills. Visualization, analytical, programming, and data capture and management skills follow. Skills related to EO/GI and society, computing platforms and organisational issues are the skill sets rated as least important in relation to the other skill sets. The aggregated assessment of profiles per organization type provides results that correspond to findings of the interviews: for example, software development and programming skills are highly relevant in large companies. SMEs require workforce with more generalised skills for the development of value-added services, because tasks are divided between less people than in large organisations.

The relevance ratings of skill sets further suggest that all of the suggested skill sets are relevant; the profiles put emphasis on the combination of skill sets. The cluster analysis indicated frequent joint emphasis of data skills and programming skills as well as data skills and analytical methods (refer to 3.3 Results of the survey). Further skills related to visualization, data capture and management closely follow these leading skills sets.

5.2. Occupational profiles suggested by the skills analysis

Numerous profiles did not provide a clear differentiation of the importance of single skill sets, which characterises a generalist EO/GI profile. Despite the discussed heterogeneities of the relevance ratings, we attempt to characterise three occupational profiles that have been described in the survey as well as in the interviews. These profiles are linked to the EQF levels for master and PhD degrees as these are the levels that have been indicated as relevant in the online survey.

For easing the discussion about the profiles, we add names to the profiles that are indicative only:

- EO/GI developer (master level): The technically oriented master level EO/GI graduate that is proficient in data related skills and has programming and development skills. This profile requires additional skills in analytical methods, visualization, data capture and management required for the development of EO/GI products and services.
- EO/GI data analyst (master level): The analysis oriented master level EO/GI graduate that is highly proficient in space/geospatial data skills and analytical methods; the profile is complemented by skills in visualisation, programming and development and data capture and management.
- EO/GI specialist / project manager (PhD level): The 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.

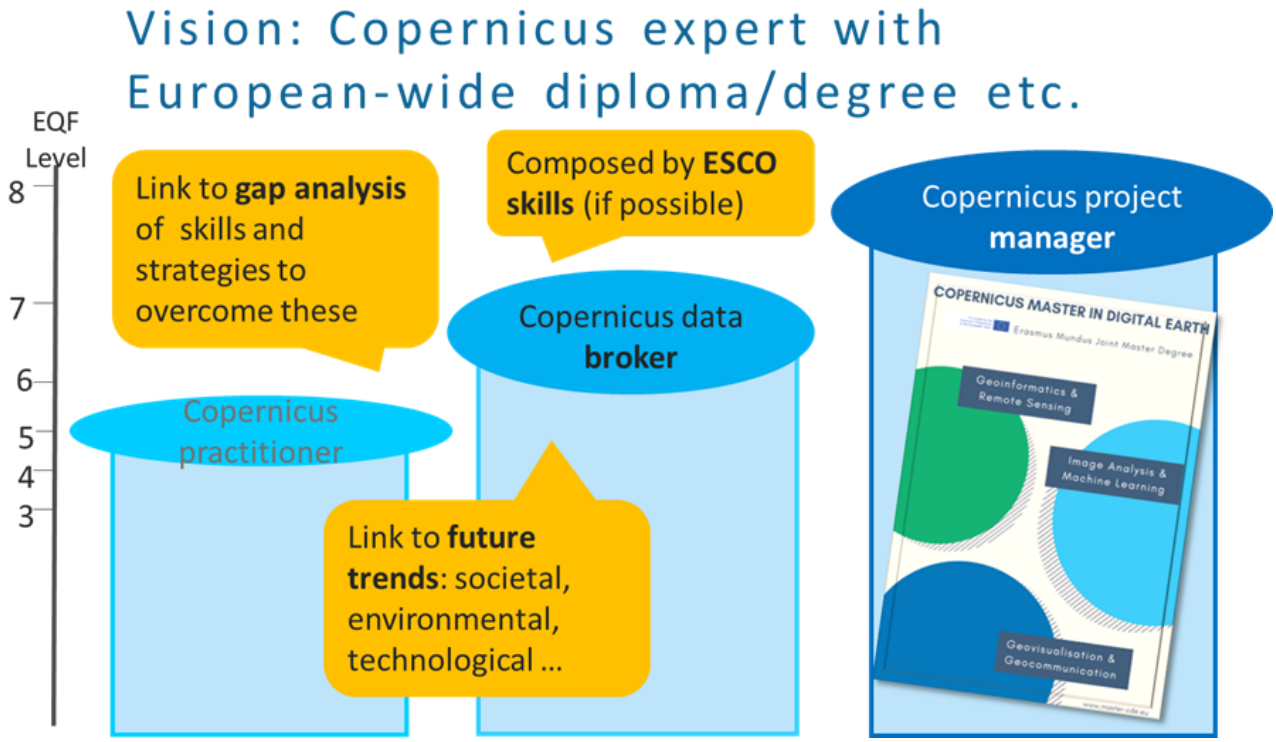

Figure 32. Exemplifying the envisaged profile levels in the Copernicus domain, this is a vision of a potential trans-EQF education and training schema in Europe. The upcoming Erasmus+ European joint masters programme "Copernicus Master in Digital Earth" led by the University of Salzburg is an example of cross-cutting, demand-oriented education as may gain importance in the future.

5.3. Skills to be considered in an EO/GI BoK

Besides the analysis of occupational profiles, the work aimed at identifying skills that are relevant for an EO/GI Body of Knowledge. There are known technological changes that are expected to affect the sector as has been indicated by a large company representative (I_03), who expects 'a shift of classical remote skills (seen as a future), and in future will more turn into programming, cloud computing, harvesting, understanding computing systems'. Programming has been indicated as highly relevant skill as well as analytical methods that lists state-of-the-art approaches like machine learning. The skill set computing resources and platforms, that refers to the use of cloud computing infrastructures and high performance computing resources did not receive an overall high rating. That does not reduce the importance of the related skills, but rather indicates that there

might be fewer profiles with these specific skills required. Overall, the detailed skill ratings may serve as input for a subsequent analysis of skills relevant for the BoK.

A request made before is the supplement of domain-specific skills with transferable skills required for customer relationships, consulting jobs, networking and policy development. These additional skills were focussed on during the discussion of workflows in the interviews and might bear potential for the specification of a BoK that considers the reality of jobs in the EO/GI sector.

The outcomes from the 30 semi-structured interviews may also partly support these three profiles. There is a main connection to the different market streams (please refer also *Figure 29*). We identified the following main points from the interviews:

- Competencies in SMEs are more related to customized products in the downstream sector. Therefore the requested profile of applicants is focusing on an employee with a skill set that is covering most of the skills to a high degree. This relates to profile 3 and partly profile 2. Here also the statement of M. Gould during the Castellon workshop is important. He said “there is a need of building bridges between vertical and horizontal/transversal skills”. See also *Figure 29* in this context.
- Larger companies can rely on more automated workflows that require a bunch of skilled workers whereas several persons cover the tasks. In this context, individuals have selected skills (vertical skillset), as a broad range of skills is not requested: In the context of EO/GI, larger companies are linked to the midstream sector. This relates to profile 1 and partly profile 2.
- The fragmentation of activities is underpinned by the use of new methods and technologies such as cloud computing. One interviewee from a large company (I_03) expects ‘a shift of classical remote skills (seen as in future), which will more turn into programming, cloud computing, harvesting, understanding computing systems’.

6. Summary and Outlook

This report summarizes the activities of the EO4GEO project for the identification of required skills, competencies and knowledge of workforce of the space/geospatial sector. It analyses the results of a survey on demand for space/geospatial skills and occupational profiles based on 175 valid responses received until July 28, 2018 (the total amount of responses is 196 responses until September 10, 2018). Based on the first insights of the survey and feedback from EO/GI sector representatives, we conducted 30 semi-structured interviews to deepen the insights on the required EO/GI skills for future innovations.

The survey showed that respondents tend to characterize potential employees in their organization with a similar background and level of education as their own. Because of that, the occupational profiles specified in the demand survey mainly focus on people with MSc and PhD degrees. In addition, there is little agreement on which particular skills are linked to with occupation; general lables like GIS&T specialist subsume occupational profiles with an emphasis on programming skills as well as an emphasis on cartography skills (see section 5.2). Data skills were given the highest importance across all answers to the survey, which should be considered in the development of curricula. The analysis of skill set ratings per organization type pointed out differences as respondents from large companies and other organizations put most emphasis on programming and development related skills; data skills were rated as most important by other organisation types. These findings lead to the suggestion of three occupational profiles that are required in the EO/GI sector (see section 5.2): EO/GI developer, EO/GI data analyst and EO/GI project manager.

The outcomes of the interviews partly complemented the findings from the survey. A general point mentioned was that with the rise of new technologies the organization of work changes as well as the flexibility and fragmentation of activities and workflows. Furthermore, we identified a shift of classical remote sensing skills towards programming, cloud computing, harvesting, and understanding computing systems. Consequently, both findings would require a possible bridging of horizontal and vertical skills to provide a potential direction on future requirements of future job profiles and therefore, of future applicants. Returning from this (near) future point of development to present offers in education and training, a comprehensive adaptation of currently available education and training measures is required as well as the creation and content-wise extension of future offers is necessary to fulfil demands from the market towards applicants and educate

applicants best possible recursively. This is one of the key objectives within the EO4GEO project for the remaining project lifetime and beyond in close cooperation with complementing initiatives such as the Copernicus User Uptake (D'Oleire-Oltmanns et al. 2018), the Copernicus Academy[12] and similar.

The report documents the analysis of the current demand for EO/GI skills and occupational profiles based on a survey and interviews. The findings provide input for the sector skill strategy development, as they show what currently is considered important in the sector and which occupational profiles receive less attention (VET and highschool diploma). The skills sets that were used in the survey together with their rating might be use interest for the development of a EO/GI BoK in WP 2. WP4, which will focus on the development of a set of curricula, can build on the identified requested occupational profiles; it will be required, however, to additionally consider the VET and highschool related profiles as they are part of the sector skill strategy. The long-term action plan of EO4GEO could pick up the objective of defining a specific label for certificates/diploma that are agreed upon in Europe and that serves as seal of quality for EO/GI education programmes framed in the project.

As required skills, knowledge and competencies constantly evolve, the requirements of jobs are changing accordingly. In case a new survey on the demand of EO/GI workforce is planned in a couple of years, we suggest some modifications and provisions. Given the experience from the survey and interviews, a challenge for a repeated action is to broaden the 'universe' from which responses are collected; innovation might take place outside current users of EO/GI technology and it is these increased user base that needs to be reached in the survey. The survey presented here, specifically focused on a set of skills that had to be rated, which were mostly taken from the BoK capturing the skills in the sector(s). Given the planned work in WP4 on business processes and workflows, it might be useful to derive tasks and skills from these workflows as a basis for the survey.

[12] http://copernicus.eu/main/copernicus-academy

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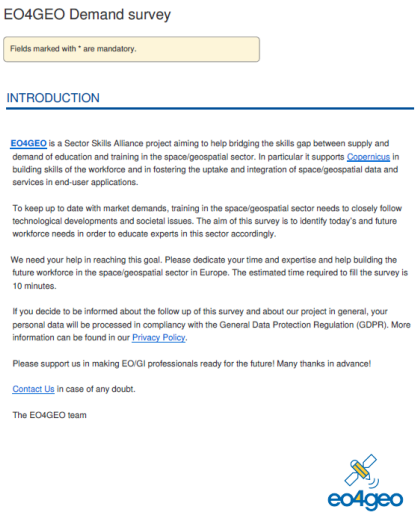
Annex 1 Demand Survey[13]



EO4GEO Demand survey

Fields marked with * are mandatory.

INTRODUCTION

EO4GEO is a Sector Skills Alliance project aiming to help bridging the skills gap between supply and demand of education and training in the space/geospatial sector. In particular it supports Copernicus in building skills of the workforce and in fostering the uptake and integration of space/geospatial data and services in end-user applications.

To keep up to date with market demands, training in the space/geospatial sector needs to closely follow technological developments and societal issues. The aim of this survey is to identify today's and future workforce needs in order to educate experts in this sector accordingly.

We need your help in reaching this goal. Please dedicate your time and expertise and help building the future workforce in the space/geospatial sector in Europe. The estimated time required to fill the survey is 10 minutes.

If you decide to be informed about the follow up of this survey and about our project in general, your personal data will be processed in compliancy with the General Data Protection Regulation (GDPR). More information can be found in our Privacy Policy.

Please support us in making EO/GI professionals ready for the future! Many thanks in advance!

Contact Us in case of any doubt.

The EO4GEO team

SECTION 1 – You and your organization

*1. In which country do you currently work?

- Afghanistan

1

- Albania
- Algeria
- Andorra
- Angola
- Antigua and Barbuda
- Argentina
- Armenia
- Australia
- Austria
- Azerbaijan
- Bahamas
- Bahrain
- Bangladesh
- Barbados
- Belarus
- Belgium
- Belize
- Benin
- Bhutan
- Bolivia
- Bosnia and Herzegovina
- Botswana
- Brazil
- Brunei Darussalam
- Bulgaria
- Burkina Faso
- Burundi
- Côte D'Ivoire
- Cabo Verde
- Cambodia
- Cameroon
- Canada
- Central African Republic
- Chad
- Chile
- China
- Colombia
- Comoros
- Congo
- Costa Rica
- Croatia
- Cuba
- Cyprus
- Czech Republic
- Democratic Republic of the Congo
- Denmark

2

- Djibouti
- Dominica
- Dominican Republic
- Ecuador
- Egypt
- El Salvador
- Equatorial Guinea
- Eritrea
- Estonia
- Ethiopia
- Fiji
- Finland
- France
- Gabon
- Gambia
- Georgia
- Germany
- Ghana
- Greece
- Grenada
- Guatemala
- Guinea
- Guinea Bissau
- Guyana
- Haiti
- Honduras
- Hungary
- Iceland
- India
- Indonesia
- Iran
- Iraq
- Ireland
- Israel
- Italy
- Jamaica
- Japan
- Jordan
- Kazakhstan
- Kenya
- Kiribati
- Kuwait
- Kyrgyzstan
- Laos
- Latvia
- Lebanon

3

- Lesotho
- Liberia
- Libya
- Liechtenstein
- Lithuania
- Luxembourg
- Madagascar
- Malawi
- Malaysia
- Maldives
- Mali
- Malta
- Marshall Islands
- Mauritania
- Mauritius
- Mexico
- Micronesia
- Monaco
- Mongolia
- Montenegro
- Morocco
- Mozambique
- Myanmar
- Namibia
- Nauru
- Nepal
- Netherlands
- New Zealand
- Nicaragua
- Niger
- Nigeria
- North Korea
- Norway
- Oman
- Pakistan
- Palau
- Panama
- Papua New Guinea
- Paraguay
- Peru
- Philippines
- Poland
- Portugal
- Qatar
- Republic of Moldova
- Romania

4

[13] https://ec.europa.eu/eusurvey/runner/EO4GEO_demand_survey

- Russian Federation
- Rwanda
- Saint Kitts and Nevis
- Saint Lucia
- Saint Vincent and the Grenadines
- Samoa
- San Marino
- Sao Tome and Principe
- Saudi Arabia
- Senegal
- Serbia
- Seychelles
- Sierra Leone
- Singapore
- Slovakia
- Slovenia
- Solomon Islands
- Somalia
- South Africa
- South Korea
- South Sudan
- Spain
- Sri Lanka
- Sudan
- Suriname
- Swaziland
- Sweden
- Switzerland
- Syrian Arab Republic
- Tajikistan
- Tanzania
- Thailand
- The former Yugoslav Republic of Macedonia
- Timor-Leste
- Togo
- Tonga
- Trinidad and Tobago
- Tunisia
- Turkey
- Turkmenistan
- Tuvalu
- Uganda
- Ukraine
- United Arab Emirates
- United Kingdom
- United States of America

5

- Uruguay
- Uzbekistan
- Vanuatu
- Venezuela
- Viet Nam
- Yemen
- Zambia
- Zimbabwe

Your organization

* 2. How can your organization be best characterized?
- Public body
- Non-profit
- International organisation
- International organisation of European interest
- Secondary or Higher education establishment
- Vocational education and training (VET) provider
- Small Medium Enterprise (SME)
- Large company
- Legal person /Individual professionist
- Other

If selected other, please specify here

3. If your organisation is a SME. How many FTE (Full Time Equivalent) employees do you have?
- Micro company (less than 10)
- Small company (between 11 and 50)
- Medium company (between 51 and 250)

* 4. Does your organisation support training measurs? If yes, which is the type of training preferred in your organisation?
- Distance learning
- In-house training
- External workshop
- Postgradual studies
- Summer/winter school
- No training measures are offered / supported
- other

If selected other, please specify here

6

* 5. Please indicate the top 3 professional EO/GI related skills that are needed in your organization.

Skill 1

50 character(s) maximum

* Skill 2

50 character(s) maximum

* Skill 3

50 character(s) maximum

* 6. Following your experience, do new applicants for vacancies in your organization fulfill the required skills?
- Yes
- Partially
- No

Your expertise

* 7. What is your highest level of education?
- Highschool graduate
- Certificate in professional/vocational training
- Bachelor
- Master
- PhD / Doctorate
- other

If selected other, please specify here

* 8. Please name your current position / job profile

* 9. What EO/GI related profile would describe your current position best?
- EO/GI data/service user
- EO/GI data/service technician
- EO/GI data/service expert (analyst, researcher, educator)
- EO/GI data/service manager
- I am not involved with EO/GI data/service in my job

7

* 10. Is your work related to one or more of these primary Copernicus application domains ("Copernicus core services")?
- Atmosphere & Climate
- Land Services
- Ocean & Marine
- Built Environment & Human Factors
- Disasters & Geohazards
- Security
- other

If selected other, please specify here

* 11. Consider your professional work: which tasks do you frequently perform in your current job with specific relation to EO/GI? Please provide 3 keywords describing the tasks.

Task 1

50 character(s) maximum

* Task 2

50 character(s) maximum

Task 3

50 character(s) maximum

SECTION 2 - Demand of GI/EO skills in your organization

In section 2 of the survey we would like to find out which EO/GI related job position/occupational profile is most needed in your organization and which skills are required to be successful in this job position. Please think of a specific job profile/occupational profile for filling in the following questions. The profile can be related to a currently required job profile or to future demand of your organization.

* 12. Name the one most needed job position/occupational profile in your organization (e.g. GIS developer, Remote Sensing technician, etc.)

* 13. Please specify one or more disciplines in which applicants for the suggested job profile have been trained.

8

- [ ] Cartography
- [ ] Computer Science
- [ ] Data science
- [ ] Economics
- [ ] Environmental Sciences
- [ ] Geodesy
- [ ] Geography
- [ ] Geoinformatics
- [ ] Hydrology
- [ ] Meteorology
- [ ] Remote Sensing
- [ ] Statistics
- [ ] other

If selected other, please specify here

* 14. Define the highest level of education of that occupational profile

- ○ Highschool graduate
- ○ Certificate in professional/vocational training
- ○ Bachelor
- ○ Master
- ○ PhD / Doctorate
- ○ other

If selected other, please specify here

15. In the following we provide eight EO/GI related skill sets ranging from data handling, to data capture and analysis, programming skills, visualization as well as organizational and societal aspects. Please specify in the presented matrices, which skills are required for the job position mentioned above. You can choose the three most relevant skills and rate the level of expertise an applicant requires. For each skill set we ask you to specify the overall relevance of the skills for the occupational profile.

15a Space/Geospatial Data

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Data retrieval from data portals	○	○	○	○
Knowledge about nature of multispectral data	○	○	○	○
Data models (object, field, network, TINs, etc.)	○	○	○	○
Modelling of 3D, uncertain and temporal phenomena	○	○	○	○

Knowledge about sensor platform types (UAV, airplane, satellite), orbits and flight paths	○	○	○	○
Extraction, transformation and loading EO/GI data	○	○	○	○
Georeferencing and resampling data	○	○	○	○
Orthorectification and mosaicking EO data	○	○	○	○
Pre-processing of data: calibration and correction (radiometric, topographic etc.)	○	○	○	○
Understanding map projections and datums	○	○	○	○
Knowledge of metadata, standards and concepts of spatial data infrastructures	○	○	○	○
Interpretation of EO/GI data (aerial images, satellite data, VGI, trajectories etc.)	○	○	○	○
Competence in radar remote sensing	○	○	○	○
Evaluation of data quality	○	○	○	○
other	○	○	○	○

If selected other, please specify here

* Please weight the overall relevance of Space/Geospatial Data skills

- ○ not relevant (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ extremely relevant (6)

15b Data Capture and Management

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Planning and collection of field data (sample size selection, field data technologies)	○	○	○	○
Land surveying and GPS measurements	○	○	○	○
Knowledge of different data capture technologies (multispectral sensors, LiDAR, Radar, etc.)	○	○	○	○
Establishment and usage of a sensor web	○	○	○	○

Management of real-time data in a database	○	○	○	○
Design, creation and maintenance of a database for EO/GI data	○	○	○	○
Usage of data cubes for multidimensional data	○	○	○	○
Querying databases in different languages (e.g. SQL)	○	○	○	○
other	○	○	○	○

If selected other, please specify here

* Please weight the overall relevance of Data Capture and Management

- ○ not relevant (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ extremely relevant (6)

15c Analytical Methods

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Application of different image classification methods (e.g. machine learning routines, artificial intelligence for data analysis).	○	○	○	○
Usage of analytical operations (e.g. map algebra, overlay)	○	○	○	○
Creation of composite indicators	○	○	○	○
Application of statistical methods (e.g. spatial statistics for point pattern analysis, geostatistics for interpolation)	○	○	○	○
Application of context-specific methods, like object-based image analysis (OBIA), mathematical morphology, CNNS (convolutional neural networks) or similar	○	○	○	○
Analysis of time series data	○	○	○	○
Application of data mining approaches (pattern recognition, data classification, Big Data analysis, knowledge discovery)	○	○	○	○
Surface analysis (cost surfaces, visibility analysis)	○	○	○	○
Natural language processing	○	○	○	○

Mathematical optimization (graph theory, routing, utility networks)	○	○	○	○
other	○	○	○	○

If selected other, please specify here

* Please weight the overall relevance of Analytical Methods

- ○ not relevant (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ extremely relevant (6)

15d Programming and Development

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Development of prototypes of new analysis algorithms	○	○	○	○
Requirement analysis and identify user needs	○	○	○	○
Development of web applications (JavaScript APIs, Html5, CSS etc.)	○	○	○	○
Design and development of applications (Python, Java, C++ etc.)	○	○	○	○
Realization of applications for mobile devices (e.g. location-based services)	○	○	○	○
Integration of sensor data and Internet of Things (IoT) in applications	○	○	○	○
Automation of geoprocessing through scripts	○	○	○	○
Usage of Jupyter notebooks, Google Earth engine etc.	○	○	○	○
Adaptation of EO/GI applications	○	○	○	○
Supporting the testing and deployment of new products	○	○	○	○
Monitoring software life cycle	○	○	○	○
other	○	○	○	○

If selected other, please specify here

* Please weight the overall relevance of Programming and Development
- not relevant (1)
- (2)
- (3)
- (4)
- (5)
- extremely relevant (6)

15e Computing Resources and Platforms

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Usage of high performance computing resources				
Accessing, analysis and visualization of EO/GI data on cloud infrastructures				
Usage and provision of data as web services (e.g. using OGC web services)				
Administration of web server infrastructures (Linux or Windows servers including map servers)				
Managing of security and privacy issues on platforms				
Application of the MapReduce concept, e.g. implementation in Apache Hadoop				
Managing infrastructure (user support, system revision, database administration)				
other				

If selected other, please specify here

* Please weight the overall relevance of Computing Resources and Platforms
- not relevant (1)
- (2)
- (3)
- (4)
- (5)
- extremely relevant (6)

15f Visualization and Cartography

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Data preparation and maps design (considering scale, generalization, symbology, etc.)				
Creation of web mapping products				
Design of user interfaces				
Synthesis of EO/GI data				
Analysis and visualization of complex and big data				
Interpretation and evaluation of maps				
other				

If selected other, please specify here

* Please weight the overall relevance of Visualization and Cartography
- not relevant (1)
- (2)
- (3)
- (4)
- (5)
- extremely relevant (6)

15g Organizational and Institutional aspects

at least 3 answered row(s)

	basic	intermediate	expert	n /a
EO/GI workforce themes (training and education, staff development)				
Adopting standards				
Planning project resources (data costs, product requirements etc.)				
Estimation of budget for EO/GI management				
Balancing costs, risks and benefits				
other				

If selected other, please specify here

* Please weight the overall relevance of Organizational and Institutional aspects
- not relevant (1)
- (2)
- (3)
- (4)
- (5)
- extremely relevant (6)

15h EO/GI and Society

at least 3 answered row(s)

	basic	intermediate	expert	n /a
Knowledge of space/geospatial policy frameworks (Copernicus, GEO, Inspire, Open Geospatial Consortium)				
Understanding opportunities/challenges for future markets of EO/GI data exploitation				
Awareness of legal issues (liability, privacy, etc.) and data sharing policies				
Running citizen science projects				
Dissemination of space/geospatial information to the public				
other				

If selected other, please specify here

* Please weight the overall relevance of EO/GI and Society
- not relevant (1)
- (2)
- (3)
- (4)
- (5)
- extremely relevant (6)

* 16. Please select transferable and soft skills that are relevant for complementing the competencies of the applicant:
- [ ] Build strong customer relationships
- [ ] Is aware of business strategies
- [ ] Has entrepreneurial competencies
- [ ] Can open new markets

- [ ] Is motivated to enter new thematic fields
- [ ] Willing to re-train and re-skill (in response to technological change)
- [ ] Has management/leadership skills
- [ ] Has expert procedural knowledge on sustainable development (energy, waste, resource efficiency etc.)
- [ ] Has communication skills (including social media)
- [ ] Has foreign language skills
- [ ] Has independent and proactive working attitude
- [ ] Has good time management skills
- [ ] other

If selected other, please specify here

* 17. Domain Applications (please specify the focus of the job profile on one or more domain applications)

Agriculture	Urban Areas	Atmosphere	Monitor sensitive risk areas
Inland Water	Infrastructure	Climate	Monitor land border incursions
Land Ecosystems	Marine ecosystem	Meteorology	Monitor economic activity
Topography	Metocean	Floods	Forecasting epidemics and diseases
Forests	Ships	Earthquakes	Map disaster areas
Snow & Ice	Coastal	Volcanos	Monitor movement of people
Land use	Fisheries	Fires	Monitor transport routes
Geology	Sea-ice and icebergs	Landslides	other

If selected other, please specify here

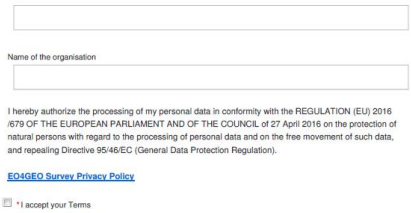
SECTION 3 – Contact Information

18. Would you like to receive information on forthcoming EO4GEO activities, results and follow up initiatives? And/or would you like to take part in personal, qualitative interviews on EO/GI skills demands?

	Yes	No
* I would like to receive information on EO4GEO activities.		
* I would like to be contacted for personal, qualitative interviews.		

* If yes, please leave your Email address.

Name/Surname


Name of the organisation
I hereby authorize the processing of my personal data in conformity with the REGULATION (EU) 2016 /679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).
EO4GEO Survey Privacy Policy
* I accept your Terms

17

Annex 2 Skill ratings

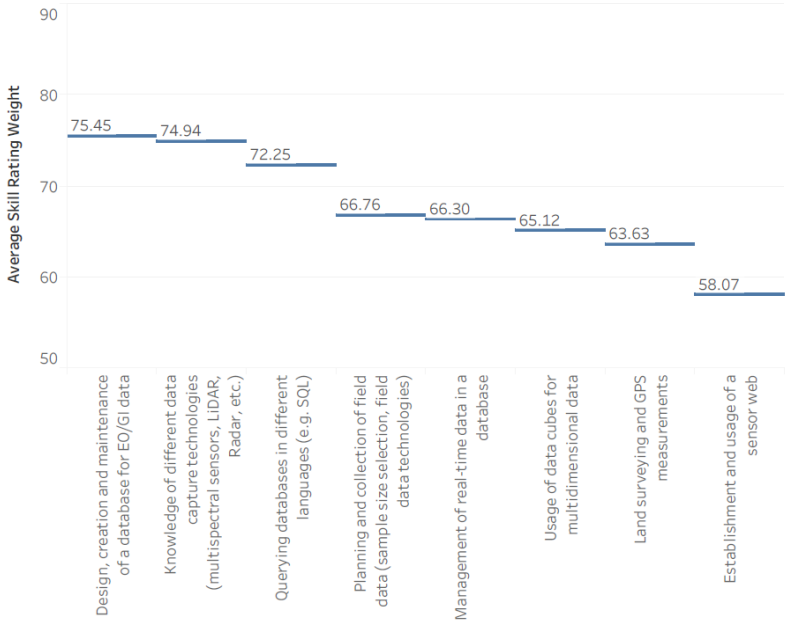


Figure 33. Skill rating for Data Capture and Management.

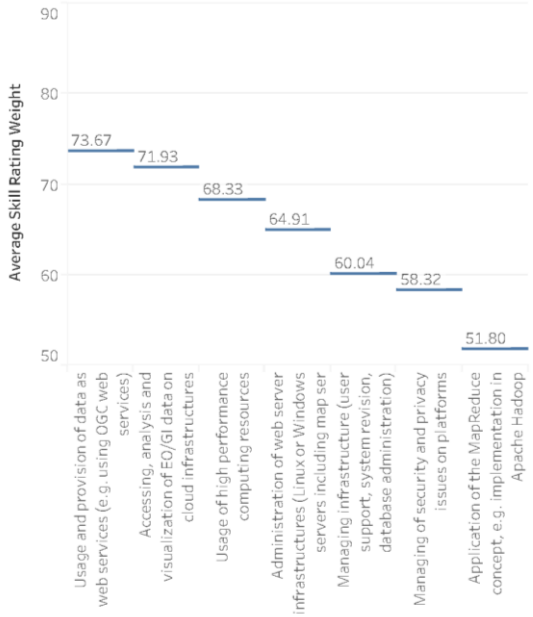


Figure 34. Skill rating for Computing Resources and Platforms.

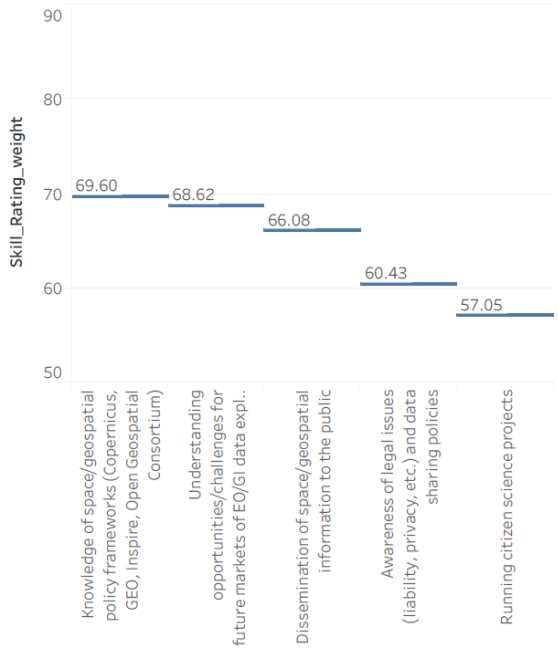


Figure 35. Skill rating for EO/GI and Society.

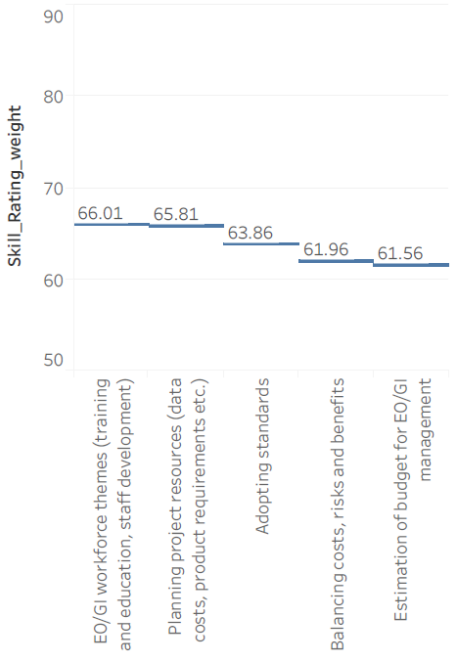


Figure 36. Skill rating for Organizational and Institutional aspects.

Annex 3 Topic List semi-structured interviews

Question/Stimulus	Request for further explanation	Comments
1.Could you please briefly describe the main (**business) activities** of the enterprise/organization you are working for?	•	
2.Who are your **customers**?	• i.e Municipalities, regional Government, companies …	
3.What are the services **customers' requests** most frequently concerning the activities of the company/organization in the EO area?	•	
4.If you describe a service request which **tasks** (are most relevant) to handle a EO service request?	• How big is the portion of work which is done using software products, do project management, customer communication etc?	
5.Which tasks require **pre-defined workflows**, please describe such a workflow? Are those workflows always the same?	• If you think of different pre-defined workflows how much do tasks overlap. What are the tasks that overlap with other tasks of other workflows?	
6.**Who is responsible** for service requests?	• Do you have a person responsible for the whole value adding process within the service request or only for specific tasks? • If different people handle parts of a request what is their highest level of	• Occupational profiles (i.e. remote sensing technician, key account manager)

	education? • How does the communication with your clients work? Do you employ personnel for sales and distribution tasks connecting to clients?	
7.Do you use **Copernicus data/services**?	• Which services of your company/organization are based on Copernicus products or services? Please name the most important.	**Copernicus Core Services** (i.e. Atmosphere, marine Environment, Land, Climate Change, Emergency Management, Security) **Copernicus products or services** (Systems/products i.e. Drones, Radar instruments, Data processing software AND/OR Applications i.e. Forest Management, Mapping, Transports[14], Enterprise Resource Planning to optimize decisions[15])
8.Do you get service requests you are not able to handle because you don´t have trained personnel/staff?		
9.If you consider the changing tasks/workflows in the EO/GI sector, how would you/ your staff/ your co-workers like to **prepare for the changing demand of skills**?		
10.In which areas of your business activities/ workflows staff needs training?	• How should the training look like? (in-house, online course, summer school …) • If you do in-house training how the training should be?	

[14] eoVOX page 10
[15] Gildhoff H. (2018)

	• How long should the training take organized? • Content	
11.Do you/your staff/colleagues use external training offers?		
12.What course did you attend lately?		
Final Question: Would you like to add anything else to the discussed topic. Do you have a final remark?		

Annex 3 Coding results semi-structured interviews

Document name	Code	Segment
I_01_SME	Business activities\Service Provider	Humanitäre Services für NGOs Bügercockpit Bügerbeteiligung auf Gemeindeebene/Appentwicklung Consulting im Bereich GI BigData Mobile Daten Research Projekte
I_01_SME	Workflow	Beispiel Emergency Mapping[FN2] a. Rufbereitschaft b. Aktivierung c. Basisinfos zu Lage in Regionen (muss eigentlich ständig up to date gehalten werden) d. Datensuche e. Kommunikation mit Kunden/Budget f. Individuelle Wünsche mit Kunden abklären g. Vorprozessierung der Daten h. Analyse der EO Daten i. Social media tracking j. Kartographie/Visualisierung k. Integration Webtool/WebGIS l. Bericht m. Abrechnung[FN3]
I_01_SME	Workflow\responsabilities workflow	Normalerweise sind die Aufgaben unter den Mitarbeitern aufgeteilt. Es kann aber dazu kommen (Urlaub/Krankheit), dass mehrere Aufgaben auch von einer Person erledigt werden müssen.
I_01_SME	Business activities\Research	Research Projects
I_01_SME	workforce\soft skills	Es muss dem Kunden erklärt werden können was der Kunde braucht, Verkauf
I_01_SME	workforce\soft skills	Kommunikation (sollte immer dieselbe Person sein, da Kundenkontakt/bestehende Beziehungen zu Kunden) Diese Tätigkeit läuft meist nebenbei ab
I_01_SME	workforce\demand	Programmieren war bisher ein großes Manko –
I_01_SME	workforce\demand	Nutzung von Social media b. Big data c. Programmierung d. Datenbanken e. Kommunikation mit Kunden f. Projektmanagement

I_01_SME	training measures	Nicht geblockt oder zu lang, eher kürzere Blöcke, da Arbeit sonst liegen bleibt b. Eher kurz oder regelmäßig 1 Tag pro Woche über einen längeren Zeitraum c. Sollte sehr viel Praxis beinhalten d. Sollte Integration von Fallbeispielen aus der Firma ermöglichen 12. Neue Frage: Werden in-house Trainings angeboten?
I_01_SME	training measures\in-house traing	Ja es werden Trainings konzipiert um studentische Mitarbeiter/Praktikanten einzuschulen b. Es wird untereinander Wissen ausgetauscht/gezeigt wie etwas funktioniert.
I_01_SME	training measures	Meist nur Tageskurse über Uniangebot b. Kursangebot der FFG wird auch in Erwägung gezogen
I_01_SME	workforce\prefered educational profile	a. Praktikanten /studentische Mitarbeiter -> Aufgabe manuelles Digitalisieren -> Studenten, Ausbildung mit grundlegenden Kenntnissen im EO Bereich b. Kommunikation (sollte immer dieselbe Person sein, da Kundenkontakt/bestehende Beziehungen zu Kunden) Diese Tätigkeit läuft meist nebenbei ab -> einschlägiger Abschluss im EO/GI Bereich/ Bachelor + Berufserfahrung bzw. praktische Erfahrung mit Kunden oder Masterabschluss Es muss dem Kunden erklärt werden können was der Kunde braucht, Verkauf c. Analysen -> Masterabschluss + Berufserfahrung bzw. Bachelor mit reichlich Berufserfahrung d. Weiterentwicklung /Research -> sollte PhD haben e. Visualisierung wird von einer Person gehandhabt, einschlägige Ausbildung f. Admin -> teilweise CEO, teilweise MitarbeiterInnen g. Kundenakquise: CEO, teilweise auch durch MitarbeiterInnen, h. Projektanträge wird durch CEO durchgeführt, langjährige Erfahrung + Kontakte,
I_01_SME	Copernicus data/ services	Sentinel data in all business areas i.e. Emergency Mapping
I_09_SME	Business activities\Service Provider	Application development, prototyping, solution development

I_09_SME	Business activities\Developer	Application development, prototyping, solution development
I_09_SME	Business activities\Customers	Public adminstrations, national, international level * Increasingly more local, NGO, (since open data initiative)
I_01_SME	Business activities\Customers	NGOs, Municipalities, provincial governments,
I_09_SME	Workflow\most frequent taks/services requested	Consulting for application development
I_09_SME	Workflow	Now spending more time on meta-level * Processing level gets less * Collaborate with other consultants
I_09_SME	Workflow\changes	Now spending more time on meta-level * Processing level gets less * Collaborate with other consultants
I_09_SME	Workflow\changes	* Past: one-off map, new trend: clients require more monitoring concepts, ingesting new satellites, no longer self-contained piece of work * More operational
I_09_SME	Copernicus data/ services	Use for demonstration * Intermediate product concept, e.g. HRL for wetlands * Also Urban Atlas, also to enhance (more development) * Incorporate open gov data
I_09_SME	Workflow\limitations	Collaborating with sub-contractors * Also refused projects due to small size (one-man)
I_09_SME	training measures\where is training needed	* Personal development, listen to webinars (e.g. ESRI), also NASA * But no strategy
I_09_SME	workforce\prefered educational profile	Prefer MSc level, not necessarily PhD
I_09_SME	training measures	Technological development cycle faster than educational cycle
I_09_SME	training measures\courses attended	ESRI course (could not complete)
I_09_SME	workforce\prefered educational profile	Copernicus expert on EQF 5 would be definitely useful!
I_03_largeCompany	Business activities\type of service\vertical	vertical solutions (specific image analysis problem, like the eCog oil palm plantation).
I_03_largeCompany	Business activities\type of service\horizontal	horizontal (eCognition suite),
I_03_largeCompany	Business activities\type of service\vertical	Data sources for verticals: whole range of data gathered by UAV, up to Sentinel-2

I_03_largeCompany	Workflow	Workflow: (1) we start to investigate need for vertical application. Is it an image analysis problem? Then conduct feasibility study. (2) What is the demand and the market potential and profitability. (3) Specifics of the product. The role of data: usually data are with the customer, and primary focus of automation.
I_03_largeCompany	Copernicus data/ services	Depends on resolution, Sentinel-1 & 2 widely used, testing and development of training material. Not using information products so far …
I_03_largeCompany	Business activities\future business drivers	We see a shift of classical remote skills (seen as a future), and in future will more turn into programming, cloud computing, harvesting, understanding computing systems
I_03_largeCompany	workforce\demand	Not always easy to find someone to have a working level of eCognition
I_03_largeCompany	workforce\demand	Breakdown into skills: application development, command remote sensing (the higher the better, to communicate with customers, image interpretation, indices, band width, sensor specifics, photogrammetric principles), and GIS, ruleset programming No PhD required, MSc, understanding image analysis process
I_03_largeCompany	workforce\prefered educational profile	No PhD required, MSc, understanding image analysis process
I_03_largeCompany	workforce\soft skills	Generally valued, cross-cultural competence, time allocation, project management, communication, flexibility and motivation, no frustration
I_03_largeCompany	training measures	Internal trainings (reacting to GDRP), also leaving for continuous education, great deal of support VET: not applicable currently, but could be strengthened in the future
I_03_largeCompany	training measures\in-house traing	Internal trainings (reacting to GDRP), also leaving for continuous education, great deal of support
I_03_largeCompany	workforce\demand	Specific domain knowledge is not needed, because the technology is so universal
I_04_mediumCompany	Business activities	Service in remote sensing, information products based on satellite data Accuracy requirements too high for fully automated analysis If then rule-sets

		Represents Team that works on automation
I_04_mediumCompany	Workflow	post-processing of image data, surface and elevation data, image analysis
I_04_mediumCompany	workforce\demand	Workers should have a clear understanding of resolution and tasks and problems to be solved Basic understanding of spatial referencing Maybe academic education too theoretical FH alumni too practical
I_04_mediumCompany	workforce\prefered educational profile	FH alumni too practical
I_04_mediumCompany	Copernicus data/ services	Uses Corine, Land core services, Urban Atlas ==> students have limited knowledge about this! Sentinel 1 & 2, OSM constrained Planet re-seller and free contingent Free data will open business cases but principle competition, new USP needed Sentinel-1 competence center, R&D ESA Projects
I_04_mediumCompany	Business activities\future business drivers	Internal trainings, new profiles for big data, cloud computing, in particular IT persons searched Reduce manual interaction in the future, potentially more projects and new fields
I_04_mediumCompany	workforce\prefered educational profile	Some academic staff is over-educated, in particular at large projects with high operational share, technician would be suitable Small projects academics better suited because new challenges
I_04_mediumCompany	workforce\demand	Some academic staff is over-educated, in particular at large projects with high operational share, technician would be suitable Small projects academics better suited because new challenges
I_04_mediumCompany	Workflow\limitations	Maybe academic education too theoretical

I_04_mediumCompany	Workflow\limitations	FH alumni too practical
I_04_mediumCompany	workforce\soft skills	project management: internal training otherwise not really considered … time organizing important decision making
I_04_mediumCompany	training measures\in-house traing	3-days trainings in-house
I_04_mediumCompany	training measures	IT and programming skills can be trained
I_04_mediumCompany	Workflow\changes	IT and programming skills can be trained
I_04_mediumCompany	training measures\where is training needed	IT and programming skills can be trained
I_04_mediumCompany	workforce\demand	Also important: domain experts for specific projects
I_05_largeCompany	Business activities\Developer	Team: working and developing technologies for OBIA in new emerging technologies including data cubes and deep learning/AI
I_05_largeCompany	Business activities	Team: working and developing technologies for OBIA in new emerging technologies including data cubes and deep learning/AI
I_05_largeCompany	Workflow\most frequent taks/services requested	Workflow: develop technology / framework to enable you to use workflow Traditionally not involved in service provider domain, only on demand (e.g. HAP)
I_05_largeCompany	Copernicus data/ services	All sensors, but support S-2 Are aware but only use partly
I_05_largeCompany	workforce	Currently: application development and collaborates with specialist, domain experts, most programmers have masters, three PhDs, highly specialized
I_05_largeCompany	workforce\applicants	Up to now, very good experience with finding profiles, job announcements
I_05_largeCompany	workforce\soft skills	depending on EQF, for Post Doc they require high level. PCI would carry out internal training and coaching.
I_05_largeCompany	training measures\in-house traing	soft skills depending on EQF, for Post Doc they require high level. PCI would carry out internal training and coaching. 8.

I_05_largeCompany	workforce\demand	PCI approaches new things very carefully, but then do substantial steps like establishing a innovation team
I_05_largeCompany	workforce\demand	Also important: domain experts for specific projects
I_08_publicBody	Business activities\Research	Lot of activities around Copernicus Working in different thematic areas * Disaster management / DRR * Land use /land cover * Climate atmosphere * Research and operational (validated service)
I_08_publicBody	Business activities\Customers	EC, ESA, EE, Worldbank, national stakeholder forestry ,fire brigades, private sector energy
I_08_publicBody	workforce\prefered educational profile	Ideal profile (rather refers to skills- comment interviewer) – blend remote sensing skills with programming skills
I_08_publicBody	Workflow	Conversion of generated information into appealing, user-understandable format * Discover and understand user needs * Translate to technical solutions * Because EO really provides societally relevant solutions * Research outcome should be relevant * Demanding communication skills * Meet the expectations from users!
I_08_publicBody	Workflow\responsabilities workflow	3 thematic units (DRR, IT, agriculture) * According to user requirements profiles are announced * Have a dissemination /social media manager
I_08_publicBody	Copernicus data/ services	Use both, S1, S2, S3, automated ingestion at earthquake > 5 Richter and deformation map, S2 affected by fire of Greece, burnt area extent, and land cover change; Copernicus third party missions, and Copernicus products * EFFIS and EFAS service * CAMP * Urban Atlas
I_08_publicBody	Workflow\limitations	* Always challenged when responding risk & recovery task, engaging different scientists from other department
I_08_publicBody	training measures	Participate with educational activities, linked to universities * Engage staff to undergo training
I_08_publicBody	workforce\prefered educational profile	1/3 first level, 2/3 PhD and PostDoc Highly skilled, deliver MSc degree in space applications

I_08_publicBody	workforce\demand	1/3 first level, 2/3 PhD and PostDoc Highly skilled, deliver MSc degree in space applications
I_08_publicBody	training measures\where is training needed	Would be good to form Copernicus-like mindset
I_08_publicBody	training measures\courses attended	Yes, external training courses, e.g. open source GIS, phython, ESRI ArcGIS Server
I_08_publicBody	training measures\courses attended	Training course CNES, about SAR interferometry
I_21_public_body	Business activities	Territorial programming, planning, monitoring, protection in the sector of environment, Urbanistic, Civil Protection, agriculture
I_21_public_body	Business activities\Customers	Municipalities, Public Authorities, companies citizen, professionals, Universities, research centres…
I_21_public_body	Workflow\most frequent taks/services requested	Data, informations for the territorial monitoring, for environmental applications, of civil protection, agricolture
I_21_public_body	Workflow\changes	* Now spending more time on meta-level * Processing level gets less * Linked with other services
I_21_public_body	Workflow\most frequent taks/services requested	* Now spending more time on meta-level * Processing level gets less * Linked with other services
I_21_public_body	Workflow\pre-defined wf	There are predefined flux, common to various users and a subsequently processing of the outputs on the basis of the different goals (NDVI, Change detection)
I_21_public_body	Workflow\responsabilities workflow	* Occupational profiles (i.e. remote sensing technician, key account manager)
I_21_public_body	Workflow\limitations	Yes sometime we wait to find personnel skilled
I_21_public_body	training measures	Life-long learning and the use of platforms as RUS (Research User Support of Copernicus)
I_21_public_body	training measures\where is training needed	Improvement skills on images processing
I_21_public_body	training measures\in-house traing	We use as well external as in house training
I_21_public_body	training measures	We use as well external as in house training
I_21_public_body	training measures\courses attended	RUS (Research User Support – Copernicus)

I_21_public_body	workforce\demand	It is very important an investigation, research, survey of the available platforms of satellite data and information, on payment and not
I_20_public_body	Business activities	Territorial programming, planning, monitoring * Civil protection * Agriculture ? * Urbanistic ? GIS, SDI
I_20_public_body	Business activities\Customers	* Public administrations, local, regional, national, level * Various type of public institutions Subjects producing cartography: 1. Military Institute of Geography 2. Aviation 3. Navy 4. Region 5. Cadastre
I_20_public_body	Workflow\most frequent taks/services requested	Raw data (image from satellite) * Processed data for territorial managing, environmental protection, urban planning, mapping (added value index)
I_20_public_body	Workflow\most frequent taks/services requested	* Link with other services
I_20_public_body	Workflow\responsabilities workflow	Department / Office. Everi request has to be dispatched and approved at management level (for internal request there is more autonomy)
I_20_public_body	Copernicus data/ services	Copernicus RUS * Land * Emergency management * Change detection
I_20_public_body	Workflow\limitations	Use of external services, due to a lack of human resources rather than a lack of skills
I_20_public_body	training measures	* Lifelong learning. Continuous training to the staff and use of platform as Copernicus RUS
I_20_public_body	training measures\courses attended	External course: Master in “Remote piloting systems” of the University of Padova
I_20_public_body	training measures\in-house traing	* In-house course
I_20_public_body	training measures\courses attended	* Copernicus RUS
I_20_public_body	training measures	It is important to map all the platforms providing raw data and processed data because, this services could reduce the amount of work and help/integrate activities

I_20_public_body	training measures\comments	It is important to map all the platforms providing raw data and processed data because, this services could reduce the amount of work and help/integrate activities
I_17a-b_public_body	Business activities	Our activity is non-commercial and financed by regional, national and European subventions. In this sense
I_17a-b_public_body	Business activities\type of service	Research institution - Institutions of higher education (Universities and engineering Schools) - Companies (Small and medium-sized enterprises, startups) - Regional and local authorities - National and European networks (NEREUS, FabSpace, Theia) Our main activity is a support of these actors. We do not directly produce EO-bases products or services.
I_17a-b_public_body	Business activities\Customers	Our members are academic and research institution Our partners are - research laboratories, - public administration at local and regional level, - companies (Small and medium-sized enterprises, startups) - academic institutions providing training related to or interested in EO

I_17a-b_public_body	Workflow\most frequent taks/services requested	The most common requests of our partners are: LRA : Consulting on EO-based products - to identify relevant products regarding specific needs - to choose suitable method of production (in-house implementation or subcontracting by providers) - to facilitate discussion with potential service provider (clarify needs) Companies: - benefit from a network - benefit from supports (incubation) - be fully informed on demand (including LRA expectations and practices) - be informed on supply (search for complementarity of skills, available data, including in situ data) Training - create links between technical, methodological and applied training Research - request for images (VIGISAT project and KALIDEOS programme) - request for financial support (allocated by Brittany Region to GIS BreTel and its members) - be informed of other laboratories research activities (pool skills, methods, tools) We also inform all our partners of national and European interesting calls, events…
I_17a-b_public_body	Workflow	To illustrate our main tasks we will take the example of the design and implementation of a EO-based demonstrator : Our main tasks are : - Stay informed about new EO-based products discussing with R&D actors (institutional or private) - Stay informed on European and national space application policy - Promote regional space application ecosystem in national and European instances - Make the potential customers (LRA) aware of EO-based products - Make providers (companies) aware of LRA (or other customers) needs - Facilitate link between customers and providers

		- Make products available
I_17a-b_public_body	Workflow\pre-defined wf	Setting of Regional Copernicus
I_17a-b_public_body	Workflow\responsabilities workflow	team is composed of 3 persons, each one having a transversal vision but working principally
I_17a-b_public_body	Workflow\responsabilities workflow	Research:
I_17a-b_public_body	Workflow\responsabilities workflow	Companies
I_17a-b_public_body	Workflow\responsabilities workflow	Uses
I_17a-b_public_body	Workflow\responsabilities workflow	Training
I_17a-b_public_body	Copernicus data/ services	Currently we use Copernicus products for demonstration. A demonstrator is under construction to add Copernicus products in Regional Geoportal. In the near future we plan to use Copernicus images to implement local demonstrators provided by our partner companies. Moreover, our partners could provide in situ data for the in situ component of Copernicus.
I_17a-b_public_body	workforce\demand	We are convinced that this is a relevant level to address user uptake issues, but it is not the appropriate level to benefit from European support. Being part of consortia is a good option, but it takes times. For now we try to balance out local and international animation. To respond to European calls, a person in charge of European projects could help us to develop our activity. To develop local demonstrators and facilitate Copernicus data and products availability,

		someone with informatics and development skills could be very helpful. For now, we plan to contract with a company.
I_17a-b_public_body	training measures\where is training needed	Training on API, cloud services, informatics development could be helpful. Not necessary to become a developer but to better address informatics issues to make EO-data (remote-sense and in situ data) easily available for a community of users.
I_17a-b_public_body	training measures\comments	but also for our partners: have a list of all webinar, training, provided by different providers (RUS, Synergise, ESRI)
I_17a-b_public_body	Workflow\changes	Our role in the changing is more an accelerator, facilitator and support role.
I_17a-b_public_body	training measures\training offers	We offered some courses - remote sensing initiations (land management students) - entrepreneurship awareness (remote-sensing students) We plan to offer a mini MOOC on Copernicus data for LRA
I_17a-b_public_body	training measures\training offers	With ESA BIC Nord France, we (and our partners) offer training and expertise to incubated companies
I_17a-b_public_body	training measures\courses attended	ESRI course (mainly at work)
I_18_SME	Business activities	Business development toward commercialization of products based on geospatial information and data * Communication and outreach * Translation and interpretation of geospatial data into products in the context of the neo-industrial revolution * Bridging users to producers 2. Who are your customers? * European Commission * Copernicus services (Mercator Ocean, ECMWF)

I_18_SME	Workflow\most frequent taks/services requested	Consulting for commercialization of products * Communication
I_18_SME	workforce	Business development: this task needs the capacity of identification of potential customers, data analytics skills and logical thinking * Communication: this task needs digital literacy skills, logical reading, analytical skills and ability to synthesize
I_18_SME	Workflow\pre-defined wf	* Business development: this task needs the capacity of identification of potential customers, data analytics skills and logical thinking * Communication: this task needs digital literacy skills, logical reading, analytical skills and ability to synthesize
I_18_SME	Workflow\responsabilities workflow	The company does not receive direct requests because is involved in EU-funded projects and service contracts
I_18_SME	Workflow\responsabilities workflow	Director 1 is responsible for monitoring and evaluation of EU bids * Director 2 is responsible for business development * Directors are supported in these activities and on communication by the other 2 members of the team
I_18_SME	Copernicus data/ services	* Yes, but only for communication purpose and demonstration
I_18_SME	Workflow\limitations	* No. Sometimes the company is not able to handle requests because of limited human resources
I_18_SME	training measures\in-house traing	* Yes, but in an informal scheme due to the size of the company
I_18_SME	training measures\comments	* No, but the company welcomes such initiatives
I_18_SME	training measures\courses attended	No, because of lack of time
I_19_SME	Business activities	Exploitation of scientific results * Translating scientific results into products * Identification of the users' needs * Selling products in the market
I_19_SME	Business activities\Customers	local, regional, national and international public administrations * Private sector
I_19_SME	Workflow\most frequent taks/services requested	Systems for managing * Consultancy services * Solutions for farmers aiming at cost reduction * Air quality indexes through Copernicus data

I_19_SME	Workflow\most frequent taks/services requested	* Identification of the needs * Development of the software * Commercialization of the product
I_19_SME	Business activities\type of service\most frequently requested	Systems for managing * Consultancy services * Solutions for farmers aiming at cost reduction * Air quality indexes through Copernicus data
I_19_SME	Workflow\most frequent taks/services requested	Project management and software development are the main activity, followed by communication with customers.
I_19_SME	Workflow\pre-defined wf	Technical tasks in general * Workflows are built on a solid base but can vary depending on the project Workflows do not usually overlap but sometimes they can be linked if necessary.
I_19_SME	Workflow\responsabilities workflow	* Projects' developers
I_19_SME	Copernicus data/ services	Yes, data and services related to Climate Change, Atmospheric models and Weather
I_19_SME	workforce	The company is recruiting experts of data management, data analysis and big data in general.
I_19_SME	workforce\demand	The company is recruiting experts of data management, data analysis and big data in general.
I_19_SME	training measures\where is training needed	EO services
I_19_SME	training measures\where is training needed	* Tracking of changes in the sector * Investing in education programs
I_19_SME	training measures\courses attended	Yes, on Climate Change.
I_16_public_body	Business activities	Spatial planning * Climate change * Coastal management * Risk management
I_16_public_body	Business activities\Customers	Public administrations at local, regional and national * Private sector
I_16_public_body	Business activities\type of service\most frequently requested	Images for Spatial planning purpose
I_16_public_body	Workflow\most frequent taks/services requested	* Data analysis and elaboration

I_16_public_body	Workflow\pre-defined wf	Acquisition of images for Spatial planning
I_16_public_body	Workflow\responsabilities workflow	All the team (10 people) is responsible for each thematic area
I_16_public_body	Copernicus data/ services	Only data from Sentinel-1
I_16_public_body	Workflow\limitations	Yes, in case of requests of radar images. More support from ESA would be useful
I_16_public_body	training measures\where is training needed	* Radar images
I_16_public_body	Workflow\changes	* Artificial Intelligence
I_16_public_body	workforce\demand	* Artificial Intelligence
I_16_public_body	training measures\training offers	Yes, specific courses on: raise awareness on the uses of space data, use of images, access to data, Copernicus program, satellite applications (related to Spatial planning, coastal management and risk management)
I_16_public_body	training measures\courses attended	Radar images
I_06_public_body	Business activities	Managing programmes, missions * Research * No business branches, but promote industrial business * Supporting industries * Part of Ministry
I_06_public_body	Business activities\Customers	Governmental agencies * Institutional users
I_06_public_body	Business activities\type of service\most frequently requested	Directly manage EO missions (Cosmo Skymed etc) * Centre for Emergency (data on demand) * Mirror site for Italy (management)
I_06_public_body	Workflow\most frequent taks/services requested	Deliver data as data provider to other centers of competence (mainly public organizations,
I_06_public_body	Workflow\most frequent taks/services requested	* (and finally civil protection)
I_06_public_body	Workflow\pre-defined wf	Develop scientific space data center, new development for EO * Collects data from ground segments * Possibly at level 2 etc. * Access to community
I_06_public_body	workforce\prefered educational profile	* Only post-graduate education you develop mixed profiles

I_06_public_body	Workflow\responsabilities workflow	Recently changed to in-house research! * Not only traditional remote sensing * Also extracting parameters, * EO & data analytics (standard RS profile, processing from L0 to L3, integrate different types of data with urban science data * Only post-graduate education you develop mixed profiles * Cross-boundary education * Mathematical methods
I_06_public_body	workforce\demand	* Cross-boundary education
I_06_public_body	workforce\soft skills	* Would also feel comfortable with motivation to do specific operational tasks (training on the job, flanking)
I_06_public_body	Workflow\changes	New tasks may not be taken over by machines (quality evaluations) * New challenges with data integration, statistics, re-purpose of data
I_06_public_body	Copernicus data/ services	* Yes (naturally)
I_06_public_body	training measures\comments	* Not yet, because training only recently started * Use webinars (like NASA) * External material needs to be more harmonized and streamlined
I_06_public_body	training measures\in-house traing	* Offer internships * Supervise students, selected * Also linked to other duties within Copernicus
I_06_public_body	training measures\courses attended	Yes, use external professionals or attending courses

I_22_NGO	training measures\training offers	Within this framework, the Association is thoroughly active in promoting the concept of a spatially enabled society. Among the projects followed, SGI, together AM/FM GIS Italia (with whom it has a Memorandum regarding collaboration on innovative themes relevant to GI) and other subjects, promoted the new professional profile "Geographic Information Manager" (GIM) and it participate to the project of UNINFO (the Italian regulatory agency for ICT): "Not regulated Professional Activities - Generation 3 European ICT Professional Profiles: Geographic Information Profiles". Always within the geospatial field, SGI organizes training initiatives such as, for example, the OpenGeoData School, aimed at involving wide categories of citizens, engaging them on open geospatial data as well as technologies and services available thanks to mobile devices (smartphones and tablets) and promoting their use in the context of professional activities, or related to cultural and recreational interests.
I_07_SME	Business activities	Cloud-based spatial handling
I_07_SME	Business activities\Customers	patial service provider (internal divisions of public authorities, etc)
I_07_SME	Workflow\pre-defined wf	* Production of fundamental software structures and infrastructure
I_07_SME	training measures\where is training needed	Software development * Less content, more engineering
I_07_SME	workforce\applicants	* Skilled people are directly hired
I_07_SME	workforce	No job announcement * Workflows further optimized, less people * Skilled people are directly hired
I_07_SME	Business activities\future business drivers	* Software is interface between geospatial data and cloud as a layer
I_07_SME	training measures\where is training needed	Standardization * Geospatial/software
I_07_SME	workforce\demand	* Standardization * Geospatial/software
I_07_SME	training measures\in-house traing	Active involvement in standardization efforts * Training is too late

I_03_largeCompany	Business activities	provides a range of products (hardware, software, solutions) in various fields or industries
I_03_largeCompany	Business activities	Within (the company) we have two primary business foci, horizontal (eCognition suite), and a raising focus on vertical solutions (specific image analysis problem, like the eCog oil palm plantation). Data sources for verticals: whole range of data gathered by UAV, up to Sentinel-2
I_01_SME	Workflow\educational background	Analysen -> Masterabschluss + Berufserfahrung bzw. Bachelor mit reichlich Berufserfahrung d. Weiterentwicklung /Research -> sollte PhD haben e. Visualisierung wird von einer Person gehandhabt, einschlägige Ausbildung f. Admin -> teilweise CEO, teilweise MitarbeiterInnen g. Kundenakquise: CEO, teilweise auch durch MitarbeiterInnen, h. Projektanträge wird durch CEO durchgeführt, langjährige Erfahrung + Kontakte,
I_01_SME	Workflow\limitations	Teilweise fehlen technische Mittel, dies wird durch Weitergabe der (Teil)Aufträge an kooperierende Unternehmen ausgeglichen
I_25_SME	Business activities	* Consultancy in remote sensing and GIS * Application development mainly using SAR data * Data processing (optical and radar) * Products for forestry, soil moisture mapping, land cover / land use, DEM generation, InSAR * Trainings
I_25_SME	Business activities\Customers	Public administration at regional, national and international level
I_25_SME	Business activities\type of service\most frequently requested	* Applications development using Sentinel data * Education and consultancy mainly in using SAR data
I_25_SME	Workflow\most frequent taks/services requested	* Gathering user requirements * Relevant spatial data acquisition * Processing of big data * Method development and generation of value-added products
I_25_SME	Workflow\pre-defined wf	* Data acquisition and pre-processing (operational) * Documentation and presentation of results * Workflows are not the same
I_25_SME	Workflow\responsabiliti	* Remote sensing technician

	es workflow	
I_25_SME	Copernicus data/ services	* Sentinel data: 1 and 2 * HRLs: Waterbodies, Urban Atlas * CORINE Land Cover
I_25_SME	Workflow\limitations	* No
I_25_SME	training measures\where is training needed	* Soft skills, working with clients * New technologies (e.g. Tomography SAR TomoSAR)
I_25_SME	Workflow\changes	* More programming skills required * Use of cloud technologies
I_25_SME	workforce\demand	* Experts at BSC and MSc level (EQF 6 – 7)
I_25_SME	workforce\soft skills	Soft skills, working with clients
I_25_SME	training measures\in-house traing	* Training at customer place * SAR remote sensing * Use of open source softwares and sample data
I_25_SME	training measures\where is training needed	* German Aerospace Center (DLR) internal training * Training in TomoSAR
I_25_SME	training measures\training offers	* Training at customer place
I_24_LargeCompany	Business activities\type of service	IT company that provides, software, services and consultancy to local and central public administrations and utility companies.
I_24_LargeCompany	Business activities\Customers	Local and central public administrations and utility companies.
I_24_LargeCompany	Workflow\most frequent taks/services requested	Extract meaningful information from remotely sensed data: i.e. feature recognition, 3d building modelling, terrain (and rooftops) slope derivation, etc.
I_24_LargeCompany	Workflow\responsabilities workflow	. Usually a EO-related service request involves the roles of: data analyst, software developer, system architect, project and account manager;
I_24_LargeCompany	Workflow\responsabilities workflow	Depending on the complexity of the requested service and on the availability of existing software already performing the requested elaboration, the importance of the listed roles may vary; For example, software developer and system architect might not be needed for an already existing software;
I_24_LargeCompany	workforce\prefered educational profile	. Most relevant role is data analyst skilled in EO data analysis and elaboration;
I_24_LargeCompany	Workflow\responsabilities workflow	. Most relevant role is data analyst skilled in EO data analysis and elaboration;

I_24_LargeCompany	Workflow\pre-defined wf	. 3d building modelling is usually achieved via pre-defined workflows, as well as single tree identification from LiDAR data; . Different requests have usually different workflows with few of little overlap;
I_24_LargeCompany	Workflow\responsabilities workflow	. The project manager of the project the request is related to;
I_24_LargeCompany	Copernicus data/ services	. We used Copernicus data in a limited way but we plan to use them more in future projects;
I_24_LargeCompany	Workflow\limitations	. No, we are usually capable to cope with all service requests either because we have inhouse skilled staff, or capability to self-train on lacking skills, or partner agreements with other companies already having the necessary skills;
I_24_LargeCompany	training measures\where is training needed	. EO data elaboration
I_24_LargeCompany	training measures	. In-house intensive training (or online if inhouse is not available)
I_24_LargeCompany	training measures\courses attended	. ESRI's training modules on ArcGIS, Python, etc
I_23_SME	Business activities\Customers	* Public administrations, local, regional, national, international level * Private companies
I_23_SME	Business activities\type of service\most frequently requested	* Consulting for downstream services
I_23_SME	Workflow\most frequent taks/services requested	* Understand the client's need (in terms of data) * Understand how the client wants to use these data * Develop a way to implement the service provided in the specific framework of the client
I_23_SME	Workflow\pre-defined wf	* Provide a software in the agriculture sector Workflow: 1. Understand user's need 2. Translate the need in technical requirements to be elaborated by the IT Department 3. Develop the software The workflow may change depending on the kind of client and the kind of need
I_23_SME	Workflow\responsabilities workflow	* Head of EO division

I_23_SME	Copernicus data/ services	* Copernicus marine monitoring data * Copernicus atmosphere monitoring service
I_23_SME	Workflow\limitations	* Collaborating with sub-contractors, in particular graphic designer
I_23_SME	training measures\where is training needed	* IT department do not have enough experience in the use of multidimensional data
I_23_SME	training measures	* Attending EO seminars and workshops
I_23_SME	training measures\courses attended	ESRI course
I_23_SME	training measures\courses attended	Course on spectral images
I_14_large_company	Business activities	* Earth Observation * Geoformation * Project consulting * Special areas of interest department for agriculture, geology, Forest, climate change, * UN Red Project * Land registry * Emergency mapping
I_14_large_company	Business activities\Customers	* International organizations * Defense & security * Business * Infrastructure * Oil & Gas
I_14_large_company	Business activities\type of service\most frequently requested	* Data reception satellite data –receiving station * Distribution & sales of data * Digital image processing * Mapping, * Sentinel 1+2 data
I_14_large_company	Workflow\most frequent taks/services requested	* Service request department of image processing o client acquisition o communication o data search o acquire data o digital image processing/ software o programming
I_14_large_company	Workflow\pre-defined wf	* for standardized products standardized workflows are used
I_14_large_company	Workflow\responsabilities workflow	* Person responsible for data processing and data processing 80-90% working with software and 10-20% quality control * Divided responsibilities

		* customer/client contact less
I_14_large_company	training measures\where is training needed	* Cloud solutions (expertize is growing) * Working in international projects also Copernicus * Programming - GIS and Earth Observation * Communication platforms – Scrum, project organisation
I_14_large_company	training measures\in-house traing	* Technical meetings * Presentations by colleagues * Parent company organizes trainings * HR development program
I_14_large_company	training measures\comments	If external training online/ on demand and short one day courses is prefered
I_12-13_SME	Business activities\type of service	* Satellite based environmental monitoring * 5 main pillars: agriculture & rural; energy & infrastructure; Environment & Natural Resources; ICT and Transport; Urban & Population * Data reseller * EODC data storage & processing * complete value chain business analytics trainings etc. * through the growth of the company a verticalization process was initiated
I_12-13_SME	Business activities\Customers	Governmental organisations * Local authorities and municipalities * Financial institutions * Map data providers * Urban services industries * Insurances * Policy makers * Governments * Agencies * Commodity traders * Farmers * Insurances * etc
I_12-13_SME	Workflow\most frequent taks/services requested	* Admin tasks * Clarify service request details with customer * Specify customer requirements * Technician is either from the beginning involved or gets information since the colleagues sit together (close contact, share office space) * If the project is bigger more than one technician

		is involved
I_12-13_SME	Workflow\pre-defined wf	* Workflows are not documented as such, since the company is grown very fast * Project management tasks/workflows are documented
I_12-13_SME	Workflow\responsabilities workflow	* Project manager is responsible (depending on the size of the project) for customer contact, sales, conceptualization and quality assurance * In smaller projects theproject manager is responsible for the development of technical solutions/support as well as the customer contact * If the project is bigger technician get involved
I_12-13_SME	Copernicus data/ services	* supplier of Copernicus data and services
I_12-13_SME	training measures\where is training needed	* Technician: Programming, automatic processing, databases, * Project manager: Marketing, Social Media, project management, manager trainings
I_12-13_SME	training measures\courses attended	* Technician is registered at UNIGIS Professional
I_12-13_SME	training measures\in-house traing	* Experienced technicians present their work * If someone attended a training presents something on the newly learned
I_12-13_SME	training measures\training offers	2-3 day training, face to face is preferred over online training
I_11_large_company	Business activities\type of service	3 main pillars * Software distribution * Software development * Consulting (specific, technical complex implementation projects)
I_11_large_company	Business activities\Customers	* From small municipalities to federal agencies * Public insurance companies * Business, industry, trade (ÖBB, OMV)
I_11_large_company	Business activities\type of service\most frequently requested	* Software EO link to distributed software (ESRI) * Sensor specific specifications * Distribution – Support – Training

I_11_large_company	Workflow\most frequent taks/services requested	* customer request, * definition of customer needs, example request: customer has data and needs a specific process to be developed to mine the data (consulting) * conceptualization
I_11_large_company	Workflow\responsabilities workflow	* No strict separation, everybody needs to be a generalist, general flexibility and openness are requirements to be hired, a person is responsible for all tasks within a service request, staff is responsible for a service request from beginning to the end such as: * Distribution * Account management * Support * Training
I_11_large_company	Workflow\limitations	* If needed external expertise is requested by Universities and long-term contacts to specific University professional personnel
I_11_large_company	training measures\where is training needed	* ESRI certificates are a must for newbies in the job * Internal job training is organized – training for trainers * Soft skills from external training offers – rhetoric, databases, Oracle,
I_11_large_company	workforce\soft skills	Soft skills from external training offers – rhetoric,
I_11_large_company	workforce\demand	* Copernicus is not yet a big topic in contact with customers, it is more or less an exotic topic covered by universities * Drones * Cloud solutions (emotional and legal barriers) still a difficult topic but first big company (ÖBB) is a customer, mostly smaller companies who prefer integrated solutions
I_11_large_company	training measures\in-house traing	Yes, University graduates who start in the company get a training for 12 months which includes certifications for ESRI and technical specification from external training provider i.e. Oracle * Experienced colleagues offer in house training to
I_11_large_company	training measures\courses attended	technical specification from external training provider i.e. Oracle
I_11_large_company	training measures\training offers	Yes, University graduates who start in the company get a training for 12 months which includes certifications for ESRI

I_15_large_company	Business activities\type of service	Data capture and communication technologies (Airborne, Space borne, military and civil applications) * Image processing software developer for automatically and scalable solutions * Sensor development and transfer of data
I_15_large_company	Business activities\Customers	* Defense * Research * Universities in the past * Public authorities * Ordnance survey
I_15_large_company	Workflow\responsabilities workflow	* Distribution (a general knowledge of the sector is needed) * Pre-Sale team * Specialists for specific sectors of the company
I_15_large_company	workforce\soft skills	General soft skills * Communication skills * Language
I_10_SME	Business activities\type of service	3 main pillars * Remote sensing & Research (development of workflows, Geospatial software) * Software development (flight planning, drone flights, digital solutions) * Drones, photogrammetry, §D
I_10_SME	Business activities\Customers	Quite diverse customer base * Remote sensing – Universities, and public authorities, engineers and planner * Software for example for fire protection or facility management, construction industry * Drones also for facility management, construction industry etc
I_10_SME	Business activities\type of service\most frequently requested	Data processing of satellite image data * Atmospheric correction * Orthorectification * Development of automatic workflows * Research projects * Software development

I_10_SME	Workflow\most frequent taks/services requested	Sentinel 2 date workflow * Specifications/Concept – new development or use of former development * Feasibility and costs * Development, set-up, test of workflow * Presentation to the customer * Iteration process until the customer is satisfied * 20% concept * 50% development * 30% optimization and quality control
I_10_SME	Workflow\responsabilities workflow	Bigger projects developer and project manager If it is a smaller project only one person responsible * If needed cooperation with other stakeholders/ subcontracts if it is a bigger project
I_10_SME	Copernicus data/ services	See above – Sentinel workflow development etc.
I_10_SME	training measures\where is training needed	Cloud solutions, * ICT in general * Online process developments * Big data analysis (technical possibilities to effectively incorporate Copernicus data * Diversity on platforms to access data/information, for SME little information how it is possible to efficiently integrate data in company workflows * Impression that Small companies don´t get the latest data * Development tools – which toll are available from ESA and EU
I_02_SME	Workflow\pre-defined wf	workflows differ, depending on service request * Mainly: data search, pre-processing, analysis and post-processing
I_02_SME	Workflow\pre-defined wf	Workflows are not standardized, customer requests differ too much to transfer
I_02_SME	Workflow\most frequent taks/services requested	Mainly: data search, pre-processing, analysis and post-processing
I_02_SME	Workflow\responsabilities workflow	Deepens on customer, * Mostly the CEO gets service request * Involves specialists to develop offer * mostly the specialist is doing the implementation * customer acquisition depends on customer, mostly CEO
I_02_SME	Business activities\Customers	NGOs, public authorities, private

I_02_SME	Business activities\type of service	* Emergency service * Risk & Vulnerability * Research projects
I_02_SME	Business activities\type of service\most frequently requested	Emergency service * Risk & Vulnerability
I_02_SME	Business activities\type of service\most frequently requested	analysis and data processing
I_02_SME	workforce\prefered educational profile	preferred educational profiles are Master graduate, Geoinformatics professional with EO focus or Bachelor graduate with professional experience, but also a person with no academic education but a longer professional experience in the field
I_02_SME	Copernicus data/ services	Sentinel data for overview, not for detailed analysis * Use of commercial HR or VHR data
I_02_SME	Workflow\limitations	The only problem is the project size, if too big not enough human resources
I_02_SME	training measures\where is training needed	For the specialist additional training in project management, customer service and practical experience in academic education would be necessary
I_02_SME	training measures\in-house traing	The company is closely related to University * The colleagues help each other
I_10_SME	workforce	Practical relevance * Free of charge, open access * Online * Limited to 2-3 hours * On demand
I_02_SME	training measures	Webinar, online courses

I_26_large_company	Business activities\type of service	COMPANY ACTIVITIES FOCUS ON THREE FOLLOWING AREAS: SPACE APPLICATIONS AND SERVICES DIVISION Application and Services Division focuses on creating and providing integrated services combining satellite, telecommunication and Earth Observation technologies. Specialization includes mainly GNSS and Earth Observation applications, GIS and crisis management IT systems. Astri Polska is also a country distributor of geoinformation data, including satellite imagery of Airbus Defence and Space satellites OPTICAL GROUND SUPPORT EQUIPMENT (OGSE) * Optical/optomechanical design * Data processing and analysis * Beam propagation (static and uniform media, dynamic and non-uniform media, high-power beam propagation ELECTRICAL GROUND SUPPORT EQUIPMENT (EGSE) * EGSE design and manufacturing for space applications * On Board Computers for Nano/Micro satellites design * ASIC Design dedicated to electrical engineering * Customized Small size and small series hardware
I_26_large_company	Business activities\Customers	i.e Municipalities, regional Government, companies … * ESA, GSA, NCBiR, Airbus - (manufacturing of Ground Support Equipment and software) * Public administrations, national, international level (EO data & services) * Private companies (EO data order) * Universities (EO data order) * Research Units (EO data order) * Public Crisis Management Units (EO data order)
I_26_large_company	Business activities\type of service\most frequently requested	* creation of dedicated web services & platforms based on EO data & products * acquisition and delivery of EO data * delivery of geoinformation products based on EO data (orthophotomaps, DEM, 3D models, specific GIS analysis, algorithms for EO data post-processing etc.) * consulting for application development

I_26_large_company	Workflow\most frequent taks/services requested	data gathering - 10% * data processing & service development - 60% * project management - 15% * customer communication - 15% * informing the customer about EO services & opportunities takes a long time * collecting customer requirements - determining his needs takes a long time * programming of data acquisition consume less time * development of EO services (including dedicated processing algorithms) takes a long time * collaborate with other consultants
I_26_large_company	Workflow\changes	Past: one-off map, new trend: clients require more monitoring concepts, ingesting new satellites, no longer self-contained piece of work. * More requests for more operational and compound EO product & services dedicated for clients' needs * More and more requests about EO products & services from new areas (agriculture, environment, security, crisis management others) – generating needs of using experts specific knowledge
I_26_large_company	workforce	Occupational profiles (i.e. remote sensing technician, key account manager) * Space Application and Services Division Manager – search for new EO business opportunities * Geoinformation Project Manager – managing of GIS&EO projects * Sales Specialist – first contact with potential customers (mainly EO data and services sales) * GIS&EO specialist (creating new EO services concepts, development of EO services & products, data acquisition etc.) * IT team (programmers with geoinformation skills) – support and development of EO applications/software/web services etc.
I_26_large_company	workforce	All Team Members are high-level experts in their main domains (EO/GIS, IT, sales, project management) but also they have many years of experience working together, so their knowledge partly overlaps - it guarantees the success of tasks understanding. 7. Do you use Copernicus data/services?

I_26_large_company	Copernicus data/ services	Main Copernicus products : * Sentinel-1 & -2 data processing and algorithms development * Some GIS&EO products * Dedicated EO (satellite imagery, UAVs etc.) data gathering and processing software & services: * EO web services and applications: - Environmental Management, - Agriculture, - Forest Management, - Crisis Management, - Mapping, - Spatial management. Samples: * River ice monitoring (http://www.eo4sd-eastern.eu/portfolio/product/river-ice-monitoring) * Biomass (http://www.eo4sd-eastern.eu/portfolio/product/biomass)
I_26_large_company	Workflow\limitations	High-level experts in different domains are able to handle most of requests, also Partners and subcontractors are needed.
I_26_large_company	training measures\where is training needed	* Additional courses and training are needed - mainly in programming and new Sentinel data processing. * Technological development cycle faster than educational cycle * Copernicus expert on EQF 5 would be definitely useful!
I_26_large_company	training measures\where is training needed	Main training needs in Organization: * EO (including SAR) data processing Personal development, listen to webinars, participation in dedicated high-level trainings with many examples of EO data usage is needed.
I_26_large_company	training measures\training offers	Team members often benefit from: - online courses, - external trainings, - workshops, - post-graduate studies, - etc.
I_26_large_company	training	Fraunhofer Radar Summer School

	measures\courses attended	
I_27_SME	Business activities	- Special aviation works (e.g. aerial rabies vaccination of foxes and racoon dogs); - Airborne remote sensing surveys using hyperspectral, Lidar, thermal and UV technologies (mainly for nature conservation and environment protection services); - Remote sensing and EO data-based application development (e.g. lake quality assessment, forest monitoring); - Aerial surveillance missions (for nature protection and public security purposes).
I_27_SME	Business activities\Customers	State institutions and municipalities; - Nature protection organizations; - Research institutes; - Private companies owning and managing natural resources.
I_27_SME	Business activities\type of service\most frequently requested	Remote sensing data acquisition and analysis for a specific purpose (as one-time activity, not on regular basis); - Special aviation works (assessment of situation after natural disasters (e.g. storms, snow-falls).
I_27_SME	Workflow\most frequent taks/services requested	- Definition of customer requirements (communication with the customer) – 30% - Planning of data acquisition campaigns (project management) – 20% - Data acquisition in proper way and appropriate weather conditions (preparation and operation of remote sensing technologies onboard the aircraft) – 10%; - Data processing and analysis (use of existing software products as well as development and improvement of data classification algorithms) – 40%.
I_27_SME	Workflow\pre-defined wf	The processes of remote sensing survey planning, data acquisition and remote sensing and EO data pre-processing have pre-defined workflows; the data analysis and interpretation is science and art at the same time and varies from project to project. Many of the services provided by the company are customized to a particular client and do not have reoccurring character.

I_27_SME	workforce	1. Director / owner of the company – responsible for sales, customer relationship building and networking; identification of customer needs; 2. Remote sensing specialists / senior researchers – responsible for customer requirement definition and designing of data acquisition, data quality control, and data analysis; communication with the customer about the final deliverables; 3. Remote sensing specialists / research technicians – responsible for data pre-processing; 4. Remote sensing technician – responsible for obtaining of flight permissions, data acquisition, operation of remote sensing technologies;
I_27_SME	Copernicus data/ services	The company uses Sentinel 1 and Sentinel 2 data as one data layer in the final product. Recently, the company launched an R&D project about the human settlement pattern modelling based on multiple data sources, including Sentinel 2 data (for land use – land cover classification).
I_27_SME	Workflow\limitations	Yes. These are services related to the needs to assess the condition of civil engineering objects in urban environments at extremely high accuracy level. The company does not specialize in such services. Its focus is on natural resources and natural environment.
I_27_SME	Workflow\changes	With the growing competition and increasing number of players in the EO sector, the company is thinking a lot about the development of niche services and more complex solutions that require multi-disciplinary knowledge base and would be based on multiple data sources (ground data, drones, IoT, satellite data, citizen science etc.). Preparation for future is happening through attendance of international conferences, workshops, participation in international projects (EU funded projects) where there is an opportunity to learn from others, visit partner organizations.

I_27_SME	workforce\demand	With the growing competition and increasing number of players in the EO sector, the company is thinking a lot about the development of niche services and more complex solutions that require multi-disciplinary knowledge base and would be based on multiple data sources (ground data, drones, IoT, satellite data, citizen science etc.). Preparation for future is happening through attendance of international conferences, workshops, participation in international projects (EU funded projects) where there is an opportunity to learn from others, visit partner organizations.
I_27_SME	training measures\where is training needed	- Data analysis approaches and tools (online courses, interaction with others in professional web-based discussion forums); - Customer need analysis and rapid prototyping (in-house training); - Project management and management of multi-disciplinary teams (in-house training, attendance of external courses); - Global development trends and challenges (TED talks, The in-house training would take place in the form of a crush-course (very intense two-day training), online courses can last for longer, e.g. several months.
I_27_SME	training measures\courses attended	Rapid prototyping (in-house training provided by external expert) Business intelligence (Coursea course) Machine learning (Coursea course)
I_28_SME	Business activities	Engineering office that provides surveying, planning, mapping, controlling, consulting and research services in environmental geoscience * Environmental Impact Assessment and environmental construction consultancy * Climate impacts and adaptation strategies
I_28_SME	Business activities\Customers	* Private companies and public administrations at national and international level * Mainly local authorities
I_28_SME	Business activities\type of service\most frequently requested	* EO data are used for surveying, planning and mapping tasks (mainly airborne data, Google Maps) * EO data serve as an additional geodata source
I_28_SME	Workflow\most frequent	* Surveying, mapping and planning, e.g. land use

	taks/services requested	planning
I_28_SME	Workflow\pre-defined wf	From data acquisition to classification results * Workflows are different and project-related
I_28_SME	Workflow\responsabilities workflow	Company's administration (office manager, managing director)
I_28_SME	Copernicus data/ services	* No (not yet)
I_28_SME	Workflow\limitations	No * Projects are selected based on the company's experience and expertise
I_28_SME	training measures\where is training needed	Training is provided when required (e.g. internal soft skills training) * Employees train themselves e.g. through webinars (young employees)
I_28_SME	workforce\prefered educational profile	Mainly employees with EQF 6 and higher * Prefer MSc level, not necessarily PhD
I_28_SME	training measures\training offers	* Yes but only by request * The training is tailored to the clients' needs
I_28_SME	training measures\courses attended	Introduction to QGIS
I_29_public_body	Business activities	Acquisition and maintenance of the EO/GIS data (geodata) * Development of GEO-based solutions for forestry * Production of digital maps * Applied science in remote sensing and navigation
I_29_public_body	Business activities\Customers	Public administration at regional and national level (ThüringenForst, nature conservation organizations) * General public
I_29_public_body	Business activities\type of service\most frequently requested	Data acquisition for forest inventory (mainly aerial images) * Change detection: detection of forest disturbances, rapid mapping
I_29_public_body	Workflow\most frequent taks/services requested	Processing the data
I_29_public_body	Workflow\pre-defined wf	User requirements * Data acquisition and processing
I_29_public_body	Workflow\responsabilities workflow	Head of Division (Diploma)
I_29_public_body	Copernicus data/ services	Copernicus HRL: Forests * Sentinel data: 1&2
I_29_public_body	Workflow\limitations	* No/yes. The bottleneck is seen more in the limited processing capacity (old IT infrastructure) as well as task related costs (e.g. costs of new

		softwares)
I_29_public_body	training measures\where is training needed	* Data processing using dedicated software
I_29_public_body	training measures\where is training needed	More programming skills required (especially in open source softwares, programming languages such as R, Python)
I_29_public_body	training measures\in-house traing	* Use of ForstamtsGIS (GIS application for foresters) * Use of GIS/remote sensing data within the ForstamtsGIS
I_29_public_body	training measures\courses attended	In ArcGIS (ESRI) * Programming in Python * In ERDAS (Spatial Modeler)
I_29_public_body	training measures\comments	Use of new methods and technologies, e.g. cloud computing, big data processing, is under discussion. Limited experience exists.