

Bridging the Skills Gap in Remote Sensing and GIS: Insights from the ReSENSE Project

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ABSTRACT

Identifying Geographic Information Systems (GIS) and Remote Sensing (RS) as indispensable tools underscores the critical demand for skilled professionals in land-use mapping, urban morphology analysis, vegetation monitoring, and disaster management.

Despite this demand, the lack of experts limits the effective application of these technologies in both academic and professional contexts. The Remote Sensing Technology Training (ReSENSE) project, funded by Erasmus+, aims to bridge this gap by providing targeted vocational education and training in Cartography, RS, GIS, Copernicus Services and Image Processing including emerging technologies such as cloud computing, Information and Communication Technologies (ICT), the Internet of Things (IoT), Machine Learning (ML), and Artificial Intelligence (AI).

This study presents key findings from a comprehensive survey conducted in Cyprus and Greece, assessing the training needs of professionals in environmental and governmental sectors. To address these challenges, ReSENSE offers accessible, hands-on training opportunities both in person and remotely to meet the growing demand in the industry. It is vital to enhance participants' educational experience through upskilling and reskilling. By making these resources widely available, the project enhances professional competencies, fosters career advancement, and expands opportunities in sectors that increasingly rely on GIS and RS technologies.

Keywords: Remote sensing, GIS, Vocational Training, Skills Development

1. INTRODUCTION

Remote sensing and Earth Observation (EO) are used to acquire information about the Earth's surface and analyze its physical characteristics without requiring physical contact. Specifically, it utilizes reflected, emitted, or returned electromagnetic radiation at a distance, typically from satellites or aircraft ¹. According to the literature, the available observations since 1980, along with the increasing number of earth observation satellites and availability of imagery, have been widely used in numerous applications for research and monitoring ^{2,3}. These applications include agriculture ^{4,5}, forestry ⁶⁻⁹, natural hazards ¹⁰⁻¹³, defense and security^{14,15}, atmosphere ^{16,17}, energy ¹⁸, cultural heritage ¹⁹⁻²¹, marine pollution ²², coastal erosion^{23,24} and many other topics.

The growing use of remotely sensed data by industry and government is well-documented and supported by numerous studies and market trends. Reports indicate that the remote sensing technology market, valued at approximately \$17.53 billion in 2022, is expected to grow at a CAGR (Compound Annual Growth Rate) of 11.6% from 2023 to 2030²⁵. Furthermore, the EO sector provides a wide range of social, environmental, and economic benefits not only to the citizens of Europe but also to the global community by supporting critical applications such as urban planning, disaster management, and sustainable development.

Remote sensing has advanced rapidly through technological innovation and multinational collaboration in satellite launches. As of May 1, 2023, the Union of Concerned Scientists (UCS) reports 7,560 satellites in orbit, primarily for communication (73.07%), Earth observation (16.65%), and technology development (4.95%). Satellites, operated by 75 countries and regions, facilitate global data exchange, supporting international cooperation^{26,27}. Remote sensing and Geographic Information Systems are essential tools in disciplines like geography and environmental science, particularly for analyzing urban globalization through spatial analysis and map visualization. This synergy between remote sensing advancements and globalization continues to drive technological and societal progress²⁷.

Academics and civil society organizations have increasingly employed GIS and RS as valuable tools. These technologies enable detailed land-use mapping, urban morphology analysis, vegetation distribution assessment, and disaster management²⁸. Their applications extend to environmental and socioeconomic risk assessments, including disaster mitigation at local scales, as well as cumulative and strategic impact assessments at regional, national, and global scales. Additionally, these tools are instrumental in analyzing industry-wide land use trends, offering insights that inform sustainable planning and decision-making processes²⁹.

According to the European Association of Remote Sensing Companies (EARSC) Industry Survey, the total revenue in the sector for 2023 reached €2.27 billion, representing a significant increase over the previous year. Moreover, the sector has seen notable growth in employment. In 2023, the total number of employees in the Earth Observation sector reached 14,928, representing a growth rate of 8.3% over the past twelve months. This increase underscores the sector's expanding workforce and its crucial role in fostering innovation, driving economic growth, and delivering societal benefits throughout Europe and beyond. However, challenges remain in filling open positions. Surveyed companies reported significant barriers to hiring skilled employees, with the main challenge being a lack of knowledge and skills in new technologies, as noted by approximately 30% of respondents³⁰.

This growing demand highlights a significant skills gap, as the rapid integration of advanced technologies such as cloud computing, artificial intelligence, and machine learning and the Internet of Things (IoT), continues to exceed the ability of existing educational systems to train adequately skilled professionals in geospatial fields.

Furthermore, traditional education often does not reach underemployed professionals, recent graduates and employees in small and medium-sized enterprises (SMEs), who are most in need of upskilling or reskilling opportunities³¹. These individuals face barriers such as limited time, lack of access to up-to-date resources, and ignorance about the emerging environmental applications of Information Systems and Geographic Information Systems (GIS). To address this problem, the European Commission is promoting digital readiness, green transition skills and lifelong learning through the Digital Education Action Plan and the Skills Agenda³². In response, the Erasmus+-funded ReSENSE project aims to bridge the skills gap through targeted vocational training in Cyprus and Greece, and beyond, with a strong focus on remote sensing, GIS, Copernicus services, ICT and AI for environmental applications.

ReSENSE adopts a hybrid education model, including the creation of customized learning materials, an online Moodle classroom, and both virtual and in-person workshops. The curriculum is shaped by a comprehensive survey of industry and academic stakeholders, targeting the most relevant emerging technologies, such as precision agriculture, environmental monitoring, and disaster response. This paper presents the background and motivations for ReSENSE, focusing on the training needs identified through stakeholder consultation and research analysis. It describes the project's role in addressing the evolving labor market demands and environmental challenges faced by Mediterranean regions, such as Cyprus and Greece.

2. METHODOLOGY

The methodological framework of the ReSENSE project followed a structured, three-phase approach designed to identify existing skills gaps, prioritize training content, and select suitable target participants for vocational education in RS, Geographic Information GIS, and related geospatial technologies as presented in Figure 1. This process formed the basis for the development and implementation of training activities across Cyprus and Greece.

To capture sector-specific needs and stakeholder perspectives, the consortium employed a combination of qualitative and quantitative techniques. Custom-designed questionnaires were developed and distributed as part of the project's initial phase.

These tools were intended to assess the perceived relevance of various training topics, the current skill levels of potential participants, and the sectoral demands for upskilling and reskilling.

Questionnaires were developed within the scope of the project to help the consortium identify the importance and current training needs on remote sensing, GIS, and other relevant topic areas. The questionnaires comply with the General Data Protection Regulation (GDPR).

The data collection was conducted through stakeholder events and through direct communication with industry stakeholders, academic partners, and new graduates in both countries, enabling broad input across the environmental and geospatial sectors.

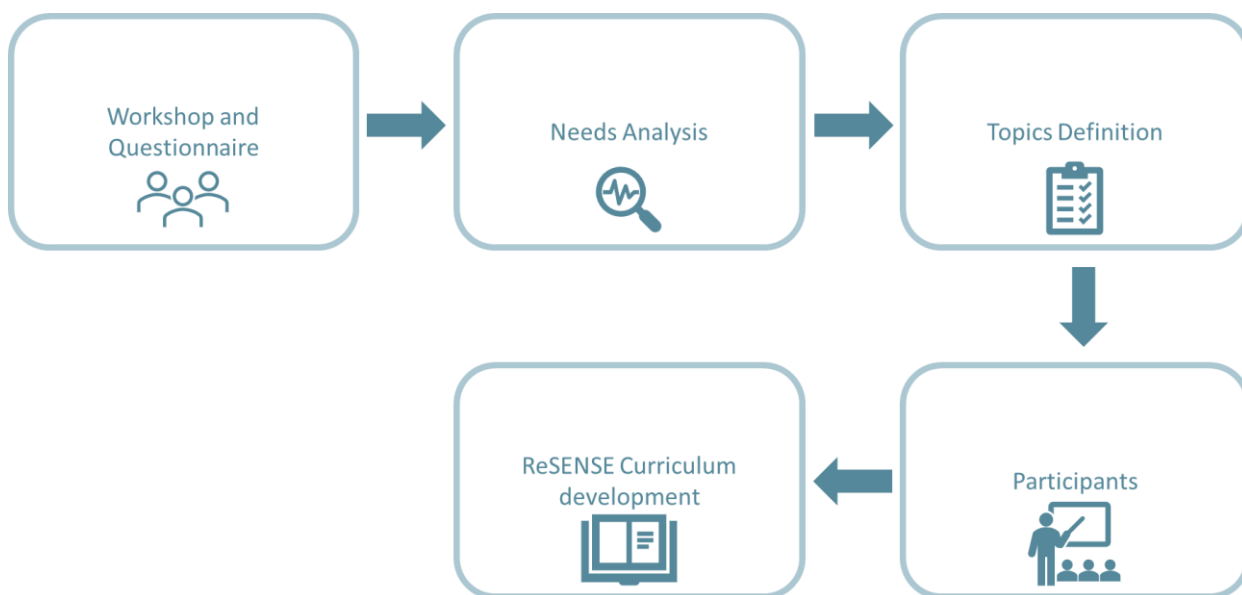


Figure 1 Methodological framework of the ReSENSE project

3. RESULTS AND DISCUSSION

This section presents the key findings obtained through two complementary tools: (i) a Mentimeter-based interactive workshop, and (ii) a structured questionnaire distributed to postgraduate students and industry

professionals. These tools aimed to identify existing knowledge levels, sectoral interests, and training needs in Remote Sensing (RS), Geographic Information Systems (GIS), and emerging digital technologies.

3.1 Results from Mentimeter Survey

The Mentimeter survey was conducted during a workshop session at the 10th International Conference on Remote Sensing and Geoinformation of the Environment (RSCy2024) with 24 participants from different backgrounds registered. Participants responded live to a series of questions regarding their background and familiarity with geospatial technologies.

Age distribution: The majority of participants were aged 25-34 (36%), followed by 35-44 (29%) and 45-54 (14%). The 18-24 and 55-64 groups each represented 7%, with only one participant aged 65 or older.

Geographic Origin: Most participants were from Cyprus (66%), followed by Greece (20%). A smaller percentage (7%) represents other European countries, with no participants from outside Europe, highlighting a primarily regional, European response.

Educational background: Respondents came from diverse fields including Forestry, Engineering, GIS, Business Development, Computer Science, Physics, Remote Sensing, and Social Sciences.

Professional Sectors: There was a diverse field of work of the participants, with Agriculture Payments and Remote sensing being the most frequently mentioned answers. Other fields included researchers, Surveying Engineering, Consulting, Earth Surveillance, Geomatics, IoT, Land Cover, Project Management, Research Engineer, Robotics and Software Development. Through these answers the broad applicability of remote sensing and GIS technologies are highlighted across different industries/backgrounds.

Familiarity with Remote Sensing and GIS: As seen in Figure 2, a significant percentage, 36% considered themselves experts, and another 36% had basic knowledge of Remote Sensing. Additionally, 21% were pretty familiar with it. Regarding the GIS a significant number of the participants, a 38%, considered themselves experts and another 38% were pretty familiar. Those with basic knowledge comprised 15% and 8% knew nothing about GIS. This distribution mirrors familiarity with remote sensing, indicating a range of experience levels among the survey participants.

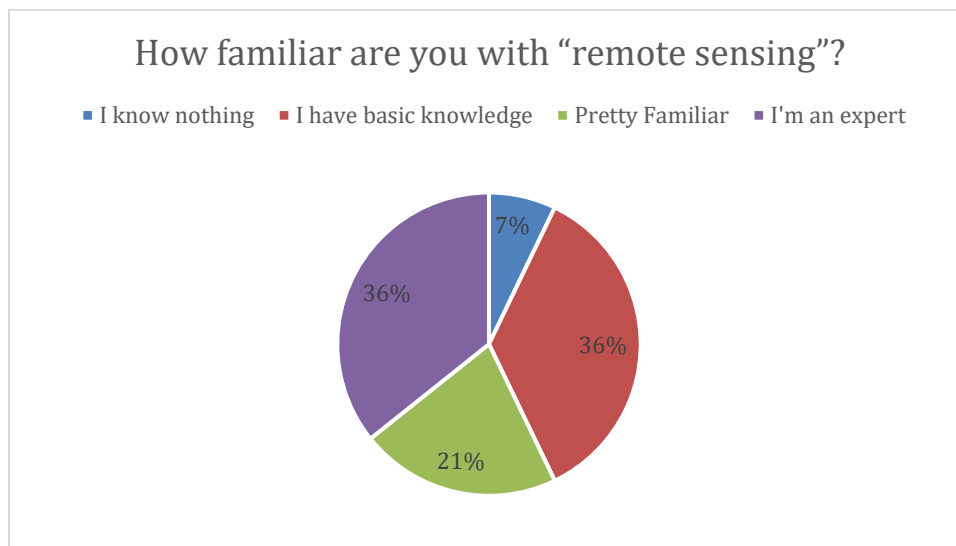


Figure 2 Results on Familiarity with Remote Sensing

Topic interest: The majority of participants showed significant interest in several topic areas, according to Figure 3. Agriculture and Forestry is preferred, with 34% of respondents. Environmental Monitoring followed closely at 27%, and Smart Cities and Infrastructure showed 23% interest. Disaster Risk Management was of interest to 8% of respondents, while another 8% listed other areas.

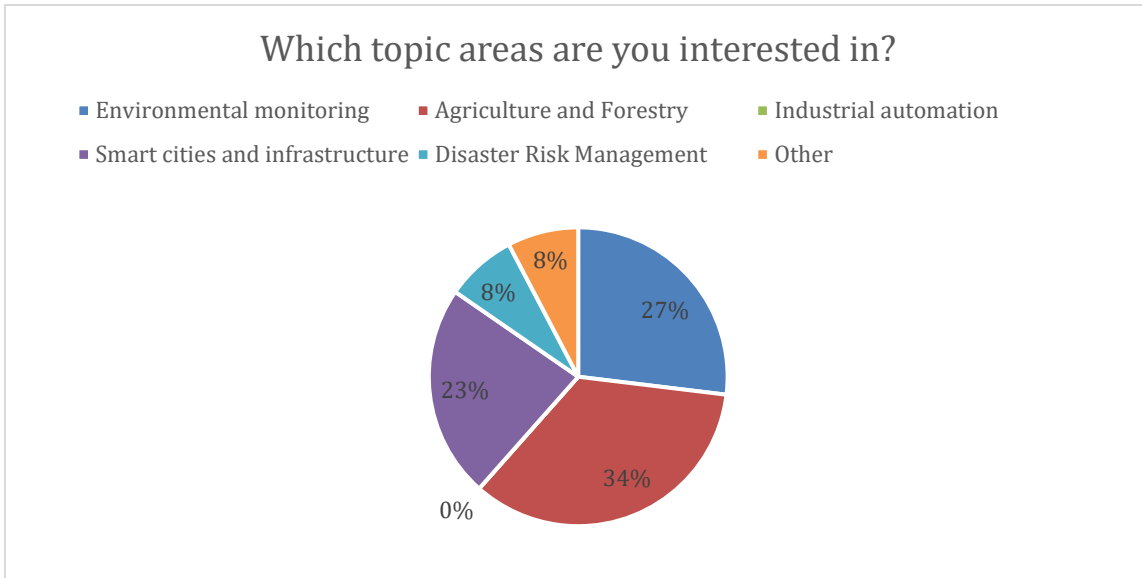


Figure 3 Participants areas of interest in Remote Sensing

Training preferences: Most of the respondents (60%) expressed a preference for in-person training sessions. An additional 20% favored online training, while the remaining 20% opted for a hybrid model that combines both in-person and online formats.

Motivation for training: As seen in Figure 4, the leading motivation, with 8 mentions, for participating in remote sensing and GIS training, was enhancing job performance. This indicates a strong desire among participants to improve their skills for their current roles. Personal interest and curiosity, as well as fulfilling professional development requirements, each had 6 mentions, showing that respondents are driven by both personal and professional growth. Reskilling for career advancement was also a significant motivator, mentioned by 6 respondents, reflecting an interest in expanding their skill set for career progression. Lastly, exploring new career opportunities was mentioned by 2 respondents, indicating some interest in leveraging new skills to transition into different fields or roles.

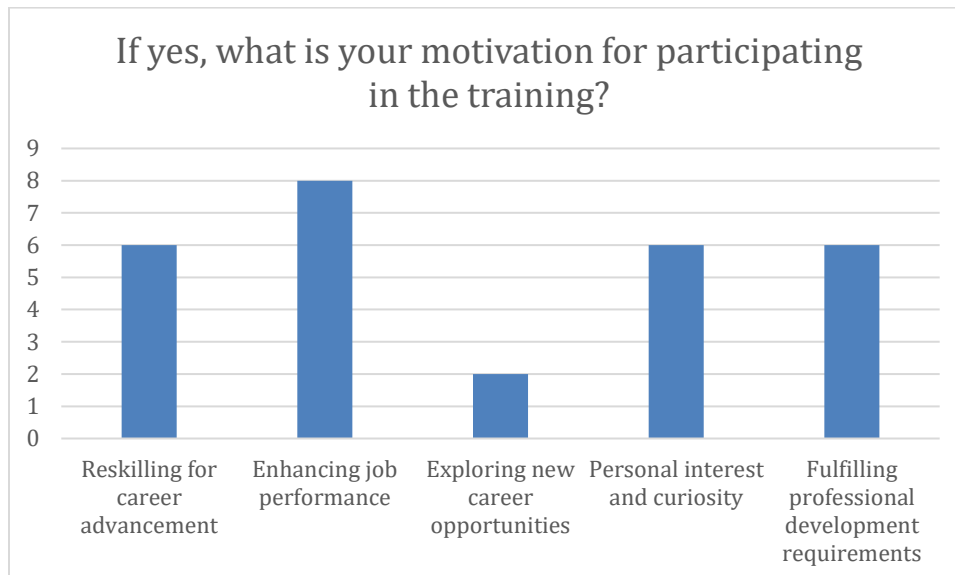


Figure 4 Motivation for participating in training

Through this interactive survey, attendees and experts engaged in discussions and hands-on sessions, gaining valuable insights into cutting-edge methodologies and best practices. This exchange set the stage for transformative advancements in geoinformation and environmental monitoring, particularly in forestry and agriculture.

Part B: Questionnaire results

The analysis of the questionnaire distributed to postgraduate students and employees (including freelancers and companies) is presented in this section, with a total of 74 responders. The questionnaire was prepared to gather feedback on the most common training needs and was divided into six main sections as seen below:

1. Demographic Information

As presented in Figure 5 The respondents include both postgraduate students and professionals, with a relatively balanced gender distribution: 41.9% female and 58.1% male. Nearly half responders are based in Greece (47.3%) and Cyprus (44.6%), with smaller representation from Tunisia(4.1%), Algeria, Egypt, and Turkey (each 1.4%). The largest age group was 45-54 (41.9%), followed by 35-44 (25.7%), with younger groups (25-34 at 6.8% and 18-24 at 4.1%) less represented. In terms of education, most respondents hold a Master's degree (63.5%), indicating a highly educated audience. Doctorate holders make up 25.7%, while participants with Bachelor's degrees, College education, and MS Science Degrees represent smaller percentages (5.4%, 4.1%, and 1.4%, respectively).

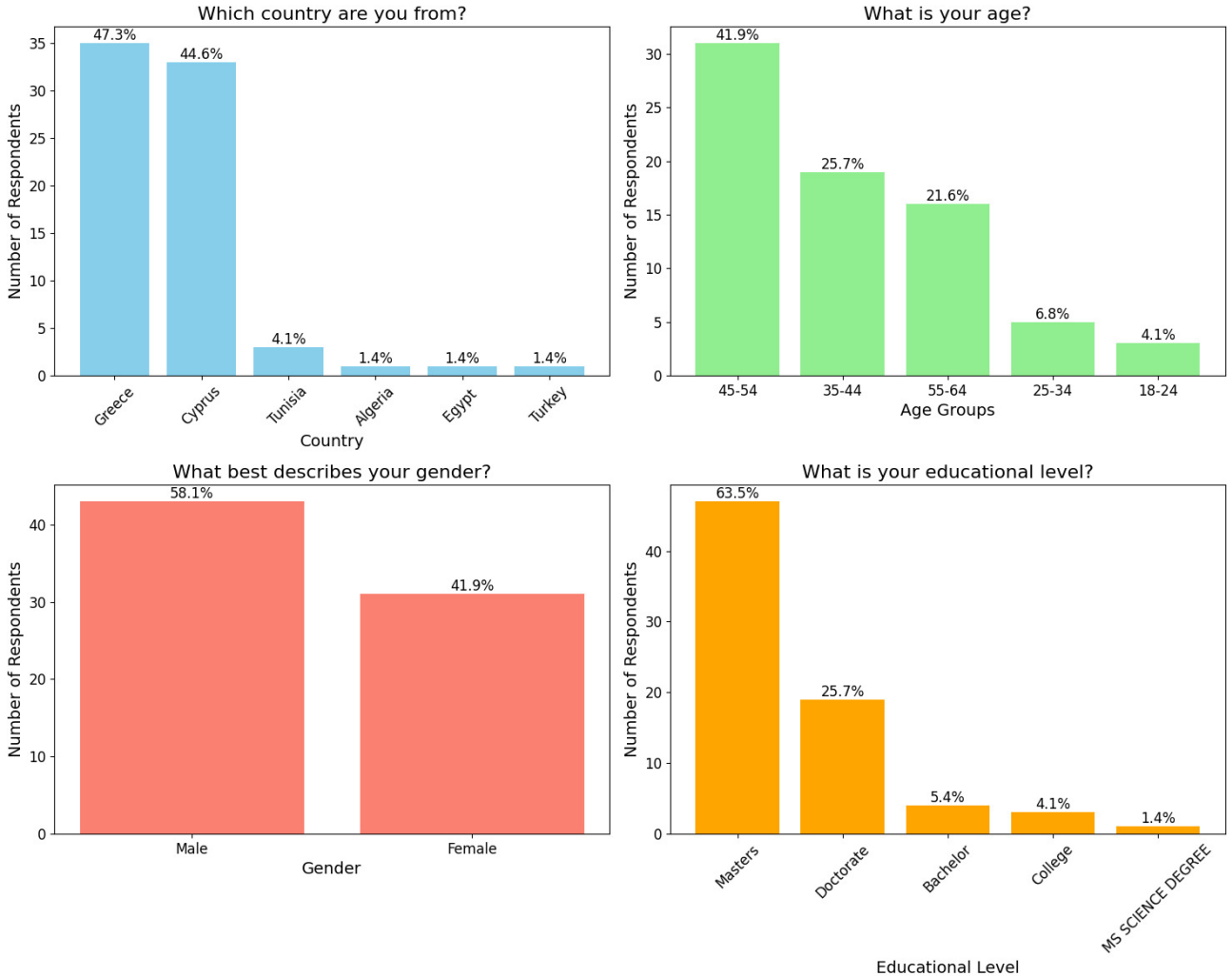


Figure 5 Demographics of the survey respondents

Organization Information

The results from the questionnaire show a diverse range of **educational and scientific backgrounds**, with a strong focus on forestry and environmental sciences. Many participants hold degrees from the Aristotle University of Thessaloniki (APTH) and the International Hellenic University (DI.PA.E.), ranging from bachelor's to doctoral levels. Key fields of study include forestry, natural environment, geosciences, geoinformatics, environmental management, biological sciences, and various engineering disciplines. Additionally, some respondents mentioned backgrounds in public administration, history, archaeology, and art, reflecting a broad spectrum of academic interests.

What best describes the industry your work in?

The results, as shown in Figure 6, present the distribution of respondents across various industries. The majority of participants work in the environmental sector (54.1%), followed by the government and public bodies sector, which consists of 48.6% of respondents. Engineering (21.6%) and research (20.3%) are also significant fields. Education accounts for 9.5% of participants, while manufacturing includes 5.4%. Other industries, such as agriculture, telecommunications, finance, healthcare, media, consulting services for farmers, and forestry, each have minimal representation, with 1.4% of respondents in each. These findings highlight a strong focus on environmental and governmental roles, with notable involvement in engineering, research, and education.

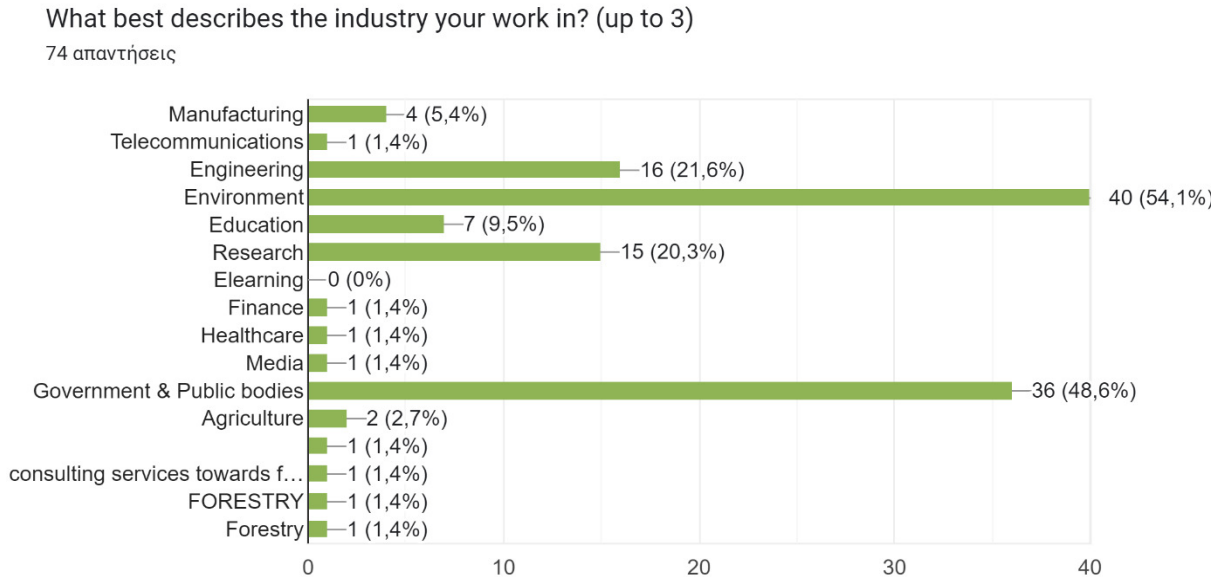


Figure 6 Industry sectors

Do you own or represent an organization?

Based on the responses regarding ownership or representation of an organization, the majority of the respondents do not own or represent an organization. Specifically, the results show that most individuals participating in this survey are likely employees, freelancers, or associates (67.6%) rather than owners or key representatives of an organization (32.4%). This information is useful for understanding the demographic makeup of the group surveyed, which can influence the focus and implementation of organizational strategies, policies, and services.

Organizations: The results indicate a diverse range of organizations primarily based in Greece and Cyprus. These organizations can be divided into five categories:

- 1) Forest Management
- 2) Agricultural and Environmental Organizations
- 3) Local Government Departments
- 4) Research and Innovation
- 5) Private and Nonprofits Companies

What best describes your organization? (up to 3)

The results show that a significant majority (62.5%) of respondents work in governmental organizations. This is followed by micro-small enterprises (20.8%), medium enterprises (8.3%), large enterprises (4.2%), and non-profit organizations (4.2%).

Total employees in each department

Figure 7 displays the total number of employees across various technical departments within an organization. Based on the results derived from our analysis Remote Sensing and Software Development generally have smaller teams, with most departments employing 1–5 people or none at all. Geographic Information Systems (GIS) stands out with a wider range, including several departments with over 50 employees, indicating strong institutional investment. IoT and Data Analysis show moderate capacity, with most teams comprising 1–5 employees but also a few cases of larger teams, suggesting emerging or growing focus areas. Cloud Computing teams are typically small to mid-sized, while ML/AI remains a developing field in most departments, characterized by small or absent teams. Overall, staffing varies widely by domain, reflecting differing levels of technological integration and institutional priorities.

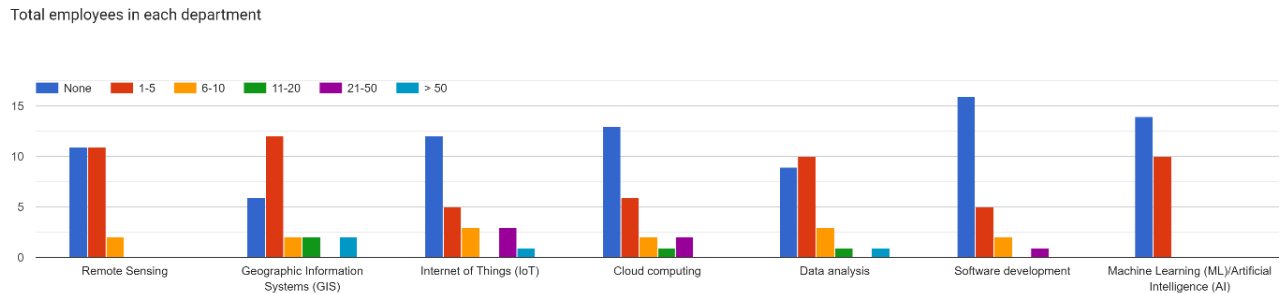


Figure 7 Total employees in each department

In which application areas do you focus on? (up to 3)

According to our results (Figure 8), the most emphasized area is **Natural Resources Management**, with 16 out of 24 respondents (66.7%) indicating a focus on this area. This is followed closely by **Environmental Monitoring and Management**, with 15 out of 24 respondents (62.5%). **Urban and infrastructure planning** are also significant but with a smaller percentage (25%), followed by **Disaster Management and Response** (16.7%) and **Risk Assessment and Mitigation** (12.5%). Other areas like transportation, public health, and marketing, each receiving 0% focus, are not focal points for this particular group.

As shown in Figure 9, **Natural Resources Management** is the most prominent focus area, highlighted by 66.7% of respondents (16 out of 24). **Environmental Monitoring and Management** follows closely, with 62.5% (15 respondents). **Urban and Infrastructure Planning** is also noted, though by a smaller share (25%). Other areas such as **Disaster**

Management and Response (16.7%) and Risk Assessment and Mitigation (12.5%) receive limited attention. Fields like transportation, public health, and marketing received no mentions, indicating they are not priority areas for this group.

In which application areas do you focus on? (up to 3)
24 απαντήσεις

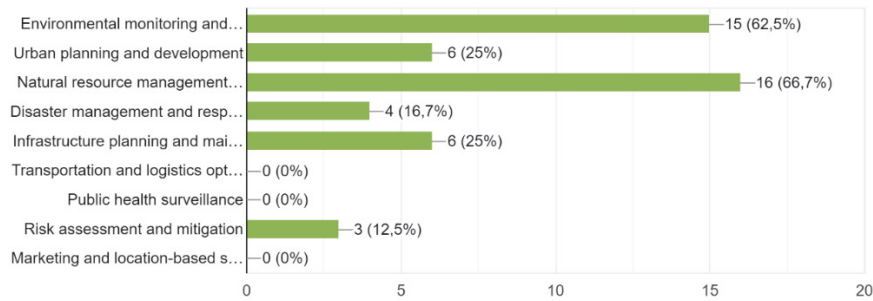


Figure 8 Focus areas in the application of remote sensing

Desktop Research

Based on the results (Figure 9), across all topics, the majority of respondents rated their knowledge as "Limited" or "Basic." For the "Intermediate" and "Advanced" categories, there is a consistent trend of lower numbers. The topic with the highest number of respondents rating their knowledge as "Limited" is Software Development. Additionally, there is a significant gap between the "Limited" and "Advanced" knowledge levels across all topics, indicating an overall lower self-assessed proficiency in these technical areas.

Rate your current knowledge in the following topics:

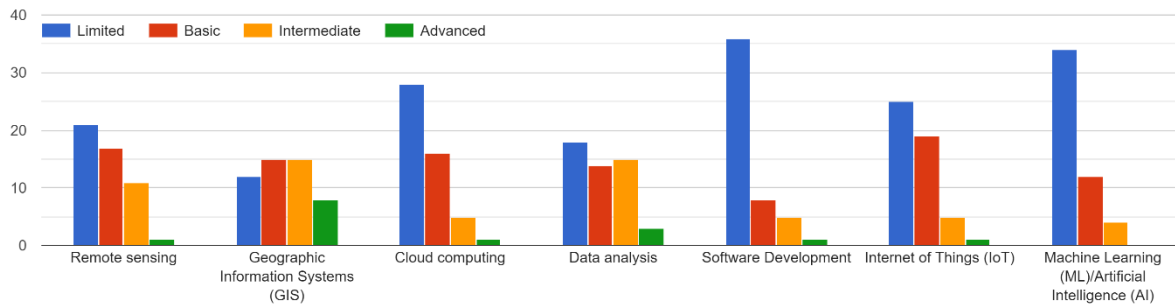


Figure 9 Knowledge levels in the specific topics

Areas where training is needed for you or your team? (select all that apply)

According to Figure 10 shows a significant demand for Geographic Information Systems (GIS) and Remote Sensing and Earth Observation, with about 79.7% and 78.4% of the respondents identifying these areas, respectively, as their top training priorities. There is also notable interest in Cloud Computing (32.4%) and the Internet of Things (IoT) (31.1%). Machine Learning (ML) and Artificial Intelligence (AI) were highlighted by 45.9% of participants, reflecting substantial interest in advancing skills in these critical technologies for data analysis and automation.

Traditional Software Development and software related to environmental issues received comparatively lower interest, at 23% and 1.4%, respectively. Data analysis emerged as a key training need for 58.1% of respondents, underscoring the importance of data-driven decision-making in their professional roles.

Areas where training is needed for you or your team? (select all that apply)

74 απαντήσεις

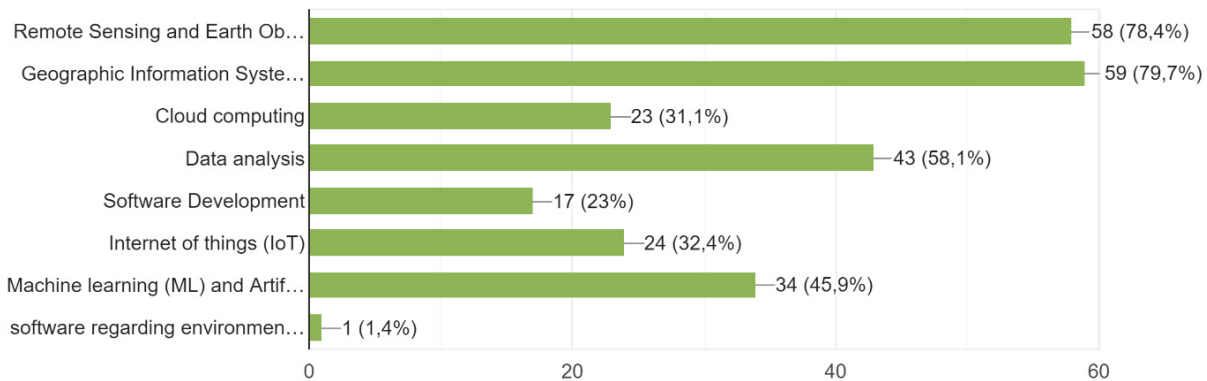


Figure 10 Training needs

What is your motivation for participating in the training?

The data at Figure 11 shows that the majority of participants (75.7%) indicated that enhancing job performance was their primary motivation, underscoring a strong interest in improving their current job skills. Personal interest and curiosity were also significant factors, motivating 66.2% of respondents. Additionally, over half of the participants (56.8%) mentioned fulfilling professional development requirements as a key reason for seeking training. Reskilling for career advancement was important for 36.5% of respondents, indicating a proactive approach to career growth through acquiring new skills. Exploring new career opportunities motivated 24.3% of participants. Lastly, a small percentage (1.4%) aimed to improve capabilities and efficiency for people with disabilities (PWD).

What is your motivation for participating in the training? (select all that apply)

74 απαντήσεις

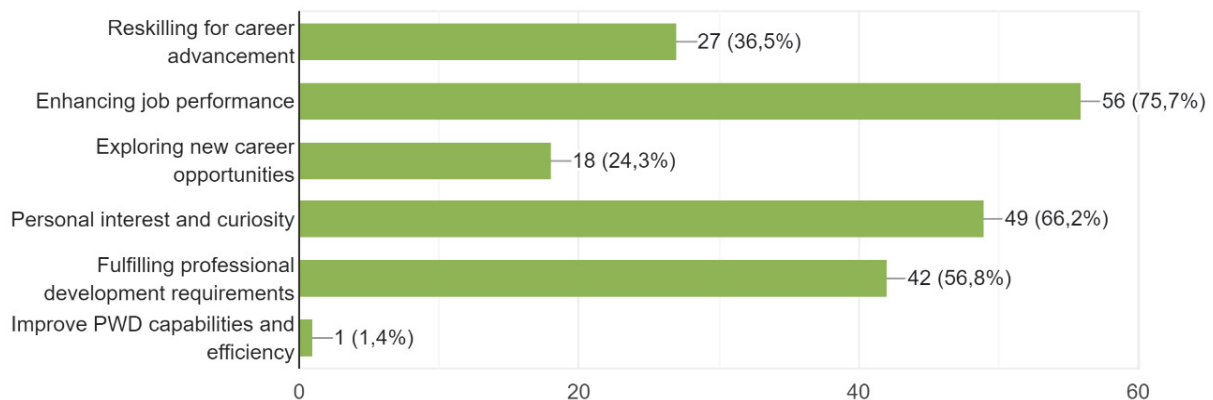


Figure 11 Motivations for participating in workshops

Preferred type of training and language

Based on the data, in-person training was the most preferred option, with 43.2% of participants preferring this traditional method. Hybrid training, combining in-person and online elements, was preferred by 33.8%, while only 23% of participants favored online training.

Regarding language preferences, the majority (55.4%) preferred Greek for their training sessions, while 14.9% chose English. The remaining 29.7% indicated that either language would be acceptable.

1. CONCLUSIONS

The ReSENSE project, supported by Erasmus+, aims to bridge the skills gap in remote sensing and GIS technologies by providing targeted vocational education and training to unskilled professionals, newcomers to the job market, and individuals seeking to enhance their career prospects. The project identified significant demand for training in Geographic Information Systems (GIS), Remote Sensing, Earth Observation, and related fields, with additional interest in newer technologies like Cloud Computing, the Internet of Things (IoT), Machine Learning (ML), and Artificial Intelligence (AI). Through the workshop conducted at the RSCy2024 conference, participants demonstrated a strong desire for hands-on, in-person training to improve their job performance, fulfil professional development requirements, and explore career advancement opportunities. Most respondents were professionals from the environmental and governmental sectors, the projects' target group, reflecting the broad applicability of these technologies across diverse industries.

The data collected through surveys revealed that most participants have basic to intermediate knowledge of remote sensing and GIS, underscoring the importance of upskilling and reskilling in these areas. By offering free workshops and tailored educational materials, ReSENSE is well-positioned to meet the evolving training needs of professionals and provide them with the tools to succeed in an increasingly digital and data-driven workforce.

Ultimately, the project's efforts to deliver accessible and tailored training in cutting-edge technologies will contribute to improved job performance, career growth, and the creation of new opportunities within industries reliant on remote sensing and GIS.

ACKNOWLEDGEMENTS

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