Ref. Ares(2016)6880202 - 09/12/2016

Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans and Developing Links with GEO related initiatives towards GEOSS

Deliverable D3.1 Gap Analysis

Contract Number	H2020 SC5-18b-2015, Project GA number: 690133	**Acronym**	GEO-CRADLE
Full title	Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans and Developing Links with GEO related initiatives towards GEOSS.		
Project URL	http://geocradle.eu		
EC Project Officers	Ms Gaëlle LE BOULER & Ms Malgorzata ROGIVAL		

Deliverable/Document	**Number**	D3.1	**Name**	Gap Analysis Report				
Work package	**Number**	WP3	**Name**	Gap Analysis, Indicator and Priorities				
Date of delivery	**Contractual**		M09	**Actual**	09.12.2016			
Status	Final							
Nature	Report							
Distribution Type	Public							
Authoring Partner	INS							
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Executive Summary

Objectives

Overall, WP3 will bridge inventorying activities from WP2 with the pilot projects in WP4, contributing to the design of relevant and needs-driven pilots key to actualizing project objectives and maximizing post-project impact. The gap analysis has the objective to contribute to this process by deriving conclusions from inventorying data to identify and characterize gaps in the EO sector for each country represented by a country partner in the RoI[1].

Methodology

A gap analysis is conducted to characterize shortfalls between desired outcomes and actual outcomes, and thus provides guidance to address underperformance. GEO-CRADLE adopted an indicator-based approach tailored to the needs of the project and the resources at its disposal to conduct a gap analysis. A tiered survey was formed that sought to trace the collection, processing and flow of EO data along the value chain. Respondents identified which category of capacities they possess – space-borne, in-situ, modelling or data exploitation – and were asked to provide various details. This survey was the primary input for the gap analysis, and was intensly complemented by desk research. The following framework was used to characterize identified gaps: geographic, observational, structural, quality/quantity and capacity.

Results

Groupings of the countries were made in accordance to commonalities in identified gaps of each country:

Western Balkan countries: Albania, FYROM and Serbia.

These countries have basic space-borne capacities, consisting of weather data receiving antennae. Several end-users do use satellite imagery sourced from small commercial companies. In-situ networks are in need of further development. Gaps were identified in existing developed networks: meteorological, atmospheric composition and hydrometric. Soil

[1] RoI: Region of interest, covering Middle East, North Africa and the Balkans

attributes/radiation/energy networks are to a large degree non-existent and rely on *ad hoc* or sparse manual collection.

The EO sector is dominated by the public sector, including both institutional organizations and public companies. Several research groups are also active.

Structural gaps within the ecosystem of this group of countries is pronounced. Information sharing is unsatisfactory, cooperation is at a low level, and there is little EO related networking. Structural gaps are caused by human capital limitations while the financial crisis further aggravates these gaps.

EU financial instruments and other support are identified as an opportunity to narrow the identified gaps.

EU Member States in the RoI: Bulgaria, Cyprus, Greece, Romania

Bulgarian and Romanian structural gaps are similar to the previous groups. These countries all have lower, but varying, levels of space capacities, all have satellite receiving stations and former ties to ESA. Bulgaria and Romania have defined space-programs. In Romania significant progress was identified, while in Bulgaria this has largely stalled. Greece has the most developed capacities, being a member of the ESA the longest.

There are indications that in-situ networks and modelling and processing capacities are generally more advanced than most countries in the previous typology. EO capacities have benefitted from EU membership through access to Structural Funds and other EU financial instruments, and through greater integration with European level organizations. However, recent fiscal consolidation has negatively impacted capacities.

Independent space programs: Egypt, Tunisia and Turkey

The development of EO sectors in these countries was less intensively influenced by interaction with the EU, and a result of long-term efforts led by a defined space strategy. Egypt and Turkey have both launched their own EO satellites into space as part of a space program while Tunisia actively receives satellite data through ground-based segments. Turkey was identified as the most advanced in this group in regards to capacities, and the survey shows indication of a large degree of local and international cooperation of the EO ecosystem. On the other hand, Egypt has large capacities which are hampered by structural gaps. Both Tunisia and Egypt reported bureaucratic obstacles that amount to structural gaps. Capacity gaps are apparent from a lack of sufficient personnel and expertise.

Advanced ecosystem: Israel

Israel has by far the most advanced capacities in the RoI, as validated in the survey. The end-user interviews demonstrate advanced commercial exploitation of EO in the country. The country has specialized in the micro-/nano-satellite market niche on the global scale.

Upstart EO Countries: United Arab Emirates and Saudi Arabia

Both Saudi Arabia and UAE have advanced space programs that have seen rapid development over the past two decades. This development has been spurred by strong government investment. However, recent political and economic contexts have lowered available EO funding. Bureaucratic obstacles also slow the pace of EO development and both countries continue to significantly rely on foreign experts.

Correlation between gaps and maturity

Comparison of the gap analysis with preliminary results of the maturity indicators suggest a correlation between gaps and maturity. This conclusion is intuitive – maturity involves systemic changes in capacities and needs. As countries mature, the EO sector transforms from being primarily public sector oriented towards having a private sector that exploits EO in various industries. The typology presented in this section suggests that EU membership has had a positive impact on EO capacities in the Balkans. Membership has provided: access to finance (e.g. structural funds), greater connectivity nationally and internationally (e.g. membership in ESA), legal frameworks for key issues (e.g. INSPIRE) and a coordinated effort to advance the sector with a defined vision (e.g. byproduct of informed decision making). These elements independent of the EU are replicable in all countries.

EO capacities can greatly empower informed decisions to help address looming challenges in the region, including climate change, food security, access to raw material and energy.

GEO-CRADLE thematic areas

Survey results show that meteorological capacities are the most developed in all countries across the RoI. Atmospheric composition and hydrometric capacities are also established. Soil attribute, radiation and energy capacities are less developed. In general, the EO sector can best contribute to the climate change thematic area. Further development of the EO sector will allow for this thematic area to be better addressed. Similarly, gap analysis results suggest further development is needed to address the other GEO-CRADLE thematic areas in the RoI.

Project Information

This document is part of a research project funded under the **European Union Horizon 2020 Programme - Coordination and Support Action.**

Call Identifier: SC5-18b-2015, Integrating North African, Middle East and Balkan Earth Observation capacities in GEOSS.

Project GA number: 690133

Project Title: GEO-CRADLE - Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans and Developing Links with GEO related initiatives towards GEOSS.

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Acronyms and Abbreviations

Acronym	Description
Cal/val	Calibrate/validate
CEDARE	Center for Environment and Development for the Arab Region and Europe
CERT	Research and Studies Telecommunications Center
CUT	Cyprus University of Technology
D*x.y*	Deliverable number *y* from Work Package *x*
EC	European Commission
EO	Earth Observation
EU	European Union
EARLINET	European Aerosol Research Lidar Network
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
ESA	European Space Agency
FYROM	Former Yugoslav Republic of Macedonia
GEO	Group on Earth Observation
GEOSS	Global Earth Observation System of Systems
GI	Geo-information
GIS	Geographic information system
INCA	Institute for Nature Conservation in Albania
INOE	National Institute for Research and Development in Optoelectronics
INO	InoSens doo
ISA	Israeli Space Agency
IPA	Instrument for Pre-Accession Assistance
IPB	Institute of Physics Belgrade
NARSS	National Authority for Remote Sensing & Space Sciences
NGO	Non-governmental organization

NOA	National Observatory of Athens
SBA	Social Benefit Areas
SEE	South East Europe
SRTI	Space Research and Technology Institute of the Bulgarian Academy of Sciences
STAR	Space Technology and Advanced Research (Romania)
TAU	Tel Aviv University
T*x.y*	Task *y* from Work Package *x*
UAE	United Arab Emirates
USCM	Ss. Cyril and Methodius University
UZAY	Scientific and Technological Research Council of Turkey Space Technologies Research Institute
QC	Quality Control
RoI	Region of Interest
ROSA	Romanian Space Agency
WMO	World Meteorological Organization
WP	Work Package

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1. Introduction

1.1. *The RoI and the GEO-CRADLE Thematic Areas*

The geographic position of GEO-CRADLE's Region of Interest (RoI) – which covers the Balkans, North Africa and the Middle East – is of strategic importance to the European Union (EU). The Balkans are located on the South-Eastern corner of the continent. Five countries are already Member States, while non-member Turkey and states in the Western Balkans are all either candidates for membership or potential candidates for membership. The EU provides direct support to Balkan Member States through Structural Funds and other mechanisms, and to non-member states through the Instrument for Pre-Accession Assistance (IPA). North Africa and the Middle East, on the other hand, straddle the EU's southern border. All countries with access to the Mediterranean Sea, plus Jordan, are engaged through the European Neighborhood Policy (Southern Neighborhood) granting them direct assistance to adopt EU democratic governance and economic standards, as well as preferential trade agreements.

Earth Observation (EO) has large potential to forward the EU's Enlargement Policy and its Neighborhood Policy objectives in the RoI. It provides robust tools based on scientific models to:

- inform decision-making and policy on the strategic and operational level;
- promote sustainable political, social and economic development; and
- encourage closer cooperation and economic integration.

The **potential impact of EO-based services is particularly important to address large challenges facing societies in the RoI throughout this century**. This includes adaptation and mitigation to climate change, addressing techno-social aspects of food security, guaranteeing access to natural resources whilst safekeeping the environment and securing efficient and equal access to energy.

The Mediterranean region is considered a hotspot for **climate change**. Prevalent ecological conditions in the RoI are set to shift in a way that will complicate human existence: higher temperatures, less precipitation and more extreme variation in weather between seasons[2]. As

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[2] Giorgi, F., Lionello, P., 2008. Climate change projections for the Mediterranean region. Mediterranean climate: trends, variability and change. 63 (2-3): 90-104.

a consequence, the RoI will observe a negative impact on water resources, a drop in agricultural production, selective pressure favoring bush species over trees, an increased risk of floods and droughts. By disproportionately affecting the vulnerable poor, climate change can exacerbate economic inequality[3].

Food security is another cardinal issue, particularly in North Africa and the Middle East. The regions have a paucity of fertile land and water, set to be further diminished as a consequence of climate change. Together, North Africa and the Middle East import more food as a portion of overall consumption than any other region in the world, at least 50% of their total caloric intake; a figure expected to rise further due to rapid population growth and a high urbanization rate[4]. Food security is also dependent on socio-economic parameters, including sufficient incomes and assets that make food affordable and/or accessible. Households in the region spend a very high portion of their income on food, e.g. 38.3% in Egypt and 40.8% in Jordan, and have recently been experiencing rising poverty and high unemployment, particularly following the sharp food price shock in 2008[5]. Moreover, pronounced and protracted political insecurity is causing growing hunger in the region[6].

Access to Raw Materials is of prime economic and social importance to the RoI. In North Africa and the Middle East, raw materials comprise 42% of total exports from the region[7]. In the Balkans, the figure is significantly lower yet is still an important economic activity. Precise knowledge on availability, in terms of quantity, quality and geographic distribution, is important for long-term management of resources to optimize exploitation in relation to demand and prevailing market prices. In addition, extraction of resources causes land changes and has high possibility to contribute to soil, air and water pollution, impacting local populations and degrading natural assets on which rural livelihoods depend. Raw materials are the input for essential consumer goods and services, including energy, shelter, food production, etc.

[3] Parry, M.L., et al., 2007. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change, 2007. Cambridge University Press: UK and New York, USA.
[4] World Bank, 2009. Improving food security in Arab countries.
[5] African Development Bank, 2012. The political economy of food security in North Africa.
[6] FAO, 2015. Regional overview of food insecurity: Near East and North Africa.
[7] World Bank, 2014. World integrated trade solution: Middle East and North Africa. Available at: http://wits.worldbank.org/CountrySnapshot/en/MEA/textview

Equitable access to **energy** is a basic requisite for economic development and an important condition to galvanize economic activity. The whole RoI is heavily dependent on fossil fuels – coal and petroleum – to a large degree extracted within the region. Exploitation and distribution must be closely monitored to identify investment opportunities and drive greater efficiency, whilst avoiding pollution and damage to water and land. This is particularly important in Balkan candidate countries that must adopt European energy standards, requiring a drastic departure from the state of the art[8]. Demographic trends in North Africa and the Middle East require informed, long-term planning of energy sector investments at the national level to expand existing electricity production capacities and meet growing demand. To ensure sustainability and mitigate climate change, the energy sector needs to tap promising sources of renewable energy. Hydropower is already developed to some degree in the Balkans, yet the area still has the largest unexploited hydro potential in Europe[9]. Comparatively, North Africa and the Middle East have conditions for the largest production of renewable energy in the world[10]. There has been demonstrated market traction for the region's solar power in a growing export market for clean energy[11].

These issues are complex and interacting. EO provides robust data-based tools to drive policy-making needed to properly and efficiently address them in the long-term, particularly by following GEOSS best practices. **GEO-CRADLE aims to understand the sector as it has currently developed in the RoI, and identify priority areas for high-impact pilot activities that will help in stimulating demand-driven uptake**. An important step to achieve this is an analysis of the gap between current needs in EO sectors and existing capacities. This information will help identify priority areas and thus inform the design of the pilots to maximize project impact and post-project sustainability. A more detailed overlook of the GEO-CRADLE project structure and how the role of the gap analysis is provided in the next section.

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[8] IEA, 2008. Energy in the Western Balkans: The path to reform and reconstruction.
[9] International Hydropower Association, 2016. Hydropower status report 2016.
[10] Jalilvand, D.R., 2012. Renewable energy for the Middle East and North Africa: Policies for a successful transition.
[11] Cormier, C., 2015. Greening the energy sector in the Middle East and North Africa. On: The World Bank Voices and Views: Middle East and North Africa. Available at: http://blogs.worldbank.org/arabvoices/greening-energy-sector-middle-east-and-north-africa

1.2. Relation to GEO-CRADLE Project Structure

GEO-CRADLE has the overall objective to create a multi-regional coordination network in the Balkans, North Africa and the Middle East, the RoI in the project, to: (i) support the effective integration of EO capacities, (ii) provide the interface for engaging the complete ecosystem of EO stakeholders, (iii) promote the uptake of EO services and data in response to regional needs and (iv) contribute to implementing GEOSS and Copernicus in the RoI.

The GEO-CRADLE gap analysis, to be presented in this document, is an important step to meet these objectives. It will provide details regarding current shortcomings in the value chain to guide integration efforts (i), help identify and characterize regional needs (iii) and provide insight into awareness regarding GEO and Copernicus.

Overall, WP3 is meant to bridge inventorying activities from WP2 with the pilot projects in WP4, contributing to the design of relevant and needs-driven pilots key to actualizing project objectives and maximizing post-project impact.

In addition, the overall project will contribute to one of desired results of the SC5-18b call – *strengthen the Earth Observation networks (space-based, airborne, and particularly in-situ of the broad European and North African, Middle East, and Balkan region to reinforce its contribution to the knowledge base for climate, natural resources, and raw materials*.

1.3. Gap Analysis Approach

The gap analysis used by the project and presented within this document is tiered and nested; it examines gaps in the EO value chains separately in each country, taking into account the countries' current needs, in section *4 – Gap Analysis*, and then compounds results to note and explain general trends at the regional level, in section *5 – Conclusions*.

A gap in the value-chain is identified through user-needs interviews conducted in *T2.4 User Needs Analysis* of the project. The interviews focused a great deal of attention on unmet information needs and how EO could address them. To characterize the gap, the value chain is examined to locate the missing link that accounts for the gap. To do this systematically, an analytical framework for EO capacity (presented in subsection *2.2.2 Indicators*) is used.

Identified gaps are relative to the specific needs of the country. Comparison with a baseline that ranks the maturity of EO capacities is conducted in *T3.2 Maturity Indicators* of the project and available in *D3.2 Maturity Indicators and Country (G)EO Profile (I)* and *D3.4 Maturity Indicators and Country (G)EO Profile (I)* of the project, that will become available on the GEO-CRADLE website.

The reason for the focus on relative needs on the country level is to contribute needed information to other project tasks. In addition, the standalone document will be relevant to support effective integration of EO in the short- to medium-run, in the sense that it will identify weak points in the value chain in regards to current needs specific to the country. This information will be elaborated to a greater degree in *T3.3 Regional Priorities*, incorporating results from the gap analysis with local experience and expertise to synthesize EO project recommendations for each country.

2. Methodology

2.1. *Available Methodologies*

A gap analysis is conducted to characterize shortfall between desired outcomes and actual outcomes, and thus provides guidance to address underperformance. In this light, a systematic approach is required, particularly for a multifaceted value chain like that of EO, with multiple data providers at different levels and multiple end-users. There is a variety of methodologies used in the past in the EO domain, dependent on data availability and other contextual parameters as well as the goals and scope of the task.

During the **GIGAS project**[12] (co-funded by the European Commission as a Support Action under Grant Agreement number 224274), a highly robust gap identification methodology was developed for technology watch and comparative analysis of information and data management systems, that included a gap analysis as an important element. The methodology has already been validated through its application on several projects funded by the FP7 framework.

The GIGAS methodology is highly complex and detailed. For example, the Technology Watch component is resource-intensive requiring very close cooperation between partners. Given the fact that GEO-CRADLE inventorying is done by several project partners, close international coordination at the level required by GIGAS is a large technical challenge. In addition, not all EO key actors in the RoI are open to share data to the extent needed. The level of detail which GIGAS requires and provides in its gap analysis is significantly beyond the goals and needs of the GEO-CRADLE gap analysis.

Another methodology that was considered was the **Environmental Management Gap Analysis Tool** used by European Environmental Agency[13]. The methodology entails a survey with 351 *yes* or *no* questions. The methodology is simple and direct and could be adapted for the needs of GEO-CRADLE. However, its structure lacks flexibility to allow for open answers considered appropriate given the high diversity within the RoI and the subjective nature of certain inputs required by the project.

[12] www.thegigasfocum.eu
[13] ISO 14001 2004 Gap Analysis Tool

2.2. Gap Analysis Approach adopted by GEO-CRADLE

GEO-CRADLE adopted an **indicator-based approach** tailored to the needs of the project and the resources at its disposal.

A tiered survey was formed that sought to trace the collection, processing and flow of EO data along the value chain. Respondents identified which category of capacities they possess – space-borne, in-situ, modelling or data exploitation – and were asked to provide various details. The survey was the primary input for the gap analysis; see subsection *2.2.1 Input* for more details.

Survey results were used to provide an indication of the state of the art of EO capacity. This task was supported by additional input from desk research. A **framework was adopted to allow for characterization of gaps**. The framework is presented in subsection *2.2.2 Indicators*.

Unmet EO needs from end-user interviews were traced through the value chains to identify gaps and characterize them in relation to the capacity framework. A description of this procedure is provided in subsection *2.2.3 Identification and characterization of gaps*.

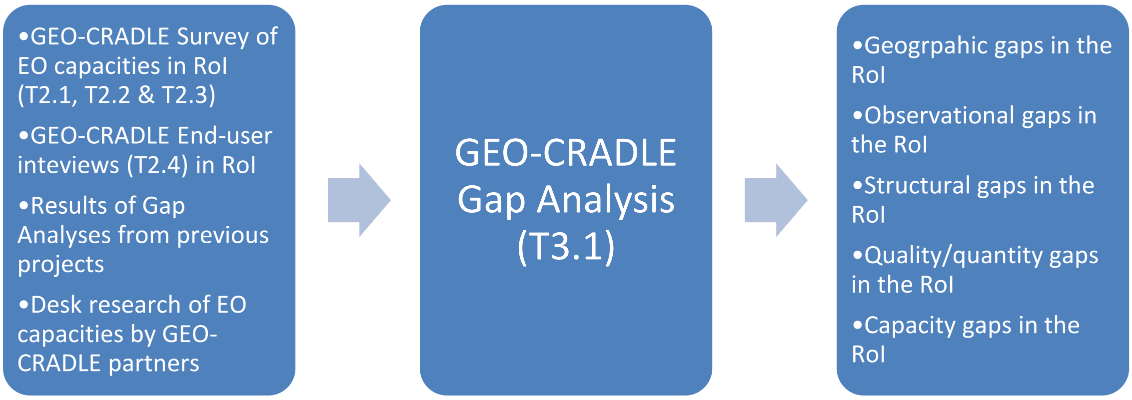

Figure 2-1. Input-output diagram of the GEO-CRADLE gap analysis.

The surveying and analytical work was not without shortcomings. Challenges faced by the consortium within *T3.1 Gap Analysis* will be presented in the final subsection of this section, *2.2.4 Challenges and constraints*.

2.2.1. *Input*

The gap analysis is conducted on the basis of three sources of information:

- Results of gap analyses from previous projects,
- Results of GEO-CRADLE inventorying in WP2,
- Desk research to complement inventorying.

Results of gap analyses from previous projects are used to create a picture of EO overtime to complement the static picture provided by inventorying in GEO-CRADLE. Previously existing gaps are compared to results from the GEO-CRADLE to see if previous gaps have been addressed. Where possible, success stories as well as new problems are explored. Results from previous projects are reviewed in section *3 – Gaps Identified in Previous Projects* while a comparison with results from GEO-CRADLE are provided for each country in *4 – Gap Analysis*.

Inventorying data from other projects is not used by the GEO-CRADLE gap analysis. There are several reasons for this: only aggregate data is accessible due to privacy restrictions that apply to raw data; different survey methodologies and approaches were employed; projects focused on different aspects of capacities; and biases cannot be accounted for with full confidence. In contrast, it is assumed that gaps that are reported explicitly have been validated by expert opinion of consortium members and the quality control process.

Only projects that were relevant to GEO-CRADLE were used. This includes those with similar geographic or thematic coverage (or, ideally both). The table 2-1 below shows the projects that were considered, indicating those projects where a GEO-CRADLE partner was actually participating (thus ensuring better access to the data).

*Table 2-1. Previous EO projects conducted by project partners and third parties with potential information for the gap analysis. *Projects included in section 3.*

Project (with website link)	Project partner	Geographic Focus	Thematic Focus	Gap Analysis
ACTRIS	INOE, NOA, CUT, IPB	EU	Aerosols and trace gases	Yes
*AfriGEOSS**	NARSS	Africa	EO capacity building towards GEOSS/Copernicus	Yes
*Balkan GEO Net**	INS	Balkans	EO capacity building towards GEOSS/Copernicus	Yes
*BRAGMA**	CERT, NARSS	Africa	Marine and coastal areas, water resources management, long-term management of natural resources	Yes

ConnectinGEO	EARSC	EU	Climate, water, agriculture, natural resources, carbon, ecosystems, energy, raw materials	Yes
EnerGEO	Advisory Board	Global	Energy	Yes
EO-Miners	TAU, EGS-members	Global	Raw material extraction	Yes
EOPOWER	INS, UZAY	Global	Economic development	No
*Iason**	INS	Balkan	Environment	Yes
OBSERVE*	UZAY	Balkan	EO capacity building towards GEOSS/Copernicus	Yes
PanAfGeo	EGS	Africa	Sustainable mineral exploitation	No

Results of the GEO-CRADLE inventorying were used as the primary input for the GEO-CRADLE gap analysis. Aggregated data is available in the deliverables of WP2: *D2.1 User Need Analysis Survey*, *D2.2 Inventory of In-situ Instrumentation and Regional Networks*, *D2.3 Inventory of Numerical Modelling and Computing Facilities*, *D2.4 Inventory of Space-Borne Capacities*, *D2.5 User Need Analysis Report I* and *D2.6 User Need Analysis Report II*.

GEO-CRADLE WP2 was dedicated to inventorying. The first task was to compile an exhaustive list of key EO actors. This was done as a mapping exercise, to define targets for dissemination of the online survey, the means through which information was gathered on the activities of these organizations. The second step was to disseminate the survey. This was done by the whole consortium primarily through email invitations with a link, in particular by country partners. Country partners primarily focused on their own countries, although they also engaged peers within their field in neighboring countries. Consortium members that were not country partners also disseminated within their networks, particularly to their contacts in the RoI.

The initial approach relying on emailed invitations resulted in an unsatisfactory response rate and had to be addressed through a change in strategy. Country partners were encouraged to find their own way to produce results, but were supported by the whole consortium, sharing experience and offering advice. A starting target of 10 survey responses was set per partner. This was followed by the drafting of an internal document, *Inventorying Checklist*, which identified holes in information gathered from the survey for each country to guide country partners to target organizations active in areas with missing information.

Country partners adopted a variety of strategies to deliver results. For reference, a few of these methods are described in brief:

- **Relying on existing networks**. Existing direct contact and indirect contact (i.e. through an interlocutor) with organizations pre-identified as key EO actors was leveraged to urge response. At times, this took several kind reminders in the form of both emails and telephone calls.
- **Asking for referrals to other EO actors**. Several partners asked for referrals to other EO actors from those they successfully engaged. In the case that the referent had a close relationship with her/his referee, this strategy proved very successful.
- **Surveys conducted through an interview over the telephone**. A couple of country partners would speak with respondents over the telephone while filling in the online survey for them. An explanation of the project and purpose of the survey were explained before commencing, and consent was sought. The response rate was high.
- **Surveys conducted in hardcopy during an interview**. A few partners sought an interview/meeting during which they filled in the survey in hardcopy and later transcribed it onto the online version. This approach was very time intensive and was not used to a large degree. However, it did have a high response rate.
- **Organizing workshops with key EO actors**. This strategy was followed by two of the country partners with very high success. Invitees were asked to fill in the survey (online and hardcopy) and offered on site assistance. In the case of one partner, entrance to the barbeque outside the room was contingent on handing in a hardcopy survey.

When the checklist was disseminated to country partners, these strategies were shared to encourage higher response rates. The Project Coordination Team, WP2 and WP3 task leaders were available to discuss survey strategy and approach for country partners if needed. The successful strategies were also discussed at length during the working session of the Novi Sad Workshop on 15 July, 2016, after which the inventorying period was extended.

In addition to inventorying EO capacities through the survey, country partners conducted end-user interviews to collect information on end-user needs. GEO-CRADLE's methodology involved a small sample size, but one yielding high quality per respondent. This approach was based on consortium partner Eurisy's expertise with EO end-users and was deemed to fit well with the overall GEO-CRADLE approach.

Requests for interviews had a high response rate unlike survey requests. Nonetheless, some partners did have trouble delivering results, claiming low response rates in their context. Despite outliers, the strategy was successful overall and no large changes to methodology were adopted at any point.

Similar to surveying, an end-user interviews checklist was provided two-thirds through the allotted time-period for this task. Country partners could see information holes in the conducted interviews they conducted, and which interviews they already provided were validated or invalidated.

To conduct the gap analysis, two elements are indispensable:

- **Large quantity and high quality of responses in the survey**. GEO-CRADLE's scope is on the EO value chain, which is multi-faceted and prolonged involving several steps, i.e. collecting, processing, making products and using products, and several organizations. The project also has four thematic areas, which expand into five main operational foci: meteorological/climatic, atmospheric composition and profiling, hydrometric/water quality, soil attributes/spectra and energy/radiation.
- **High quality end-user interviews**. This means that the interviewee was fully engaged to describe the way that they operate and particularly the problems that they faced. The best interviews discussed these problems with the interviewee and together explored how EO could contribute to solving them. To obtain optimal results, several of these high-quality interviews were needed per country.

These criteria are very demanding, which is why only sufficient information of satisfactory quality was available from countries with a project partner. Table 2-2 list project partners and cooperation partners of the GEO-CRADLE project.

Table 2-2. Country partners and cooperation partners involved in the project active in inventorying efforts in GEO-CRADLE by country.

Country	Project partner	Acronym
Albania	Institute for Nature Conservation in Albania	INCA

Bulgaria	Space Research and Technology Institute	SRTI
Cyprus	Cyprus University of Technology	CUT
Egypt	Center for Environment and Development of the Arab Region and Europe	CEDARE
Greece	National Observatory of Athens	NOA
	InterBalkan Environment Center	IBEC
	EuroGeoSurveys	EGS
Israel	Tel Aviv University	TAU
FYROM	University of Saints Cyril and Methodius	UCSM
Romania	National Institute of R&D for Optoelectronics	INOE
Serbia	Institute of Physics Belgrade	IPB
	InoSens ltd.	INS
Tunisia	Research and Studies Telecommunications Center	CERT
Turkey	TUBITAK UZAY Space Technologies Research Institute	TUBITAK
Country	Cooperation partner	Acronym
Saudi Arabia	King Fahd University of Petroleum and Minerals	KFUPM
UAE	University of UAE	UUAE

Quality control of survey results was the responsibility of country partners to ensure that information provided was accurate and complete. Contacting respondents to validate certain responses was often necessary.

Desk research was conducted to complement inventorying results from WP2. Information holes still remained at the end of surveying due to failure of all key EO actors to respond to the survey, and because of a lack of the capacity in a given country. Desk research filled in the information holes as best possible. Lack of capacities had to be validated.

The consortium urged a proactive approach to desk research. This means that country partners were expected to rely equally on telephone calls, interviews, internet searches and literature reviews to provide information.

2.2.2. *Indicators*

Indicator-based scoring and indexing is useful where the concept being measured is fuzzy. This is the case for most of the framework categories used by GEO-CRADLE to reflect EO capacity.

Certain elements of EO capacity are palpable and therefore measurable, e.g. geographic coverage. However, the concept is complex in that it contains several defining elements whose individual state and interaction determine the maturity of EO capacity. That is, EO capacity does not only reflect physical equipment and its set-up, human resources available and how they are applied in practice, but also to a large degree the strength and coherence of the network of data stream; measuring all these elements and their relationships requires a detailed network analysis befitting of a case-study, and beyond the scope of GEO-CRADLE.

Using parameters that are simple to measure as indicators is a parsimonious solution appropriate to the context of the project. The deconstruction of the EO capacity concept into constituent categories is necessary to provide a strong reflection of EO capacity, and such an analytical framework is already present. During the 19th GEO Executive Committee Meeting, the need to streamline gap analyses in EO was recognized[14]. A task was created outlining the need to promote standardization and thus comparability between efforts:

Action 19.11 – The Science & Technology Committee, the Monitoring and Evaluation Working Group, the Secretariat, and other interested members of the GEO Community to draft an initial outline of a process that can eventually lead to a coherent overall mechanism being put in place for required GEO/GEOSS gap analyses.

An action team was formed to follow through with this action and formed the following analytical framework with constituent categories:

- **Geographic**- Spatial discrepancy in the coverage of the observation system in regards to availability of data and its quality.
- **Observational**- Technologies and system for EO are not available or insufficient to provide the data and quality needed.
- **Structural**- The connectivity and ability of data to flow freely within organizations or networks.

[14] GEO, 2011. Summary report: 21st executive committee meeting Geneva, 22-23 March 2011.

- **Qualitative/quantitative**- EO products are available but not of sufficient timeliness, frequency or quality to be of use.
- **Capacity**- EO products are available but there is insufficient technical capacity in regards to infrastructure and personnel to make use of it.

By the nature of the categories, some can be reflected to a large degree with a single indicator, e.g. information on coverage to show geographic capacity, while for others this is not possible. Therefore, the quantity of indicators used between the categories is uneven. All the indicators were sourced from GEO-CRADLE online survey, with the exception of indicators for capacity where responses from the end-user interviews were used. The indicators in relation to their position on the value chain are presented in Table 2-3.

Table 2-3. The indicators used to describe EO capacity categories drawn from the GEO-CRADLE capacities survey as well as the end-user interviews.

Framework category	Type of capacity	Indicator Parameter
Geographic	Space-borne capacities	Range of satellite coverage
	In-situ networks	Coverage of in-situ networks
	Modelling and processing capacities	Coverage extent of models
Observational	Space-borne capacities	Number of organizations with space capacities in the country
		Number of EO space-missions
		Number of linkages with international organizations for space-borne EO
	In-situ networks	Number of organizations with in-situ networks
		Number of stations
		Number of different professional fields with in-situ capacities
	Modelling and processing capacities	Number of organizations with modelling and processing capacities
		Number of algorithms/models
		Number of different professional fields with modelling capacities
		Availability of technical capacity (Server clusters, cloud infrastructure, etc.)
Structural	Space-borne capacities	Number of local actors with which they cooperate
		Data availability (i.e. near real-upon request, etc.)

		Data policy (i.e. open, commercial, etc.)
	In-situ networks	Is the network registered in a national/regional network (yes/no)
		Data policy (i.e. open, commercial, etc.)
	Modelling and processing capacities	Number of data sources
	Data exploitation	Delivery of downstream services (yes/no)
		Policy of data products (open, commercial, etc.)
		Availability of open EO data sources (yes/no)
		Number of end-users
	National activities	Availability of national funding for EO (yes/no)
		Existence of a national space policy (yes/no)
		Existence of a national space agency (yes/no)
		Degree of national coordination (none, basic, etc.)
		Coordination with decision makers (yes/no)
Quality/Quantity	Space-borne capacities	Availability of satellite data catalogues (yes/no)
		Satellite temporal resolution (hourly, daily, etc.)
	In-situ networks	Which attributes are measured (temperature, humidity, etc.)
		Availability of METADATA (yes/no)
		Number of months of observations recorded
		Temporal resolution (hourly, daily, etc.)
		Data availability (real time, upon request, etc.)
	Modelling and processing capacities	Availability of METADATA (yes/no)
		Number of algorithms
Capacity	End-users	Familiarity with Copernicus (yes/no)
		Familiarity with GEO (yes/no)

2.2.3. *Identification and characterization of gaps*

The indicators presented in *subsection 2.2.2 Indicators* can suggest the existence of a gap in themselves. For example, if only 5% of end-users interviewed in *country y* are familiar with Copernicus and the Sentinels programs, this is a suggestion that there is a gap in capacity. On the other hand, other indicators are less straightforward: if *country x* has few attributes being measured in its in-situ capacities, its data is only measured daily, and is available only upon request, a suggestion results that there is a gap in quality/quantity.

However, this approach is insufficient. First of all, it is hard to systematize, in that it is hard to establish benchmarks that are applicable across countries with different land areas, different income levels, different populations and, of course, different needs in regards to EO. Alternatively, a correction coefficient can be devised, but it is a challenge to maintain simplicity while assuring accuracy, and still it cannot account for different end-user needs. Secondly, even with benchmarks of correction coefficients, this approach would allow for a large amount of false positives in the identification of gaps; the assumption would be that end-users have a need for elements that the indicators measure and thus overestimate end-user needs in a given country. For this reason, a review of capacities can suggest a gap in capacities, but the gaps must be validated by end-user needs to be accepted as a gap for the country.

The identification of gaps will start with the end-user needs identified in *T2.4 User Needs Analysis*. The end-user interviews allowed for respondents to elaborate on missing information and explore how EO can contribute to their operations. These results, which have already been distilled in *D2.5 User Need Analysis Report I*, will be tracked against results from the inventorying of capacities. This will be done in a successive manner through the categories of the analytical framework for EO capacities, shown in *Figure 2-2*.

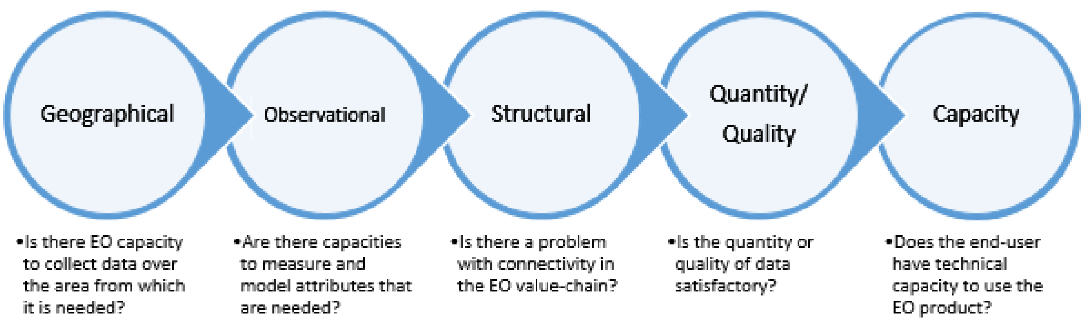

Figure 2-2. The analytical framework for EO capacity used to identify gaps in GEO-CRADLE.

First of all, the existence of the **geographic** category will be examined. Is the information need measured by EO, either by space-borne or in-situ capacities, and is this data analyzed by models/algorithms? If this capacity exists in the country, the next category will be examined: whether the gap might exist in the **observational** category. Is the unfulfilled information need resulting from the lack of organizational capacities collecting and analyzing the needed data? The next category is **structural**: if the data coverage is adequate and there is infrastructure in place to measure and analyze the desired data, is the need resulting from a lack of connectivity in the EO value chain and at what point is this present? If the EO value chain is seamlessly connected, the **quantity/quality** category will be examined. Is the data product provided of sufficient quantity or quality to meet end-user needs? If the disconnect cannot be attributed to this category, it is most likely that the end-user does not have the technical **capacity** to use products and data resulting from the EO value chain. The following question will be posed: does the end-user show lack of knowledge of and engagement with EO?

This methodology will identify the first disconnect in the chain, which might not be the only one. For example, data might not be shared sufficiently yet also not be of sufficient quality. The analytical framework assumes that the succession of categories are conditional requisites. This is not unreasonable:

- Without EO coverage, all other categories are irrelevant.
- If there is coverage, the capacity of organizations to measure and processes what is of interest must be examined. Clearly data that is not collected will not flow between actors along the value chain and not provide sufficient quantity/quality of information.
- If there is the organizational capacity, the stream of data must be examined to see how accessible it is for end-users. If data is being collected but not shared, the quality/quantity of information that end-users have access to is clearly lower than possible.
- If all the data or most of the data being collected is accessible to end-users, then the quality and quantity of the entire EO value chain can be judged.
- If all the other categories do not show a missing link, then the EO value chain must be deficient at its end, where information products are made available but end-users cannot make use of them (or else data is not properly translated into actionable information that the end-user can make use of).

The gaps that are identified will be validated by country partners with profound knowledge of the local EO value chain. This will also allow for country partners to identify false negatives and ensure that they are included in the gap analysis.

2.2.4. *Challenges and constraints*

Openness to share information

The project faced a challenge in regards to the openness of respondents to share information. This was present in all countries to some degree, while in several countries it was expressed to a sufficient degree to represent a constraint.

Low response rate to the online survey was due to a variety of reasons, in part due to openness to share information. In the case that this was due to suspicion of motives, direct contact through a telephone call was usually sufficient to urge the respondent to provide answers, e.g. noted by partners in Serbia and Israel.

In more extreme cases, there was suspicion and/or active avoidance. In Egypt, the quality of original survey responses was very superficial. According to the country partner, this was due to the fact that respondents felt personally viable for the provided information and avoidance was a protection mechanism. In FYROM, the country partner recognized a pattern of avoidance of the survey by potential respondents due to a lack of interest in the project; however, this was successfully addressed through proactive desk research by partner. In Bulgaria, the partner also reported low responsiveness.

Another reason for lack of responsiveness was not necessarily due to purposeful withholding of information. Israel marked only a couple of respondents to the online survey when invitations were initially sent through email, yet the country partner was able to provide a large response rate through conducting the survey over the phone. A similar situation was found in Serbia for commercial companies active in EO.

Lack of responsiveness also applied to the level of detail provided. The most telling answer was that the large majority of respondents from all countries provided only one algorithm if they claimed this capacity and one space-mission if they claimed space-borne capacity. It is assumed by the consortium that this was due to two reasons: the length of the survey (all eight options appear immediately), or that the individual respondent had only knowledge of their specialty area as opposed to the activities of the entire organization. In future efforts, this problem can be addressed by combining phone and written elements in the interview process for respondents with more complicated answers.

The Egyptian partner reported that they had to tailor their approach in regards to presenting GEO-CRADLE. The fact that it was financed by the EU resulted in several potential respondents asking for money to answer the survey. The partner had to clearly present the project in a way that implied that such a thing was not possible.

Few responses beyond countries with active partners

GEO-CRADLE survey results were largely contained to countries in which there was a country partner. For other countries in the RoI, the quantity of answers was small – not greater than six replies for any country. The reason for this was that country partners surveyed their countries by relying on their connections within the local EO ecosystem, urging cooperation through their professional networks, and providing constant reminders. The reach of this approach considerably weakened outside national borders in the RoI. This represents a constraint for the gap analysis. Therefore, conclusions on the regional level extrapolate conclusions from surveyed countries to all regional countries.

In addition, some sectors also remained off limits, i.e. military and sectors deemed to fall under national security. Although military capacities are beyond the scope of GEO-CRADLE, the energy sector in Egypt was considered to be under the blanket of national security and could not be sufficiently surveyed.

Limited sample size and variety of end-users

There was a trade-off between breadth and depth in regards to collecting information on end-user needs. Previous projects had mostly chosen the former, while GEO-CRADLE chose the latter. The reason for this choice was based on Eurisy’s (a consortium partner) experience. The major drawback is that a small sample can miss input from end-users that might have a different experience than those interviewed. However, for those that are interviewed, the interview process is open-ended and allows for identification and characterization of end-user needs in great detail. Unlike other projects that use a rigid survey, the organizational context and its potential for EO can be fully explored. Predetermined indicators assume the existence of certain gaps and constrict end-user’s response within these boundaries, which means that gaps that were not preconceived by the consortium are hard to identify especially when the end-users are not aware of them.

There was a bias in the implementation of the surveys in that partners were predominantly data conversant: results of the end-user needs are mostly data needs rather than information needs.

The end-user groups that were reached were organizations that were either current users of EO or had been at some point. This leaves out needs from further down the value chain, e.g. farmers and citizens, as well as potential users that have not explored the potential of EO products/services.

Geo-political issues

Due to geo-political tensions and recent events, some of the countries had a lower response rate than expected, as organizations were either unwilling to provide information or forced to abstain from doing so.

Language of the survey

The language of the survey at the level of the consortium was in English. This facilitated processing and sharing of results within the consortium, but did prove a barrier to certain respondents to answer. In Morocco, for example, there was a direct request from respondents for a French language survey, which might have also been of benefit to the partner in Tunisia. In FYROM, the country partner specifically mentioned the language of the survey as a major reason that dissuaded potential respondents from completing the survey. Foreseeing this problem, the Egyptian partner translated the questionnaire into Arabic and translated responses back into English.

Approach to identification and characterization of gaps

At the country level and the regional level, end-user needs of a limited sample are extrapolated to the general level. There is the challenge to ensure that exceptions are recognized and that false claims are not made. This is addressed in two ways. Selection of end-users was based on expert opinion of country partners to be representative of the national EO value chain. Country partners provided validation of the gap analysis for their country, asking for input from other local EO players where appropriate. Gaps are identified per country as well as on a general level.

Another challenge to this approach is to equate needs across different institutional types. If a ministry has certain data needs, to what degree can it be said that a municipality can have these needs as well if they do comparable work on the local level? To a certain degree, the inherent assumption is that they could be a potential end-user of EO and not be aware of it, which can be appropriate in some cases but not others, and therefore generates false positives. If the trajectory of development of EO maturity in more developed countries is observed, this could be a fair assumption: EO is usually adopted top-down in regards to institutional hierarchy as well. The GEO-CRADLE methodology leaves this point open for discussion, as a detailed case study is needed to make such claims with full confidence. The pilot projects in WP4 provide a more appropriate context for in-depth analyses which can address such issues.

2.2.5. *Added-Value of GEO-CRADLE Gap Analysis Methodology*

The methodology presented in this document was developed primarily to serve the needs of the GEO-CRADLE project and to meet specific goals defined in this subsection *2.3 Gap Analysis Approach*. Nonetheless, it provides a flexible yet robust framework that can be applied outside of the project and its thematic context, particularly to situations with high system fragmentation and significant institutional barriers to accessing information. In this regard, the accumulated experience on GEO-CRADLE is also of considerable use. Section *2 – Methodology* in its whole describes various lessons learned and resulting insight on best practice from the inventorying process – these can be of use for other initiatives, even those that pursue another methodological approach. Some of these lessons are briefly overviewed here:

- **Tiered effort**: mapping the EO ecosystem before building a specific outreach strategy based on reachability, i.e. direct contact, referrals, responsiveness to workshop, etc. Tools to use and paths to end-users should be identified before contact is established for inventorying.
- **Having partners with a presence in EO hotspots**: as the public sector dominates EO in the RoI, national as well as regional capitals were identified as areas where

organizations active in EO were concentrated. Having a partner with a pre-existing network in these nodes is of great use to surveying.

- **Using complementary partner types for surveying**: research groups, non-governmental organization and private companies were active in the project. In Serbia, coordination between a company and a research group yielded two perspectives on the country's EO capacities. Sharing of perspectives and experiences throughout the consortium particularly during working session events is of great use to broaden perspectives and improve overall approach to surveying tasks.
- **Proactivity and networking are key**: the quality and quantity of results varied directly with the proactivity of the partner. Telephone calls provided an effective improvement over email outreach. This was especially the case when coupled with building a relationship with the EO ecosystem, taking the time to explain the project and demonstrating that the respondent's opinion is of value. It was considered a success that the project allowed for great flexibility for individual partners, supplemented by support when needed and allowing for partners to share experiences.
- **Complexity of end-user needs**: Eurisy's recommendation to use an open-ended interview approach showed great promise on the GEO-CRADLE project. It allows the end-user to explore their needs; in comparison, a survey sets need assumptions and can only validate them. The extra resources required for this effort are judged to have been worthwhile.

By its definition, the project seeks to explore four thematic areas of large consequence for the economic development and stability of the RoI: climate change, food security, access to raw materials and energy. The gap analysis provides unique information into how EO has, or indeed has not, been applied to tackle these looming challenges in the region.

The gap analysis is not only an input for the other outputs of WP3, but can also be used in parallel to offer unique insights. Comparing results from the gap analysis and maturity indicators (i.e. *D3.2 Maturity Indicators and Country (G)EO profile (I)* and *D3.4 Maturity Indicators and Country (G)EO Profile (II)*) will show the connection between maturity and end-user needs. That is, if greater maturity pushes the commercial sector to differentiate from primarily serving the needs of the public sector to establishing new EO based products, processes and business models. Does greater maturity lead to a shift in the most pronounced gaps from one set of framework categories to another? What factors can account for maturity differences, e.g. how important is EU membership, and how do they change end-user data needs? These questions are important to answer when drafting regional priorities, as clearly different countries and sectors have different needs. Understanding why these needs arise and relate to capacity development will allow for more precise recommendations to be given.

3. Gaps Identified in Previous Projects

There have been several projects that conducted an inventory of EO capacities and/or needs in the Balkans, North Africa and the Middle East. Some of them have also conducted a gap analysis that is comparable in regards to objectives with GEO-CRADLE's gap analysis.

However, all these projects have a different scope than GEO-CRADLE, without a full overlap of thematic areas or the geographic area that is being surveyed. For this reason, the information that they collect cannot be directly transferred into GEO-CRADLE. Relevant elements that fit into GEO CRALDE's focus, and into the analytical framework of GEO-CRADLE's gap analysis where possible, have been selected in the level of detail that is of benefit to the project. The conclusions of gap analyses are presented without the underlying details that led to these conclusions, i.e. EO capacities and user needs. References are provided to direct the interested reader to the source where greater detail is presented.

In the following sections dedicated to individual projects, a brief explanation of project aims and scope will be presented, followed by identified gaps from each project.

3.1. AfriGEOSS

The project is a coordination initiative to enhance Africa's capacity for "managing and using Earth observations … enabling the region's participation in … GEOSS"[15]. It will do this by developing the framework to allow for cooperation between different organizations active in EO throughout the continent. The project was developed within the GEO framework.

The project is ongoing and a gap analysis has been conducted although the final results and the deliverable are unfinished at the time of publication of the GEO-CRADLE gap analysis.

Dr. Islam Abou El-Magd from NARSS, a partner on the AfriGEOSS project, kindly provided the key gaps identified:

[15] http://www.earthobservations.org/afrigeoss.php

- Lack of EO infrastructures at continental level
- Lack of EO data coverage
- Lack of in-situ networks
- Redundancy of EO projects
- Lack of valued outcomes from EO that meet stakeholders needs
- Lack of coordination & communication

3.2. Balkan GEO Net

BalkanGEONet aimed at identifying existing EO-data providers and users in the wider Balkan region, determining their status, potentials and needs, and coordinating the EO players by establishing a proper interface and networking between them. It was funded by the European Union within the FP7 scheme under the Grant Agreement No. 265176. More information about the project is available on the Balkan GEO Net website.

In 2011, Balkan GEO Net conducted a systematic survey with very good results for Serbia, Bulgaria and Albania, and more limited results for FYROM, Romania and Greece. Compared to GEO-CRADLE, their surveying approach differed in terms of the focus and approach in many ways. Of particular importance, the project provided a survey-based inventorying of end-users as opposed to a more in-depth yet less extensive interview-based inventorying approach adopted by GEO-CRADLE. The gap analysis results are presented in *D4.1 Report on integrated potentials and gap analysis in the wider Balkan region*[16].

Overall, there was a large difference in the level of development of EO between Balkan countries. The project identified several gaps based on the basis of the information it collected:

- ***Geographic***: Data is mostly restricted to a national scale. A low portion of surveyed organizations have regional, international or worldwide data coverage.

[16] Proske, H., et al., 2012. D4.1: Report on integrated potentials and gap analysis in the wider Balkan region. Available at the following link.

- ***Observational***: There is a difference in the degree of maturity of observational systems between Balkan countries, with GEO members and EU Member States demonstrating higher capacities.
- ***Structural***: A larger difference between sectors is noted as compared to between countries due to fragmentation of EO communities. Nonetheless, a high willingness to cooperate and share data (90%) was noted, although generally for a fee.
  - There exists a costly practice of replication of data collection between different organizations for the same geographic area in a short time frame.
  - The scientific community engaged in EO is active amongst itself and not with other key actors in relevant sectors.
  - Data providers typically have few end-users with whom they cooperate. Data producers are mostly the users of their own data.
  - EO networks are also hampered by the fact that data providers disagree with free access to their data as it represents a source of income for the institution.
  - Most providers do not make their data available via the internet.
  - A large amount (80%) of end-users share their data with other end-users, mostly in a restricted or monetized manner. Almost 50% of end-users do not have partnerships or cooperation in regards to EO.
- ***Qualitative/quantitative***: End-users complain about lack of data quality information and poor adherence to existing standards. Overall end-user satisfaction varies.
  - METADATA is partial.
  - There are long responding times.
  - 60% of end-users do not use any standards.
- ***Capacity***: There is a lack of awareness of the full breadth and potential of EO, of GEO and GEOSS and how they seek to promote the field.
  - Only 50% of end-users use geoportals.
  - Highest data needs of end-users are noted for satellite and aerial imagery.

In comparison to these general trends, disaster management is an area that is more advanced in most countries in regards to all these aspects. This sector even demonstrates interaction between the scientific community and other key actors in the sector.

The gap analysis for Balkan GEO Net provides most of the country data within the document as well, however no adequate indicator is provided for geographic gaps. Identified gaps are summarized in Table 3-1.

Table 3-1. Country data for indicators relevant to GEO-CRADLE gap analysis framework.

	Albania	Bulgaria	Greece	FYROM	Romania	Serbia	Turkey
Observational							
Number of organization active in EO	15	21	12	12	16	21	12
Structural							
Collaboration of data producers (yes)	78%	92%	100%	60%	75%	67%	69%
Collaboration of data users (yes)	54%	61%	33%	50%	80%	55%	69%
Availability of data (yes)	29%	62%	67%	0%	67%	33%	80%
Availability of data online (yes, all and partially)	80%	100%	100%	100%	100%	80%	100%
Redundancies in data (high and medium)	80%	54%	84%	100%	75%	60%	92%
Qlt/Qnt							
METADAT available (yes completely & partially)	80%	100%	100%	100%	100%	80%	100%
Compatibility of data (yes)	72%	81%	100%	60%	57%	100%	80%
Standard-ization (yes)	62%	56%	25%	50%	40%	50%	69%
Capacity							
Use of geoportals by end-users (yes)	8%	56%	42%	25%	80%	35%	69%

3.3. BRAGMA

As written on the BRAGMA website, the project's aim is focused on supporting GMES and Africa coordination and promotion within the context of the Space Track of the 8th Africa - EU Strategic Partnership (Science, Information Society, Space). It does this by:

- Organizing coordination and thematic expert workshops,
- Facilitating participation of pre-qualified African stakeholders at relevant events to ensure pan-African engagement,
- Building the GMES and Africa community, by engaging with key stakeholders, establishing and connecting networks face to face and online.

Within these activities, gaps were identified for EO on the continent, specifically in relation to the project's thematic areas. These gaps will be reviewed herein.

The project was supported by the European Union with cofounding under FP7 (grant agreement no. 284422).

Long-term management of natural resources[17]

Infrastructure capacities for collection of data, space-borne and in-situ, are low to the degree that they do not match existing human capacities. For regular monitoring activities, current fragmentation has to be overcome as a major barrier towards user-friendly support for decision-making. Collected data is not harmonized, standardized or structured to a sufficient degree.

Low-resolution (300m-1km) are sufficiently available, but there is a lack of receiving stations and Africa-based data for higher resolutions. For most indicators, in-situ observations have major geographic, observational and structural gaps. Data collection can be improved to a large degree to complement and validate space-borne capacities. Existing capacities have to be consolidated both at the national level and African level into networks with clear standards.

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[17] Nonguierma, A., and Mayaux, P., 2010. 5. Long-term management of natural resources. In: GMES & Africa action plan. Available at the following link.

Land cover maps also represent gaps. They are incomplete, or of insufficient resolution for analysis to track land-cover change. A systematic land-cover system is needed for all of Africa.

In addition, spatial data for non-renewables is needed, to advance prospection and monitor both current and former mining sites.

Water Resources[18]

For development of operational EO services in this area, the following have to be addressed:

- *Institutional gaps*: lack of awareness, low IT penetration in African institutions, lack of coordination and cooperation between end-users and potential service providers, lack of procedures to integrate EO into decision making and planning on the institutional level, lack of mature service provider groups.
- *Human gaps*: lack of skilled operators, lack of training, high turnover of skilled personnel, lack of EO technical capacity in water authorities, insufficient EO related studies in education curriculum.
- *Technical gaps*: limitation of geographic coverage, lack of in-situ data infrastructures, lack of easy EO data provision and access, lack of satisfactory software and hardware for EO in institutions, lack of fast internet

Existing in-situ networks are “severely degraded or outdated” making resultant data of insufficient reliability to validate satellite-based data or be used in downstream applications. Some programs share data freely, for example WHYCOS.

Climate Variability and Change[19]

Four categories of gaps were identified for this thematic area:

- *Thematic gaps*: Climate change is a process of great complexity. Land resources, in as much as they are crucial for the continent, have been damaged over the years. There is a need for improvement of land resource management to address the multi-sided

[18] Kirugara, D., Fernandez, D., 2010. 7. Water resources. In: GMES & Africa action plan. Available at the following link.
[19] Odada, E., Cherlet, M., 2010. 8. Impacts on climate variability and change. In: GMES & Africa action plan. Available at the following link.

consequences, including poverty issues, climate change, etc. This requires data from a large multitude of parameters.

- *Data gaps*: First of all, there are no up-to-date and harmonized data collection systems in place. In-situ data is not integrated into national networks and often not shared with others beyond the initial purpose of its collection. Institutional capacity is missing to cover less common data needs. Secondly, data collection methods and storage are "dispersed and not harmonized". Finally, Baselines are lacking for most variable and integrated products.
- *Methodological gaps*: The complementarity between in-situ and satellite-derived data is not exploited sufficiently. Long-term satellite-derived data series are necessary to identify trends.
- *Knowledge gaps*: Climate data has to be integrated to a large degree in climate change analysis to gain understanding into cause-effect relationships. Also, there is a need to nest bio-physical models into socio-economic ones in holistic assessment to better understand climate change impact.

Food Security and Rural Development[20]

Existing food security early warning systems need to be strengthened in regards to their infrastructure, and better connected to provide knowledge and data to institutes at the national level. Similarly, EO provided to receiving institutions is not disseminated to other actors and potential actors; it is necessary to develop a data sharing policy and an archiving system.

In-situ networks have to be strengthened to provide supporting field data in real time. Current spatial coverage is poor and must be expanded upon, for most biophysical and particularly for socio-economic parameters. In addition, there is a lack of standardization of collected data. A coherent data exchange policy is needed to facilitate data sharing.

[20] Samba, A., et al., 2010. 10. Food security and rural development. In: GMES & Africa action plan. Available at the following link.

There are several gaps in regards to satellite-derived data. At a low resolution, current products are not validated to a sufficient degree. There are problems with inter-comparability of data, and a lack of strategy to address this gap. For medium and high resolution, lack of satellite possibilities for acquisition are significant. Costs of very high resolution imagery is prohibitive.

Best practices should be defined in regards to data processing methods, to support development of standard products, and facilitate integration of data on the continental scale.

3.4. IASON

IASON "has the ultimate goal to establish a permanent and sustainable Network of scientific and non-scientific institutions, stakeholders and private sector enterprises belonging in the EU and third countries located in two significant areas: The Mediterranean and the Black Sea regions.

The main focal points of the project [was] the usage and application of Earth Observation (EO) in the following topics:

- climate change
- resource efficiency
- raw materials management"[21]

The gap analysis conducted in IASON was presented in *D2.6 Multilevel Assessment and Gap Analysis*[22]. The results are summarized below.

The project was supported by the European Union with cofounding under Horizon 2020 (grant agreement no. 603534).

[21] http://cordis.europa.eu/project/rcn/109068_en.html
[22] Mazzetti, P., et al., 2014. D2.6 Multilevel assessment and gap analysis. Project website unavailable at the time of publication, link.

Black Sea Region

Research and networking activities. The region is well covered by research and networking initiatives in EO, in particular by EU-funded initiatives. These initiatives have a European focus or one of a larger geographic area, indicating that "some of its specificities might be missed". There are two relevant transnational initiatives/programs: The Commission on the Protection of the Black Sea against Pollution and International Commission for the Protection of the Danube River.

Thematic coverage. The raw materials thematic area is less covered than climate action and resource efficiency, the latter two are interconnected and jointly approached on several projects.

Resource availability. 62% of initiatives have geospatial data and/or services, and all of them have open access licenses (full or share-alike). The GEO portal has numerous datasets from the region, but only a small amount are open and free in line with GEOSS principles.

GEO membership. 90% of countries are GEO members already.

Mediterranean Region

Research and networking activities. The region is well represented by research and networking initiatives, particularly by EU-funded initiatives. Unlike for the Black Sea region, the Mediterranean has dedicated projects that deal with the area separately from wider regional groupings. The Mediterranean region has cross-border initiatives/programs: Towards a Shared Environmental Information System in the European Neighborhood and European Neighborhood Partnership Initiative.

Thematic coverage. The raw materials thematic area is less covered than climate action and resource efficiency, the latter two are interconnected and jointly approached on several projects.

Resource availability. 64% of initiatives have geospatial data and/or services, and 55% of them have open access licenses (full or share-alike). The GEO portal has numerous datasets from the region, but only a small amount are open and free in line with GEOSS principles.

GEO membership. 65% of countries are already members of GEO.

Relevant case studies

- **Egypt:** Egyptian Environmental Agency
    - Low networking capacity
    - Data standardization and quality control/assurance are main needs
- **Israel:** environmental information management sector
    - High networking capacity
    - Environmental information system management and data flow are main needs
- **Tunisia:** information management of geospatial data
    - Low networking capacity
    - Data management, flow and publication; IT, data, information standardization are main needs
- **Turkey:** Advancing Shared Environmental Information System
    - High potential
    - Data harmonization, flow and publication are main needs

3.5. OBSERVE

The OBSERVE project was supported financially by the European Union (grant agreement no. 265282) from the same FP7 call as Balkan GEO Net. The projects ran their activities in parallel and have cooperated regarding information exchange.

The following description was made available on CORDIS: "The aim of the OBSERVE project is to collect and compile all the necessary information for delivering an integrated analysis on the current status of EO activities and networks in the Balkans regarding environmental monitoring, the potential benefit from the full exploitation of an integrated capacity development strategy and the prospect of establishing a relevant permanent EO Community in the broader region."[23]

Gaps that were identified at the regional level are the following:

[23] http://cordis.europa.eu/result/rcn/54857_en.html

- EO data regulation is not clear to data producers.
- Access to data is expensive in most countries
- Data is incomplete/limited, outdated, not available or incorrect in most countries
- Standardization would greatly facilitate data sharing between EO actors
- Sharing of regional datasets could be improved and increased
- Data compatibility with GEOSS is low and can be improved
- Data producers/providers are only partially aware of end-users needs
- Potential end-users are not sufficiently informed about new data sources, data availability and data usage

4. Identification and Characterization of Gaps

As discussed in section *2 – Methodology*, the gap analysis is based on the results of inventorying efforts and desk research by the GEO-CRADLE consortium.

The inventorying of space-borne capacities was conducted in T2.1 and is presented in *D2.4 Inventory of space-borne capacities*. The inventorying of in-situ and ground-based networks was conducted in T2.2 and obtained results were presented in *D2.2 Inventory of in-situ instrumentation and regional networks*. Modelling and computing facility capacities were inventoried in T2.3 and presented in *D2.3 Inventory of numerical modelling and computing facilities*. All these documents are available online over the GEO-CRADLE website.

The analysis contained in this section and the conclusions drawn are a reflection of the breadth and depth of information gathered by consortium partners. There is a significant difference in the responses between countries, with higher engagement achieved in some countries compared to others. Due to the need to describe the entire EO value chain, the results from surveys contained information holes that were addressed by additional surveying efforts and desk research to the extent possible.

Inventorying results from countries in the RoI for which GEO-CRADLE did not have a country partner are considered insufficient to perform a gap analysis, and these countries will not be addressed in this section.

4.1. Albania

4.1.1. *Overview*

It is important to stress that **most of EO in Albania is covered by the public sector**. There are some recent developments in the engagement of public institutions and research organizations with EO, driven by modest financial and technical support from European actors. Additionally some private companies and NGOs use satellite images in their studies and projects. GIS is becoming more familiar in the private, public and government sectors and is used to support some of the projects in the environmental sector.

Some public organizations ceased collecting EO data for financial reasons even though they had great tradition and expertise in geodetic and surveying projects. At the beginning of 1993, Albania started to establish a new cadastral system (called the system of Registration of Property and Parcels) oriented towards the ownership registration. New institutions were established for that reason in a hierarchical schema. ALBPOS (Albanian Positioning System) was established. The ALUIZNI Agency completed a flying mission to capture aerial-based orthophotos of almost the entire country.

There are still large barriers to development of EO in the country.

One barrier is financial. Albania's economy is still weak, and the country is undergoing institutional and financial reforms. Public institutions are facing budget cuts and the inability to hire new personnel. During GEO-CRADLE activities, respondents cited lack of funding as a barrier to accessing satellite images, orthophotos and other EO data, as well as attend seminars and other educational programs. The **inability to hire new, qualified employees** is a barrier to developing additional EO capacity. In Albania EO is mainly utilized in the following areas: environmental, climate, land/soil and natural disasters monitoring system.

Sharing of data is a point of weakness rooted in the attitude of public institutions. Access to data between institutions formally requires written requests; in practice they are not easily provided. Thus, sharing of data between institutions is largely based on personal relationships rather than a systematic framework promoting free and open access to data.

Another barrier for EO is the low level of awareness from public and private institutions in the country. Modern technology allows for tracking important parameters that can lead to support of decision-making, including in emergency situations. This is the reason that EO use in Albania has increased. The process of EU accession for Albania has introduced obligations to adopt EU legislations and standards – this includes the use of EO for decision-making.

There are large opportunities to counterbalance challenges in the EO sector through individual initiatives.

Established in 2013, the Ministry of Innovation and Public Administration (MIPA) is conducting preparatory work to create an institutional and legal framework based on the INSPIRE Directive. They plan to realize many activities towards the drafting and implementation of policies on the basis of spatial and EO data. The Ministry has taken into account the Strategy for the Environment and the Development of Infrastructure made by the Ministry of Environment, and the Ministry of Transport and Infrastructure. In 2013 – in accordance with law 72/2012 "On the organization and functioning of the national infrastructure of geospatial information in the Republic of Albania" – MIPA founded the State Authority for Geospatial Information (ASIG), becoming operational in 2015. The main responsibilities of ASIG are:

- Implementation of the national policy for geospatial information infrastructure.
- Responsibility for the design, construction, maintenance and updating of the Geodetic Framework "KRGJSH2010".
- Making decisions on the collection, processing and updating geospatial information from public authorities, according to relevant topics.
- Set uniform standards and rules for creating GIS for each topic, and for the creation of the National GIS in accordance with the relevant European standards.
- Prepare rules associated with creating, updating, sharing, access and use of geospatial information and related services.
- Administer geospatial information collected, processed and updated by public authorities under the relevant topics.
- Ensure coordination of work by coordinating the initiatives and activities related to geospatial information in the public and private sectors.
- Develop and administer the National Geoportal and guarantee public access for all stakeholders in accordance with the provisions of Law 72/2012.

The establishment of the ASIG aims to create a geodetic framework on the basis of European standards, to enable the support of a unique map of the entire territory of the Republic of Albania. Moreover, they will provide a geo-portal where geospatial data created by public institutions can be accessed.

This geo-portal is a very important step in the framework of Open Governance (OGP), which promotes access to and re-use of data for citizens. It will serve as a "bridge" for efficient interagency cooperation in the public sector. It is also a necessary step in the establishment of geospatial Data Infrastructure (NSDI), a priority under the current government that will align Albania closer to the European Digital Agenda. National Geo-portal is in the initial phase of its structuring, performing a harmonization of geospatial data in order for them to be as complete, accurate and up to date.

Albania has profited from the EU Instrument for Pre-Accession Assistance, providing support for capacity building in public institutions. Beneficiaries are the EO providers and end-users.

4.1.2. *Capacities*

Space-borne capacities

Albania has no space-borne capacities.

In-situ networks and facilities

As far as in-situ capacities are concerned, the survey reached 14 organizations with such capacities in Albania, either institutional, or research oriented (see Figure 4-1).

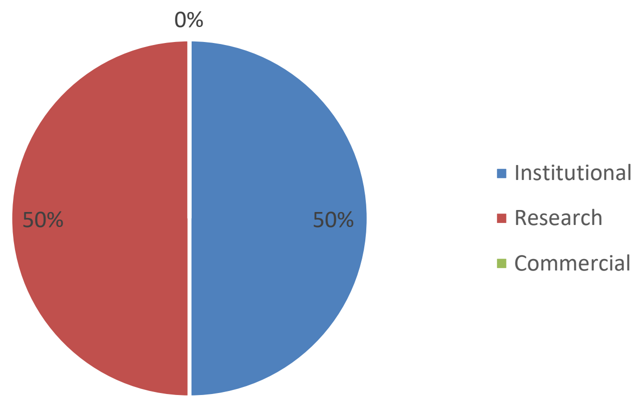


Figure 4-1. The type of organizations with in-situ networks in Albania.

As shown in Figure 4-2, Albanian organizations with in-situ capacities are active in all areas of relevance to GEO-CRADLE, especially energy and climate change. Albanian organizations with in-situ capacities are also involved in the preservation of natural monuments, Earth studies, monitoring of the quality of the surface waters in Albania, analysis of seismic data.

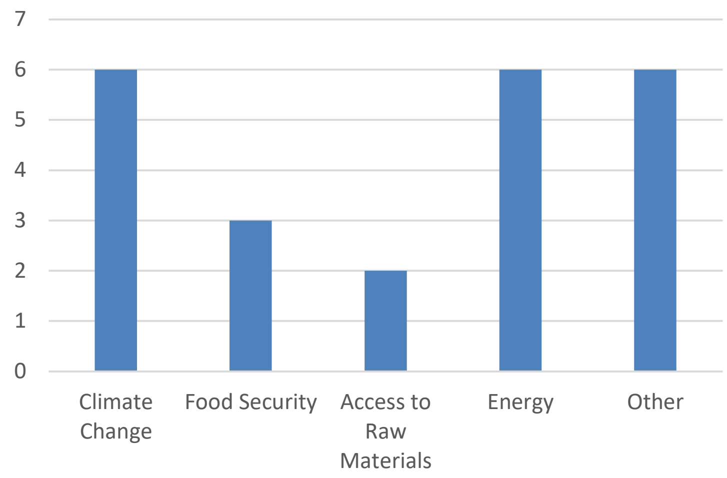


Figure 4-2. Activity of Albanian organizations with in-situ networks in GEO-CRADLE thematic areas.

The survey showed that a large majority of Albanian organizations with in-situ capacities took participation in EO related projects (see Figure 4-3). Examples of such projects include:

- Disaster Risk Mitigation and Adaptation Project
- IPA Floods
- SEERA-EI

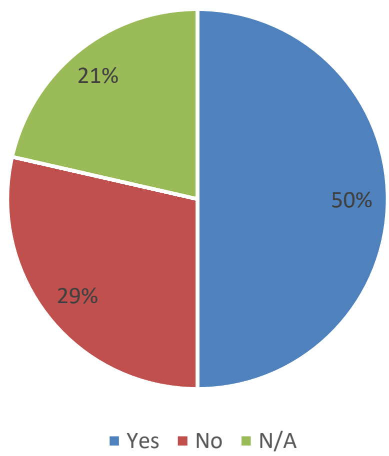


Figure 4-3. Participation of Albanian organizations with in-situ networks in EO activities.

Participation in Copernicus, however, is non-existent for these organizations (see Figure 13). Similarly, a large majority of these organization did not participate in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-5).

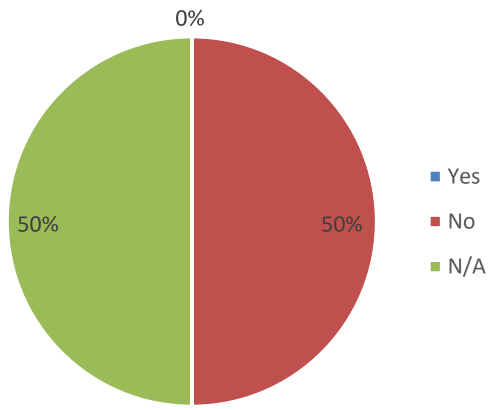


Figure 4-4. Participation of Albanian organizations with in-situ networks in a Copernicus action.

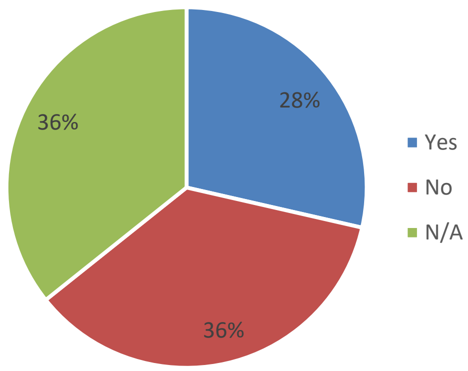


Figure 4-5. Participation of Albanian organizations with in-situ networks in a GEO/GEOSS SBA task.

As shown in Figure 4-6the collaboration between local EO players is largely rated as low. Similarly, collaboration with EO actors abroad is also rated as low (see Figure 4-7).

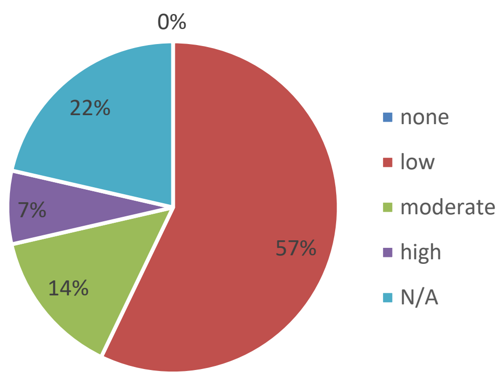


Figure 4-6. Level of cooperation of Albanian organizations with in-situ networks with local EO actors.

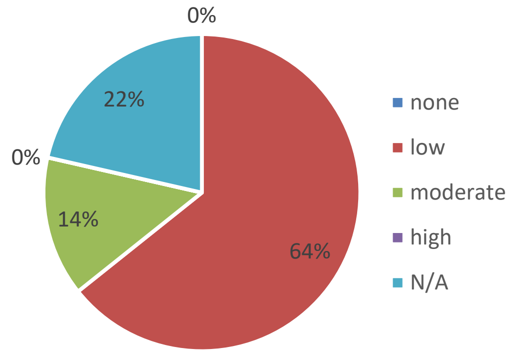


Figure 4-7. Level of cooperation of Albanian organizations with in-situ networks with EO actors abroad.

A large majority of respondents stated that their organizations do not have additional capacities. A smaller number of respondents indicated that their organizations have space-borne capacities in addition to in-situ capacities. Only 1 respondent stated that their organization has modelling and processing capacities (see Figure 4-8). As far as the thematic areas of relevance to GEO-CRADLE are concerned, respondents indicated that their organizations are active in all relevant thematic areas (see Figure 4-9).

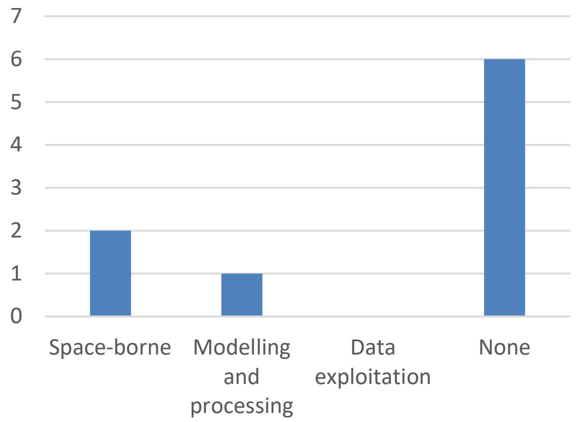


Figure 4-8. Additional EO capacities of Albanian organizations with in-situ networks.

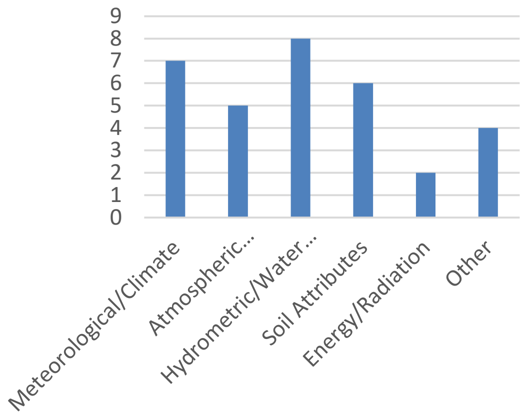


Figure 4-9. Activity area of in-situ networks of Albanian organizations.

Meteorological/climate stations are present in the largest number (663). Furthermore, the respondents indicated the existence of 640 hydrometric/water facilities (see Figure 4-10). Most facilities have national coverage; none have global coverage (see Figure 4-11).

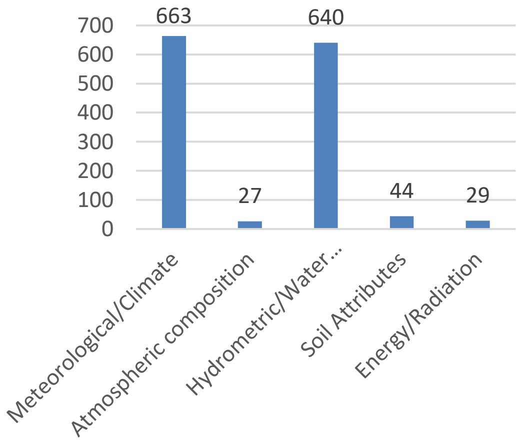


Figure 4-10. Number of stations of in-situ networks in Albania by activity area.

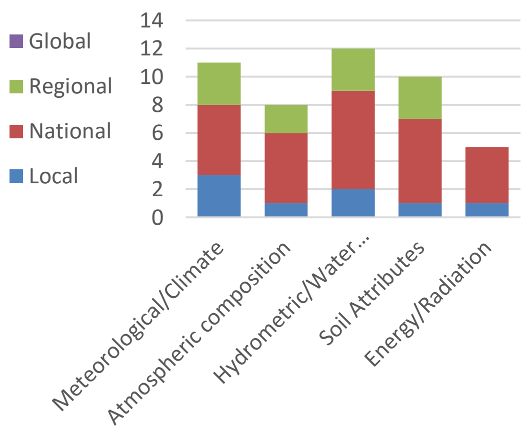


Figure 4-11. Geographic coverage of in-situ networks in Albania by activity area.

Furthermore, the survey showed that most facilities are registered in a national network (see Figure 4-12). Data is systematically collected for all types of networks/facilities (see Figure 4-13).

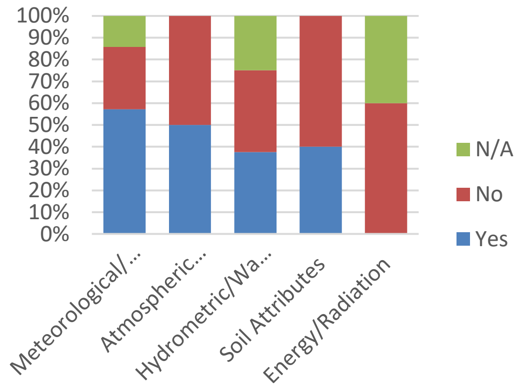


Figure 4-12. Registration of in-situ networks in Albania by activity area.

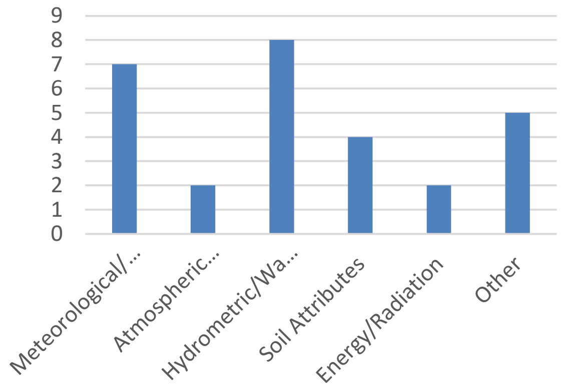


Figure 4-13. Systematic collection of data by in-situ networks in Albania by activity area.

For meteorological and climate in-situ networks, as shown in Figure 4-14, METADATA is mostly available. Temporal resolution of data acquisition is usually daily. Other types of temporal resolutions are also applied (see Figure 4-15).

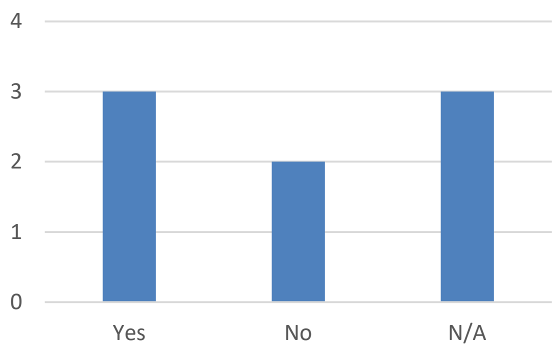


Figure 4-14. Availability of METADATA from meteorological and climate in-situ networks in Albania.

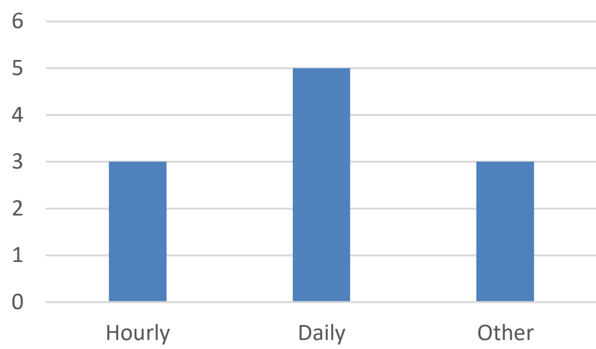


Figure 4-15. Temporal resolution of meteorological and climate in-situ networks in Albania.

For these networks, data is usually available in real time; however, it can also be obtained upon request, or from past archives (see Figure 4-16). Data policy applied is either license restricted, or commercial. There are also other policies applied (See Figure 4-17).

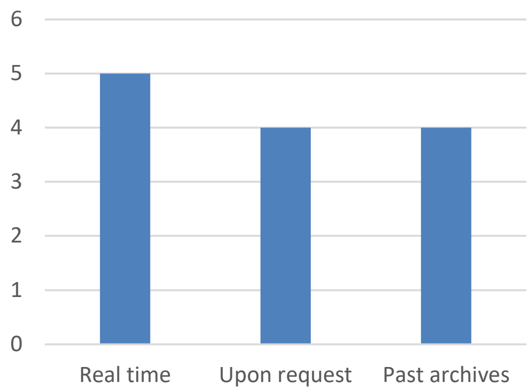


Figure 4-16. Data availability from meteorological and climate in-situ networks in Albania.

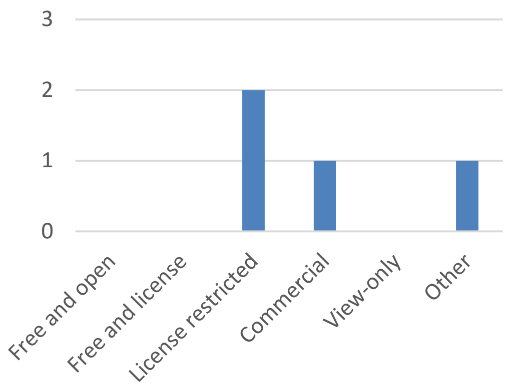


Figure 4-17. Data policy of meteorological and climate in-situ networks in Albania.

For organization with atmospheric composition/profiling facilities, two confirmed that they have METADATA (see Figure 4-18). Their temporal resolution is either hourly or daily, shown in Figure 4-19.

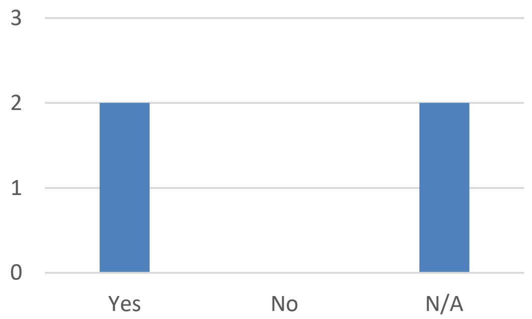


Figure 4-18. Availability of METADATA from atmospheric composition and profiling in-situ networks in Albania.

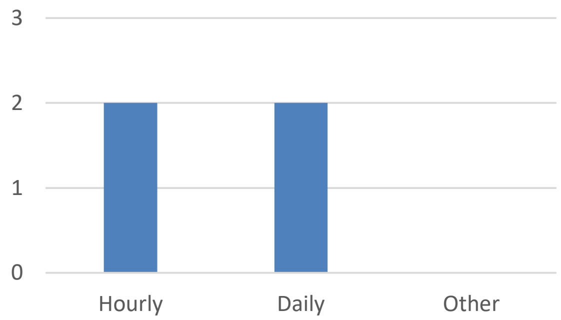


Figure 4-19. Temporal resolution of atmospheric composition and profiling in-situ networks in Albania.

As seen in Figure 4-20, data in one network is available upon request. The only organization that specified its data policy had a license restricted one (Figure 4-21).

Figure 4-20. Data availability from atmospheric composition and profiling in-situ networks in Albania.

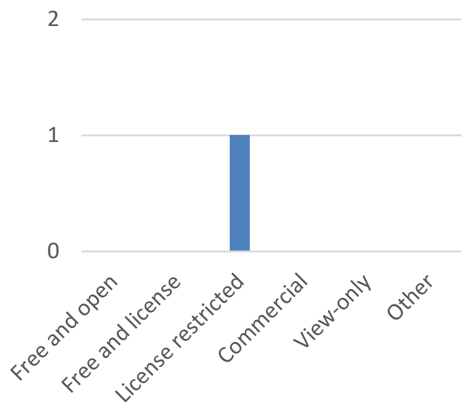


Figure 4-21. Data policy of atmospheric composition and profiling in-situ networks in Albania.

The same amount of respondents said that METADATA is available from their hydrometric and water quality in-situ networks (see Figure 4-22) as those that said it is not. Most respondents stated that the temporal resolution of their in-situ networks is daily (see Figure 4-23).

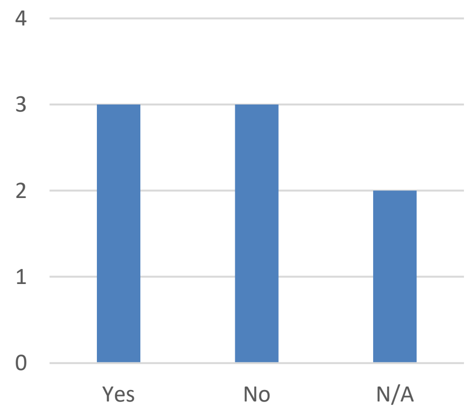


Figure 4-22. Availability of METADATA from hydrometric and water quality in-situ networks in Albania.

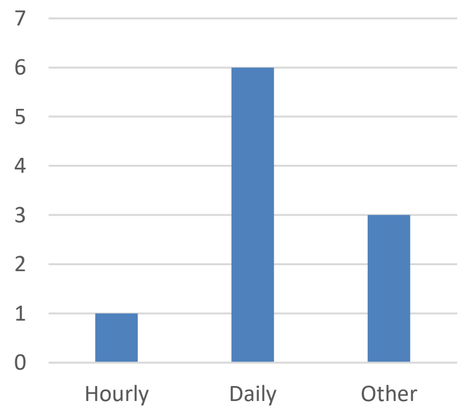


Figure 4-23. Temporal resolution of hydrometric and water quality in-situ networks in Albania.

These same networks have different data availability, with half offering data upon request as shown in Figure 4-24. None specified that they offer a free and open data policy, (see Figure 4-25).

Figure 4-24. Data availability from hydrometric and water quality in-situ networks in Albania.

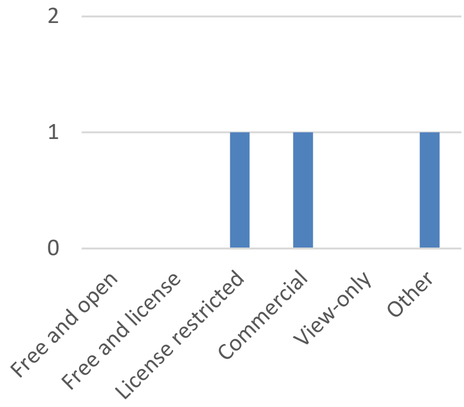


Figure 4-25. Data policy of hydrometric and water quality in-situ networks in Albania.

Availability of METADATA for soil in-situ facilities in Albania was confirmed by two respondents (see Figure 4-26). However, four respondents stated that this question does not apply to them. One organization specified that it collects information daily, while three specified that their networks collected data less frequently, shown in Figure 4-27.

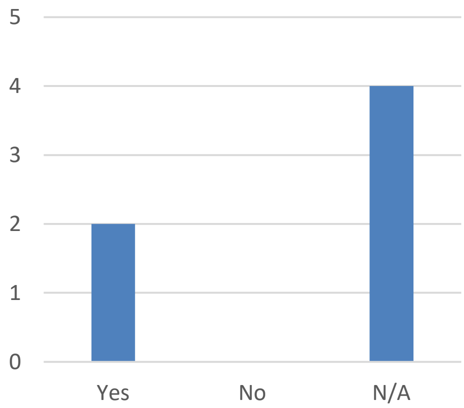


Figure 4-26. Availability of METADATA from soil attributes/spectra in-situ networks in Albania.

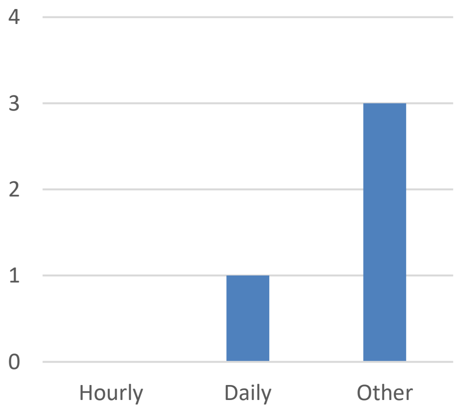


Figure 4-27. Temporal resolution of soil attributes/spectra in-situ networks in Albania.

For these organizations, data is either available upon request, or from past archives (see Figure 4-28). One respondent specified that their data has a commercial license (see Figure 4-29).

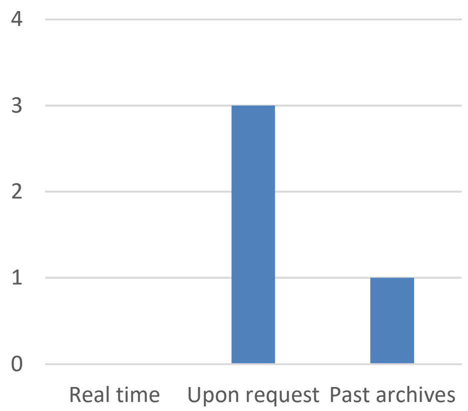


Figure 4-28. Data availability from soil attributes/spectra in-situ networks in Albania.

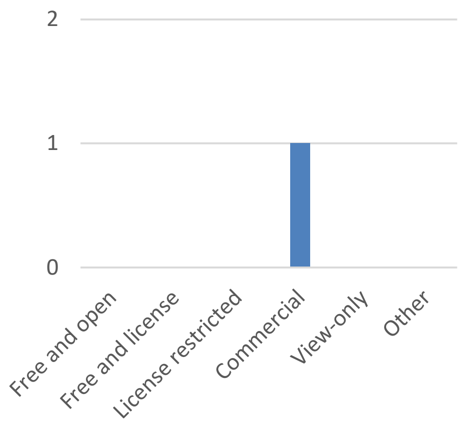


Figure 4-29. Data policy soil attributes/spectra in-situ networks in Albania.

As shown in Figure 4-30, most respondents consider that the availability of METADATA is not applicable to them. Few specified temporal resolution, as shown in Figure 4-31.

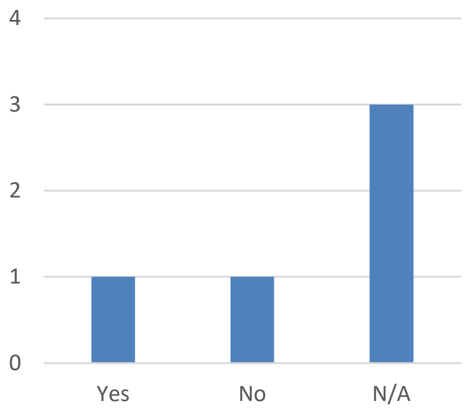


Figure 4-30. Availability of METADATA from energy/radiation in-situ networks in Albania.

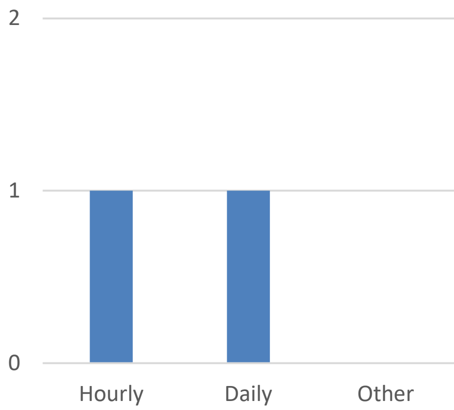


Figure 4-31. Temporal resolution of energy/radiation in-situ networks in Albania.

Information on data availability and the main data policy applied remains unknown, as no organization with energy/radiation facilities provided details.

Modelling and processing capacities

In Albania, the survey reached three organizations with modelling capacities, all of which are institutional, shown in Figure 4-32.

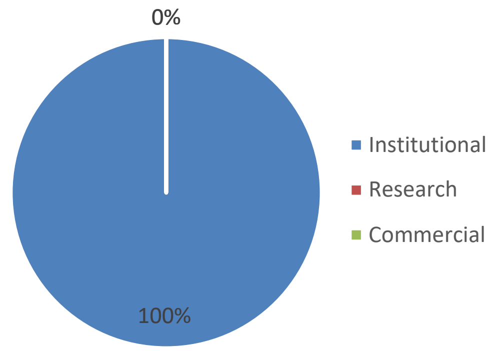


Figure 4-32. The type of organizations with modelling and processing capacities in Albania.

As shown in Figure 4-33, the Albanian organizations with modelling capacities are active in food security and climate change. There are also other thematic areas in which Albanian organizations are active, including forest management, and preservation of monuments.

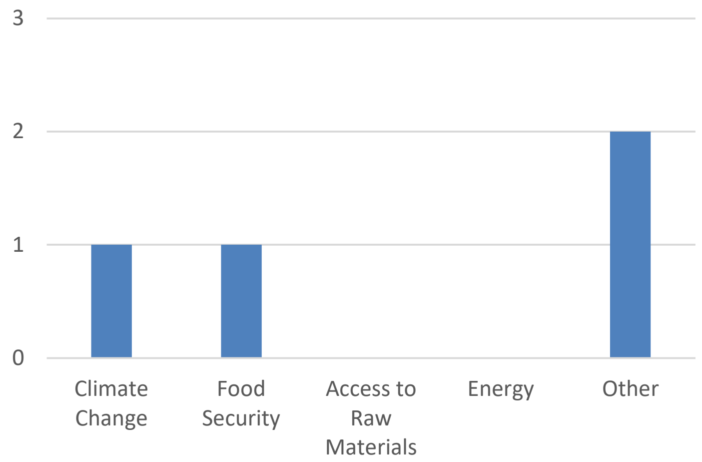


Figure 4-33. Activity of Albanian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

The survey showed that Albanian organizations with modelling capacities did not take participation in EO related projects (see Figure 4-34).

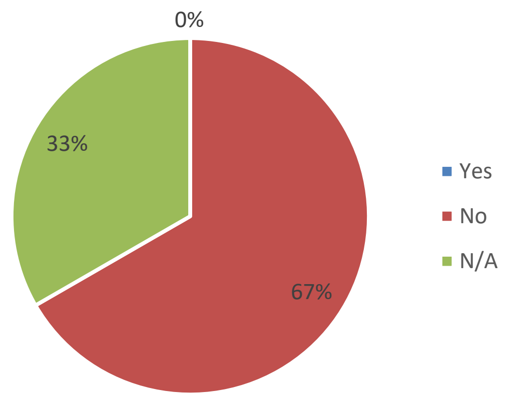


Figure 4-34. Participation of Albanian organizations with modelling and processing capacities in EO activities.

Similarly, participation in Copernicus service provision, Copernicus user requirements definition, or Copernicus research and innovation action is non-existent (see Figure 4-35). For most Albanian organizations with modelling capacities participation in GEO/GEOSS SBA Tasks, community activities or initiatives is also non-existent (see Figure 4-36).

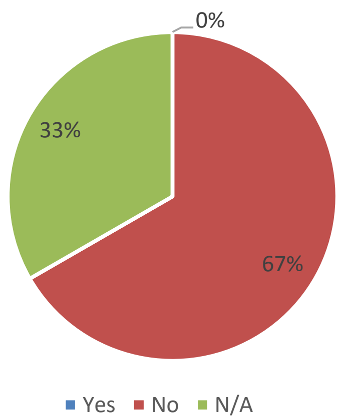


Figure 4-35. Participation of Albanian organizations with modelling and processing capacities in a Copernicus action.

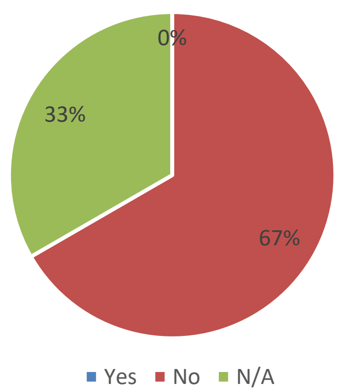


Figure 4-36. Participation of Albanian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

Most respondents agree that the cooperation between local EO actors ranges from low to high, shown in Figure 4-37. However, respondents mostly gave none to moderate rankings for collaboration with EO actors abroad (see Figure 4-38).

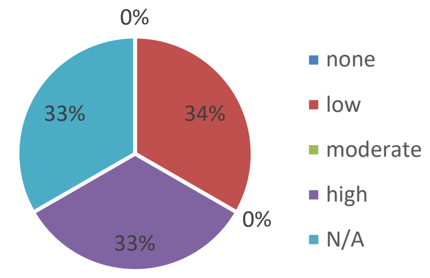


Figure 4-37. Level of cooperation of Albanian organizations with modelling and processing capacities with local EO actors.

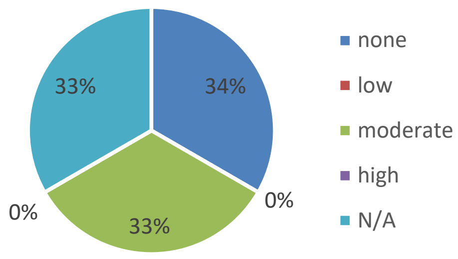


Figure 4-38. Level of cooperation of Albanian organizations with modelling and processing capacities with EO actors abroad.

As far as other capacities are concerned, one organization with modelling capacities also has in-situ capacities. In addition, 2 organizations have no other capacities apart from modelling capacities (see Figure 4-39).

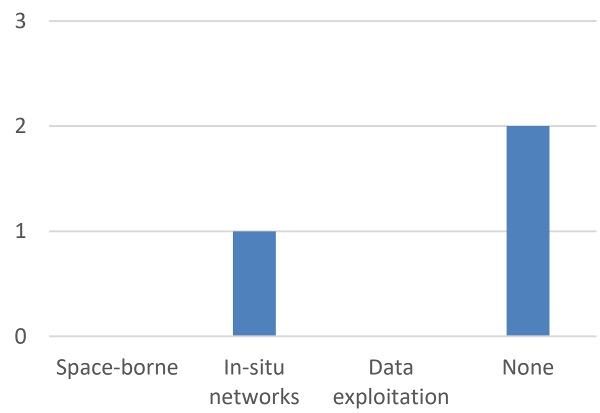


Figure 4-39. Additional EO capacities of Albanian organizations with modelling and processing capacities.

Application areas the models were found to serve include: meteorological, hydrometric, and the area of soil attributes. No model serves the application area of energy/radiation, while only one respondent stated that its model serves the application area of atmospheric composition, as shown in Figure 4-40. As far as the source of EO data is concerned, data usually used is geospatial data, together with remote sensing data. The survey shows that in-situ data is not used (see Figure 4-41).

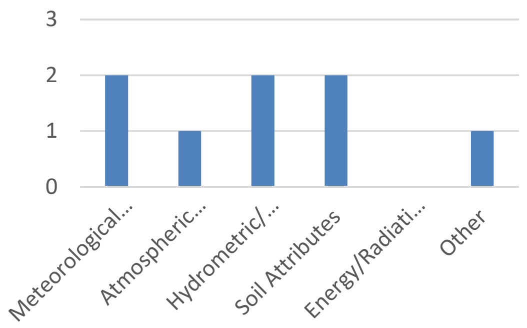


Figure 4-40. Algorithms and models available in Albania by activity area.

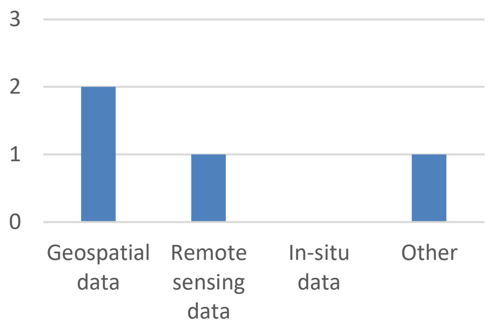


Figure 4-41. Sources of EO data used by organizations with modelling and processing capacities in Albania.

As shown in Figure 4-42, models used usually have local and national coverage. The survey also implies that METADATA is not available (see Figure 4-43).

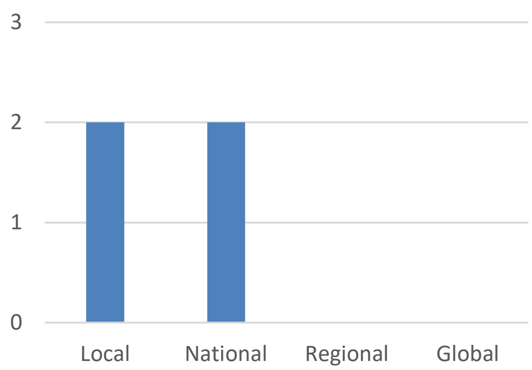


Figure 4-42. Geographic coverage of models and algorithms in Albania.

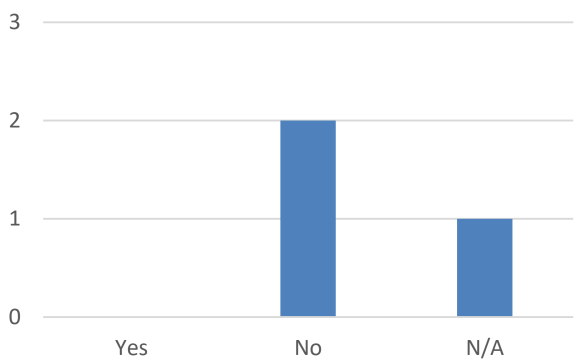


Figure 4-43. Availability of METADATA for models and algorithms in Albania.

Albanian organizations with modelling capacities identified that they have server clusters and processing power capacities (see Figure 4-44).

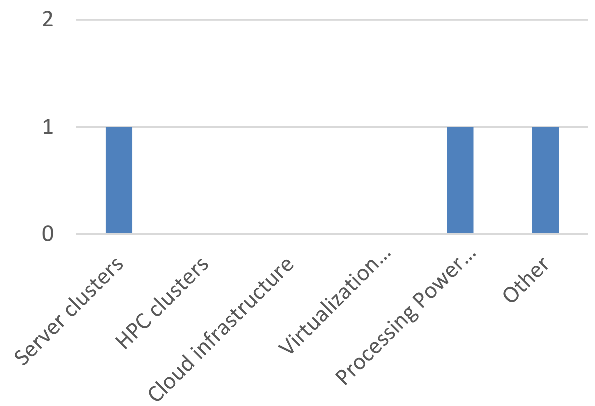


Figure 4-44. Computing resources available for processing and exploitation of EO data in Albania.

Data exploitation capacities

In Albania, the survey reached 10 organizations with data exploitation capacities, a large majority of which (80%) are institutional, shown in Figure 4-45.

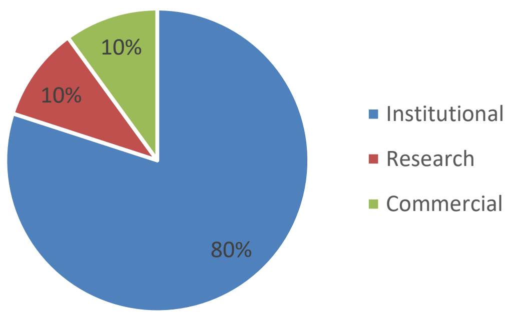


Figure 4-45. The type of organizations active in data exploitation in Albania.

Organizations that the survey reached are active in all thematic areas relevant to the GEO-CRADLE project, particularly energy and food security (see Figure 4-46).

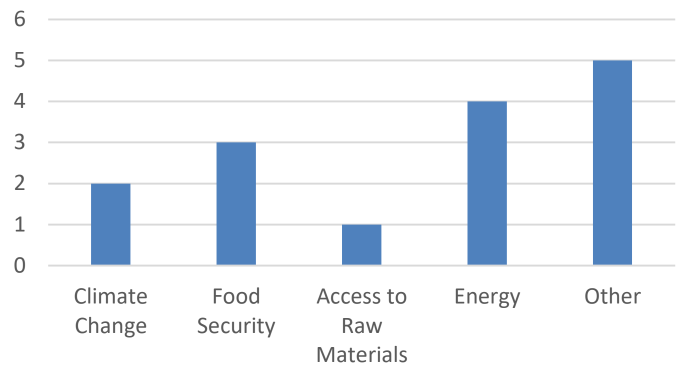


Figure 4-46. Activity of Albanian organizations active in data exploitation in GEO-CRADLE thematic areas.

Participation in EO related projects was identified for 20% of Albanian organizations with data exploitation capacities. 70% claimed they did not participate in EO related projects (see Figure 4-47).

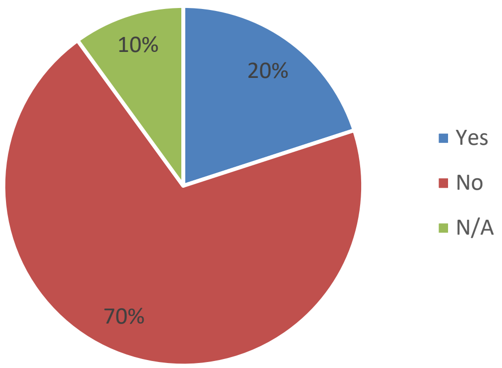


Figure 4-47. Participation of Albanian organizations active in data exploitation in EO activities.

Similarly, there is no prior participation in Copernicus service provision, Copernicus user requirements definition or Copernicus research and innovation action, shown in Figure 4-48. 10% of the organizations surveyed did participate in GEO/GEOSS SBA Tasks, community activities or initiatives, while 80% did not (see Figure 4-49).

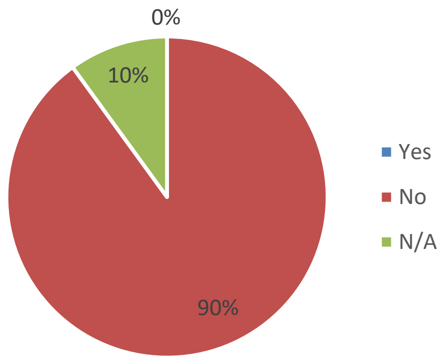


Figure 4-48. Participation of Albanian organizations active in data exploitation in a Copernicus action.

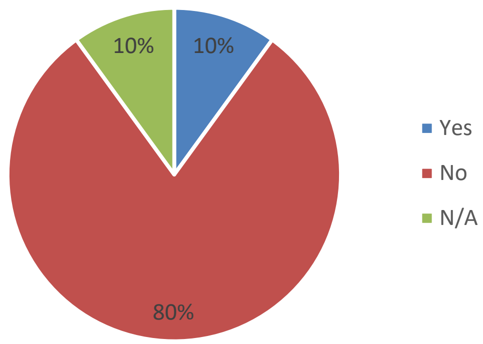


Figure 4-49. Participation of Albanian organizations active in data exploitation in a GEO/GEOSS SBA task.

As shown in Figure 4-50, locally, the level of collaboration between EO actors is perceived as low. Similarly, most respondents also perceive the level of collaboration with actors outside Albania as low (see Figure 4-51). No respondent claimed a high level of collaboration.

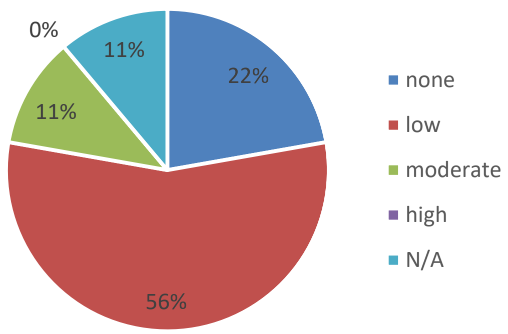


Figure 4-50. Level of cooperation of Albanian organizations active in data exploitation with local EO actors.

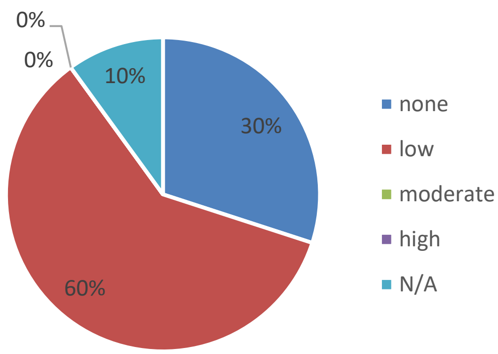


Figure 4-51. Level of cooperation of Albanian organizations active in data exploitation with EO actors abroad.

The survey showed that Albanian organizations with data exploitation capacities do not have additional capacities (see Figure 4-52).

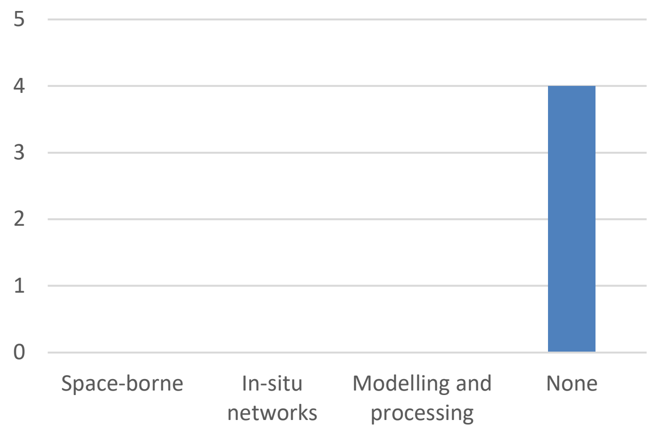


Figure 4-52. Additional EO capacities of Albanian organizations active in data exploitation.

Organizations with data exploitation capacities in Albania are active in almost every product thematic areas. As shown in Figure 4-53, there are no organizations active snow & ice, metocean, air quality.

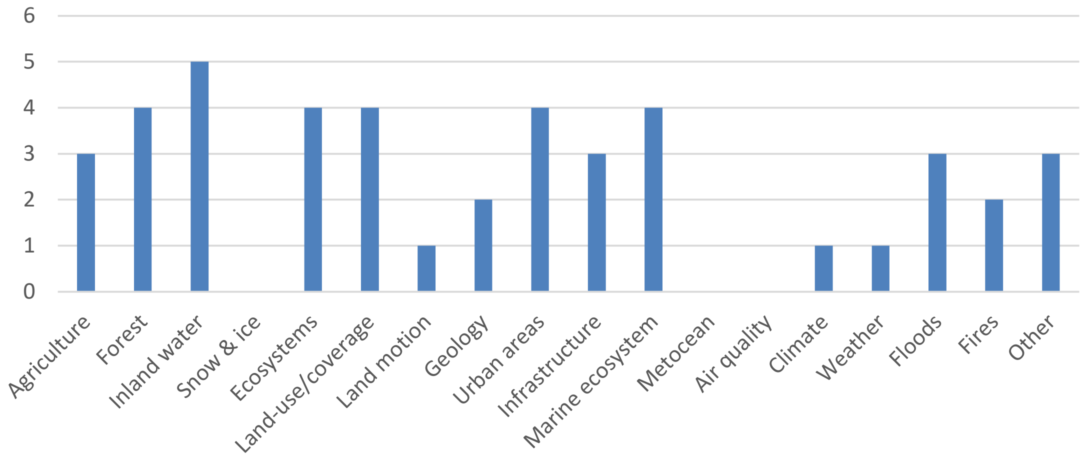
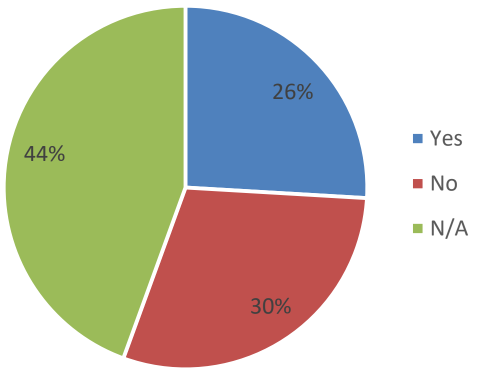


Figure 4-53. Activity areas of EO products/services of Albanian organizations.

National activities

Most respondents agree that funding for EO is not available in Albania (see Figure 4-54). However, a significant percentage of respondents (26%) have confirmed the availability of such funding. EO funding is mostly dedicated to infrastructure development, shown in Figure 4-55.



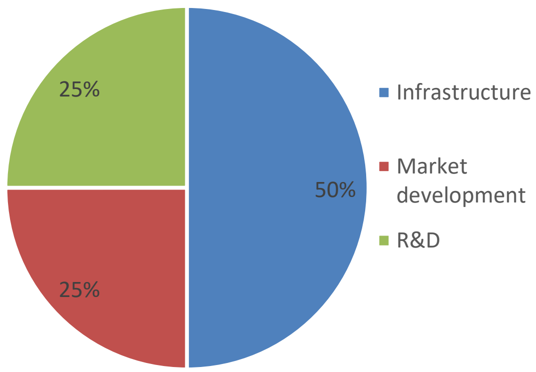


Figure 4-54. Albanian EO actors' perception of the availability of national funding for EO.

Figure 4-55 Albanian EO actors' perception of areas for which national EO funding is available.

As shown in Figure 4-56, there is no national space policy/strategy in Albania. According to desk research, there are three institutions in charge of establishing a space research program, the Nuclear Physics Institute, National Academy of Science and University of Tirana Department of Physics. Furthermore, the respondents confirmed that Albania does not have a national Space Agency, shown in Figure 4-57.

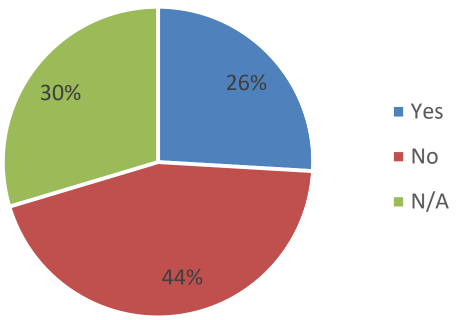


Figure 4-56. Albanian EO actors' awareness of a space strategy in Albania.

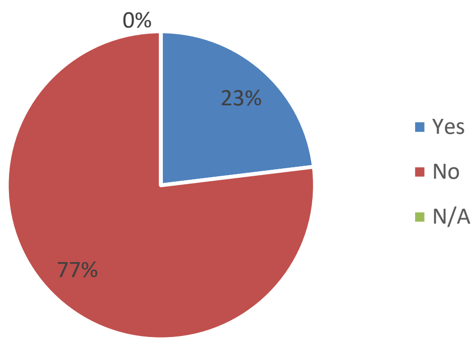


Figure 4-57. Albanian EO actors' awareness of a space program in Albania.

Locally, the level of coordination of EO activities ranges from none to basic. Only a small percentage of respondents have rated coordination between EO players as fully integrated (see Figure 4-58). As shown in Figure 4-59, interaction with decision makers is perceived as scarce (33%).

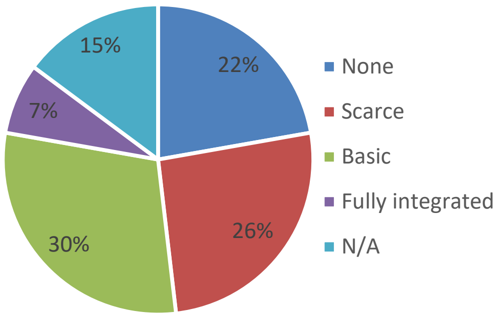


Figure 4-58. Albanian EO actors' perception of national coordination of EO activities in Albania.

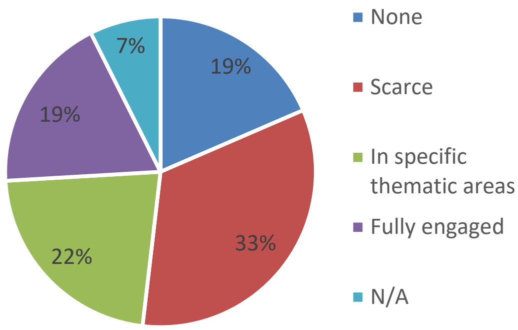


Figure 4-59. Albanian EO actors' perception of interaction with decision makers in Albania.

A large percentage of the organizations that responded to the survey indicated that they would contribute with their capacities to a regional initiative of GEO/Copernicus. Another significant percentage of respondents (33%) would contribute under specific circumstances (see Figure 4-60).

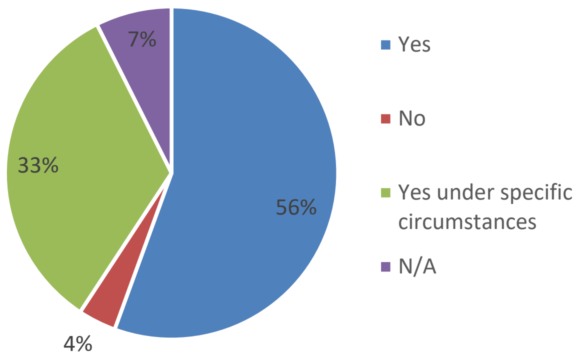


Figure 4-60. Albanian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

In Albania, most end-users are aware of both Copernicus and GEO (Figure 4-61 and Figure 4-62).

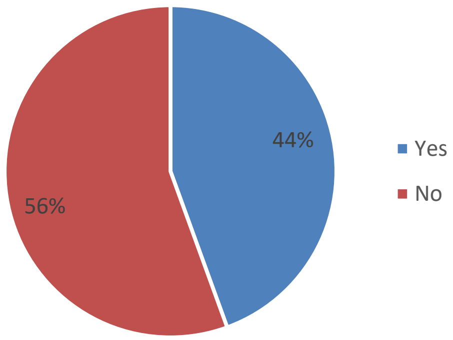


Figure 4-61. End-user awareness of Copernicus in Albania.

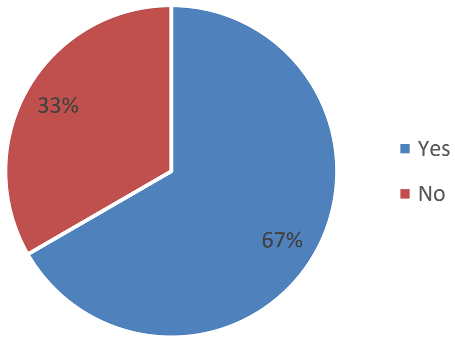


Figure 4-62. End-user awareness of GEO in Albania.

4.1.3. *Gap analysis*

No **geographic** gaps could be identified for Albania.

An **observational** gap was identified during project implementation through desk research. An in-situ network operated by a public institute was offline due to financing issues.

Several **structural** gaps were identified. Several organizations with in-situ networks stated through the survey that they have high temporal resolutions and real-time data availability. Overall, end-users claimed that the data that they need is not updated on a regular basis. Data providers showed in the survey that they offer only restricted and commercial licensing. End-users do not have the budget to purchase this data when needed, and several of them obtain data necessary for their work through unspecified illegal means. A centralized national system for sharing geospatial data was suggested as a solution.

Quality/quantity gaps are expressed in insufficient detail and quality of information/data received.

In terms of **capacity** gaps, most end-users pointed to human resource limitations. End-users claimed that their staff did have the training and expertise required for EO related tasks. Moreover, many organizations did not have enough employees to conduct their tasks. Probable cause can be found in a lack of funding.

Most end-users agree that the availability of national funding is limited, and that their annual budgets as public bodies are insufficient. Moreover, they also agree that there is an overall lack of governmental support. These constraints are also validated in the survey: most survey respondents agree that there is no national funding for EO activities and cooperation with decision makers is largely perceived as scarce.

4.2. Bulgaria

4.2.1. *Overview*

Historically, Bulgaria had serious advances in space-based EO in the framework of its contribution to the international program INTERCOSMOS. The first Bulgarian cosmonaut (launched in April 1979) developed a multichannel spectrometric instrument named Spektar-15, having 15 channels in the visible part of the EM spectrum, and its successor Spektar-15M. The next instrument for EO, SMP-32 with 32 spectral channels, was developed for the satellite “Bulgaria 1300 – II”. In 1988 the second Bulgarian cosmonaut used purposely developed trace spectrometer Spektar-256 and was able to acquire data from 256 spectral channels in the visible range of the spectrum. In 1989 VSC Fregat developed at Bulgarian Academy of Sciences flew onboard the international mission to Phobos (Mars’ satellite) and made unique digital color images of it. It should be noted that for all this activity, strong financial support was provided to the scientific community.

Currently, EO activities in Bulgaria are predominantly based on the requirements of the public sector. **Most governmental structures (ministries, agencies or other bodies) use EO derived information provided on a project basis**. Most of these projects have financial support from the EU, e.g. Structural Funds and European Environment Agency, with only a few funded from the national budget. One of the possible reasons for this is a lack of a National Strategy for EO data acquisition and exploitation for economic development. Last year marked a positive development: the government adopted a plan for the creation of a web portal for data sharing from several public bodies, but only in Bulgarian which might be considered an obstacle for foreign researchers/users. Nonetheless, a legal basis for public bodies to provide EO data at no cost or at an affordable price is not yet foreseen. In many cases, even the data sharing between governmental authorities cannot be implemented easily.

Some public institutions have specialized EO and/or GIS departments, while others have this function performed by IT specialists. There have been several past projects focused on EO data management. Overall, there is a need for further capacity building.

EO activities are one of the key elements of the National Space Program that is under preparation, and one of the priorities set out in the Plan for European Cooperating States signed with ESA.

Public Sector

- *Ministry of agriculture and food*: The Agricultural Cadaster consists of orthophotos from aerial surveys for monitoring subsidized agricultural parcels. Funding is provided by the Ministry, data usage is under a commercial license.
- *Ministry of Regional development and Public Works*: its subsidiary the Geodesy, Cartography and Cadaster Agency (GCCA) has the responsibility to create, update and maintain cadastral and mapping data at a national level. Most of the services are under a commercial license. The GCCA also monitors the sea level of the Black Sea using four stations maintained by the Institute of Oceanology (BAS). The Ministry has other EO related data such as maps of administrative units, rivers and watersheds, active landslides, etc., some of which are available as a Web Map Service.
- *Ministry of Environment and Water*: the Executive Environment Agency (ExEA) is an administration delegated to create, maintain and update the National System for Environmental Monitoring, providing data from the national monitoring networks for air, water, land and soil, forests and protected areas, biodiversity, radiological monitoring and noise monitoring. ExEA holds data from other sources as well, but only those specified by the Environmental Protection Act are provided on the agency's website, while restrictions apply for the rest of the data. For example, the water directorates are responsible at a regional level to deliver a daily data report to ExEA about the quantity and quality of surface and ground water, however the data is used internally.
- *Ministry of Transport, Information Technology and Communications*: one of its administrations is responsible for the implementation of the INSPIRE directive in Bulgaria. Since April 2016, there is a fully functional geoportal to fulfil the

requirements under said directive. Road administration, Maritime Administration, Exploration and Maintenance of the Danube River, Railway Administration are also part of the same Ministry, but do not provide the EO-related data they work with to the public.

Industry

The EO related industry in Bulgaria is mostly composed of medium or small sized companies working in: cadaster, ecology, hydrography, construction, etc. They deliver a whole spectrum of services – data purchase and delivery, product development, hardware and software provision and training and consulting – and customers typically purchase packages. This is an indication that end-users are not able to process EO data and need complete EO solutions. A **cluster of GIS companies named GIS Alliance Bulgaria has formed consolidating several EO companies**.

Several utility companies in Bulgaria, such as the electricity network operators or water works, have their own GIS departments. Details regarding EO data is considered as internal information.

Several large open pit mining companies operate in Bulgaria, but are not current users of EO. However, they might find EO useful for their production cycle. It is possible that they lack information about EO potential and/or properly trained staff.

Research

Several research organizations produce, process and distribute EO data mainly from in-situ networks. The main actors from Bulgaria are given below:

- *National institute of meteorology and hydrology*: NIMW-BAS is the official Bulgarian representative to the European Centre for Medium-Range Weather Forecasts (ECMWF), The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), Operational Program for the Exchange of Weather Radar Information (OPERA) of the Network of European Meteorological Services (EUMETNET), International Hydrological Program to the UNESCO, the International Program for the Study of the Danube River, and others. NIMH is the official representative of Bulgaria in the World Meteorological Organization (WMO). The organization issues weather forecasts on the basis of numerical models, measurements, radar and satellite data.

The main numerical model for short-range forecast is ALADIN. Daily operations of the group for Marine Meteorology at the Information Center of NIMH-BAS includes 3 wave model: WAVEWATCH III (NOAA), WAM (ECMWF) and SWAN (TU-DELFT) for near shore forecasts. The Division of Hydrological Forecasting at the Hydrology Department has the task of preparing hydrological predictions and products as well as the development and set-up of relevant methodologies and software.

- *The National Institute of Geophysics, Geodesy and Geography*: the organization maintains the following in-situ networks: National Seismological Service, the national network of Permanent Stations of Global Navigation Satellite Systems (GNSS), the national network of strong ground motions, geomagnetic service, ionosphere service, network for terrestrial measurements of biologically active solar UV radiation, a system for predicting levels of tropospheric ozone in ambient air, and meteor radar (EMDR20).
- *Institute of Oceanology*: IO-BAS provides data regarding the current state of sea water in Black Sea. Several laboratories form part of the institute – Laboratory of Marine Structures, Underwater Investigations Laboratory, Tools and Equipment Laboratory. Scientific contributions are: digital modelling and prediction of sea currents and processes of dynamical distribution and spreading of suspended matter in marine environment in the Black Sea; modelling of coastal dynamic processes; and modelling the anthropogenic impact on the quality of the coastal waters and sediments.

The data policy implemented in these research organizations is restricted by national legislation and internal regulations. Data are provided only to the corresponding Ministry or agency and only excerpts are reported in scientific publications.

4.2.2. *Capacities*

Space-borne capacities

Bulgaria has no space-borne capacities.

In-situ networks and facilities

Of the six organizations reached by this survey, four were involved with research (Figure 4-63). These organizations were mostly focused on the climate change thematic area (Figure 4-64).

Aside from the provided thematic areas, the organizations reached by this survey indicated that they have activities in remote sensing, Earth observation, natural hazards, risk and disaster assessment, geography, geophysics and geodesy.

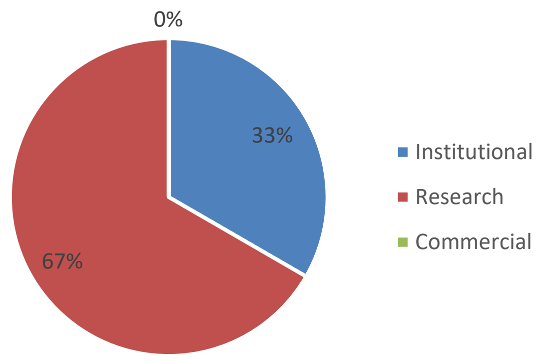


Figure 4-63. The type of organizations with in-situ networks in Bulgaria.

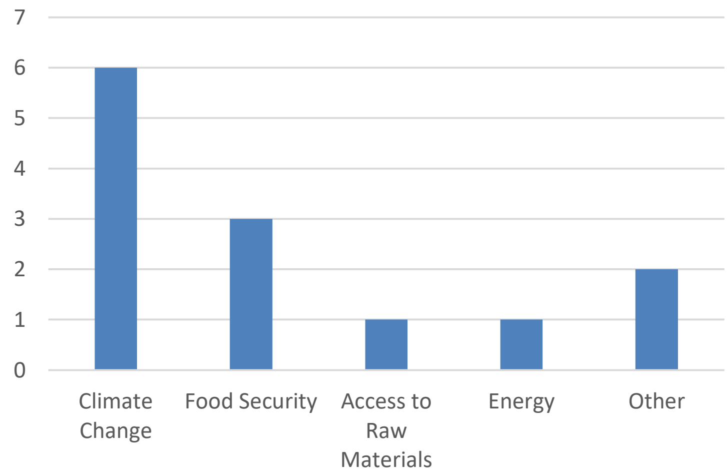


Figure 4-64. Activity of Bulgarian organizations with in-situ networks in GEO-CRADLE thematic areas.

The majority of organizations responded that they had taken part in past EO projects (Figure 4-65). In regards to Copernicus service provision participation, an equal amount of organizations responded to having past experience and not having past experience (Figure 4-66). In regards to GEO/GEOSS SBA Tasks, community activities or initiatives, 50% of organizations indicated having no past experience (Figure 4-67).

Those organizations having taken part in past EO projects pointed to their participation in the MERA project, FP7 IGIT, FP7 Balkan GEO Net, FP7 PASODOBLE, FP7 iSOIL. In regards to Copernicus activities, one respondent pointed to Executive Environment Agency (ExEA) using Copernicus services.

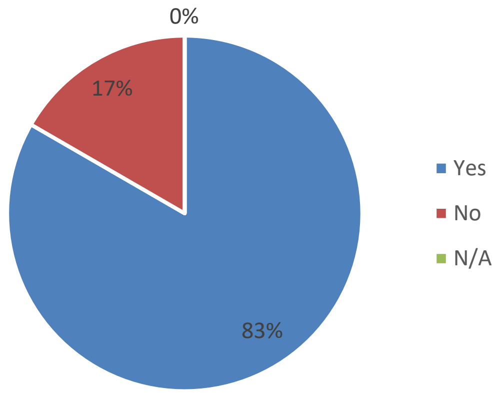


Figure 4-65. Participation of Bulgarian organizations with in-situ networks in EO activities.

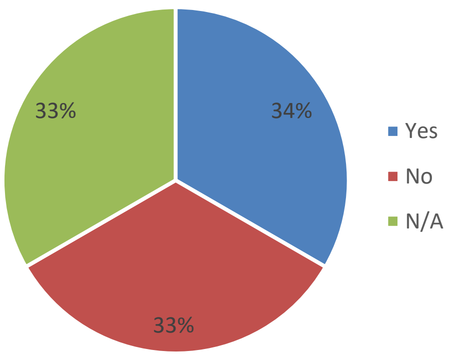


Figure 4-66. Participation of Bulgarian organizations with in-situ networks in a Copernicus action.

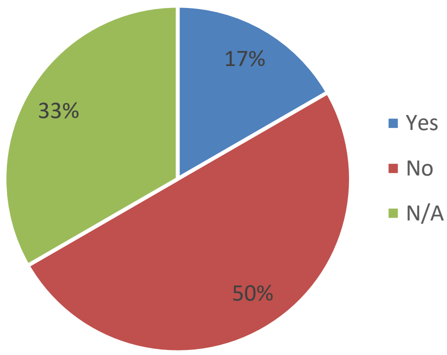


Figure 4-67. Participation of Bulgarian organizations with in-situ networks in a GEO/GEOSS SBA task.

With regards to international and national cooperation, most respondent organizations described it as being *low* or *none* (Figure 4-68). Respondents clarified that local cooperation is channeled through Bulgaria`s Ministry of Environment and Water, the Ministry of Agriculture and Food, institutes within the Bulgarian Academy of Sciences. In regards to international cooperation, respondents specified that it is realized with other EU countries and China (Figure 4-69).

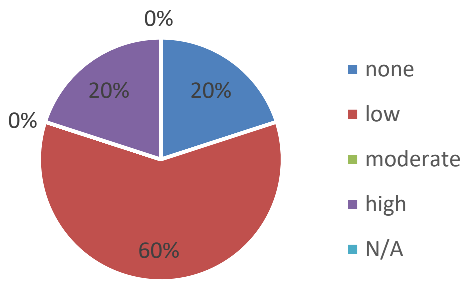


Figure 4-68. Level of cooperation of Bulgarian organizations with in-situ networks with local EO actors.

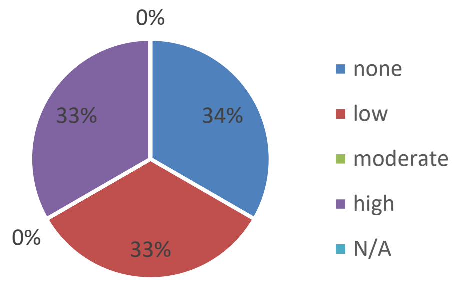


Figure 4-69. Level of cooperation of Bulgarian organizations with in-situ networks with EO actors abroad.

The majority of organizations with modelling and processing capacities have other capacities (Figure 4-70). Their modelling capacities are equally spread across the defined areas (see Figure 4-71). Organizations indicated having capacities through the National Seismic Network, the National GNSS (Global Navigation Satellite System) Permanent Network and Geomagnetic Field Variations Monitoring.

Most of the facilities operated by the organizations dealt with hydrometry and water quality Figure 4-72. Stations belonging to this group had the broadest coverage (Figure 4-73).

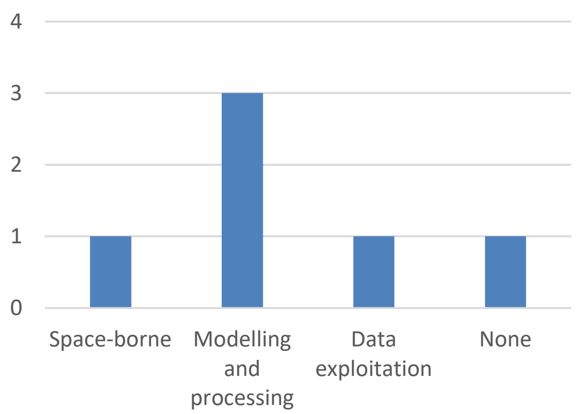


Figure 4-70. Additional EO capacities of Bulgarian organizations with in-situ networks.

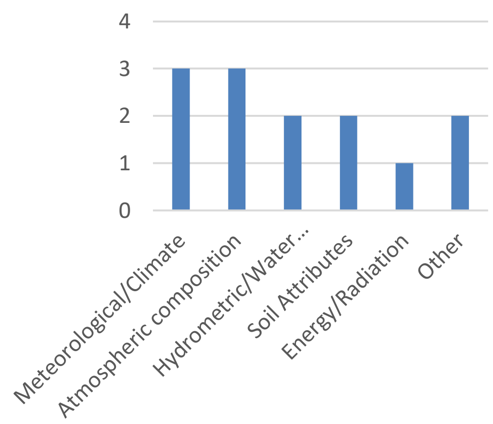


Figure 4-71. Activity area of in-situ networks of Bulgarian organizations.

Most types of facilities are registered in some national/regional/international network (Figure 4-74), while all facilities collect and store data regularly (Figure 4-75). Organizations specified that data is also collected and stored regularly for seismic networks.

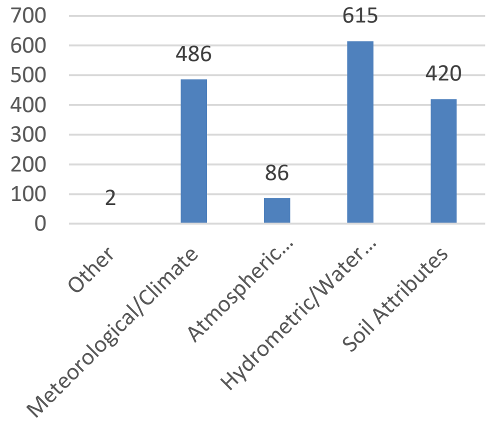


Figure 4-72. Number of stations of in-situ networks in Bulgaria by activity area.

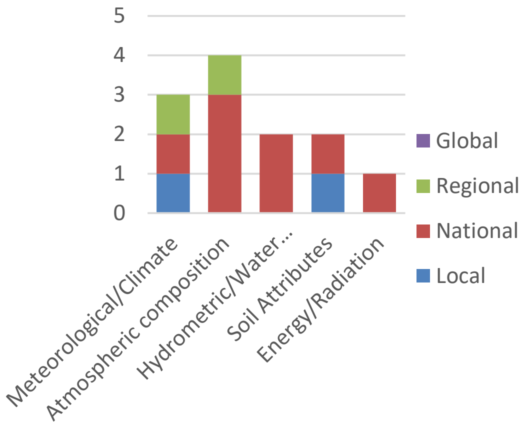


Figure 4-73. Geographic coverage of in-situ networks in Bulgaria by activity area.

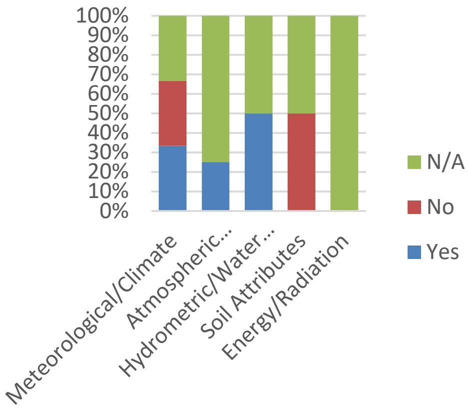


Figure 4-74. Registration of in-situ networks in Bulgaria by activity area.

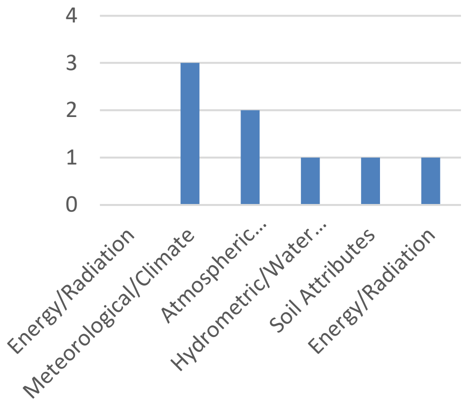


Figure 4-75. Systematic collection of data by in-situ networks in Bulgaria by activity area.

Meteorological facilities have METADATA available (Figure 4-76) and resolution is evenly spread between hourly and daily (Figure 4-77). Data for meteorological facilities is available mostly through past archives (Figure 4-78) while the data policy is mostly license restricted (Figure 4-79).

According to the survey, METADATA is available for atmospheric composition and profiling networks (Figure 4-80), while the temporal resolution of data from these facilities is mostly daily (Figure 4-81). Data is evenly available in real time, upon request, and through past archives (Figure 4-82). The applied data policy is license restricted (Figure 4-83).

Data from hydrometric and water quality in-situ networks in Bulgaria is made available by request or past archives (Figure 4-84), while the applied data policy is license restricted (Figure 4-85). No information was provided in regards to METADATA availability or resolution for this group of in-situ networks.

According to the survey, METADATA from soil attributes/spectra in-situ networks in Bulgaria is available (Figure 4-86) while the temporal resolution of these facilities was provided as other (Figure 4-87). Data from these networks is made available through past archives (Figure 4-88) and the applied data policy is license restricted (Figure 4-89).

METADATA is available from energy/radiation in-situ networks in Bulgaria (Figure 4-90) and the temporal resolution was indicated as being hourly (Figure 4-91). Data from these networks is made available in real time (Figure 4-92) while the applied data policy was indicated as being free and license (Figure 4-93).

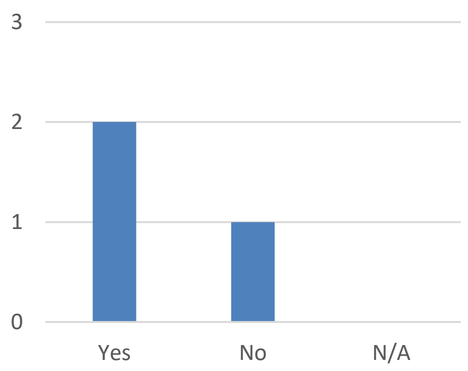


Figure 4-76. Availability of METADATA from meteorological and climate in-situ networks in Bulgaria.

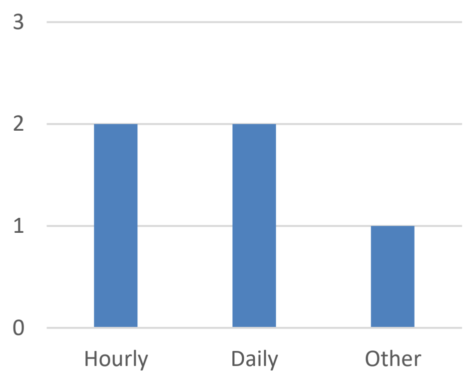


Figure 4-77. Temporal resolution of meteorological and climate in-situ networks in Bulgaria.

Figure 4-78. Data availability from meteorological and climate in-situ networks in Bulgaria.

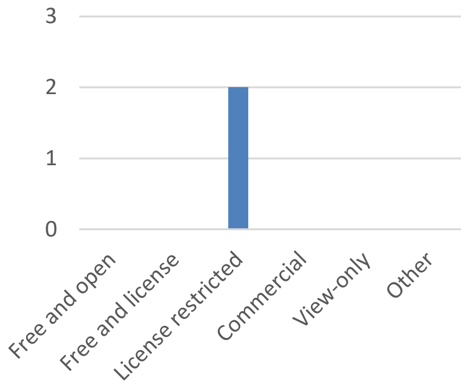


Figure 4-79. Data policy of meteorological and climate in-situ networks in Bulgaria.

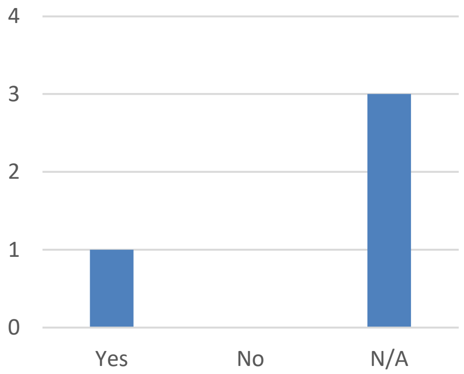


Figure 4-80. Availability of METADATA from atmospheric composition and profiling in-situ networks in Bulgaria.

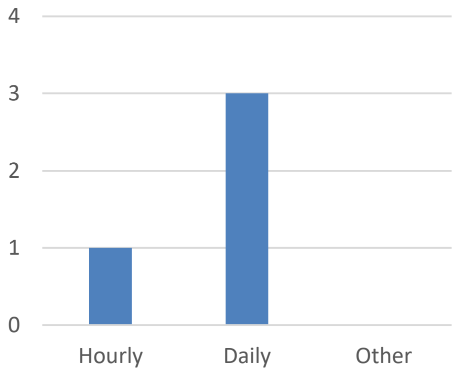


Figure 4-81. Temporal resolution of atmospheric composition and profiling in-situ networks in Bulgaria.

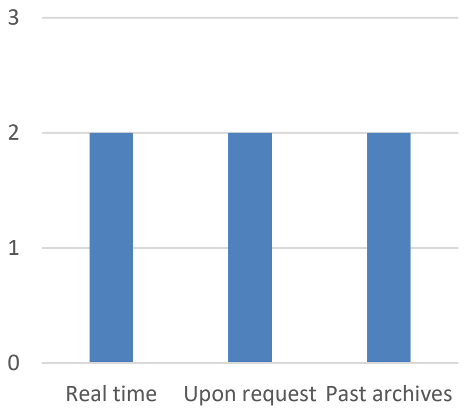


Figure 4-82. Data availability from atmospheric composition and profiling in-situ networks in Bulgaria.

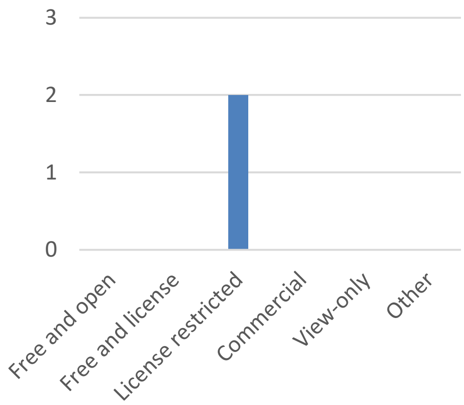


Figure 4-83. Data policy of atmospheric composition and profiling in-situ networks in Bulgaria.

Figure 4-84. Data availability from hydrometric and water quality in-situ networks in Bulgaria.

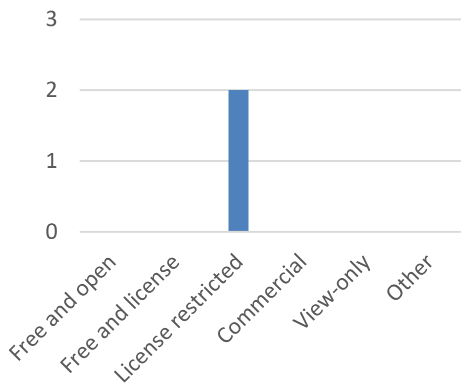


Figure 4-85. Data policy of hydrometric and water quality in-situ networks in Bulgaria.

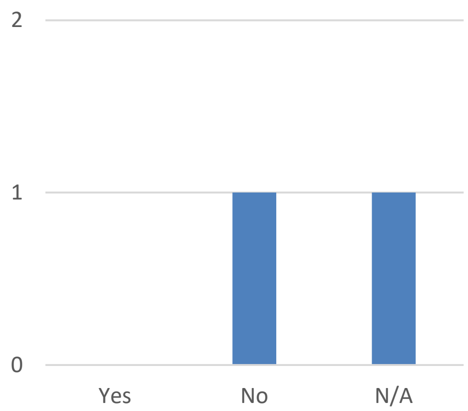


Figure 4-86. Availability of METADATA from soil attributes/spectra in-situ networks in Bulgaria.

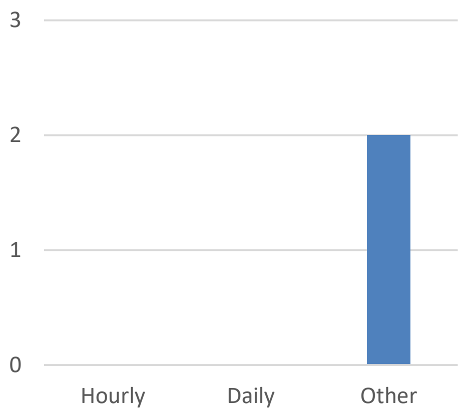


Figure 4-87. Temporal resolution of soil attributes/spectra in-situ networks in Bulgaria.

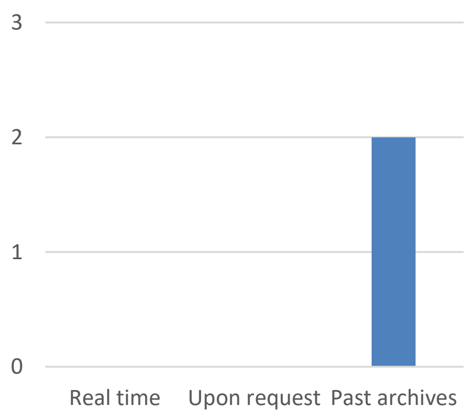


Figure 4-88. Data availability from soil

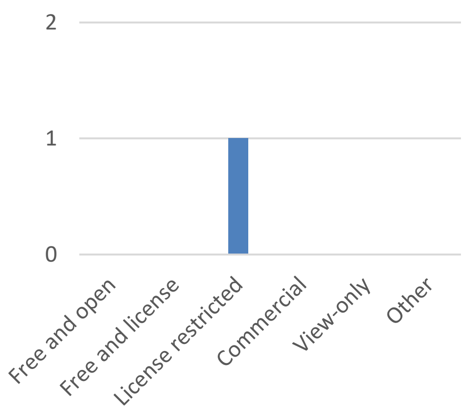


Figure 4-89. Data policy soil

attributes/spectra in-situ networks in Bulgaria.

attributes/spectra in-situ networks in Bulgaria.

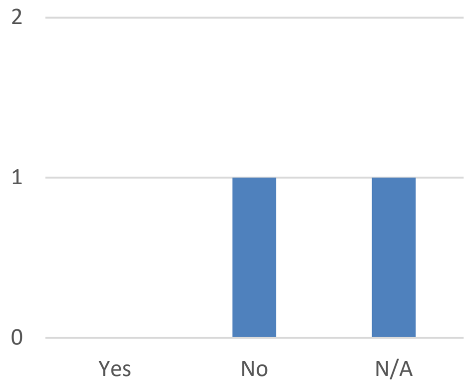


Figure 4-90. Availability of METADATA from energy/radiation in-situ networks in Bulgaria.

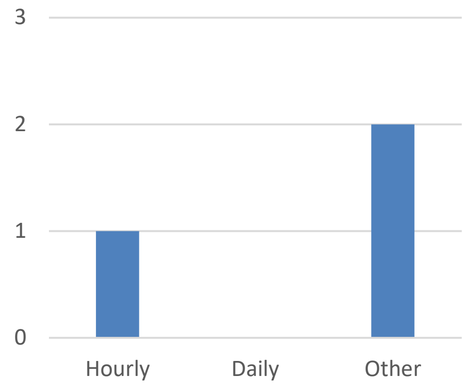


Figure 4-91. Temporal resolution of energy/radiation in-situ networks in Bulgaria.

Figure 4-92. Data availability from energy/radiation in-situ networks in Bulgaria.

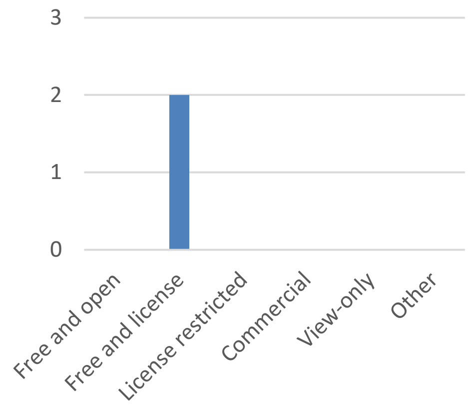


Figure 4-93. Data policy of energy/radiation in-situ networks in Bulgaria.

Modelling and processing capacities

Three respondent organizations indicated belonging to the commercial sector (Figure 4-94) while most organizations dealt with climate change as a thematic area (Figure 4-95).

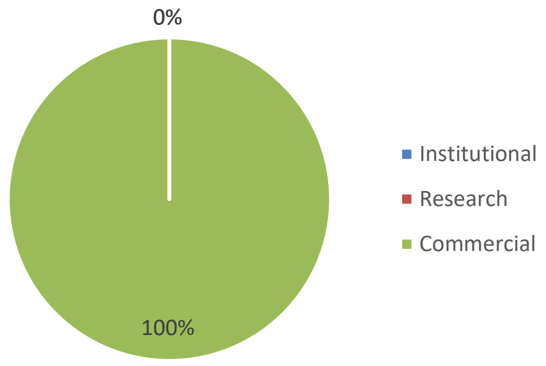


Figure 4-94. The type of organizations with modelling and processing capacities in Bulgaria.

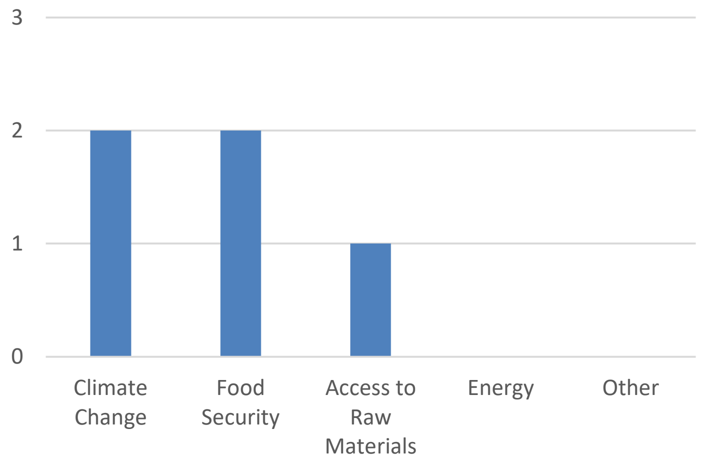


Figure 4-95. Activity of Bulgarian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

All organizations responded that they had taken part in past EO projects (Figure 4-96), Copernicus service provision, Copernicus User requirements definition or Copernicus Research and Innovation action (Figure 4-97), and GEO/GEOSS SBA Tasks, community activities or initiatives (Figure 4-98).

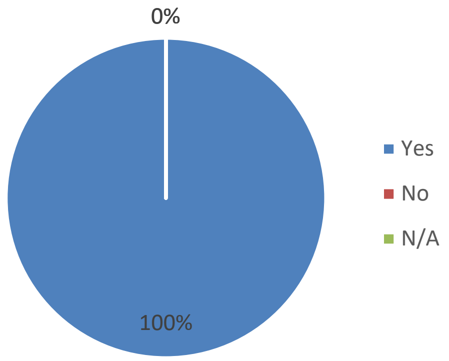


Figure 4-96. Participation of Bulgarian organizations with modelling and processing capacities in EO activities.

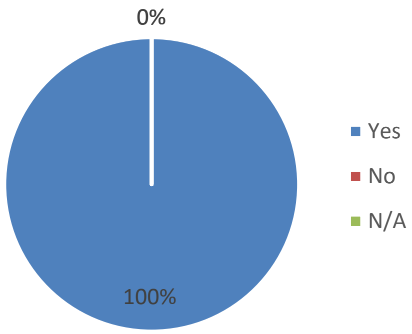


Figure 4-97. Participation of Bulgarian organizations with modelling and processing capacities in a Copernicus action.

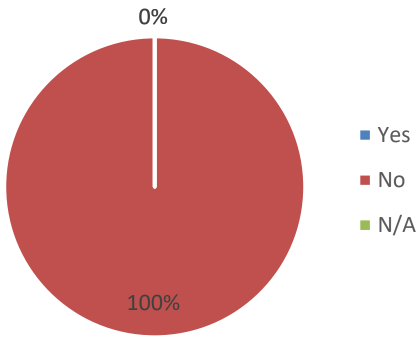


Figure 4-98. Participation of Bulgarian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

With regards to cooperation abroad and local, two organizations responded that it was high while one organization indicated cooperation as being low (Figure 4-99). Organizations indicated that local cooperation is channeled through Ministry of Environment and Water and the Ministry of Agriculture and Food. International cooperation (Figure 4-100), on the other hand, is realized through the JRC (Joint Research Center) and the European Soil Bureau.

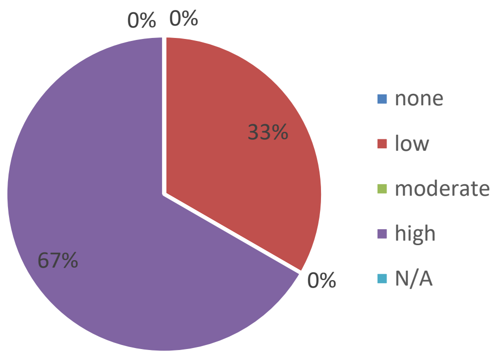


Figure 4-99. Level of cooperation of Bulgarian organizations with modelling and processing capacities with local EO actors.

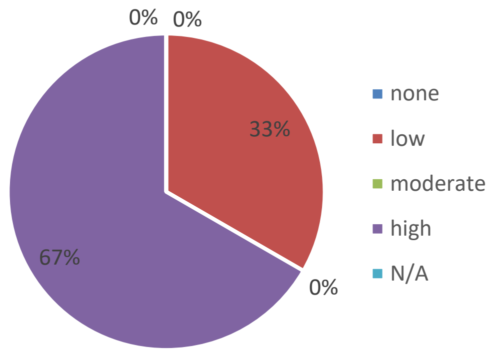


Figure 4-100. Level of cooperation of Bulgarian organizations with modelling and processing capacities with EO actors abroad.

The respondent organizations indicated that their other capacities are related to in-situ capacities (Figure 4-101).

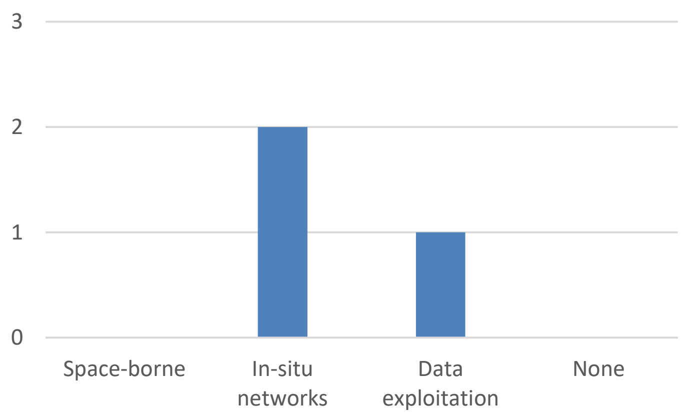


Figure 4-101. Additional EO capacities of Bulgarian organizations with modelling and processing capacities.

The majority of the organizations' models are related to soil attributes (Figure 4-102). The source of Earth observation data is evenly split between in-situ data and geospatial data while coverage is mostly local (Figure 4-103). Organizations further specified that providers of input data for the models are ESA, USGS, the Poushkarov Institute of Soil Science, Agro-technologies, and Plant Protection (ISSAPP).

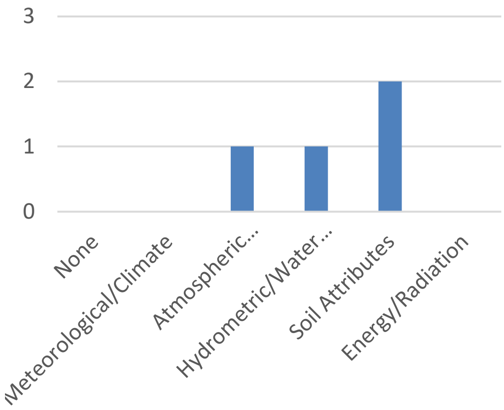


Figure 4-102. Algorithms and models available in Bulgaria by activity area.

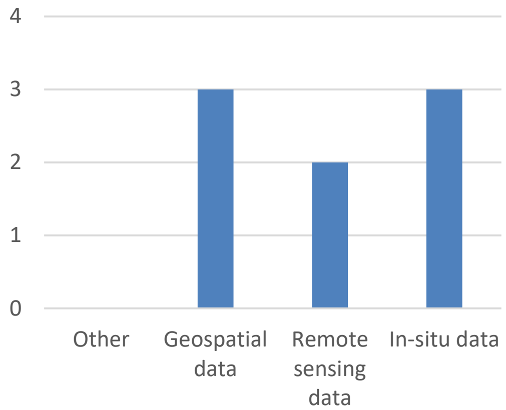


Figure 4-103. Sources of EO data used by organizations with modelling and processing capacities in Bulgaria.

Coverage of models and algorithms in Bulgaria are mostly local and national (Figure 4-104). Two organizations indicated having METADATA made available (Figure 4-105)

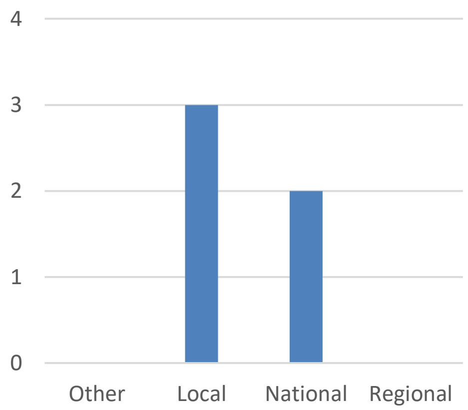


Figure 4-104. Geographic coverage of models and algorithms in Bulgaria.

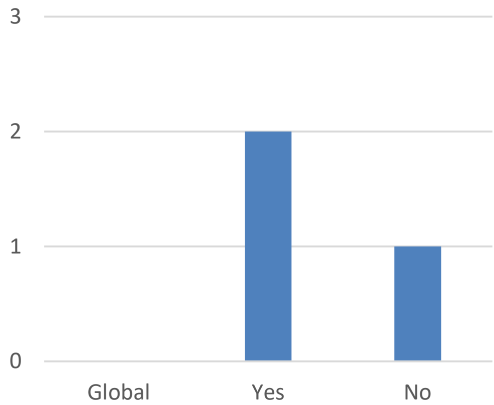


Figure 4-105. Availability of METADATA for models and algorithms in Bulgaria.

Respondent organizations also indicated that the computing resources available are mostly processing power capacity (Figure 4-106).

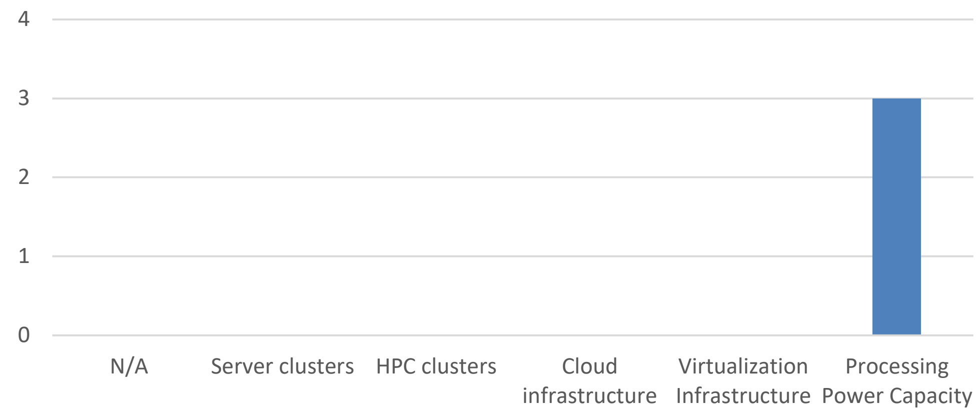


Figure 4-106. Computing resources available for processing and exploitation of EO data in Bulgaria.

Data exploitation capacities

Of the 4 organizations reached by this survey, half are a research type organization, while the other half is commercial (Figure 4-107). With regards to thematic area, organizations were relatively equally involved in all the defined thematic areas (Figure 4-108).

Organizations pointed out that their organizations also take part in geography, geophysics, and geodesy; more specifically some organizations pointed out providing geo-information services and production of cartographic data from high and very high-resolution sensors and aero-space technology transfer for crisis management and natural disaster, environmental monitoring, security and defense.

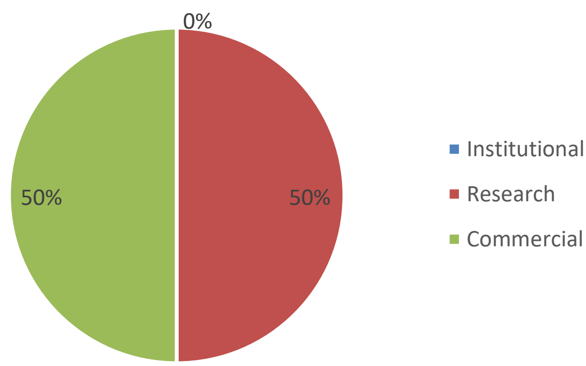


Figure 4-107. The type of organizations active in data exploitation in Bulgaria.

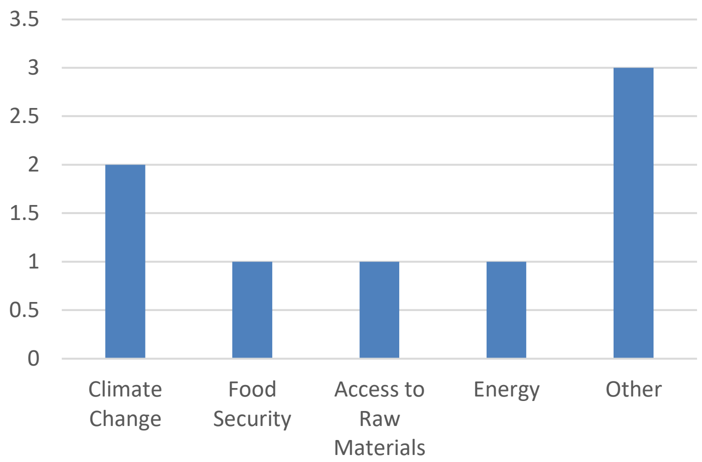


Figure 4-108. Activity of Bulgarian organizations active in data exploitation in GEO-CRADLE thematic areas.

Most organizations indicated that they had taken part in previous EO projects (Figure 4-109). However, in regards to Copernicus service provision, Copernicus User requirements definition or Copernicus Research and Innovation action (Figure 4-110), and GEO/GEOSS SBA Tasks, community activities or initiatives organizations indicated no previous experience (Figure 4-111).

Organizations provided further clarification of EO projects such as FP7 IGIT, FP7 Balkan GEO Net, FP7 PASODOBLE, and FP7 iSOIL. In regards to participation in GEO/GEOSS SBA activities, one organization pointed out that it had carried out research projects.

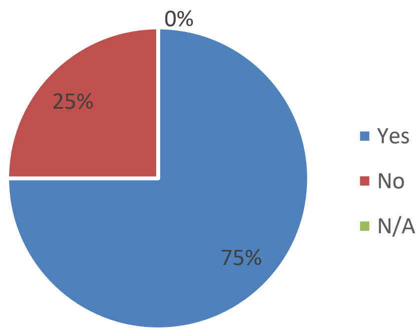
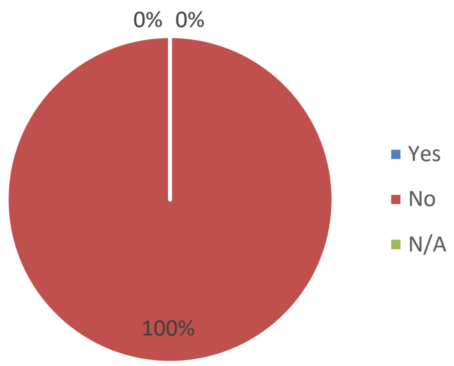


Figure 4-109. Participation of Bulgarian organizations active in data exploitation in EO activities.



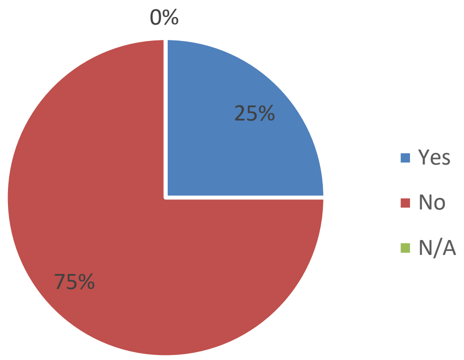
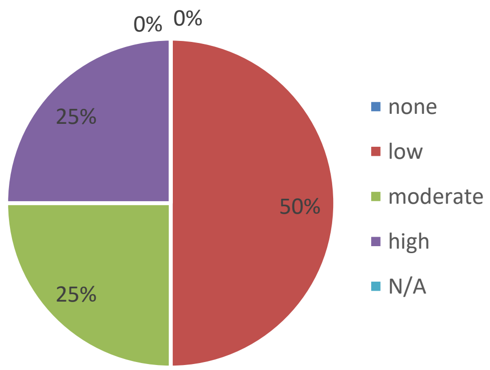


Figure 4-110. Participation of Bulgarian organizations active in data exploitation in a Copernicus action.

Figure 4-111. Participation of Bulgarian organizations active in data exploitation in a GEO/GEOSS SBA task.

Half of the respondent organizations saw both local and international cooperation as low (Figure 4-112 and Figure 4-113).

Local cooperation, as the respondent organizations pointed out, mainly took place through the various institutes of the Bulgarian Academy of Sciences and through various levels of government in Bulgaria: national, regional and municipal.



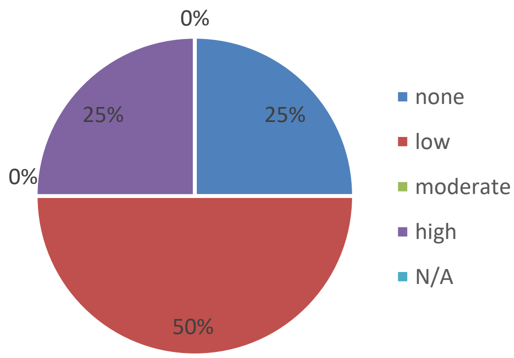


Figure 4-112. Level of cooperation of Bulgarian organizations active in data exploitation with local EO actors.

Figure 4-113. Level of cooperation of Bulgarian organizations active in data exploitation with EO actors abroad.

With regards to other capacities, organizations indicated having modelling and processing and in-situ, with two organizations indicating that they have no capacities outside of data exploitation (Figure 4-114).

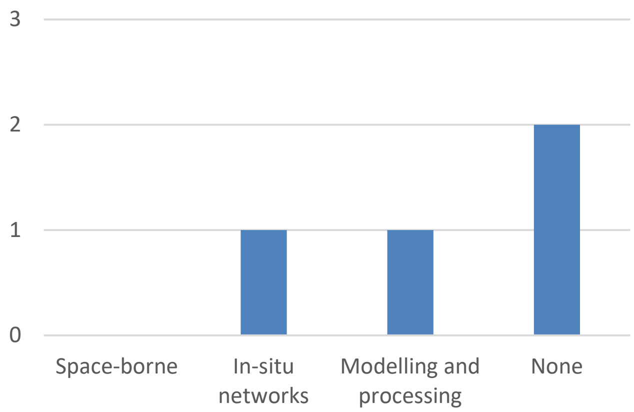


Figure 4-114. Additional EO capacities of Bulgarian organizations active in data exploitation.

As shown in the Figure 4-115, the organizations` products belong to a wide range of areas.

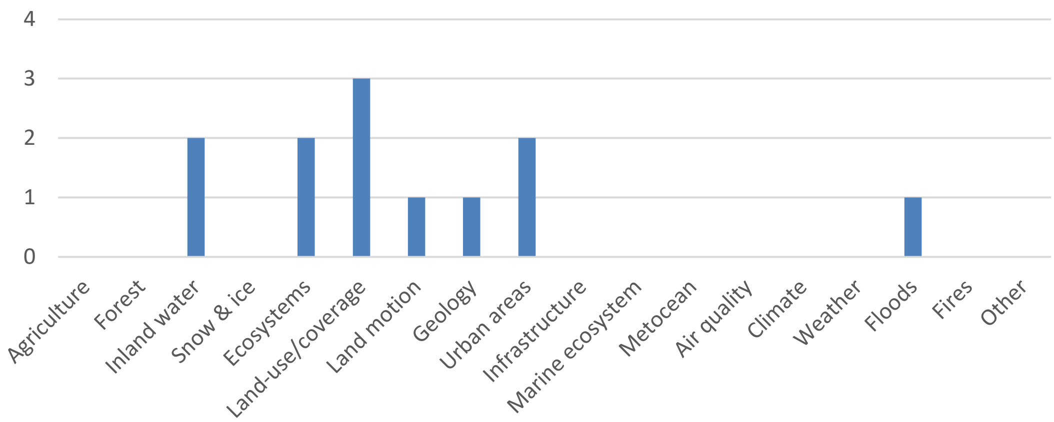


Figure 4-115. Activity areas of EO products/services of Bulgarian organizations.

National Activities

Most organizations that responded to this survey indicated that funding is available for EO activities (Figure 4-116). Specifically, funding is focused towards research and development, as is show in Figure 4-117.

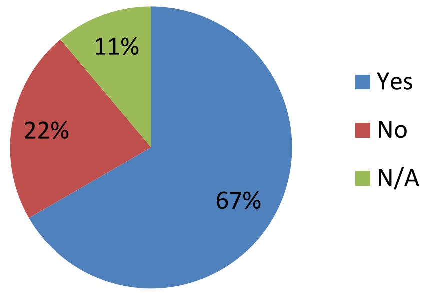


Figure 4-116. Bulgarian EO actors' perception of the availability of national funding for EO.

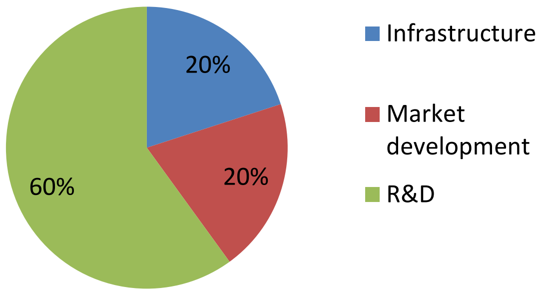


Figure 4-117. Bulgarian EO actors' perception of areas for which national EO funding is available.

Most organizations also indicated that their country does have a space strategy (Figure 4-118). 5 organizations indicated not having space agencies, as is shown in Figure 4-119.

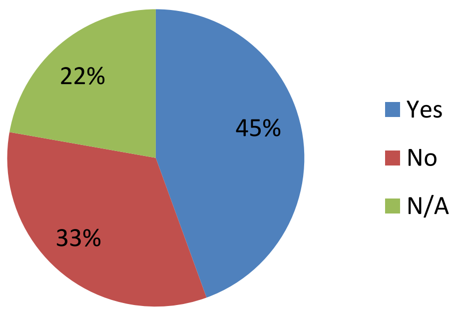


Figure 4-118. Bulgarian EO actors' awareness of a space strategy in Bulgaria.

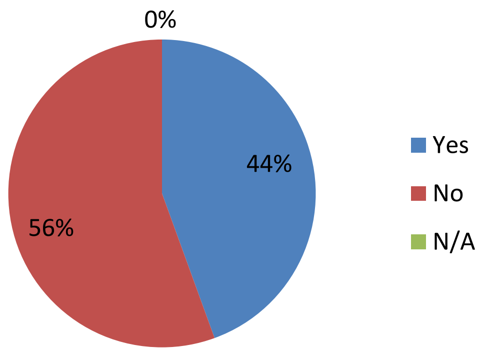
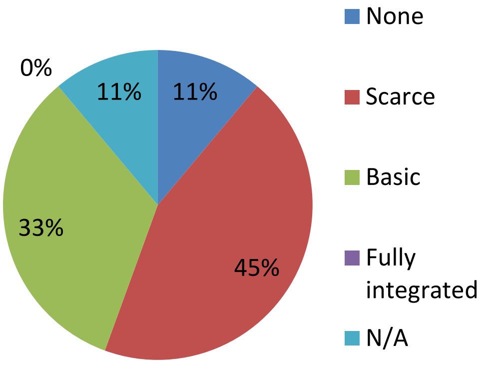


Figure 4-119. Bulgarian EO actors' awareness of a space program in Bulgaria.

Organizations indicated that coordination of EO activities is either scarce or basic while interaction with decision makers is mostly limited to specific thematic areas (Figure 4-121).



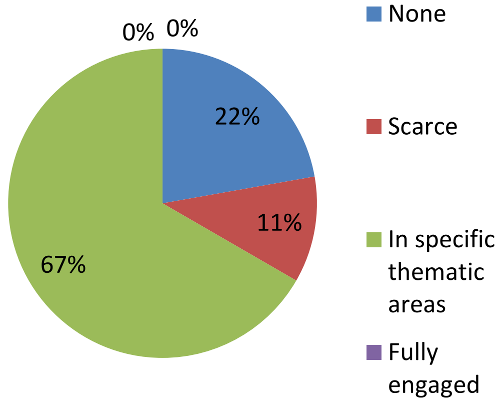


Figure 4-120. Bulgarian EO actors' perception of national coordination of EO activities in Bulgaria.

Figure 4-121. Bulgarian EO actors' perception of interaction with decision makers in Bulgaria.

Most organizations indicate that they are willing to engage further in the future (Figure 4-122).

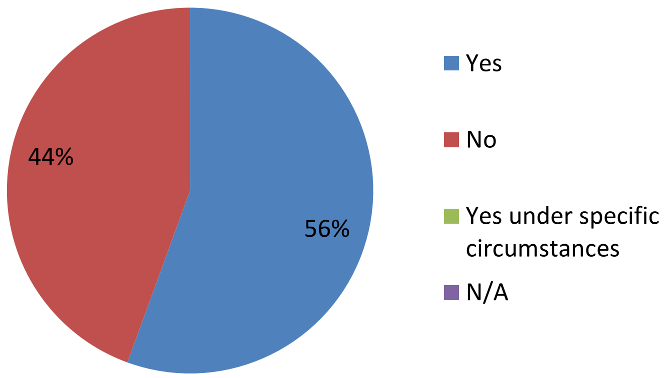


Figure 4-122. Bulgarian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

Significantly more end-users were aware of Copernicus than GEO as shown in Figure 4-123 and Figure 4-124. However, most end-users were not aware of either.

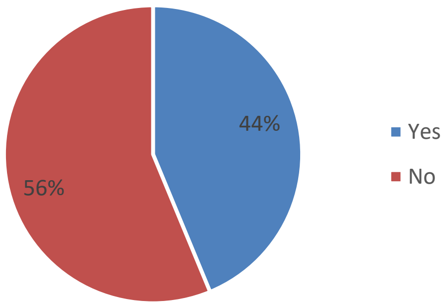


Figure 4-123. End-user awareness of Copernicus in Bulgaria.

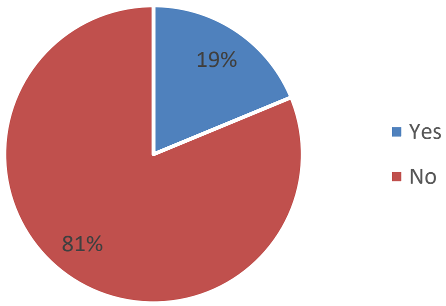


Figure 4-124. End-user awareness of GEO in Bulgaria.

4.2.3. *Gap analysis*

No end-user interviews were concluded in the first phase but will be conducted in the second one. From the overview and indicators it is most probable that large **structural** gaps are present in the country.

4.3. Cyprus

4.3.1. *Overview*

EO in Cyprus is mainly connected with research activities. The public sectors makes poor use of EO, especially from space-borne missions. The only data/information/services that the public sector and authorities provide to the public relate to the air quality network (13 stations, Department of Labor Inspection), and the network of the Department of Meteorology (more than 100 meteorological stations). The strong geospatial background of certain public institutes (e.g. Cyprus University of Technology) can promote and support public sectors where EO application has clear benefits. Although the public sector is not fully involved and active in the wide use of space-borne EO and modelling, this situation is presently overcome through strong ties between public sector and research organizations. The Department of Meteorology together with Cyprus Institute is responsible for weather and air quality forecasting in Cyprus. The engagement of public institutions and research organizations with EO is growing, driven by financial and technical support from European actors. The Ministry of Interior of the Republic of Cyprus is responsible for the Geospatial Portal of Cyprus (and the implementation of INSPIRE).

A limited number of commercial companies have been identified that provide EO products, principally to the public sector and mainly participating in EU projects studying and analyzing case studies.

There are large barriers to development of EO in the country.

One important barrier is financial. Cyprus's economy is recovering from the economic crisis since 2013. Public institutions face budget cuts and a freeze on hiring, which clearly limits the ability of the public sector to develop EO capacities. During GEO-CRADLE activities, respondents cited lack of funding as a barrier to accessing satellite images, orthophotos and other EO data. Furthermore, inability to hire new employees is a barrier to developing additional EO capacity. The only funds allocated to the EO activities are for research projects, mainly from EC, due to a 5 year freezing of projects from the Research Promotion Foundation of the Republic of Cyprus.

Except for limited data sharing between institutes that participate at the European Research Infrastructure Networks (e.g. CUT, CyI), EO actors in the country have a reserved attitude regarding sharing of data. Formally, access to data between institutions requires contracts. Overcoming these barriers is easiest to achieve during projects. Although these arrangements are temporary in nature, and they provide limited and specific use of the data, connections that are established remain after the project and serve as a foundation to facilitate interaction and encourage data sharing between institutions. Thus, sharing of data between institutions is largely based on personal relationships rather than a systematic system promoting free and open access to data.

Of particular concern to end-users was the lack of access to the digital cadaster maintained by the Department of Cadaster and Chorometry of Ministry of Interior. The portal is based on air photographs and is only for "online" information. End-users are charged fees to access the data; and even Public institutions and Universities are not exempt to charges. It is necessary for Cypriot authorities to follow up with a public relations campaign to raise awareness of data availability, as this fact is still largely unknown in the ecosystem. Further steps need to be taken to change the *culture* of sharing data.

There are also large opportunities to counterbalance challenges.

The Ministry of Transport, Communications and Works is the country's representative for space policy**. In July 2016, Cyprus became the 11th country to sign the European Cooperating State Agreement**, strengthening its relations with ESA. A broad range of capacities and domains for the potential future Plan for European Cooperating States (PECS) projects were identified in EO in particular, including water resources, forest monitoring, agricultural mapping, maritime surveillance, environment protection and urban development. The **Cyprus Remote Sensing Society** can contribute in this regard, as it is active in building a stronger national EO community. Space science, navigation, telecom and integrated applications, and space situational awareness were also considered as areas for potential projects. Following the signing of the agreement, the selections for PECS projects will start soon. The PECS Charter, including the list of approved PECS projects, will allow the placement of the first contracts with Cyprus.

Horizon 2020 represents an opportunity through which Cyprus can increase its research and innovation performances. Cyprus is so far a low research and innovation performing Member State. Through the Work Programs of Horizon 2020 the country can create Centers of Excellence and become a key EO player in the region of Eastern Mediterranean and beyond.

After 5 years (since 2012), the Research Promotion Foundation (RPF) of Cyprus has again released new calls that offer funding opportunities for the development of new EO products, services and studies. The RESTART 2016-2020 Programs of RPF is a new multiannual development framework program to support Research, Technological Development and Innovation in Cyprus. The vision of the Program RESTART 2016-2020 is the emergence of the field of Research, Technological Development and Innovation (RTDI) as a driver of economic development of Cyprus, contributing to addressing key economic and social challenges. The vision is in line with the principles of Europe2020 strategic framework to generate smart, sustainable and inclusive growth to achieve sustainable development.

4.3.2. *Capacities*

Space-borne capacities

Cyprus has no space-borne capacities.

In-situ networks and facilities

In Cyprus, the survey reached nine organizations with in-situ networks: four institutional and four research (Figure 4-125). These organizations are active in all thematic areas relevant to GEO-CRADLE (Figure 4-126). The organizations that indicated *other* dealt with thematic areas such as: digital cultural heritage, higher performance computing, weather forecasting, meteorological databases, archaeology, and hydrogeology.

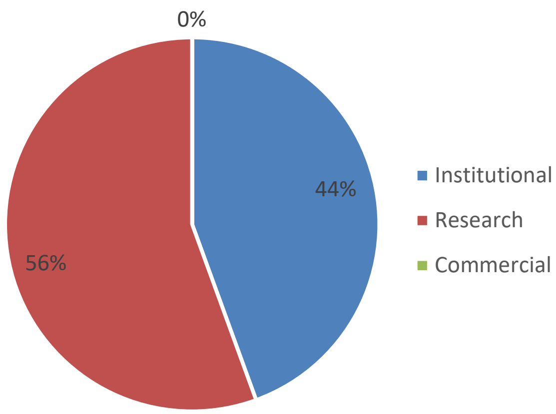


Figure 4-125. The type of organizations with in-situ networks in Cyprus.

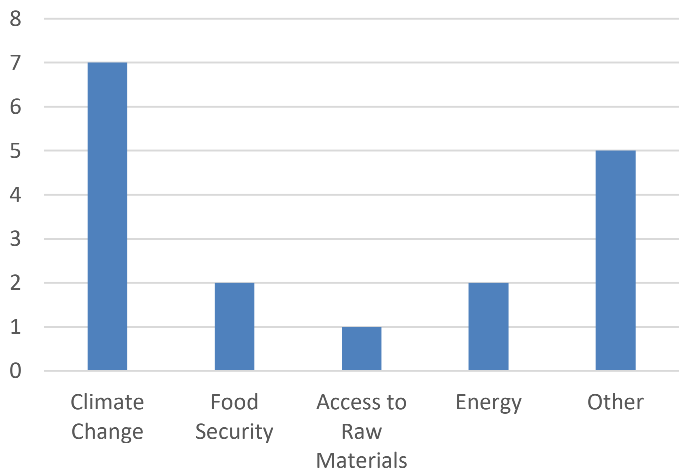


Figure 4-126. Activity of Cypriot organizations with in-situ networks in GEO-CRADLE thematic areas.

Four organizations have taken part in EO projects previously, while the same number has not (Figure 4-127). Two organizations have taken part in Copernicus activities, while six have not (Figure 4-128). Six organizations indicated not having taken part in GEO/GEOSS SBA tasks

(Figure 4-129). One organization specified that the EO projects it had participated in was ACTRIS-2 (Horizon 2020) and Bachus (FP7).

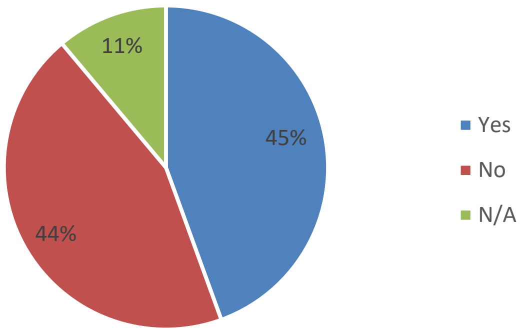


Figure 4-127. Participation of Cypriot organizations with in-situ networks in EO activities.

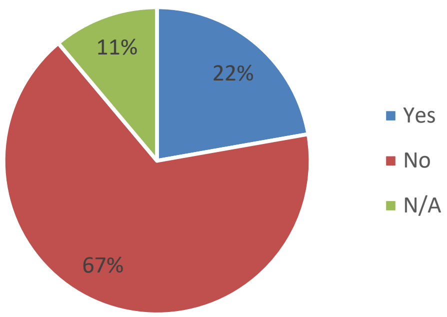


Figure 4-128. Participation of Cypriot organizations with in-situ networks in a Copernicus action.

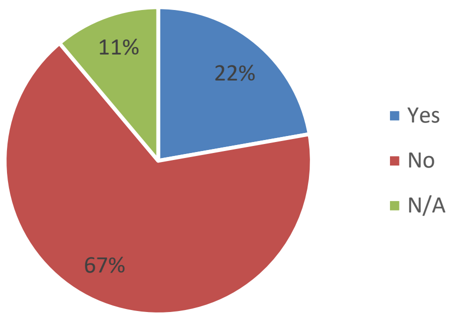


Figure 4-129. Participation of Cypriot organizations with in-situ networks in a GEO/GEOSS SBA task.

89% of organizations see their local cooperation as low or non-existent, and 11% see it as high (Figure 4-130). On the other hand, cooperation abroad is perceived as high by 45% of respondents, and low or none by 55% (Figure 4-131). It was further specified in the survey that international cooperation is realized through various universities, ESA (European Space Agency), and DLR (German Aerospace Center).

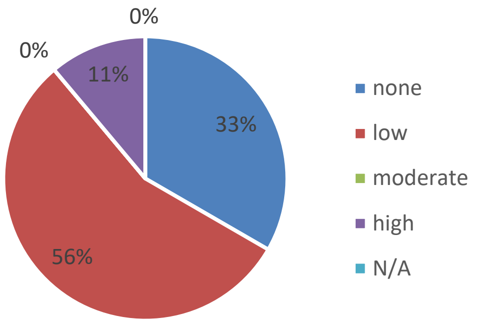


Figure 4-130. Level of cooperation of Cypriot organizations with in-situ networks with local EO actors.

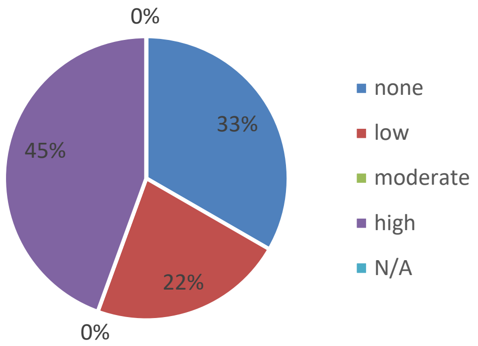


Figure 4-131. Level of cooperation of Cypriot organizations with in-situ networks with EO actors abroad.

Cypriot organizations with in-situ networks mostly have other EO capacities, 40% of them do not (Figure 4-132). The areas in which these organizations are active is shown in Figure 4-133. In-situ capacities for soil-attributes are nonexistent, while most capacities are concentrated in the atmospheric composition area.

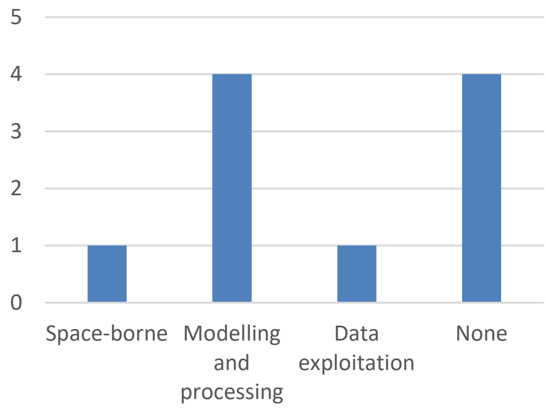


Figure 4-132. Additional EO capacities of Cypriot organizations with in-situ networks.

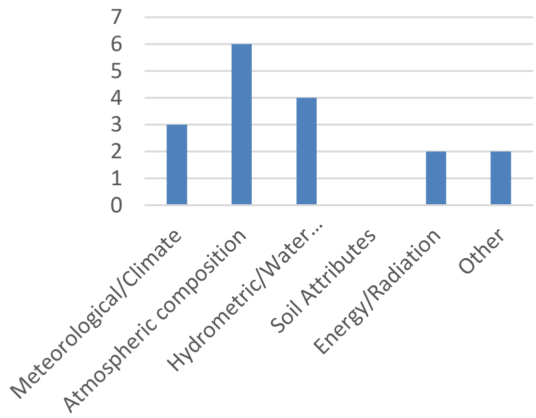


Figure 4-133. Activity area of in-situ networks of Cypriot organizations.

The amount of measuring stations in each area is shown in Figure 4-134: a large number of meteorological/climate stations and hydrometric stations, more limited amount of atmospheric composition, a couple of energy/radiation stations and no stations measuring soil properties. The survey also showed that the majority of in-situ stations or networks were regional or national in coverage (Figure 4-135). The following figure shows which stations are registered in national/regional/international networks (Figure 4-136). The survey has shown that energy/radiation and atmospheric composition stations have the highest percentage of registered stations. However, as is shown in Figure 4-137 below, not all stations collect and store generated data.

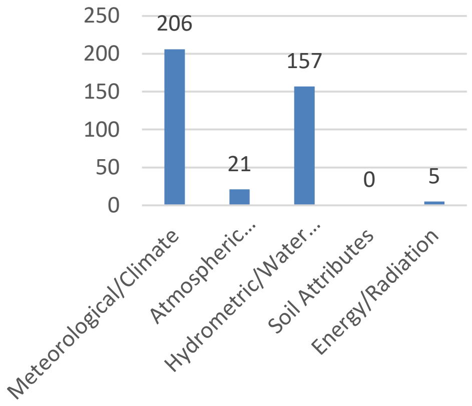


Figure 4-134. Number of stations of in-situ networks in Cyprus by activity area.

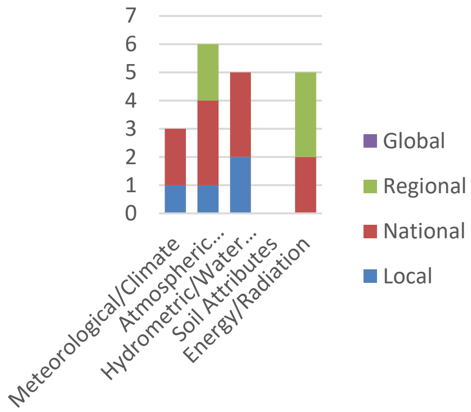


Figure 4-135. Geographic coverage of in-situ networks in Cyprus by activity area.

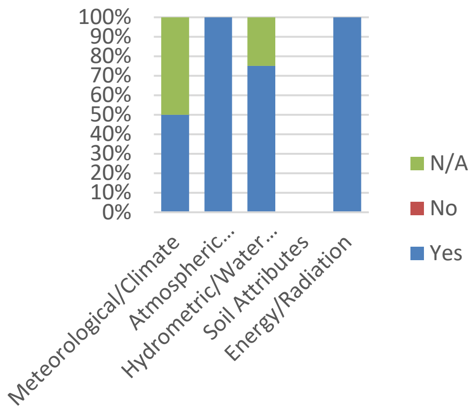


Figure 4-136. Registration of in-situ networks in Cyprus by activity area.

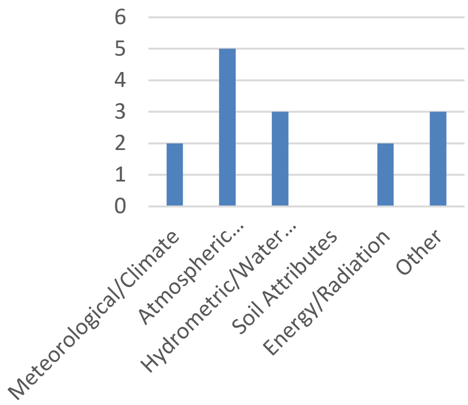


Figure 4-137. Systematic collection of data by in-situ networks in Cyprus by activity area.

The survey identified two organizations that have METADATA available for **Meteorological or Climatic Networks or Facilities** (Figure 4-138), and one organization indicated that temporal resolution can be set down to 5 minutes (Figure 4-139). One organization responded that it had data available in real time, upon request and through past archives (Figure 4-140). The survey has shown that one organization follows a commercial data policy (see Figure 4-141).

One organization indicated that this METADATA is available to the consortium of Bachus and ACTRIS-2 EU projects.

In regards to **atmospheric composition and profiling in-situ networks**, all respondent organizations indicated the availability of METADATA (Figure 4-142). The temporal resolution for these networks was mostly hourly, with organizations indicating *other* specifying weekday and twice-per-day resolutions (Figure 4-143).Three organizations had data available in real-time, while one had access to past archives available (Figure 4-144). Three organizations specified their data policy: one had free and license while one had commercial licesncing (Figure 4-145).

In regards to **hydrometric/water quality in-situ networks,** two organizations reported having METADATA available, while one reported not having METADATA available (Figure 4-146). Two organizations specified that they have a daily temporal resolution (Figure 4-147). In regards to data availability, one organization reported having data available through requests and past archives (Figure 4-148). No details were provided for data policy (Figure 4-149).

In regards to the availability of METADATA for **energy/radiation facilities**, the survey showed two instances of availability (Figure 4-150). One instance of hourly temporal resolution was reported (Figure 4-151), while one organization claimed to have other resolution without specifying. The survey also showed availability of data through requests (two organizations) and past archives (one organization), see Figure 4-152. Respondent organizations did not specify their data policies in regards to data from energy/radiation networks (Figure 4-153).

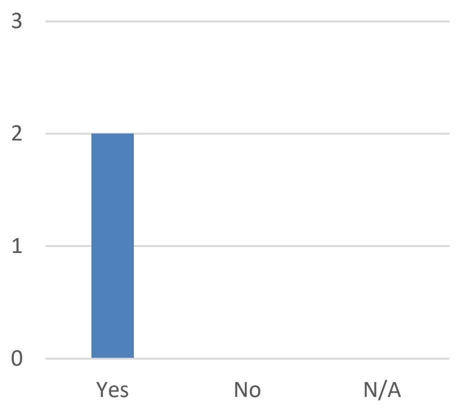


Figure 4-138. Availability of METADATA from meteorological and climate in-situ networks

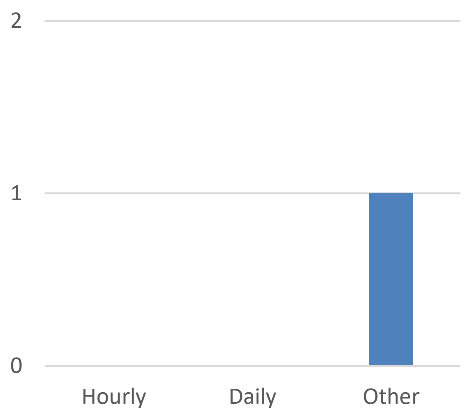


Figure 4-139. Temporal resolution of meteorological and climate in-situ networks

in Cyprus.

in Cyprus.

Figure 4-140. Data availability from meteorological and climate in-situ networks in Cyprus.

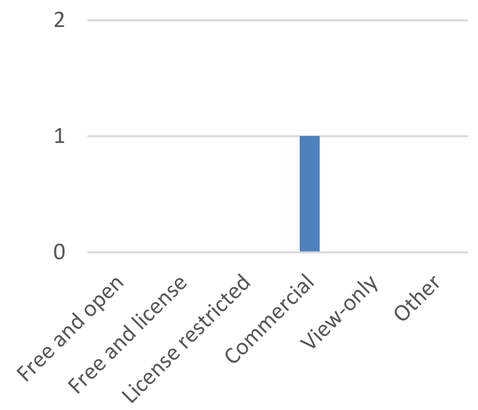


Figure 4-141. Data policy of meteorological and climate in-situ networks in Cyprus.

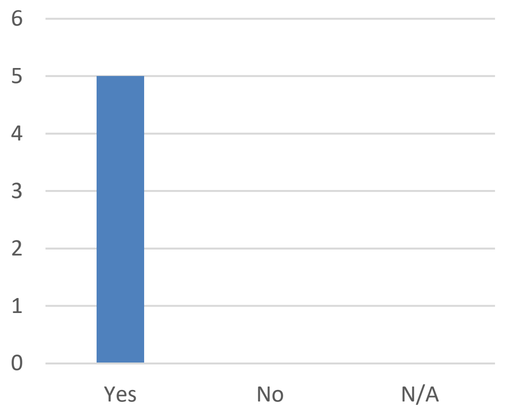


Figure 4-142. Availability of METADATA from atmospheric composition and profiling in-situ networks in Cyprus.

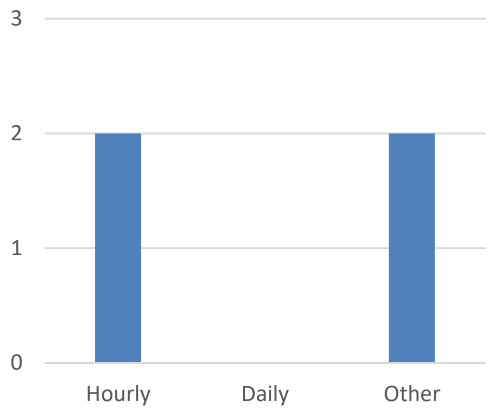


Figure 4-143. Temporal resolution of atmospheric composition and profiling in-situ networks in Cyprus.

Figure 4-144. Data availability from

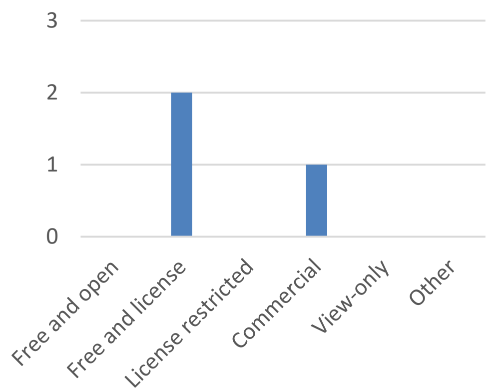


Figure 4-145. Data policy of atmospheric

atmospheric composition and profiling in-situ networks in Cyprus.

composition and profiling in-situ networks in Cyprus.

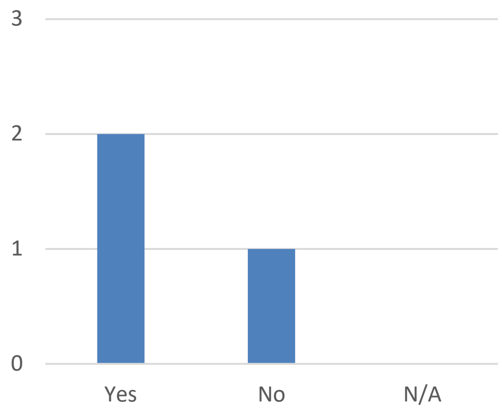


Figure 4-146. Availability of METADATA from hydrometric and water quality in-situ networks in Cyprus.

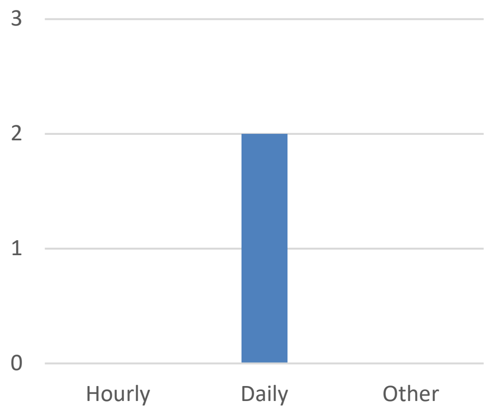


Figure 4-147. Temporal resolution of hydrometric and water quality in-situ networks in Cyprus.

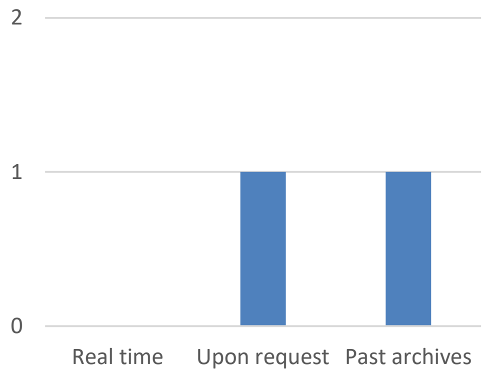
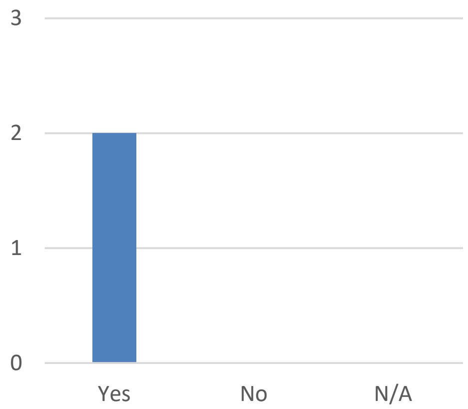


Figure 4-148. Data availability from hydrometric and water quality in-situ networks in Cyprus.

Figure 4-149. Data policy of hydrometric and water quality in-situ networks in Cyprus.



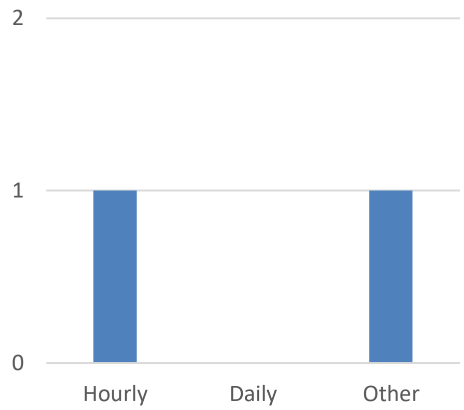


Figure 4-150. Availability of METADATA from energy/radiation in-situ networks in Cyprus.

Figure 4-151. Temporal resolution of energy/radiation in-situ networks in Cyprus.

Figure 4-152. Data availability from energy/radiation in-situ networks in Cyprus.

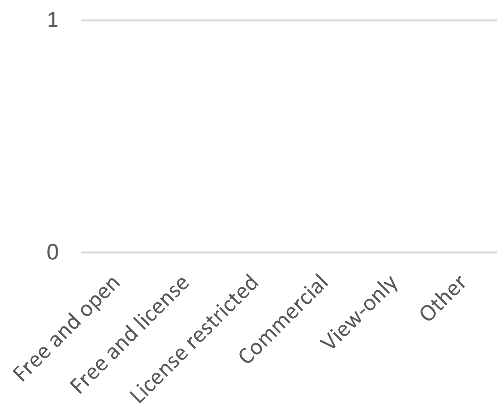


Figure 4-153. Data policy of energy/radiation in-situ networks in Cyprus.

Modelling and processing capacities

With regards to modelling capacities, four organizations were research-oriented while one was of an institutional character (Figure 4-154). There were organizations active in all the thematic areas, with the most, five, focused on climate change, as is shown in Figure 4-155.

Organizations active in *other* thematic areas indicated taking part in digital cultural heritage, computational sciences, high performance computing, archaeology, weather forecasting, and various areas of agriculture.

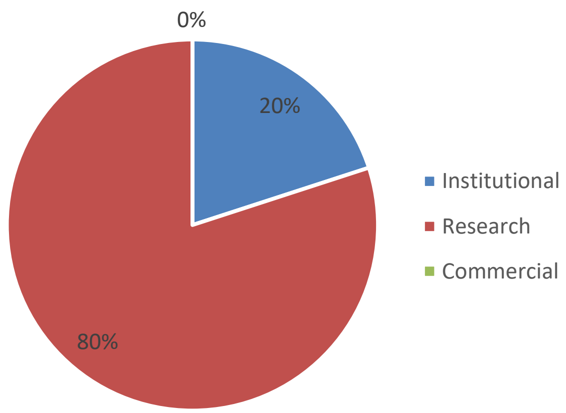


Figure 4-154. The type of organizations with modelling and processing capacities in Cyprus.

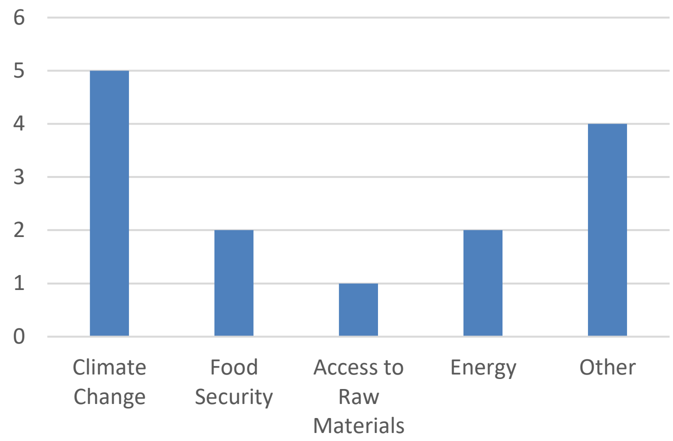


Figure 4-155. Activity of Cypriot organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

Three out of five Cypriot organizations with modelling capacities reported having participated in previous EO activities (Figure 4-156). Four organizations have taken part in Copernicus actions (Figure 4-157), while none of the respondent organizations indicated having taken part in GEO/GEOSS SBA tasks (Figure 4-158).

The organizations that took part in previous EO projects indicated as having experience in FP7 Bachus and Horizon 2020 ACTRIS-2.

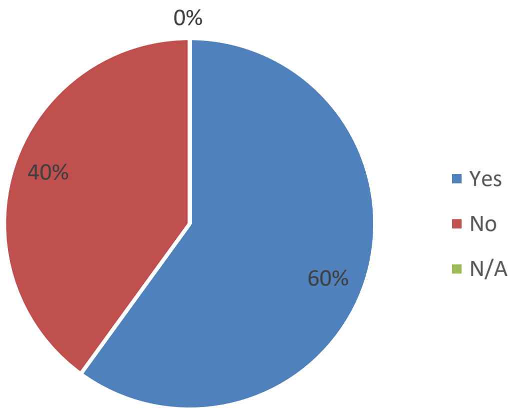


Figure 4-156. Participation of Cypriot organizations with modelling and processing capacities in EO activities.

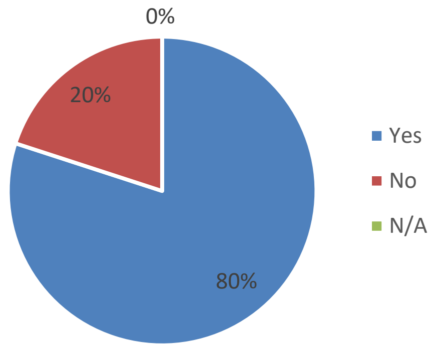


Figure 4-157 Participation of Cypriot organizations with modelling and processing capacities in a Copernicus action.

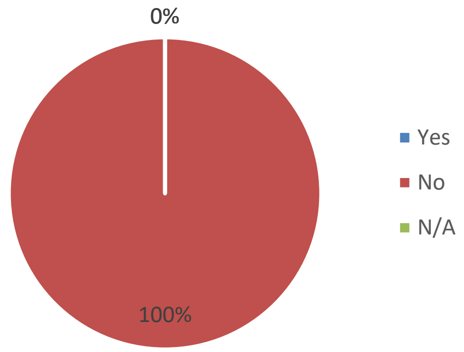


Figure 4-158. Participation of Cypriot organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

The majority of organizations (60%) reported that local cooperation is at a low level (Figure 4-159). However, one organization has high local cooperation and one organization has no local cooperation. In regards to international cooperation, 60% of organizations responded that cooperation is low or none, and the other 40% responded that cooperation is high (Figure 4-160).

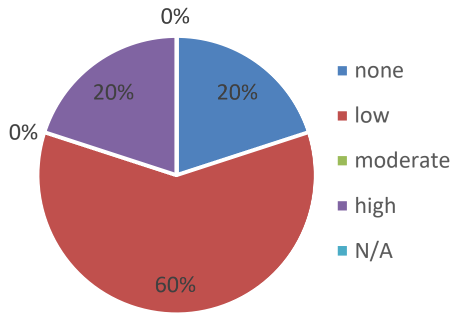


Figure 4-159. Level of cooperation of Cypriot organizations with modelling and processing capacities with local EO actors.

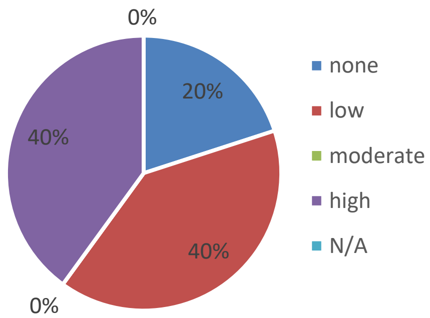


Figure 4-160. Level of cooperation of Cypriot organizations with modelling and processing capacities with EO actors abroad.

Four organizations with modelling capacities possess in-situ networks. Three organizations are also active in data exploitation, while one organization also had space-borne capacities (Figure 4-161).

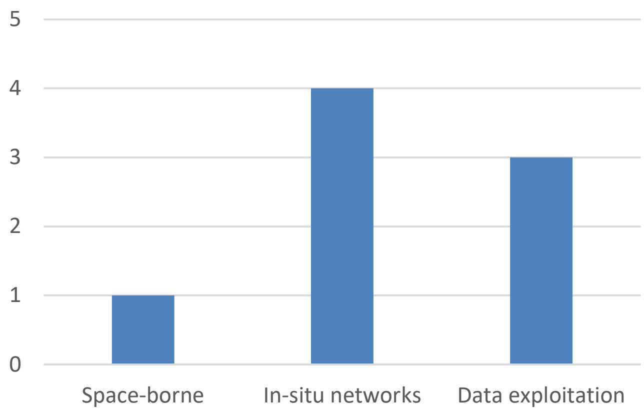
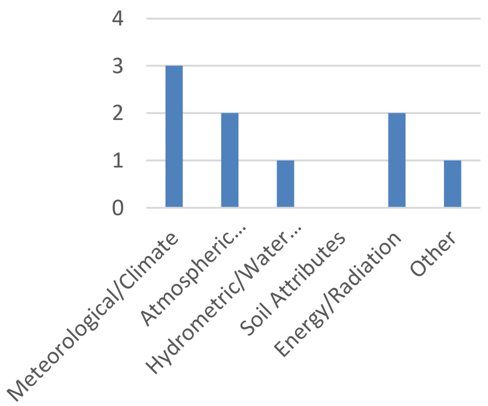


Figure 4-161. Additional EO capacities of Cypriot organizations with modelling and processing capacities.

Cypriot organizations have algorithms for every area measure by the survey except soil attributes, with the most algorithms and models reported for meteorology/climate (Figure 4-162).

All sources of EO data are used, with three models using remote sensing data and three using data from in-situ networks (Figure 4-163). With regards to other sources of EO data, one organization indicated that they use rainfall statistics, expert opinions, and land management literature.

The survey indicates that METADA is generally available from these organization (Figure 4-165). It was indicated that METADATA is made available through such organizations as The Cyprus Institute, an international research center. Coverage of the models was specified for only two: one local and one national (Figure 4-164).



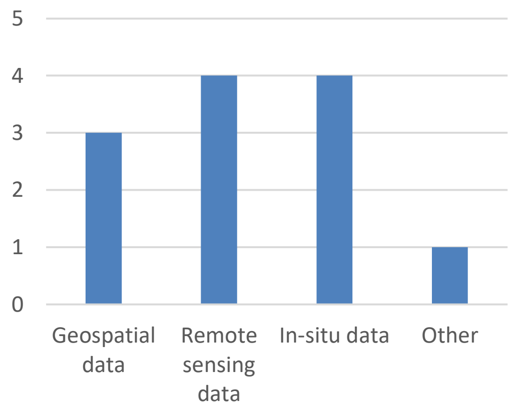


Figure 4-162. Algorithms and models available in Cyprus by activity area.

Figure 4-163. Sources of EO data used by organizations with modelling and processing capacities in Cyprus.

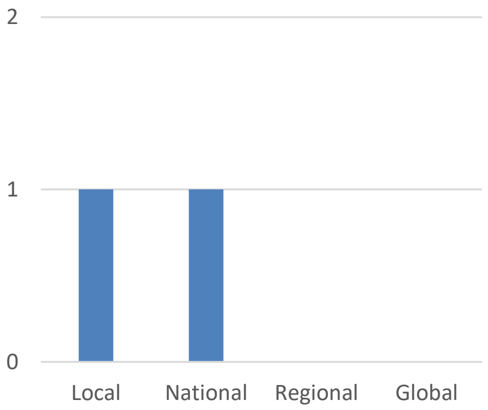


Figure 4-164. Geographic coverage of models and algorithms in Cyprus.

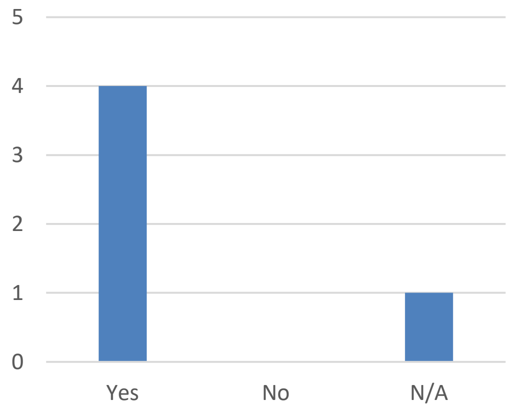


Figure 4-165. Availability of METADATA for models and algorithms in Cyprus.

Cyprus has all computing resources measured by the survey available, particularly server clusters and processing power capacity (Figure 4-166).

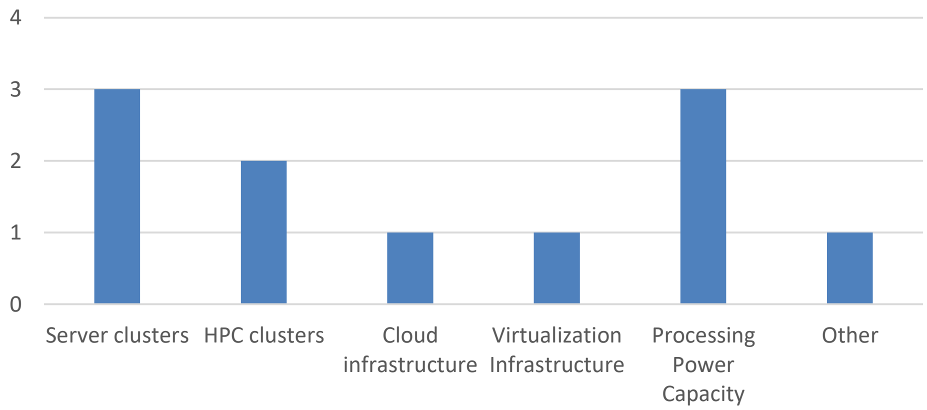


Figure 4-166. Computing resources available for processing and exploitation of EO data in Cyprus.

Data exploitation capacities

Of the five organizations that responded to this survey, two were institutional and three were research (Figure 4-167). There are organizations active in all thematic areas except energy (Figure 4-168).

Beyond the GEO-CRADLE thematic areas, organizations indicated activities in exploitation and protection of mineral and groundwater resources, the investigation and assessment of the geological environment and geohazards, the monitoring and assessment of seismicity, the investigation of the foundation conditions, weather forecasting, and various agricultural services.

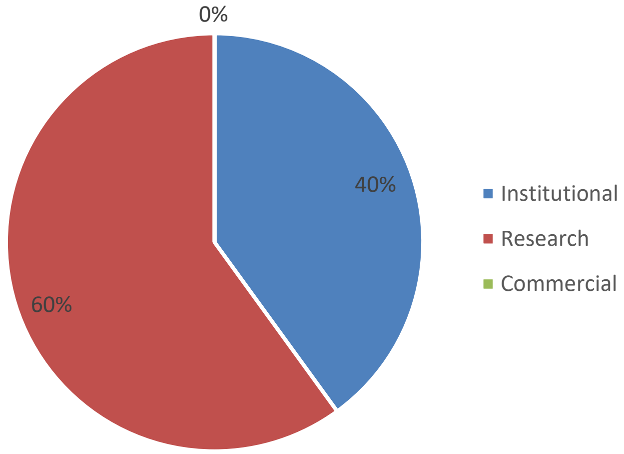


Figure 4-167. The type of organizations active in data exploitation in Cyprus.

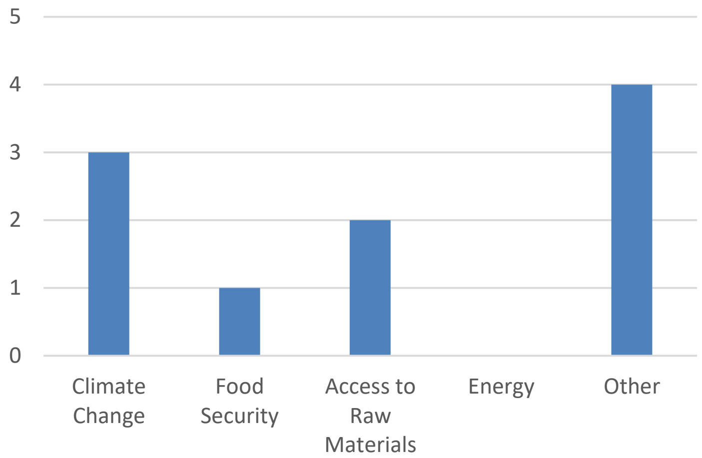


Figure 4-168. Activity of Cypriot organizations active in data exploitation in GEO-CRADLE thematic areas.

Three organizations have participated in EO projects in the past while one organization had not (Figure 4-169). No organizations had taken part in Copernicus service provision or GEO/GEOSS SBA Tasks (Figure 4-170 and Figure 4-171). Organizations indicated that experience in previous EO projects stems from the Pangeo project and the Terafirma project.

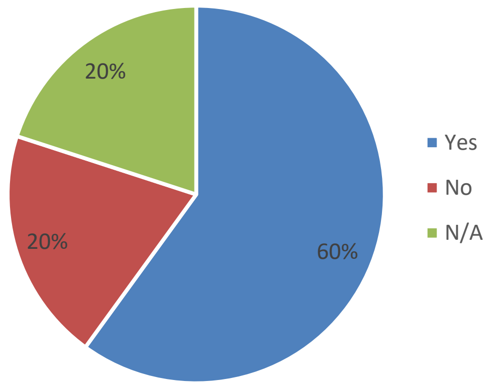


Figure 4-169. Participation of Cypriot organizations active in data exploitation in EO activities.

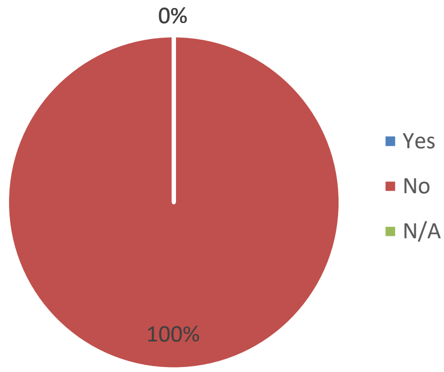


Figure 4-170. Participation of Cypriot organizations active in data exploitation in a Copernicus action.

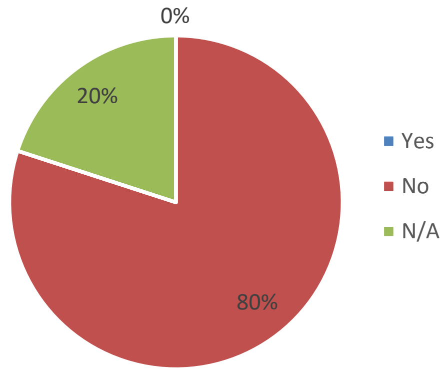


Figure 4-171. Participation of Cypriot organizations active in data exploitation in a GEO/GEOSS SBA task.

Four respondents described local cooperation as either none (40%) or low (40%), and one as high (Figure 4-172). On the other hand, cooperation abroad was described by an equal number of respondents as low (40%) and high (40%), as seen in Figure 4-173.

Organizations indicated international cooperation stems from Geosystem Hellas which provides data for PSI (Persistent Scatterer Interferometry) and interactions between various universities and ESA (the European Space Agency) and the DLR (German Aerospace Center).

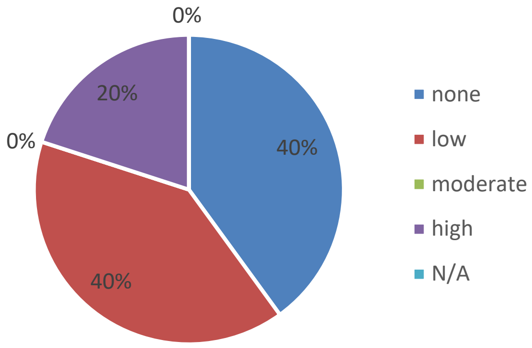


Figure 4-172. Level of cooperation of Cypriot organizations active in data exploitation with local EO actors.

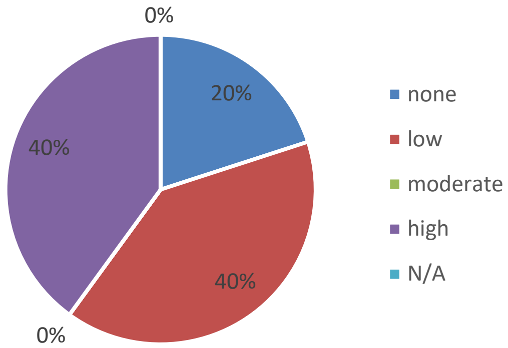


Figure 4-173. Level of cooperation of Cypriot organizations active in data exploitation with EO actors abroad.

In addition to being active in data exploitation, three organizations indicated that they have in-situ networks and three organizations that they have modelling and processing capacities, while one organization indicated that it lacks capacities outside of EO data exploitation (Figure 4-174).

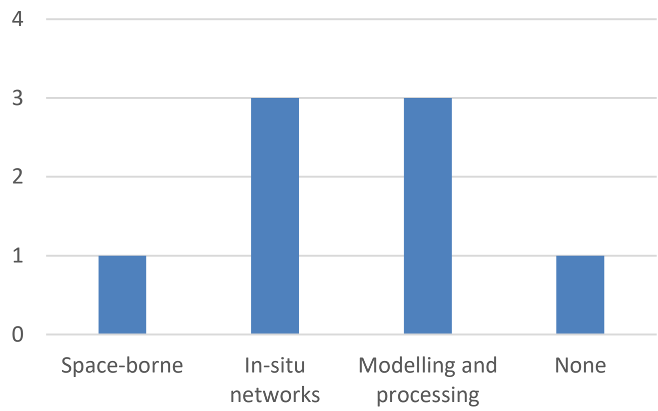


Figure 4-174. Additional EO capacities of Cypriot organizations active in data exploitation.

Thematic areas of the organization`s products were spread over most areas measured, as shown in Figure 4-175. The survey was able to identify only one product maximum in each area.

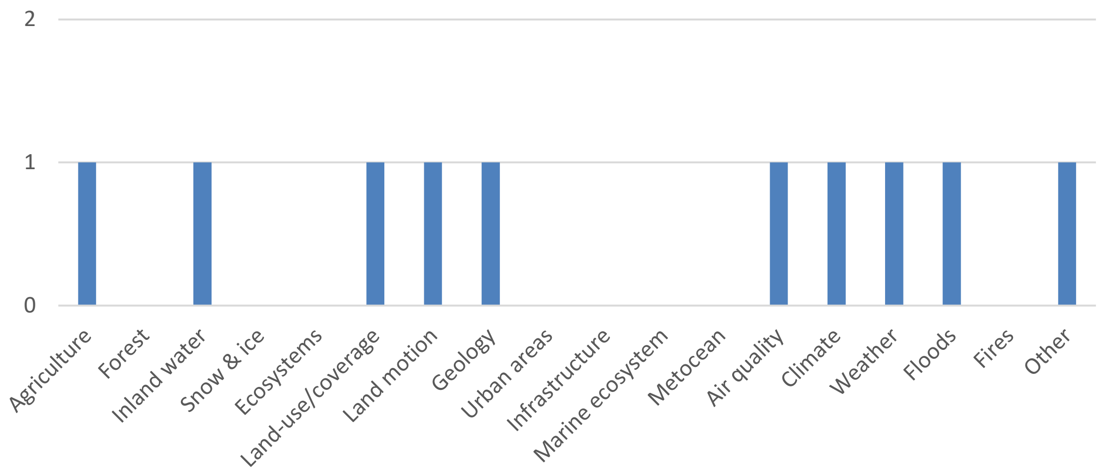


Figure 4-175. Activity areas of EO products/services of Cypriot organizations.

National Activities

With regards to funding, three organizations indicated that there is no support for EO activities, while one indicated that there is (Figure 4-176). Of the available funding, the organizations indicated that it is used for infrastructure development and research and development (Figure 4-177).

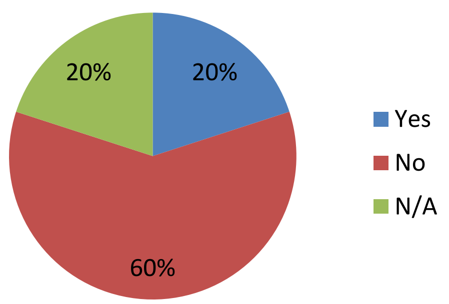


Figure 4-176. Cypriot EO actors' perception of the availability of national funding for EO.

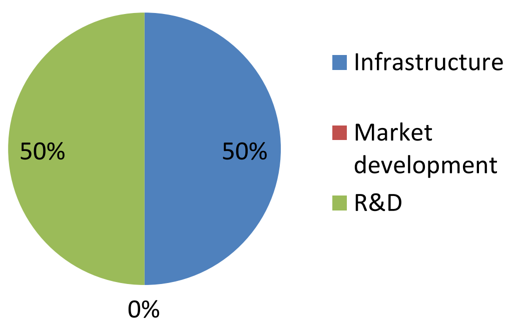


Figure 4-177. Cypriot EO actors' perception of areas for which national EO funding is available.

The majority of respondents indicated that their country does not have a space strategy nor a space agency (Figure 4-178 and Figure 4-179).

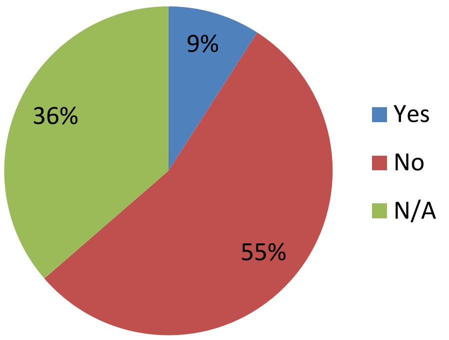


Figure 4-178. Cypriot EO actors' awareness of a space strategy in Cyprus.

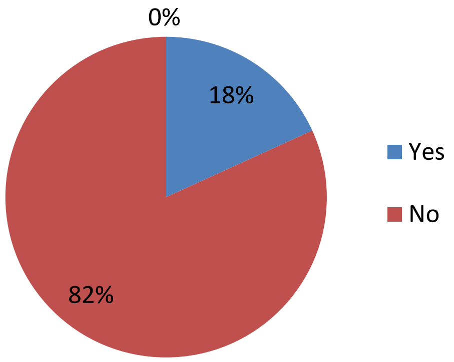


Figure 4-179. Cypriot EO actors' awareness of a space program in Cyprus.

Most of the organizations reached by this survey (73%) indicated that coordination of EO activities is either scarce or basic (Figure 4-180). Similarly, no organizations indicated that they were fully engaged with decision makers, predominantly characterizing their interaction as either scarce (36%) or specific to certain thematic areas (46%), as seen in Figure 4-181.

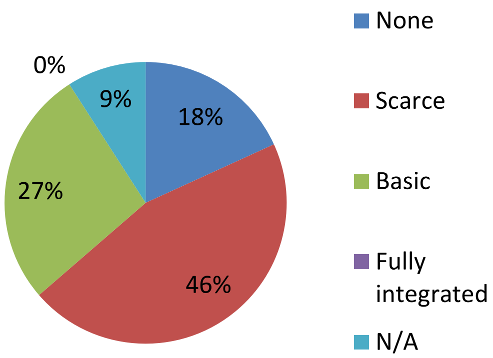


Figure 4-180. Cypriot EO actors' perception of national coordination of EO activities in Cyprus.

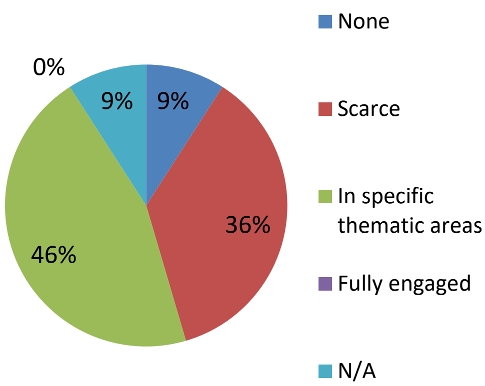


Figure 4-181. Cypriot EO actors' perception of interaction with decision makers in Cyprus.

Respondents provided examples of EO-based services and/or products in Cyprus which are operationally used by public sector bodies, such as the commercial use of images from satellites: ASTER and Quickbird.

A majority of respondents also indicated their willingness to contribute with their capacities to a regional initiative of GEO and/or Copernicus (Figure 4-182).

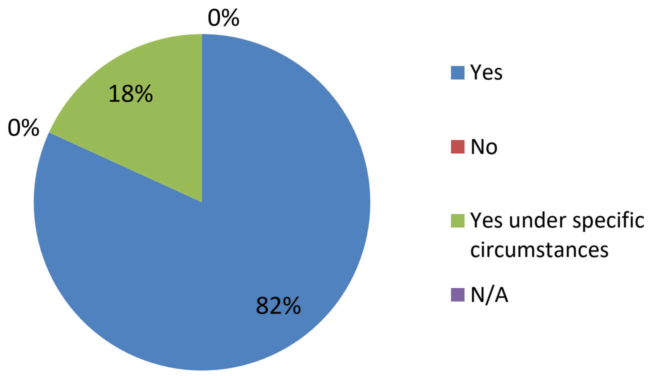


Figure 4-182. Cypriot EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

In Cyprus, all organizations that responded to this survey are aware of Copernicus (Figure 4-183). In regards to GEO, 75% of organizations indicated being aware (Figure 4-184).

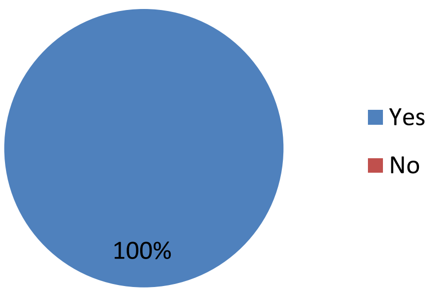


Figure 4-183. End-user awareness of Copernicus in Cyprus.

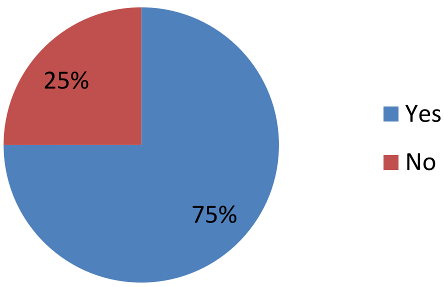


Figure 4-184. End-user awareness of GEO in Cyprus.

4.3.3. *Gap analysis*

All end-user interviews conducted have attributed large **quality/quantity** and **capacity** gaps mostly to a lack of funds. As presented in the overview above, a tough economic situation has led to a fiscal consolidation at the national level and budget tightening in the public sector. This has also impacted the EO sector – half of survey respondents perceive that there is no funding available for EO activities. Three end-users were from the public sector and one from the private sector that offers services to the public sector. Two of these organizations stated that they did not have sufficient funds to purchase EUMETSAT data at the temporal resolution that they needed. Several organizations stated that they could not purchase data at the spatial resolution that they required. Compounded by a freeze in the public sector, there is a lack of sufficient personnel needed to complete tasks.

No **structural** gaps could be identified with the information gathered. All respondents received data from other organizations and all stated that they had no problems in cooperation with data providers. Cypriot organizations demonstrated greater cooperation with organizations abroad than locally: 40% of organizations with in-situ capacities have high cooperation internationally but only 11% locally, 40% and 20% respectively for organizations with modelling and processing capacities and 40% and 20% respectively for ones active in data exploitation. This implies that integration with European peers may be more profound than with local organizations. However, results from end-user interviews do not explicitly point out any structural gaps.

Several end-users identified a lack of standards and protocols as presenting a **quality/quantity** barrier. One end-user claimed this was a problem only occasionally. The same end-user also claimed that lack of METADATA is an issue. Apart from one response each, all actors with in-situ networks and modelling and processing capacities have stated that they provide METADATA and it remains unclear whether this gap refers to the quality of the METADATA.

Without end-user input active in the thematic areas of access to raw material and energy, it is not possible to identify thematic area gaps for Cyprus.

4.4. Egypt

4.4.1. *Overview*

In Egypt, EO is present in both the public and private sectors. In the public sector, some institutions do provide EO products, but most use EO for their internal benefit and neither share collected data with, nor offer products/services to other organizations. Several public research institutions and universities share EO products for research purposes. Overall, cooperation is growing between public institutions and research organizations, especially where EO application has a clear benefit. In the private sector, there are two well-known vendors of global satellite data that provide these services to governmental and non-governmental institutions.

As EO-based business grows around the world, it faces barriers in developing countries like Egypt. A major barrier is finance. The Egyptian economy has experienced several crises in the past few decades, the most recent one in 2011, and this has strongly affected the ability to develop national EO capacities. Although there are global satellite systems that provide free and open access to data, the limitation of ICT infrastructures in the governmental sector possesses another marked barrier. These infrastructure limitations also limit the ability to exchange data between the institutions. In this context, a solution to overcome the problem of sharing the data is making a full or a partial exemption for EO access, especially for use by public sector actors and for research and education purposes.

NARSS, as the leading EO data producer in the country, can provide ample data and other EO value-addition services to the public sector – particularly for pertinent national issues and/or situations. The organization is also positioned to generate a strong link for research and education through universities and cooperation with other research institutions. This data could be provided most efficiently through a dedicated geoportal.

NARSS is an excellent example for other EO data providers in the country. The organization draws upon specific EO expertise of its personnel as well as its advanced research infrastructure: well-equipped laboratories, in-situ capacities, modelling capacities, and it is capable of providing EO products. It also has a large, national, regional and international portfolio, with multiple cooperation contracts, memorandums of understanding and other formal engagements with many public and private institutions, both nationally and internationally. NARSS has the capacity to provide varied data products, and has developed long-term working relationships with several end-users. This institution could be classified as a large institution with 500+ staff of PhD holder, MSc holders, engineers and specialists.

The Egyptian Space Program was established in 1998 and successfully launched its first EO satellite in April 2007, with its latest mission in October 2010. The program has a ground station that receives data from various satellites, including SPOT in addition to the Egyptian satellite EgyptSat-1. There are plans to upgrade the receiving station and launch two small experimental satellites by 2017 and 2019.

It is anticipated that the Egyptian space agency will be launched in the near future creating a good framework for better management of EO policy for data, products, and relevant services. It will also work as an official open avenue to the world through new frameworks and cooperation as well as developing national capacity building in this sector. It will provide a framework for awareness activities to disseminate and define the concept, standards and policy regarding “data openness, availability, and sharing” and to coordinate between outputs and beneficiaries in the local ecosystem, as well as the participation of the country in major transnational/regional initiatives and collaborative programs.

There are two private companies in Egypt active in EO. Global Geobits-Egypt was founded in 1997, and is a member of Osman Group companies. It has a branch in the United States market, Global Geobits Inc. located in San Diego, California. Global Geobits has developed several applications, conducted many projects and offered various training programs for a number of national and international clients. Rectification and geo-referencing of satellite images were based on GCP's mainly from GPS surveys. Field teams are usually sent to the site to collect relevant attribute data. Edge-Pro was established in 2004 to meet the challenges in geomatic engineering and IT services. Edge-pro has qualified staff with more than 20 years of experience in remote sensing, photogrammetry and GIS. EDGE-Pro is located in Cairo which gives the company the opportunity to serve Egypt as well as the Middle East Region, especially Arabic speaking countries. In 2009, EDGE-Pro became a partner with European Space Imaging, a provider for high resolution satellite images, becoming one of the largest providers of satellite images in the region.

4.4.2. *Capacities*

Space-borne capacities

Of the two organizations reached by this survey, both were focused on research (Figure 4-185). Both focused on climate change, and one was also active in food security (Figure 4-186).

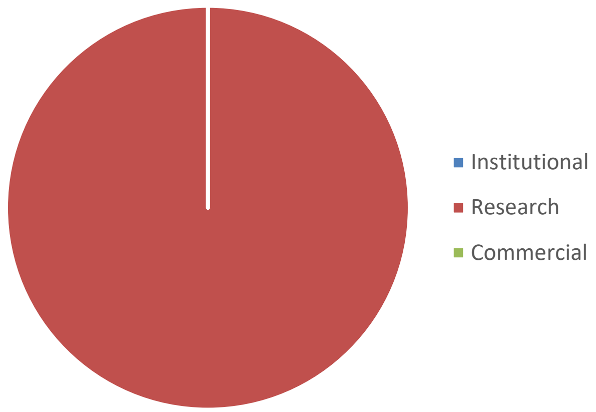


Figure 4-185. Types of organizations with space-borne capacities in Egypt.

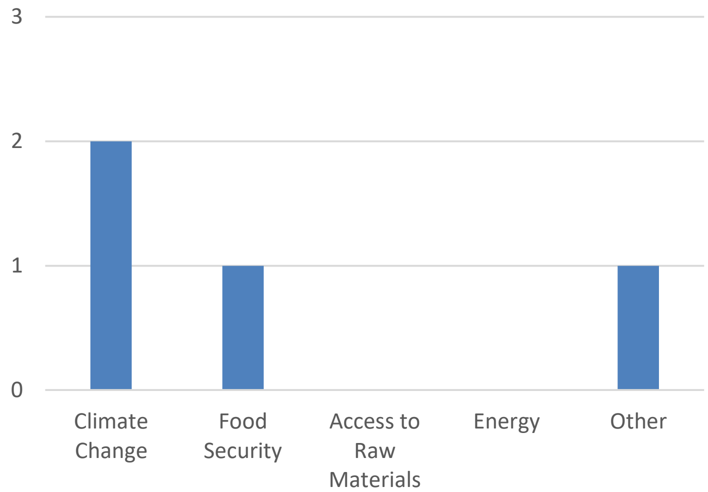


Figure 4-186. Types of organizations with space-borne capacities in Egypt.

One organization indicated it had taken part in previous EO projects (Figure 4-187). Similarly, one organization indicated it had taken part in Copernicus related activities (Figure 4-188), while neither organization indicated having taken part in GEO/GEOSS SBA activities (Figure 4-189).

Previous activities in GEO/GEOSS social benefit areas stem from the AfriGEOSS project.

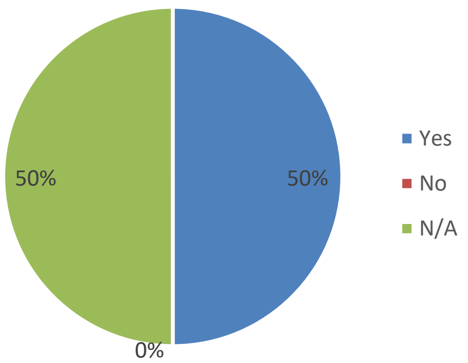


Figure 4-187. Activity of Egyptian organizations with space-borne capacities in GEO-CRADLE thematic areas.

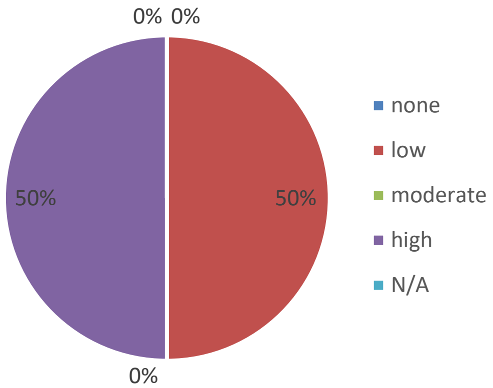


Figure 4-188. Participation of Egyptian organizations with space-borne capacities in EO activities.

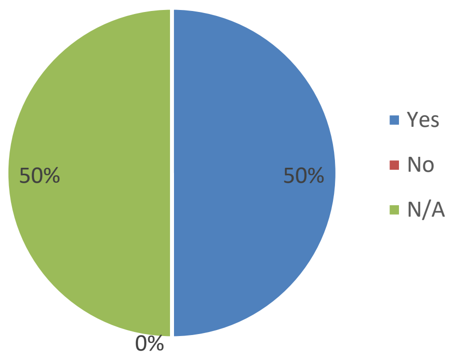


Figure 4-189. Participation of Egyptian organizations with space-borne capacities in a Copernicus action.

Local participation was perceived by one of the respondents as low and the other as high (Figure 4-190), while international cooperation was perceived as low and moderate (Figure 4-191).

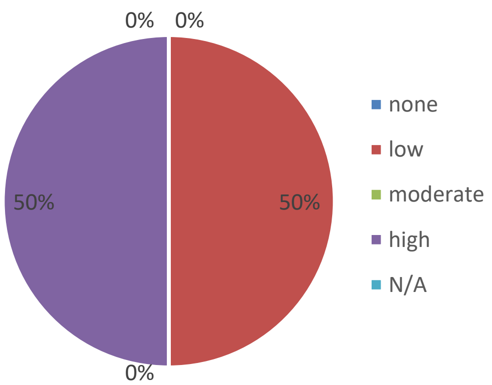


Figure 4-190. Participation of Egyptian

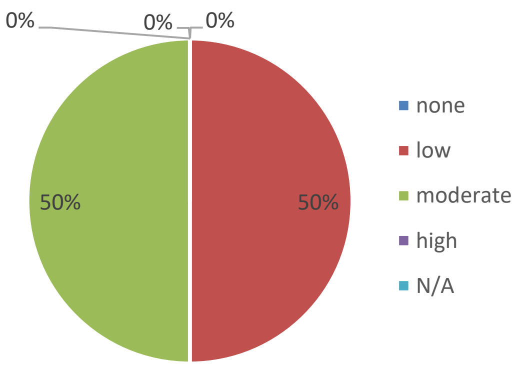


Figure 4-191. Level of cooperation of

organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

Egyptian organizations with space-borne capacities with local EO actors.

Aside from space-borne capacities, both organizations indicated that they have modelling capacities, and one indicated it was active in data exploitation (Figure 4-192). One organization indicated having both satellite and ground segment capacities (Figure 4-193). It was further specified that the coverage of this satellite is dominantly regional (Figure 4-194).

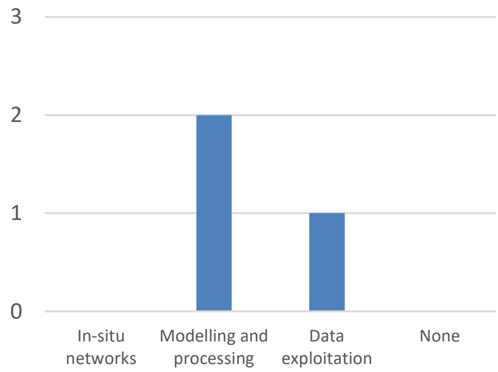


Figure 4-192. Additional EO capacities of Egyptian organizations with space-borne capacities.

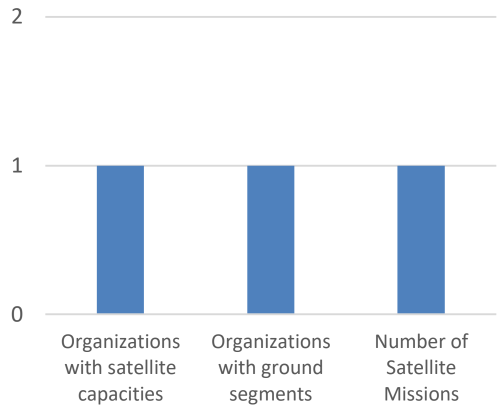


Figure 4-193. Type of space-borne capacities of Egyptian organizations.

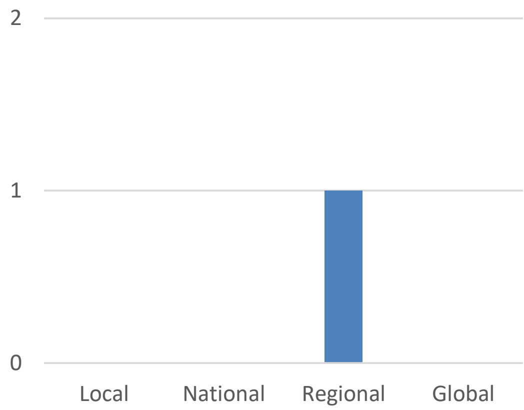


Figure 4-194. Geographic coverage of Egyptian satellite missions.

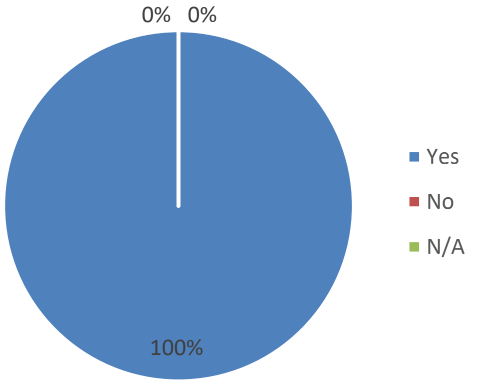


Figure 4-195. Data availability from Egyptian satellite missions.

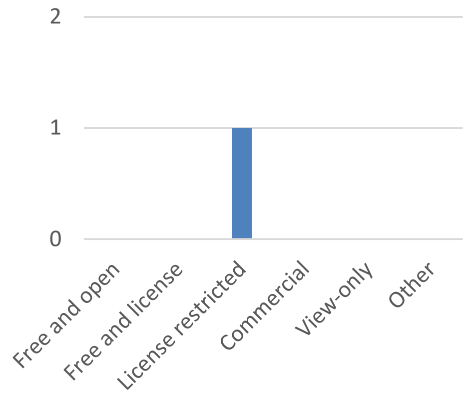


Figure 4-196. Data policy of Egyptian satellite missions.

In-situ networks and facilities

The six organizations reached include institutional, research and commercial organizations (Figure 4-197). Four of them are active climate change and two in food security (Figure 4-198). Surveyed organizations are also specified that they are active in water and waste-water, environmental and scientific consulting, preparing environmental impact assessments, and preparing quality risk assessment studies.

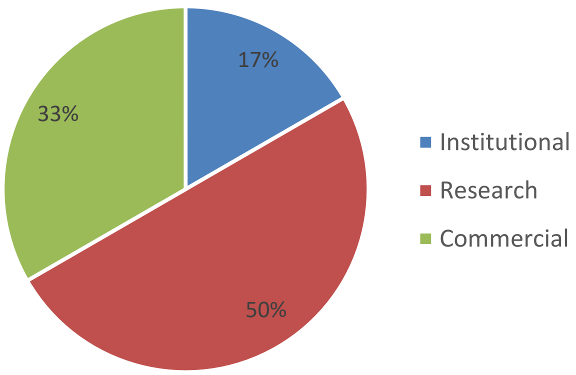


Figure 4-197. The type of organizations with in-situ networks in Egypt.

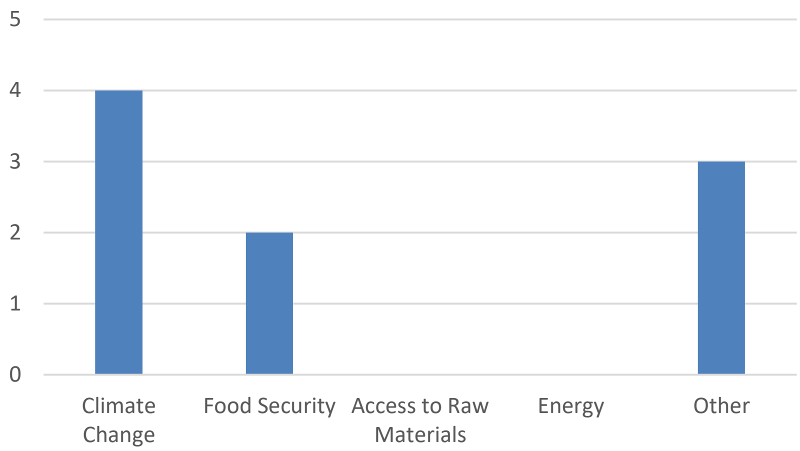


Figure 4-198. Activity of Egyptian organizations with in-situ networks in GEO-CRADLE thematic areas.

Half of the organizations indicated having taken part in previous EO projects (Figure 4-199). One organization indicated having taken part in Copernicus related activities (Figure 4-200), while no organization indicated having taken part in GEO/GEOSS SBA activities (Figure 4-201).

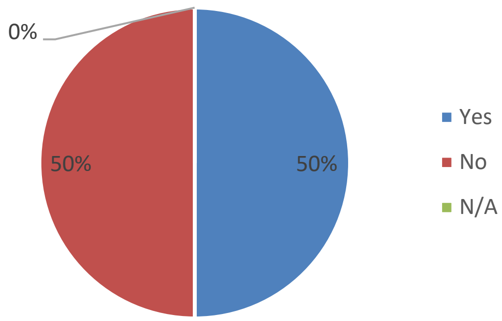


Figure 4-199. Participation of Egyptian organizations with in-situ networks in EO activities.

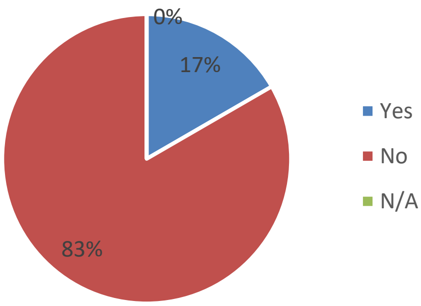


Figure 4-200. Participation of Egyptian organizations with in-situ networks in a Copernicus action.

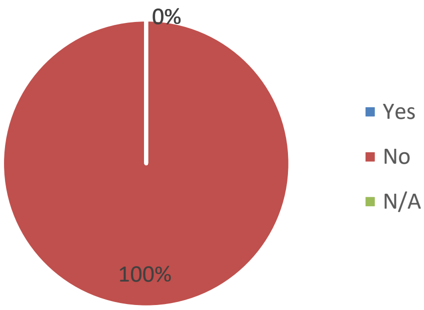


Figure 4-201. Participation of Egyptian organizations with in-situ networks in a GEO/GEOSS SBA task.

All organizations indicated no local cooperation (Figure 4-202). In contrast 25% of respondents claimed high international cooperation, while 75% claimed none (Figure 4-203).

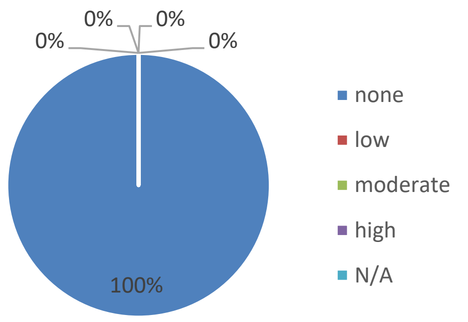


Figure 4-202. Level of cooperation of Egyptian organizations with in-situ networks with local EO actors.

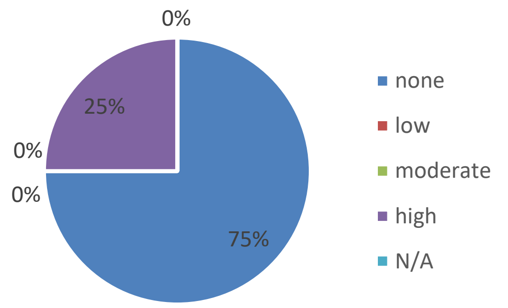


Figure 4-203. Level of cooperation of Egyptian organizations with in-situ networks with EO actors abroad.

Two organizations with in-situ capacities also had modelling and processing capacities; however, most organizations did not have any other capacities beyond in-situ networks (Figure 4-204). Organizations that responded to this survey indicated having capacities in meteorological/climate, hydrometric/water, and energy/radiation areas (Figure 4-205).

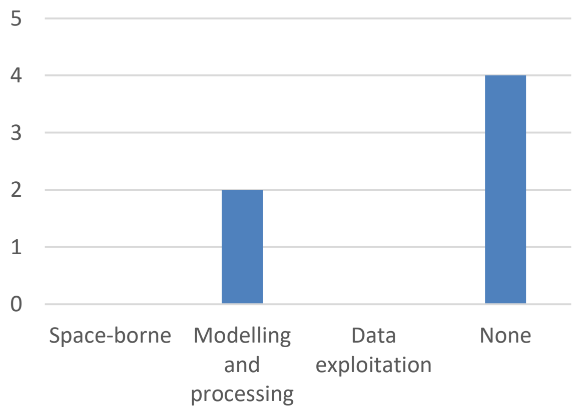


Figure 4-204. Additional EO capacities of Egyptian organizations with in-situ networks.

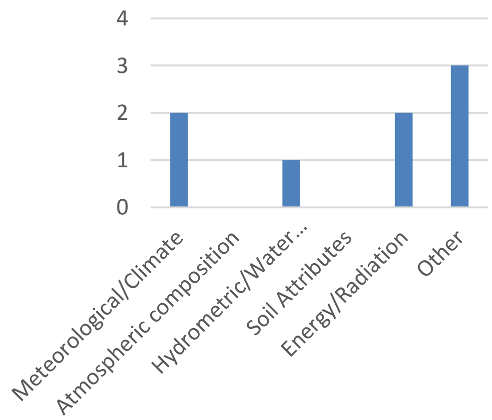


Figure 4-205. Activity area of in-situ networks of Egyptian organizations.

The highest number of stations or facilities were focused on hydrometry/water quality (Figure 4-206). All stations or facilities were mostly local or national (Figure 4-207). Registration in a national/regional/international network (Figure 4-208). While data is regularly stored mostly for meteorological climate and energy radiation (Figure 4-209).

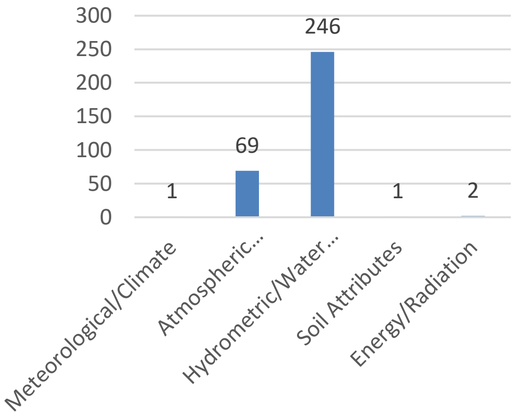


Figure 4-206. *Number of stations of in-situ networks in Egypt by activity area.*

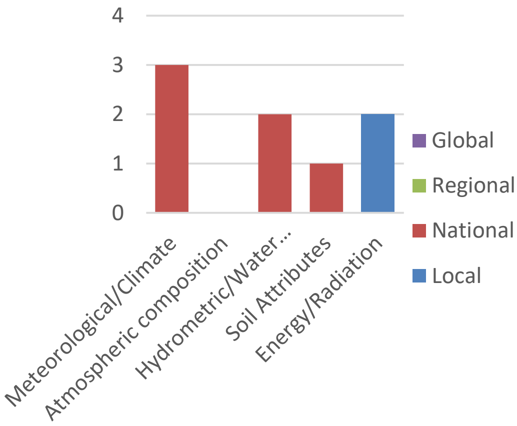


Figure 4-207. Geographic coverage of in-situ networks in Egypt by activity area.

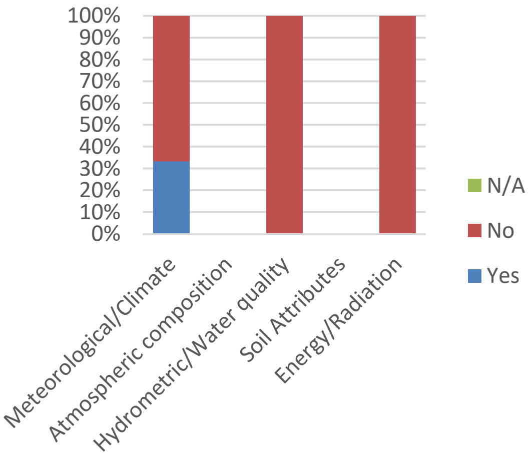


Figure 4-208. Registration of in-situ networks in Egypt by activity area.

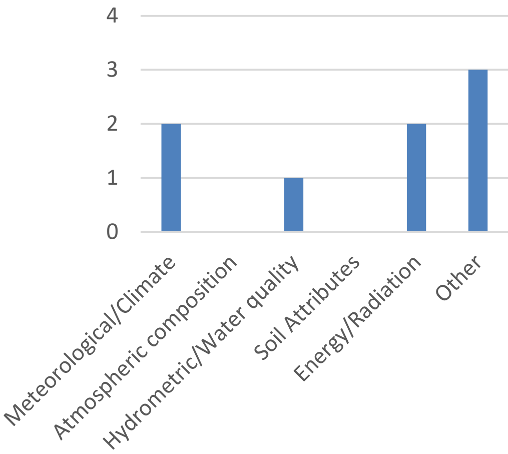


Figure 4-209. Systematic collection of data by in-situ networks in Egypt by activity area.

Organizations responded that METADATA was available from **meteorological and climate in-situ networks**. Organizations did not provide information in regards to the temporal resoution of these networks. One of the organizations specified that it makes data available only from past archives (Figure 4-211). There was no information provided about data policy.

One organization provided greater details in regards to its **hydrometric and water quality in-situ network**: it indicated availability of METADATA (Figure 4-212), a daily temporal resoution

(Figure 4-213) and data availability upon request (Figure 4-214). No organization provided information regarding data policy.

Organizations with **in-situ networks measuring in atmospheric composition** did not provide any further details than those presented above.

One organization with **energy/radiation in-situ network** only specificed that that data is available upon request (Figure 4-215).

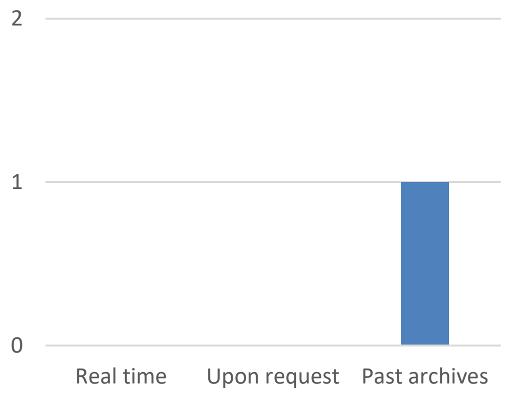


Figure 4-210. Availability of METADATA from meteorological and climate in-situ networks in Egypt.

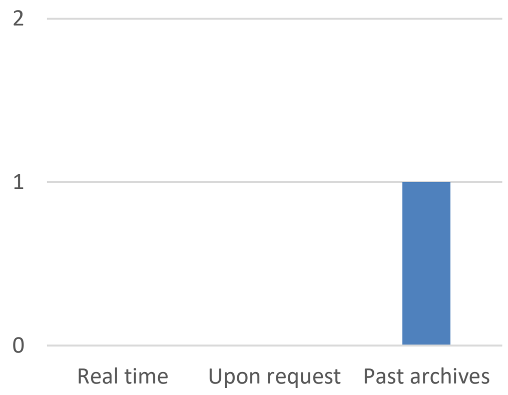


Figure 4-211. Data availability from meteorological and climate in-situ networks in Egypt.

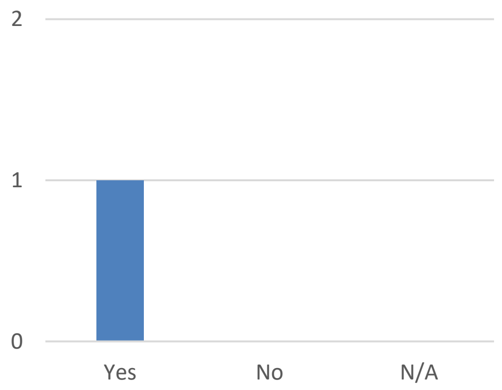


Figure 4-212. Availability of METADATA from hydrometric and water quality in-situ networks in Egypt.

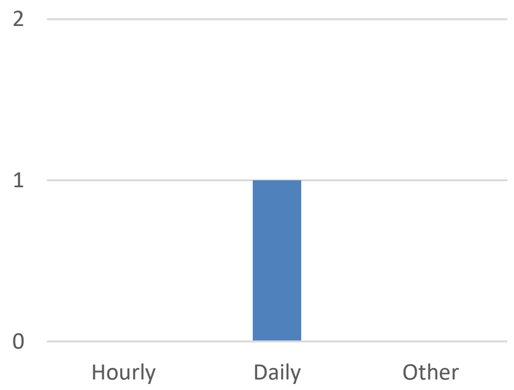


Figure 4-213. Temporal resolution of hydrometric and water quality in-situ networks in Egypt.

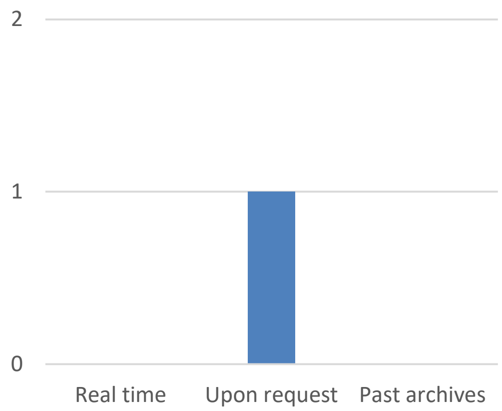


Figure 4-214. Data availability from hydrometric and water quality in-situ networks in Egypt.

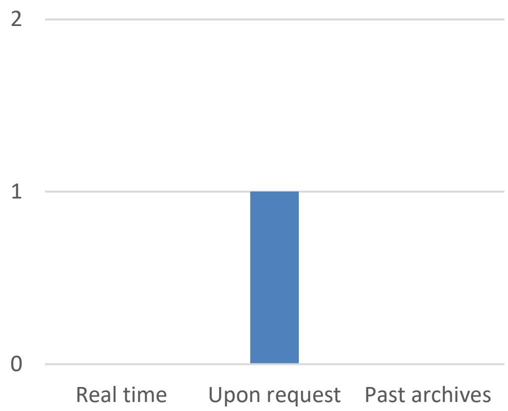


Figure 4-215. Data availability from energy/radiation in-situ networks in Egypt.

Modelling and processing capacities

Seven organizations with modelling and processing capacities were reached by the survey (Figure 4-216). The organizations were active in climate change and access to raw materials (Figure 4-217). The organizations did not specify what other thematic areas they were active in.

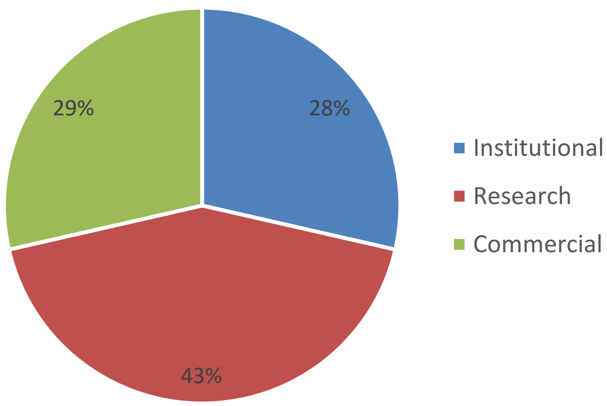


Figure 4-216. The type of organizations with modelling and processing capacities in Egypt.

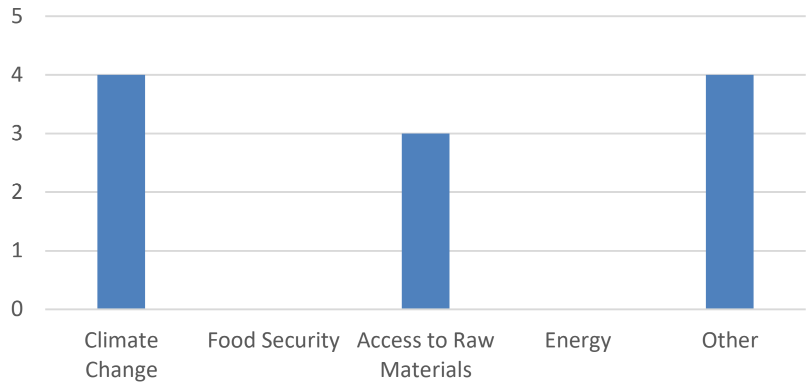


Figure 4-217. Activity of Egyptian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

Most organizations indicated that they had not previously participated in EO projects, while 29% indicated they had (Figure 4-218). In regards to participation in Copernicus related activities and GEO/GEOSS SBA (Social Benefit Areas) tasks, most organizations indicated they had no prior experience as well: only one organization had participated in a GEOSS subtask (Figure 4-219 and Figure 4-220). Previous experience in EO projects stems from the BRAGMA project. Previous experience in a GEO/GEOSS SBA comes from the AfriGEOSS project.

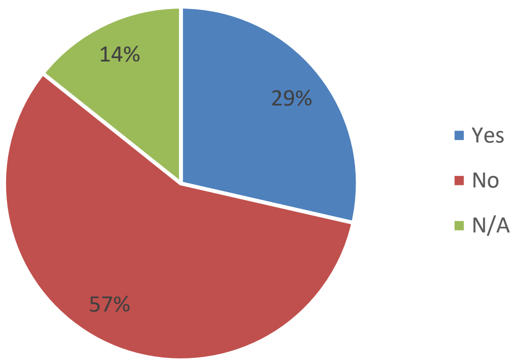


Figure 4-218. Participation of Egyptian organizations with modelling and processing capacities in EO activities.

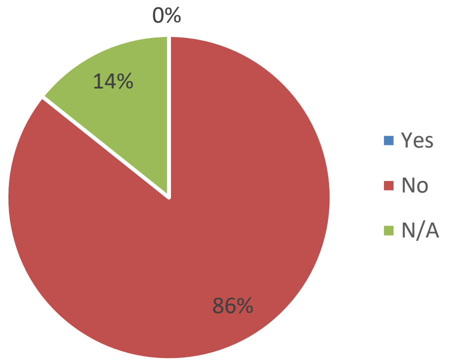


Figure 4-219. Participation of Egyptian organizations with modelling and processing capacities in a Copernicus action.

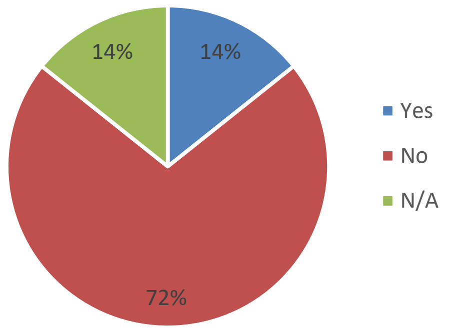


Figure 4-220. Participation of Egyptian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

Most organization had neither local nor international cooperation, 57% for both. Two organizations had a low level of cooperation for both, and one organization had high local cooperation and moderate international cooperation (Figure 4-221 and Figure 4-222).

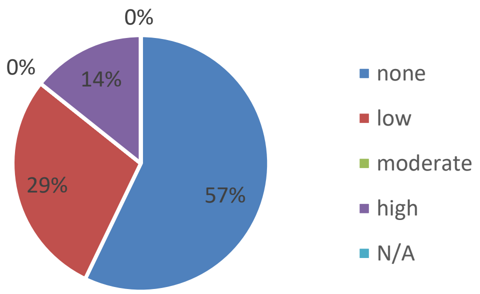


Figure 4-221. Level of cooperation of Egyptian organizations with modelling and processing capacities with local EO actors.

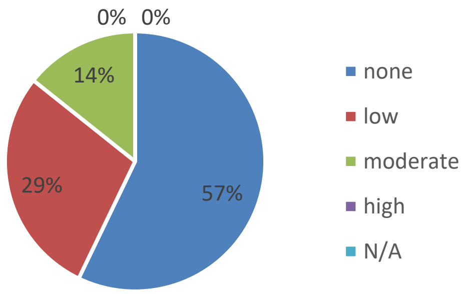


Figure 4-222. Level of cooperation of Egyptian organizations with modelling and processing capacities with EO actors abroad.

Organizations with modelling and processing capacities also had space-borne capacities (two organizations and were active in data exploitation (one organization); however, three organizations had only modelling and processing capacities. See (Figure 4-223).

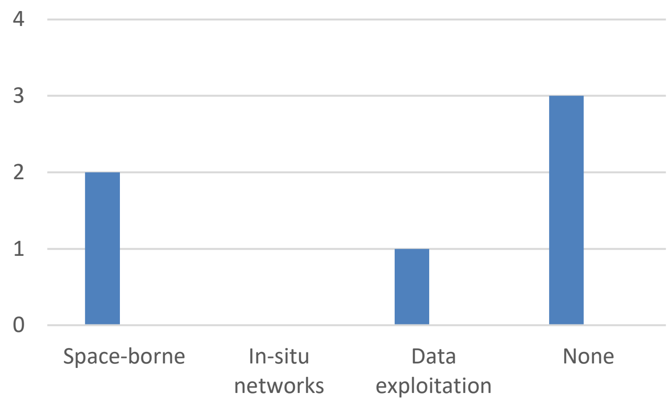


Figure 4-223. Additional EO capacities of Egyptian organizations with modelling and processing capacities.

The models and algorithms are available for all areas measured by the survey (Figure 4-224). Similarly, Egyptian organizations use all sources of EO data measured by the survey (Figure 4-225). The coverage of the models was predominantly national (Figure 4-226). METADATA is available for three models, while it is not for two (Figure 4-227). The computing resources available were HPC clusters and processing power capacity (Figure 4-228).

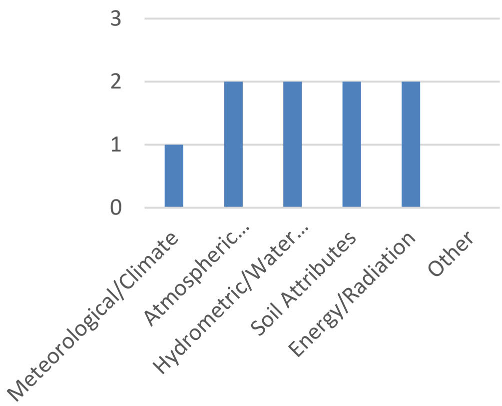


Figure 4-224. Algorithms and models available in Egypt by activity area.

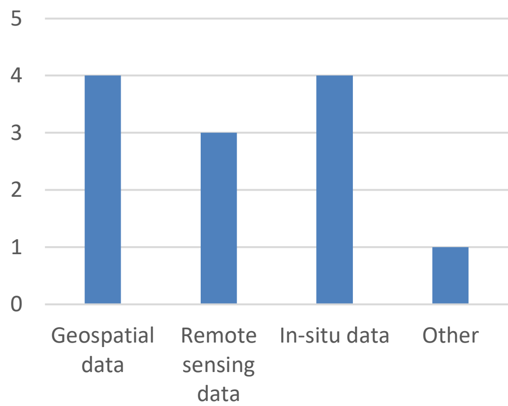


Figure 4-225. Sources of EO data used by organizations with modelling and processing capacities in Egypt.

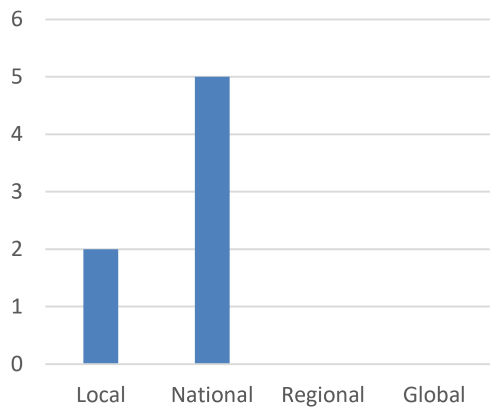


Figure 4-226. Geographic coverage of models and algorithms in Egypt.

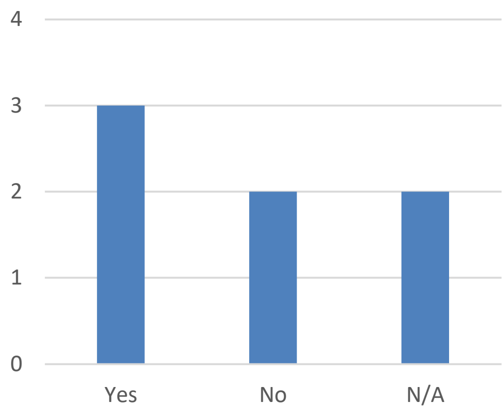


Figure 4-227. Availability of METADATA for models and algorithms in Egypt.

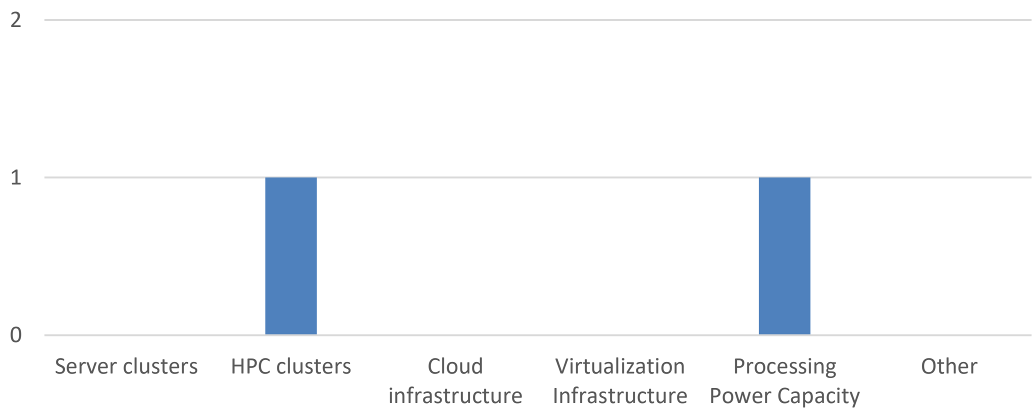


Figure 4-228. Computing resources available for processing and exploitation of EO data in Egypt.

Data exploitation capacities

29 organizations were reached by this survey in Egypt: most are research, but commercial and institutional were also reached (Figure 4-229). Surveyed organizations are active in all GEO-CRADLE thematic areas, particularly food security and climate change (Figure 4-230).

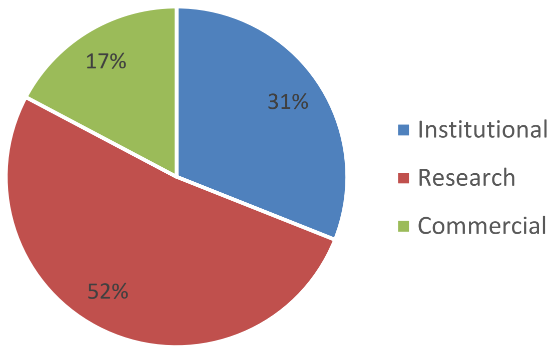


Figure 4-229. The type of organizations active in data exploitation in Egypt.

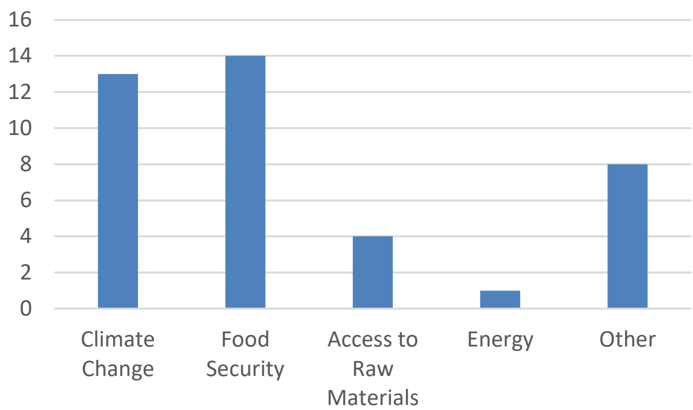


Figure 4-230. Activity of Egyptian organizations active in data exploitation in GEO-CRADLE thematic areas.

69% of organizations indicated that they had not previously participated in EO projects and 28% indicated that they had (Figure 4-231). In regards to participation in Copernicus related activities and GEO/GEOSS SBA tasks, most organizations indicated lacking prior experience: 97% and 93% respectively (Figure 4-232 and Figure 4-233).

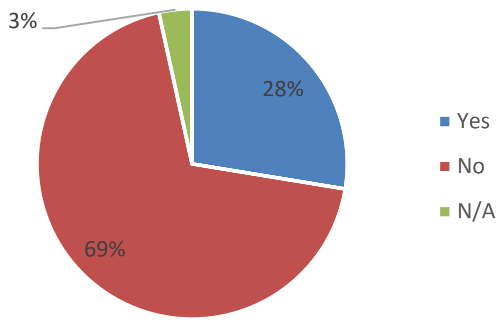


Figure 4-231. Participation of Egyptian organizations active in data exploitation in EO activities.

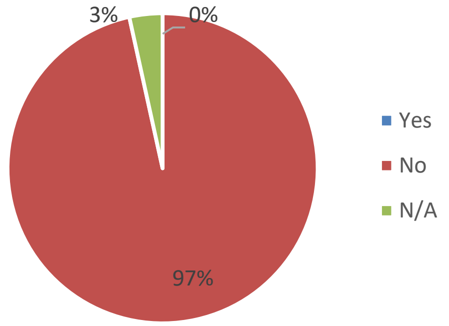


Figure 4-232. Participation of Egyptian organizations active in data exploitation in a Copernicus action.

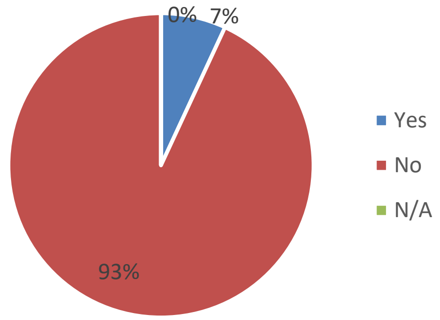


Figure 4-233. Participation of Egyptian organizations active in data exploitation in a GEO/GEOSS SBA task.

Previous experience in EO projects was specified as the BRAGMA project by one organization. Experience in GEO/GEOSS SBA experience was acquired over AfriGEOSS.

Most organizations have neither local nor international cooperation: 88% and 93% respectively (Figure 4-234 and Figure 4-235). Nonetheless, one organization does have a high level of cooperation on the local level.

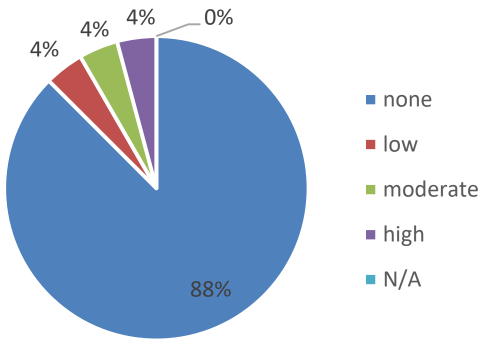


Figure 4-234. Level of cooperation of Egyptian organizations active in data exploitation with local EO actors.

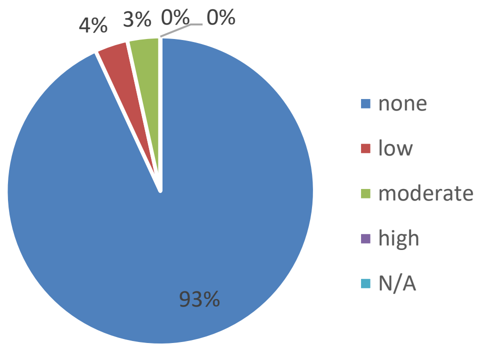


Figure 4-235. Level of cooperation of Egyptian organizations active in data exploitation with EO actors abroad.

Organizations active in data exploitation mostly specialized in these activities, with few indicating other capacities (Figure 4-236).

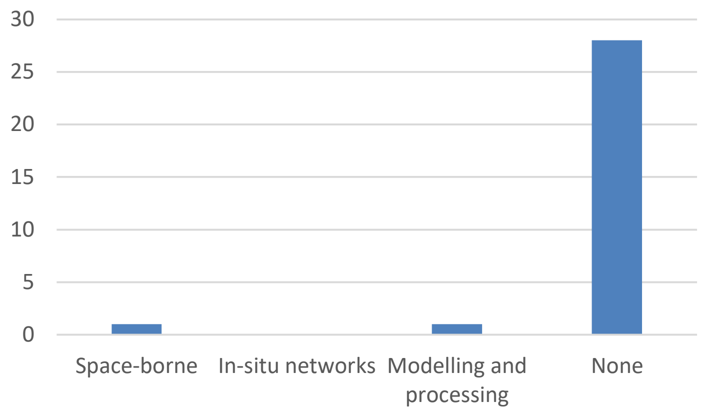


Figure 4-236. Additional EO capacities of Egyptian organizations active in data exploitation.

The organizations surveyed did not provide details that they have products available in all areas measured by the project. There were many products in the areas of agriculture and climate, unsurprisingly none in snow & ice and forest, but also none in air quality, marine ecosystems, metocean (Figure 4-237). Organizations specified they were also active in consulting, education, research, statistics and mobilization.

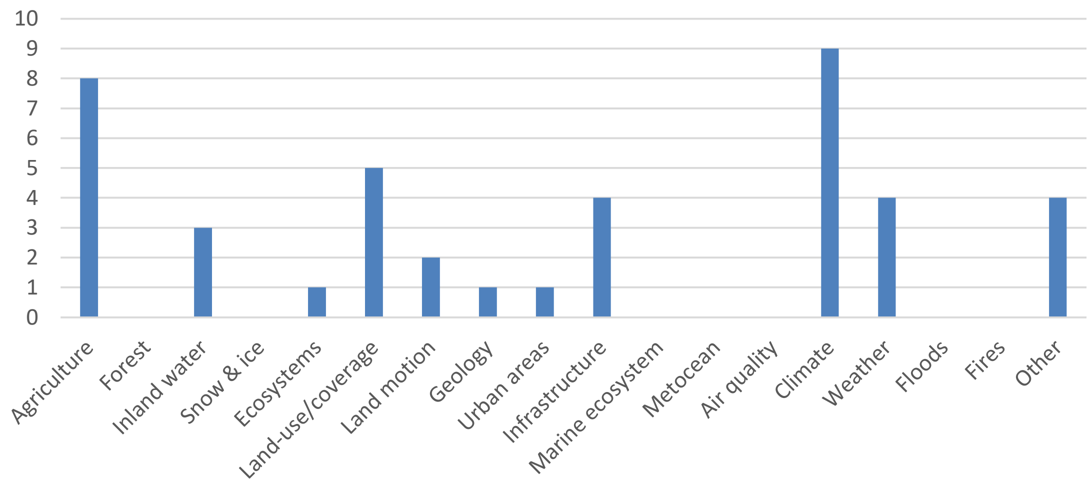


Figure 4-237 Activity areas of EO products/services of Egyptian organizations.

National activities

The majority of respondent organizations indicated that funding for EO is mostly unavailable: 34% answered no compared to 3% which answered yes (Figure 4-238). Survey results show that these funds are mostly aimed towards R&D and infrastructure (Figure 4-239), although the amount of responses for this question was low. Responses also stated that funding is available for updates to receiving stations. There is a fund for yearly research that is aimed at providing information for decision makers.

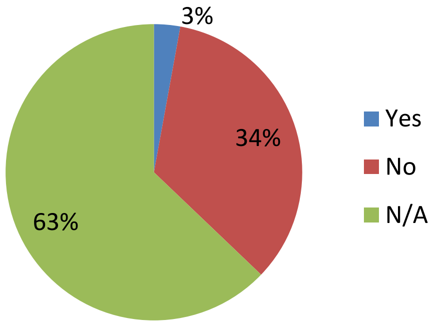


Figure 4-238. Egyptian EO actors' perception of the availability of national funding for EO.

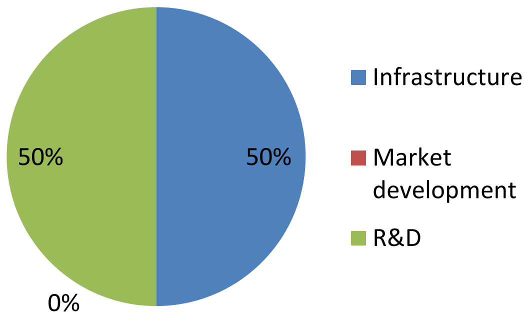


Figure 4-239. Egyptian EO actors' perception of areas for which national EO funding is available.

Surprisingly, most organizations indicated that in Egypt there is no space agency nor a space strategy (Figure 4-240 and Figure 4-241). A space agency has not been formally established, but a space program (and thus strategy) does exist. One organization did specify that there is a national space policy and strategy for Egypt that is regularly developed and updated.

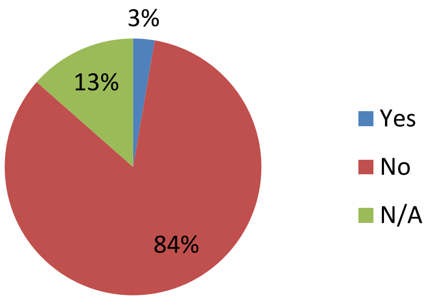


Figure 4-240. Egyptian EO actors' awareness of a space strategy in Egypt.

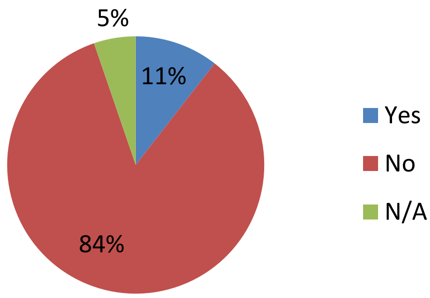


Figure 4-241. Egyptian EO actors' awareness of a space program in Egypt.

The opinion of 92% of survey respondents is that coordination of EO activities in Egypt is basic (Figure 4-242). In regards to interaction with decision makers, 58% of respondents stated that this question does not apply to them; 34% state cooperation exists in specific areas (Figure 4-242).

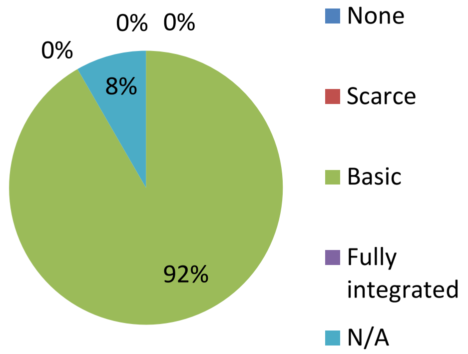


Figure 4-242. Egyptian EO actors' perception of national coordination of EO activities in Egypt.

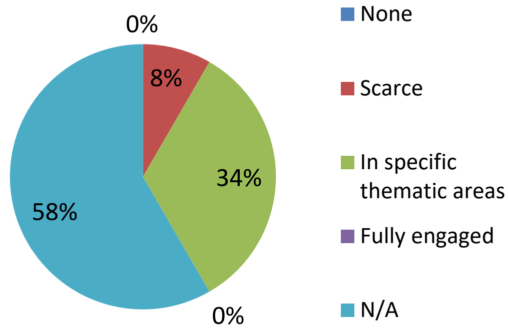


Figure 4-243. Egyptian EO actors' perception of interaction with decision makers in Egypt.

73% of respondents indicated their willingness for future engagement in GEO regional initiatives with their capacities under specific circumstances. A further 24% expressed a willingness to engage without specific circumstances (Figure 4-244).

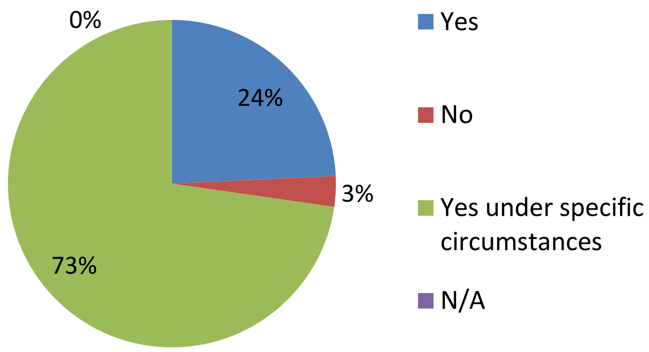


Figure 4-244. Egyptian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

In Egypt, 63% of end-users interviewed indicated not having awareness of GEO and Copernicus (Figure 4-245 and Figure 4-246).

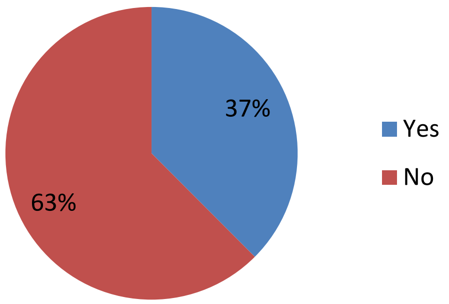


Figure 4-245. End-user awareness of Copernicus in Egypt.

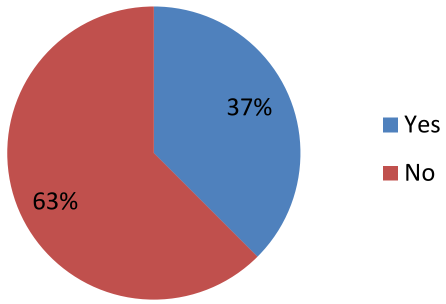


Figure 4-246. End-user awareness of GEO in Egypt.

4.4.3. *Gap analysis*

No **geographic** or **observational** gaps were identified for Egypt. The country has its own EO satellites. Its receiving stations obtain data from these satellites as well as LANDSAT and other satellites from other countries.

Large **structural** gaps were identified in Egypt. Overall, data sharing between organizations on the operational level is scarce, as most data collected and processed is kept in-house. In regards to cooperation, 100% of organizations with in-situ networks, 57% of organizations with modelling capacities and 88% of data exploiters say they have no local cooperation. End-user interviews validate that this is a problem, with interviewees stating that regulations and legislature present a barrier to data access. Desk research has also validated an aversion towards data sharing. In general, there is the perception that rules are not up-to-date to keep up with end-user needs in the country. To overcome structural barriers, legislative changes are needed to create a legal framework for data sharing between organizations, bringing the state of the art in line with best practice standards. The fact that 97% of survey respondents were willing to engage with GEO and Copernicus initiatives indicates that cooperation is perceived as beneficial and that the situation can improve with regulatory changes. There is also a difference between organizations, with several end-user organizations identifying one public institute as particularly problematic regarding data sharing.

Quality/quantity gaps were also identified. End-users pointed to lack access to affordable and high resolution EO images. A lack of near real-time or real-time information is being problematic to their work. The survey did not provide enough details to confirm if this is a quality/quantity gap or a structural gap.

In regards to **capacity** gaps, organizations were unified in pointing to human resource limitations, including a lack of training and relevant skills available. Within organizations themselves, a lack of human resources hinders communication and coordination with other departments and contributes to structural gaps. One end-user organization does not have functioning telephone or internet.

Two-thirds of end-users are not aware of Copernicus and GEO. It is surprising that 84% of respondents believe that Egypt has no space strategy while only 3% believe it does, when in fact the country has had a space program for almost two decades. This may imply poor networking in the EO ecosystem and a lack of awareness about activities in other organizations.

There are indications that a lack of funding for EO presents a significant obstacle, manifesting **structural**, **quality/quantity** and **capacity** gaps. Survey respondents echoed this impression with 12 of 13 respondents indicating there is no national financing for EO. Several end-user organizations pointed to an inability to purchase up to date equipment and invest in more advanced computers, software and maps.

4.5. Greece

4.5.1. *Overview*

Greece is constantly active in EO, with a high-level of human capital, advanced space-borne and ground-based infrastructure, and state-of-the-art remote sensing techniques and modelling. The largest barrier to the maintenance and further development of capacities and activities is the insufficient availability of financial resources. The state budget for EO was eliminated due to the continuing economic crisis and ongoing austerity measures; funding is mainly available through competitive European and international frameworks. Furthermore, there is a continuing brain-drain. Many scientists, researchers and experts emigrate to seek opportunities abroad. Nonetheless, Greece maintains a strategic role in the region and achieves a very good performance, with a great potential for further expansion and evolution.

Through the past four decades Greece has gradually developed its EO and Space-related sector. In the mid-1980s, the country joined INTELSAT, INMARSAT, EUMETSAT and EUTELSAT. In the 1990s, the Hellenic National Space Committee was founded. Its operations lasted for about fifteen years and resulted in inventorying and support & coordination of EO and Space activities in the country. The Committee also drafted a national roadmap for prioritizing investments, while suggesting measures for the uptake by SMEs and industry. In turn, this resulted in the creation of a *Strategic Plan*: providing management, planning and a resource allocation strategy for an Integrated EO system over South East Europe (SEE). It also provided the framework to encourage the involvement of Greece in several key Space and EO programs, and paved the implementation of flagship EU and ESA initiatives in the area of EO and Space aspects, such as Copernicus (former GMES), GALILEO, and GEOSS of GEO.

Greece initiated early cooperation with international organizations by signing several protocols and cooperation agreements with ESA, and stepping into the main EU Framework Programs of EC in relation to Space. In 2003, the country launched *Hellas Sat*, its first telecom satellite, supporting telecom services and data transfer. By 2005 Greece joined ESA as its 16th member-state. The country invested into mandatory and optional programs of ESA, the latter mainly referring to EO and the integrated EO/GNSS/Telecom programs such as (EOEP, ARTES, GSTP, IAP, GSE, etc.). Two years later, a governmental decision enabled local EO actors to interact with EU peers from more advanced EO countries to develop the HELIOS II EO system. In 2006 Greece joined the frame of activities of GEO and GEOSS, while a year later the Greek GEO office was established. In addition, participation in the United Nations Framework Convention on Climate Change-UNFCCC, in the Kyoto Protocol and the ESA Climate Change Initiative prove a long term interest in environment and climate change by integrating EO means and technology.

Participation in ESA, GEO and Copernicus

Greek research organizations, companies and user communities actively participate in Space dedicated activities with an emphasis on EO, including those initiated by the EU (FP4-FP7 & H2020, and Copernicus Framework program), and by ESA (participation in mandatory and optional programs and the initiation of the ESA-Greece Industry Incentive Scheme). Greece is not participating in ESA's optional EO programs since the onset of the economic crisis.

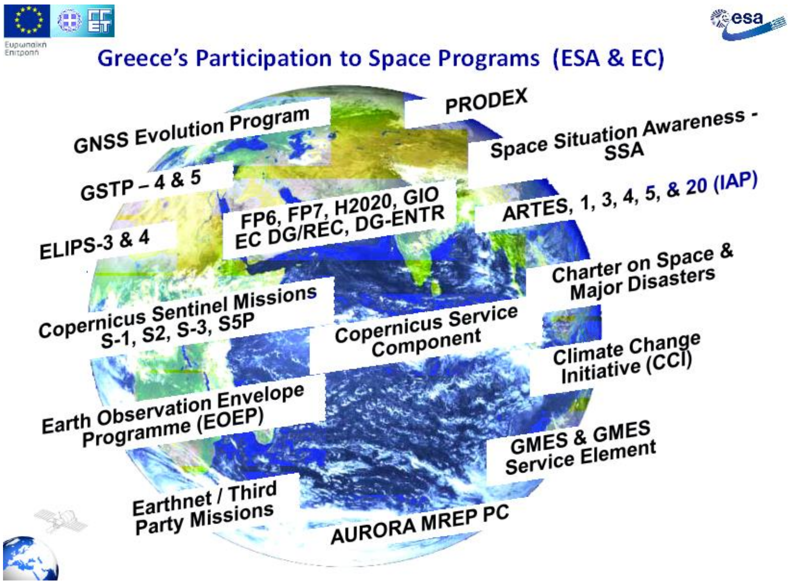


Figure 4-247. Greece's participation in the space programs of ESA and the EC.

The involvement of Greek entities in EU and ESA programs are focused on topics such as:

- Exploitation of EO technology, tools and data for deriving new products/information.
- The uptake of the EO services in the frame of various pre-operational and operational contexts, and in support to the Copernicus Service domains (mainly in Land, Emergency Response, Risk & Recovery, Ocean, and Climatology & Atmosphere Services). Indicative examples: GEOLAND, MyOcean, SAFER, RISK-EOS, MACC, MARCOAST, etc.
- The delivery of prototype EO/GNSS/Comm integrated applications to address priorities in the areas of meteorology, climatology, geology, geotechnical engineering, agriculture, land use, crisis & natural disasters management, security, and citizen safety.
- The Space Geodesy and applications (in reference to Galileo program).
- The Space Physics & Space Weather.
- Space Explorer missions for astronomy, gravitation, climate and atmosphere studies.
- The participation in CAL/VAL activities for the development of new EO sensors.
- The development of subsystem components and processors for SatCom, Critical Space infrastructure, Microelectronics, Antennas.
- Development of the research potential through EO-based Centers of Excellence.

- The development of the Collaborative Ground Segment (CollGS) concept (e.g. the Hellenic Mirror Site), and a Federated Architecture for the GS, for the management, archiving, handling, processing and dissemination of the Big Satellite Data provided in Near Real Time through the Copernicus missions (the Sentinels) in SEE, and the wider Mediterranean (Middle East and North Africa).
- The management of regional Coordination and Support Actions for uptake of EO, GEO, GEOSS, and Copernicus in the Middle East, N. Africa, and the Balkans (e.g. GEO-CRADLE CSA project) in the areas of Climate Change, Raw Materials, Food Security, and Energy.

Greek EO monitoring infrastructure with a regional dimension

Ground segment of ESA Sentinel missions and relevant acquisition stations & computer facilities:

- **ESA Copernicus infrastructure: Collaborative Ground Segment (Mirror Site) of ESA Sentinel's missions installed at NOA**. The Mirror Site provides real time acquisitions of ESA Sentinel 1, 2 and 3, and future 5p missions, covering the geographic area of SEE, North Africa and Middle East. The Mirror site has been designed so as to link to the broad bandwidths of the GEANT network for accessing to and fast retrieval (in real time) of the image data from ESA's core ground segment, and also connect to the cloud computing facilities offered by the GRNET (the Greek partner of GEANT).
- **Satellite reception equipment: X-/L-band acquisition station at NOA**. The station provides real-time acquisitions from NASA and third party satellite missions including EOS Aqua and Terra (MODIS), NPP, JPSS, NOAA/AVHRR, MetOp, and FengYun systems.
- **ESA-EUMETSAT equipment installed at NOA, University of Patras, and Hellenic National Meteorological Service**: **MSG SEVIRI acquisition stations**. The MSG antenna provides real time acquisitions from the geostationary Meteosat satellites. ESA is a key partner in the development of the satellites required by EUMETSAT's mandatory programs, as well as in the European Copernicus Initiative.
- **Big satellite archiving and management: Computer facilities of GS at NOA**. The GS hosts and maintains the operations of high performance computer facilities/servers for physical image data handling and meta-data management and querying of 300 Tbytes,

as well as the image data processing and archiving. It hosts archiving facilities (disks, and tape libraries) for the physical storage of collected satellite data.

- **Data Centre facilities of GRNET**. GRNET operates four privately owned data centers. Each data center is tailored for different needs, and part of this equipment composition is configured for addressing the high computing performance needs of big satellite data processing and handling. The Data Center is currently equipped with 28 racks hosting servers and storage equipment. Currently in the Data Center are operative 7132 logical CPUs while 1800 TB of storage space is available.

Atmospheric ground-based remote-sensing stations, suitable for ESA calibration & validation activities operated at NOA:

- **PollyXT lidar system**: a multi-wavelength dual-depolarization lidar system operated by IAASARS since 2005. The new PollyXT station is already included in the Polly network. Moreover, IAASARS included the Finokalia station in Crete, in the EARLINET European Lidar Network.
- **Mobile lidar system EMORAL**. Since 2011, operated by IAASARS in collaboration with ESA, capable of providing aerosol extinction, backscatter and depolarization vertical distributions, as well as aerosol microphysical properties utilizing innovative inversion techniques. The system currently operates in campaign mode, participating in satellite validation activities and aerosol characterization experiments.
- **CIMEL sun-sky photometer**: operated by IAASARS since 2008, member of NASA's-AERONET global sunphotometric network. The station has been recently installed in the remote area of Finokalia (Crete), which is an ACTRIS European Infrastructure super site. The Finokalia site, is a unique area for ESA cal/val activities.

Typology, capacities and international cooperation of Greek EO actors

The business activity of selling third party satellite data and EO products/services based on it is widespread (e.g. SPOT, Ikonos, Quickbird, Worldview, GeoEye, Pleiades, etc.), amounting to a pre-crisis market to the order of tens of millions of Euros. A large portion of this business is centered on large scale national projects in the public sector to address the needs of decision and policy making, for instance: the creation of very high resolution background layers for updating large scale mapping at national level, the setting up of the Greek cadastral system, the provision of enhanced societal services in relation to civil protection (e.g. earthquake, fire, flooding, landslide vulnerability, exposure and risk mapping), the administration of natural resources and ecosystems (e.g. NATURA sites), the compilation of environmental regional studies and the administration of the rural land in compliance to the EC's Common Agriculture Policy directives. The EO data and EO service market has largely declined due to the economic crisis from 2009 onwards. This has resulted in a shrinkage of the relevant private sector.

The Greek EO service and data industry has shown a large portfolio of activities, including national, ESA, and EU projects. Its main customers at the national level have been the public bodies and local authorities. The community consists mainly of SMEs acting in the EO and GI (geo-information) domains offering niche services to public and local authorities.

- 3 organizations with access to 3rd party missions (own ground stations);
- 13 organizations with significant ground-based/in-situ monitoring networks and facilities (2097 in total), including European Research Infrastructure;
- 13 organizations with modelling and computing facilities with at least 14 models;
- 20 organizations with EO data exploitation platforms (provision of value-added services and products);
- 59 companies in total: 2 large, 11 medium, 23 small and 23 micro. Among the companies 1 is satellite operator, 11 provide value-adding services, 12 offer consultancy / studies, and 34 provide hardware / software. There are 3 resellers and 1 cluster.

The Greek EO Research sector is strong, both in regards to research institutions and academia. This is shown by involvement in EO: 35 public organizations; 21 MSc programs; 109 types of courses provided; 35 departments with 564 researchers, and 533 PhD & MSc students; and 1237 relevant papers were published between 2011 and 2016 according to SCOPUS.

The involvement of the Greek EO sector in international initiatives is high. There is a Greek GEO Office hosted at NOA. Twelve organizations participate in GEO or projects linked to GEOSS, and twelve organizations have participated in GEO specific actions. 52 organizations are involved in projects linked to Copernicus, and 84 projects use data from Copernicus.

EO excellence in Greece

For the period of time 2015-2018, NOA and the Greek company Geoapikonisis SA form part of the consortium selected to provide operational Emergency Management Services for Risk

Reduction and Preparedness all over the world, within the Copernicus Emergency Management Service. Thousands of risk & recovery maps have been produced across the continent for a large range of natural disasters, as well as industrial accidents (link for more information).

The European Center of Excellence BEYOND, operated by NOA, uses EO technology for the monitoring and management of natural disasters in SEE. The center has so far developed the FireHub, FloodHub and DisasterHub services. The FireHub is BEYOND's cluster of fire-relevant services including the Real-time Fire Monitoring System, the Diachronic Mapping of Burnt Areas over Greece, the Fire Smoke Dispersion, and the Fuel Maps. The FloodHub is BEYOND's Floods Monitoring Service where all the flood events in selected river basins are monitored, and the flood mapping results are produced following the processing of Sentinel-1 images from the Hellenic National Sentinel Data Mirror Site. The DisasterHub is BEYOND's mobile application for enabling the fusion of crowd generated data with EO-supported disaster management.

4.5.2. *Capacities*

Space-borne capacities

In Greece, the survey reached four organizations with space-borne capacities, two of which are research oriented, one institutional and one commercial (see Figure 4-248).

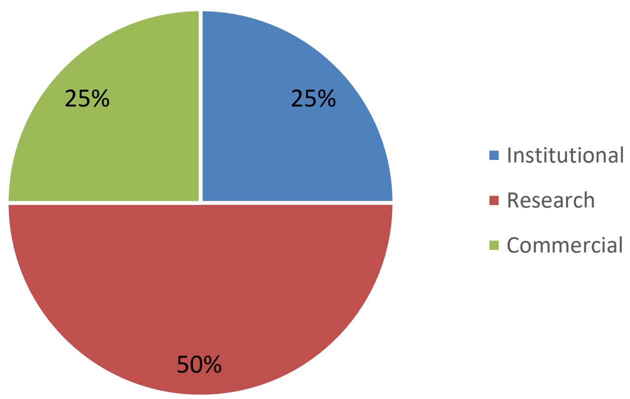


Figure 4-248. Types of organizations with space-borne capacities in Greece.

Organizations reached by the survey are active in all relevant thematic areas (see Figure 4-249).

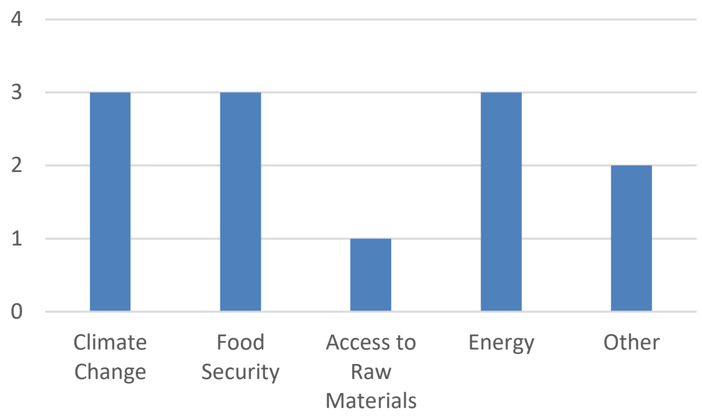


Figure 4-249. Activity of Greek organizations with space-borne capacities in GEO-CRADLE thematic areas.

As shown in Figure 4-250, most Greek organizations with space-borne capacities participated in EO related projects (75%).

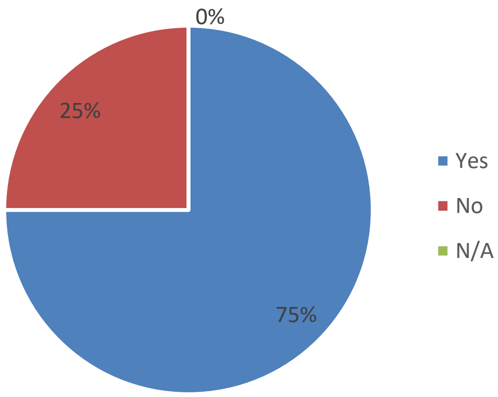


Figure 4-250. Participation of Greek organizations with space-borne capacities in EO activities.

50% of Greek organizations with space-borne capacities have participated in Copernicus service provision, Copernicus user requirements definition or Copernicus research & innovation action actions (see Figure 4-251). On the other hand, one Greek organization with space-borne capacities participated in GEO/GEOSS SBA Tasks (see Figure 4-252).

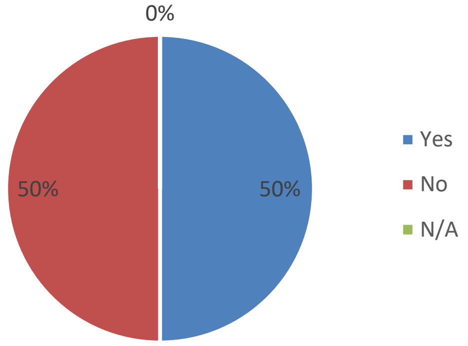


Figure 4-251. Participation of Greek organizations with space-borne capacities in a Copernicus action.

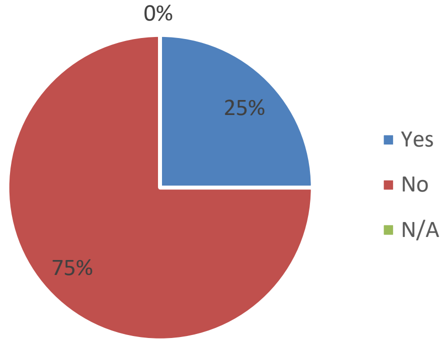


Figure 4-252. Participation of Greek organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

As shown in Figure 4-252, the level of collaboration between local EO actors was perceived as high by two organizations, low by one and none by one. Collaboration with international EO actors ranges from none (50%) to high (50%) (see Figure 4-254).

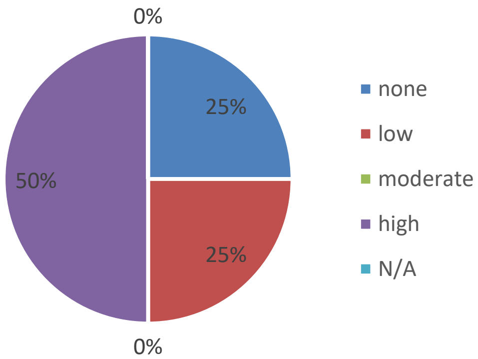


Figure 4-253. Level of cooperation of Greek organizations with space-borne capacities with local EO actors.

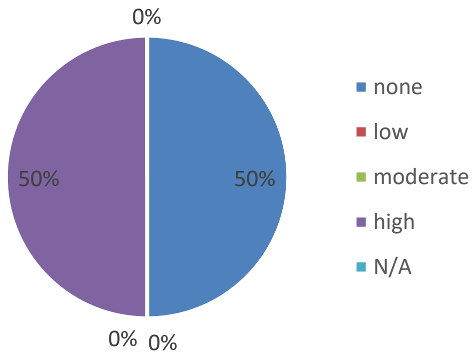


Figure 4-254. Level of cooperation of Greek organizations with space-borne capacities with EO actors abroad.

Greek organizations with space-borne capacities also have other capacities: two organizations have in-situ networks, two organizations have modelling and processing capacities and one organizations has data exploitation capacities (Figure 4-255). There is one organization with no other capacities apart from space-borne capacities. Greece does not own EO satellite missions.

As shown in Figure 4-256, there are nine satellite missions on which Greek organizations are active through their ground-segment capacities. There is one organization that claims satellite capacities, and one organization with ground segments.

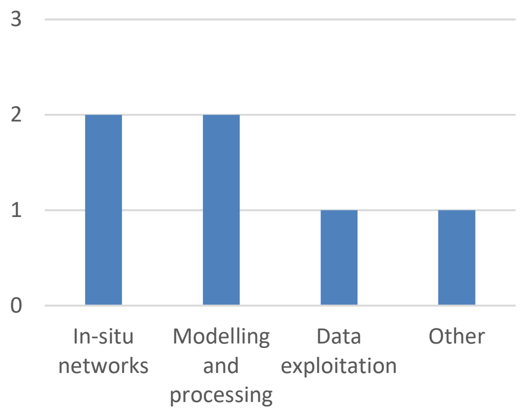


Figure 4-255. Additional EO capacities of Greek organizations with space-borne capacities.

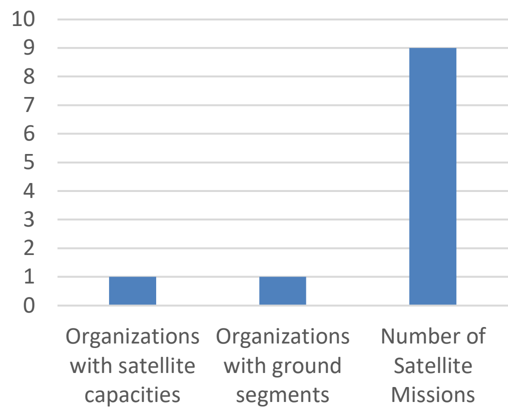


Figure 4-256. Type of space-borne capacities of Greek organizations.

Most facilities have regional coverage (see Figure 4-257). Data catalogues are usually available, shown in Figure 4-258.

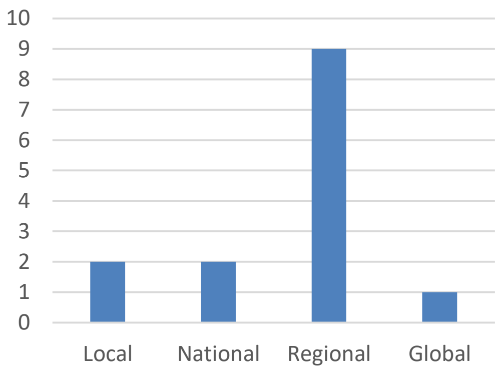


Figure 4-257. Geographic coverage of Greek satellite missions.

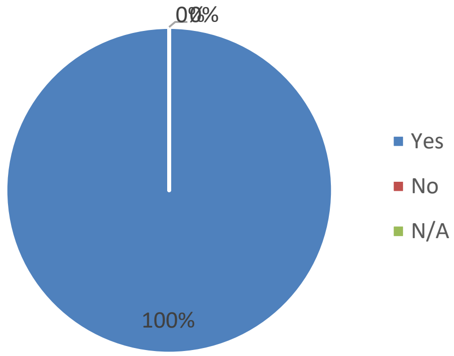


Figure 4-258. Availability of catalogues of Greek satellite missions.

Data is usually available either upon request, or from the past archives. Data can also be obtained in real time, shown in Figure 4-259. Moreover, the main data policy applied is free and open (see Figure 4-260).

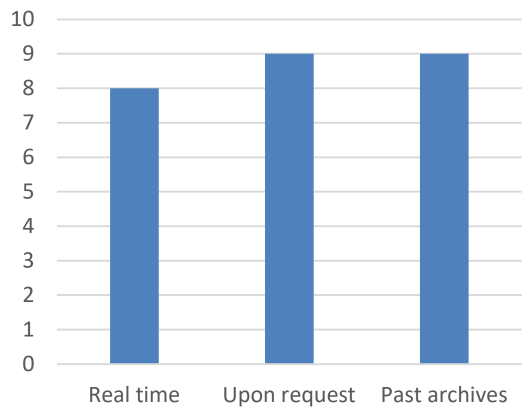


Figure 4-259. Data availability from Greek satellite missions.

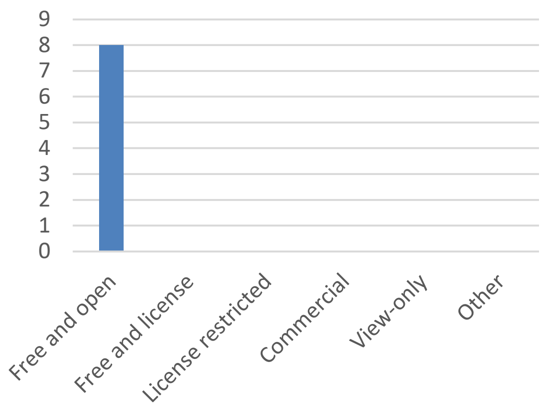


Figure 4-260. Data policy of Greek satellite missions.ata policy of Greek organizations with space-borne capacities

In-situ networks and facilities

The survey reached 19 organizations with in-situ capacities in Greece. This includes commercial, institutional and predominantly research oriented organizations (see Figure 4-261).

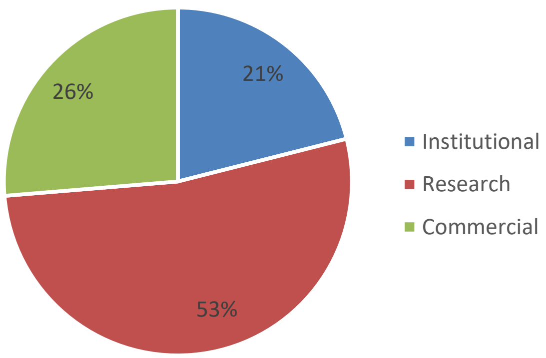


Figure 4-261. The type of organizations with in-situ networks in Greece.

As shown in Figure 4-262, the organizations are active in all the GEO-CRADLE thematic areas.

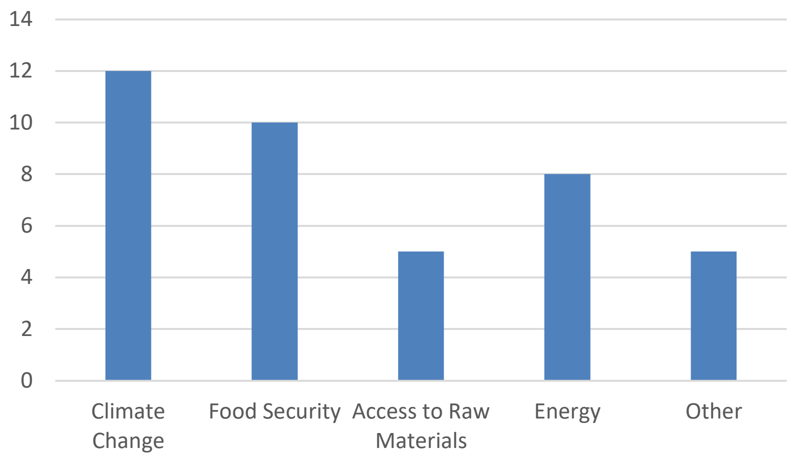


Figure 4-262. Activity of Greek organizations with in-situ networks in GEO-CRADLE thematic areas.

The survey showed that a large majority of Greek organizations with in-situ capacities take part in EO related projects (68%) (see Figure 4-263).

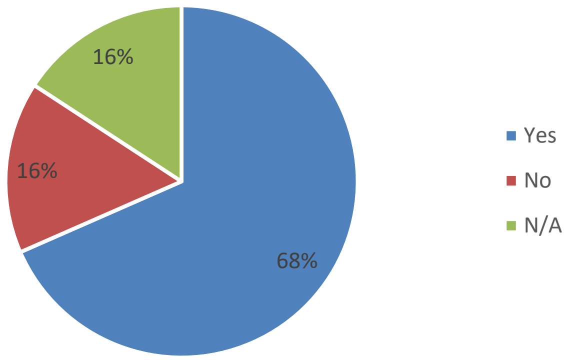


Figure 4-263. Participation of Greek organizations with in-situ networks in EO activities.

Participation in Copernicus, however, is non-existent for 42% of these organizations (see Figure 4-264). Similarly, 48% of these organization did not participate in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-265).

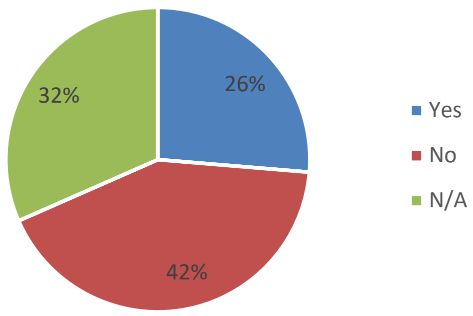


Figure 4-264. Participation of Greek organizations with in-situ networks in a Copernicus action.

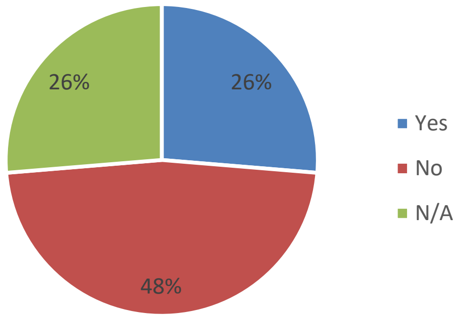


Figure 4-265. Participation of Greek organizations with in-situ networks in a GEO/GEOSS SBA task.

As shown in Figure 4-266, the collaboration between local EO players is rated as low by the majority of respondents (47%). 16% of organizations have moderate local cooperation, 16% have high and 10% have none. Similar results can be seen in Figure 4-267 for collaboration with EO actors abroad: 10% none, 47% low, 11% moderate and 21% high.

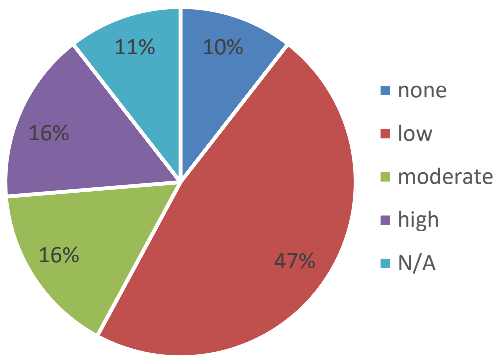


Figure 4-266. Level of cooperation of Greek organizations with in-situ networks with local EO actors.

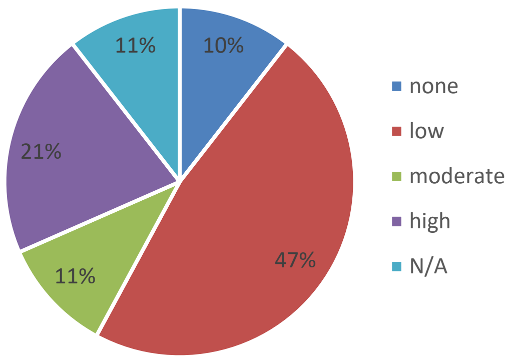


Figure 4-267. Level of cooperation of Greek organizations with in-situ networks with EO actors abroad.

Greek organizations with in-situ networks in general also have other capacities measured in the survey, particularly modelling and processing capacities as well as being active in data exploitation. Two organizations have space-borne capacities (see Figure 4-268).

Organizations have in-situ networks active in all area types covered by the survey, see Figure 4-269. Most organizations have meteorological/climate facilities, shown. Other areas of activity include national landslide inventorying, mineral and ornamental databases.

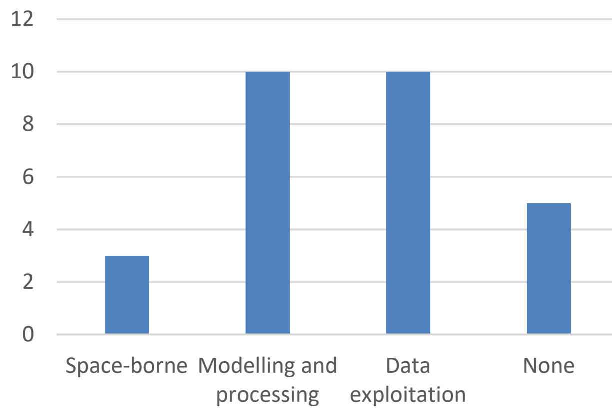


Figure 4-268 Additional EO capacities of Greek organizations with in-situ networks.

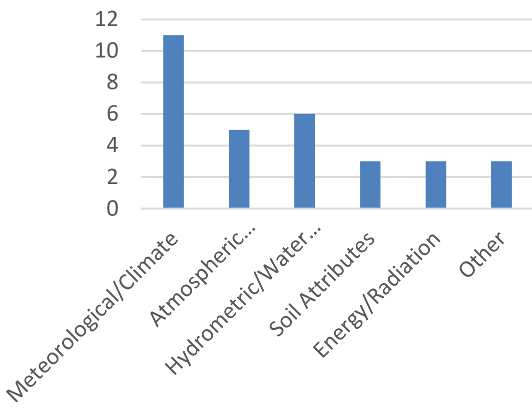


Figure 4-269. Activity area of in-situ networks of Greek organizations.

There is a large number of hydrometric/water stations (1574) and meteorological/climate facilities (697) in the country, see Figure 4-270. As far as coverage is concerned, most facilities have national coverage (see Figure 4-271).

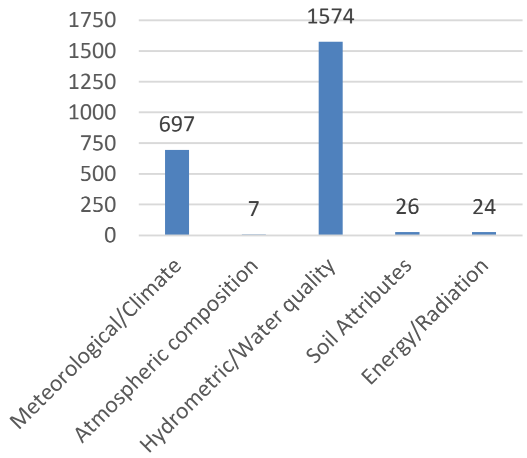


Figure 4-270. Number of stations of in-situ networks in Greece by activity area.

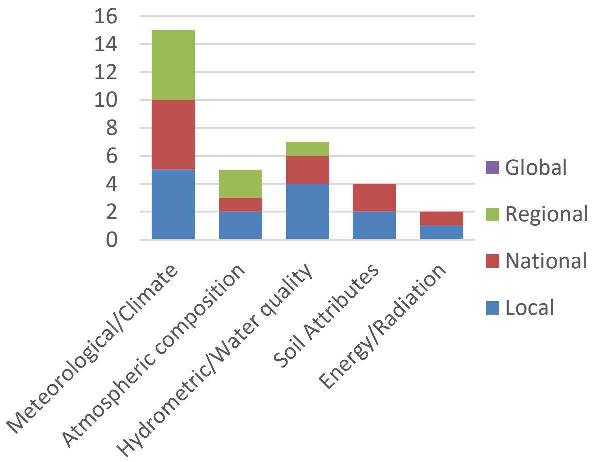


Figure 4-271. Geographic coverage of in-situ networks in Greece by activity area.

Furthermore, the survey showed that most facilities are registered in a national network, except for soil attributes (see Figure 4-272). Data is systematically collected for all types of networks/facilities (see Figure 4-273).

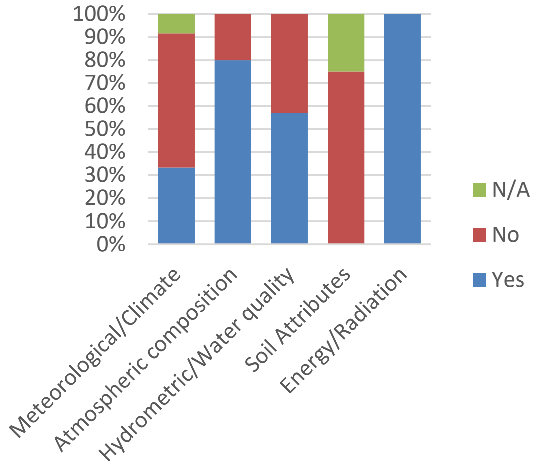


Figure 4-272. Registration of in-situ networks in Greece by activity area.

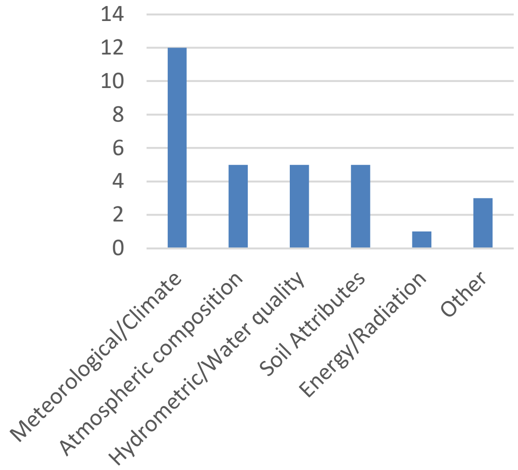


Figure 4-273. Systematic collection of data by in-situ networks in Greece by activity area.

As shown in below, METADATA is mostly available for **meteorological & climate in-situ networks** (see Figure 4-274). Temporal resolution of data acquisition is either hourly or daily. Other types of temporal resolutions are also applied (see Figure 4-275), for instance electronic rain-gauges have a resolution of 15 minutes or 20 minutes.

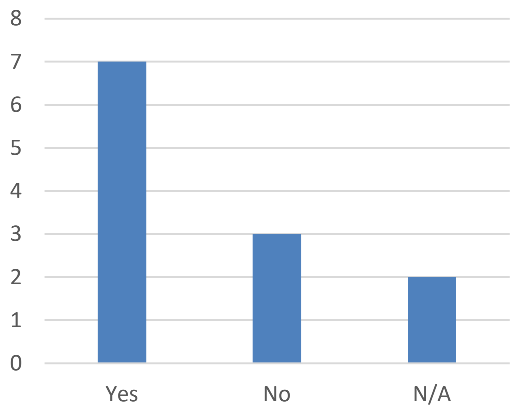


Figure 4-274. Availability of METADATA from meteorological and climate in-situ networks in Greece.

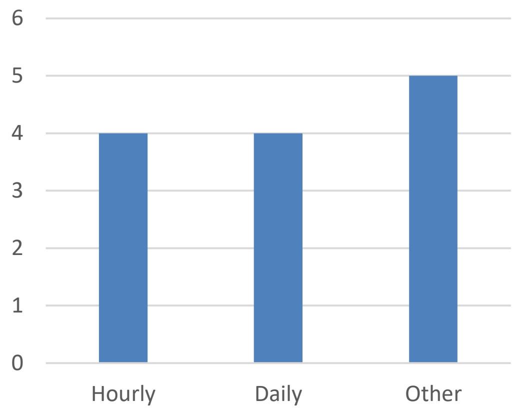


Figure 4-275. Temporal resolution of meteorological and climate in-situ networks in Greece.

Data is mostly available upon request (8 organizations); however, five networks offer it in real time, and two from the past archives (see Figure 4-276). Respondents mostly did not specify their data policy; those that did applied either free & open or free & licensed. There are also other policies applied (see Figure 4-277).

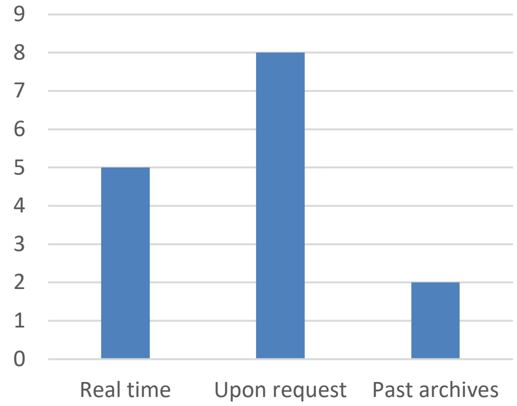


Figure 4-276. Data availability from meteorological and climate in-situ networks in Greece.

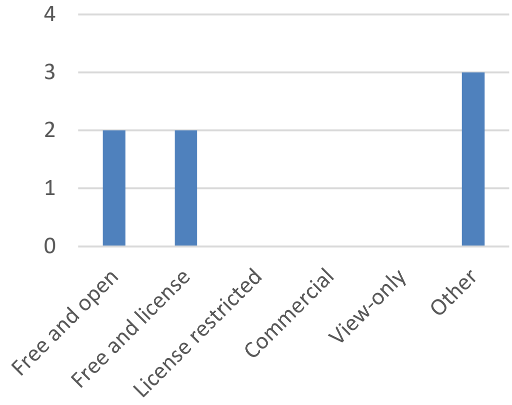


Figure 4-277. Data policy of meteorological and climate in-situ networks in Greece.

With **atmospheric composition/profiling in-situ networks**, METADATA is available for two organizations and not available for one (see Figure 4-278). Temporal resolution of the networks was hourly for one network, daily for two and other for three networks (see Figure 4-279). Other temporal resolution ranges from 1 to 5 minutes to daily.

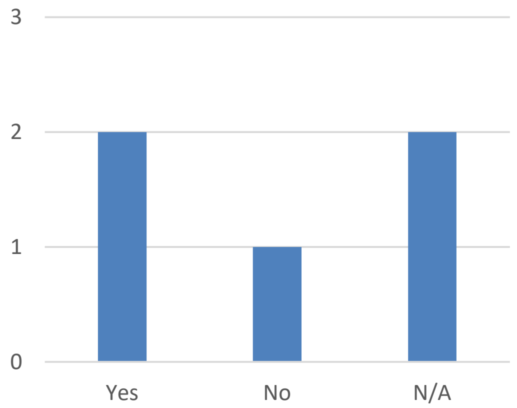


Figure 4-278 Availability of METADATA from atmospheric composition and profiling in-situ networks in Greece.

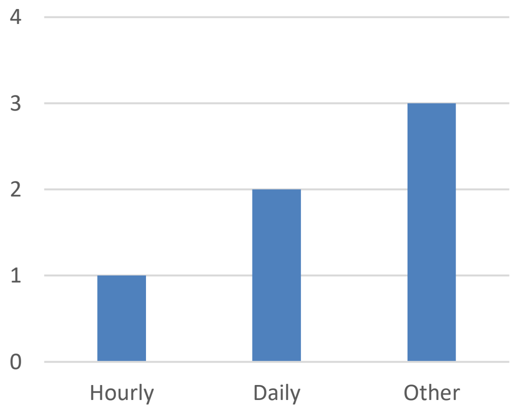


Figure 4-279. Temporal resolution of atmospheric composition and profiling in-situ networks in Greece.

As seen in Figure 4-280, data is available upon request for most of the networks, with one offering data in real time. The data policy applied for three of the networks is free and license restricted, free and open for one network and two others have other policies applied (see Figure 4-281).

Figure 4-280. Data availability from atmospheric composition and profiling in-situ networks in Greece.

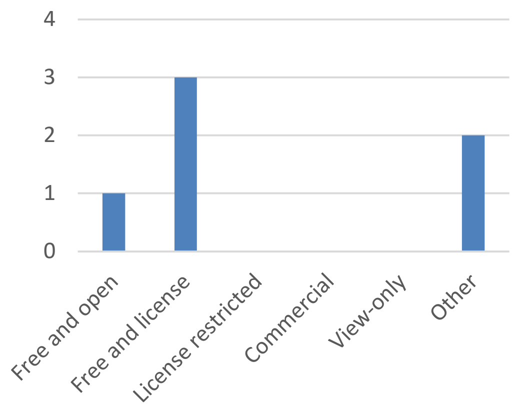


Figure 4-281. Data policy of atmospheric composition and profiling in-situ networks in Greece.

METADATA is mostly available for **hydrometric and water quality in-situ networks** (see Figure 4-282). Temporal resolution of the networks is evenly split between hourly and daily, with two networks having other resolution (see Figure 4-283), for instance water level data have a resolution of 15 to 20 minutes.

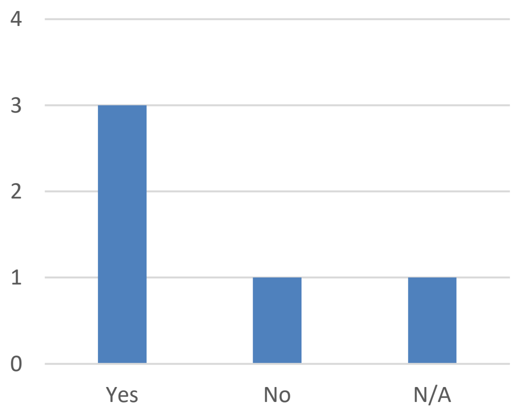


Figure 4-282. Availability of METADATA from hydrometric and water quality in-situ networks in Greece.

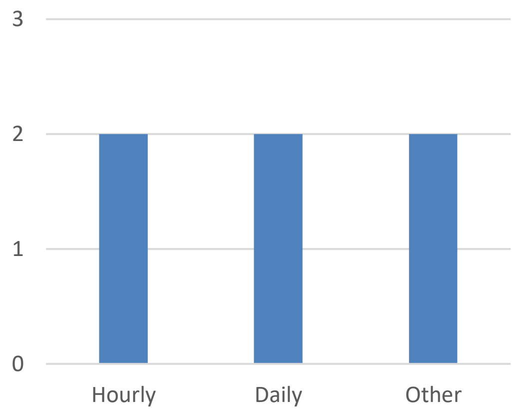


Figure 4-283. Temporal resolution of hydrometric and water quality in-situ networks in Greece.

Data is available in real-time for three networks and upon request for five networks; access to past archives is available for two organizations, shown in Figure 4-284. Respondents generally did not specify their data policy, one organization has a free and open policy (see Figure 4-285).

Figure 4-284. Data availability from hydrometric and water quality in-situ networks in Greece.

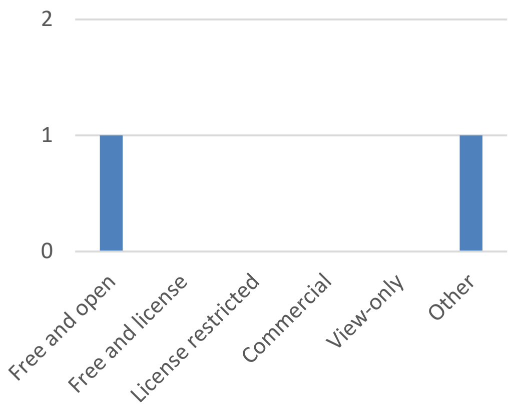


Figure 4-285. Data policy of hydrometric and water quality in-situ networks in Greece.

Soil attribute in-situ networks in Greece mostly do not have METADATA available: three respondents do not while one does (see Figure 4-286). Of the five organizations, three have an hourly temporal resolution, one has a daily temporal resolution and one has a monthly resolution, as shown in Figure 4-287.

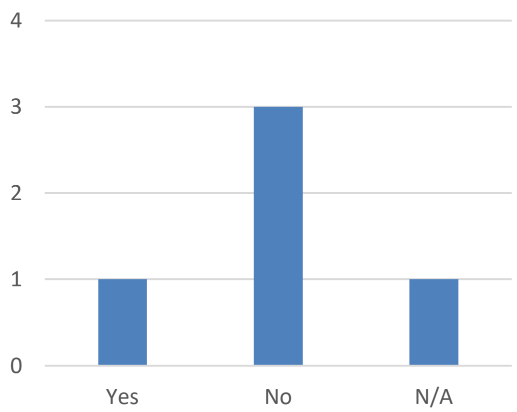


Figure 4-286. Availability of METADATA from soil attributes/spectra in-situ networks in Greece.

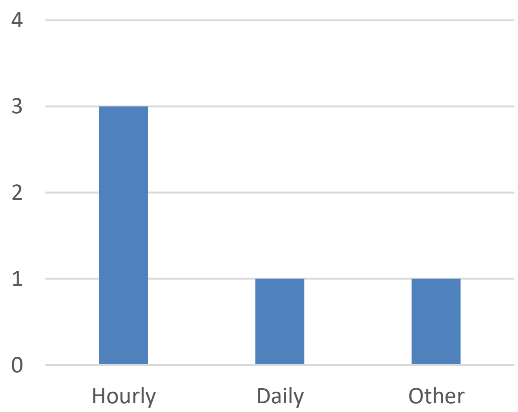


Figure 4-287. Temporal resolution of soil attributes/spectra in-situ networks in Greece.

Data availability and data policy were mostly not specified. One respondent has data available from past archives (see Figure 4-288). One respondent each has the following data policies: free and open, license restricted and other data policy (see Figure 4-289).

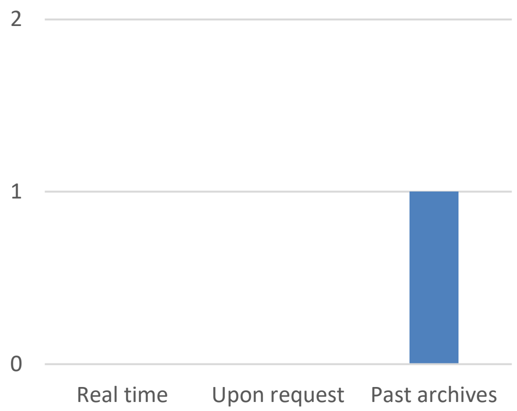


Figure 4-288. Data availability from soil attributes/spectra in-situ networks in Greece.

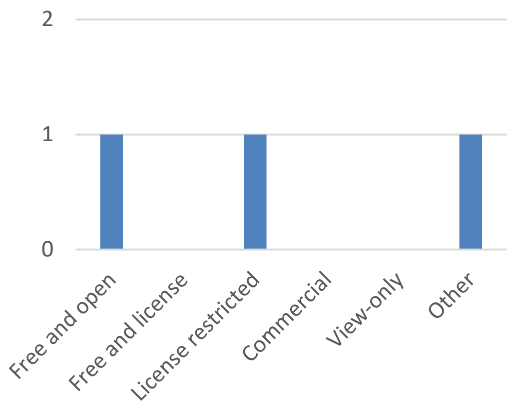


Figure 4-289. Data policy soil attributes/spectra in-situ networks in Greece.

Two **energy and radiation in-situ networks** were reached by the survey in Greece. No details were provided on the availability of METADATA (Figure 4-290). Temporal resolution was specified by one respondent as other (see Figure 4-291). This other type of temporal resolution is actually one minute. Data is available upon request from one network and from past archives for the other, shown in Figure 4-292. One organization stated that their data policy was other (see Figure 4-293).

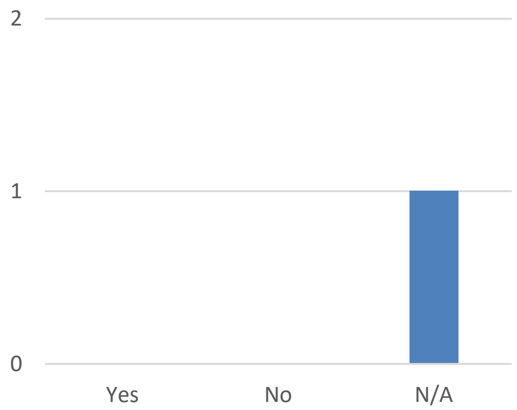


Figure 4-290. Availability of METADATA from energy/radiation in-situ networks in Greece.

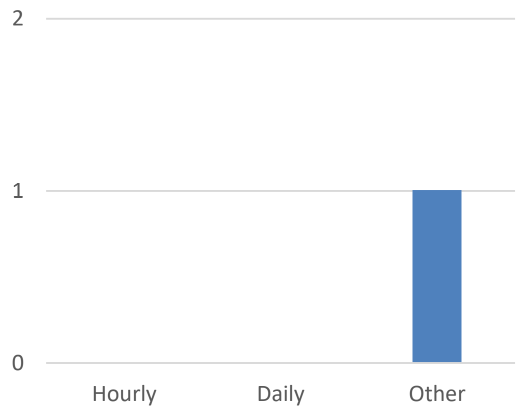


Figure 4-291. Temporal resolution of energy/radiation in-situ networks in Greece.

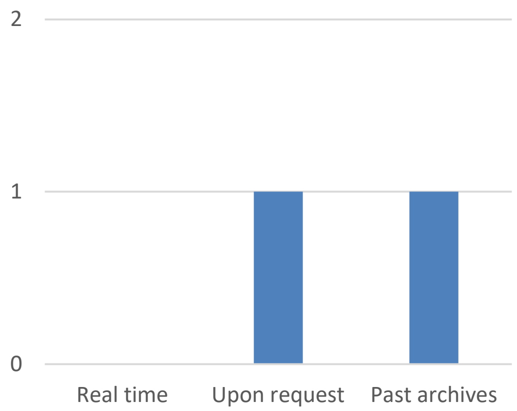


Figure 4-292. Data availability from energy/radiation in-situ networks in Greece.

Figure 4-293. Data policy of energy/radiation in-situ networks in Greece.

Modelling and processing capacities

The survey reached 13 organizations in Greece with modelling and processing capacities, most of which are research oriented (see Figure 4-294). As shown in Figure 4-295, these organizations cover all the thematic areas of GEO-CRADLE.

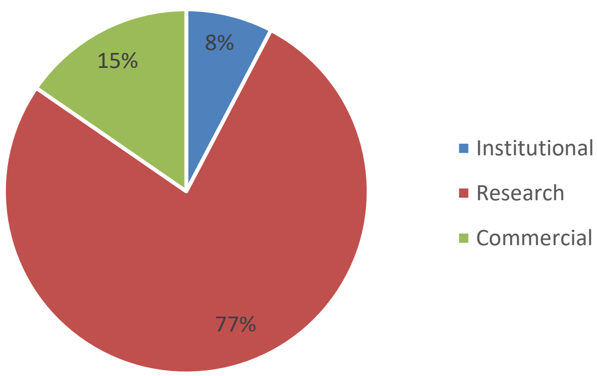


Figure 4-294. The type of organizations with modelling and processing capacities in Greece.

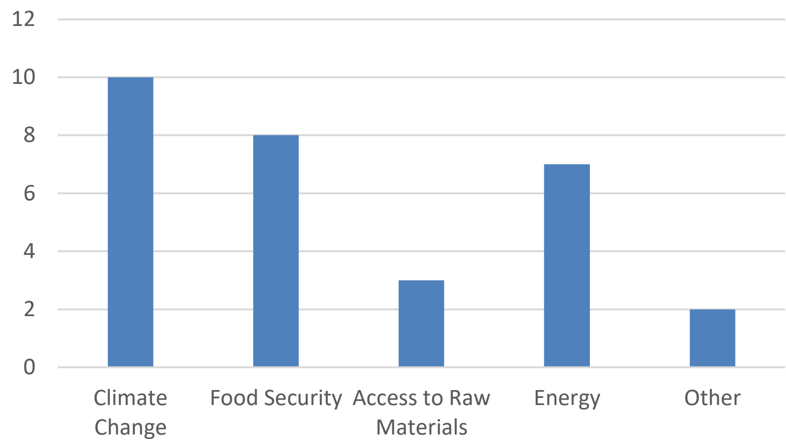


Figure 4-295. Activity of Greek organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

62% of organizations with modelling capacities that responded to the survey have taken part in EO related projects (see Figure 4-296).

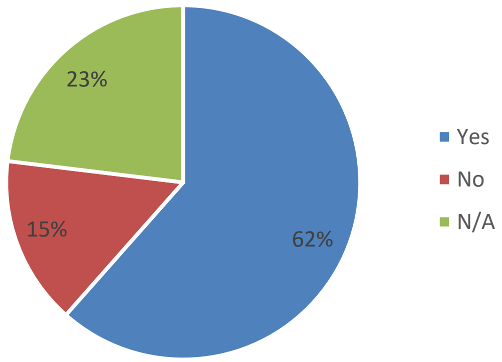


Figure 4-296. Participation of Greek organizations with modelling and processing capacities in EO activities.

31% of organizations participated in Copernicus service provision, Copernicus user requirements definition, or Copernicus research and services (see Figure 4-297). Similarly, 23% participated in GEO/GEOSS SBA Tasks, community activities or initiatives is non-existent (see Figure 4-298).

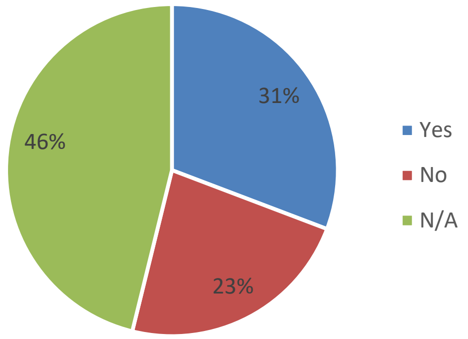


Figure 4-297. Participation of Greek organizations with modelling and processing capacities in a Copernicus action.

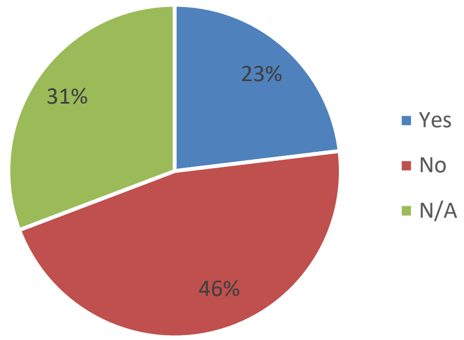


Figure 4-298. Participation of Greek organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

Respondents show a varied experience regarding cooperation with EO actors. 23% have high local cooperation and 31% have high international cooperation, 8% have moderate local cooperation and 15% have moderate international cooperation, 31% have low local cooperation and 15% have low international cooperation, while 15% have no local cooperation and 16% have no international cooperation (see Figure 4-299 and Figure 4-300).

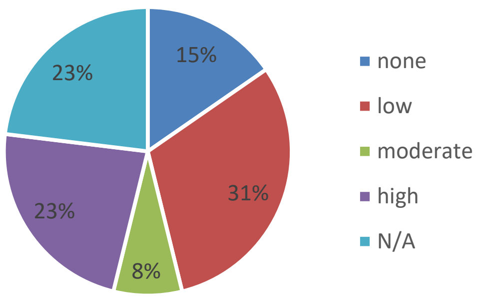


Figure 4-299. Level of cooperation of Greek organizations with modelling and processing capacities with local EO actors.

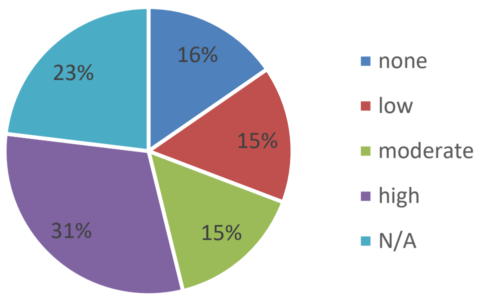


Figure 4-300. Level of cooperation of Greek organizations with modelling and processing capacities with EO actors abroad.

Besides modelling and processing capacities, these organizations have other capacities: space-borne, in-situ networks and/or data exploitation (see Figure 4-301).

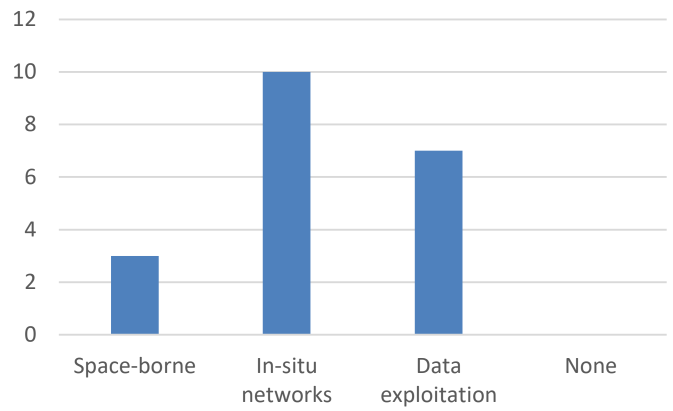


Figure 4-301. Additional EO capacities of Greek organizations with modelling and processing capacities.

Most models are in the area of meteorology and climate, although several models are available in all the other areas: atmospheric composition, hydrometric, soil attributes, and energy/radiation, shown in Figure 4-302. Various sources of EO data are used, mostly geospatial data and/or in-situ data, shown in Figure 4-303.

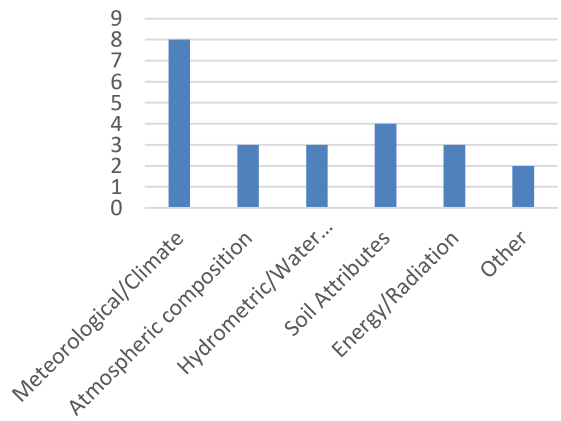


Figure 4-302. Algorithms and models available in Greece by activity area.

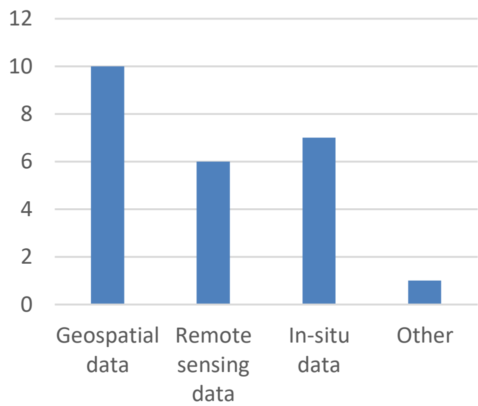


Figure 4-303. Sources of EO data used by organizations with modelling and processing capacities in Greece.

As shown in Figure 4-304, most models have a national or local coverage, but there are models with a regional and global coverage. The survey also shows that METADATA is available for five models, not available for one, and not specified for seven (see Figure 4-305).

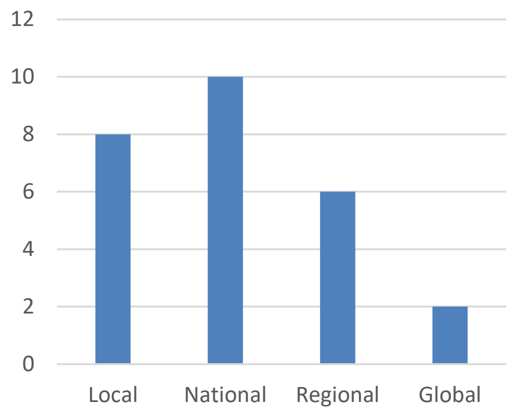


Figure 4-304. Geographic coverage of models and algorithms in Greece.

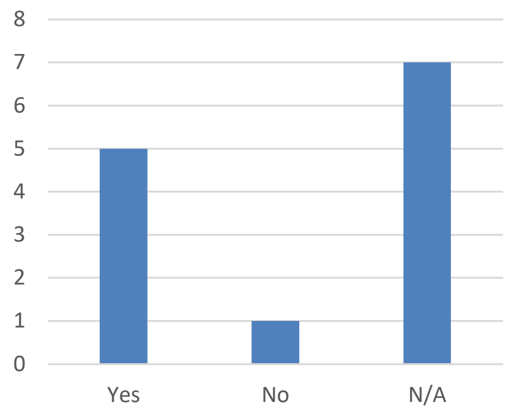


Figure 4-305. Availability of METADATA for models and algorithms in Greece.

Greek organizations with modelling and processing capacities reached by the survey mostly have processing power capacities. In addition, 4 organizations with server clusters were identified (See Figure). The survey reached 1 organization with HPC cluster and one organization with cloud infrastructure. Additionally, the survey reached virtualization infrastructure. Other capacities include Hyper V \nV-Sphere, and computers with either 4 GB RAM or at least 2 with 8GB RAM.

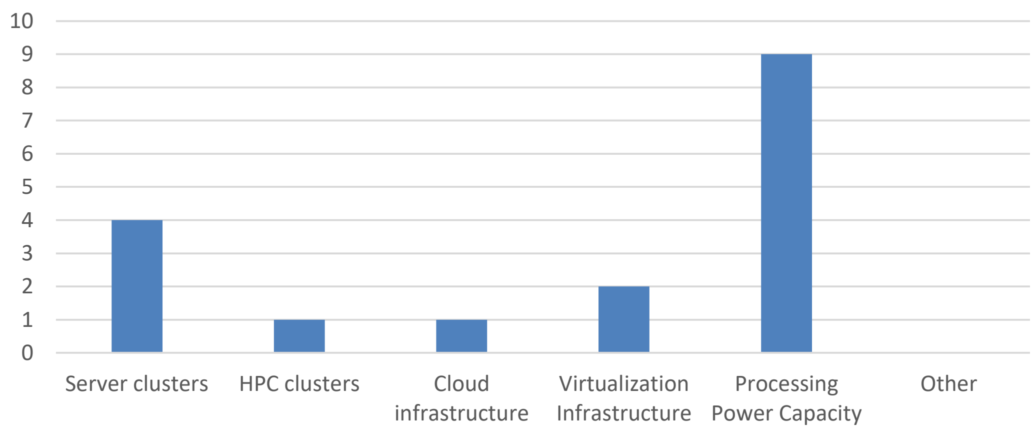


Figure 4-306. Computing resources available for processing and exploitation of EO data in Greece.

Data exploitation

In Greece, the survey reached 10 organizations with data exploitation capacities. The majority are commercial (41%), followed by research-focused (35%) and institutional (24%), as seen in Figure 4-307.

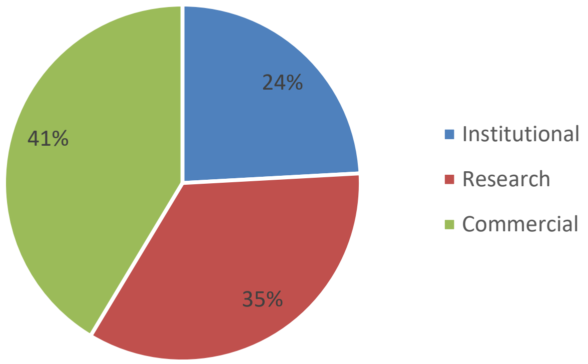


Figure 4-307. The type of organizations active in data exploitation in Greece.

Organizations that the survey reached are active in all the GEO-CRADLE thematic areas, particularly in food security and climate change (see Figure 4-308).

Other areas include geohazards, quality control of ornamental stone, soil/water pollution of soils, mine waste, consulting services in agriculture, protection and management of national parks, monitoring of endangered species of fauna, national spatial data storage and processing, cadaster and land administration, transportation, urban and regional planning.

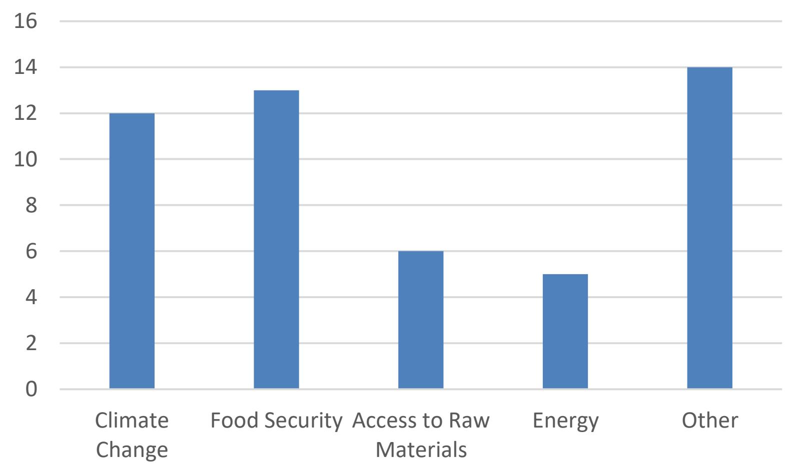


Figure 4-308. Activity of Greek organizations active in data exploitation in GEO-CRADLE thematic areas.

Most Greek organizations with data exploitation capacities have participated in EO activities: 62% compared to 31% that have not (see Figure 4-309).

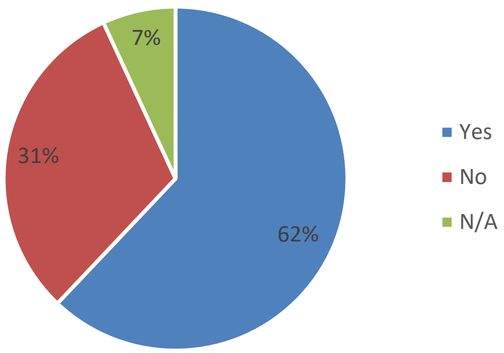


Figure 4-309. Participation of Greek organizations active in data exploitation in EO activities.

Most organizations (69%) have participated in Copernicus service provision, Copernicus user requirements definition or Copernicus research and innovation action, shown in Figure 4-310. In contrast, 10% have participated in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-311).

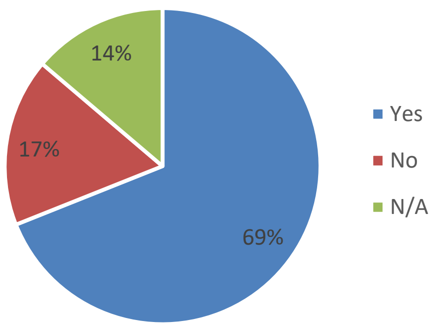


Figure 4-310. Participation of Greek organizations active in data exploitation in a Copernicus action.

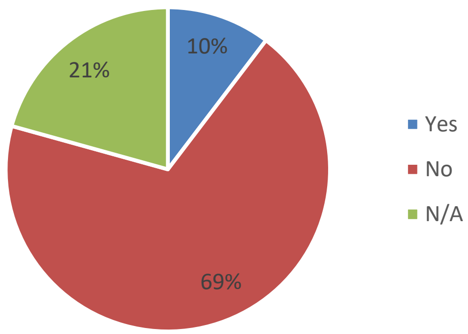


Figure 4-311. Participation of Greek organizations active in data exploitation in a GEO/GEOSS SBA task.

The level of collaboration between local EO actors is perceived as low by 55% of respondents (see Figure 4-312). 17% said they had no local cooperation, while 10% had moderate and 14% had high. Similarly, the level of collaboration with actors outside Greece differs between organizations: high (10%), moderate (14%), low (31%) and none (41%) (see Figure 4-313).

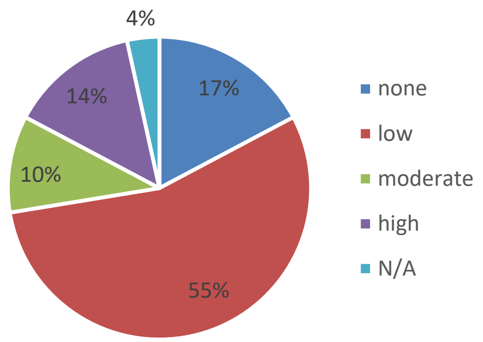


Figure 4-312. Level of cooperation of Greek organizations active in data exploitation with local EO actors.

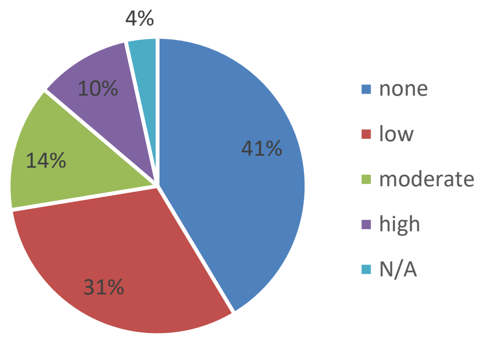


Figure 4-313. Level of cooperation of Greek organizations active in data exploitation with EO actors abroad.

Survey results show that Greek organizations with data exploitation capacities all also have other EO capacities, shown in Figure 4-314.

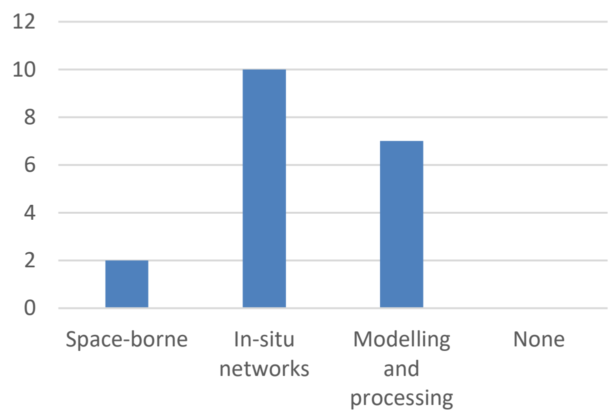


Figure 4-314. Additional EO capacities of Greek organizations active in data exploitation.

The organizations with data exploitation capacities in Greece are active in almost every product thematic area, particularly in agriculture, ecosystems, land-use/coverage and floods. As shown in Figure 4-315, there are no organizations with products/services in the following areas: metocean, air quality and snow & ice.

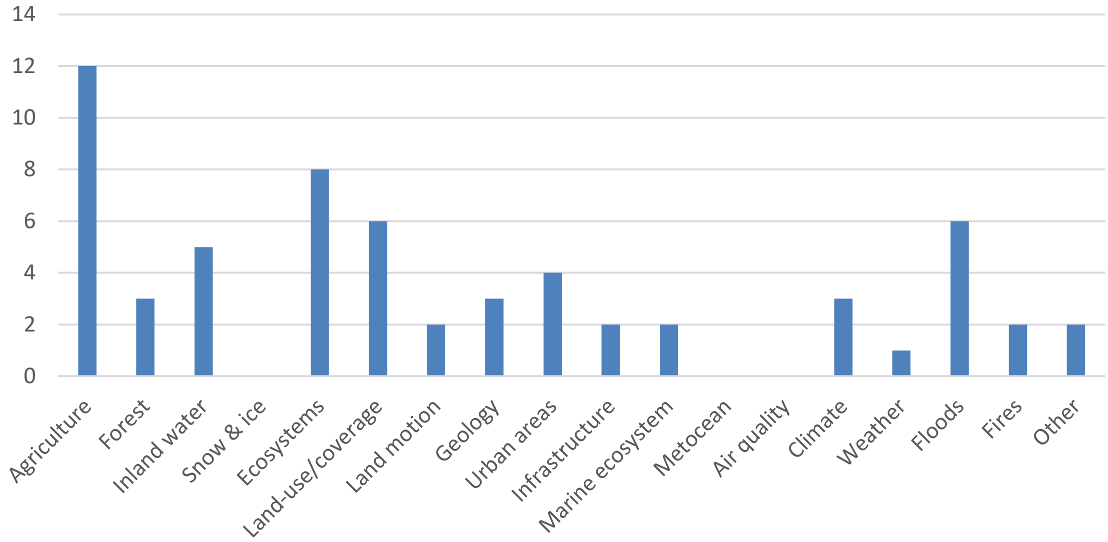


Figure 4-315. Activity areas of EO products/services of Greek organizations.

National activities

Most respondents did not answer if funding for EO is not available in Greece (see Figure 4-316): 24% said yes and 20% said no. Funding is mostly available for R&D (44%) and infrastructure development (44%), shown in Figure 4-317.

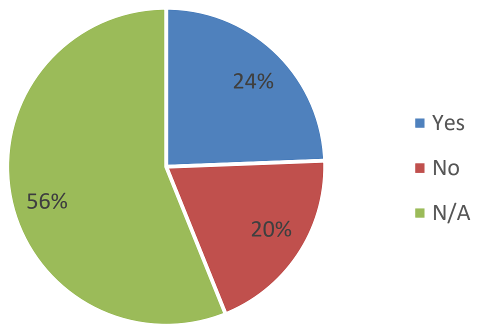


Figure 4-316. Greek EO actors' perception of the availability of national funding for EO.

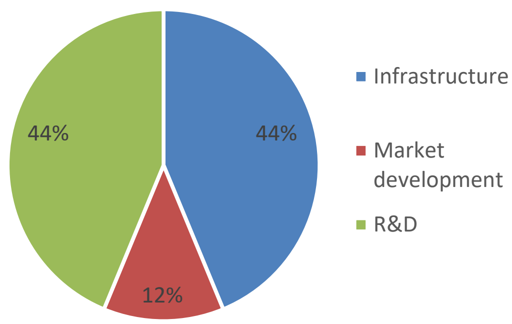


Figure 4-317. Greek EO actors' perception of areas for which national EO funding is available.

As shown in Figure 4-318, 17% of respondents are aware of a space strategy in Greece; 20% said that there one does not exist and 63% did not specify. 60% of respondents are not aware of a space program in Greece compared to 40% that are (see Figure 4-319).

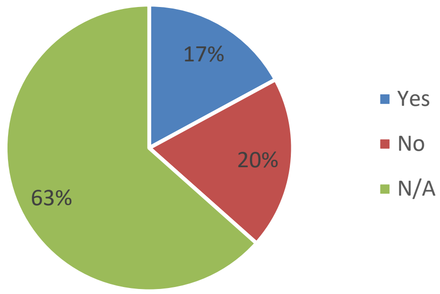


Figure 4-318. Greek EO actors' awareness of a space strategy in Greece.

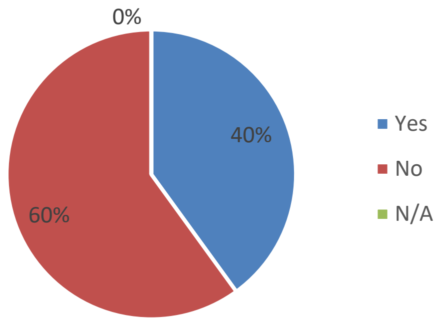


Figure 4-319. Greek EO actors' awareness of a space program in Greece.

The level of coordination of local EO activities is perceived at different levels, shown in Figure 4-320: no respondents perceive that it is fully integrated; 27% state coordination is basic; 29% that it is scarce; and 7% state that there is no coordination. Interaction with decision makers is also seen as scarce by 37% of respondents (see Figure 4-321); however, 24% of respondents state that this interaction exists in specific thematic areas.

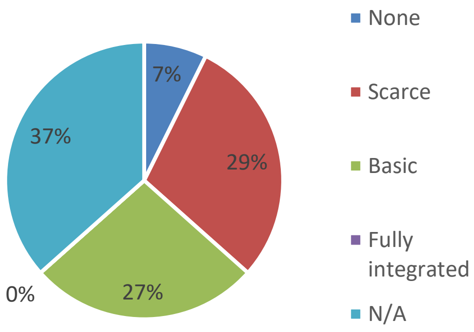


Figure 4-320. Greek EO actors' perception of national coordination of EO activities in Greece.

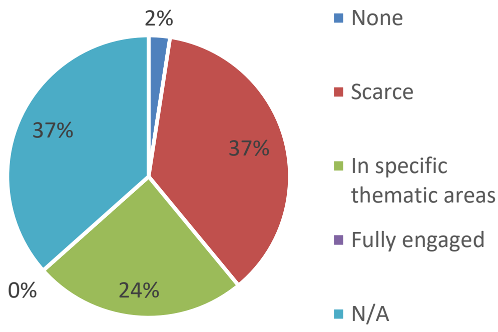


Figure 4-321. Greek EO actors' perception of interaction with decision makers in Greece.

Two-thirds of the surveyed organizations would contribute with their capacities to a regional initiative of GEO/Copernicus. Another significant percentage of respondents (32%) would contribute under specific circumstances. Only 2% would not contribute. See Figure 4-322.

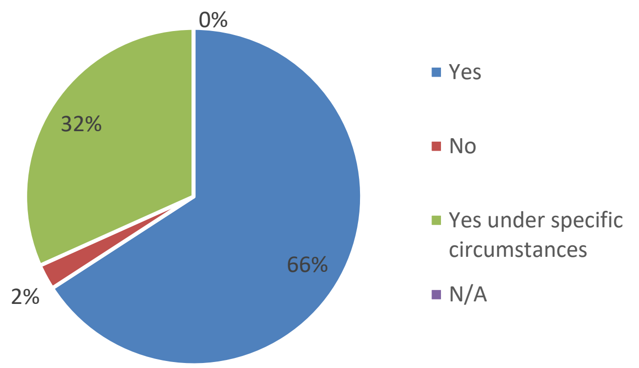


Figure 4-322. Greek EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

In Greece, surveyed end-users are all aware of Copernicus. Awareness of GEO is also high (75%). (Figure 4-323 and Figure 4-324).

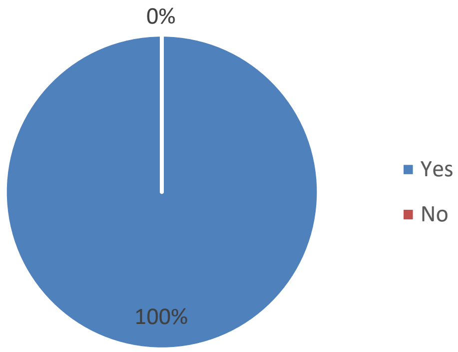


Figure 4-323. End-user awareness of Copernicus in Greece.

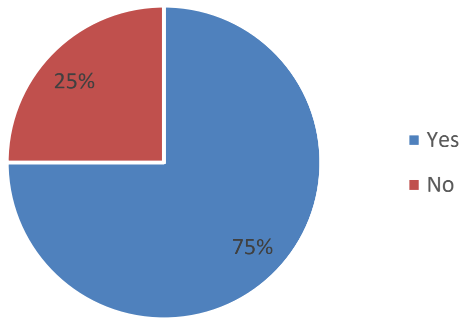


Figure 4-324. End-user awareness of GEO in Greece.

4.5.3. *Gap analysis*

No **geographic** gaps were identified.

An **observational** gap was identified by end-users in the need for denser in-situ network coverage for highly localized data. One end-user specified this need for meteorological and atmospheric composition data, which would be of great interest to local authorities and citizens. Similarly, one power transmission end-user found that radiation measurements have not kept up with the uptake of solar panel technology, and that the organization lacked the ability to predict energy generation. The need for better radiation data was echoed by another company.

Several **structural** gaps were found. No national archive exists to bring together municipal and regional data, causing structural barriers when this data is needed. There is a lack of knowledge regarding which data is available overall as there is no organization of this information on the national level, and a lag in delivery was also sometimes noted. One end-user claimed that bureaucratic limitations exist, although they do not expand on it. In addition, one end-user states that there is a need for regionally available data for its purposes:

> *There is a specific regional need for EO data concerning air pollution and climate including aerosols, characterization of natural and anthropogenic aerosols, dust aerosols, biomass burning aerosols, and short-lived greenhouse gases and pollutants (e.g. O_3). Since modelling activities are useful for future planning it is also essential a stronger interplay and exploitation of EO data for optimizing modelling activities in order to get better final products.*

Several **quality/quantity** gaps were pinpointed. Freely available data is of a low quality with commercial licenses offering better quality; public end-users facing the economic crisis have limited budgets to acquire the higher quality data that they require. Similarly, tight budgets present a barrier to acquire satellite imagery. Several end-users state that the reliability of the data they receive is an issue. One user claimed that some data they receive is non-INSPIRE compliant.

Capacity gaps in the public sector were largely attributed to the negative consequences of fiscal consolidation in Greece on public sector budget. There is a lack of staff cited to complete the breadth of tasks in EO activities, and a lack of EO specific expertise. The resulting situation diminishes performance and lowers ability to develop value-added services/products to support decision-driven management systems.

There are also **capacity** gaps outside the public sector. Difficulty in hiring permanent staff was also cited outside public institutions, and in fact only a small minority of end-users did not claim this to be a problem. Public companies are also required to follow austerity measures undertaken by the state and had a notable deficit in available expertise and the inability to acquire new equipment, as well as the quality and quantity of data they require.

An additional limiting factor identified was the lack of liquidity due to public sector austerity, which results in cash flow problems for private companies that sell services to them. Other financial restrictions that burden entrepreneurship (including in EO sector) include capital controls, recent changes to the value-added tax regime, etc. One end-user cited that European projects and other financing is harder to secure due to a fall in reputation of Greek organizations resulting from the economic crisis.

One of the end-users interviewed in Greece was a farmer group. They described the lack of a coherent long-term strategy as a major barrier to developing EO in the agricultural sector. The results are short-term initiatives whose impact is short-lived beyond project lifetime, and thus do not contribute to accumulation of EO capacity. Another end-user suggested that the commercial market can be developed through a centralized dissemination effort to establish a transparent and user-friendly interface with key contact points for different market sectors.

Greece's EO activity faces large challenges as fallout from the severe ongoing economic crisis and fiscal consolidation. This represents a threat to the continued development of the EO sector, particularly as new data needs arise – e.g. better radiation coverage data for solar power generation models and algae cultivation.

However, Greece has an established EO capacity from long-term investment and development activities as evidenced by specific and advanced user needs. Gaps are specific, e.g. O_3 measurement, or largely relate to human resources or economic conditions which impact EO activities in all thematic areas. Hydro-meteorological capacities are advanced and support EO activities in climate change and food security. There are no specific gaps identified for access to raw materials from collected data. Data provision for energy/radiation has insufficiently kept up with end-user needs which reflect private-sector activity not dependent entirely on the public sector.

4.6. *Israel*

4.6.1. *Overview*

Israel has advanced EO capacities both in the public and private sector. The Israel Space Agency (ISA) is responsible for the coordination and supervision of all activities of the civilian space program; it is sponsored by the Ministry of Science, Technology and Space. ISA is founded on recognition of the importance of research and development; it supports scientific research and development with real economic potential, such as the development of unique and innovative technologies. Moreover, the Agency's philosophy is that involvement in the space sector contributes to Israel's economy, strengthens its international standing and benefits its residents in areas such as agriculture, communications, detection of environmental contaminants and research.

The Agency's goals are many and diverse. They include expanding cooperation and developing reciprocal relationships with various countries in the field of space, promoting infrastructure research studies in academia and at research institutes, leading the world trend of miniaturizing satellites, supporting the development of unique innovative space technologies in aerospace industries, cultivating a reserve of future space scientists by promoting space education and projects in the community, and generally expanding Israel's relative advantage in the field to position it as one of the world's leading countries in the study and use of space technology.

Another goal of ISA is to strengthen the connection between youth and the space sector, to satisfy their great natural curiosity in regards to the field and to expand their knowledge and interest in space. The Agency organizes activities and events that offer interactive experiences in the space-related fields for the public at large: e.g. each year there are celestial observations of distant worlds, which are a source of inspiration. ISA organizes national contests for students, supports technological projects such as the launch of the Duchifat-1 miniature satellite, etc. In addition, conferences and seminars for educators and developers are held as well as training programs for teachers and instructors in cooperation with the Ministry of Education and the Israel Astronomy Society.

Israel has a long standing heritage of success in space; this includes achievements in technological development and applications, as well as a durable track-record of producing competitive products for the space industry. The Space Program was established in the 1980s, at which time, Israel was the eighth country in the world to succeed in launching and positioning satellites in space. Its main goal was and still remains to establish a comprehensive infrastructure for space study. Israel has had to face security issues and a shortage of resources; and consequently, it has focused on miniaturizing technology and developing small, light satellites with high resolution remote sensing and communication capabilities. Israel is currently considered a world leader in this industry niche (both development and methods for launching): a number of Israeli groups are currently developing microsatellites and nano-satellites in order to demonstrate how various technologies and applications work, and in order to examine and validate them. Israel's space industry is primarily engaged in the development, production and operation of satellites, the sale of communication services and remote sensing.

Israel's space industry focuses on high resolution photographic satellites that are positioned in the Low Earth Orbit (LEO) and communication satellites positioned in the Geocentric Orbit (GEO). Despite a relatively modest budget, the achievements of ISA since 1988 are the most impressive of all the advanced technology industries in the country. Israel's imaging satellites are considered the leaders in the global arena in terms of cost-effectiveness and high performance in relation to low weight. Among Israel's satellites in space are: the Amos - a series of 5 communication satellites, Ofek - 10 satellites for intelligence gathering, Eros - 2 photography satellites, the Techsat - 2 research satellites and 4 universities/student's satellites, 2 probes and launching capacity (Shavit).

Shavit, which translates from Hebrew as *comet*, is a space launch vehicle produced by Israel to launch small satellites into low Earth orbit. It was first launched on September 19, 1988 (carrying an Ofek satellite payload). Shavit rockets are launched from the Palmachim airbase by ISA into highly retrograde orbits over the Mediterranean Sea to prevent debris coming down in populated areas and also to avoid flying over nations to the east; this results in a lower payload-to-orbit than east-directed launches would allow.

ISA has signed cooperation agreements with the space agencies of the United States (NASA), France (CNES), Canada (CSA), India (ISRO), Germany (DLR), Ukraine (NSAU), Russia (RKA), Netherlands (NIVR) and Brazil (AEB).

On-going space-borne development

ISA is currently involved in the development of multiple satellites, space telescopes, and microsatellites:

- *VENµS*: Vegetation and Environment monitoring on a New Micro-Satellite will be used for EO. It is equipped with a superspectral sensor dedicated to vegetation monitoring.

It is the first cooperation between Israel (ISA) and France (CNES) and is set to launch in mid-2017.

- *OPsat*: is a next generation high resolution optical observation satellite for reconnaissance purposes. It is designed to be a 300 kg satellite capable of detecting objects of about 50 cm in diameter. It will be equipped with a camera with CCD/TDI sensors, producing both panchromatic imagery at a very high resolution and multispectral imagery at a medium resolution. The satellite is set to orbit in a sun-synchronous orbit. It is expected to have a lifespan of roughly 10 years.
- *LIMSAT-UV*: is a wide field transient explorer satellite mission and is planned to have eight telescopes equipped with CCD cameras and reflective filters. It is planned to be developed in just 3–4 years and at a cost of a few tens of millions of dollars instead of a few hundreds of millions.
- *INSAT-1* and *INSAT-2*: two nano-satellites currently being planned and developed by the Israeli Nano Satellite Association. Their purpose is to test new industrial components under real outer-space conditions before being installed on satellites costing tens and hundreds of millions of dollars.
- *SHALOM Project*: It is a joint project with the Italian Space Agency (ASI) announced in November 2010. The project involves the design and development of two hyperspectral Earth observation satellites.
- *SAMSON*: It is a project initiated by the Technion's Asher Space Research Institute which consists of three nano-satellites in formation flying to demonstrate high precision geo-location of civilian signals from the ground for rescue purposes. SAMSON is planned to implement and demonstrate Technion-developed formation-flying algorithms using the nano-satellite's propulsion system. This is a student project with technical help from multiple partners in the industry such as RAFAEL.

Subsequently, there is a number of private companies with air-borne capacities such as Ofek, Lavi, Trig-geo, Sadot, Dagan, and Eagle. Their main purpose is to supply aerial photography, photogrammetry, Lidar or any other spatial data for their customers.

4.6.2. *Capacities*

Space-borne capacities

Of the three organizations in Israel with space-borne capacities reached by this survey, two are research organizations, and one is commercial (Figure 4-325). The organizations are active in the food security and climate (Figure 4-326). One organization specified that beyond the GEO-CRADLE thematic areas, it conducts consulting for governmental institutions like the Ministry of Science, Technology and Space and the Ministry of Foreign Affairs in the field of international collaborations on a bilateral basis and with international organizations.

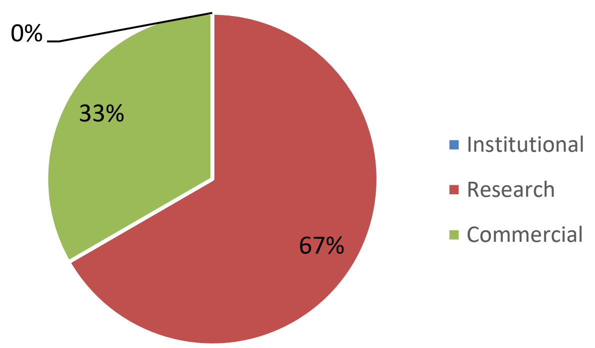


Figure 4-325. Types of organizations with space-borne capacities in Israel.

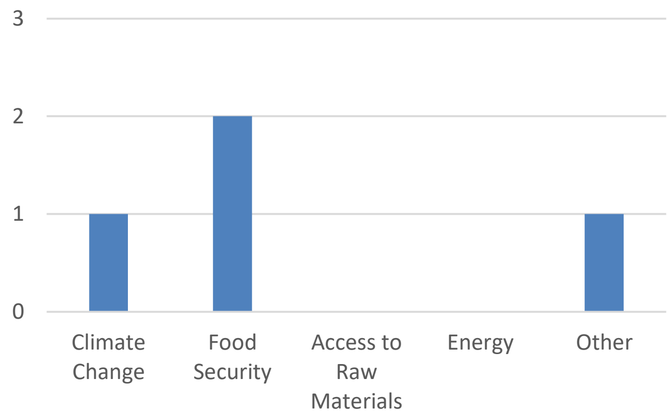


Figure 4-326. Activity of Israeli organizations with space-borne capacities in GEO-CRADLE thematic areas.

Two of the three organizations reached by this survey indicated having taken part in previous EO tasks (Figure 4-327). However, no organization had participated in Copernicus service provision, Copernicus User requirements definition or Copernicus Research and Innovation action; only one organization had participated in GEO/GEOSS SBA Tasks, community activities or initiatives organizations mostly indicated no previous experience (Figure 4-329).

When specifying EO activities organizations pointed out activities such as development of orbital remote sensing forest management tools and projects EO-miners, EUFAR-1, and EUFAR-2. In regards to GEO/GEOSS SBA activities, one organization pointed to GEOMIN.

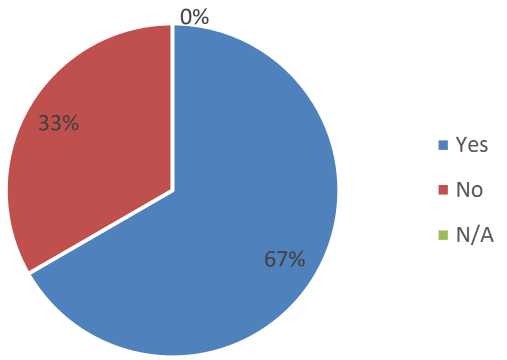


Figure 4-327. Participation of Israeli organizations with space-borne capacities in EO activities.

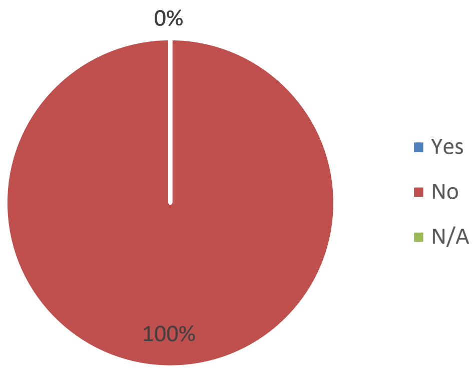


Figure 4-328. Participation of Israeli organizations with space-borne capacities in a Copernicus action.

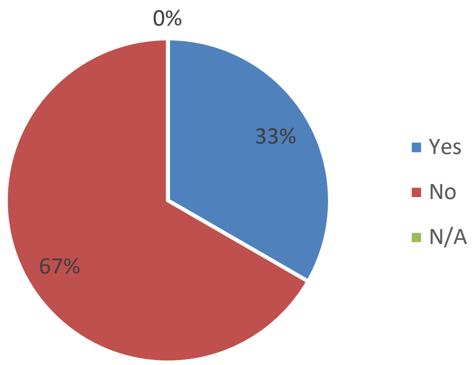


Figure 4-329. Participation of Israeli organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

Local cooperation is different for each organization: low, moderate and high (Figure 4-330). International cooperation is low for two organizations and high for one (Figure 4-331).

Examples of local cooperation provided included leading an international EO working group via ISPRS, IGARSS and EUFAR, organizing conferences and workshops about EO related issues, consulting and providing knowhow in EO-HSR related issues, and membership in scientific committees in US and Israeli space administrations. Another organization pointed to connecting Israeli researchers with their colleagues and membership in the international board of i-BEC (interBalkan Environment Center).

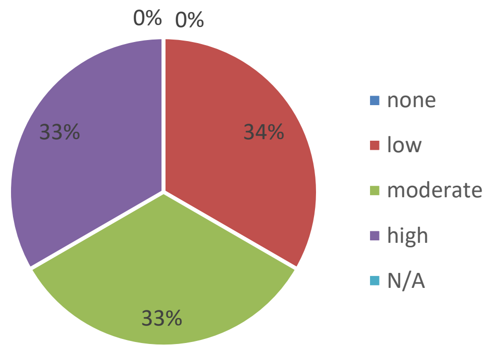


Figure 4-330. Level of cooperation of Israeli organizations with space-borne capacities with local EO actors.

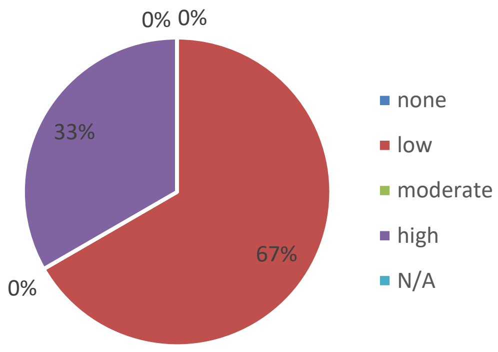


Figure 4-331. Level of cooperation of Israeli organizations with space-borne capacities with EO actors abroad.

The organizations that responded to this survey all had capacities besides space-borne; all had in-situ networks (Figure 4-332). One organization specified that they had ground segments: a Meteosat ground reception station (Figure 4-333). Israel's satellites have various geographic coverage including on a global level (Figure 4-334).

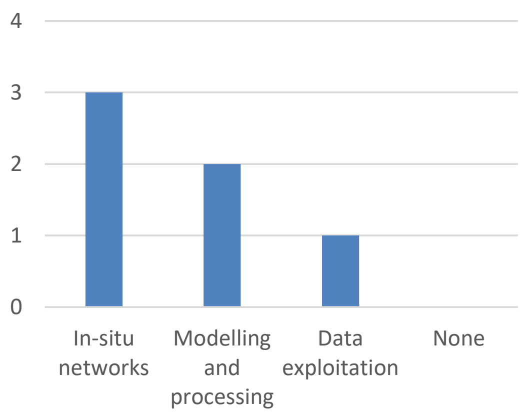


Figure 4-332. Additional EO capacities of Israeli organizations with space-borne capacities.

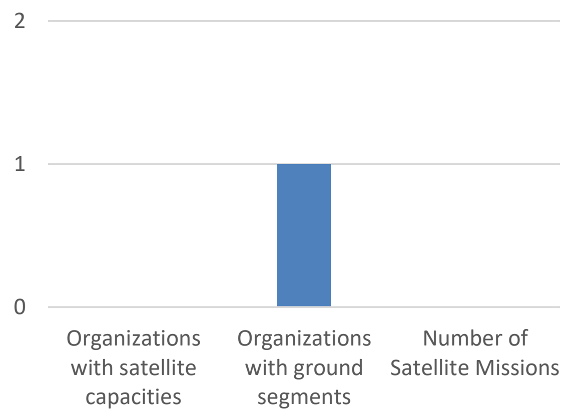


Figure 4-333. Type of space-borne capacities of Israeli organizations.

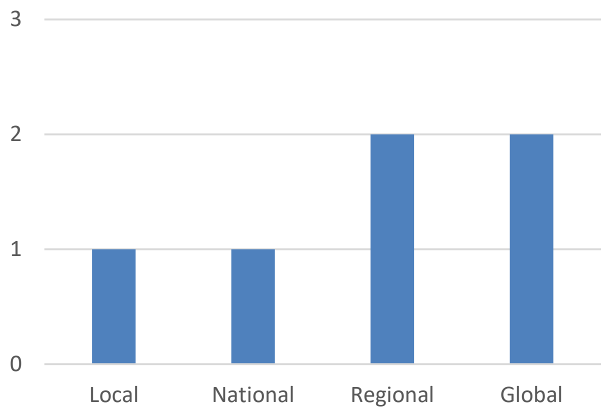


Figure 4-334. Geographic coverage of Israelisatellite missions.

One respondent organization indicated that data catalogues are not available, while one organization indicated that data catalogues are available in Israel (Figure 4-335). The applied data policy is overwhelmingly license restricted (Figure 4-336). For two missions, it was specified that data is available in real-time (Figure 4-337).

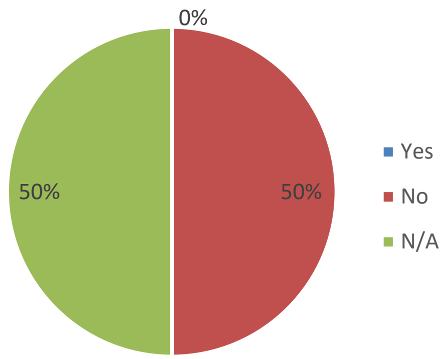


Figure 4-335. Availability of catalogues of Israeli satellite missions.

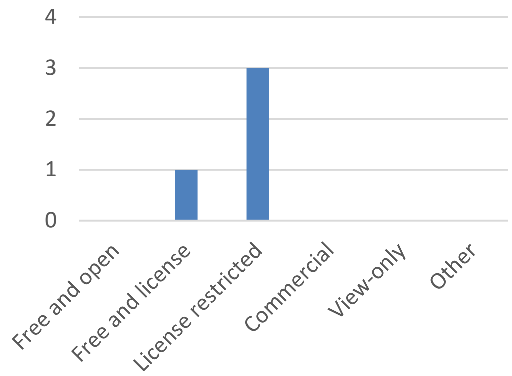


Figure 4-336. Data policy of Israelisatellite missions.

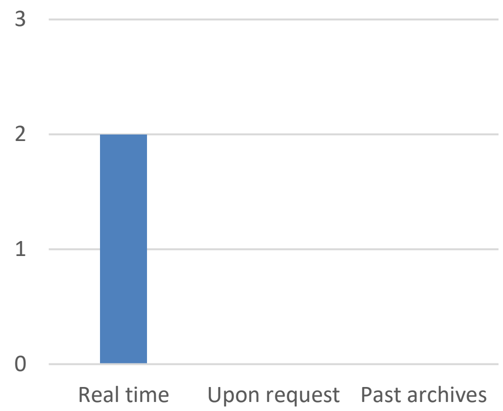


Figure 4-337. Data availability from Israeli satellite missions.

In-situ networks and facilities

13 of the 14 Israeli organizations that responded to this survey are research organizations (Figure 4-338). These organizations mostly focus on the food security thematic area (Figure 4-339). Beyond the defined thematic areas, organizations indicated involvement in consulting activities and ecology.

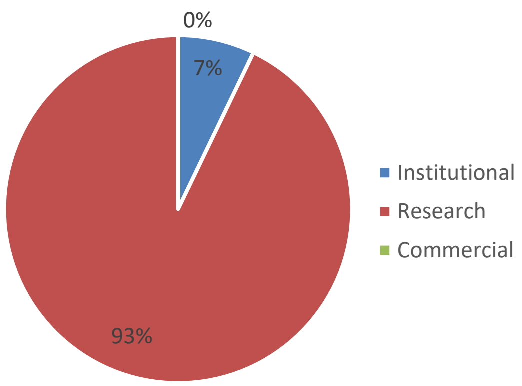


Figure 4-338. The type of organizations with in-situ networks in Israel.

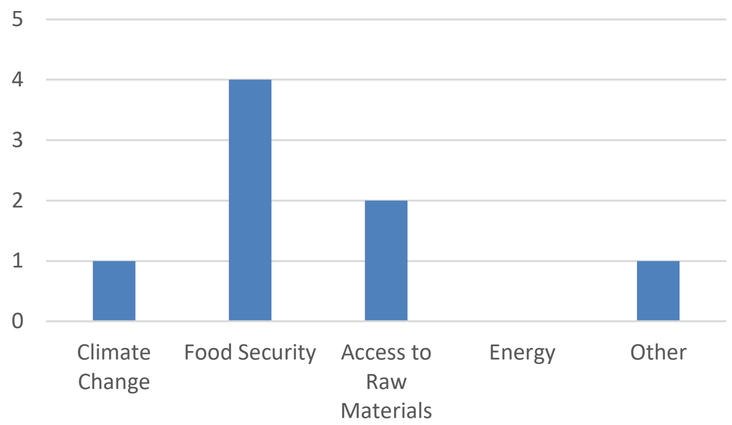


Figure 4-339. Activity of Israeli organizations with in-situ networks in GEO-CRADLE thematic areas.

Three organizations indicated that they had taken part in previous EO projects, while four indicated that they have not (Figure 4-340). One organization had participated in Copernicus service provision, Copernicus User requirements definition or Copernicus related activities, and one had participated in GEO/GEOSS SBA Tasks, community activities or initiatives (Figure 4-341 and Figure 4-342).

Specific examples of EO activities include EO-miners, EUFAR-1, EUFAR-2, and activities with the WMO. An example of GEO/GEOSS SBA activities that was given was GeoMIN.

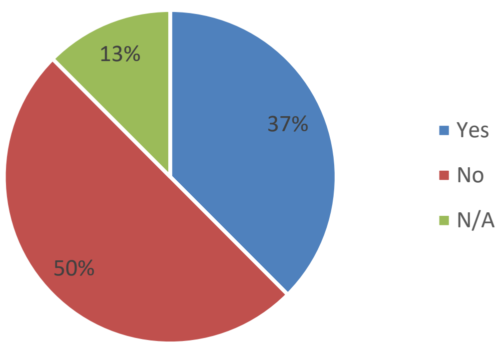


Figure 4-340. Participation of Israeli organizations with in-situ networks in EO activities.

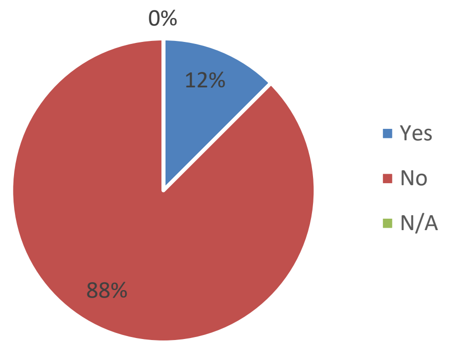


Figure 4-341. Participation of Israeli organizations with in-situ networks in a Copernicus action.

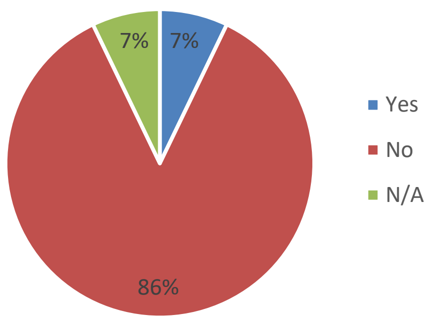


Figure 4-342. Participation of Israeli organizations with in-situ networks in a GEO/GEOSS SBA task.

As is shown in Figure 4-343 and Figure 4-344 local and international cooperation is either low or none for the majority. A larger portion of organizations have moderate and high cooperation locally compared to internationally. The organizations reached by this survey indicated that local and international cooperation was realized through: leading international EO working group via ISPRS IGARSS and EUFAR; organizing conferences and workshops or EO related issues; consulting and providing knowhow in EO-HSR related issues; and membership in scientific committees in US and Israeli space administrations.

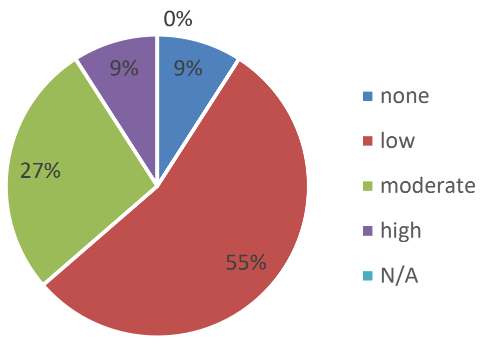


Figure 4-343. Level of cooperation with local EO actors judged by Israeli organizations with in-situ networks.

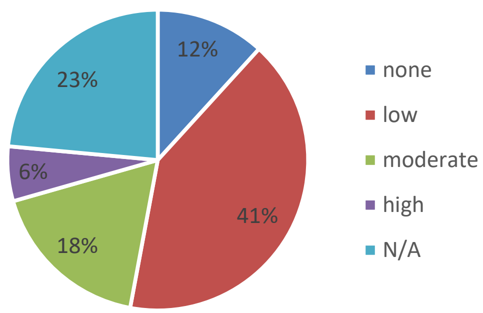


Figure 4-344. Level of cooperation of Israeli organizations with in-situ networks with EO actors abroad.

Organizations that operate in-situ networks mostly have other EO capacities, particularly modelling and processing capacities (Figure 4-345). The types of in-situ capacities include all areas measured by the survey (Figure 4-346). Organizations active in other areas not covered by the survey specified that they measured data related to vegetation, forestation and deforestation, mineralogy, flood and sinkhole monitoring, GPS and lidar.

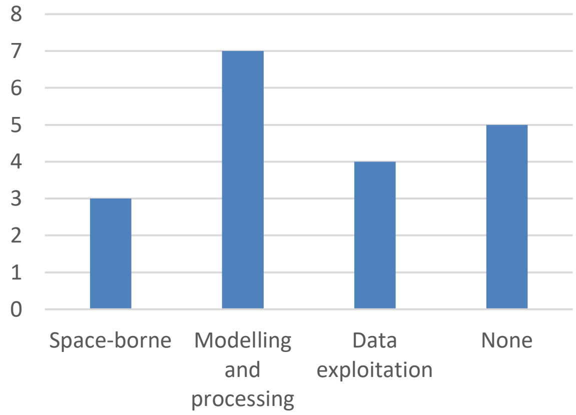


Figure 4-345. Additional EO capacities of Israeli organizations with in-situ networks.

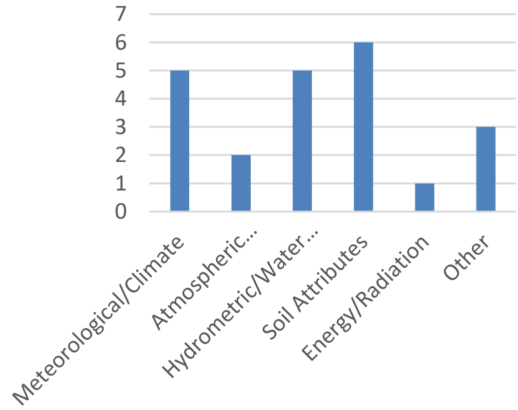


Figure 4-346. Activity area of in-situ networks of Israeli organizations.

The majority of in-situ stations in Israel identified by the survey relate to hydrometry/water quality (Figure 4-347). The coverage of networks is mostly local, although there are networks with national and regional coverage in some areas (Figure 4-348). Registration in national, regional, or international network was found for at least one network in each area, except for atmospheric composition (Figure 4-349). It was specified that the energy and radiation network identified was registered in an international network of stations around the Dead Sea area. All the in-situ networks, besides those related to energy/radiation, collect and store data regularly, albeit to varying degrees (Figure 4-350).

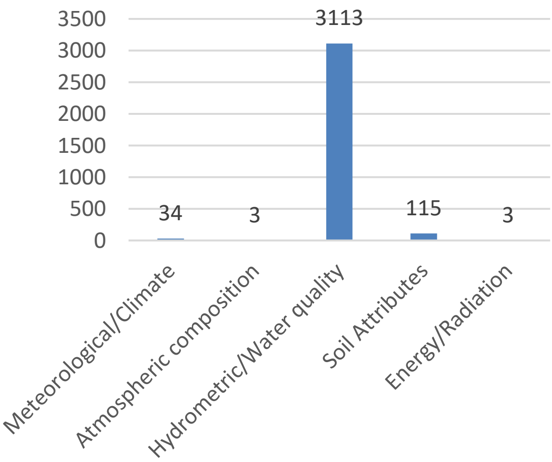


Figure 4-347. Number of stations of in-situ networks in Israel by activity area.

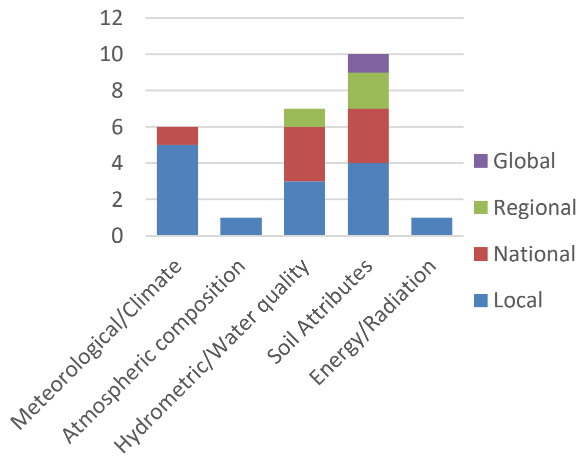


Figure 4-348. Geographic coverage of in-situ networks in Israel by activity area.

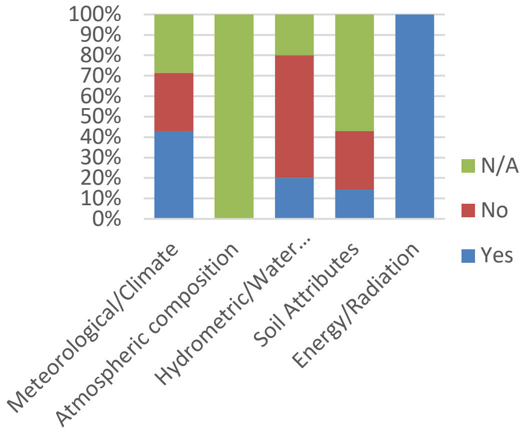


Figure 4-349. Registration of in-situ networks in Israel by activity area.

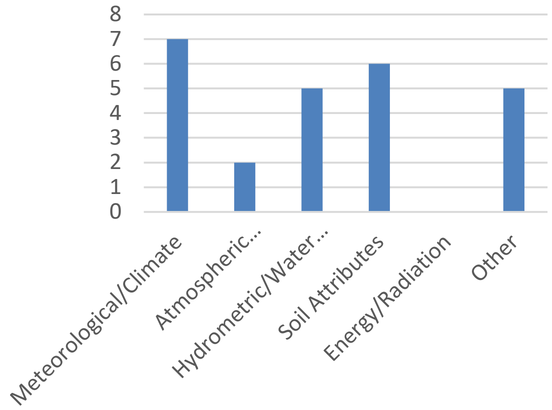


Figure 4-350. Systematic collection of data by in-situ networks in Israel by activity area.

A few **meteorological and climate in-situ networks** specified METADATA availability; for those that did, more had it available than not (Figure 4-351). Organizations indicated that METADATA was available from the Dead Sea and Arava Data Center, Israeli Ministry of Environmental Protection, Israeli Meteorological Service. Temporal resolution was hourly for seven networks and daily for two (Figure 4-352). Data is available in real-time from four networks, upon request from two and from past archives from one (Figure 4-353). Data policy was generally not specified, but included free and open, free and licensed and license restricted (Figure 4-354).

No details were specified for **atmospheric compositions in-situ networks**.

In regards to **hydrometric/water quality in-situ networks**, an equal amount of organizations indicated METADATA was and was not available (Figure 4-355). These organizations specified the temporal resolution of their networks: three with an hourly resolution, one with a daily (Figure 4-356). One network also had a yearly resolution. It was specified that two networks data available in real-time and one offers access to part archives (Figure 4-357). No details are provided on data policy

Two **soil attributes/spectra in-situ networks** have METADATA available, while four do not (Figure 4-358). Temporal resolution was mostly specified as being other (Figure 4-359), which included the following details: before plantation and when necessary. Data availability was is mostly upon request (Figure 4-360). Three networks have license restricted data policies, while two have free and licensed (Figure 4-361).

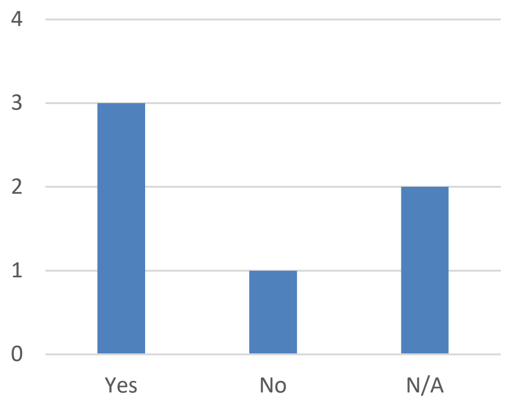


Figure 4-351. Availability of METADATA from meteorological and climate in-situ networks in Israel.

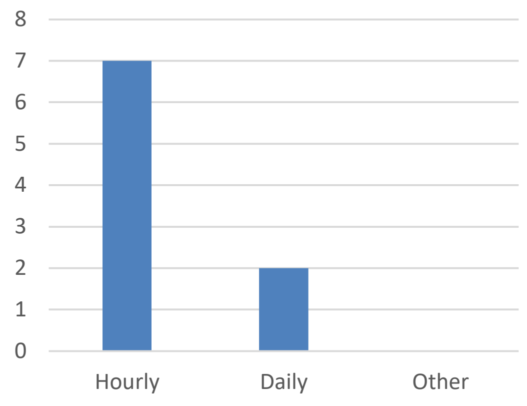


Figure 4-352. Temporal resolution of meteorological and climate in-situ networks in Israel.

Figure 4-353. Data availability from meteorological and climate in-situ networks in Israel.

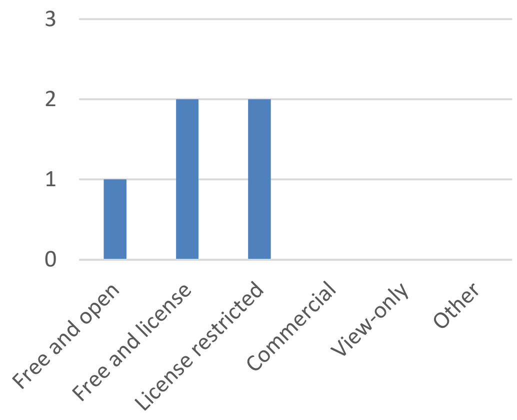


Figure 4-354. Data policy of meteorological and climate in-situ networks in Israel.

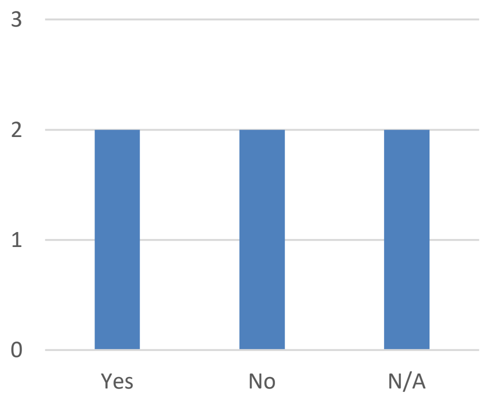


Figure 4-355. Availability of METADATA from hydrometric and water quality in-situ networks in Israel.

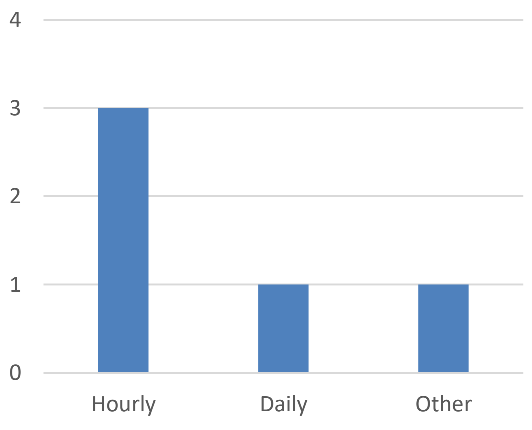


Figure 4-356. Temporal resolution of hydrometric and water quality in-situ networks in Israel.

Figure 4-357. Data availability from hydrometric and water quality in-situ networks in Israel.

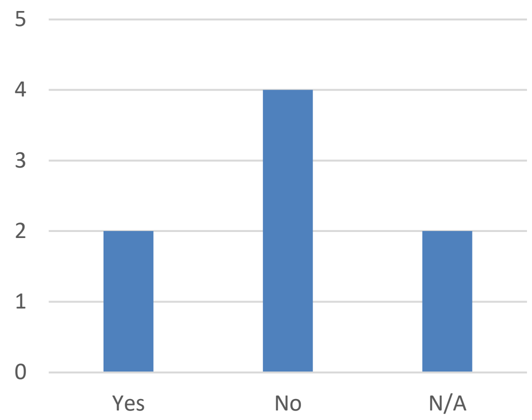


Figure 4-358. Availability of METADATA from soil attributes/spectra in-situ networks in Israel.

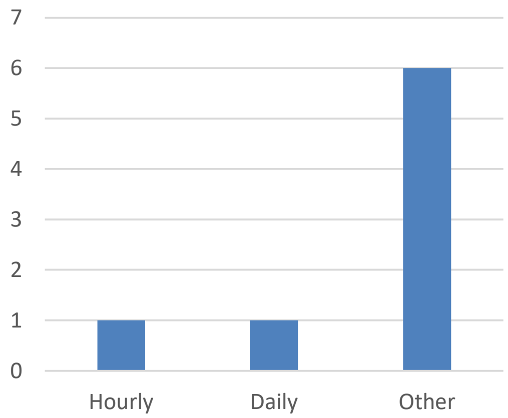


Figure 4-359. Temporal resolution of soil attributes/spectra in-situ networks in Israel.

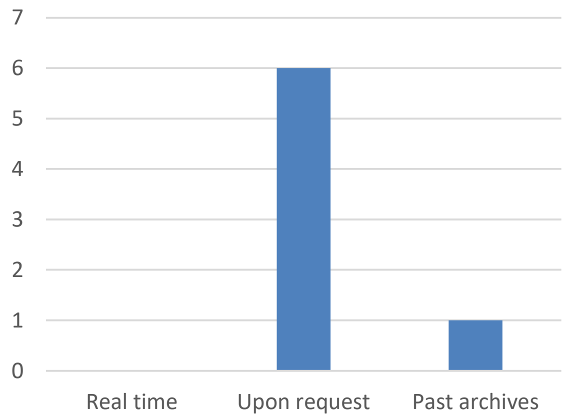


Figure 4-360. Data availability from soil attributes/spectra in-situ networks in Israel.

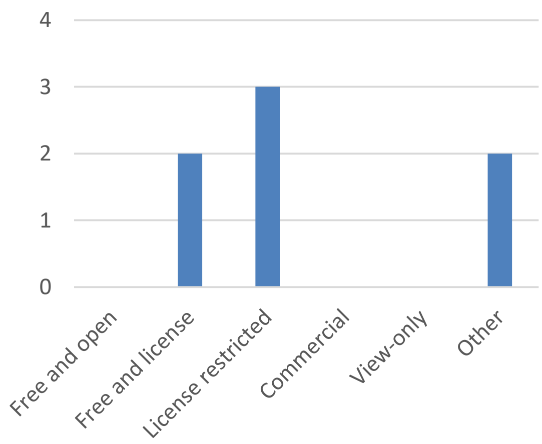


Figure 4-361. Data policy soil attributes/spectra in-situ networks in Israel.

Modelling and processing capacities

Of the 13 organizations reached by this survey, the majority of organizations are research-oriented (Figure 4-362). They are active in all thematic areas except for energy (Figure 4-363). Besides the GEO-CRADLE thematic areas, organizations indicated activities in land use, infrastructure, real estate, and consulting governmental organizations such as the Ministry of Science, Technology and Space and the Ministry of Foreign Affairs.

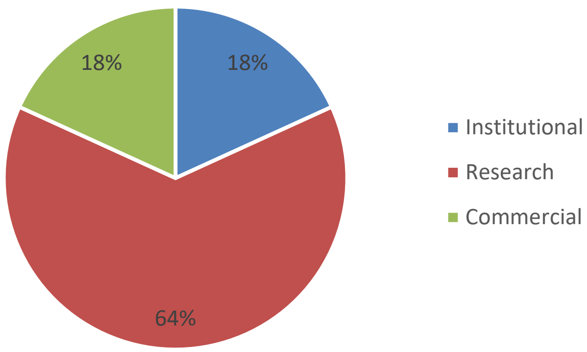


Figure 4-362. The type of organizations with modelling and processing capacities in Israel.

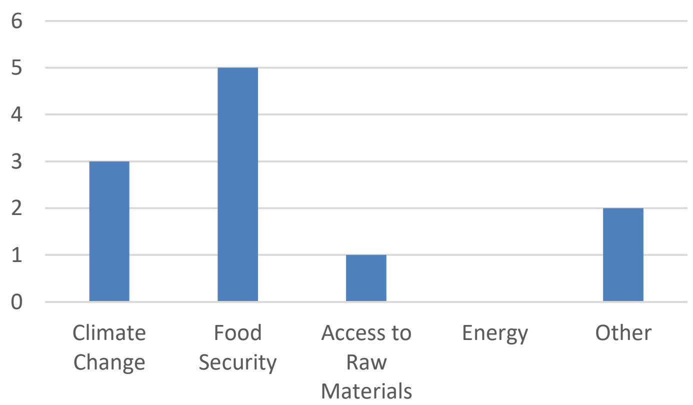


Figure 4-363. Activity of Israeli organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

Six organizations indicated that they had taken part in previous EO projects, while two indicated that they have not (Figure 4-364). Examples of previous EO project experience include EO-miners, EUFAR-1 and EUFAR-2. Eight organizations have participated in Copernicus related activities while others did not specify (Figure 4-365). Only one organization has participated in GEO/GEOSS SBA activities (Figure 4-366).

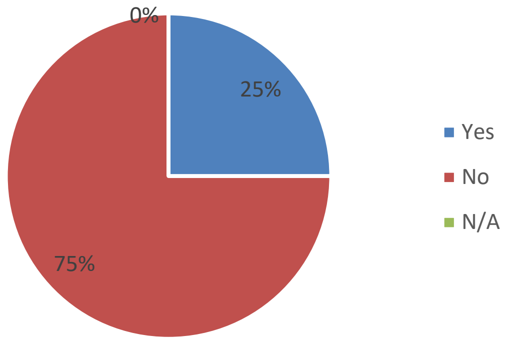


Figure 4-364. Participation of Israeli organizations with modelling and processing capacities in EO activities.

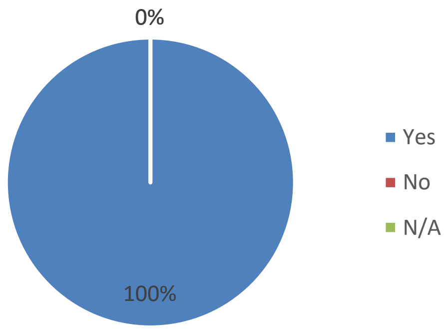


Figure 4-365. Participation of Israeli organizations with modelling and processing capacities in a Copernicus action.

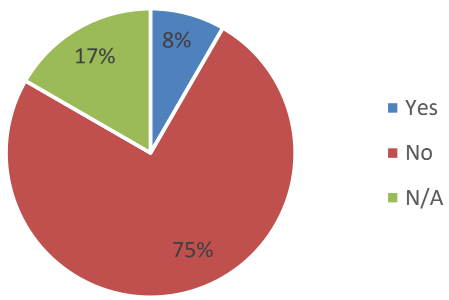


Figure 4-366. Participation of Israeli organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

Local cooperation for these organizations is 73% low or none (Figure 4-367). Similarly, 76% of organizations have low or no cooperation internationally (Figure 4-368). One organization does have high international cooperation. Local and international cooperation is realized through leading international EO working group via ISPRS, IGARSS and EUFAR, organizing conferences and workshops or EO related issues, consulting and providing knowhow in EO-HSR related issues, membership in scientific committees in US and Israeli space administrations, membership in the international board of I-BEC and Milan InnoVincY.

Israeli organizations with modelling and processing capacities reached by the survey for the most part have other EO capacities, particularly in-situ networks (Figure 4-369).

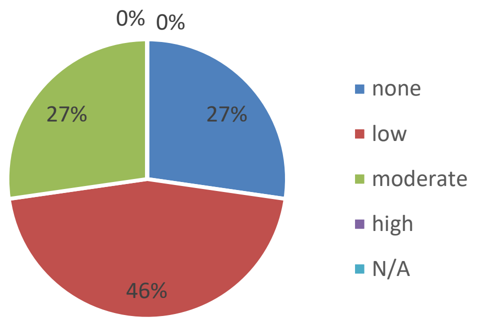


Figure 4-367. Level of cooperation of Israeli organizations with modelling and processing capacities with local EO actors.

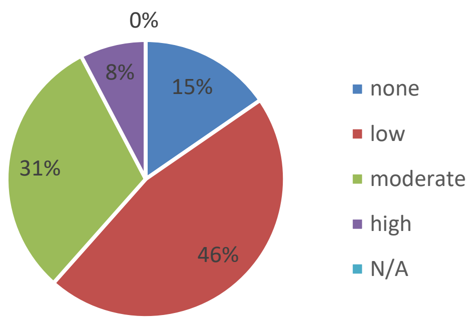


Figure 4-368. Level of cooperation of Israeli organizations with modelling and processing capacities with EO actors abroad.

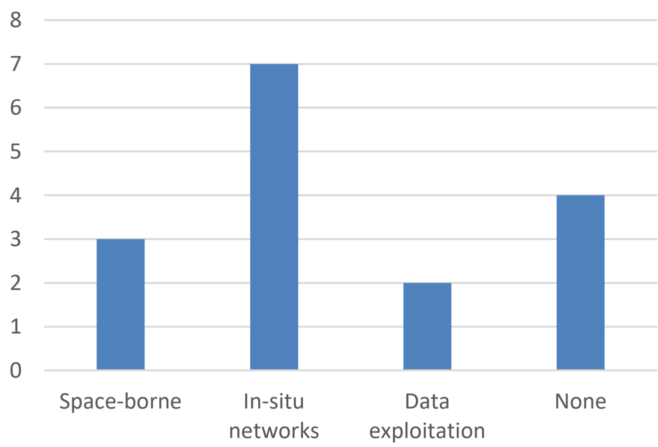


Figure 4-369. Additional EO capacities of Israeli organizations with modelling and processing capacities.

The algorithms identified by the survey are mostly related to meteorology and climate and soil attributes (Figure 4-370). No energy/radiation models were found. Sources of EO data are almost evenly spread between geospatial data, remote sensing data, and in-situ data (Figure 4-371). Organizations specified that other sources of EO data that they use include various types of satellites, data available on the internet, and national and international data from meteorological stations.

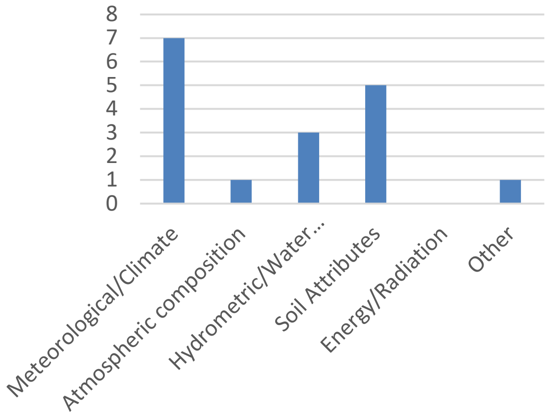


Figure 4-370. Algorithms and models available in Israel by activity area.

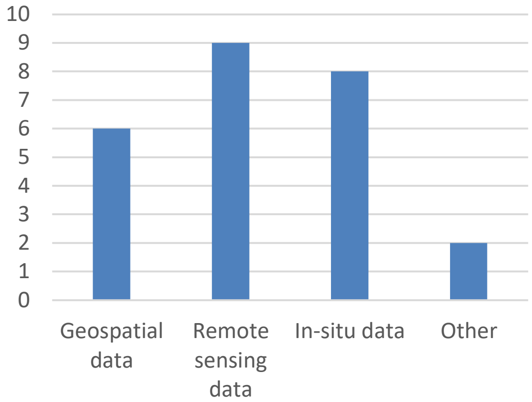


Figure 4-371. Sources of EO data used by organizations with modelling and processing capacities in Israel.

Coverage is mostly regional (7 models), although there are several with local and national coverage (3 and 5 models respectively), as seen in Figure 4-372. METADATA was equally available as it was unavailable for models where this information was provided (Figure 4-373).

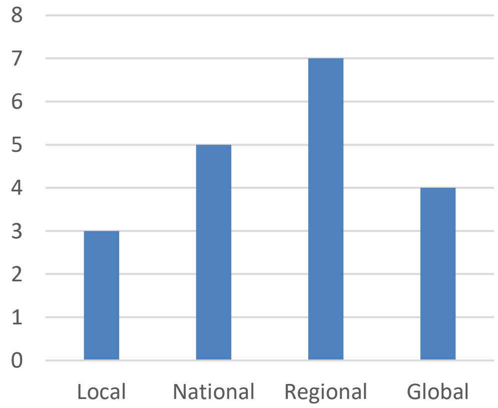


Figure 4-372. Geographic coverage of models and algorithms in Israel.

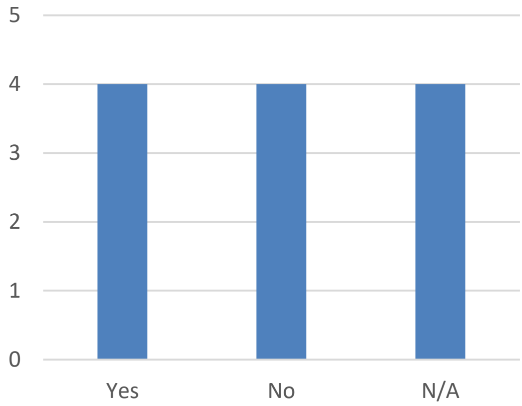


Figure 4-373. Availability of METADATA for models and algorithms in Israel.

Computing resources available to respondents cover all infrastructure measured by the survey (Figure 4-374). Furthermore, resources include super computers. One organization indicated it uses a basic computer and that it is in constant need of upgrades.

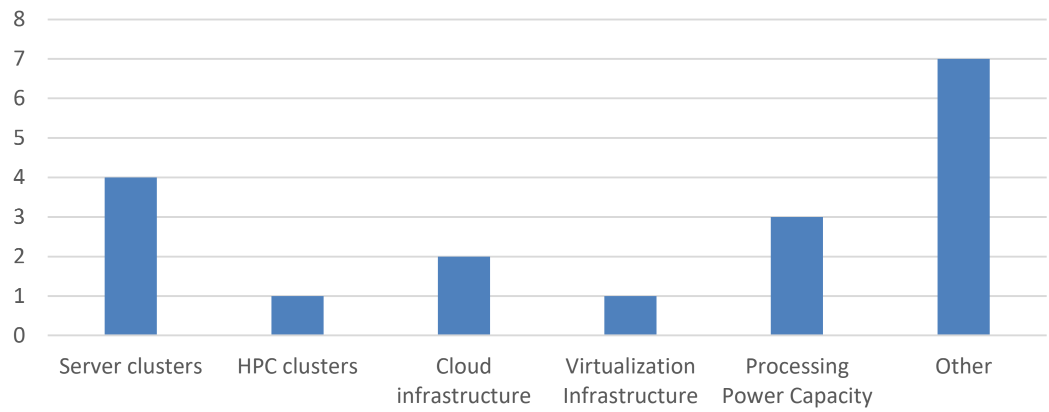


Figure 4-374. Computing resources available for processing and exploitation of EO data in Israel.

Data Exploitation

Of the seven organizations reached, three are institutional, three are commercial and one is research-oriented (Figure 4-375). They are active in all GEO-CRADLE thematic areas except energy (Figure 4-376).

One organization mentioned that it was active in consulting activities for governmental organizations such as the Ministry of Science, Technology & Space or Ministry of Foreign Affairs in the field of International Collaborations on bilateral basis or with international organizations.

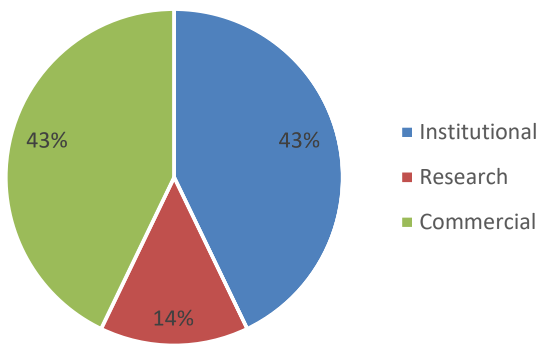


Figure 4-375. The type of organizations active in data exploitation in Israel.

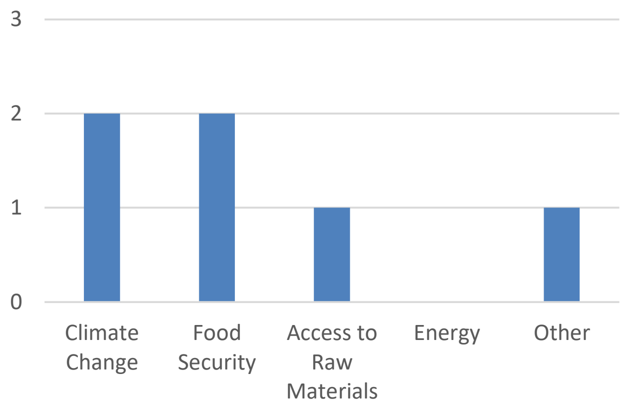


Figure 4-376. Activity of Israeli organizations active in data exploitation in GEO-CRADLE thematic areas.

An equal amount of organizations specified that they have participated in EO activities (Figure 4-377). Only one organization has participated in a Copernicus related activities (Figure 4-378); none have participated in GEO/GEOSS SBA Tasks (Figure 4-379). One organization specified that its experience in EO projects was realized through the use of aerial photography and drones.

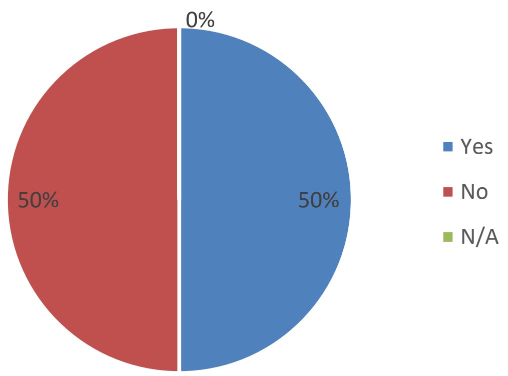
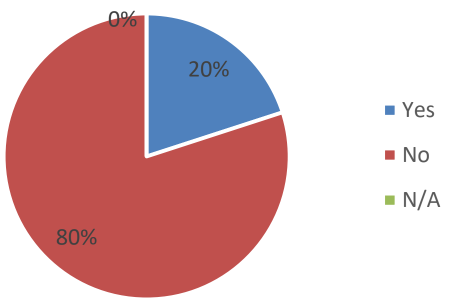


Figure 4-377. Participation of Israeli organizations active in data exploitation in EO activities.



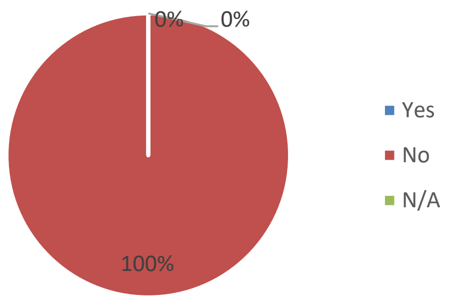


Figure 4-378. Participation of Israeli

Figure 4-379. Participation of Israeli *organizations active in data exploitation in a Copernicus action.*

organizations active in data exploitation in a GEO/GEOSS SBA task.

The five respondents that provided details have low or no local cooperation (Figure 4-380). On the other hand, one organization has moderate international cooperation (Figure 4-381).

Examples of local and international cooperation provided by the respondent organizations are connecting Israeli researchers with their colleagues and membership in the International board of I-BEC, and collaborations with various universities around the world.

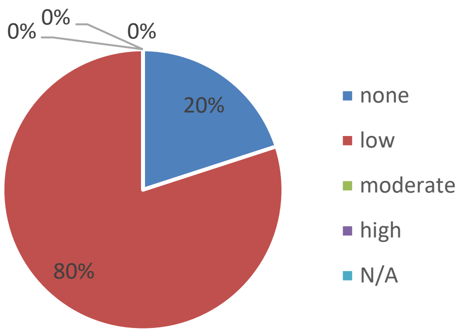


Figure 4-380. Level of cooperation of Israeli organizations active in data exploitation with local EO actors.

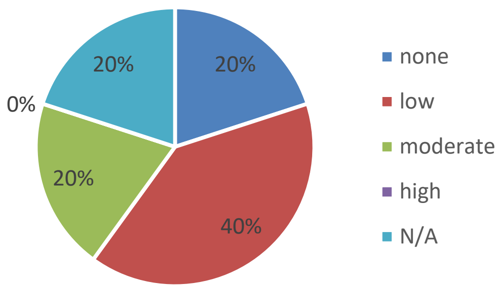


Figure 4-381. Level of cooperation of Israeli organizations active in data exploitation with EO actors abroad.

All but one of the reached organizations who are active in data exploitation have other EO capacities, as seen in Figure 4-382.

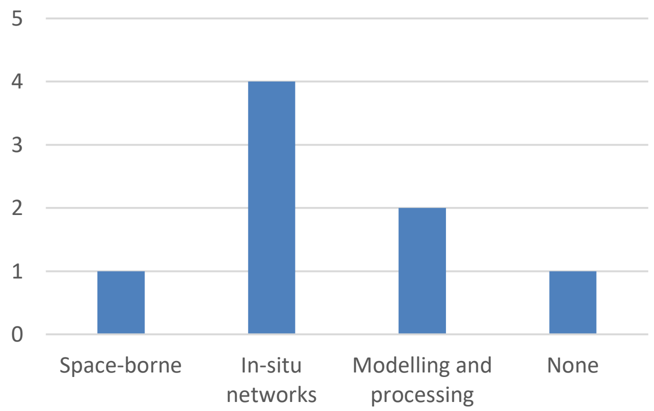


Figure 4-382. Additional EO capacities of Israeli organizations active in data exploitation.

The organizations that were included in this survey have EO products/services in a diverse set of thematic areas of their products (Figure 4-383).

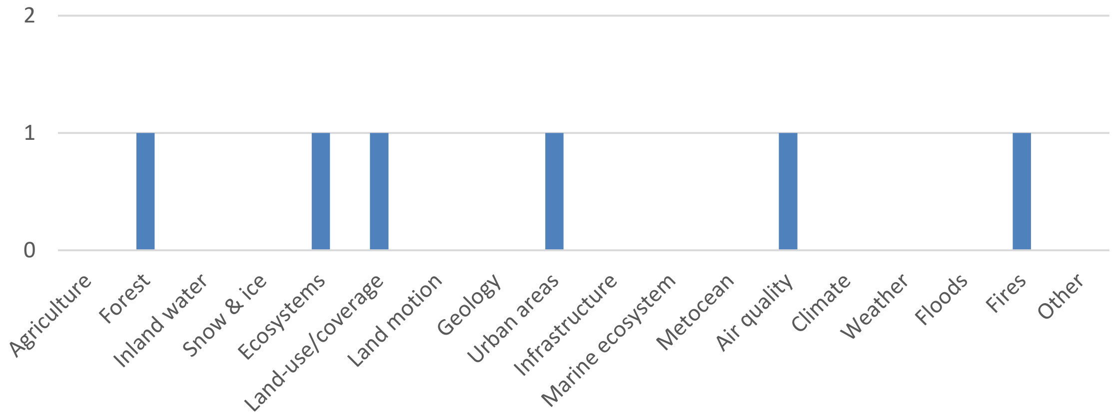


Figure 4-383. Activity areas of EO products/services of Israeli organizations.

National activities

Survey results indicate that respondents perceive that national funding for EO activities is available (Figure 4-184), of which half specified that the funding is available for infrastructure (Figure 4-385).

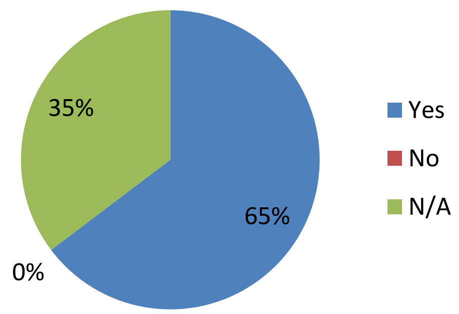


Figure 4-384. Israeli EO actors' perception of the availability of national funding for EO.

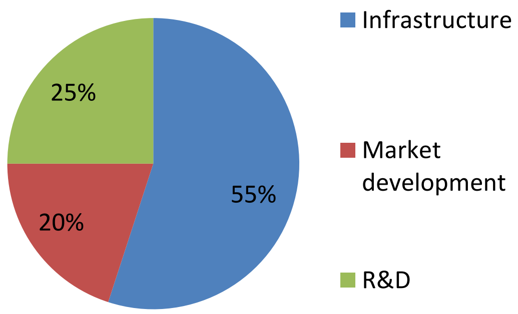


Figure 4-385. Israeli EO actors' perception of areas for which national EO funding is available.

Most responding organizations are aware of the existence of a national space strategy and a national space program in Israel (see Figure 4-386 and Figure 4-387).

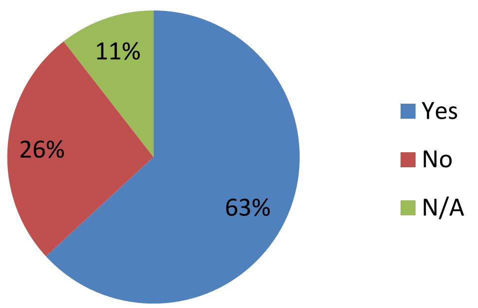


Figure 4-386. Israeli EO actors' awareness of a space program in Israel.

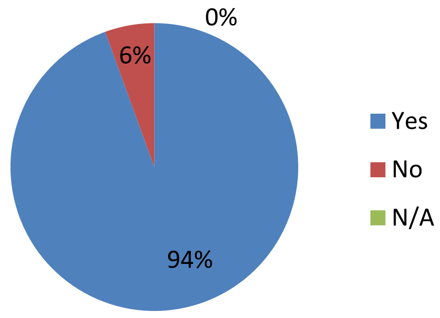


Figure 4-387. Israeli EO actors' perception of national coordination of EO activities in Israel.

There is variety in opinion in regards to coordination of EO efforts in Israel and interaction with decision makers. Half of the respondent organizations indicated that there is no coordination of EO activities in Israel while 17% believe it is fully integrated (Figure 4-388). Similarly, 50% of respondents perceive there is no interaction with decision makers while 11% consider it fully engaged (Figure 4-389).

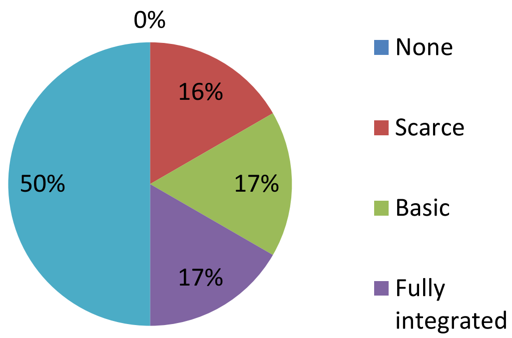


Figure 4-388. Israeli EO actors' perception of interaction with decision makers in Israel.

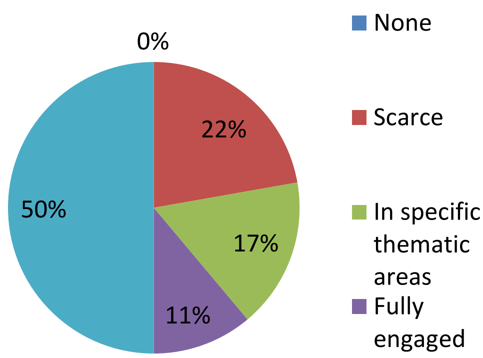


Figure 4-389. Israeli EO actors' perception of national coordination of EO activities in Israel.

Survey results indicate a widespread willingness to participate in future regional Copernicus and GEO activities by contributing own capacities (Figure 4-390).

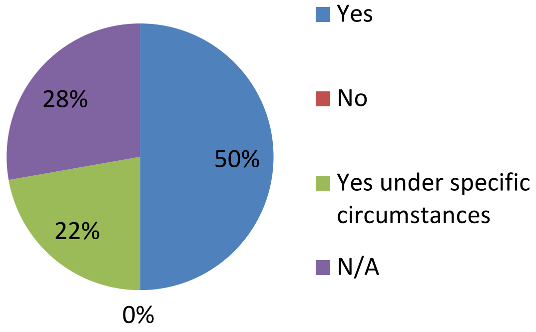


Figure 4-390. Israeli EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

End-user awareness of Copernicus and GEO, according to the results of this survey, is not widespread (Figure 4-391 and Figure 4-392).

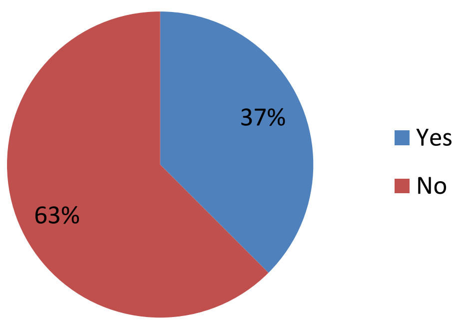


Figure 4-391. End-user awareness of Copernicus in Israel.

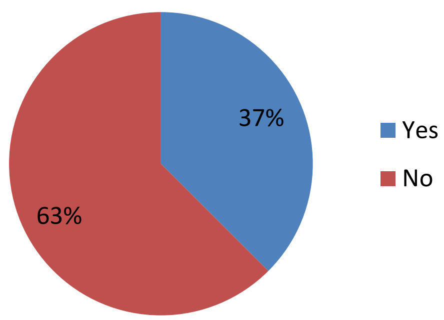


Figure 4-392. End-user awareness of GEO in Israel.

4.6.3. *Gap analysis*

Israel is a highly developed country in regards to EO, which was validated by the survey. End-user interviews offer little information regarding unmet information needs – one respondent states that there are no EO constraints that they face. It is clear that there is a large and mature public and private EO sector in the country.

One end-user from the private sector demonstrated how EO services were integrated (in-field network of sensors, satellite imagery, drone imagery) from another private company to address internal constraints.

4.7. FYROM

4.7.1. *Overview*

EO in the country is on the margins of research and operational activities. The sector is predominantly based on state owned/operated in-situ networks. These networks are partially overlapping – several institutions have networks for meteorological observation for different purposes.

The Law on Hydro-meteorological activities[24] regulates hydrological and meteorological matters and designates the responsible institution – the Hydro-Meteorological Service – to fulfill tasks comprising of: development and maintenance of hydrological and meteorological observation; research on atmosphere, soil and water resources; and application of hydrology and meteorology. According to this Law, other institutions, individuals and foreign bodies should be authorized by the Ministry of Agriculture, Forestry and Water Economy to be able to conduct any of these activities.

The law establishes a unique meteorological observing system. It is an integral part of the global observing system and all activities performed in accordance with the regulations and standards of the WMO.

The state meteorological network stations, staffed with professional observers, is established within the meteorological observing system of the country. Overall, it includes 19 main meteorological stations and 2 meteorological radar hail suppression centers. In addition, there are part-time observer stations consisting of 7 climatological stations, 103 precipitation and 24 phenological stations. In the last years, the system has installed 15 automatic meteorological stations. The number of stations has been reducing in recent years: main stations from 31 to 19, precipitation stations from more than 200 to 103, etc. The reason is lack of financing.

Another network for meteorological observations was developed for FYROM Forest Fire Information System managed by the Crisis Management Center. Meteorological data is used to run models to produce vegetation dryness maps and a weather fire index map.

[24] Official Gazzete of FYROM, No. 103, 19.08.2008.

A third meteorological network is established by the Union of Farmers Associations in the Prespa area. There is a total of 7 automated meteorological stations, and data is used for running a model on the risk of appearance of crop diseases.

Moreover, there is a Hydrological network operated by the Hydro-Meteorological Service and it is composed of 60 measuring points (water quantity and water quality).

The country's air quality network is operated by the Ministry of the Environment and Physical Planning, and is composed of 17 stations. The Ministry just initiated a soil monitoring network as a part of EUSTAT LUCAS activity.

Space-borne capacities in the country are limited to an antenna equipped on the Hydro-Meteorological Service for assessing satellite images of the WMO satellite. These images are used for weather forecast preparation. There is no National Space Agency or any relevant activity/strategic documents drafted.

Modelling capacities exist in various institutions in the country and various models are in use. At the institutional level, the Ministry of the Environment and Physical Planning is using models for air quality, the Crisis Monitoring Center is using models for vegetation dryness and forest fires index. The Hydro-Meteorological Service uses a weather forecast model. Private companies offer modelling-as-a-service (do modelling on request) and as a possible source of data (add value to existing data trough using models). Higher-education and research institutions host most of the country's modelling capacities and most of its models. However, this modelling is just for scientific purposes and not in operational use.

Major obstacles for EO are associated to each of these specific activities:

Problems with in-situ networks/monitoring

- *Financing*: The number of institutions that are authorized by law to conduct monitoring is dramatically reducing. Financial restrictions are reducing temporary staff, reducing the number of stations in networks and are problematic for maintenance/calibration of existing equipment or replacing of defective/obsolete items.
- *Overlapping responsibilities*: the Crisis Management Center and the Farmers' association run networks used only for their own purposes, instead of using Hydromet

data and/or make their network a part of regular monitoring. Exchange of data/information among stakeholders does not exist. Data from Hydromet is extremely costly; it is much cheaper to build a new network based on automated meteorological stations. Moreover, the density of the national meteorological service is not sufficient for real efficient use in some sectors: e.g. forest fires, agriculture, hydrology etc.

- *Cost of data*: The cost of the data generated through regular monitoring and international projects activities is high. In fact, the price is so high that a large share of research budgets must be spent on data purchases (meteorological, DTM, geological maps etc.). The only positive example in the country regarding data policy is the soil map that is available on the internet free of charge. The situation has a negative impact on research, modelling, evidence based decision making, citizen science, etc.

Problems with modelling

Operational use is limited to several models for forest fires, air quality and weather forecasting. All other modelling activities are sporadic, non-systematic and mainly project oriented.

- *Lack of data*: Unfortunately, not all data required is available in the country. There are attempts to use free data from the global scale, free sources or attempts to generate data in different ways; however, this is not providing satisfactory results.
- *Low access to existing data*: National data has limited availability and is usually costly.
- *Insufficient level of expertise*: In certain cases there is a lack of expertise for the use of certain models. There were attempts to introduce Mike-She (integrated modelling of groundwater, surface water, recharge and evapotranspiration). Training was provided to selected experts, but the model is still not in use. Lack of expertise has been particularly manifested in the use of biophysical models for crop growth.
- *Project based modelling*: Some projects require data from models. They will finance data collection, capacity building, training of staff (usually temporary), and running the model during project lifetime. When the project will finish, financing runs out and modelling activities do not continue. Trained staff often leave the country.

Problems with end-users

End-users are frequently not aware of the benefits that EO can bring to their operational work. Moreover, the EO society in the country is small and underdeveloped. It is not organized and most of the participants do not have information regarding what was already done leading to frequent repetition of activities. The ability of EO actors to influence decision makers to support EO development is rather weak.

4.7.2. *Capacities*

Space-borne capacities

FYROM has no space-borne capacities.

In-situ networks and facilities

Five organizations with in-situ networks were reached. Four are institutional and one is commercial (Figure 4-393). Organizations with in-situ networks are active in all GEO-CRADLE thematic areas, particularly in climate change (Figure 4-394). One organization that indicated being active in another thematic areas further specified working on crisis management.

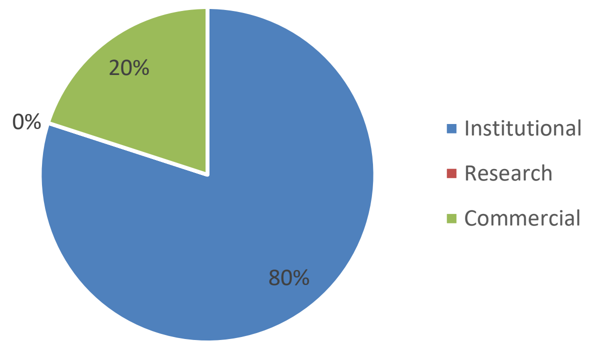


Figure 4-393. The type of organizations with in-situ networks in FYROM.

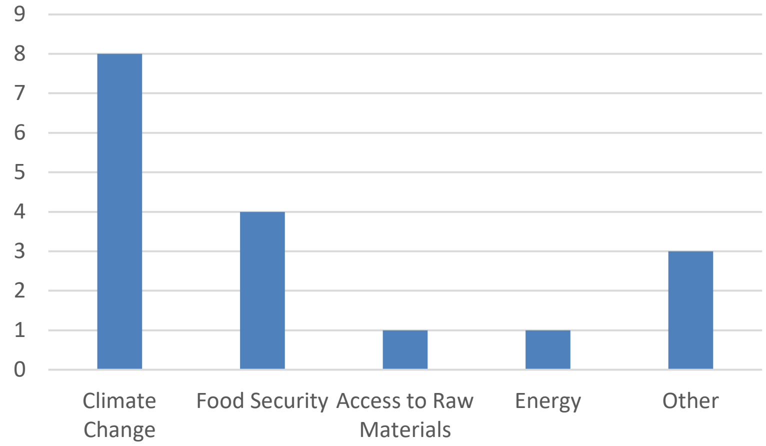


Figure 4-394. Activity of FYROM organizations with in-situ networks in GEO-CRADLE thematic areas.

None of the organizations that responded to the survey took part in EO activities, Copernicus service provision, or GEO/GEOSS SBA activities (Figure 4-395, Figure 4-396, and Figure 4-397).

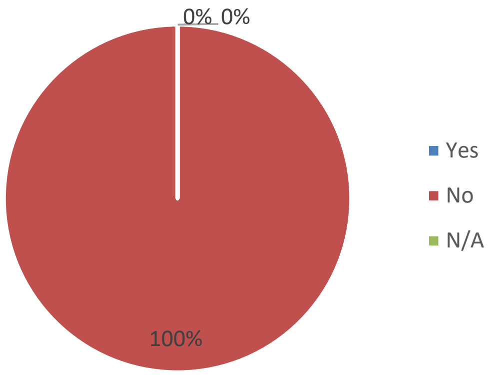
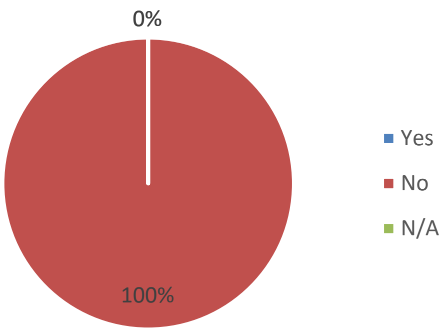


Figure 4-395. Participation of FYROM organizations with in-situ networks in EO activities.



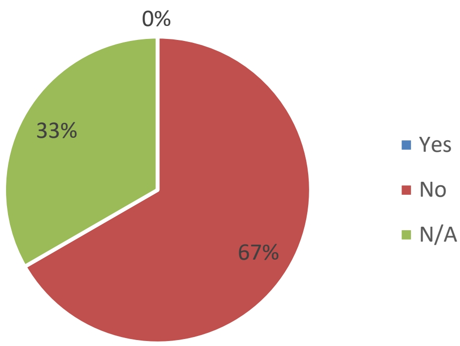


Figure 4-396. Participation of FYROM

Figure 4-397. Participation of FYROM

organizations with in-situ networks in a Copernicus action.

organizations with in-situ networks in a GEO/GEOSS SBA task.

Two organizations have low local cooperation and two organizations have high local cooperation (Figure 4-398). As for cooperation abroad, the two organizations that specified had none (Figure 4-399).

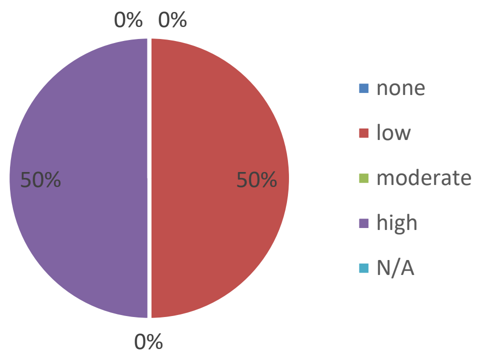


Figure 4-398. Level of cooperation of FYROM organizations with in-situ networks with local EO actors.

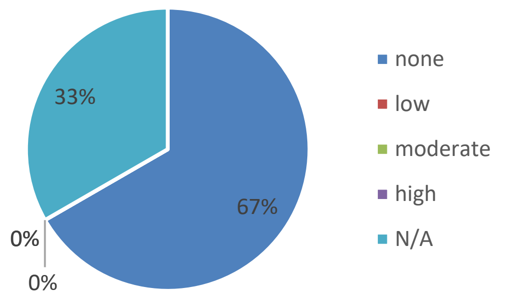


Figure 4-399. Level of cooperation of FYROM organizations with in-situ networks with EO actors abroad.

All organizations have other EO capacities in addition to the in-situ networks; the majority have capacities in modelling and processing (Figure 4-400). Survey results show that FYROM has in-situ networks active in all areas measured by the survey except for energy/radiation (Figure 4-401).

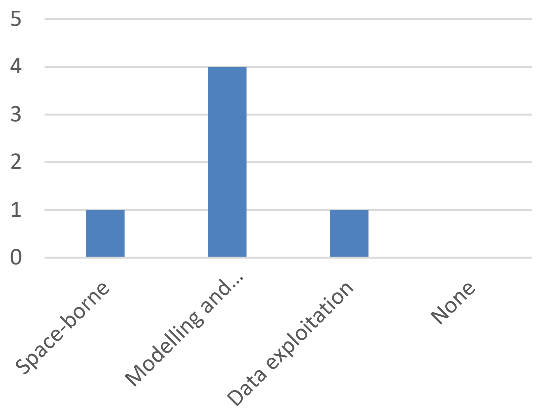


Figure 4-400. Additional EO capacities of FYROM organizations with in-situ networks.

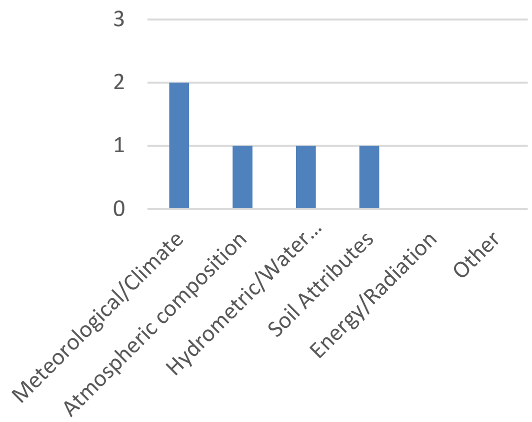


Figure 4-401. Activity area of in-situ networks of FYROM organizations.

The majority of in-situ stations identified by the survey are related to soil attributes (Figure 4-402). All networks that provided details on coverage have national coverage (Figure 4-403).

Most networks (that provided these details) are registered in a national/regional/international network; no details were provided for soil attribute networks (Figure 4-404). The systemic collection of data was noted for two meteorological networks and one hydrometric network (Figure 4-405).

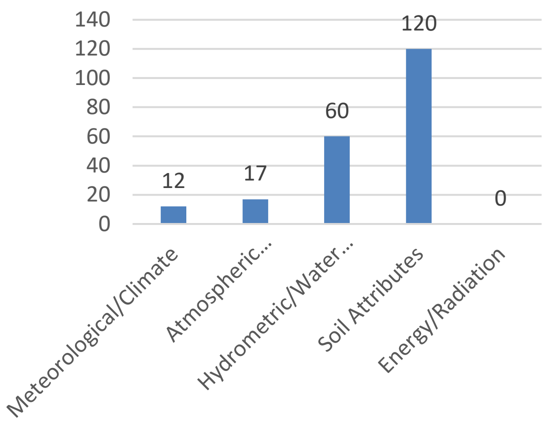


Figure 4-402. Number of stations of in-situ networks in FYROM by activity area.

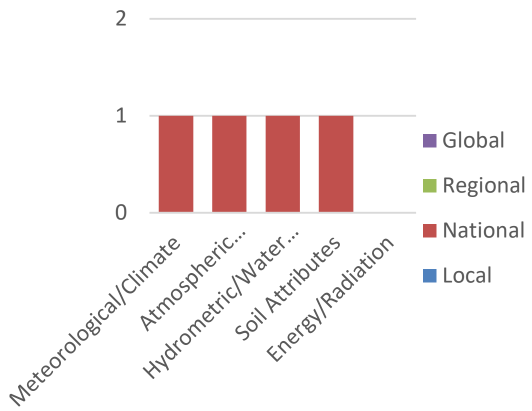


Figure 4-403. Geographic coverage of in-situ networks in FYROM by activity area.

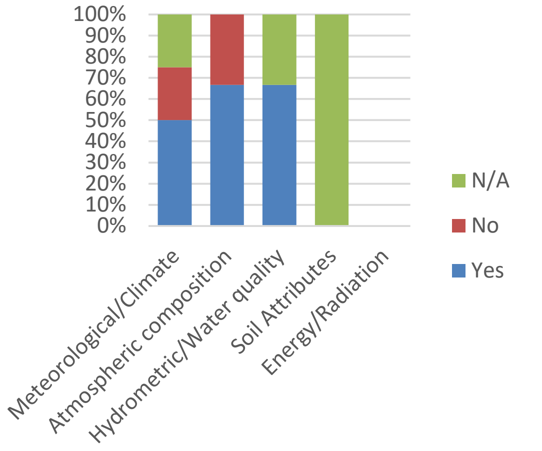


Figure 4-404. Registration of in-situ networks in FYROM by activity area.

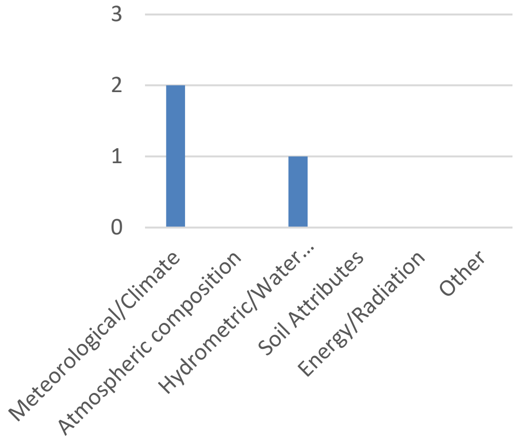


Figure 4-405. Systematic collection of data by in-situ networks in FYROM by type.

Few details were generally provided by organizations about their in-situ networks in all areas.

In regards to **meteorological and climatic in-situ networks**, METADATA is available from one organization while only one organization specified its temporal resolution as hourly (Figure 4-406 and Figure 4-407). One organization indicated that its data is available in real time, while another organization indicated its data policy as *other;* this organization indicated that the data policy is one that provides free access to recommendations for crop spraying (Figure 4-408 and Figure 4-409). As far as other data policies are concerned, one organization indicated that their data is available for free viewing over the internet.

For **atmospheric composition/profiling in-situ networks**, one organization indicated the availability of METADATA for its network and an hourly temporal resolution of data (Figure 4-410 and Figure 4-411). The same organization has its data available in real time, while the data policy applied is view-only (Figure 4-412 and Figure 4-413).

In regards to **hydrometric/water quality in-situ networks**, the only details specified were the availability of METADATA by one organization (Figure 4-414).

Organizations with **soil attributes/spectra in-situ networks** offered the following details: one organization does not have METADATA available, grants access to past archives and has a free and open data policy (Figure 4-415, Figure 4-416 and Figure 4-417).

One organization indicated the availability of METADATA from **energy/radiation** in-situ networks in FYROM (Figure 4-418).

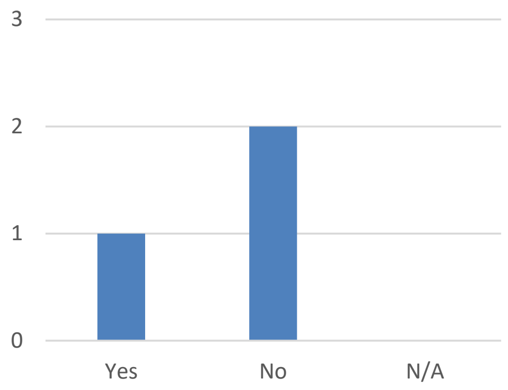


Figure 4-406. Availability of METADATA from meteorological and climate in-situ networks in FYROM.

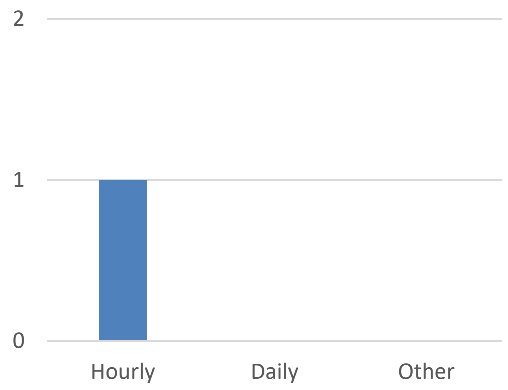


Figure 4-407. Temporal resolution of meteorological and climate in-situ networks in FYROM.

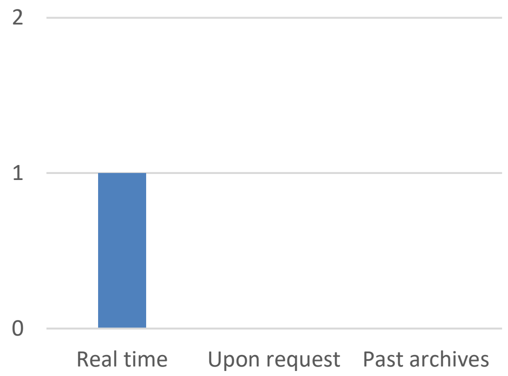


Figure 4-408. Data availability from meteorological and climate in-situ networks in FYROM.

Figure 4-409. Data policy of meteorological and climate in-situ networks in FYROM.

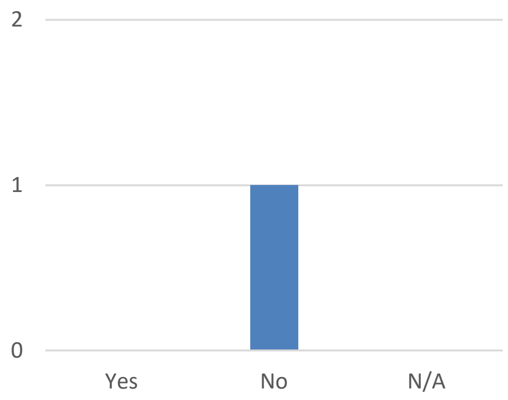


Figure 4-410. Availability of METADATA from atmospheric composition and profiling in-situ networks in FYROM.

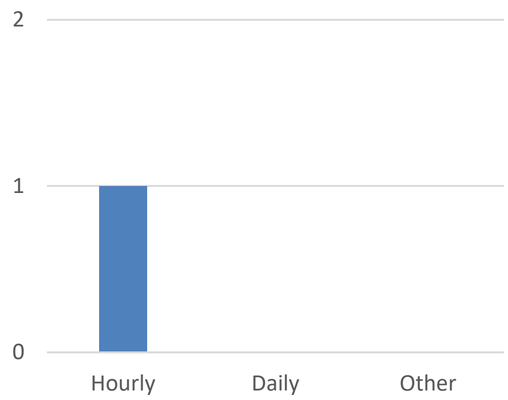


Figure 4-411. Temporal resolution of atmospheric composition and profiling in-situ networks in FYROM.

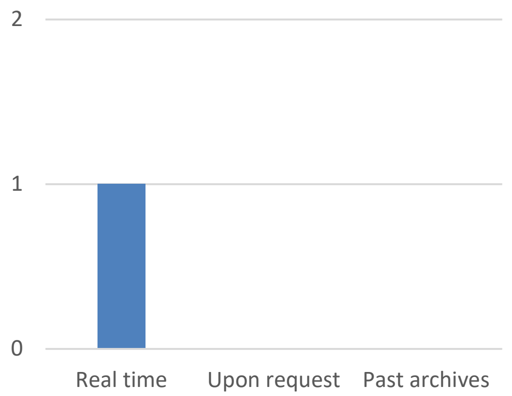


Figure 4-412. Data availability from atmospheric composition and profiling in-situ networks in FYROM.

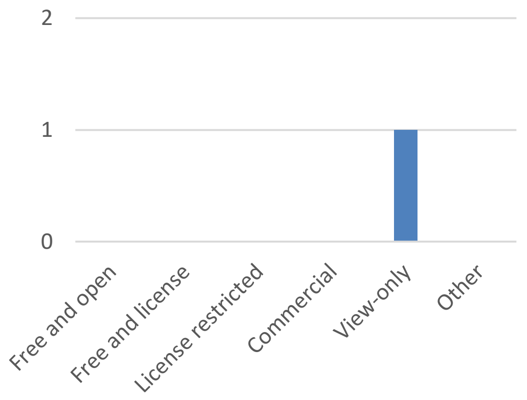


Figure 4-413. Data policy of atmospheric composition and profiling in-situ networks in FYROM.

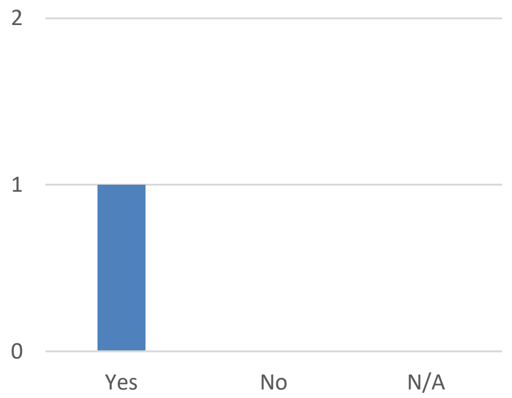


Figure 4-414. Availability of METADATA from hydrometric and water quality in-situ networks in FYROM.

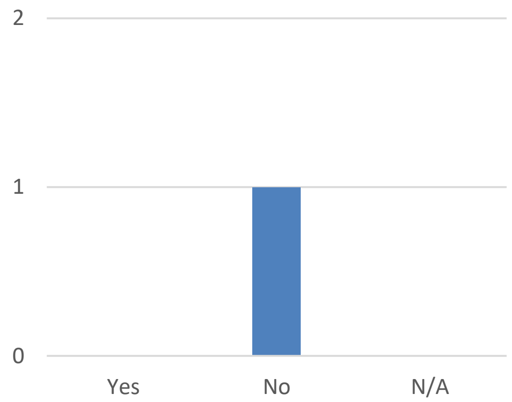


Figure 4-415. Availability of METADATA from soil attributes/spectra in-situ networks in FYROM.

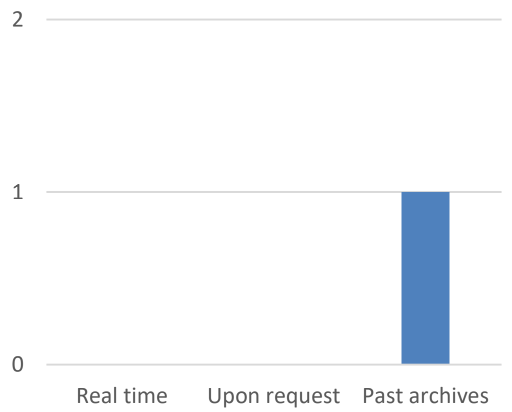


Figure 4-416. Data availability from soil attributes/spectra in-situ networks in FYROM.

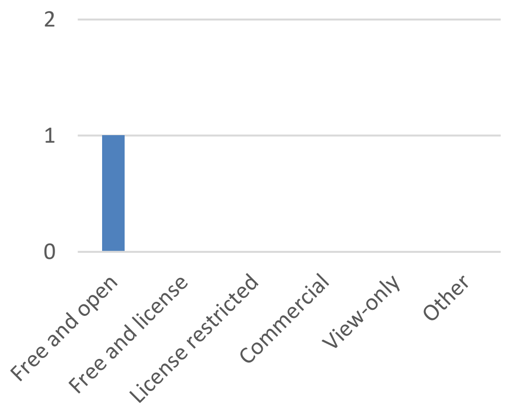


Figure 4-417. Data policy soil attributes/spectra in-situ networks in FYROM.

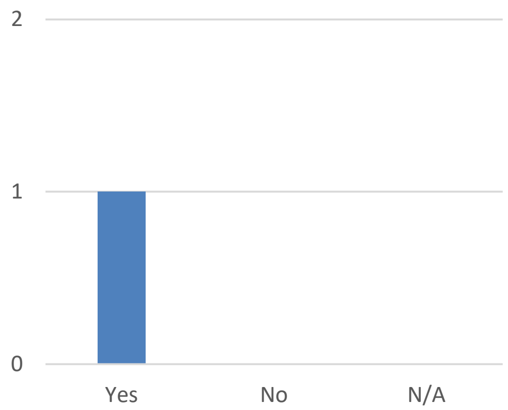


Figure 4-418. Availability of METADATA from energy/radiation in-situ networks in FYROM.

Modelling and processing capacities

Of the seven organizations reached by this survey, three were identified as institutional, two as commercial, and two as research based (Figure 4-419). These organizations are active in climate change and food security thematic areas (Figure 4-420). They have specified that they are also active in: watershed hydrology, GIS analysis and mapping as well as crisis management.

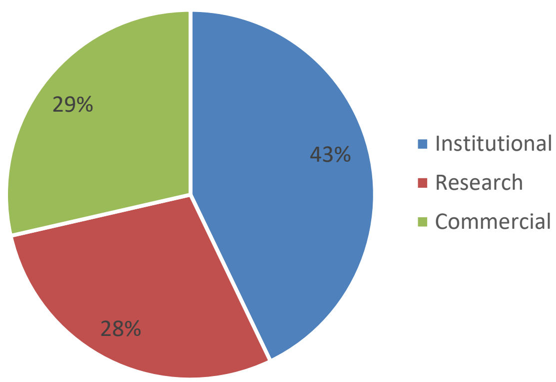


Figure 4-419. The type of organizations with modelling and processing capacities in FYROM.

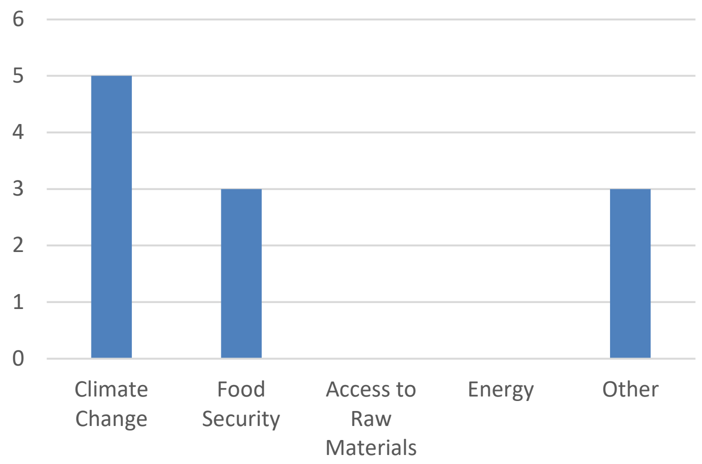


Figure 4-420. Activity of FYROM organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

Two organizations specified that they have not participated in previous EO-related projects while four have not, as seen in Figure 4-421. None of the respondents has taken part in Copernicus related activities or GEO/GEOSS SBA activities (Figure 4-422, Figure 4-423).

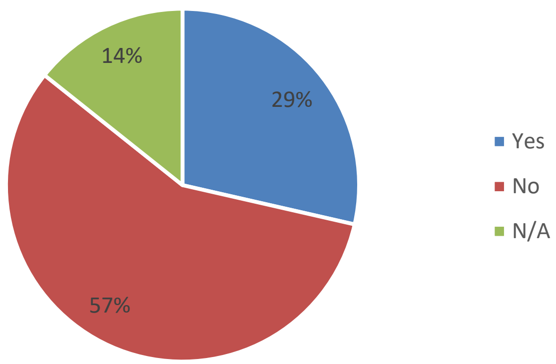


Figure 4-421. Participation of FYROM organizations with modelling and processing capacities in EO activities.

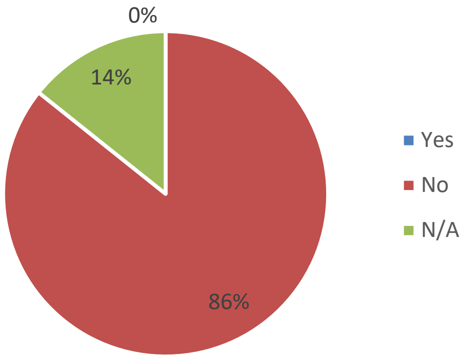


Figure 4-422. Participation of FYROM organizations with modelling and processing capacities in a Copernicus action.

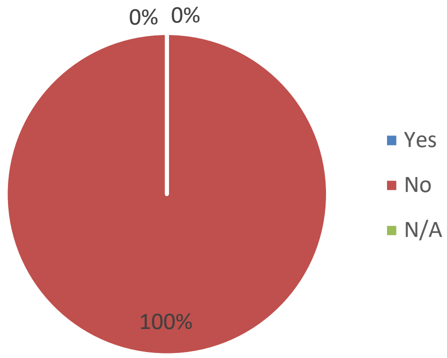


Figure 4-423. Participation of FYROM organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

83% of organizations described their local cooperation as low, and 17% described it as non-existent (Figure 4-424). Similarly, 29% described their international cooperation as low and 57% described it as non-existent (Figure 4-425).

Examples of local cooperation in FYROM are the development of a web portal for the FYROM Soil Information System.

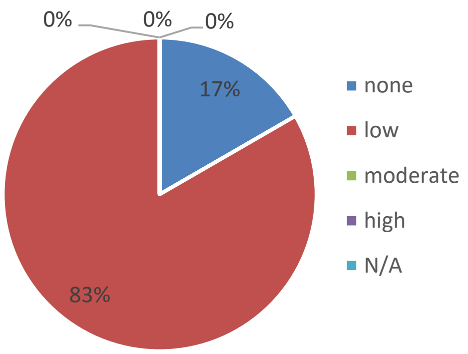


Figure 4-424. Level of cooperation of FYROM organizations with modelling and processing capacities with local EO actors.

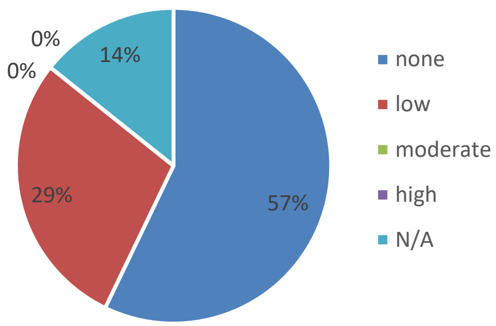


Figure 4-425. Level of cooperation of FYROM organizations with modelling and processing capacities with EO actors abroad.

All organizations have EO capacities besides modelling and processing capacities, as shown in Figure 4-426.

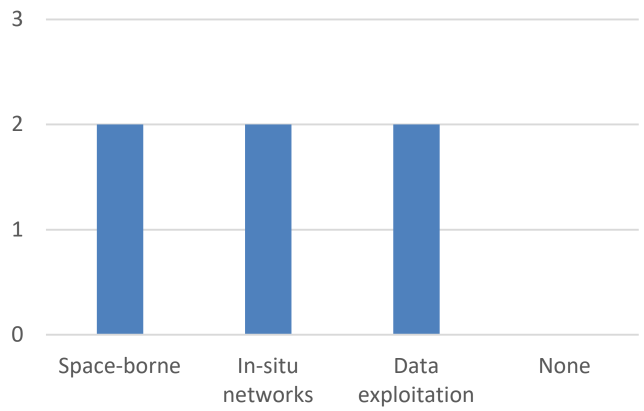


Figure 4-426. Additional EO capacities of FYROM organizations with modelling and processing capacities.

Models and algorithms identified by the survey all thematic areas except energy/radiation (Figure 4-427). Sources of EO data are varied, including geospatial data, remote sensing data and in-situ data (Figure 4-428). Other data sources include high resolution aerial photos and satellite images from LANDSAT.

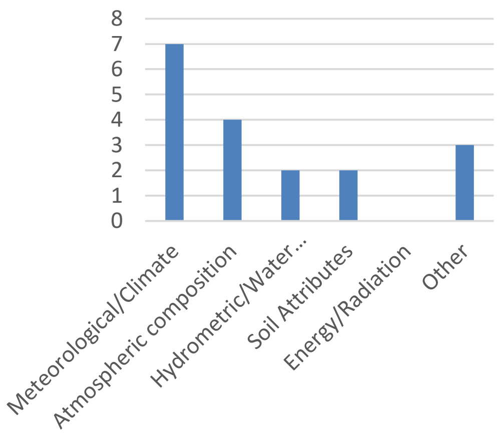


Figure 4-427. Algorithms and models available in FYROM by activity area.

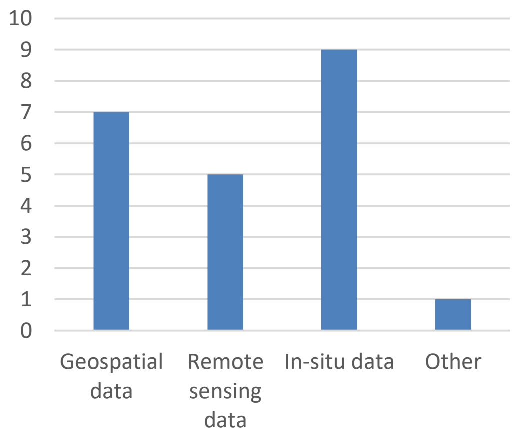


Figure 4-428. Sources of EO data used by organizations with modelling and processing capacities in FYROM.

Geographic coverage of the models is in large part national with no regional or global models (Figure 4-429). METADATA is available for eight models and it is not available for six models (Figure 4-430). It was specified that METADATA is provided for the FYROM Soil Information System. In regards to computing resources available, one server cluster was found as well as several facilities processing power capacity (Figure 4-431).

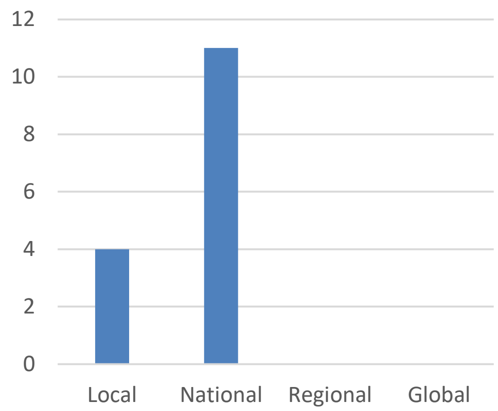


Figure 4-429. Geographic coverage of models and algorithms in FYROM.

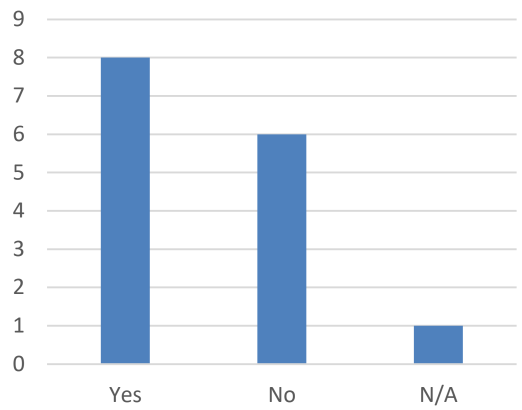


Figure 4-430. Availability of METADATA for models and algorithms in FYROM.

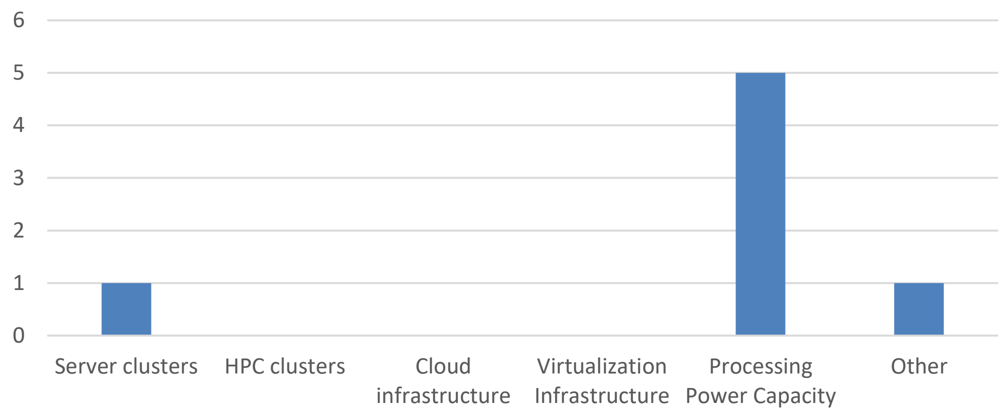


Figure 4-431. Computing resources available for processing and exploitation of EO data in FYROM.

Data exploitation capacities

Of the five organizations active in data exploitation reached, two are research-based and two are commercial (Figure 4-432). Two are active in food security, and four are active in *other* thematic areas, such as forestry, urban greenery, forest environment and natural hazards (Figure 4-433).

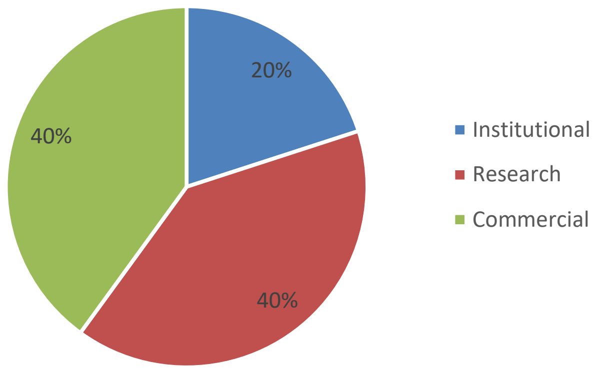


Figure 4-432. The type of organizations active in data exploitation in FYROM.

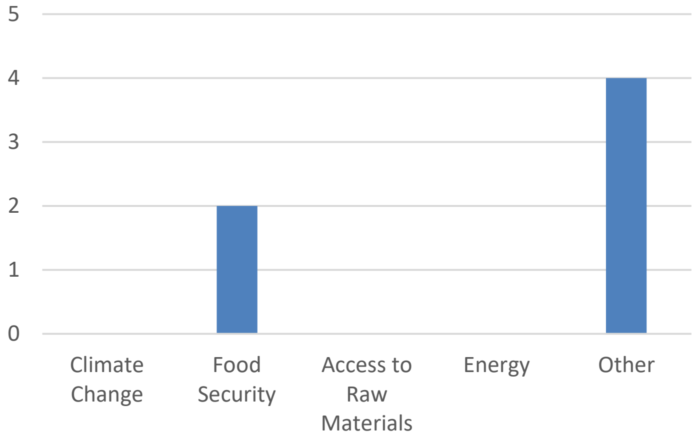


Figure 4-433. Activity of FYROM organizations active in data exploitation in GEO-CRADLE thematic areas.

Two organizations have not taken part in EO-related projects and two have (Figure 4-434). Examples of EO-related activities include: Capacity development on digital soil mapping and development of the Macedonian Soil Information System (MASIS), (FAO,TCP/MCD/3402). No respondents have taken part in Copernicus activities, or GEO/GEOSS SBA activities (Figure 4-435 and Figure 4-436).

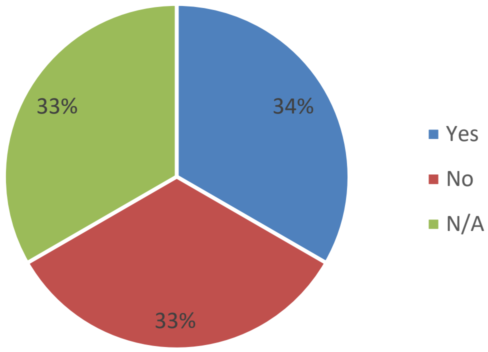


Figure 4-434. Participation of FYROM organizations active in data exploitation in EO activities.

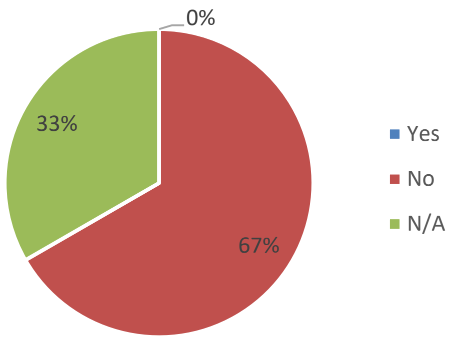


Figure 4-435. Participation of FYROM organizations active in data exploitation in a Copernicus action.

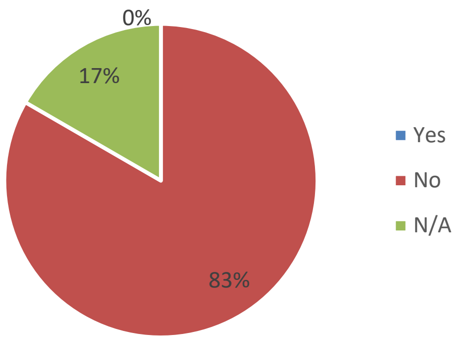
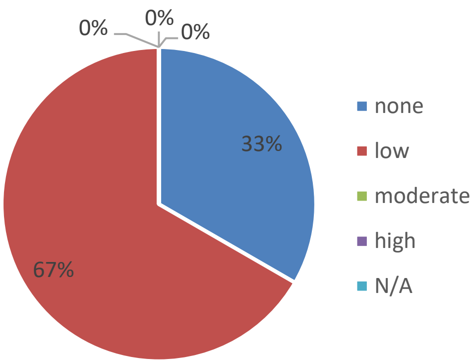


Figure 4-436. Participation of FYROM organizations active in data exploitation in a GEO/GEOSS SBA task.

67% of organizations have indicated low local cooperation and 33% have none; 67% of organizations have indicated no international cooperation and 16% have low (Figure 4-437, Figure 4-438). One respondent further explained that their low cooperation with local EO actors is due to difficulties in the financial and administrative operation of projects.



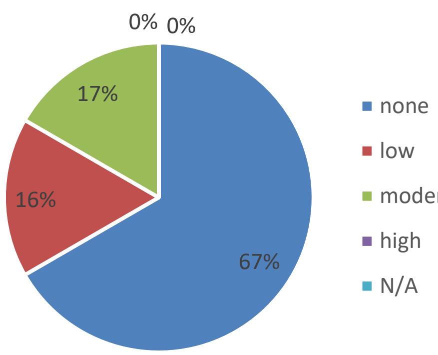


Figure 4-437. Level of cooperation of FYROM organizations active in data exploitation with local EO actors.

Figure 4-438. Level of cooperation of FYROM organizations active in data exploitation with EO actors abroad.

Beyond data exploitation capacities organizations indicated having capacities in in-situ networks and modelling and processing (Figure 4-451).

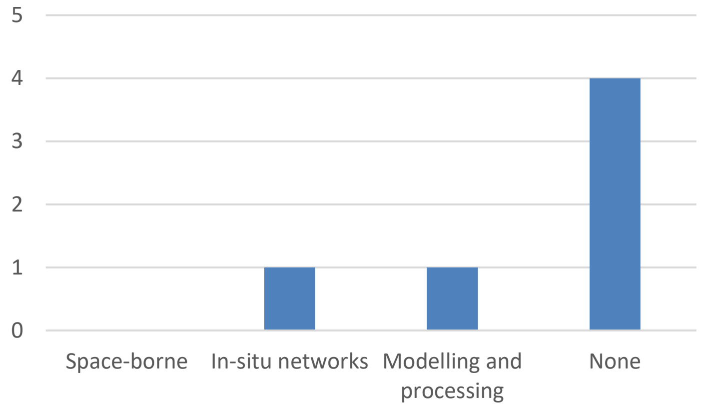


Figure 4-439. Additional EO capacities of FYROM organizations active in data exploitation.

The surveyed organizations have a wide range of EO products (Figure 4-440).

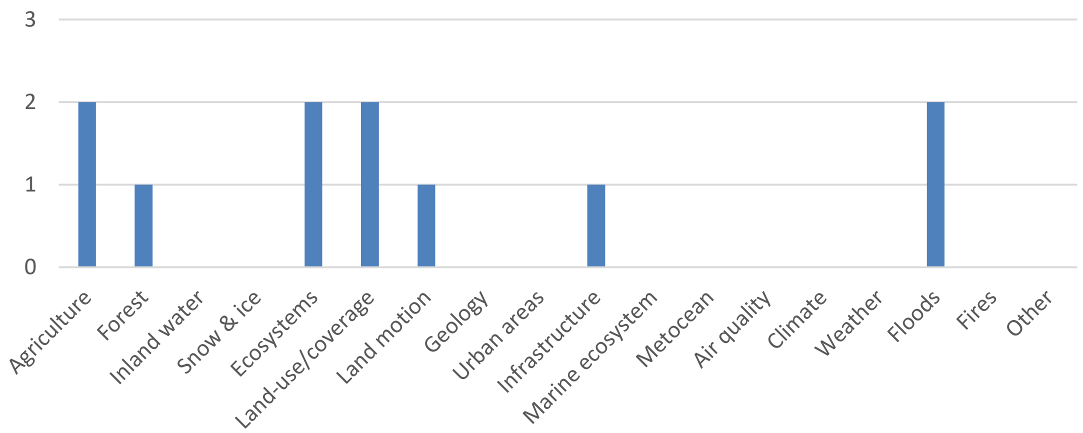


Figure 4-440. Activity areas of EO products/services of FYROM organizations.

National activities

Four organizations indicated there was no funding for EO activities, while three indicated that there was such funding (Figure 4-441). Organizations also indicated that funding was available for infrastructure development and R&D (Figure 4-442).

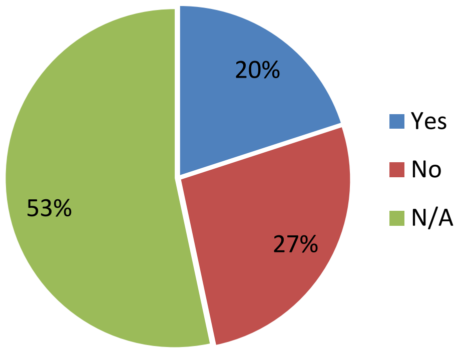


Figure 4-441. FYROM EO actors' perception of the availability of national funding for EO.

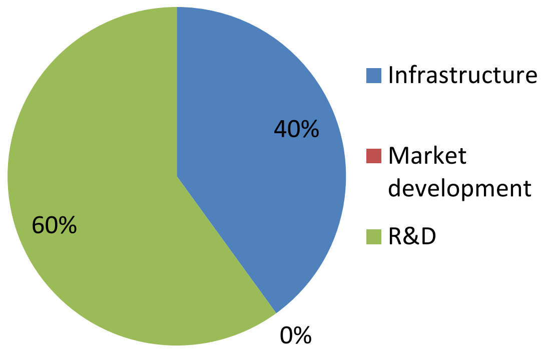


Figure 4-442. FYROM EO actors' perception of areas for which national EO funding is available.

FYROM does not have a space strategy or a space program, which was reflected in the survey answers of respondents (Figure 4-443 and Figure 4-444).

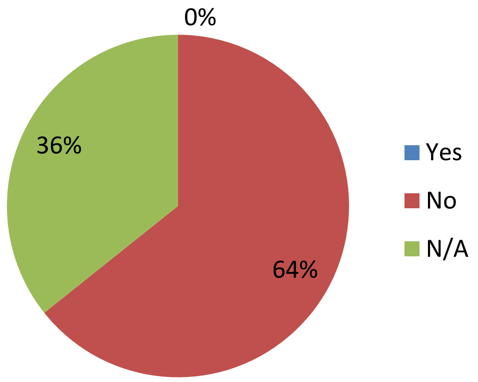


Figure 4-443. FYROM EO actors' awareness of a space strategy in FYROM.

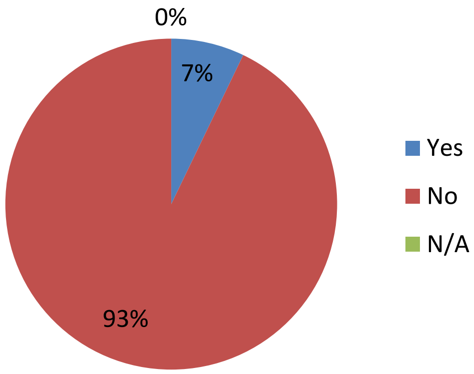
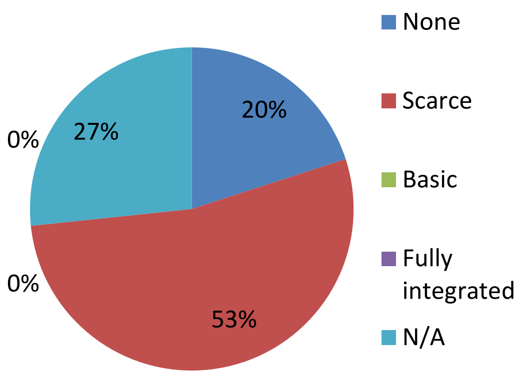


Figure 4-444. FYROM EO actors' awareness of a space program in FYROM.

Both coordination of EO activities and interaction with decision makers is overwhelmingly expressed as scarce (Figure 4-445 and Figure 4-446).



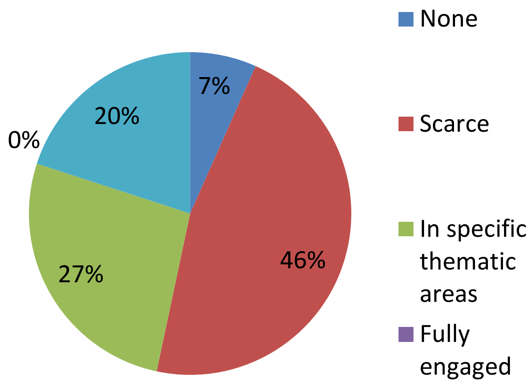


Figure 4-445. FYROM EO actors' perception of national coordination of EO activities in FYROM.

Figure 4-446. FYROM EO actors' perception of interaction with decision makers in FYROM.

The majority of respondent organizations expressed willingness to participate in future regional Copernicus and GEO initiative by contributing their capacities. 54% said they would be willing to further collaborate, while 23% responded they would be willing to collaborate under specific circumstances (Figure 4-447).

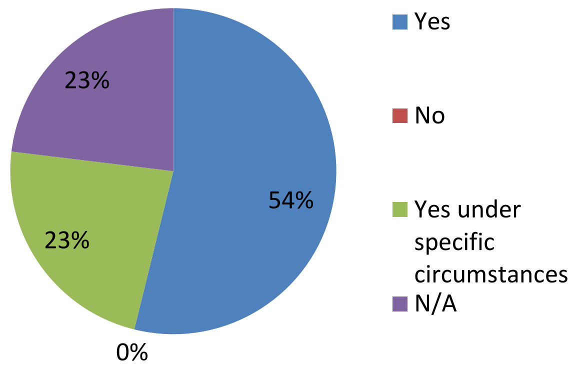


Figure 4-447. FYROM EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

The majority of respondent organizations in FYROM (75%) indicated having an awareness of both GEO and Copernicus.

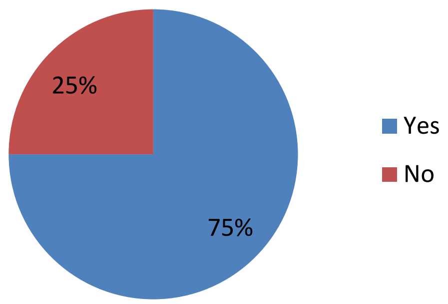


Figure 4-448. End-user awareness of Copernicus in FYROM.

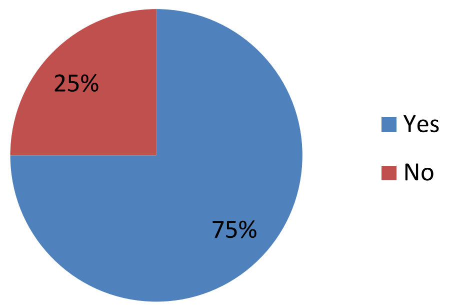


Figure 4-449. End-user awareness of GEO in FYROM.

4.7.3. *Gap analysis*

No **geographic** or **observational** gaps could be discerned from end-user interviews.

Large **structural** gaps were identified. Sharing data between organizations is at a low level, sharing that does occur is subject to a complicated legal framework that results in delays, as verified by two end-users. Another end-user claimed that they are unable to access data from data-producers and providers. This underlying complexity is reflected in survey results: 50% of organizations with in-situ networks have low or no local cooperation, 67% have low or no international cooperation; 100% of organizations with modelling and processing capacities have low or no local cooperation and 86% have no or low international cooperation; and 100% of data exploiters have no or low local cooperation and 83% have low or no international cooperation. One of the end-users is the coordinating partner implementing the INSPIRE directive through the National Infrastructure of Spatial Data. They expect the situation to significantly improve.

Gaps in the **quality/quantity** of data were identified. Half of the interviewed end-users claimed that they relied on data with quality significantly below their needs, including data that is not up to date. Data received is often in analog form and non-standardized GIS data. Overall, one end-user stated that under 40% of data received was in a suitable format. This results in data products that are below the quality level that the end-user believes can be produced, and in significant resources being devoted to processing incoming data.

Significant gaps in **capacity** were validated. All public actors had limitations in regards to a need for trained staff, to conduct field, analytical and IT functions. It is unclear from the capacities survey to what this lack of available skills is attributed, whether it is lack of education/training or a large brain drain mentioned in the country overview. Based on desk research, it is likely that the public sector is not able to attract needed skills facing budget cuts. Similarly, public institutions do not have access to the equipment and software they require due to a lack of funds. In comparison, the one private company interviewed does not have a gap with available equipment or with the capacity of its human resources.

There is insufficient information from end-user interviews to make thematic area specific conclusions. From the capacities, it is clear that hydro-meteorological capacities are the most advanced, and that data for soil, energy and radiation is largely conducted manually where necessary. Large structural and capacity gaps most likely effect organizations active in all thematic areas in the country.

4.8. Romania

4.8.1. *Overview*

EO capacities have grown significantly in the last years in Romania. The main reason is financing of space-related projects through the Romanian Space Agency's (ROSA) Space Technology and Advanced Research program (STAR) and the National Program of R&D Innovation under the coordination of the Executive Unit for University, Research and Innovation Financing. More than 50% of the overall institutions participating in such programs are either research and development institutes or universities. Private companies are also involved in both research projects and industrial EO activities. The main activities of R&D-active public institutions consist of data acquisition, analysis, software development and promoting environmental and space science in the Bachelor, Master and Doctoral studies. The companies mainly provide hardware and software services. Following an increase in expertise, Romania has also increased its participation in ESA programs and missions.

Most of the contracts with ESA are narrow in scope and targeted, addressing the very exclusive expertise of one or two Romanian institutions. As such, multi-disciplinary and large activities are still sparse for public and private research infrastructures. Insufficient access to information about existing capacities and expertise coupled with a lack of a tradition in collaboration leads to many institutions building similar infrastructures instead of sharing resources. Also, the Romanian representation in ESA committees is at a medium level, due to the fact that the community is still not consolidated and not fully organized. One important reason is that the country recently joined ESA and started a consolidated approach regarding EO activities.

Romania's participation in EO programs can significantly improve by creating a framework of collaboration between the different actors – space competence centers, universities, research institutions, private companies – in the EO field. Romania can become an important actor in European EO activities by overcoming the fragmentation of the industry and promoting joint initiatives, and boosting the use of EO data in various economic sectors at a national level. Workshops presenting EO activities are organized yearly to promote this field of activities and to attract more institutions to contribute. Another kind of event organized annually, brings students from primary to high school on visits to research institutions and companies. They have the chance to see what the institutions are doing and have a hands-on experience. Another opportunity for publicity and outreach to end-users is participation at public events such as Researchers Night, where EO activities performed by research institutions and companies are presented.

A couple of networks cooperate regarding EO activities at the national level, extending their activities continuously and attracting more participants. EO involves different scientific fields: land observations, marine remote sensing, atmospheric remote sensing, climate change, etc. The Romanian scientific community is involved in most of the above mentioned fields. Moreover, the national industry has a great potential for scientific instruments development, platform development, ground segment and space applications development. The creation of a coherent cluster could facilitate the relation between the scientific community (instrument definition) with the industry (instrument developers) and the space application sector (value adders). The primary goal here would be to increase the Romanian contributions to EO activities towards multi-disciplinary, high-complexity projects and also to create a critical mass of expertise that could support Romania's interests in EO missions.

The impact of national funding on EO activities is in its early stages in Romania, leading to the creation of a solid scientific community regarding different EO field activities. Therefore an increase of interest in ESA programs and missions has been also developed. Romania is becoming an active scientific actor for European and global communities and networks. This chain reaction continues with the development of several Centers for Earth Observation which have state-of-the-art systems and instruments and present a great opportunity for Romanian scientific researchers to do EO related work and to become key players in the European and global EO networks.

4.8.2. *Capacities*

Space-borne capacities

In Romania the survey reached four organizations with space-borne capacities: three research oriented and one institutional (see Figure 4-450).

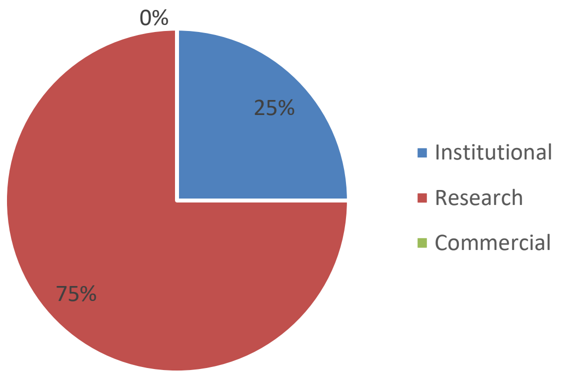


Figure 4-450. Types of organizations with space-borne capacities in Romania.

Most of these organizations are active in climate change (see Figure 4-451).

Figure 4-451. Activity of Romanian organizations with space-borne capacities in GEO-CRADLE thematic areas.

As far as participation in EO related projects is concerned, a large majority of respondents indicate that their organizations have participated in such projects (see Figure 4-452). Examples include:

- ACTRIS
- AQUAGRO
- MULTIPLY

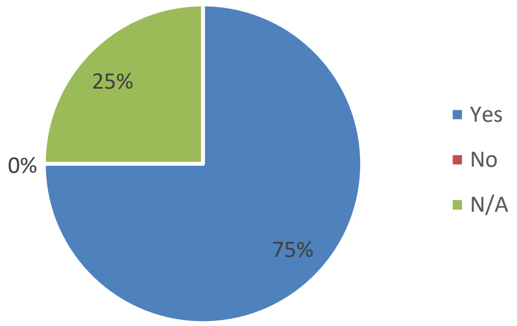


Figure 4-452. Participation of Romanian organizations with space-borne capacities in EO activities.

Two respondents have participated in Copernicus (see Figure 4-453), and one participated in GEO/GEOSS SBA tasks (see Figure 4-454).

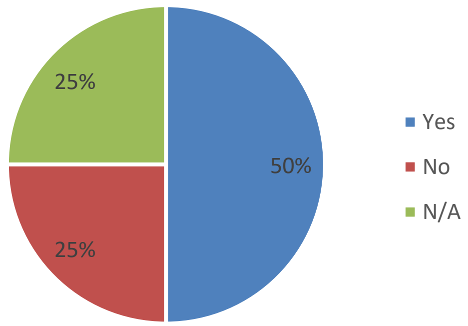


Figure 4-453. Participation of Romanian organizations with space-borne capacities in a Copernicus action.

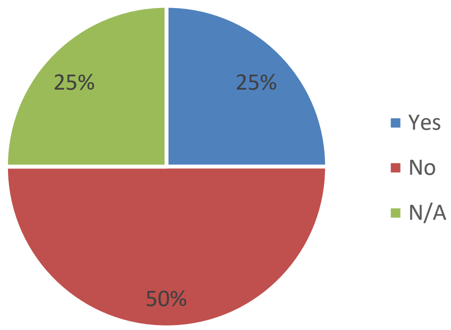


Figure 4-454. Participation of Romanian organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

Locally, the level of collaboration with EO actors is moderate for three organizations (see Figure 4-455). Similarly, on an international level collaboration with EO actors is rated as moderate by two organizations and high by one (see Figure 4-456).

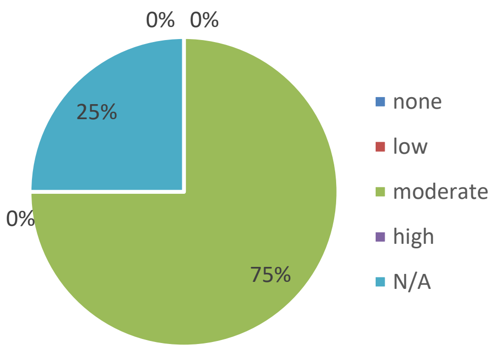


Figure 4-455. Level of cooperation of Romanian organizations with space-borne capacities with local EO actors.

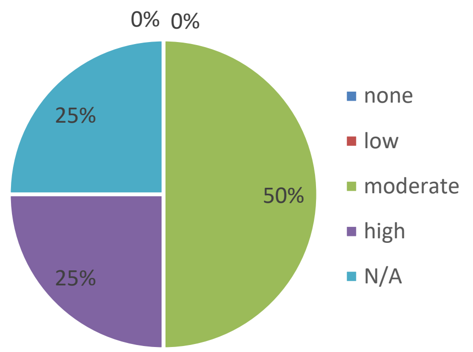


Figure 4-456. Level of cooperation of Romanian organizations with space-borne capacities with EO actors abroad.

Most respondents have other EO capacities. Two organizations have no other capacities apart from in-situ capacities (see Figure 4-457).

While there are no organizations with satellite capacities, there are two organizations with ground segments as shown in Figure 4-458. Respondents did not specify any satellite missions owned/operated by their organizations.

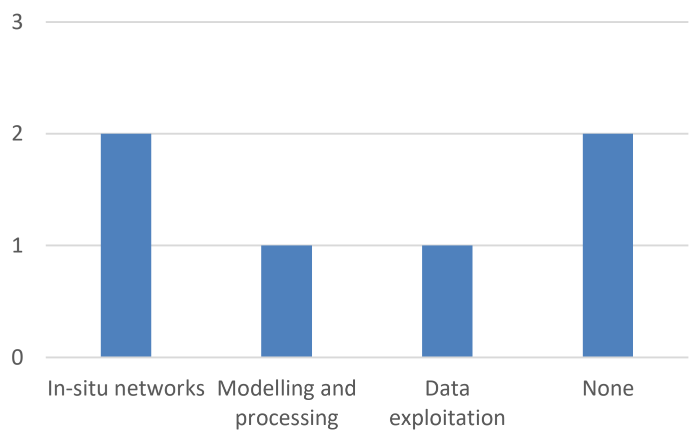


Figure 4-457. Additional EO capacities of Romanian organizations with space-borne capacities.

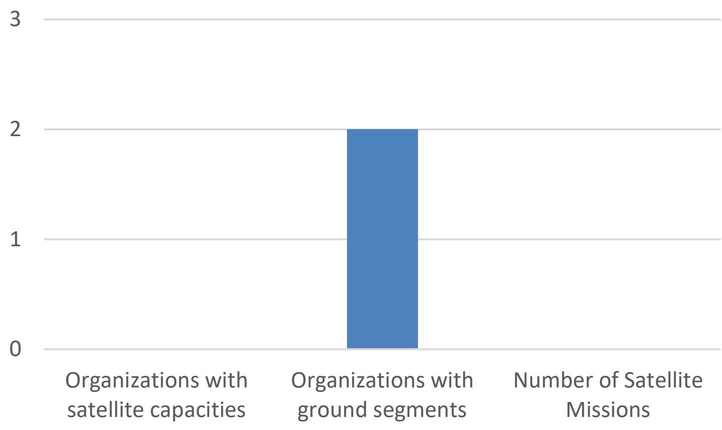


Figure 4-458. Type of space-borne capacities of Romanian organizations.

Respondents specified details about the space-missions that they participate in. Geographic coverage is either national or global (see Figure 4-459), and no data catalogues are available (see Figure 4-460).

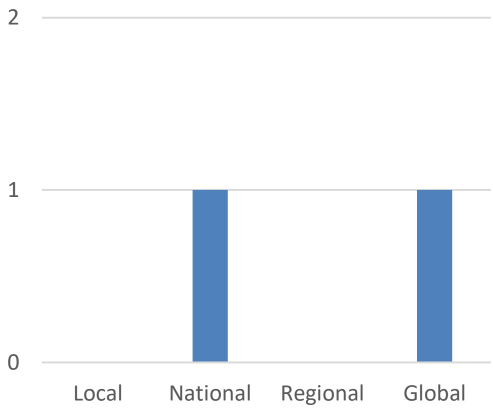


Figure 4-459. Geographic coverage of Romanian satellite missions.

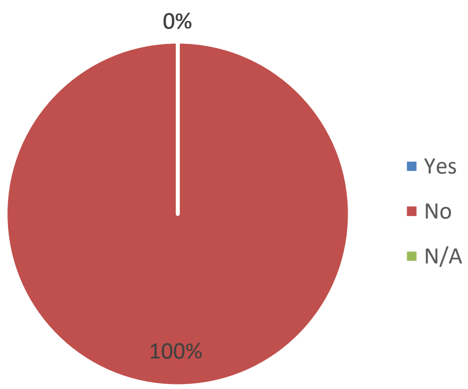


Figure 4-460. Availability of catalogues of Romanian satellite missions.

Data collected is available upon request (see Figure 4-461). One organization specified their data had a license restricted policy applied; one organization applied a policy for which it provided no details (see Figure 4-462).

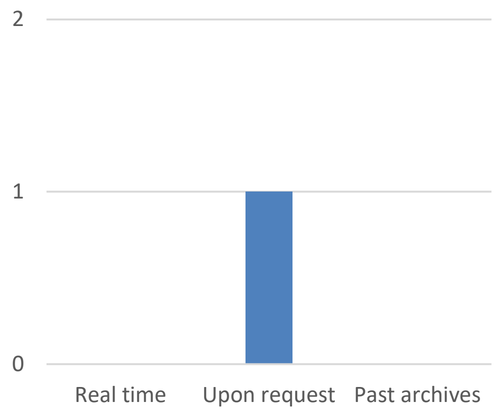


Figure 4-461. Data availability from Romanian satellite missions.

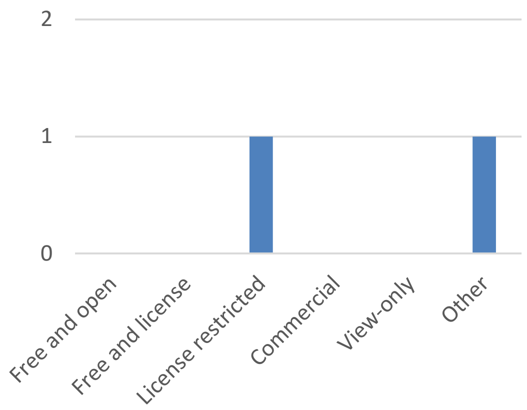


Figure 4-462. Data policy of Romanian satellite missions.

In-situ networks and facilities

As shown in Figure 4-463, the survey reached 11 organizations with in-situ networks in Romania, all of which are research-oriented.

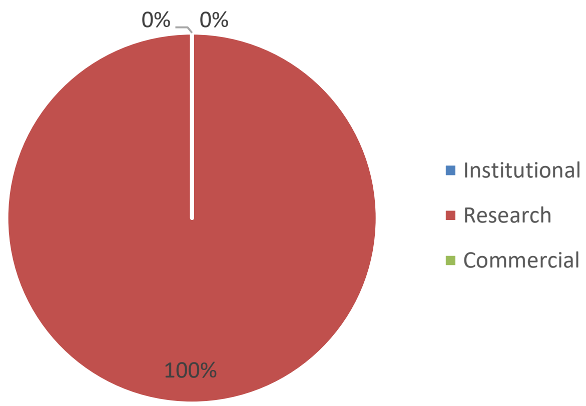


Figure 4-463. The type of organizations with in-situ networks in Romania.

Most organizations with in-situ capacities are primarily active in climate change, while the other thematic areas of GEO-CRADLE (see Figure 4-464) are covered too. One organization specified that it is also active in seismology.

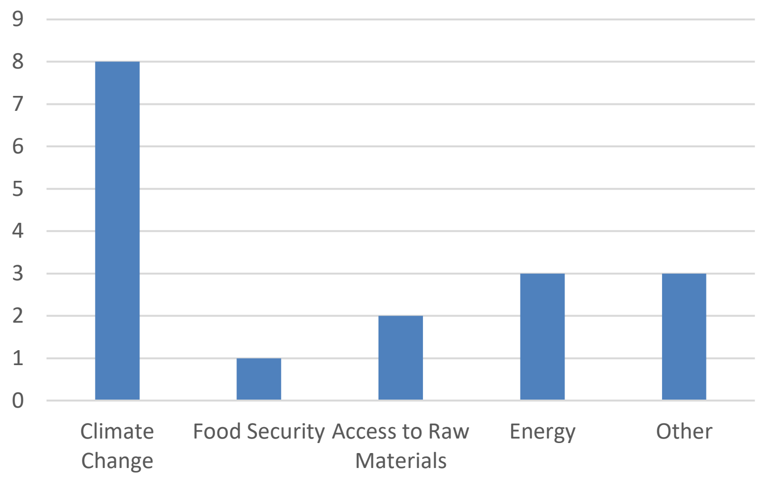


Figure 4-464. Activity of Romanian organizations with in-situ networks in GEO-CRADLE thematic areas.

Most organizations with in-situ capacities have participated in EO related projects (see Figure 4-465). Examples of such projects include:

- EPOS
- FP7 ACTRIS
- H2020 ACTRIS

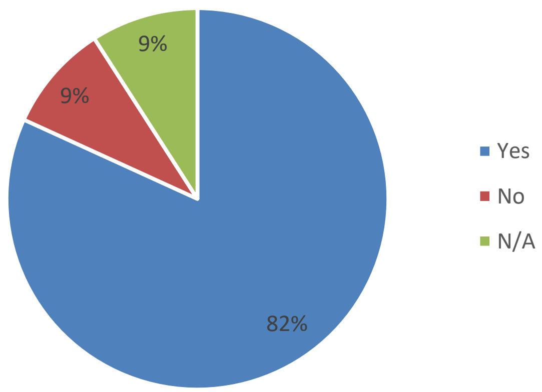


Figure 4-465. Participation of Romanian organizations with in-situ networks in EO activities.

27% of organizations have participated in Copernicus while 37% have not (see Figure 4-466). 9% of organizations have taken part in GEO/GEOSS SBA tasks, community activities or initiatives while 55% have not (see Figure 4-467).

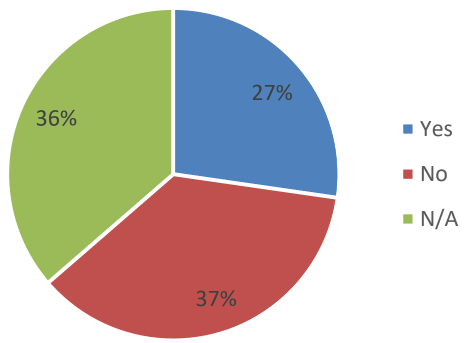


Figure 4-466. Participation of Romanian organizations with in-situ networks in a Copernicus action.

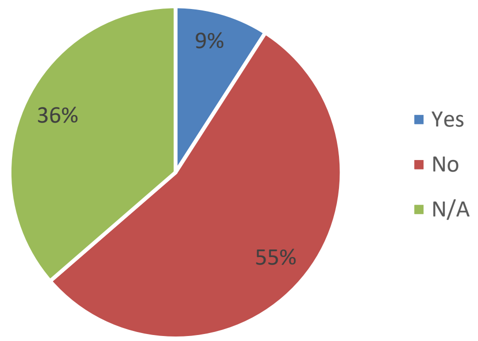


Figure 4-467. Participation of Romanian organizations with in-situ networks in a GEO/GEOSS SBA task.

A majority of respondents have low collaboration with local EO actors (55%), while 27% have high collaboration (see Figure 4-468). In contrast, the picture is reversed internationally: 27% have low collaboration while 55% have a high level of collaboration (see Figure 4-469).

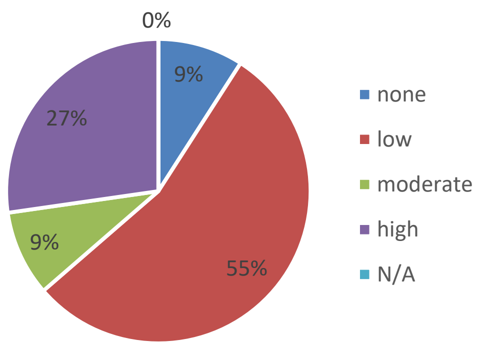


Figure 4-468. Level of cooperation of Romanian organizations with in-situ networks with local EO actors.

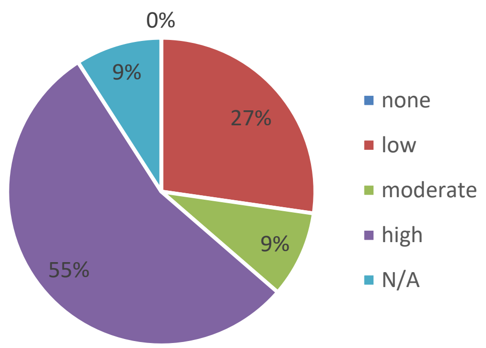


Figure 4-469. Level of cooperation of Romanian organizations with in-situ networks with EO actors abroad.

Examples of collaborative activities are:

- EARLINET
- AERONET
- MWRNET

Most organizations also have modelling, data exploitation capacities, or space-borne capacities; only two organizations have no other capacities apart from in-situ capacities (see Figure 4-470).

As shown in Figure 4-471, respondents indicated that there are 29 meteorological/climatic stations, 9 atmospheric composition stations, 2 hydrometric/water quality stations and 2 energy/radiation stations in Romania. No soil attributes/spectra stations were identified by the survey.

As far as geographic coverage is concerned, most networks have local and national coverage (see Figure 4-472). Several networks in meteorology/climate and atmospheric composition have regional and global coverage.

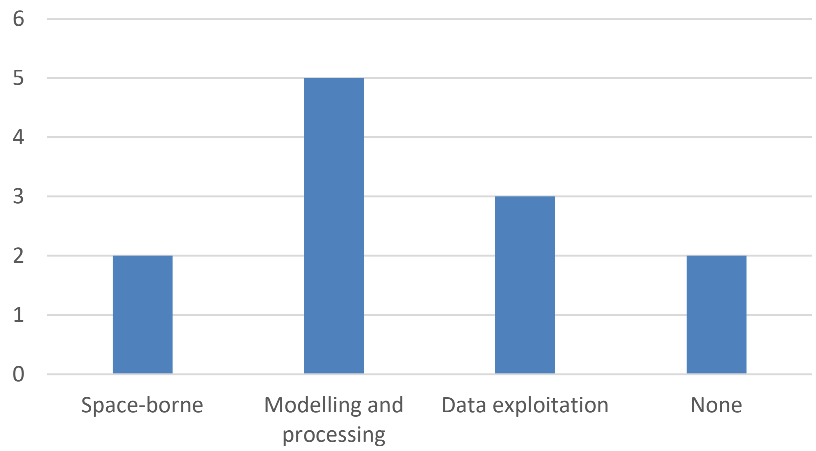


Figure 4-470. Additional EO capacities of Romanian organizations with in-situ networks.

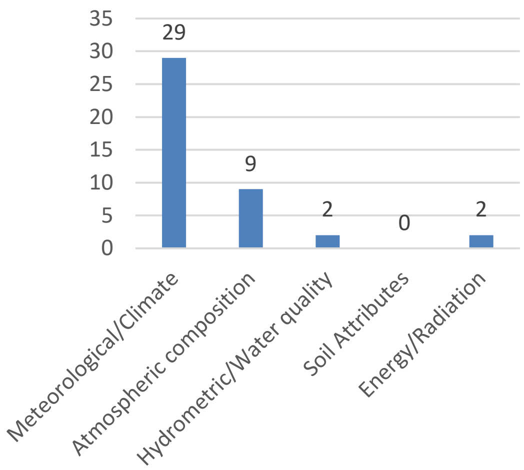


Figure 4-471. Number of stations of in-situ

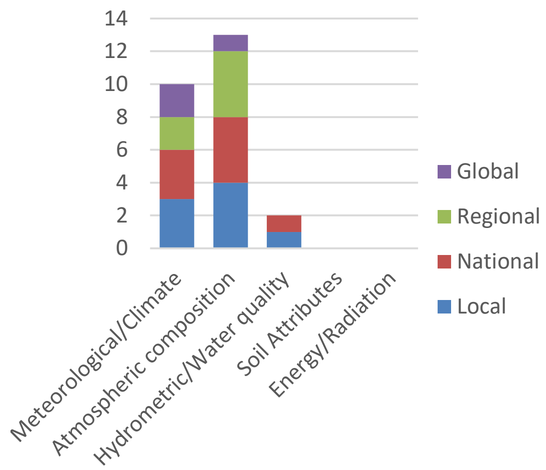


Figure 4-472. Geographic coverage of in-situ

networks in Romania by activity area. *networks in Romania by activity area.*

Most meteorological/climatic, atmospheric and energy/radiation stations/facilities are registered in some national/regional/international network. However, as shown in Figure 4-473, hydrometric/water stations/facilities in Romania are not registered in any network.

The survey shows that data is collected and stored systematically for meteorological/climatic stations, atmospheric composition/profiling, and energy/radiation stations (see Figure 4-474). The survey did not identify hydrometric/water quality networks for which data is systematically collected. Organizations indicated that data is also systematically collected for earthquake/seismic, GPS/GNSS, infrasound and magnetism networks.

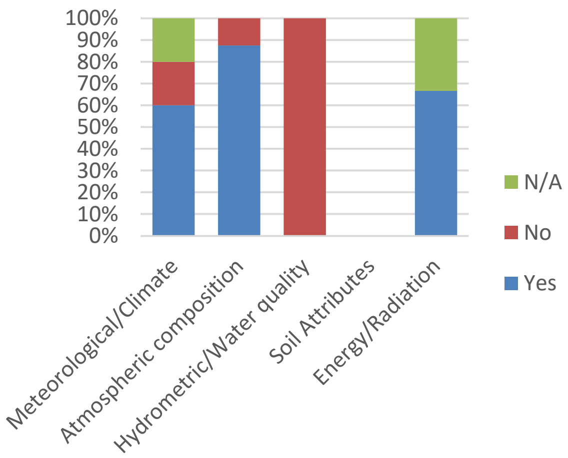


Figure 4-473. Registration of in-situ networks in Romania by activity area.

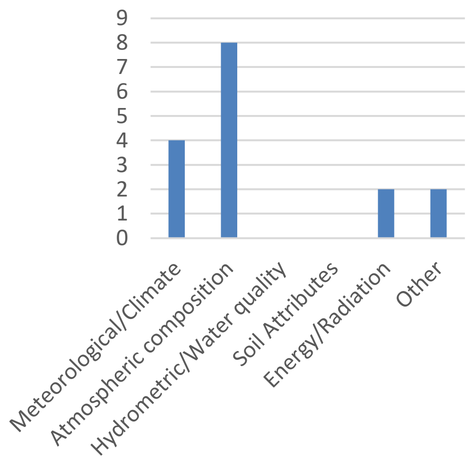


Figure 4-474. Systematic collection of data by in-situ networks in Romania by activity area.

As far as **meteorological/climatic in-situ networks** are concerned, METADA is mostly not available (see Figure 4-475). Details on temporal resolution of data is sparse, one network specified an hourly resolution and another specified daily resolution (see Figure 4-476). One organization has a monthly resolution. Data is available either upon request (1 organization), or from the past archives (1 organization), as seen in Figure 4-477. No details were provided on data policy applied for meteorological/climatic facilities.

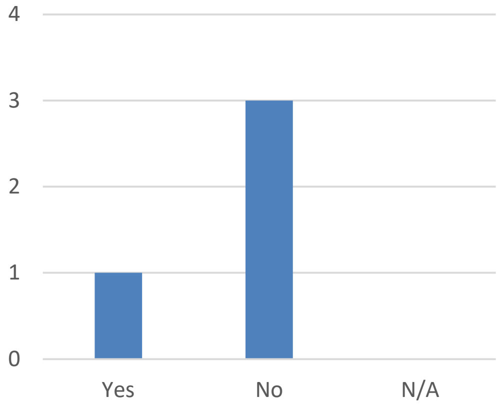


Figure 4-475. Availability of METADATA from meteorological and climate in-situ networks in Romania.

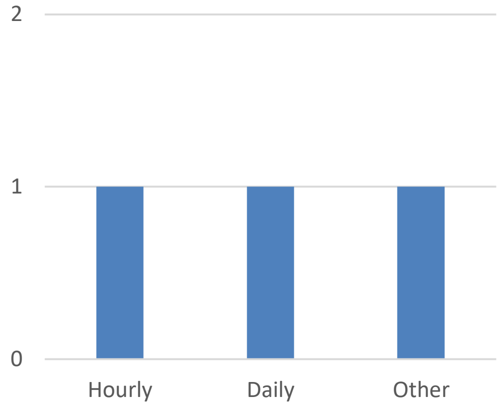


Figure 4-476. Temporal resolution of meteorological and climate in-situ networks in Romania.

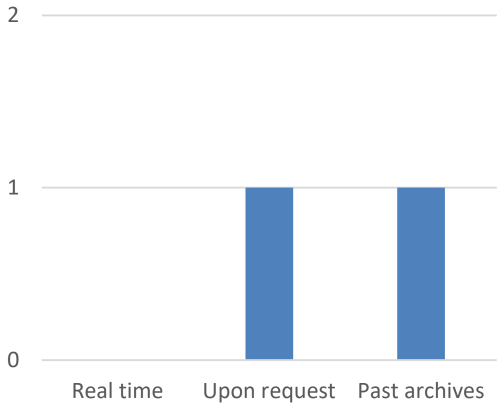


Figure 4-477. Data availability meteorological and climate in-situ networks in Romania.

Most respondents have confirmed the availability of METADATA for **atmospheric composition/profiling in-situ networks** (see Figure 4-478). In the survey, respondents show the existence of both hourly and daily temporal resolutions (see Figure 4-479). For most organizations, data is available real time, however, some respondents have their data available upon request (see Figure 4-480). Few details were specified for data policy: two organizations have free and open, and one has free and license restricted (see Figure 4-481).

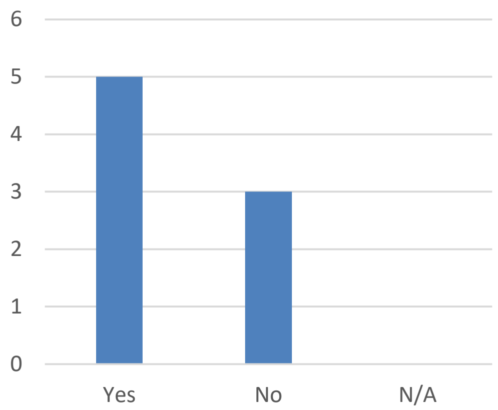


Figure 4-478. Data availability of atmospheric composition and profiling in-situ networks in Romania.

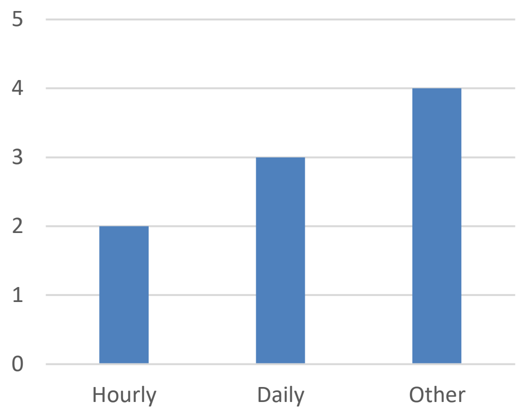


Figure 4-479. Temporal resolution of atmospheric composition and profiling in-situ networks in Romania.

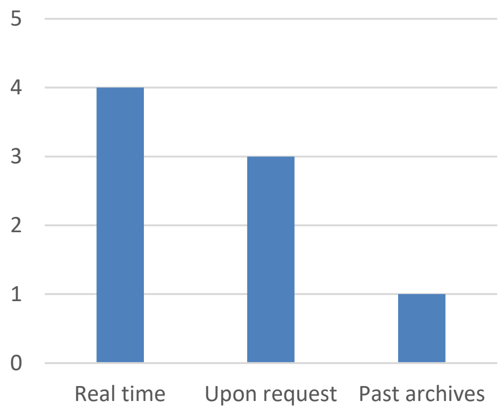


Figure 4-480. Data availability of atmospheric composition and profiling in-situ networks in Romania.

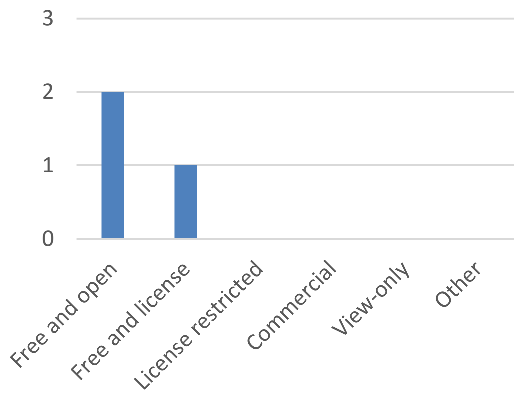


Figure 4-481. Data policy of atmospheric composition and profiling in-situ networks in Romania.

No information was provided for both **hydrometric/water in-situ networks** and **soil attributes/spectra in-situ networks** on the availability of METADATA, temporal resolution, data availability, and data policy.

As far as **energy/radiation facilities** are concerned, METADATA is not available (see Figure 4-482). Temporal resolution of data acquisition, as stated by one respondent, is daily (see Figure 4-483). As shown in Figure 4-484, data is available from past archives. No information was provided in relation to the main data policy applied.

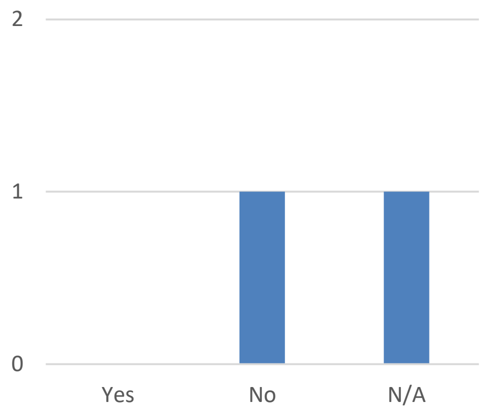


Figure 4-482. Availability of METADATA from energy/radiation facilities in Romania.

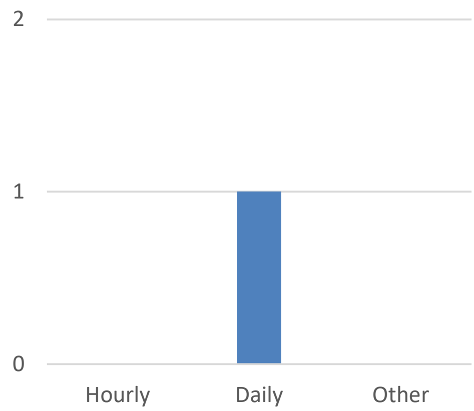


Figure 4-483. Temporal resolution of energy/radiation facilities in Romania.

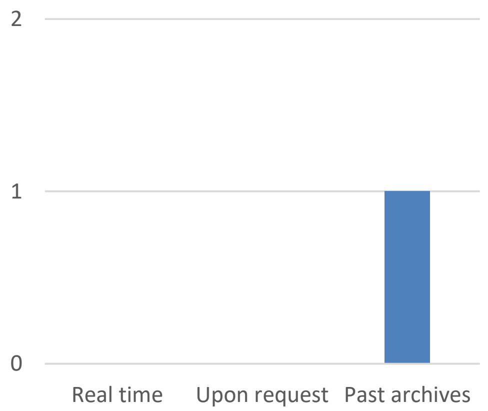


Figure 4-484. Data availability from energy/radiation facilities in Romania.

Modelling and processing capacities

As shown in Figure 4-485, in Romania, the survey reached six organizations with modelling and processing capacities, all of which are institutional.

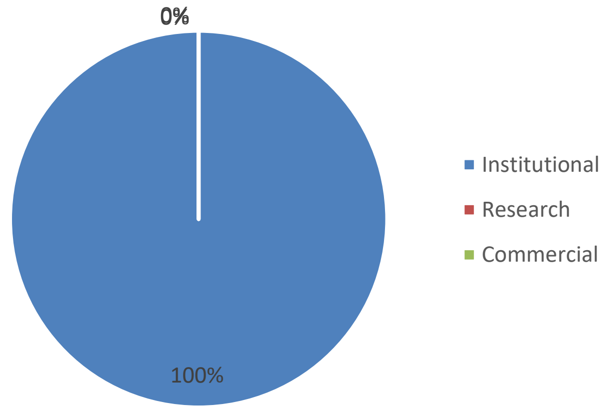


Figure 4-485. The type of organizations with modelling and processing capacities in Romania.

A large majority of organizations are active in climate change, one is active in energy (see Figure 4-486). Other thematic areas of activity include materials science, GNSS, laser applications, dosimetry, electronics, automations and control, applied chemistry.

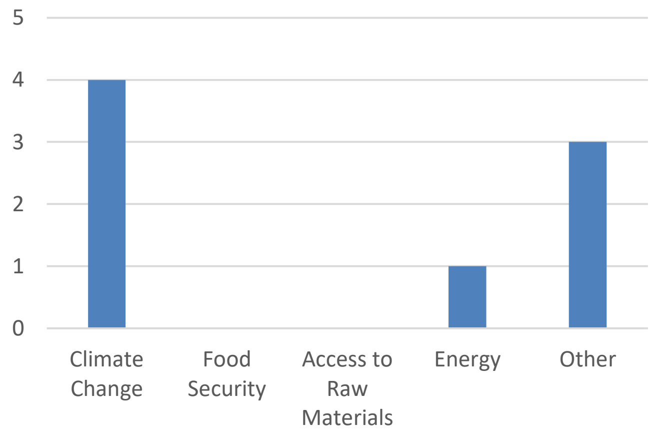


Figure 4-486. Activity of Romanian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

All respondents have indicated that their organizations have taken part in EO related projects (see Figure 4-487).

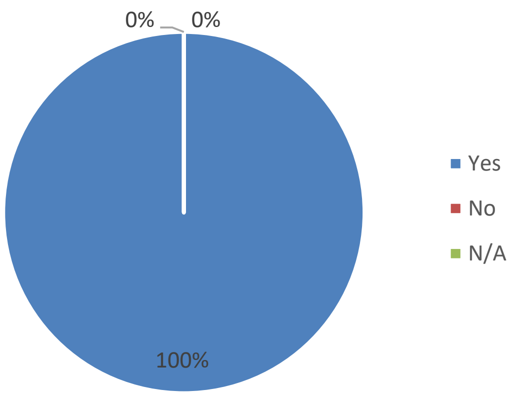


Figure 4-487. Participation of Romanian organizations with modelling and processing capacities in EO activities.

Examples of EO related projects in which Romanian organizations with modelling capacities have taken part include:

- FP7 ACTRIS
- H2020 ACTRIS-2
- EPOS
- SOLACE

Three organizations have not taken part in any Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action, while one has (see Figure 4-488). The same result can be seen for participation in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-489).

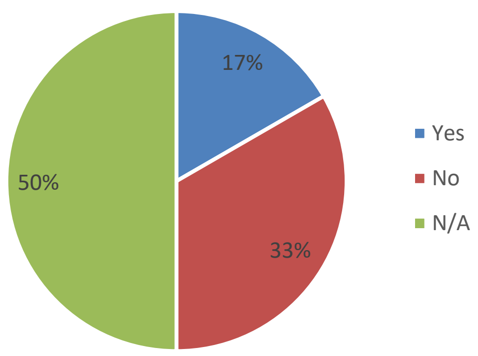


Figure 4-488. Participation of Romanian organizations with modelling and processing capacities in a Copernicus action.

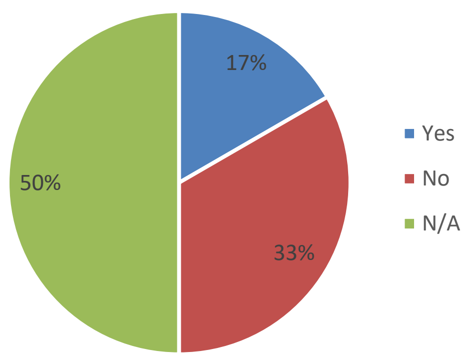


Figure 4-489. Participation of Romanian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

The level of collaboration with other EO actors ranges from low to high on a local level: 33% high, 33% moderate and 33% low (Figure 4-490). On an international level, collaboration is high for 33% of organizations with modelling and processing capacities and low for 33% (see Figure 4-491).

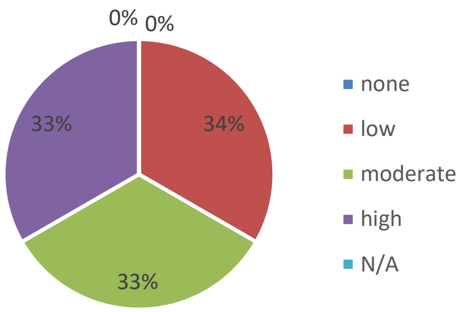


Figure 4-490. Level of cooperation of Romanian organizations with modelling and processing capacities with local EO actors.

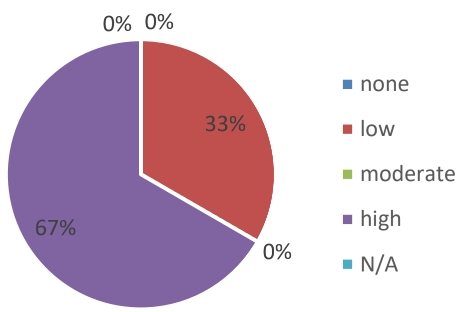


Figure 4-491. Level of cooperation of Romanian organizations with modelling and processing capacities with EO actors abroad.

Only one organization has no additional EO capacities (see Figure 4-492). Five have in-situ networks and four are active in data exploitation.

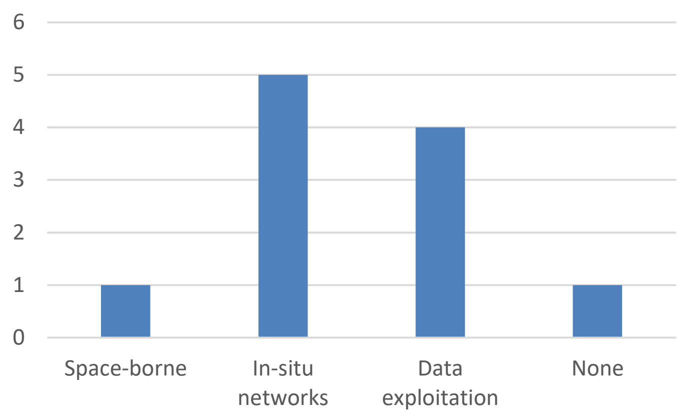


Figure 4-492. Additional EO capacities of Romanian organizations with modelling and processing capacities.

Most models serve the following application areas: meteorological/climate and atmospheric composition, one collects energy/radiation data (see Figure 4-493). The most common type of EO data used in the model is remote sensing data, as shown in Figure 4-494. One organization specified that it uses raw GNSS data.

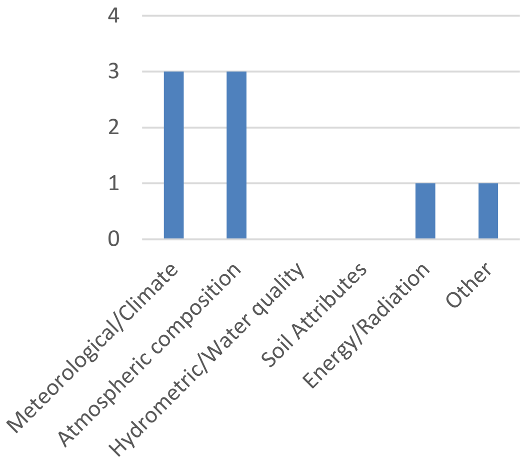


Figure 4-493. Algorithms and models available in Romania by activity area.

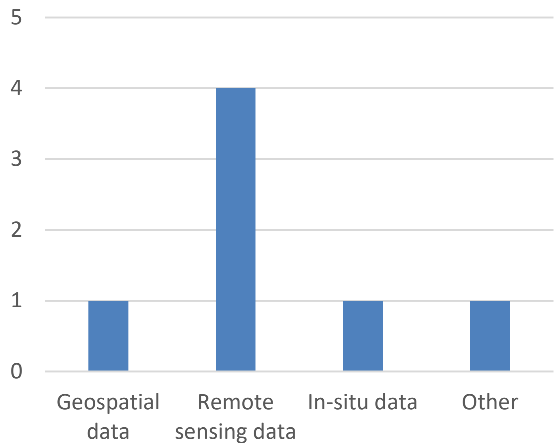


Figure 4-494. Sources of EO data used by organizations with modelling and processing capacities in Romania.

As shown in Figure 4-495, models are typically of local, national, or regional coverage. There is no global-coverage model among the organizations surveyed. METADATA is available for two models (Figure 4-496).

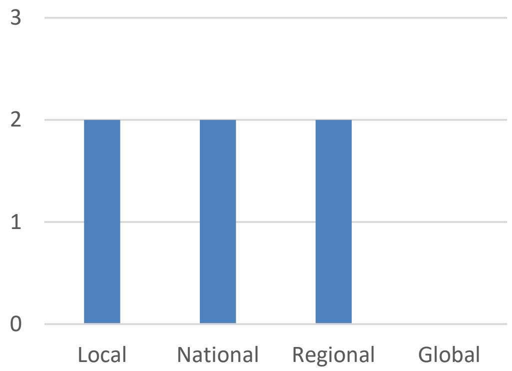


Figure 4-495. Geographic coverage of models and algorithms in Romania.

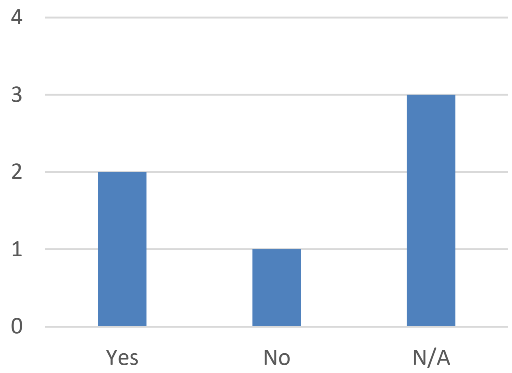


Figure 4-496. Availability of METADATA for models and algorithms in Romania.

Most computing resources were identified by the survey, save server clusters (see Figure 4-497). Organizations further specified that processing power is accomplished through networks of computers.

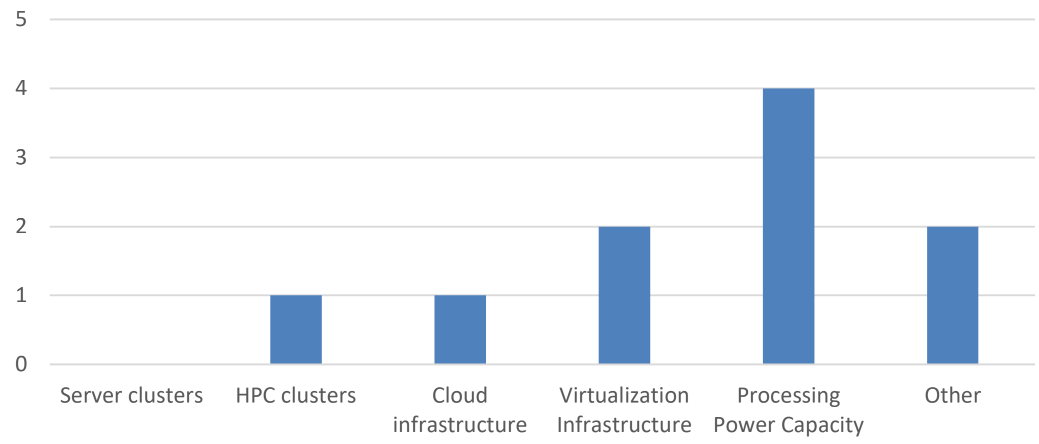


Figure 4-497. Computing resources available for processing and exploitation of EO data in Romania.

Data exploitation capacities

In Romania, the survey reached six organizations with data exploitation capacities, most of which are research-oriented (see Figure 4-498).

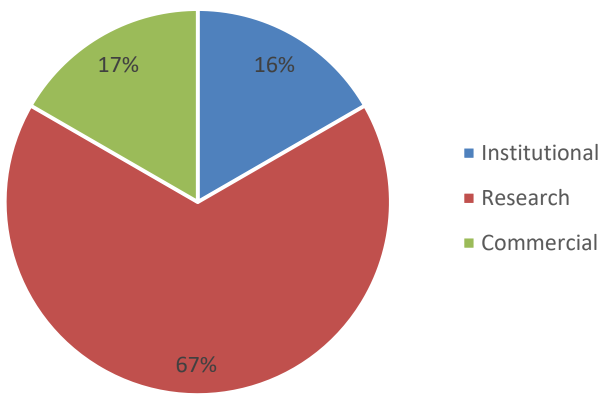


Figure 4-498. The type of organizations active in data exploitation in Romania.

As far as the thematic areas of relevance to GEO-CRADLE are concerned, organizations active in data exploitation in Romania are only active in climate change (see Figure 4-499). Other thematic areas of activity include: materials science, IT integration, UAV manufacture, GIS data production, seismology, GNSS.

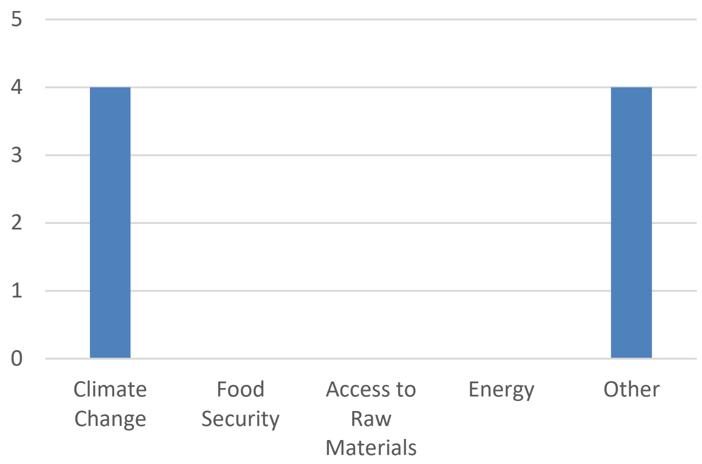


Figure 4-499. Activity of Romanian organizations active in data exploitation in GEO-CRADLE thematic areas.

As shown in Figure 4-500, a large majority of respondents (83%) have taken part in EO-related projects.

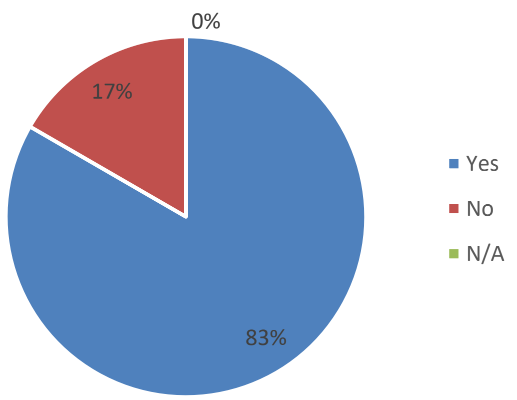


Figure 4-500. Participation of Romanian organizations active in data exploitation in EO activities.

Examples of such projects include:

- ACTRIS
- SOLACE
- EPOS

The results of the survey showed that the percentage of organizations which have taken part in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action is equal to the percentage of organizations with no previous engagement with Copernicus (see Figure 4-501). Half of the organizations participated in GEO/GEOSS SBA Tasks, community activities or initiatives, as shown in Figure 4-502. An example of such activities and initiatives include INSPIRE Technical Working Groups.

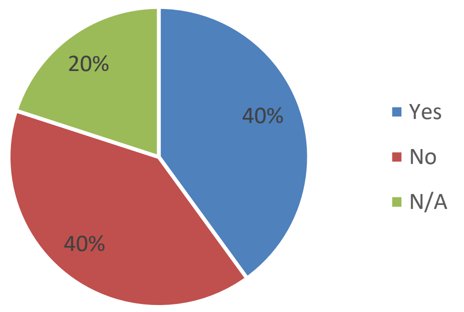


Figure 4-501. Participation of Romanian organizations active in data exploitation in a Copernicus action.

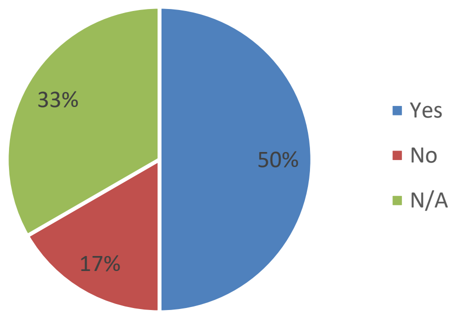


Figure 4-502. Participation of Romanian organizations active in data exploitation in a GEO/GEOSS SBA task.

As far as the level of collaboration with other local EO actors is concerned, 22% of respondents have rated it low, 33% moderate and 45% high (see Figure 4-503). Internationally, collaboration is higher: 57% high and 43% moderated (see Figure 4-504).

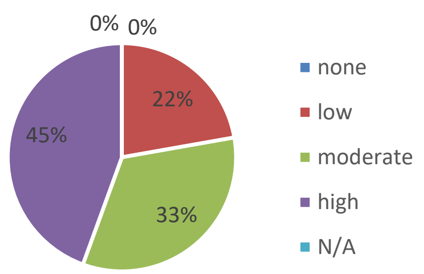


Figure 4-503. Level of cooperation of Romanian organizations active in data exploitation with local EO actors.

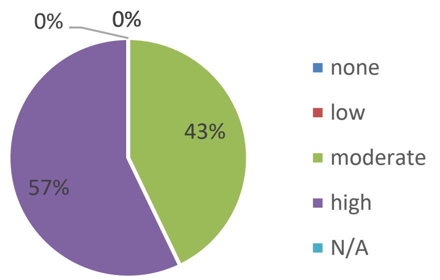


Figure 4-504. Level of cooperation of Romanian organizations active in data exploitation with EO actors abroad.

Most organizations with data exploitation capacities also have modelling capacities and in-situ networks. Among the Romanian organizations surveyed, there are two organizations with no capacities other than data exploitation capacities, as shown in Figure 4-505.

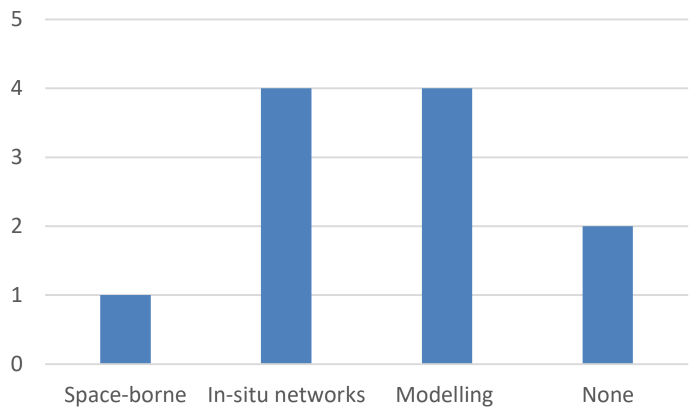


Figure 4-505. Additional EO capacities of Romanian organizations active in data exploitation.

Organizations that the survey reached are active in the following thematic areas: inland water, ecosystems, land use coverage, land motion, urban areas, air quality, climate (see Figure 4-506). Organizations further specified that their products are related to aerosol profiling and ground-based pollutant measurement. Overall, few organizations provided these details for the survey.

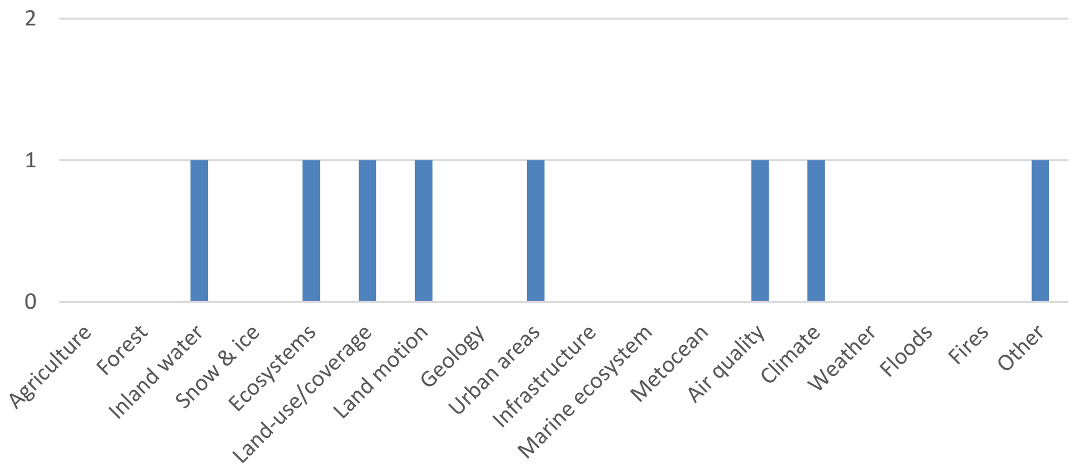


Figure 4-506. Activity areas of EO products/services of Romanian organizations.

National activities

As shown in Figure 4-507, 94% of Romanian respondents have stated that funding for EO activities is available in their country. Funding is mostly available for R&D related activities as well as for infrastructure development. According to the respondents' answers, the least amount of funding is available for EO market development (see Figure 4-508).

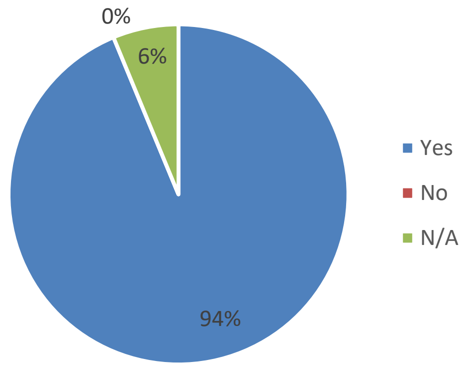


Figure 4-507. Romanian EO actors' perception of the availability of national funding for EO.

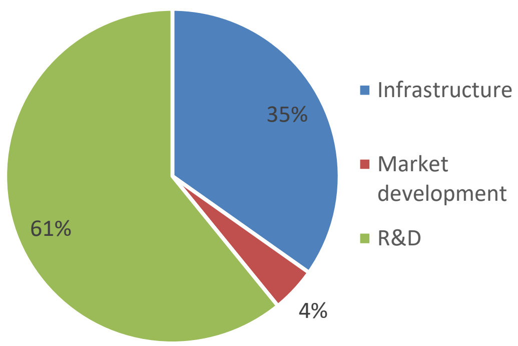


Figure 4-508. Romanian EO actors' perception of areas for which national EO funding is available.

As far as a National Space Policy/Strategy is concerned, 56% of respondents have confirmed the availability of a policy/strategy (see Figure 4-509). As shown in Figure 4-510, respondents are aware that there is a Space Agency in Romania. Respondents have indicated that ROSA is the leading organization of the Research, Development and Innovation Program for Space Technology and Advanced Research.

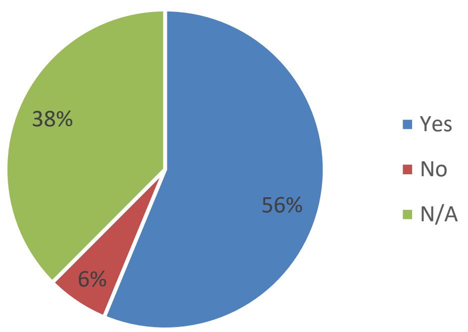


Figure 4-509. Romanian EO actors' awareness of a space strategy in Romania.

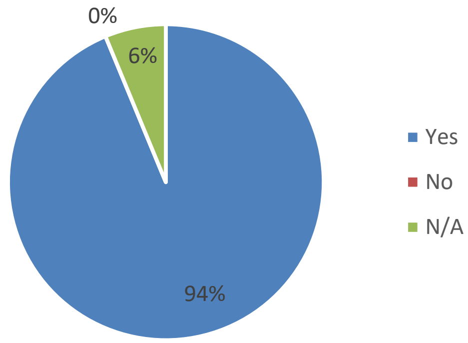


Figure 4-510. Romanian EO actors' awareness of a space program in Romania.

A large majority of respondents (63%) has indicated that there is a basic level of coordination of EO activities in Romania, and 19% have indicated that it is high (see Figure 4-511). Examples of collaboration between research and private sector entities in Romania include INOE, dedicated to research activities, SC Enviroscopy LTD, responsible for remote sensing instruments, and INTEGRAPH LTD, involved in GIS. As shown in Figure 4-512, most respondents agree that the interaction between the EO community and decision makers in Romania is present in specific thematic areas. 31% perceive it is scarce and 6% that it is fully integrated.

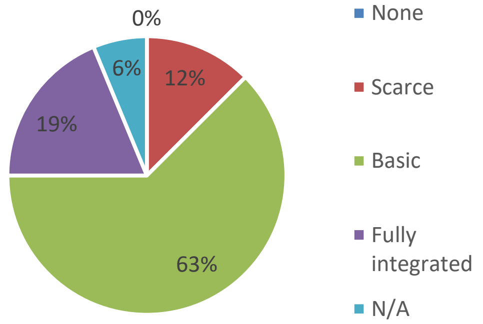


Figure 4-511. Romanian EO actors' perception of national coordination of EO activities in Romania.

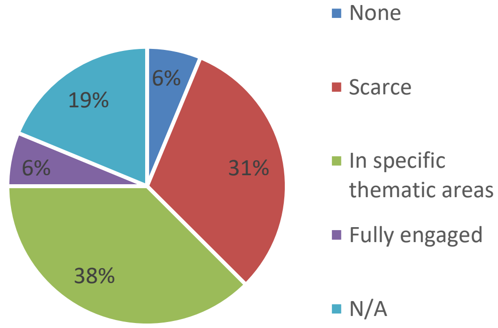


Figure 4-512. Romanian EO actors' perception of interaction with decision makers in Romania.

The vast majority of respondents (81%) have expressed their interest in contributing with their own capacities to a regional initiative of GEO and/or Copernicus (see Figure 4-513).

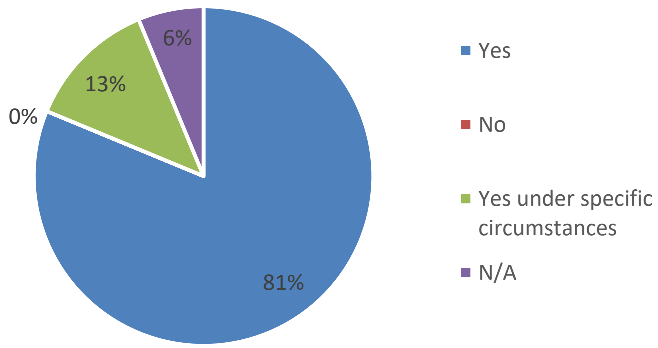


Figure 4-513. Romanian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

In Romania, end-users awareness of Copernicus and GEO is low (Figure 4-514 and Figure 4-515).

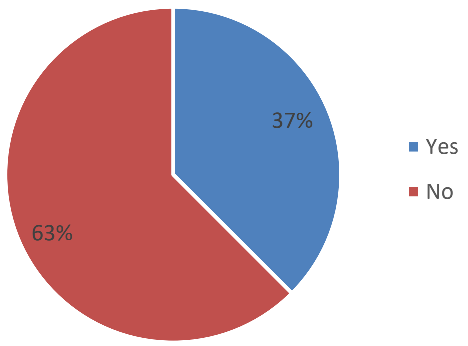


Figure 4-514. End-user awareness of Copernicus in Romania.

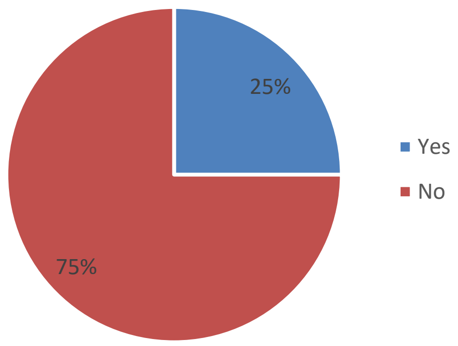


Figure 4-515. End-user awareness of GEO in Romania.

4.8.3. *Gap analysis*

Neither **geographic** nor **observational** gaps were identified in Romania. As it can be seen from the survey results, modelling capacities typically apply to local/national/regional coverage. Similarly, most Romanian in-situ facilities, for instance, meteorological, atmospheric, energy/radiation facilities, are registered in a National/Regional/International network. In this way, these organizations are able to obtain the needed coverage. In addition, Romanian organizations with in-situ capacities are well-networked abroad; this further strengthens their capacities.

Several **structural** gaps were found. Firstly, although the coordination with decision makers in Romania is present, it is typically perceived as basic. As a result, according to end-users, it is particularly difficult to interact with authorities when obtaining authorization for protected areas.

Data policy is another structural gap validated in the survey. The survey shows that data is typically license restricted, and end-users expressed their need for more freely available data, as their budget for EO activities is rather limited. According to the feedback received from end-users, communication with local EO actors is poor, and is usually seen as a source of complications in administrative procedures, and this was validated in the survey. Namely, the survey suggests that the type of collaboration is perceived as low to moderate.

In terms of **quality/quantity**, temporal resolution represents a major gap. Namely, the feedback received from end-users suggests that data reception is not regular. The information on the temporal resolution was rarely given by survey respondents.

The biggest gap in **capacities** is a limitation in human resources. Namely, according to end-users, there is an overall lack of qualified personnel. Moreover, there is also a constant need for personnel training and education, as well as for staff mobility.

One group of end-users particularly emphasized that there is an overall lack of financial allocations from national funds for the management of protected areas. In addition, according to end-users, implementation of programs financed through EU structural and cohesion funds is slow, and this is seen as a major constraint.

4.9. Serbia

4.9.1. *Overview*

EO in Serbia gravitates towards the public sector. In part, this is due to the fact that the public sector dominates the Serbian economy, particularly in industries where the application of EO brings clear benefits and the beneficiaries already have strong geospatial sectors. Furthermore, engagement of public institutions and research organizations with EO is growing, driven by financial and technical support from European actors. Ten commercial companies have been identified that provide EO products, mainly to the public sector and to construction companies.

There are large barriers for development of EO in the country.

One barrier is **financial**. Serbia's economy has undergone three economic crises since 2008, leading to fiscal consolidation in 2012. Public institutions face budget cuts and a freeze on hiring – this has clearly limited the ability of the public sector to develop EO capacities. During GEO-CRADLE activities, the respondents mention that the lack of funding is a barrier for accessing satellite images, orthophotos and other EO data, as well as for attending seminars and other educational programs. Unambiguously, the inability to hire new employees is a barrier to developing additional EO capacity.

EO actors in the country have a **reserved attitude regarding sharing of data** – respondents describe a general reluctance in the ecosystem. Formally, access to data between institutions requires contracts and in practice it is hindered by excessive bureaucracy. These barriers are easiest to overcome during projects. Although such arrangements are temporary in nature, connections that are established remain after the project, and serve as a foundation to facilitate interaction and encourage sharing of data between institutions. Thus, sharing of data between institutions is largely based on personal relationships rather than a systematic system of promoting free and open access to data.

Of particular concern to end-users was the **lack of access to the digital cadaster** maintained by the Republic Geodetic Authority (RGZ). The end-users described use fees as a significant issue posing a barrier to their access – particularly in the general context of budget cuts. Public institutions are not exempt to charges except in emergency situations (e.g. flooding event), and resent fees that apply to data whose collection and processing was publicly-funded. The end-users also mention that other datasets owned by the RGZ are of interest to them, yet out of reach once more due to the cost. For RGZ, revenue from access to the digital cadaster remains a major source of funding. In regards to its other datasets, it is making an effort to provide data in a free and open manner via its geoportal. Since RGZ represents a central node of EO in the country, and possesses advanced capacities, this is surely a welcome development; however, it is necessary for them to follow up with a public relations campaign, to raise awareness of data availability, as this fact is still largely unknown in the local ecosystem.

There are large opportunities to counterbalance challenges, and they are being seized upon by vanguards in the EO sector through their own initiative.

Serbia has **advanced with its accession to the EU**, having initiated the negotiations in 2014 and opened four chapters thus far. EU, through the Instrument for Pre-Accession Assistance, provides support for capacity building in public institutions[25]. Beneficiaries have included the RGZ (e.g. INSPIRATION project) as well as EO providers and end-users. Similarly, foreign donors have also supported capacity building in public institutions which has also benefited capacities in the EO value chain[26].

[25] EC, 2014. Instrument for pre-accession assistance (IPA-II): Indicative strategy paper for Serbia (2014-2020).
[26] As an example: http://www.rgz.gov.rs/template1a.asp?PageName=2014_03_28_03&MenuID=0040063&LanguageID=3

Significantly, several EO actors have **leveraged project funding** (e.g. framework programs, cross-border projects, etc.) to finance new equipment and to develop capacities of human resources. This includes institutions, public companies (see Eurisy's article on VojvodinaSume as good practice) as well as academic groups.

The prime example of this is BioSense Institute, highly active in EO as a part of its mission to apply ICT in agriculture. They have a sizeable portfolio of regional, national and EU funded projects – as well as public funding from the Ministry of Education, Science and Technological Development – which they have used to develop an impressive array of EO capacities in the last five years: processing, modelling, in-situ measuring networks, sensor production facilities, etc. They actively engage public institutions and private companies, to which they provide specific data products, and have developed long-term working relationships with several of them. The institute, presently, has 68 PhD and post-doc researchers.

There have also been **efforts to overcome the reluctance to freely share data**. In the Autonomous Province of Vojvodina, several public institutions and public companies have come to an agreement to formalize data-sharing between them, as they recognize the mutual benefits. Most of these companies already have geoportals available on their website, where some of their data is shared in a free and open manner. The change of the government on the provincial level in 2016, has stalled the initiative for now, but initiators are confident that it will continue soon.

Specific actors have **built off of long-term excellence** to maintain and develop EO capacities. Atmospheric modelling expertise of Belgrade scientists is internationally-recognized over the last forty years. The limited area, atmospheric model developed in 1970s was transferred to the USA in 1990s, where it was accepted as an official numerical weather prediction system. This was a unique case of a developing country transferring a high technology to a Western country, unmatched to this day. One of the results of the accumulated experience is that Serbia hosts the South Earth Europe Climate Change Centre (SEEVCCC) – a consortium that gathers organizations from most neighboring countries in the field of climate research and assessments. SEEVCCC has been used as a model to establish another regional consortium in 2015: the South East Europe Consortium in Operational Weather Prediction (SEECOP), in which Serbia's Republic Hydro-meteorological Service has leading role. The major development effort in the two consortia is on designing an Earth Modelling System that integrates models of different natural environments, such as the atmosphere, aerosols, soil, hydrology and ocean. EO results of the two components of this integrated model system (dust DREAM model and hydrology HYPROM model) are included in the GEO-CRADLE project. Based on such activities, Serbia through SEEVCCC and SEECOP participates/participated in several EU and other international projects, such as WMO SDS-WAS project (dust model intercomparison initiative), EUMETNET, OrientGate, SEERISK, CARPATCLIM. In the field of computational networking, Serbia has been involved in a group of EU funded projects as well (SEE-GRID-2, SEE-GRID-SCI, HP-SEE).

4.9.2. *Capacities*

Space-borne capacities

Serbia has no space-borne capacities.

In-situ networks and facilities

The survey reached nine organizations with in-situ capacities, either institutional or research oriented, but no commercial organizations (see Figure 4-516).

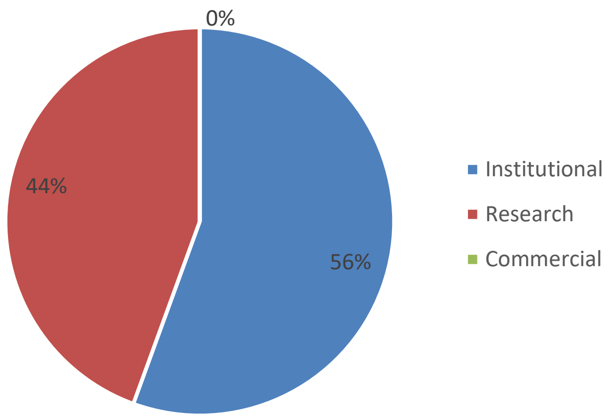


Figure 4-516. The type of organizations with in-situ networks in Serbia.

Serbia has organizations with in-situ networks that are active in all the thematic areas of GEO-CRADLE, particularly in climate change and food security (Figure 4-517). Some organizations have included capacities in *other activities*, like: weather modification, hydrology, weather forecast, air and water quality monitoring, National Environment Information System and National Registry of Pollution.

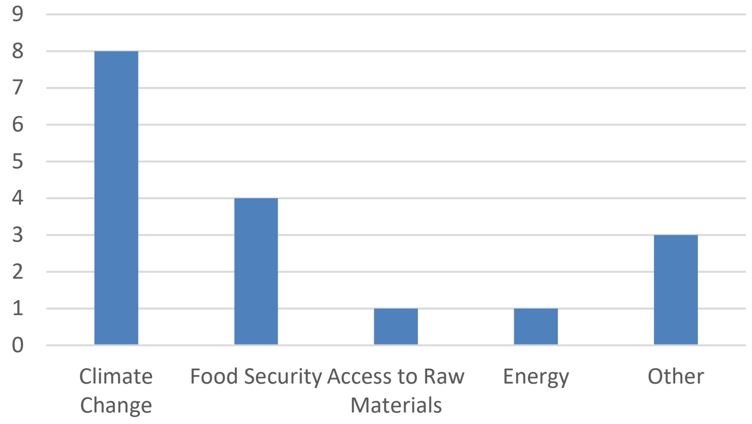


Figure 4-517. Activity of Serbian organizations with in-situ networks in GEO-CRADLE thematic areas.

Participation of organizations with in-situ capacities is evenly split between those that do and those that do not participate in EO-related projects, as shown in Figure 4-518. Examples of EO activities include FP7 and other international projects:

- DRIHM – Distributed Research Infrastructure for Hydro-Meteorology
- OrientGate - A network for the integration of climate knowledge into policy and planning. Funded by the EU South East Europe Transnational Cooperation Program
- SEERISK - Joint Disaster Management risk assessment and preparedness in the Danube macro-region; funded by the South East Europe Transnational Cooperation Program.
- CARPATCLIM - Climate of the Carpathian Region
- Enorasis
- BalkanGEONet
- EOPower
- IASON

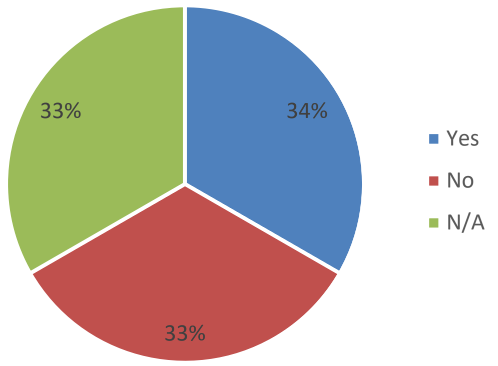


Figure 4-518. Participation of Serbian organizations with in-situ networks in EO activities.

Serbian organizations with in-situ capacities have not participated in Copernicus actions or in a GEOSS subtask, shown in Figure 4-519 and Figure 4-520.

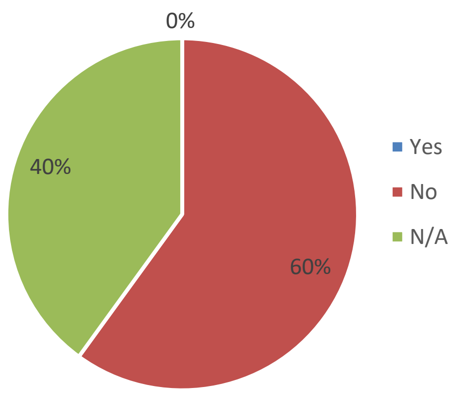


Figure 4-519. Participation of Serbian organizations with in-situ networks in a Copernicus action.

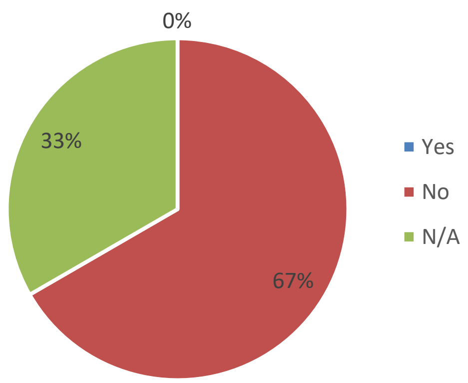


Figure 4-520. Participation of Serbian organizations with in-situ networks in a GEO/GEOSS SBA task.

Cooperation in EO, both with local and international actors, is judged by respondents at different levels, as shown in Figure 4-521 and Figure 4-522.

Local cooperation for the majority is at a low level (56%), with an equal portion (22%) with moderate and no cooperation. No respondent considers that their cooperation with local actors is high, and none claimed that this question was not applicable to them.

The majority of the respondents have no cooperation with EO actors outside of Serbia (45%). One third of the respondents mention that they have a low level of cooperation, while one states that they have a moderate level of cooperation.

Examples of cooperation provided by the respondents include: cooperation in regards to data sharing and personnel exchange between two research organizations, a government ministry providing soil maps and receiving data from public institutes. One of the respondents is a member of EARLINET and an associated member of ACTRIS-2.

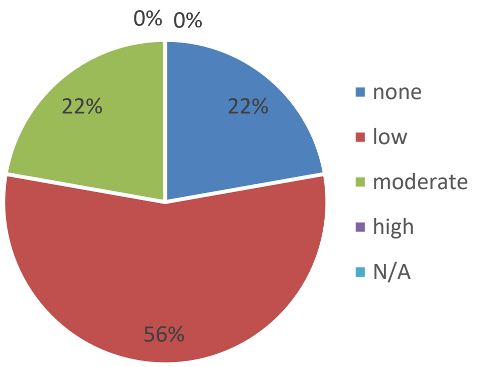


Figure 4-521. Level of cooperation of Serbian organizations with in-situ networks with local EO actors.

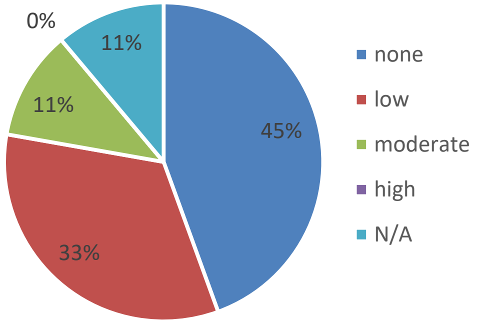


Figure 4-522. Level of cooperation of Serbian organizations with in-situ networks with EO actors abroad.

Almost half of the respondents do not have additional EO capacities. Of those that do, three organizations have modelling and processing capacities and are active in data exploitation. Two organizations have only modelling and processing capacities, in addition to in-situ capacities. This can be seen in Figure 4-523.

In regards to the type of in-situ capacities, the survey identified in-situ networks for every category except energy/radiation, as shown in Figure 4-524. Four organizations had in-situ measuring capacities of two types.

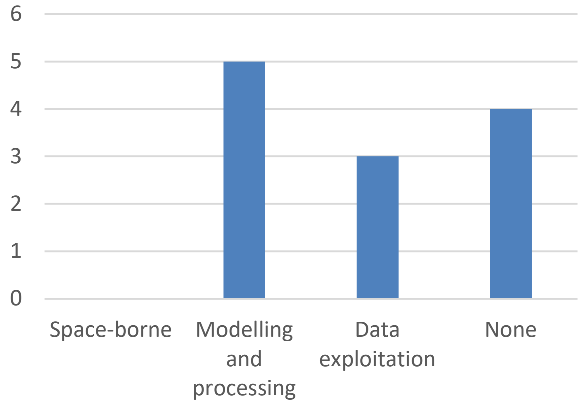


Figure 4-523. Additional EO capacities of Serbian organizations with in-situ networks.

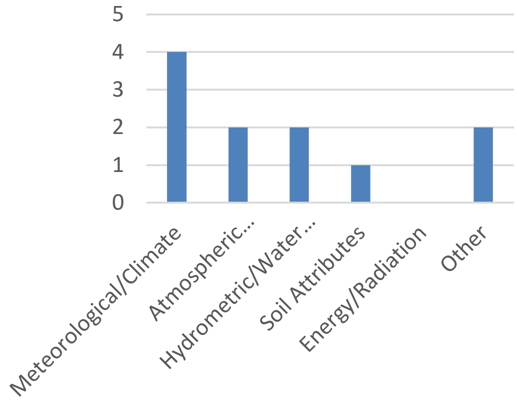


Figure 4-524. Activity area of in-situ networks of Serbian organizations.

The number of stations in in-situ networks, by activity area in Serbia, is shown in *Figure 4-525*. As can be seen, hydro-meteorological in-situ capacities are the most developed, while this is not the case for soil attributes and energy/radiation. The respondents that require this data, collect it manually either themselves, or rely on others to do it for them. In regards to soil attributes, capacities are currently being developed. In particular, a research institute and agricultural extension services in the Autonomous Province of Vojvodina are expanding their current in-situ meteorological network to also have the capacity to measure soil parameters; they could not however specify the exact amount, but over 100 are expected. No plans were mentioned to establish an energy/radiation in-situ network or station.

The geographic coverage of Serbian in-situ networks by type is shown in *Figure 4-526*. Most networks are local or national, with two networks providing regional data. Greater coverage is demonstrated for in-situ networks used for meteorological purposes.

Over 50% of in-situ networks used for meteorological purposes are registered, as shown in *Figure 4-525*. All owners of in-situ networks in Serbia that were reached claimed to systematically collect data, as shown in *Figure 4-528*.

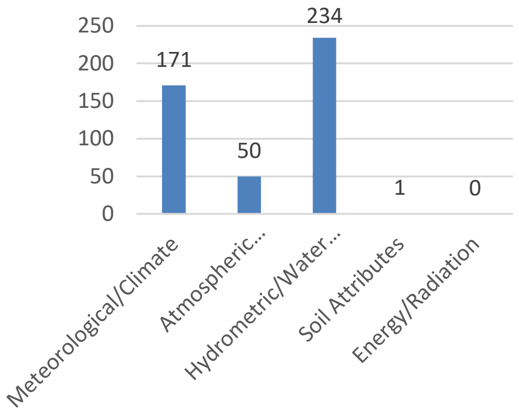


Figure 4-525. Number of stations of in-situ networks in Serbia by activity area.

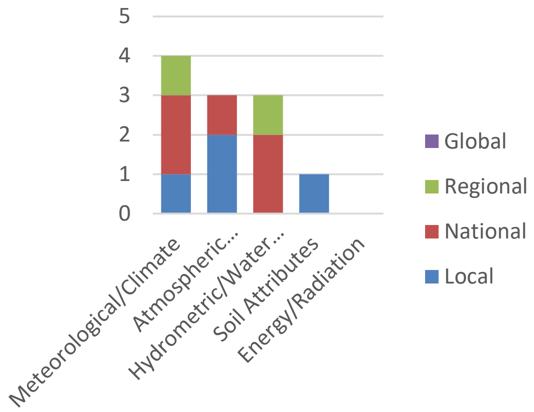


Figure 4-526. Geographic coverage of in-situ networks in Serbia by activity area.

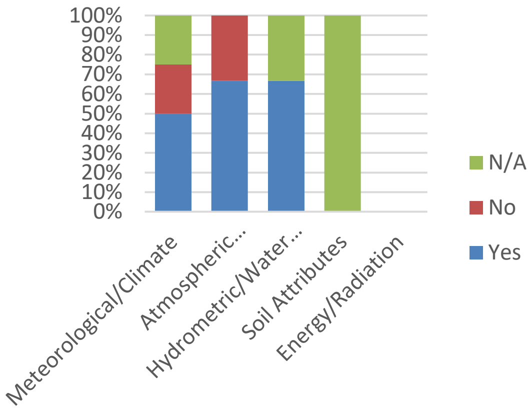


Figure 4-527. Registration of in-situ networks in Serbia by activity area.

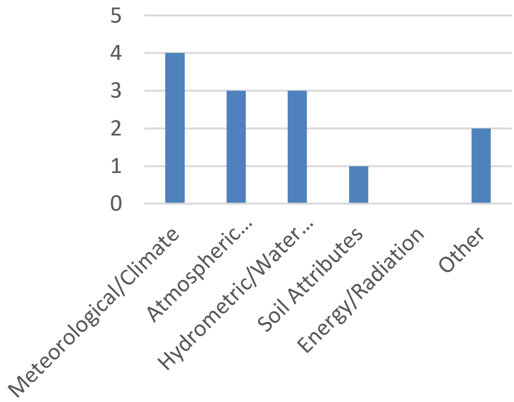


Figure 4-528. Systematic collection of data by in-situ networks in Serbia by activity area.

Organizations that have **meteorological and climate in-situ networks** measure temperature, humidity, precipitation, wind speed, wind direction, pressure and all other conventional observations. Only one respondent provided a time period: from 2010 to ongoing.

Organizations that have **atmospheric composition and profiling in-situ networks** measure vertical profiles of backscatter and extinction coefficients, NO_x, SO_2, CO, O_3, PM_{10} reference samplers with subsequent in-vivo heavy metal, OC/EC and PAH analyses, PM_{10} automatic monitors, VOC-automatic and semiautomatic, aldehydes and ketones in air and atmospheric pollutants. Only one respondent gave a time period: from 2002 to ongoing.

Organizations that have **hydrometric and water quality in-situ networks** measure water level, discharge, DO, BOD5, EC, pH, temperature and other parameters. No respondents provided a time period.

Organizations that have **soil attributes and spectra in-situ network** provided no details. Desk research showed that soil data is currently collected and analyzed manually by organizations that require this data. One public research organization and a public institute are looking to expand their current network of meteorological stations, to include in-situ measurements of soil parameters, on an hourly basis. The initiative is not in an advanced stage but it is likely to be realized due to the recognized need for both organizations and no perceived problems with financing.

No organizations were surveyed that have **radiation and energy in-situ networks**. Desk research did not indicate that this capacity exists; there are public research organizations and institutes that do these parameters manually to suit their needs.

METADATA was only available from one group within a public institute related to weather prediction, as shown in *Figure 4-529*, *Figure 4-532* and *Figure 4-536*.

Resolution of most in-situ networks related to hydrometeorology and the atmosphere was either hourly or daily as shown in *Figure 4-530*, *Figure 4-533* and *Figure 4-537,* with one network providing monthly figures and one providing per minute.

Real-time availability of data exists for the three types of in-situ data related to meteorology, while others provide access upon request and to past archives as shown in *Figure 4-531*, *Figure 4-534* and *Figure 4-538*. The same group that offered METADATA had real-time access, access upon request and access to past archives. No details were provided by the soil attributes network.

Only one organization provided information on data policy, shown in Figure 4-535. Desk research showed that the respondents were not aware of what data policy entailed, as most data sharing is done through bilateral agreements between public institutions. Data sharing is mostly without cost in these arrangements, with the key exception being the cadastral data owned by the Republic Geodetic Authority.

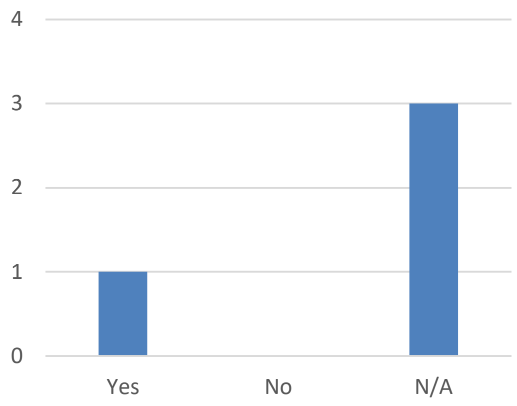


Figure 4-529. Availability of METADATA from meteorological and climate in-situ networks in Serbia.

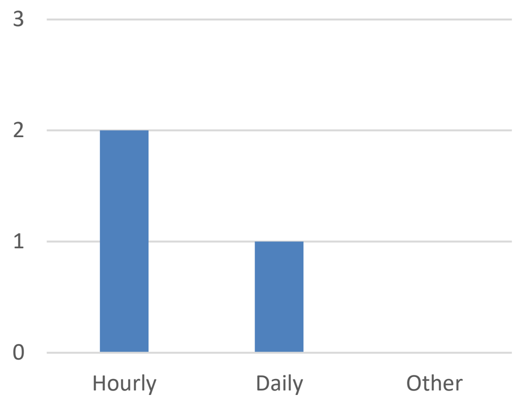


Figure 4-530. Temporal resoution of meteorological and climate in-situ networks in Serbia.

Figure 4-531. Data availability from meteorological and climate in-situ networks in Serbia.

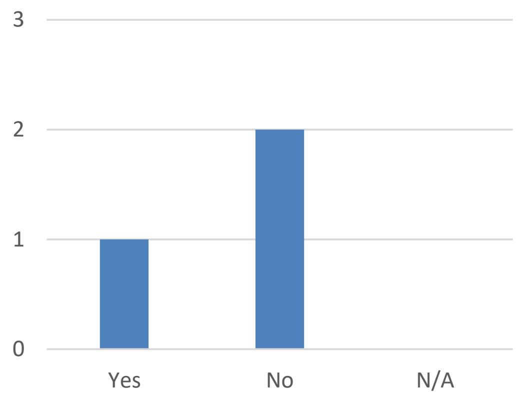


Figure 4-532. Availability of METADATA from atmospheric composition and profiling in-situ networks in Serbia.

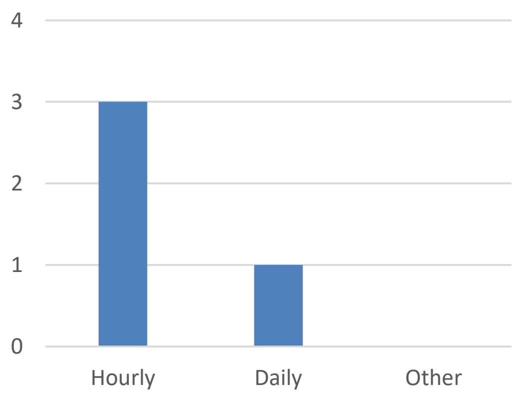


Figure 4-533. Temporal resoution of atmospheric composition and profiling in-situ networks in Serbia.

Figure 4-534. Data availability from atmospheric composition and profiling in-situ networks in Serbia.

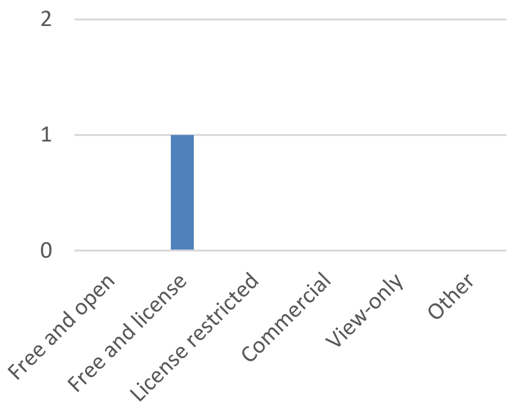


Figure 4-535. Data policy of atmospheric composition and profiling in-situ networks in Serbia.

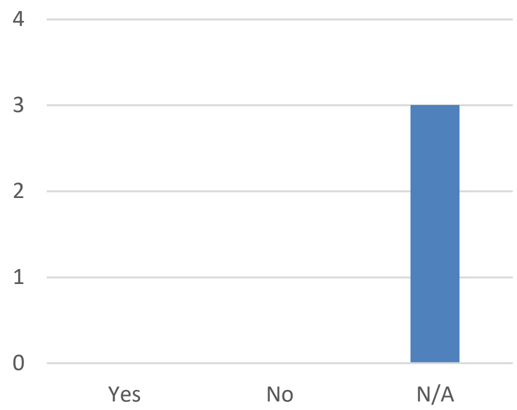


Figure 4-536. Availability of METADATA from hydrometric and water quality in-situ networks in Serbia.

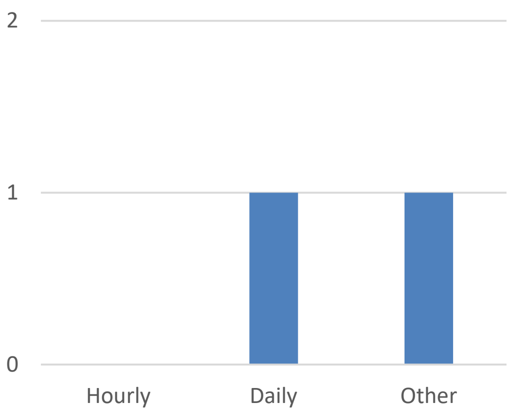


Figure 4-537. Temporal resoution of hydrometric and water quality in-situ networks in Serbia.

Figure 4-538. Data availability from hydrometric and water quality in-situ networks in Serbia.

Modelling and processing capacities

The survey reached thirteen organizations with in-situ capacities, almost equal between institutional, research oriented and commercial organizations (see Figure 4-539).

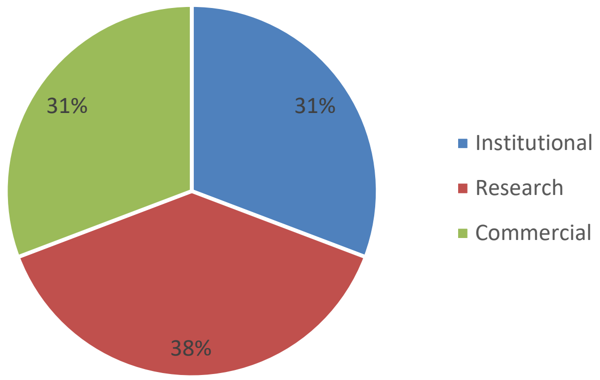


Figure 4-539. The type of organizations with modelling and processing capacities in Serbia.

Serbian organizations with modelling capacities are active in all the thematic areas of GEO-CRADLE, particularly in climate change (Figure 4-540). Organizations reported capacities in *other activities*, these are related to: weather modification, hydrology, weather forecast, biodiversity, terrestrial ecology, landscape ecology, land use planning, environmental planning, environmental management, nature management, plant and animal ecology, population genetics, ecosystems research, carbon cycle, data analytics and geospatial data.

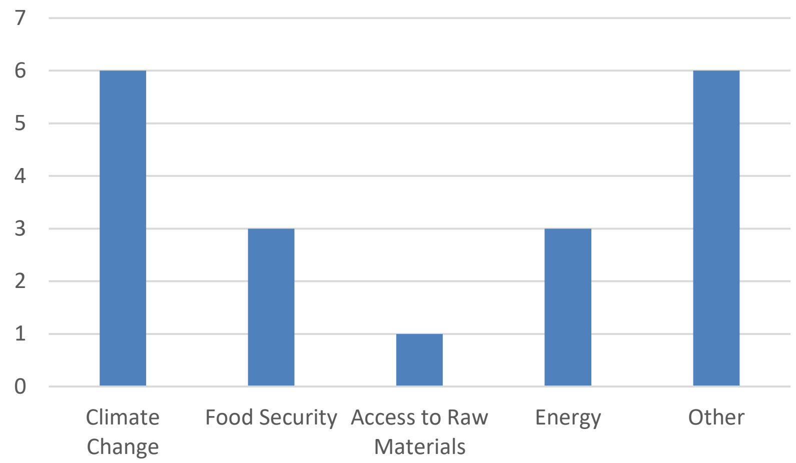


Figure 4-540. Activity of Serbian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

Participation of organizations with modelling and processing capacities in EO-related projects is almost evenly split between those that do and those that do not, as shown in Figure 4-541. Examples of EO activities include FP7 and other international projects:

- Hymex
- DRIHM – Distributed Research Infrastructure for Hydro-Meteorology
- OrientGate - A network for the integration of climate knowledge into policy and planning. Funded by the EU South East Europe Transnational Cooperation Program
- SEERISK - Joint Disaster Management risk assessment and preparedness in the Danube macro-region; funded by the South East Europe Transnational Cooperation Program.
- CARPATCLIM - Climate of the Carpathian Region
- Enorasis
- BalkanGEONet
- EOPower
- IASON
- SEE GRID SCI
- Establishment of national spatial data infrastructure and remote sensing center for the Republic of Serbia – based on integrated geo-information solution (IGIS project)
- IMPULS Project – cooperation of Western Balkan countries and development of SDI in the Western Balkan countries
- ELF Project – European location framework
- ISCGM – Global mapping project
- Rural development – efficient land management component 4 (GIZ)

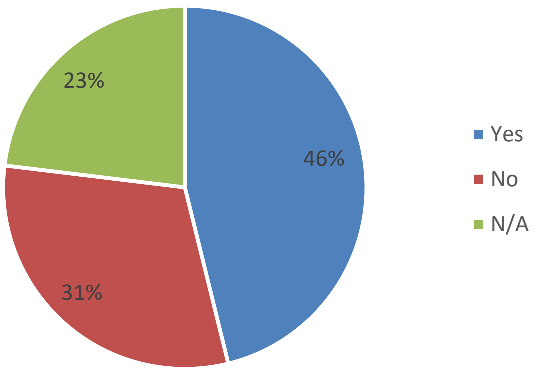


Figure 4-541. Participation of Serbian organizations with modelling and processing capacities in EO activities.

Serbian organizations with modelling capacities have not participated in Copernicus actions, shown in Figure 4-542. There was one organization that participated in a GEOSS subtask, shown in Figure 4-543. This same public institution offered the following details:

- Provision of EO data and flood hazard and landslide hazard maps during the 2014 Balkan floods to the governmental, local self-governmental and public service institutions;
- Provision of EO data for implementation of national development projects in the field of risk management and environment protection;
- Provision of remote sensing products to the agriculture, forestry, water management, construction, environment and statistic for private and public sector.

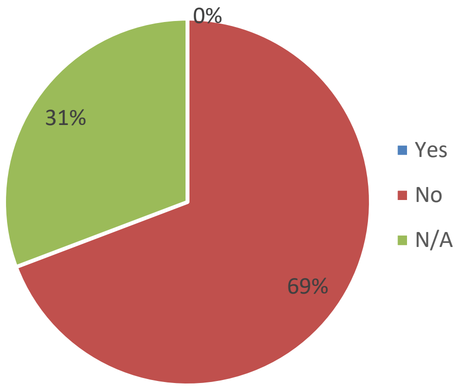


Figure 4-542. Participation of Serbian organizations with modelling and processing capacities in a Copernicus action.

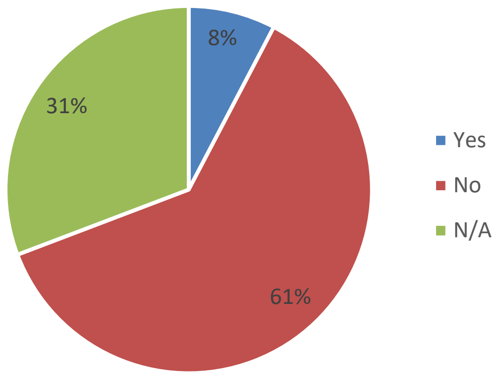


Figure 4-543. Participation of Serbian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

Cooperation in EO, both with local and international actors, is judged by respondents to be at different levels, as shown in Figure 4-544 and Figure 4-545.

As shown in Figure 4-544, local cooperation for the majority is at a low level (42%), with 32% moderate, and one response high (8%). The respondent with high local cooperation was a commercial company that sells geospatial data. One of the respondents reported the question was N/A and one claimed no cooperation. Examples of cooperation include:

- A research organization with three public institutes with in-situ networks
- A commercial organization mostly with national academic and research organizations
- Commercial data distributors, but not in a long-term partnership

As shown in Figure 4-545, the majority of the respondents have low cooperation with EO actors outside Serbia (46%). 23% have moderate cooperation and none have high cooperation. Two respondents have no cooperation internationally (16%). Examples of cooperation include:

- Ecological modelling, ecological network and spatial models with a university and research center in the Netherlands and a research institute in Spain
- A public institute with Airbus Defense and Space, EuroGeographics, UNGGIM, ISCGM, INTERMAGNET and EUPOS
- A research organization that is a member of EARLINET and an associated member of ACTRIS-2.
- A research organization that cooperates with research groups in ecology and agriculture and provides data products to the provincial government

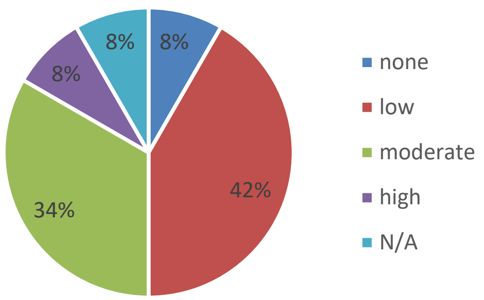


Figure 4-544. Level of cooperation of Serbian organizations with modelling and processing capacities with local EO actors.

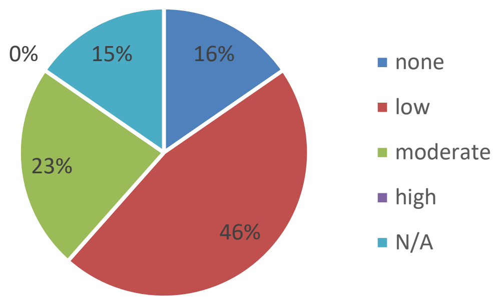


Figure 4-545. Level of cooperation of Serbian organizations with modelling and processing capacities with EO actors abroad.

Most respondents with modelling and processing capacities have either their own in-situ networks or are active in data exploitation, as shown in Figure 4-546. Six organizations that have only modelling and processing capacities for EO, are either research organizations or commercial companies.

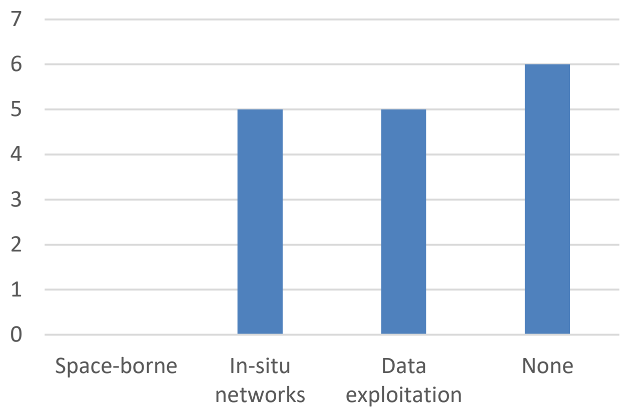


Figure 4-546. Additional EO capacities of Serbian organizations with modelling and processing capacities.

As shown in Figure 4-547, Serbia has algorithms and models in all the categories examined by GEO-CRADLE, including those for which it does not have mature in-situ networks, i.e. soil attributes and energy/radiation. Most algorithms are meteorological and climate related.

Figure 4-548 shows the sources of data used by the models. Most organizations use more than one source of data. Other sources of data were only specified by one respondent as ground control points.

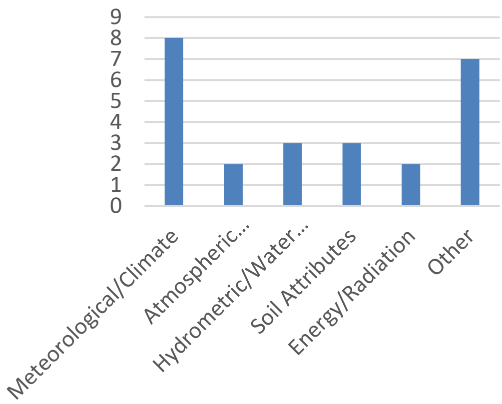


Figure 4-547. Algorithms and models available in Serbia by activity area.

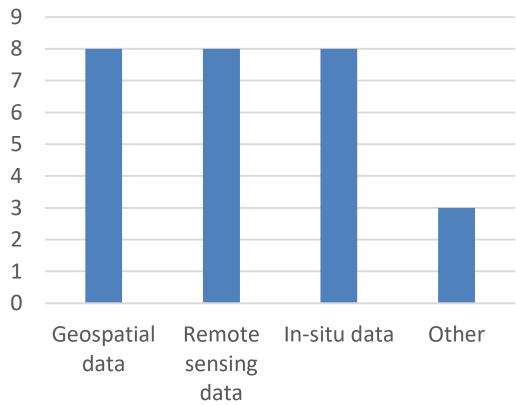


Figure 4-548. Sources of EO data used by organizations with modelling and processing capacities in Serbia.

Most models and algorithms have a regional cover as shown in *Figure 4-549*, with several also having a global coverage. This mainly derives from the fact that several meteorological models have these scales: global in the case of climatic models and regional in the case of transport models.

METADATA is available for four models and not available for two models, as shown in *Figure 4-550*. Organizations that did not have METADATA available were commercial organizations. Organizations that did have METADATA available were predominantly research organizations. Public institutions mostly answered that the question did not apply to them.

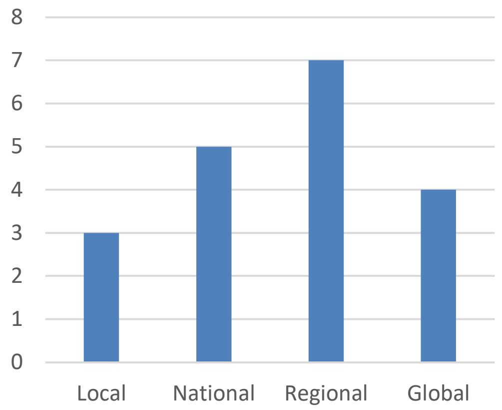


Figure 4-549. Geographic coverage of models and algorithms in Serbia.

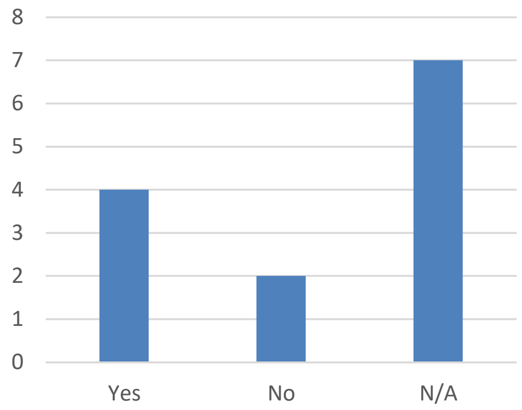


Figure 4-550. Availability of METADATA for models and algorithms in Serbia.

Results of the survey demonstrate that Serbia has access to all computing resources covered by this survey. Most respondents had more than one computing resource, with two commercial companies and two public institutions with generally high EO-related capacities. Details specified included:

- Approximately 500 cpu
- ~50 TB, ~10^2 GB ram, ~10^2 CPU cores
- Use of ECMWF Cray

IPB provided a very detailed list of its capacities:

A 64CPU Server Cluster is used for simulations with 2TB storage running on Ubuntu Linux. Additional computing and storage resources are available through Horizon 2020 VI-SEEM project on PARADOX cluster. Paradox is an HP Proliant SL250s based cluster with the following components:

• Compute nodes: HP Proliant SL250s

• Processors Type: Intel® Xeon® Processor E5-2670 (Sandy Bridge, 8 Core, 20M Cache, 2.60 GHz)

• Number of nodes: 106

• Number of CPU cores: 1696

• Number of GPUs: 106 NVIDIA® Tesla™ M2090 (5375MB of RAM, 512 CUDA cores at 1.3GHz, Compute capability 2.0)

• RAM: 32 GB/node (4x8GB) DRR3 1600MHz

• Network infrastructure: InfiniBand QDR

Operating system: The operating system on PARADOX cluster is Scientific Linux 6.4.

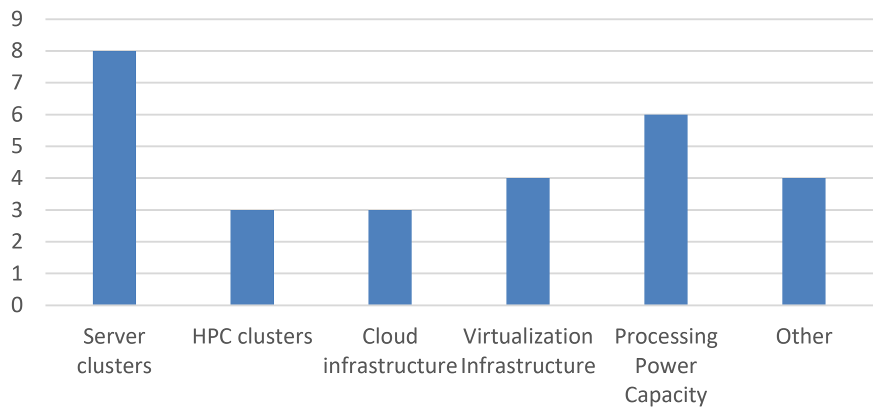


Figure 4-551. Computing resources available for processing and exploitation of EO data in Serbia.

Data exploitation

The survey reached thirteen organizations active in data exploitation, mostly institutional organizations (see Figure 4-552).

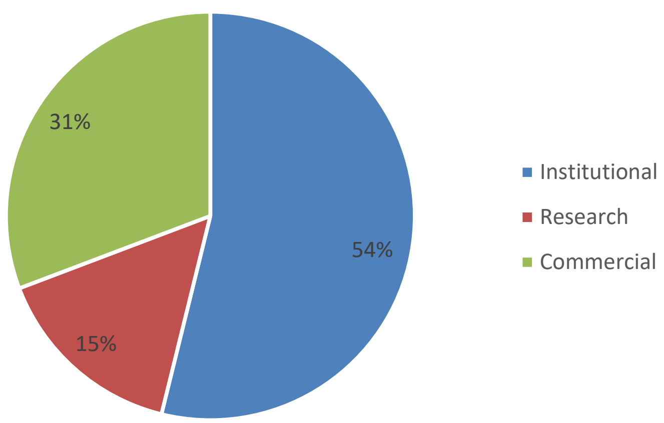


Figure 4-552. The type of organizations active in data exploitation in Serbia.

Organizations in Serbia with data products/services are active in all thematic areas of GEO-CRADLE (*Figure 4-553*). Organizations that have capacities in *other activities,* specified that they are in the following fields: weather modification, hydrology, weather forecast, ecosystems research, carbon cycle, geology, spatial/urban planning, statistics and geospatial data.

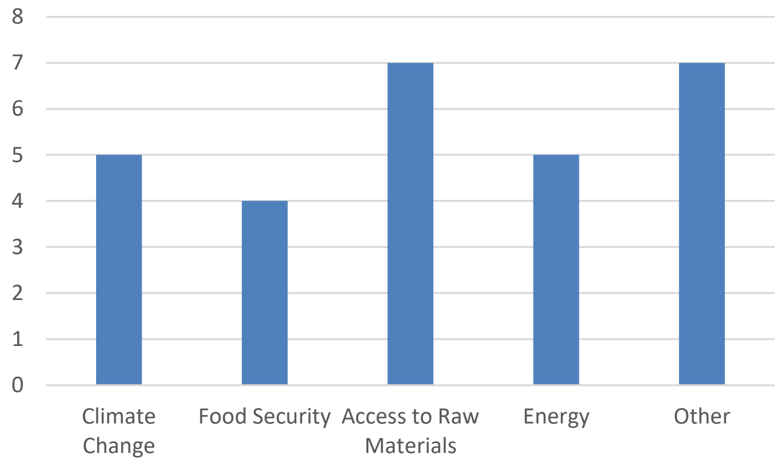


Figure 4-553. Activity of Serbian organizations active in data exploitation in GEO-CRADLE thematic areas.

Twice as many respondents active in data exploitation have taken part in EO-related projects than those that have not, as shown in *Figure 4-554*. Examples of EO activities include FP7 and other international projects:

- Hymex
- DRIHM – Distributed Research Infrastructure for Hydro-Meteorology
- OrientGate - A network for the integration of climate knowledge into policy and planning. Funded by the EU South East Europe Transnational Cooperation Program
- SEERISK - Joint Disaster Management risk assessment and preparedness in the Danube macro-region; funded by the South East Europe Transnational Cooperation Program.
- CARPATCLIM - Climate of the Carpathian Region
- Enorasis
- BalkanGEONet
- EOPower

- IASON
- SEE GRID SCI
- Establishment of national spatial data infrastructure and remote sensing center for the Republic of Serbia – based on integrated geo-information solution (IGIS project)
- IMPULS Project – cooperation of Western Balkan countries and development of SDI in the Western Balkan countries
- ELF Project – European location framework
- ISCGM – Global mapping project
- Rural development – efficient land management component 4 (GIZ)

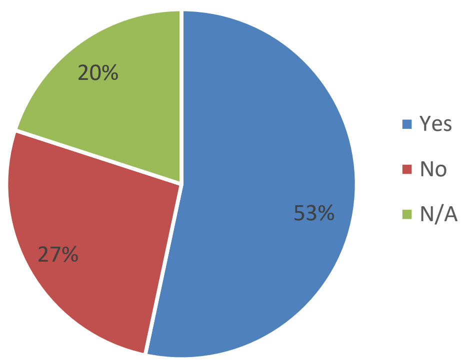


Figure 4-554. Participation of Serbian organizations active in data exploitation in EO activities.

A handful of respondents have been and/or are participating in Copernicus actions and in GEOSS subtasks, as shown in *Figure 4-555* and Figure 4-556. Only one of three respondents offered further details regarding their participation in Copernicus. They participated in the framework of the *Danubeparks* project wherein Copernicus services are included in planned activities. The public institution that participated in a GEOSS subtask provided EO data in regards to flood and landslide hazards, to various levels of governance during the emergency situation in 2014, to support risk management and environmental protection projects and to remote sensing projects to various sectors (agriculture, forestry, water management, construction and environment).

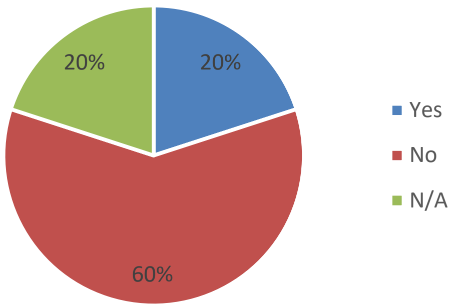


Figure 4-555. Participation of Serbian organizations active in data exploitation in a Copernicus action.

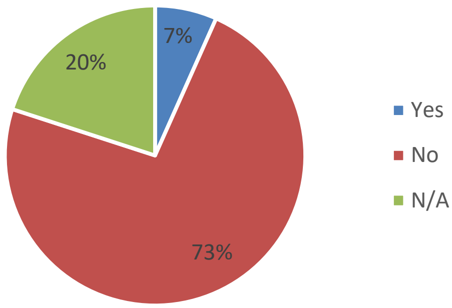


Figure 4-556. Participation of Serbian organizations active in data exploitation in a GEO/GEOSS SBA task.

Serbian organizations that offer EO products/services are focused on the local market in large part. As shown in *Figure 4-557*, local cooperation is at a low level for 47% of respondents and none for 20%; however, for 33% it is moderate. In comparison, *Figure 4-558* shows that cooperation with actors abroad is low for 40% of respondents and none for 40%; only 13% indicate that they have moderate cooperation. The two companies (one public and one private) that have moderate cooperation with actors abroad also have moderate cooperation at the local level.

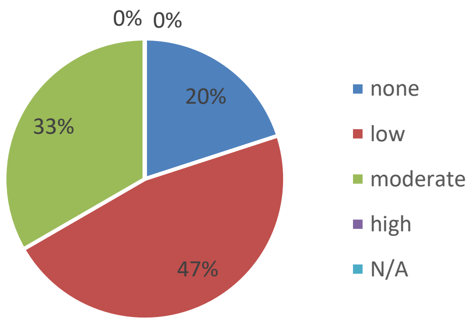


Figure 4-557. Level of cooperation of Serbian organizations active in data exploitation with local EO actors.

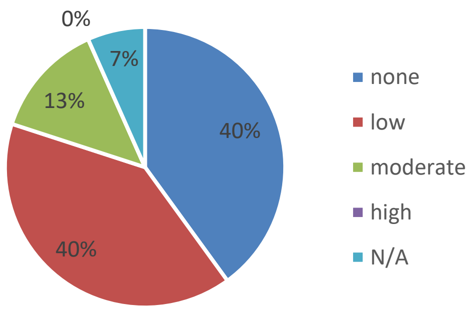


Figure 4-558. Level of cooperation of Serbian organizations active in data exploitation with EO actors abroad.

Half of respondents active in data exploitation do not have other capacities, as can be seen in *Figure 4-559*. These organizations are either publicly owned enterprises or institutes.

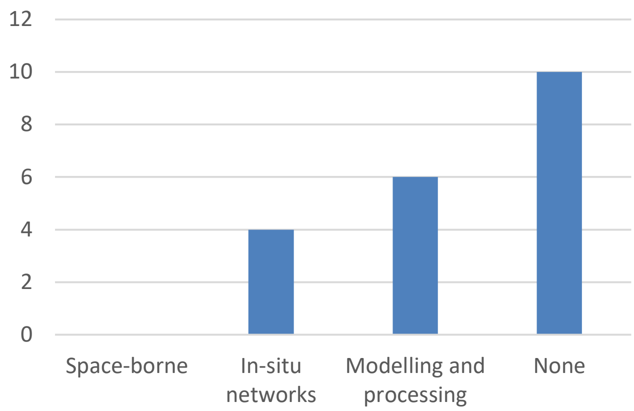


Figure 4-559. Additional EO capacities of Serbian organizations active in data exploitation.

As shown in *Figure 4-560*, Serbia has EO products/services in almost every category measured by the survey. Serbia is a land-locked country accounting for the lack of marine ecosystem and metocean EO products/services.

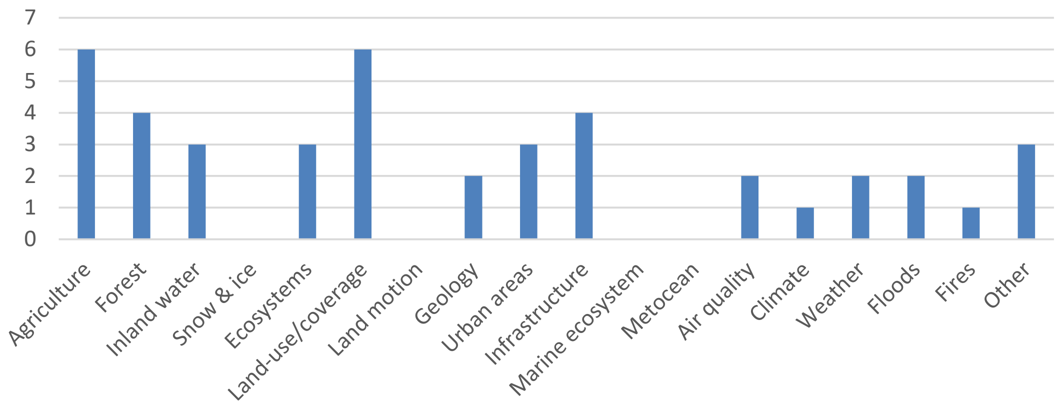


Figure 4-560. Activity areas of EO products/services of Serbian organizations.

National activities

While 23% of respondents recognized that the existence of national funding available for EO (23%), another 27% did not. The other half of respondents replied that this question did not apply to them as shown in Figure 4-561. Funding is perceived to be available for R&D (57%), infrastructure development (29%) as well as market development (14%), as seen in Figure 4-562.

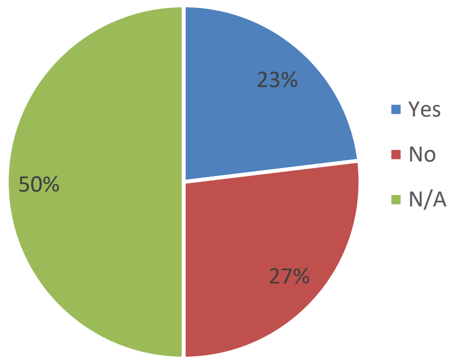


Figure 4-561. Serbian EO actors' perception of the availability of national funding for EO.

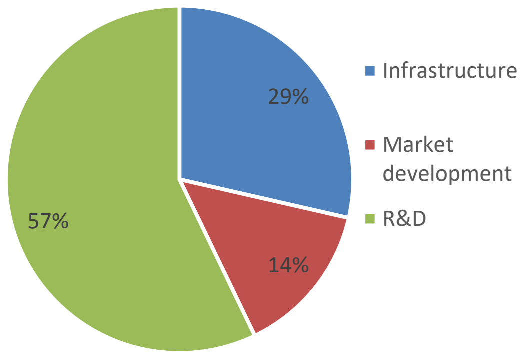


Figure 4-562. Serbian EO actors' perception of areas for which national EO funding is available.

Serbia does not have a space strategy or a space agency, which was known by respondents: see *Figure 4-563* and *Figure 4-564*.

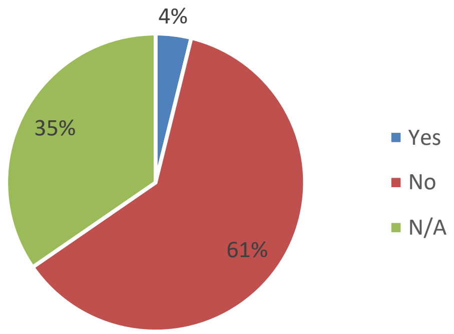


Figure 4-563. Serbian EO actors' awareness of a space strategy in Serbia.

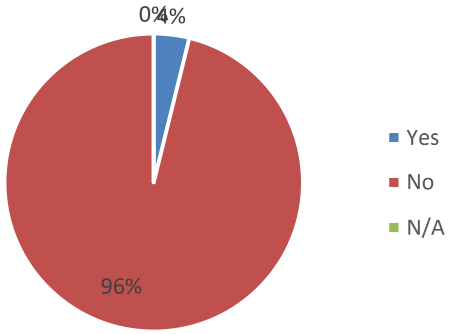


Figure 4-564. Serbian EO actors' awareness of a space program in Serbia.

Most respondents did not voice an opinion about the national coordination of EO activities (54%) and interaction with decision makers (50%), as shown in *Figure 4-565* and *Figure 4-566*. For those that did reply, only one respondent claimed both aspects to be fully integrated/engaged. For both questions, 11% replied that there was no coordination/interaction and 23% replied that coordination/integration was scarce. Two respondents mentioned that national coordination was basic, and three respondents that interaction with decision makers existed in specific thematic areas.

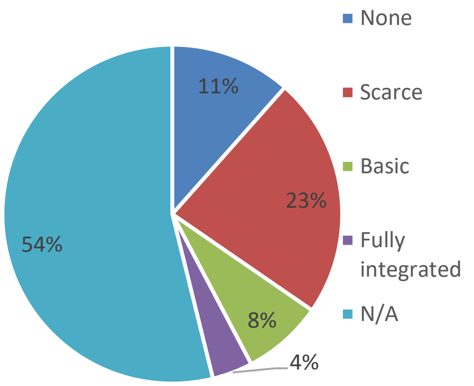


Figure 4-565. Serbian EO actors' perception of national coordination of EO activities in Serbia.

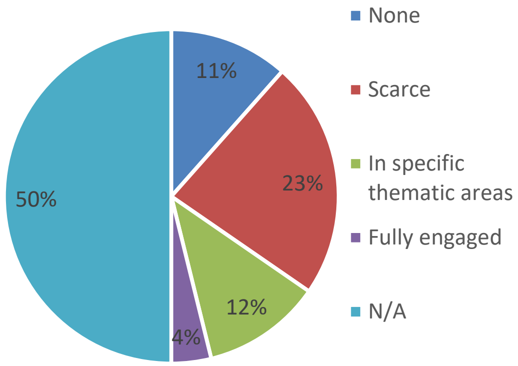


Figure 4-566. Serbian EO actors' perception of interaction with decision makers in Serbia.

The willingness of Serbian respondents to contribute with their capacities in a regional GEO or Copernicus initiative addressing regional needs in the domains of climate change, food security, access to raw materials, energy and water was overall positive (62% yes and 23% under specific circumstances), as shown by Figure 4-567.

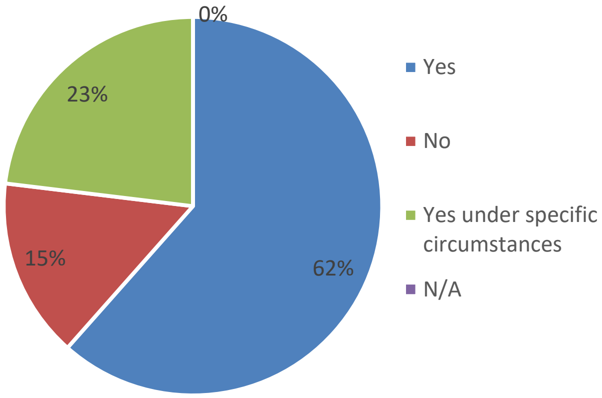


Figure 4-567. Serbian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

Significantly more end-users were aware of Copernicus than GEO as shown in *Figure 4-568* and *Figure 4-569*. However, most end-users were not aware of either.

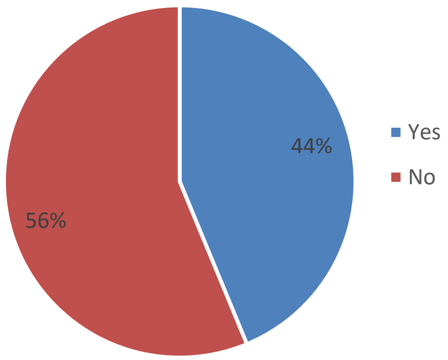


Figure 4-568. End-user awareness of Copernicus in Serbia.

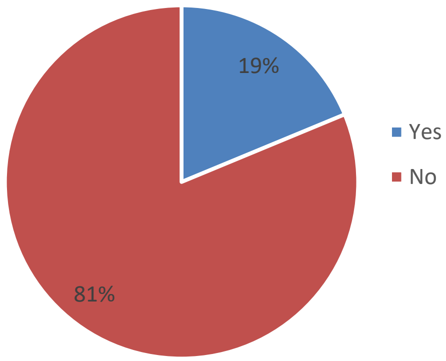


Figure 4-569. End-user awareness of GEO in Serbia.

4.9.3. *Gap analysis*

There are no **geographic** gaps identified. Although Serbia does not have any space-borne capacity, satellite images are purchased from commercial providers and local resellers. The survey identified that LANDSAT images were also used.

Several **observational** gaps were identified for specific geographic areas. In mountainous regions, data with a better temporal resolution is required by end-users, particularly in emergency situations, where the current pace of situational updates is unsatisfactory. One public organization active in emergency management described an internal process constraint and that it needs to decentralize its capacities to be closer to emergency areas, allowing for faster data flow and reaction. One end-user cited a need for higher resolution of meteorological data to better forecast extreme weather, implying that available in-situ networks have insufficient observational capacities in mountainous regions.

The survey demonstrated that no automated, in-situ capacities exist for soil attributes or radiation/energy. End-users currently obtain such data from manual sampling and analysis, fitting their needs. One user claimed that annual sampling is sufficient for their purposes, while another claimed that financial constraints limit sampling frequency and number. Although this is not a pressing gap, there is an indication that access to data derived from such a network would represent an improvement for end-users.

Large **structural** gaps were apparent in Serbia as a result of the gap analysis. Most end-users claimed that they face barriers to accessing data from other organizations, including public actors. Lack of connectivity was directly referred to, with one organization claiming that even communication with another public sector actors was a challenge when data was needed. Two organizations claimed that they do not have data that was identified in the local value chain. Underlying reasons were identified, as for instance the reluctance to share in the organizational culture, compounded with complex bureaucratic procedures that together form a significant barrier. This can clearly be seen in the value chain: organizations with in-situ networks have 78% low or no cooperation with local actors, organizations with modelling capacities have 50% and data exploiters have 67%. Indicatively, only one organization of all surveyed claimed to have high cooperation with local actors. A lag in data delivery was also noted by two end-users, although one claimed that it only occurred during “busy times”. However, it should be noted that there was a high diversity between the experiences of end-user organizations, a minority directly stated that they have no problems cooperating with others and accessing their data.

A couple of gaps in **quality/quantity** were suggested for Serbia. Several end-users stated that some data that they received was not in digital format, particularly from municipalities and other local government actors. One end-user found that municipal data is sometimes outdated and requires an effort to conduct corrections. Another claimed that data on climate and land-use can be improved for their use, as well as that greater precision in geo-referencing of data is to be desired. Another end-user that collects a large array of data from across public agencies said that quality is “probably the biggest challenge in many sectors” for their work, and that biodiversity and health time series are very short. Three end-users require better quality/quantity of data that they are unable to purchase due to lack of funding.

The survey indicates that key EO actors in the country have capacities with a high quantity/quality of data, e.g. in-situ networks with an hourly temporal resolution are available for meteorological and climate data, as well as atmospheric composition data, while hydrometrical data is available on a daily basis. On the other hand, there are no comparable in-situ networks for soil, radiation and energy related data. The implication is that certain capacities do not exist to meet end-user needs, and others are not of sufficient quality to meet the needs of certain end-users.

Large gaps in **capacity** were pinpointed. 56% of end-users claim that they need more staff, particularly experts to provide missing expertise in geospatial groups of organizations. Two end-users mentioned that they needed better measuring and processing equipment, one particularly at its remote units. Overall, there was a low awareness of Copernicus (44%) and GEO (19%), implying that full realization of advances in EO have yet to be disseminated to many geospatial professionals in the country. As one end-user observed, it would be useful to have an inflow of young staff that would be more willing to adopt new technology and processes.

Many of the identified gaps are manifested due to a lack of funding and a freeze in hiring in the public sector. This manifests a lack of capacity, insufficient human resources and expertise, suboptimal data quality, inability to purchase desired resolution, structural gaps, inaccessibility to costly data, investment in expansion of in-situ networks and insufficient funds for maintenance of current capacities. However, considering that most end-users interviewed and most key EO actors were from the public sector, a clear legal framework for free and open intra-agency data sharing could solve several of these problems. An important discontinuity in the value chain is the access to the cadaster maintained by the RGZ, for research as well as institutional organizations. 44% of end-users claimed to have insufficient access to the cadaster due to high costs that were not feasible for the organization given budget cuts.

It is clear that Serbia's EO strengths are primarily based on hydrometeorology. This provides a solid value chain for all of the thematic areas, including energy, as Serbia has a large portion of its energy derived from hydropower. It is clear that the largest dedicated activity is in climate change, with a governmental group tasked to report on the subject. There is no organization mandated with food security, however there are several institutional and research organizations active in agriculture, that fit within the domain. Research organizations (not included as end-users) identified a clear need to upgrade in-situ soil data collection. There are significantly less key EO actors active in access to raw materials and energy. Mining (including coal for energy) is regulated by the government, which employs EO to some extent in this process. It is envisioned that the EU accession process will bring about more stringent standards in environmental protection. The state of the art in legislation and practice has been identified as drastically below EU standards; the change will require powerful cost effective monitoring tools for which EO is ideally suited. Thus it is expected that these capacities will develop as the need arises with legislative changes and their implementation.

4.10. Tunisia

4.10.1. *Overview*

In the last years, there has been a growing interest in integrating the use of EO data and information for helping decision makers. This is reflected on the relevant educational efforts in the country. The Tunisian Ministry of Higher Education and Scientific Research (MHESR) is promoting space knowledge and has included specific EO subjects in bachelor and master degrees, to improve expertise and scientific capabilities of graduates. In the National Engineering School of Sfax, it was conceived that a micro satellite and some satellite components are to be designed. In addition, many institutes are teaching techniques for remote sensing and satellite image processing, like the laboratory of ENIT (Ecole Nationale d'Ingénieurs de Tunis) for space information systems and the laboratory COSIM (COmunication, Signaux et IMages) of Sup'Com. More recently, the CNCT (Centre National de Cartographie et de Télédétection – the national Space Agency in Tunisia) launched in coordination with the MHESR a four-year research framework program (2015-2018) to work on challenges related to the assessment of natural resources and land use, food security and climate change. Most of the partners are research centers, universities and public institutes.

Despite the growing interest in EO data and information, most of the Tunisian governmental services, which dominate the EO sector, are still less prepared to produce and use the geospatial information in decision making and to define and implement their EO data policies. The main diffuclties encountered by governmental services are:

Lack of coordination between different institutions, leading often to duplicated research efforts. This case applies to the Ministry of Agriculture where the activities of INRAT (Institut National of Agricole de Tunis) and the general directions of the ministry are not coordinated, because of the inefficiency of CRDAs (Commissariat of Regional Development of Agriculture) in disseminating research results and information within ongoing projects.

Intensive administrative procedures: Most public institutes and private companies suffer not only from heavy administrative procedure to access, share and use EO data, but also from complicated procedures to import new IT equipment when needed.

Difficulty of data collection and sharing: It is often difficult to collect EO data for specific needs. For example, the INM (Institut National de Métrologie) used to collect data freely from its partner INGC (Institut National des Grandes Cultures); today, however, it has become difficult to get the data, as some private consulting offices are using researchers to get the data freely.

Financial constraints: Public institutions are facing a lack of funds for hiring qualified human resources and purchasing new equipment to meet their evolving needs. Moreover, the finance process which is regulated by the finance law is complex and time consuming, leading to considerable delays in the purchase of equipment.

At the level of human and technological capacities, there is **a lack of remote sensing and GIS expertise in some public institutes**, resulting in insufficient understanding and use of geospatial information to address vital needs of the country. On the other hand, where human capacities exist, it is often underused due to lack of hosting institutions and facilities. In this case, the main challenge is to retain and maintain existing capacities.

Recognizing the importance of EO, Tunisia has strengthened its cooperation ties through involvement in international and regional intiatives and networks. For example: the GMES and Africa and AfriGEOSS initiatives. Several EO actors have also been involved in many EO-related projects within Framework Program 7, including:

- AGRICAB -Enhancing EO capacity for Agriculture and Forest Management in Africa
- WAHARA -Water Harvesting for Rainfed Africa: Investing in dryland agriculture for growth and resilience
- WATER - Biotechnology for Africa's sustainable water supply
- REELCOOP - Research cooperation in renewable energy technology for electricity generation

To this end, it is important to interconnect existing EO data management systems into a national network of EO information. NIS (Institut National de Statistique) is doing a good work in this aspect, by collecting environmental data and integrating it into one single database, yet still much work has to be done to make it a reference source. Increasing interoperability between national EO data management systems is therefore crucial. In addition to computing interoperability, it is necessary to harmonize terminology, methodology and nomenclature between the different EO actors. It is also essential to develop the processes of data validation and quality control. Finally, there is a need to set up a regulatory framework that formalizes the networks for EO data collection and sharing between institutions and simplifies the procedure of EO data access and sharing.

4.10.2. *Capacities*

Space-borne capacities

As shown in Figure 4-570, in Tunisia, the survey reached two organizations with space-borne capacities. These organizations are commercial.

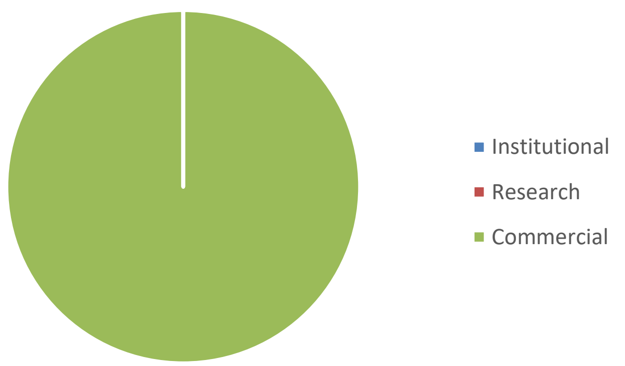


Figure 4-570. Types of organizations with space-borne capacities in Tunisia.

Organizations in Tunisia with space-borne capacities are active in all thematic areas except access to raw materials (see Figure 4-571). Organizations that claimed to have capacities in *other activities* include: GIS consulting and implementation, application development, as well as data acquisition and processing.

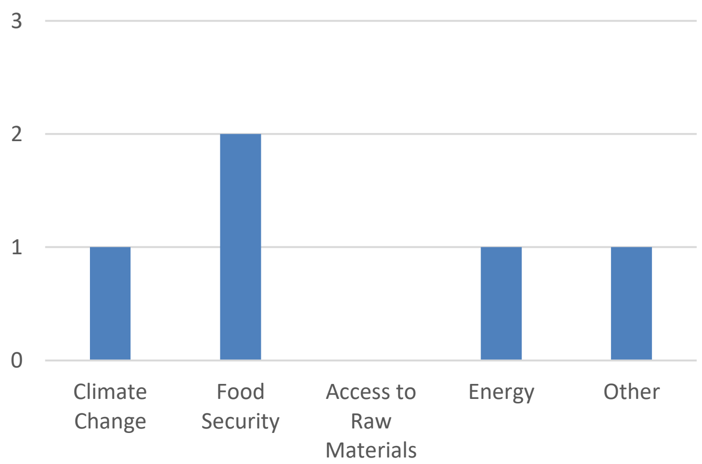


Figure 4-571. Activity of Tunisian organizations with space-borne capacities in GEO-CRADLE thematic areas.

One of the respondents participated in EO related projects (see Figure 4-572).

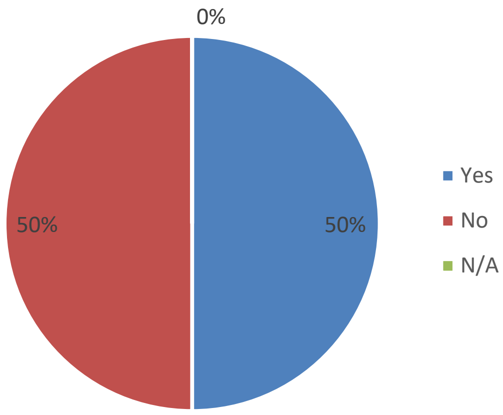


Figure 4-572. Participation of Tunisian organizations with space-borne capacities in EO activities.

Participation in Copernicus service provision, Copernicus user requirements definition or Copernicus Research & Innovation action is non-existent for Tunisian organizations with space-borne capacities (see Figure 4-573).

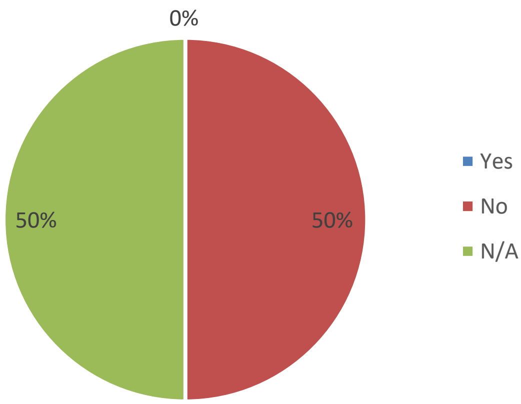


Figure 4-573. Participation of Tunisian organizations with space-borne capacities in a Copernicus action.

One of the organizations with space borne capacities indicated having taken part previously in a GEO/GEOSS SBA tasks (see Figure 4-574).

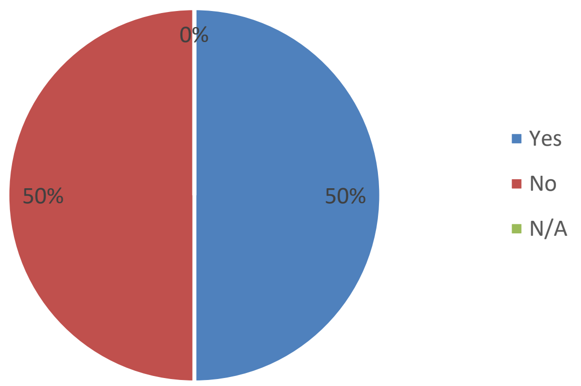


Figure 4-574. Participation of Tunisian organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

The level of collaboration between EO players in Tunisia is high for the organization that specified (see Figure 4-575), and moderate with EO players abroad (see Figure 4-576).

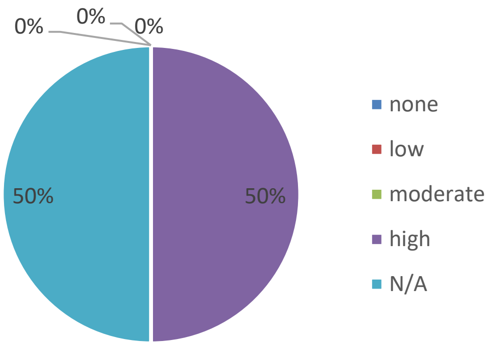


Figure 4-575. Level of cooperation of Tunisian organizations with space-borne capacities with local EO actors.

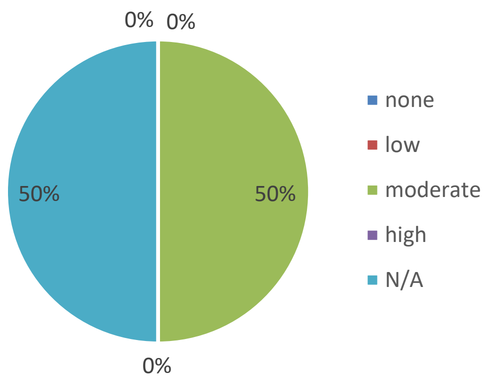


Figure 4-576. Level of cooperation of Tunisian organizations with space-borne capacities with EO actors abroad.

When asked about their additional EO capacities, one responded that they also have modelling, processing and data exploitation capacities. One organization has no other capacities apart from space-borne capacities (see Figure 4-577). As shown in Figure 4-578, both organizations with space-borne capacities have ground segments.

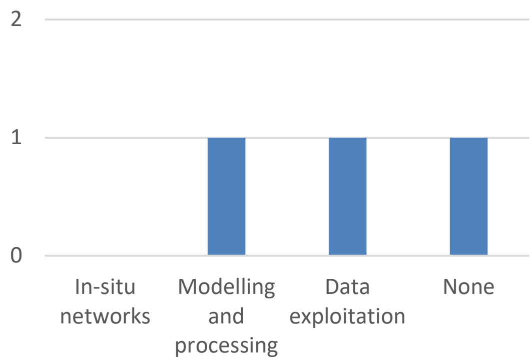


Figure 4-577. Additional EO capacities of Tunisian organizations with space-borne capacities.

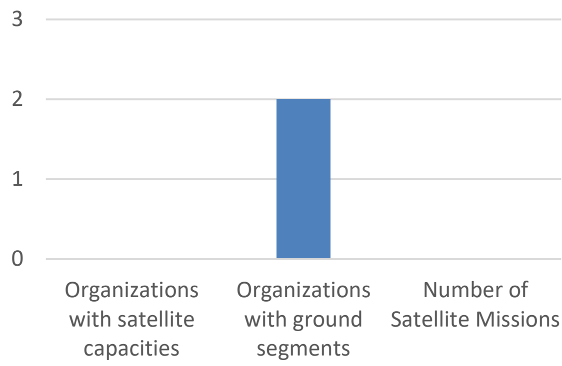


Figure 4-578. Type of space-borne capacities of Tunisian organizations.

In-situ networks and facilities

In Tunisia, the survey reached four organizations: half institutional (see Figure 4-579).

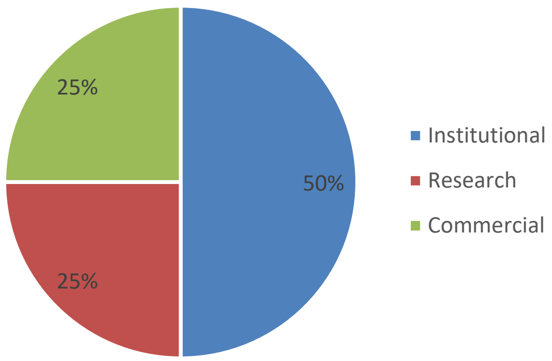


Figure 4-579. The type of organizations with in-situ networks in Tunisia.

As shown in Figure 4-580, Tunisian organizations with in-situ networks/facilities are active in the following thematic areas of GEO-CRADLE: climate change, food security and access to raw materials.

The organizations that indicated being involved in other thematic areas, further specified geological mapping, geophysical and geochemistry mapping, raw and mining, industrial rocks mapping and hazard mapping.

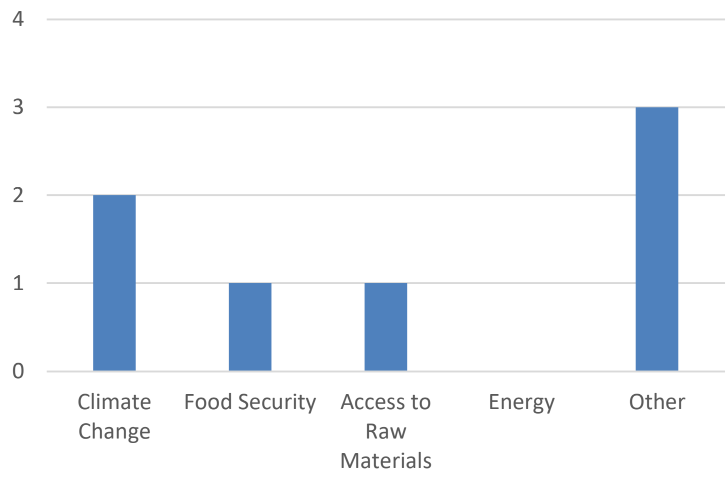


Figure 4-580. Activity of Tunisian organizations with in-situ networks in GEO-CRADLE thematic areas.

Only half of the organizations with in-situ networks/facilities reached by the survey took participation in EO related projects (see Figure 4-581).

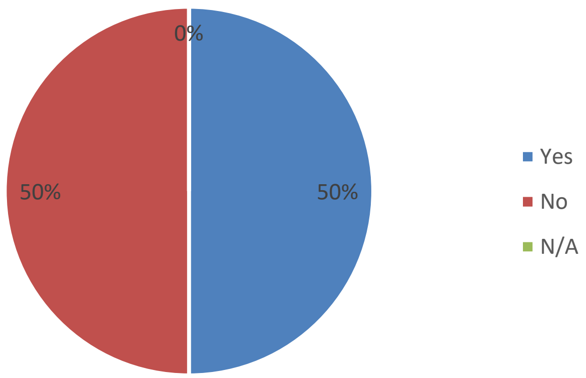


Figure 4-581. Participation of Tunisian organizations with in-situ networks in EO activities.

As the survey shows, no organization has participated in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action (see Figure 4-582). Only half of the organizations reached by the survey took participation in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-583).

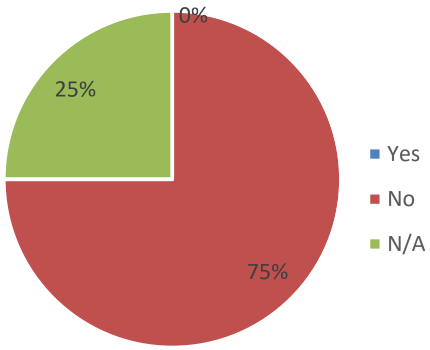


Figure 4-582. Participation of Tunisian organizations with in-situ networks in a Copernicus action.

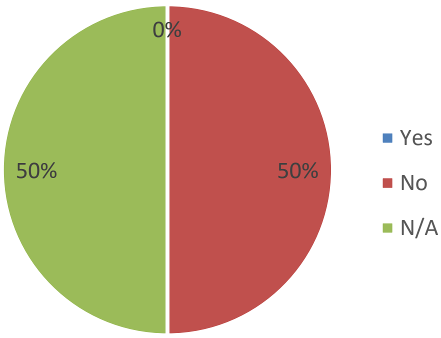


Figure 4-583. Participation of Tunisian organizations with in-situ networks in a GEO/GEOSS SBA task.

The level of collaboration between EO actors is at different levels, as shown in Figure 4-584 and Figure 4-585.

Locally, the level of collaboration between EO actors is low (50%). One respondents has high local collaboration, while has no collaboration. The situation is similar for cooperation with EO actors abroad, except the respondent with high local cooperation has moderate international cooperation.

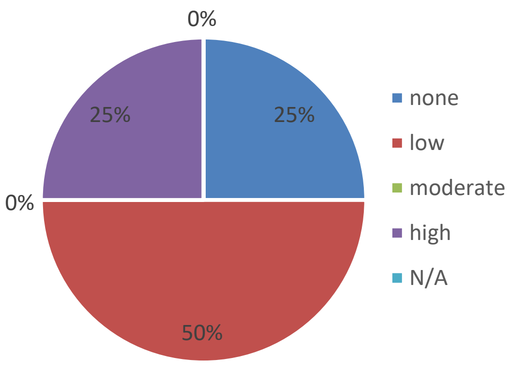


Figure 4-584. Level of cooperation of Tunisian organizations with in-situ networks with local EO actors.

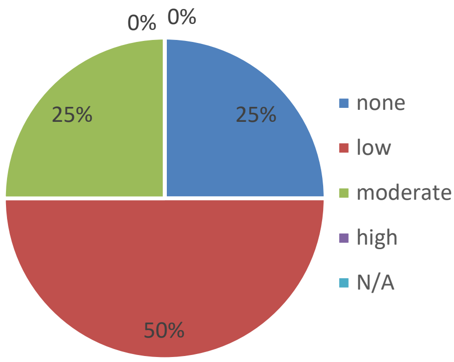


Figure 4-585. Level of cooperation of Tunisian organizations with in-situ networks with EO actors abroad.

In addition to in-situ capacities, three organizations also have data-exploitation capacities (see Figure 4-586). One organization has modelling and processing capacities. One organization has no other capacities apart from in-situ capacities.

As far as the area of activities of the networks is concerned, the survey identified meteorological/climatic facilities, hydrometric/water and soil attributes facilities (see Figure 4-587). The organizations that indicated having other types of in-situ capacities, indicated having capacities through a GNSS real time network.

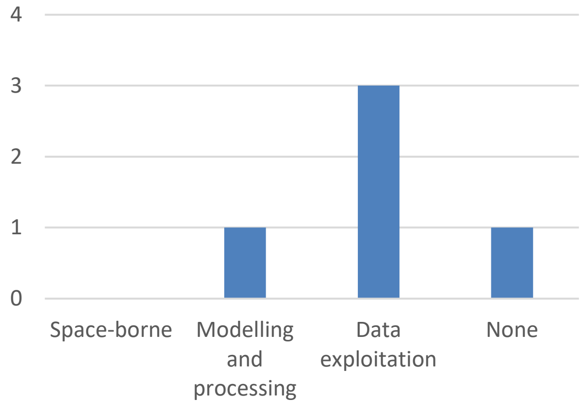


Figure 4-586. Additional EO capacities of Tunisian organizations with in-situ networks.

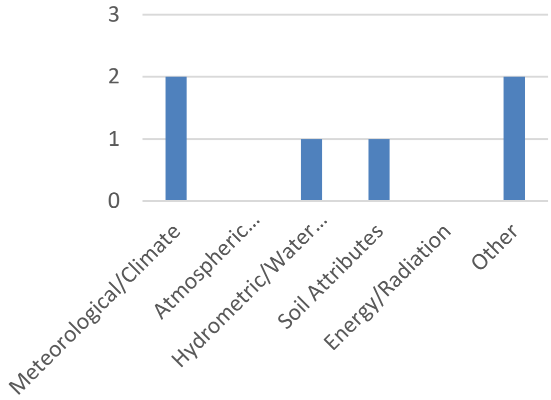


Figure 4-587. Activity area of in-situ networks of Tunisian organizations.

The number of stations in in-situ networks by activity area is shown in Figure 4-588. There are 29 meteorological/climatic facilities, 2 hydrometric/water facilities, and 3 soil attributes facilities. As can be seen, there are no atmospheric composition or energy/radiation facilities.

The geographic coverage of the Tunisian in-situ networks by activity area is shown in Figure 4-589. Few details were provided in the responses. Two local networks can be discerned, and national coverage is demonstrated for an in-situ network used for meteorological purposes.

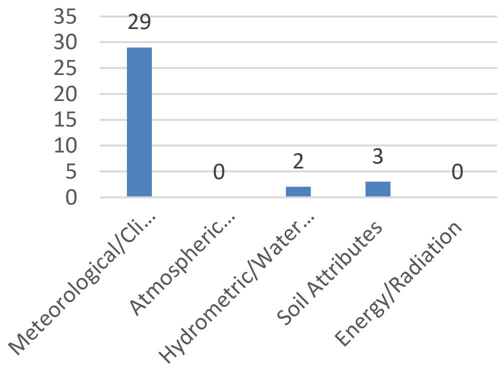


Figure 4-588. Number of stations of in-situ networks in Tunisia by activity area.

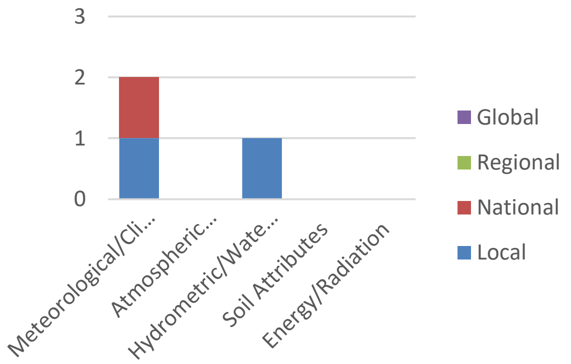


Figure 4-589. Geographic coverage of in-situ networks in Tunisia by activity area.

No information was provided if in-situ networks were a part of National/Regional/International network. Data is systematically stored and collected for meteorological/climatic facilities, and soil attributes facilities (see Figure 4-590). Organizations indicated that data is also collected for a GNSS real time network.

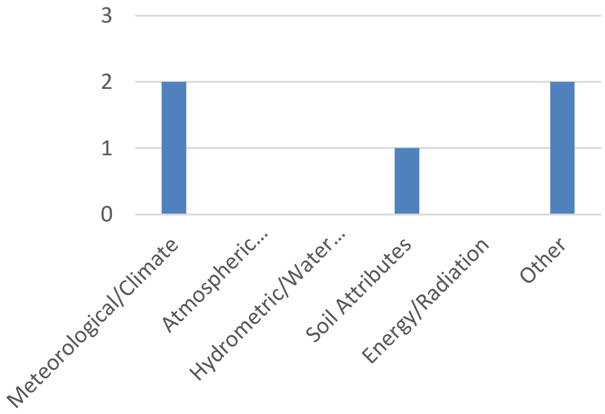


Figure 4-590. Systematic collection of data by in-situ networks in Tunisia by activity area.

As shown in Figure 4-591, only one respondent confirmed the availability of METADATA in their **meteorological/climate in-situ network**. Temporal resolution of data acquisition is daily for one network, however, other types of temporal resolutions are also applied (see Figure 4-592).

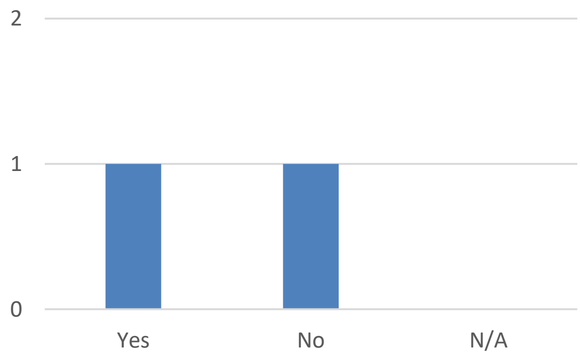


Figure 4-591. Availability of METADATA from meteorological and climate in-situ networks in Tunisia.

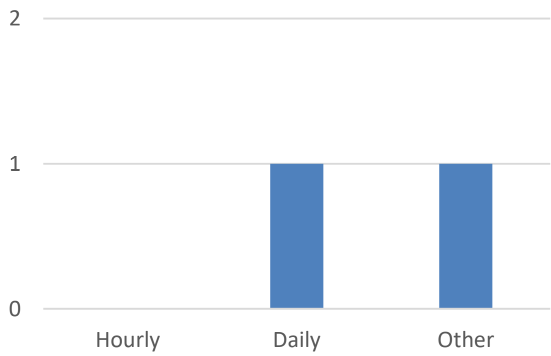


Figure 4-592. Temporal resolution of meteorological and climate in-situ networks in Tunisia.

Data is usually available upon request (see Figure 4-593). Data policy remains unknown as no information was provided by the survey respondents.

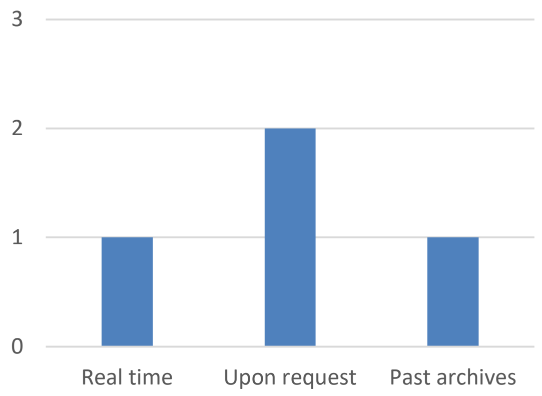


Figure 4-593. Data availability from meteorological and climate in-situ networks in Tunisia.

No further details were provided about the other in-situ networks in Tunisia.

Modelling and processing capacities

In Tunisia, the survey reached four organizations with modelling capacities: two institutional, one commercial and one research-oriented (see Figure 4-594).

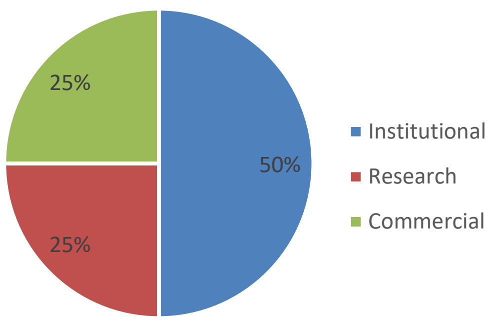


Figure 4-594. The type of organizations with modelling and processing capacities in Tunisia.

Tunisian organizations with modelling capacities are active in all GEO-CRADLE thematic areas (see Figure 4-595). Other areas of activities include: GIS consulting & implementation, application development, data acquisition and processing, geological mapping, geophysical and geochemistry mapping, raw and mining, industrial rocks mapping and hazard mapping.

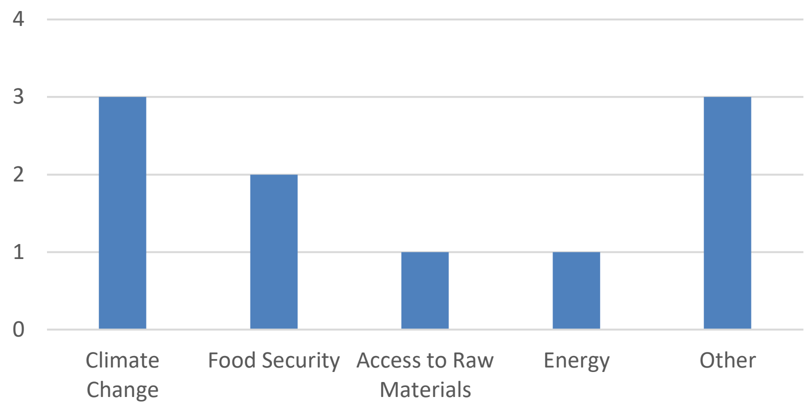


Figure 4-595. Activity of Tunisian organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

As shown in Figure 4-596, a large majority of Tunisian organizations with modelling capacities (75%) have taken part in EO related projects.

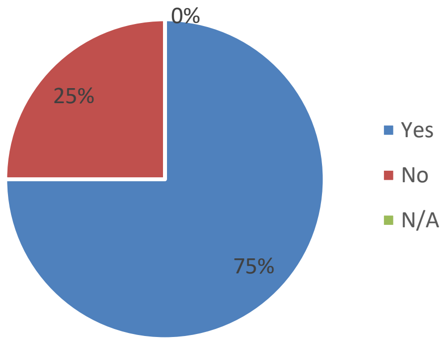


Figure 4-596. Participation of Tunisian organizations with modelling and processing capacities in EO activities.

No respondents have participated in Copernicus (see Figure 4-597). One Tunisian organization with modelling and processing capacities was involved in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-598).

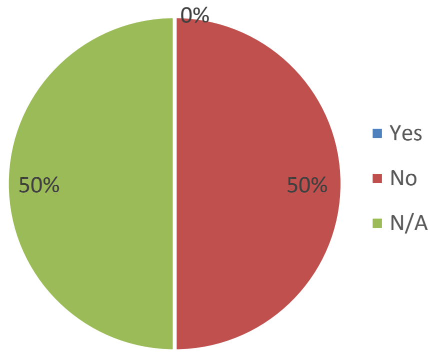


Figure 4-597. Participation of Tunisian organizations with modelling and processing capacities in a Copernicus action.

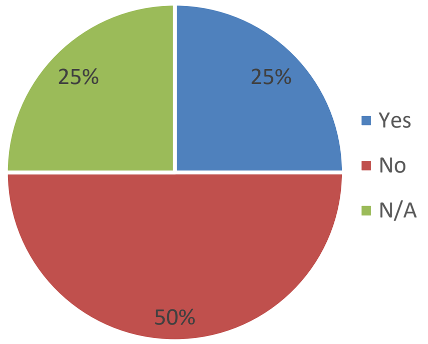


Figure 4-598. Participation of Tunisian organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

As shown in Figure 4-599, the level of collaboration with local EO actors is generally at a high level (two organizations). In addition, one organization has moderate collaboration and one has no collaboration with other EO actors in Tunisia. Internationally, the level of coordination is moderate for two organizations, low for one organization and none for one organization (see Figure 4-600). Examples of collaboration include:

- One organization that is a member of the National Committee of Outer Space;
- A signed convention with the CNCT (National Center of Cartography and Remote Sensing);

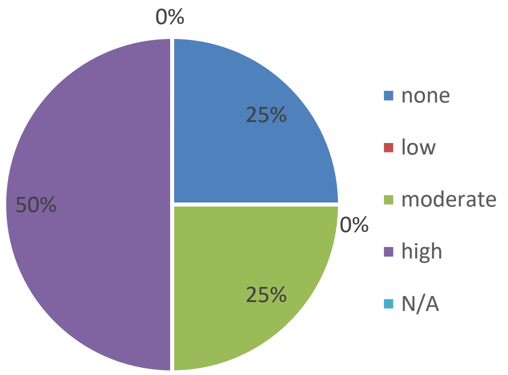


Figure 4-599. Level of cooperation of Tunisian organizations with modelling and processing capacities with local EO actors.

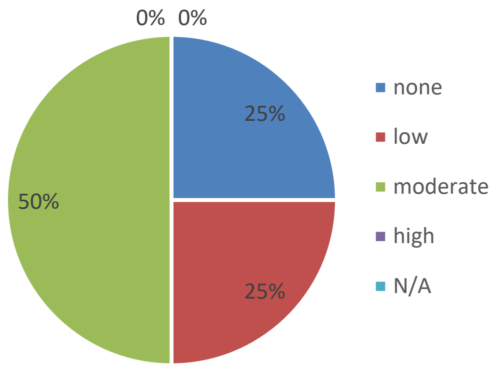


Figure 4-600. Level of cooperation of Tunisian organizations with modelling and processing capacities with EO actors abroad.

All Tunisian organizations with modelling and processing capacities have other EO capacities (see Figure 4-601). Three of the four have data exploitation activities.

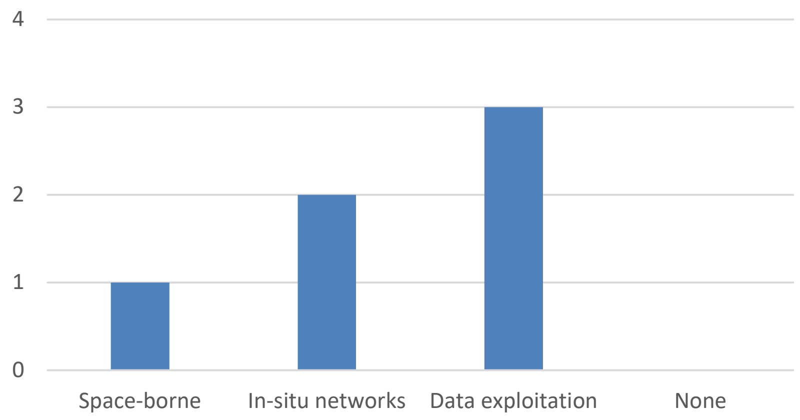


Figure 4-601. Additional EO capacities of Tunisian organizations with modelling and processing capacities.

As shown in Figure 4-602, most models serve the following areas of activity: meteorological/climate, soil attributes, energy/radiation. Tunisian respondents use a variety of EO data (see Figure 4-603).

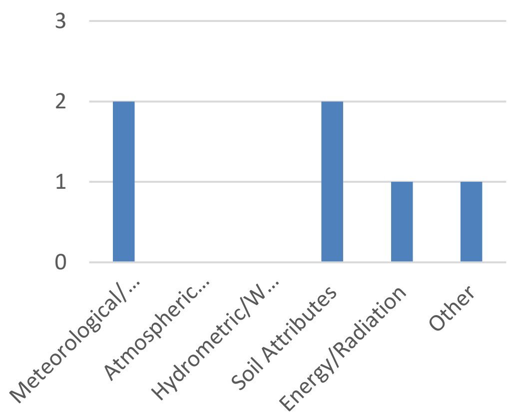


Figure 4-602. Algorithms and models available in Tunisia by activity area.

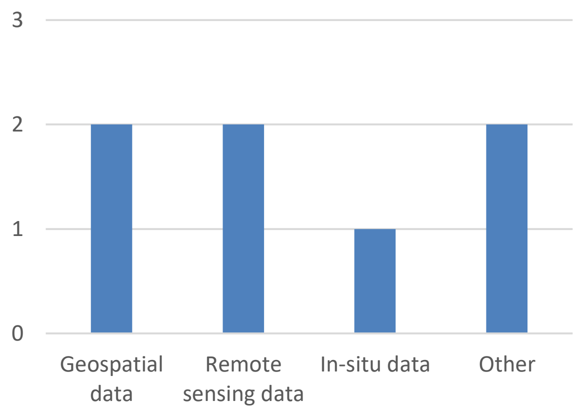


Figure 4-603. Sources of EO data used by organizations with modelling and processing capacities in Tunisia.

As shown in Figure 4-604, models have national, regional, or local coverage. There is one global-coverage model among the organizations surveyed. Few details were specified for METADATA availability, only one model has METADATA available and two do not (see Figure 4-605).

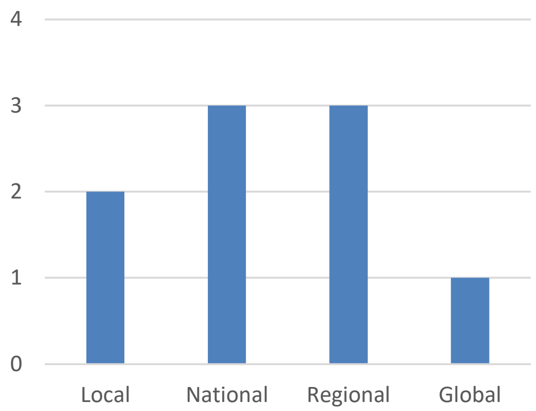


Figure 4-604. Geographic coverage of models and algorithms in Tunisia.

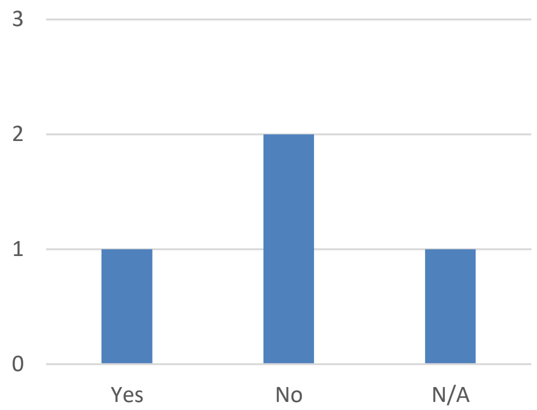


Figure 4-605. Availability of METADATA for models and algorithms in Tunisia.

Among the organizations surveyed, computing resources available did not include server clusters, HPC clusters, virtualization infrastructure (see Figure 4-606). Cloud infrastructure was identified at one organization, processing power capacity was identified at three organizations.

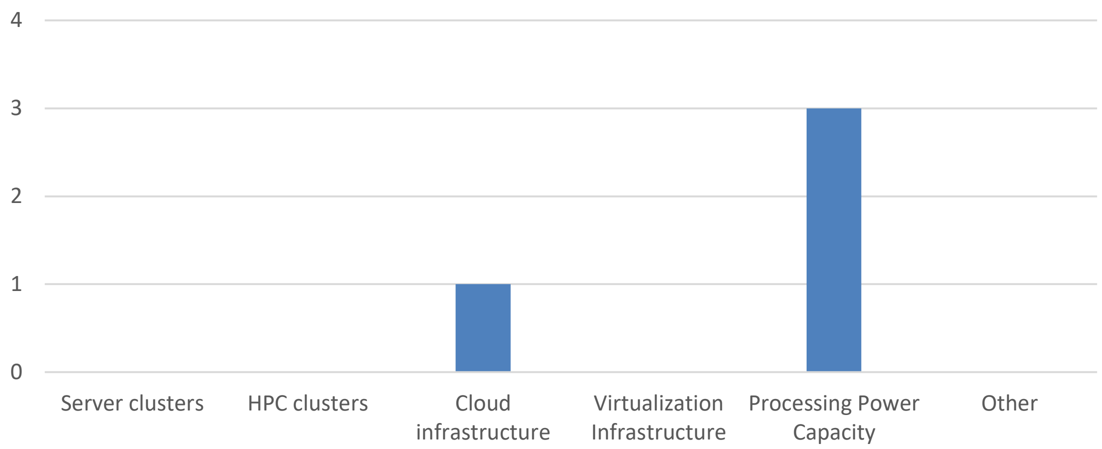


Figure 4-606. Computing resources available for processing and exploitation of EO data in Tunisia.

Data exploitation capacities

In Tunisia, the survey reached 12 organizations with data exploitation capacities of all types, most of which are institutional (see Figure 4-607).

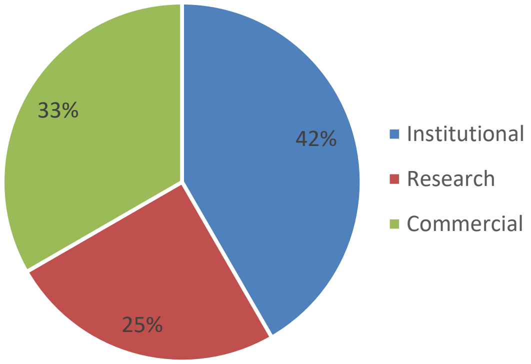


Figure 4-607. The type of organizations active in data exploitation in Tunisia.

As shown in Figure 4-608, Tunisian organizations with data exploitation capacities are active in all GEO-CRADLE thematic areas, particularly in the area of food security and climate change. Other areas of activity include: GIS consulting & implementation, application development, data acquisition and processing.

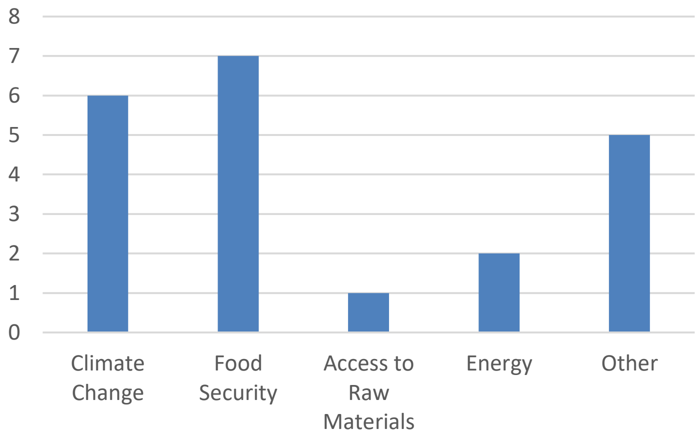


Figure 4-608. Activity of Tunisian organizations active in data exploitation in GEO-CRADLE thematic areas.

According to the respondents' answers, 50% of Tunisian organizations with data exploitation capacities took part in EO related projects. The remaining 50% of organizations did not (see Figure 4-609).

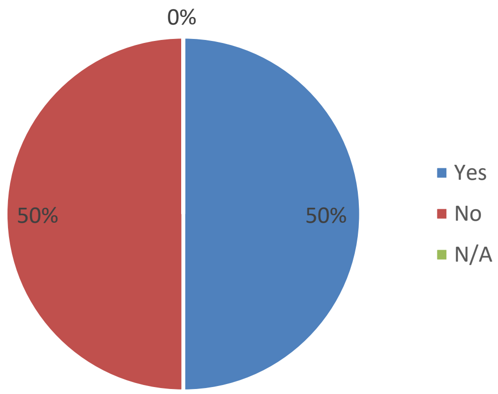


Figure 4-609. Participation of Tunisian organizations active in data exploitation in EO activities.

No Tunisian organization was identified to have participated in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action (see Figure 4-610). As shown in Figure 4-611, 12% of Tunisian organizations took part in a GEO/GEOSS SBA Tasks community activities or initiatives.

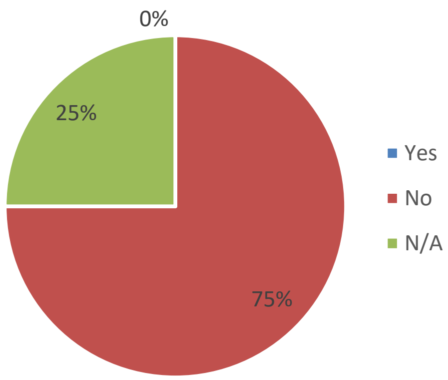


Figure 4-610. Participation of Tunisian organizations active in data exploitation in a Copernicus action.

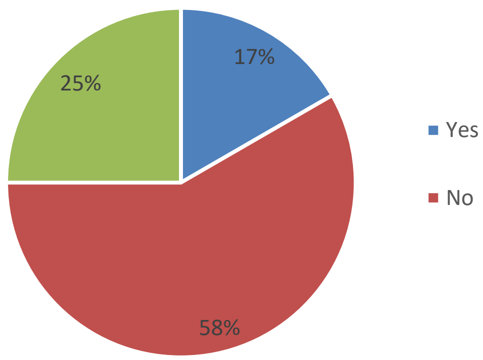


Figure 4-611. Participation of Tunisian organizations active in data exploitation in a GEO/GEOSS SBA task.

The level of collaboration between EO actors in Tunisia generally ranges from low to high. However, according to a significant percentage of respondents, this type of collaboration does not exist (see Figure 4-612). Examples of collaborative efforts between EO players in Tunisia include: land cover mapping, capacity building and training, training tool kits.

According to the Tunisian organizations with data exploitation capacities, the level of collaboration between EO players abroad mainly ranges from none to low. Only 8% of respondents rated this level as high (see Figure 4-613).

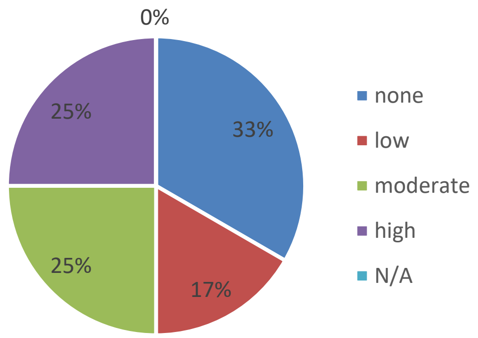


Figure 4-612. Level of cooperation of Tunisian organizations active in data exploitation with local EO actors.

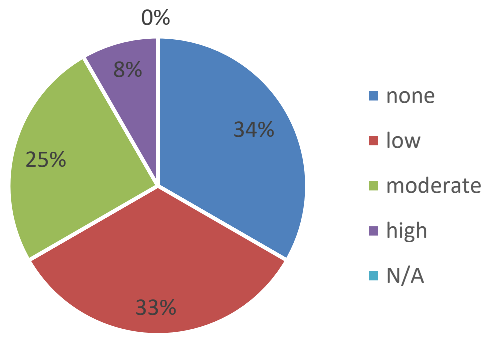


Figure 4-613. Level of cooperation of Tunisian organizations active in data exploitation with EO actors abroad.

All organizations have additional EO capacities (see Figure 4-614).

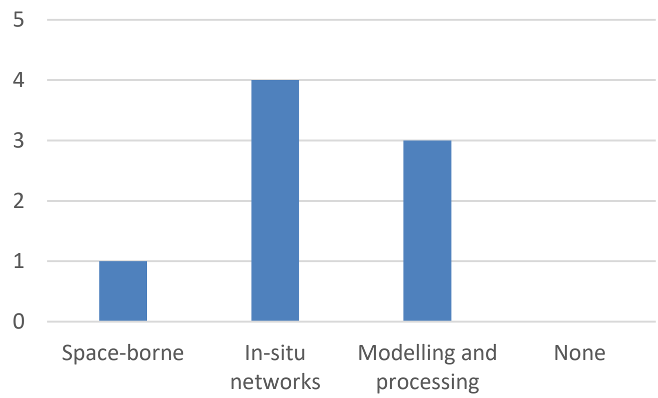


Figure 4-614. Additional EO capacities of Tunisian organizations active in data exploitation.

As shown in Figure 4-615, the organizations reached by the survey are active in most categories measured. They are the most active in the following areas: land use/coverage, infrastructure and urban areas. Organizations indicated that other EO products they provide are topographic maps, thematic maps, map land use, cereal yield estimation, and forestry inventory.

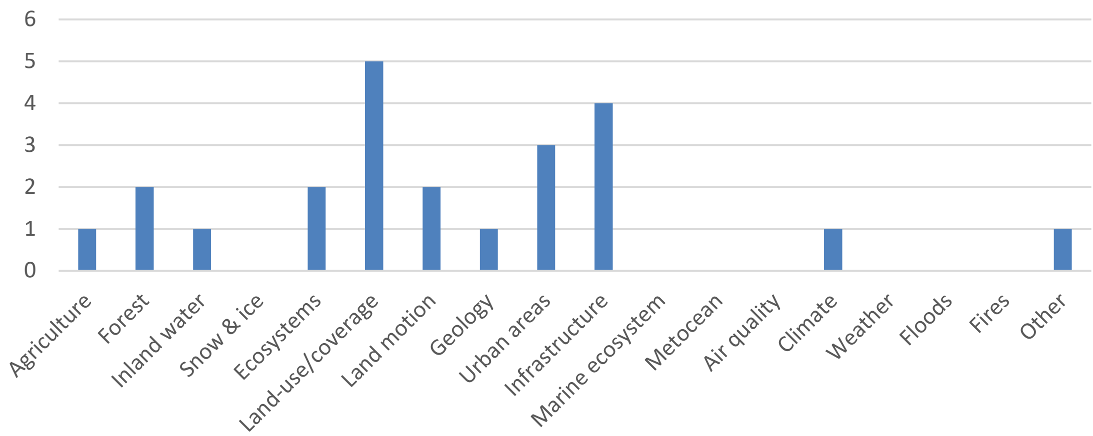


Figure 4-615. Activity areas of EO products/services of Tunisian organizations.

National activities

43% of respondents perceive that funding for EO related activities is available in Tunisia, 36% of respondents perceive that it does not (see Figure 4-616). As shown Figure 4-617, funding is available for infrastructure development and R&D.

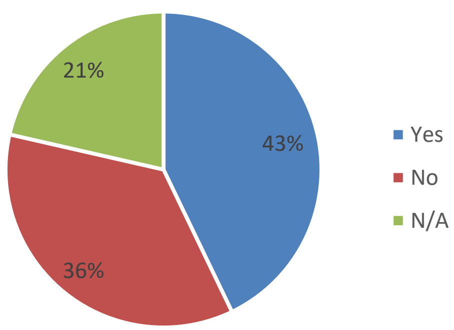


Figure 4-616. Tunisian EO actors' perception of the availability of national funding for EO.

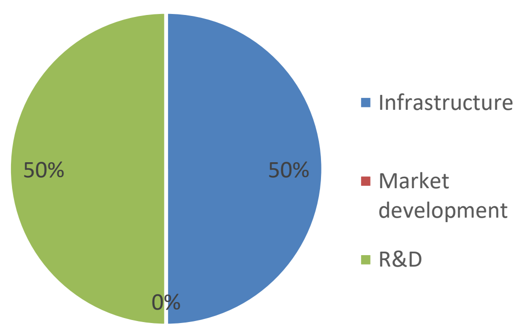


Figure 4-617. Tunisian EO actors' perception of areas for which national EO funding is available.

Awareness of a national space policy/strategy and space program is almost evenly split for both cases between those that are aware and those that are not (Figure 4-618).

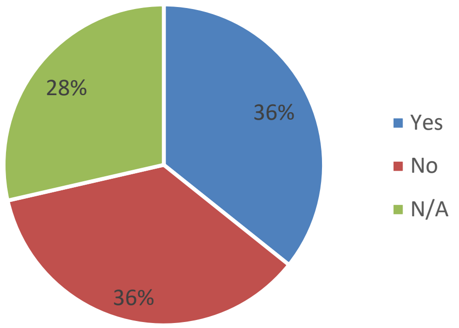


Figure 4-618. Tunisian EO actors' awareness of a space strategy in Tunisia.

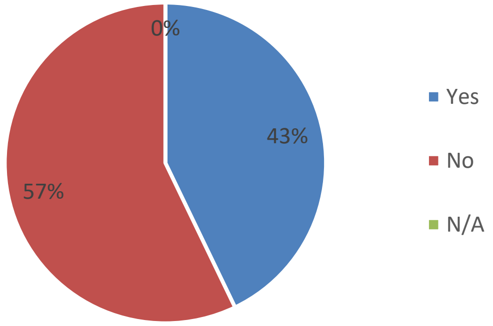


Figure 4-619. Tunisian EO actors' awareness of a space program in Tunisia.

Perceptions regarding the level of coordination of EO activities in Tunisia is varied: 14% none, 21% scarce, 29% basic and 7% fully integrated (see Figure 4-620). A similar picture can be seen regarding perceptions of interaction with decision makers: 14% none, 21% scarce, and 36% in specific thematic areas (Figure 4-621).

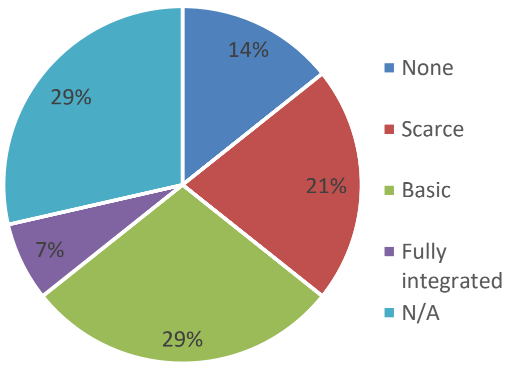


Figure 4-620. Tunisian EO actors' perception of national coordination of EO activities in Tunisia.

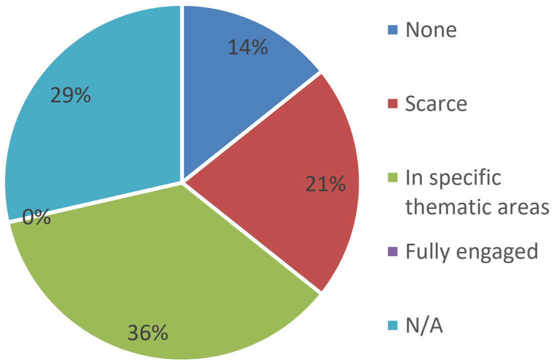


Figure 4-621. Tunisian EO actors' perception of interaction with decision makers in Tunisia.

A large majority of respondents (71%) are willing to engage in a regional initiative of GEO and/or Copernicus by contributing their capacities, Figure 4-622. 29% are willing to engage under specific circumstances

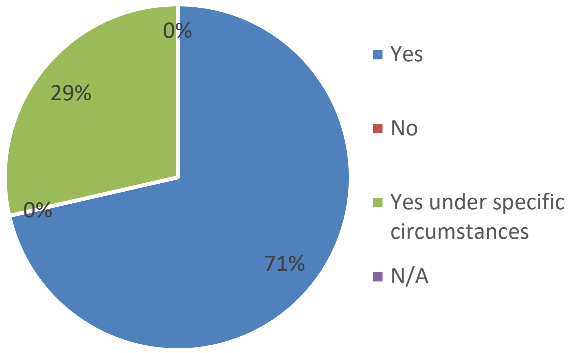


Figure 4-622. Tunisian EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

4.10.3. *Gap analysis*

No **geographic** gaps were found.

Tunisia has important **observational** gaps. Gathering very accurate spatial data in relation to the geographic resource distribution is challenging according to end-users, as such data is subject to deficiencies in spatial accuracy. The current network of ground segment facilities is scarce and does not provide sufficient coverage, particularly in the thematic area of energy. This gap was validated in the survey, by observing the geographic coverage of in-situ facilities/networks in Tunisia and their activity area. Only meteorological/climatic facilities have national coverage, and no organization confirmed their ownership of energy/radiation facilities.

Another major gap is related to the availability of technical **capacity**. In particular, old equipment, as well as limited IT infrastructure represent major barriers for advanced data analysis. The survey identified limited computing resources available for modelling and computing in the country and, therefore, overall lack of technical capacity could be validated as a gap.

In regards to **structural gaps**, end-users pointed out to several constraints, which were later validated as gaps. It is often the case that duplicated research efforts are made because of the lack of coordination between different entities of one authority. Furthermore, there are various constraints, including the availability of national funding, resulting in complicated procedures with several levels of approval needed for data sharing to take place.

In terms of **quantity/quality** of data, several gaps were identified. As seen in the survey, METADATA is usually not available. Because of such limitations, data is hardly verifiable in practice, and this was one of the major constraints identified by end-users.

Gaps in **capacity**, according to end-users, are present in human resource limitations. In particular, there is more administrative than technical staff, and there is an overall lack of qualified staff specialized in GIS. Again, with limited national funding, low levels of interaction with decision makers, and poor resources available for modelling and computing, it is obvious that in terms of capacity, human resource limitations can be truly seen as a major gap in Tunisia.

4.11. Turkey

4.11.1. *Overview*

Turkey is a country undergoing a rapid rate of change in many aspects: urbanization is not sufficiently controlled, large development projects (highways, dams, irrigation, housing, infrastructure etc.), changes in agricultural practices causing environmental problems, with soil erosion, and deforestation, etc. As the country is prone to natural hazards such as landslides, flooding and earthquakes, uncontrolled developments cause higher risks and higher damages in the likely case of a disaster event. Therefore, **changes stemming from rapid economic growth have to be monitored continuously**, in order to support any necessary revisions in the spatial policies and streamline developments.

EO systems are well suited to play this role as they can support the acquisition and handling of traditional information – as a result **most Turkish Institutions have integrated EO facilities**. Governmental agencies such as the General Directorate of State Hydraulic Works and Turkish State Meteorological Service operate for example, country wide in-situ observing networks.

University, Research and Governmental Institutions have a number of **monitoring systems and networks for natural disasters**. There are established research groups which are developing their capacities for various classes of EO data: cartography, climate, marine, geology, agriculture, fisheries, meteorology, urbanization, hydrology, forestry, etc.

Some organizations in the country, including Istanbul Technical University (ITU) and TUBITAK Space Technologies Research Institute (TUBITAK UZAY), have established facilities to acquire data from Pleiades 1A-1B, SPOT 5-6-7, RadarSAT 1-2, METEOSAT, RASAT, Göktürk-2 remote sensing satellites.

There is **notable activity in the private sector**. A major market segment is composed of companies which are vendors of hardware, software and data. In the private sector, projects are often funded by municipalities or governmental agencies and less frequently by major commercial entities, such as oil and mineral extraction companies or water supply development projects.

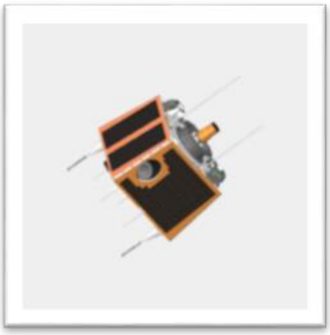
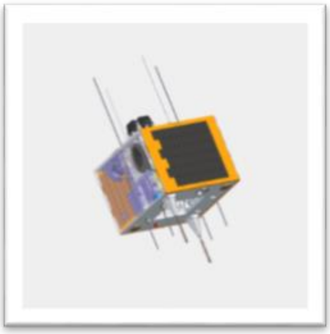
At present, the manpower requirements for the activities in public and private organizations cannot be met by existing Turkish Institutions. **Educational and training capacity available in universities must be expanded**.

Apart from providing social and economic benefits, **EO has political and strategic importance for Turkey**. In order to provide informed and independent decisions regarding internal security and border security, access to independent information is crucial.

As a research institute and both satellite manufacturer and satellite data provider, TUBITAK UZAY has operational contacts with many governmental organizations for its own purposes, and it is simple to maintain communication with EO-related organizations. TUBITAK UZAY has already long-term working relationships with public and private EO organizations, both nationally and internationally.

It is **vital to develop existing space related technology** to ensure the continuity of the technological infrastructure needed to implement and pursue national space policies, and to catch up with developed nations. Initially the country’s space program chose to develop small EO satellites through technology transfer; this was a strategic policy decision considering small available budgets, shorter development cycles and the potential promised by small EO satellites and their applications. The current state-of-the-art is that Turkey has two EO satellites named RASAT and Göktürk-2, see Table 4-1. Data collected by RASAT and Göktürk-2 is freely available to Turkish academicians and governmental organizations through a geoportal named GEZGIN.

Table 4-1. Turkish EO Satellites.

		
BiLSAT Launched in 2003 12 m PAN 26,7 m RGB 129 kg The First Turkish Indigenous Satellite Sub-systems	RASAT Launched in 2011 7,5 m PAN 15 m RGB 94 kg The First Indigenous Turkish EO Satellite	Göktürk-2 Launched in 2012 2,5 m PAN 5 m NIR+RGB 400 kg The First Indigenous Turkish High Resolution EO Satellite

Turkey has enough infrastructure to build, assemble, integrate and test LEO satellites. The following institutions have the main infrastructure for this purpose: TUBITAK UZAY, TAI, TUBITAK UME and the Information and Communication Technologies Authority. There is a **roadmap for further development of satellite-based capacity**, see *Figure 4-623*.

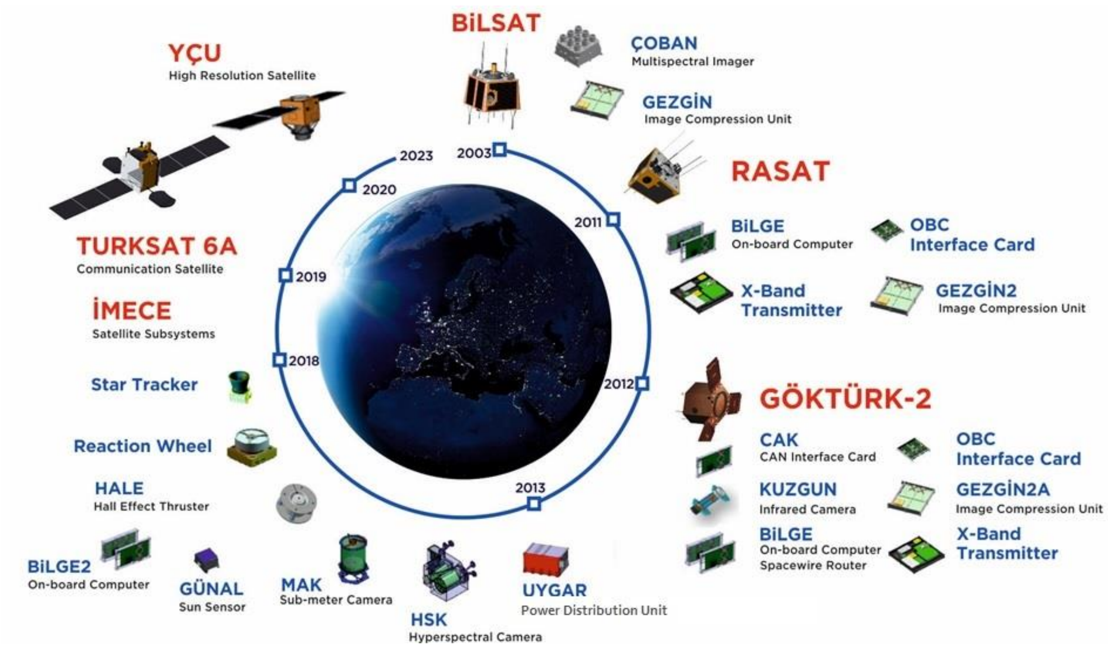


Figure 4-623. Turkish Indigenous Satellite Roadmap & Satellite Subsystems

4.11.2. *Capacities*

Space-borne capacities

In Turkey, the survey reached five organizations with space-borne capacities of all types: institutional, research-oriented and commercial (see Figure 4-624).

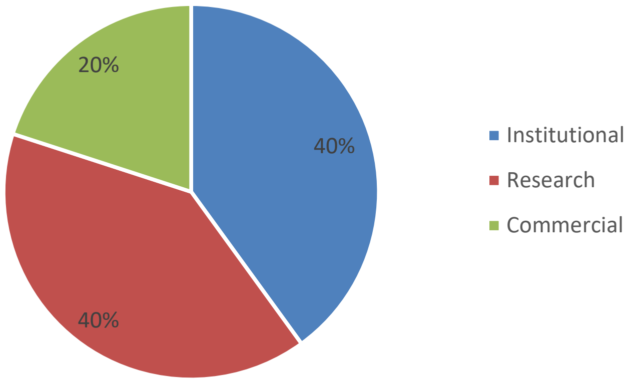


Figure 4-624. Types of organizations with space-borne capacities in Turkey.

Organizations with space-borne capacities reached in Turkey are active in all the GEO-CRADLE thematic areas, especially in the areas of food security, and climate change (see Figure 4-625).

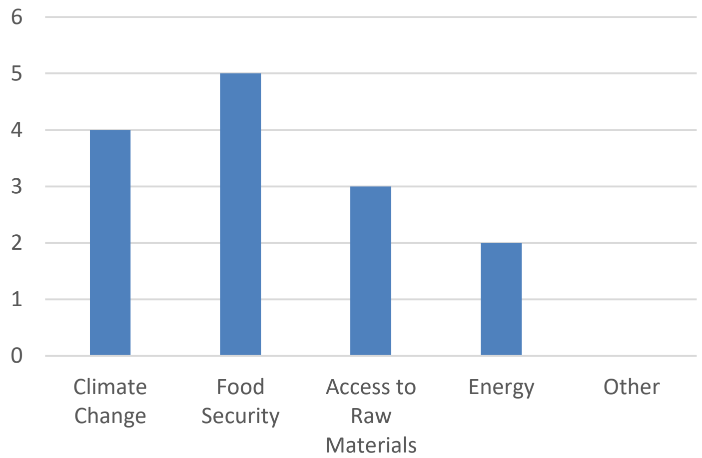


Figure 4-625. Activity of Turkish organizations with space-borne capacities in GEO-CRADLE thematic areas.

40% of organizations reached by the survey have participated in EO related projects. Only 20% of respondents have not participated in such projects (see Figure 4-626).

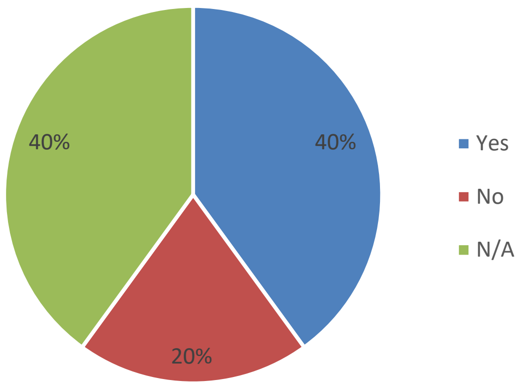


Figure 4-626. Participation of Turkish organizations with space-borne capacities in EO activities.

On the other hand, Turkish organizations with space-borne capacities have not taken part in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action (see Figure 4-627). As shown in Figure 4-628, one organization took part in a GEO/GEOSS SBA Task; otherwise community activities or initiatives is non-existent with Turkish organizations with space-borne capacities.

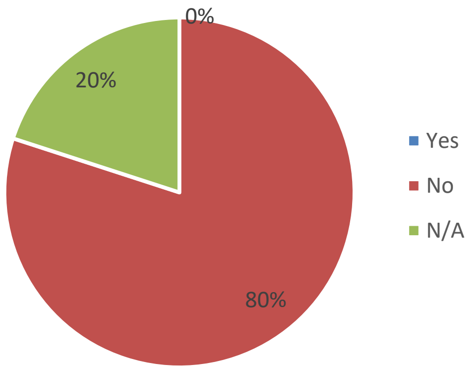


Figure 4-627. Participation of Turkish organizations with space-borne capacities in a Copernicus action.

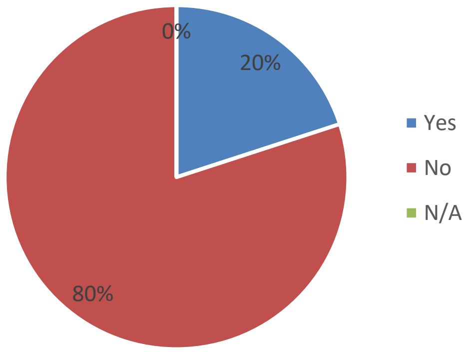


Figure 4-628. Participation of Turkish organizations with space-borne capacities in a GEO/GEOSS SBA tasks.

Collaboration with local EO actors is generally high (67%). Internationally, collaboration is also significant: 40% high and 20% moderate (Figure 4-629 and Figure 4-630).

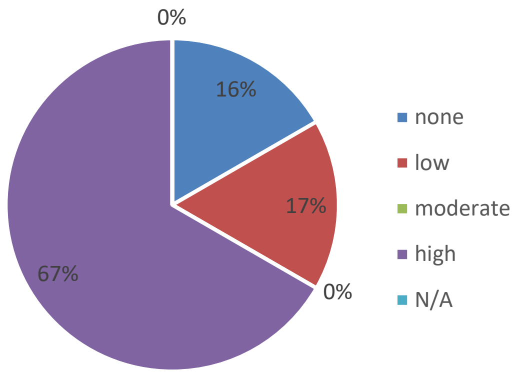


Figure 4-629. Level of cooperation of Turkish organizations with space-borne capacities with local EO actors.

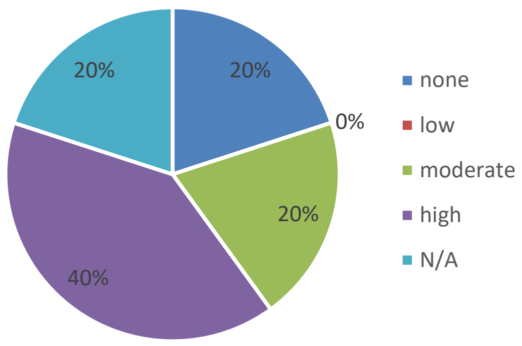


Figure 4-630. Level of cooperation of Turkish organizations with space-borne capacities with EO actors abroad.

All organizations reached by the survey except for one have other EO capacities, including data exploitation capacities, in-situ networks and modelling and computing processing capacities (see Figure 4-631). According to the survey results, there are two organizations with satellite capacities. In addition, there are three organizations with ground segments, and four satellite missions (see Figure 4-632).

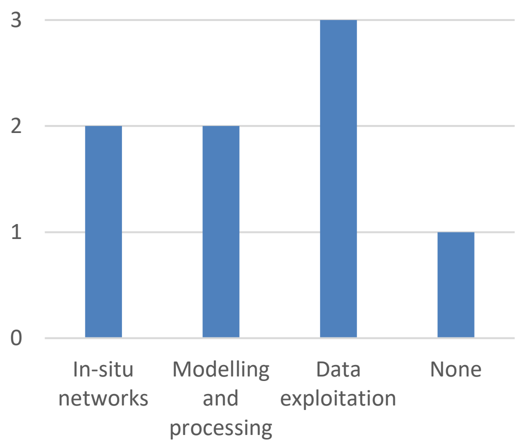


Figure 4-631. Additional EO capacities of Turkish organizations with space-borne capacities.

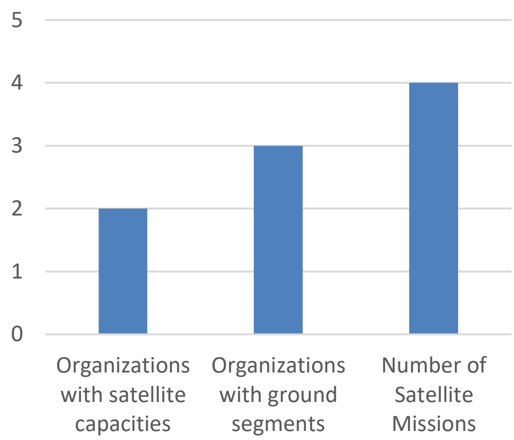


Figure 4-632. Type of space-borne capacities of Turkish organizations.

The geographic coverage of satellite missions is typically national, or global. There are also capacities with local and regional coverage (see Figure 4-633). The availability of data catalogues is non-existent in 50% of cases (see Figure 4-634).

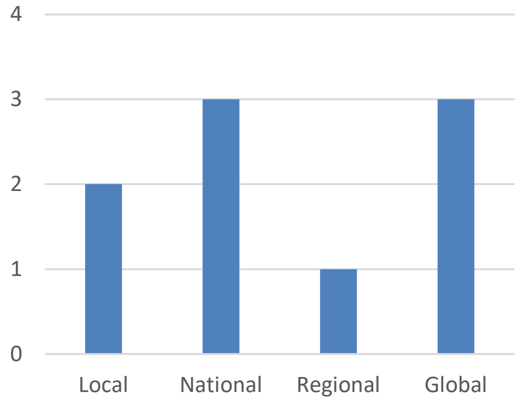


Figure 4-633. Geographic coverage of Turkish satellite missions.

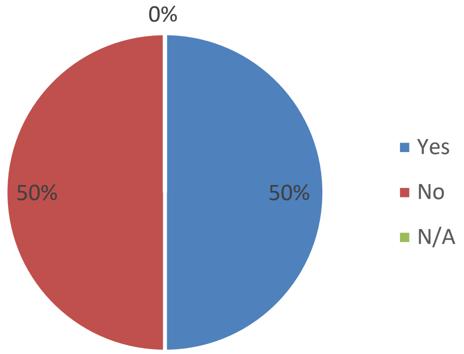


Figure 4-634. Availability of catalogues of Turkish satellite missions.

As shown in Figure 4-635, data availability is variable: real time, upon request and access to past archives. Data policies were generally not specified: one organization specified a license restricted policy and another specified a commercial license policy (see Figure 4-636).

Figure 4-635. Data availability from Turkish satellite missions.

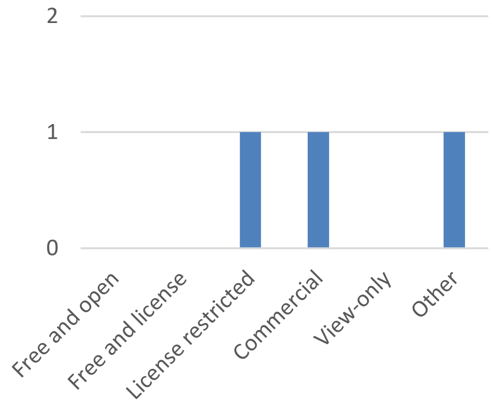


Figure 4-636. Data policy of Turkish satellite missions.

In-situ networks and facilities

In Turkey, the survey reached three organizations with in-situ capacities, either research or institutional oriented, shown in Figure 4-637.

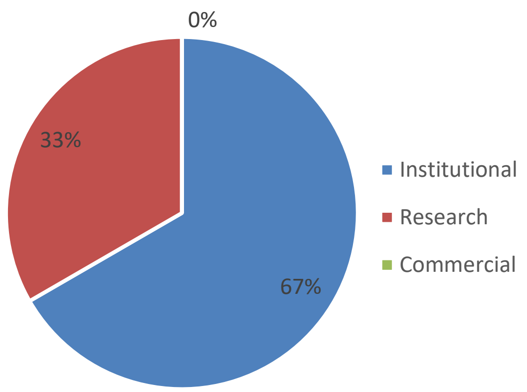


Figure 4-637. The type of organizations with in-situ networks in Turkey.

Organizations with in-situ capacities reached by the survey are active in all thematic areas of GEO-CRADLE, especially in the areas of food security and climate change (see Figure 4-638).

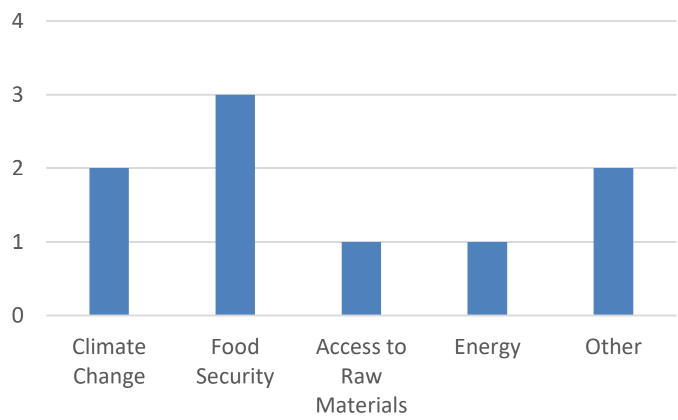


Figure 4-638. Activity of Turkish organizations with in-situ networks in GEO-CRADLE thematic areas.

As shown in Figure 4-639, one organization had taken part in EO activities while one did not.

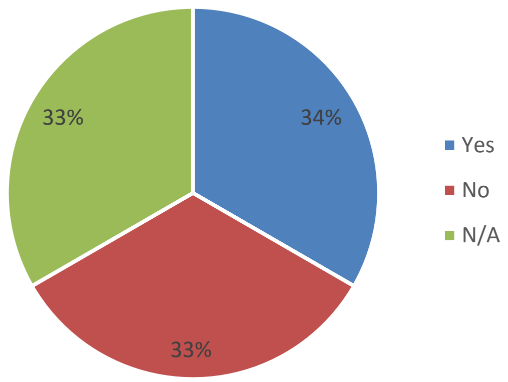


Figure 4-639. Participation of Turkish organizations with in-situ networks in EO activities.

On the other hand, every organization participated in Copernicus (*Figure 4-640*) and GEO/GEOSS Tasks, community activities and initiatives (*Figure 4-641*).

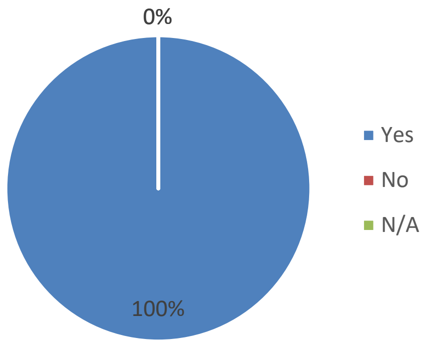


Figure 4-640. Participation of Turkish organizations with in-situ networks in a Copernicus action.

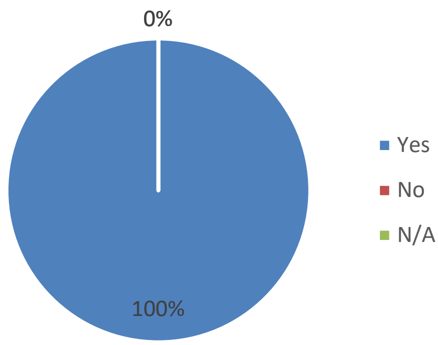


Figure 4-641. Participation of Turkish organizations with in-situ networks in a GEO/GEOSS SBA task.

The level of collaboration between local EO actors ranges from moderate (33%) to high (67%) (see Figure 4-642). Internationally, however, this type of collaboration ranges from low (34%) to moderate (33%) and high (33%), as can be seen in Figure 4-643.

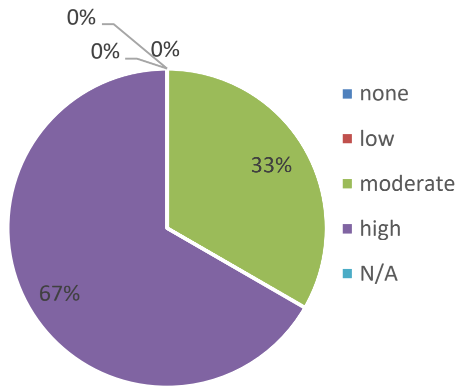


Figure 4-642. Level of cooperation of Turkish organizations with in-situ networks with local EO actors.

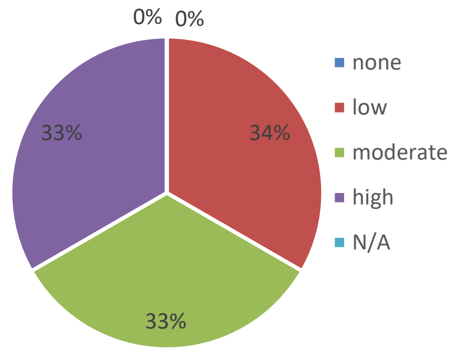


Figure 4-643. Level of cooperation of Turkish organizations with in-situ networks with EO actors abroad.

All respondents except for one have additional EO capacities. Two have space-borne capacities, two have modelling and processing capacities and one had data exploitation activities (Figure 4-644).

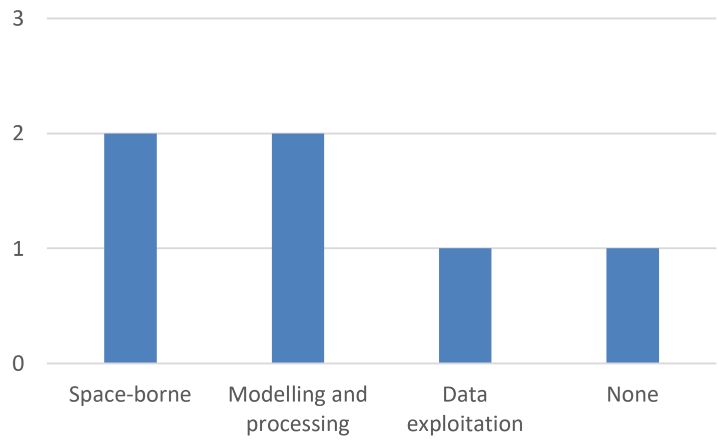


Figure 4-644. Additional EO capacities of Turkish organizations with in-situ networks.

As far as the activity area of in-situ networks or facilities is concerned, one was identified for each: meteorological/climate, hydrometric/water quality and soil attributes (see Figure 4-645). Other facilities include forestry management facilities.

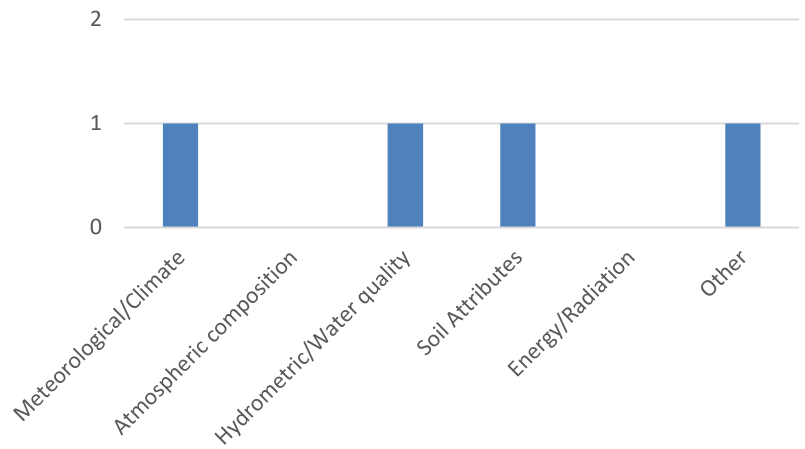


Figure 4-645. Activity area of in-situ networks of Turkish organizations.

As shown in Figure 4-646, there are 353 meteorology/climate stations in Turkey, 3 hydrometric/water quality stations and 352 soil attributes stations.

Most networks or facilities in Turkey, according to the survey, have national coverage. One network has regional coverage and one has global coverage in the hydrometry/water quality activity area. There are no networks identified with local coverage (see Figure 4-647).

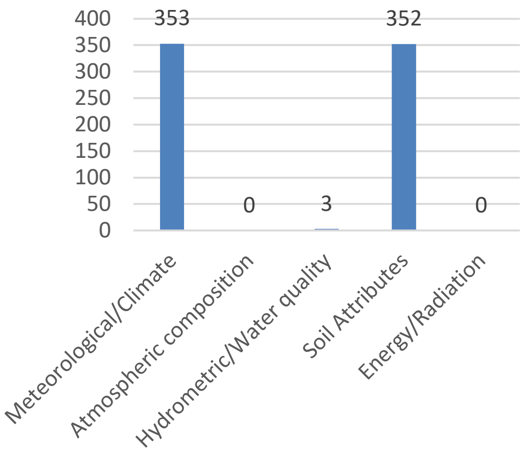


Figure 4-646. Number of stations of in-situ networks in Turkey by activity area.

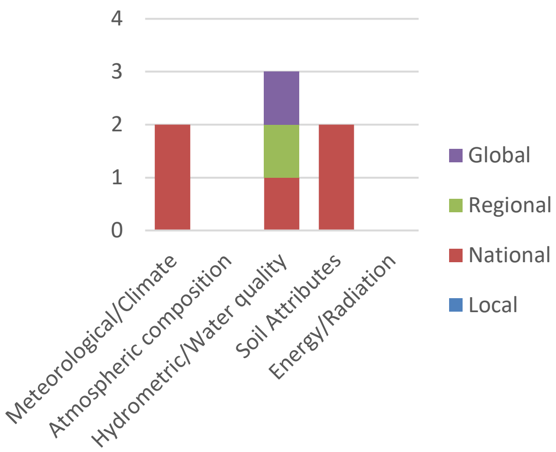


Figure 4-647. Geographic coverage of in-situ networks in Turkey by activity area.

Registration of Turkish in-situ networks in national/regional/international network remains unknown, as respondents provided no information on this issue. Similarly, sparse information was provided regarding the systematic collection of data (see Figure 4-648).

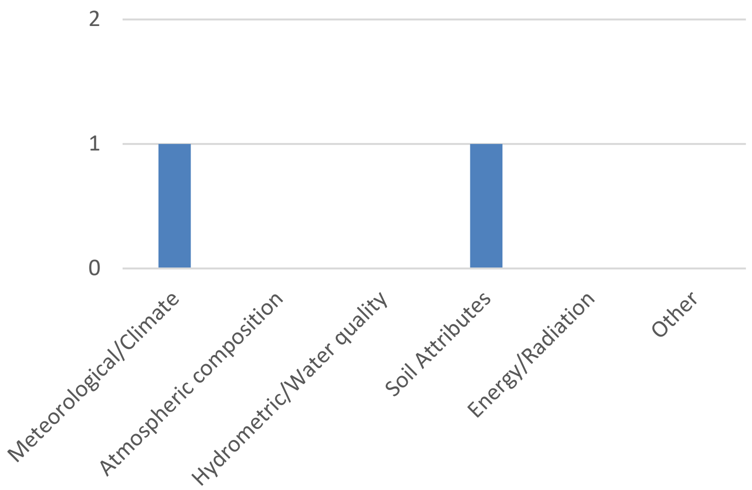


Figure 4-648. Registration of in-situ networks in Turkey by activity area.

As far as **meteorological/climate in-situ networks** are concerned, one organization confirmed the availability of METADATA (see Figure 4-649). Temporal resolution of data acquisition is neither hourly nor daily (see Figure 4-650). Data is available either upon request or from past archives (see Figure 4-651). Data policy remains unknown as there is no information provided by the survey respondents.

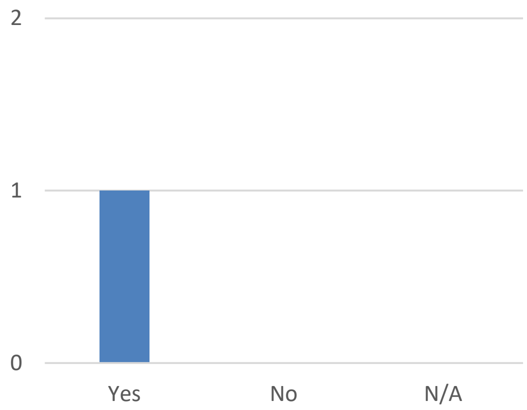


Figure 4-649. Availability of METADATA from meteorological and climate in-situ networks in Turkey.

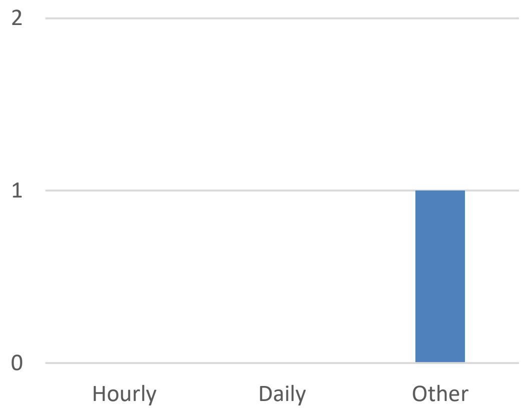


Figure 4-650. Temporal resolution of meteorological and climate in-situ networks in Turkey.

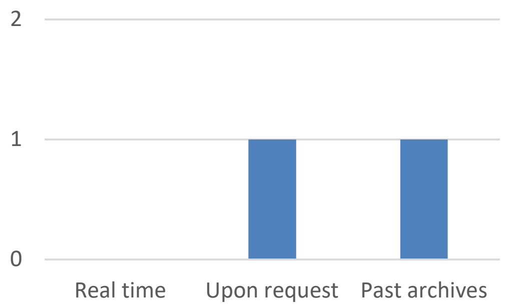


Figure 4-651. Data availability from meteorological and climate in-situ networks in Turkey.

Few details were provided for **hydrometric/water quality in-situ networks**. One organization confirmed the availability of METADATA (Figure 4-652). One organization indicated availability of data in real time and one from past archives (see Figure 4-653). Data policies and temporal resolutions of in-situ networks were not specified by respondents.

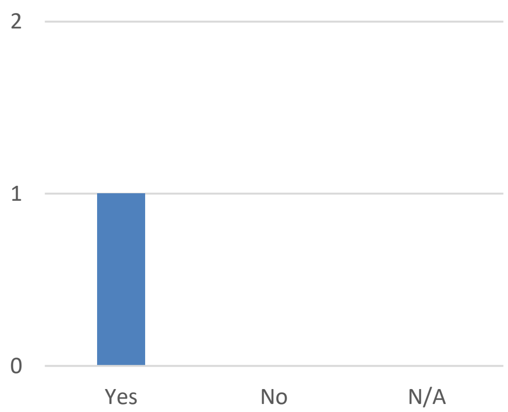


Figure 4-652. Availability of METADATA from hydrometric and water quality in-situ networks in Turkey.

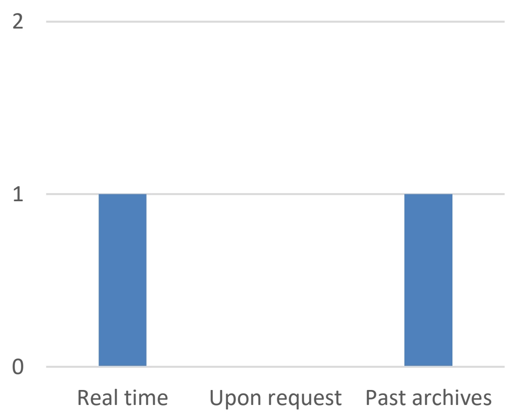


Figure 4-653. Data availability from hydrometric and water quality in-situ networks in Turkey.

Similarly, few details were provided for **soil attributes/spectra in-situ networks**. One organization has METADATA available (see Figure 4-654). One organization specified its data upon request (see Figure 4-655). Temporal resolution and data policy were not provided.

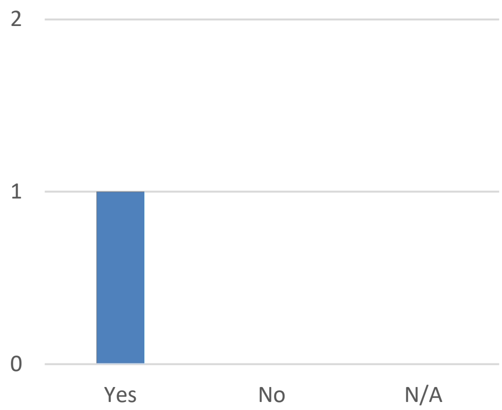


Figure 4-654. Availability of METADATA from soil attributes/spectra in-situ networks in Turkey.

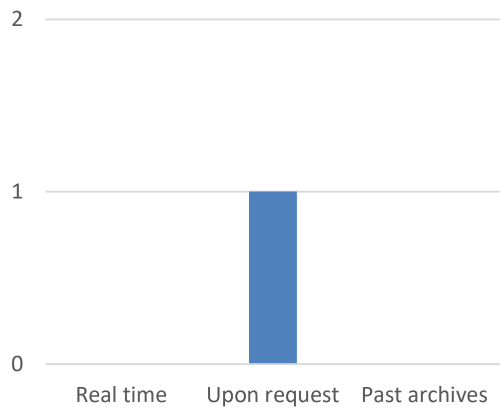


Figure 4-655. Data availability from soil attributes/spectra in-situ networks in Turkey.

Modelling and processing capacities

The survey reached five organizations with modelling or processing capacities in Turkey, either institutional (40%) or research oriented (40%). Furthermore, the survey reached one commercial organization (20%) (Figure 4-656).

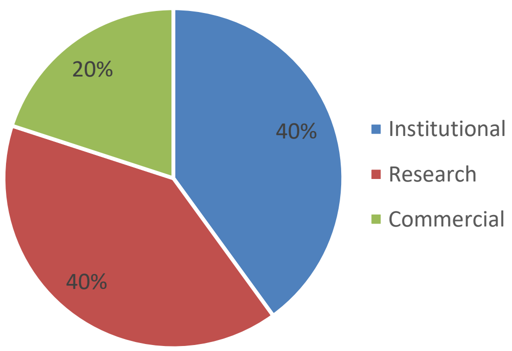


Figure 4-656. The type of organizations with modelling and processing capacities in Turkey.

Turkish organizations with modelling capacities that the survey reached are active in all GEO-CRADLE thematic areas, particularly in food security and climate change (see Figure 4-657).

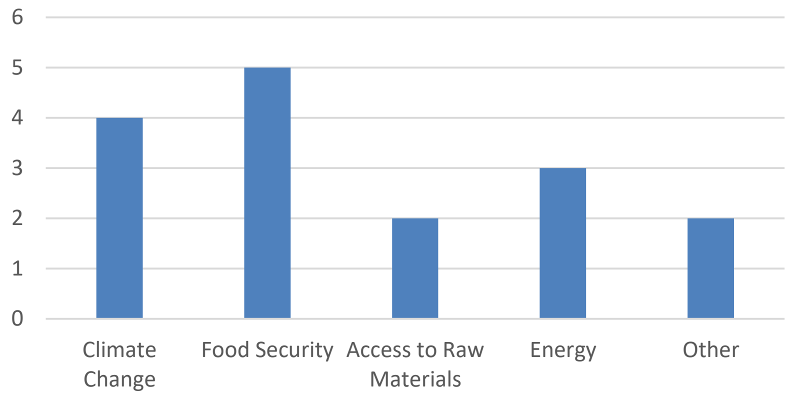


Figure 4-657. Activity of Turkish organizations with modelling and processing capacities in GEO-CRADLE thematic areas.

As shown in Figure 4-658, most organizations (60%) have taken part in EO related projects.

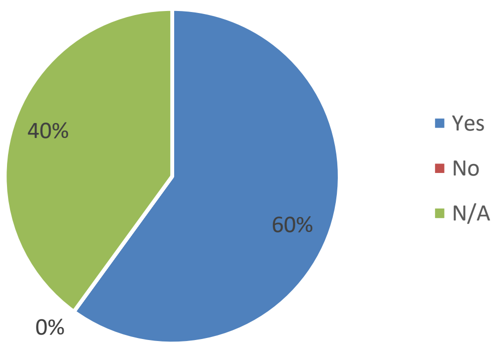


Figure 4-658. Participation of Turkish organizations with modelling and processing capacities in EO activities.

None of the organizations took part in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action (see Figure 4-659). Similarly, a large majority of organizations has not taken participation in GEO/GEOSS SBA Tasks, community activities or initiatives – only 20% as shown in Figure 4-660.

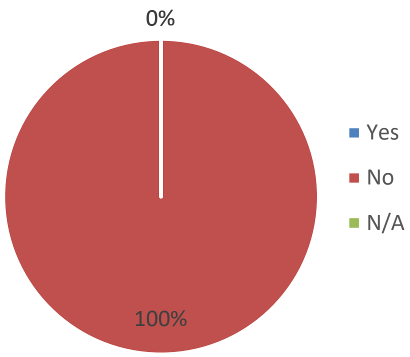


Figure 4-659. Participation of Turkish organizations with modelling and processing capacities in a Copernicus action.

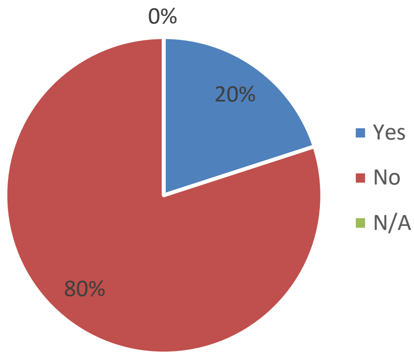


Figure 4-660. Participation of Turkish organizations with modelling and processing capacities in a GEO/GEOSS SBA task.

The level of collaboration between local EO actors ranges from low (40%) to high (40%). Only 20% of respondents rate this type of collaboration as moderate (see Figure 4-661). On an international level, however, the collaboration between EO actors is given moderate to high ratings, with only 20% of respondents having no international collaboration (see Figure 4-662).

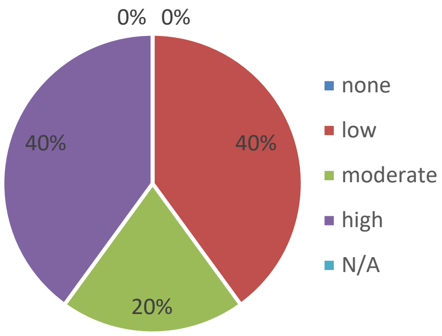


Figure 4-661. Level of cooperation of Turkish organizations with modelling and processing capacities with local EO actors.

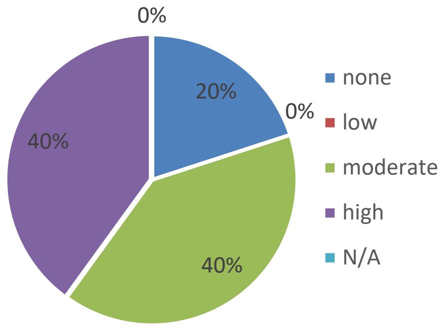


Figure 4-662. Level of cooperation of Turkish organizations with modelling and processing capacities with EO actors abroad.

Only one organization with modelling capacities does not have additional EO capacities (see Figure 4-663).

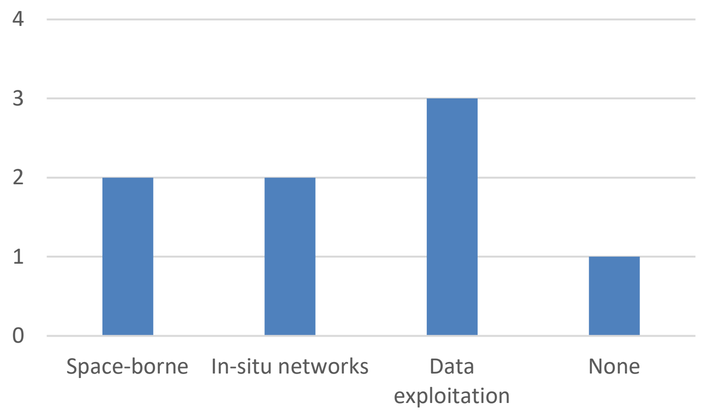


Figure 4-663. Additional EO capacities of Turkish organizations with modelling and processing capacities.

As shown in Figure 4-664, application areas the model typically serves include hydrometric/water quality, meteorological/climatic, soil attributes/spectra, energy/radiation. There are no models serving atmospheric composition/profiling. The most common type of data by source are remote sensing data and in-situ data (see Figure 4-665).

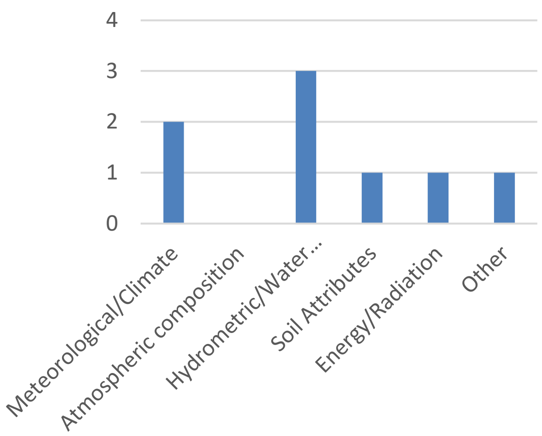


Figure 4-664. Algorithms and models available in Turkey by activity area.

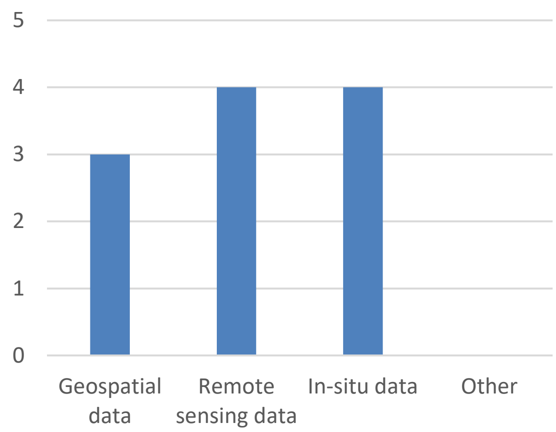


Figure 4-665. Sources of EO data used by organizations with modelling and processing capacities in Turkey.

As shown in Figure 4-666, models mostly have national coverage, although there are two with local and one with regional coverage. Few organizations provided an answer regarding availability of METADATA (see Figure 4-667).

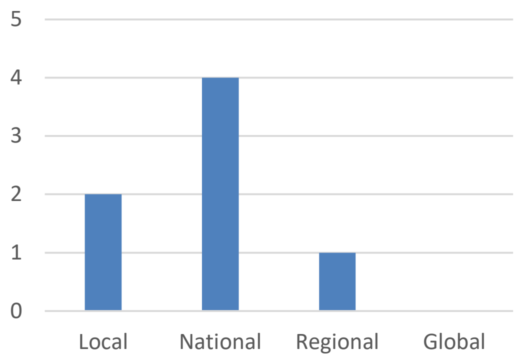


Figure 4-666. Geographic coverage of models and algorithms in Turkey.

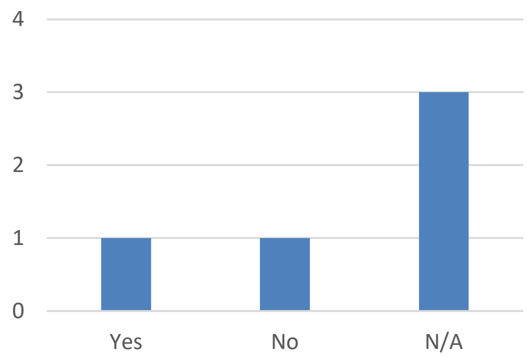


Figure 4-667. Availability of METADATA for models and algorithms in Turkey.

As shown in Figure 4-668, computing resources for the processing and exploitation of EO data include: processing power capacities, HPC clusters, and server clusters. Examples of other resources are: GIS and image processing software, such as ArcGIS, as well as state of the art personal computers and environmental units with COTS digital image processing software.

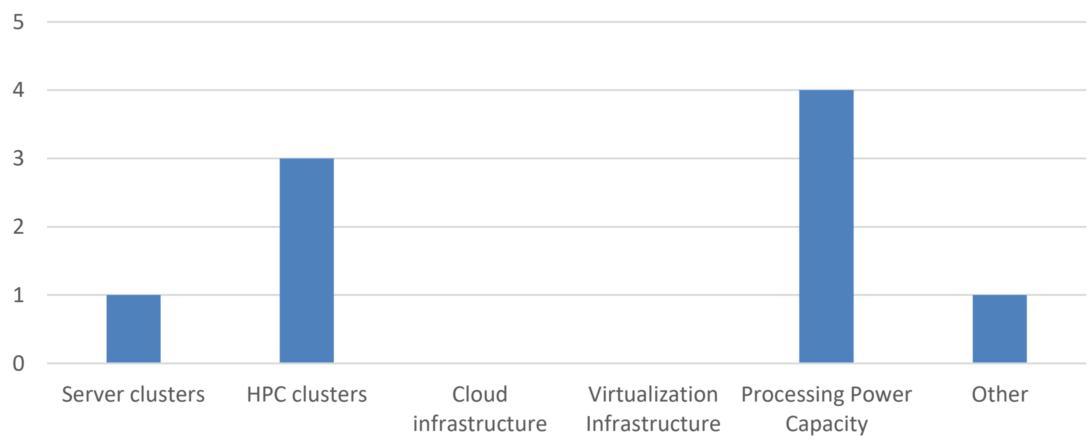


Figure 4-668. Computing resources available for processing and exploitation of EO data in Turkey.

Data exploitation capacities

In Turkey, the survey reached nine organizations, most of which are commercial (see *Figure 4-669*).

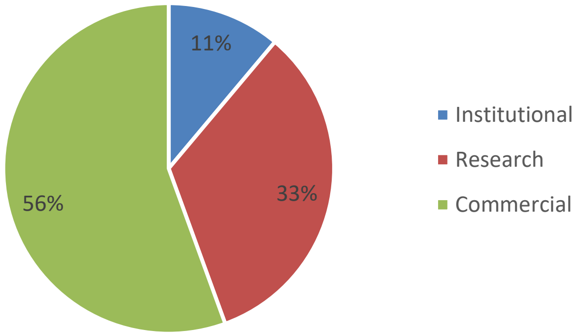


Figure 4-669. The type of organizations active in data exploitation in Turkey.

Turkish organizations with data exploitation capacities are active in all GEO-CRADLE thematic areas (see Figure 4-670). Other areas of activity include land cover/use mapping, digital terrain modelling, geospatial information technologies, in house GIS application development, GIS data collection and navigation.

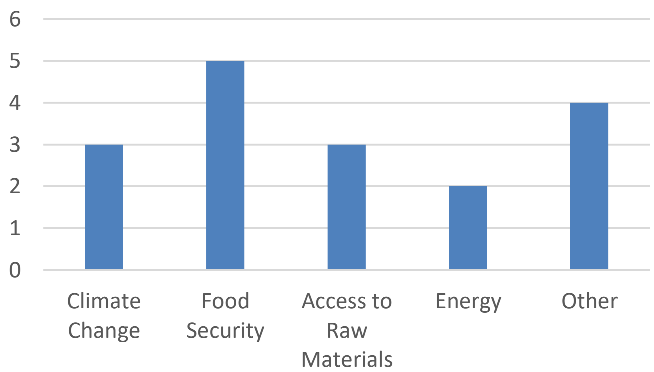


Figure 4-670. Activity of Turkish organizations active in data exploitation in GEO-CRADLE thematic areas.

45% of respondents have not taken part in EO related projects while 33% have (see Figure 4-671).

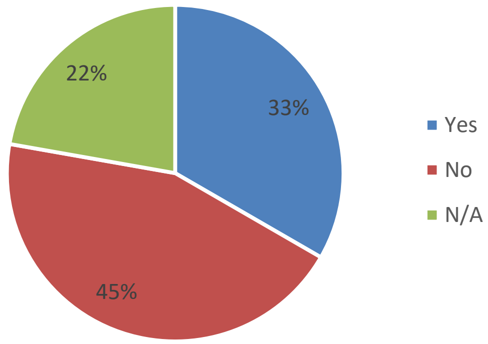


Figure 4-671. Participation of Turkish organizations active in data exploitation in EO activities.

Similarly, none of the respondent participated in Copernicus service provision, Copernicus User requirements definition or Copernicus Research & Innovation action (see Figure 4-672). Only 12% indicated participation in GEO/GEOSS SBA Tasks, community activities or initiatives (see Figure 4-673).

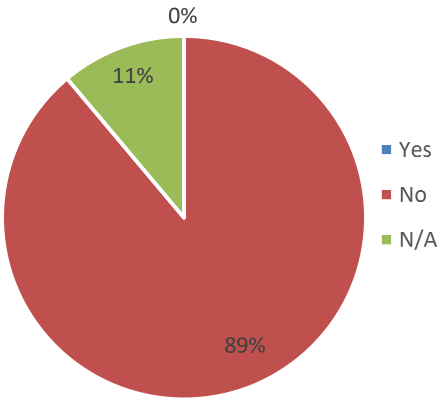


Figure 4-672. Participation of Turkish organizations active in data exploitation in a Copernicus action.

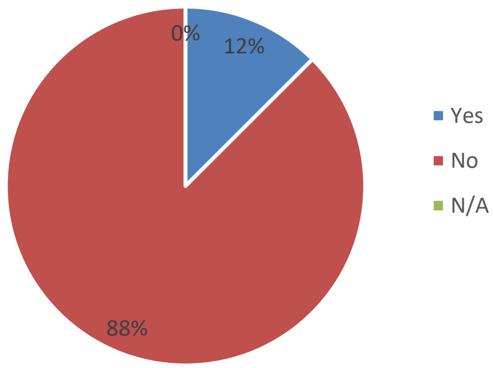


Figure 4-673. Participation of Turkish organizations active in data exploitation in a GEO/GEOSS SBA task.

Most respondents have a level of collaboration with other local EO actors that ranges from none (22%) to low (34%). However, as shown in Figure 4-674, a significant percentage of respondents (33%) have a high level of local collaboration. Internationally, cooperation ranges from none (22%) to high (11%). However, a large majority of respondents have a low level of cooperation (34%) or a moderate one (33%) as shown in Figure 4-675.

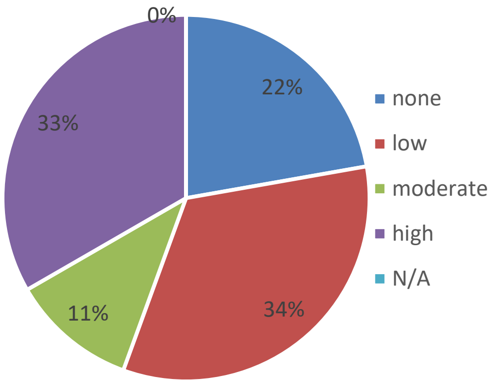


Figure 4-674. Level of cooperation of Turkish organizations active in data exploitation with local EO actors.

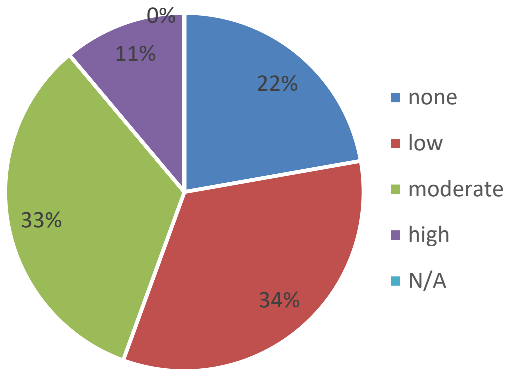


Figure 4-675. Level of cooperation of Turkish organizations active in data exploitation with EO actors abroad.

As shown in Figure 4-676, Turkish organizations with data exploitation capacities have additional EO capacities: modelling capacities, space-borne capacities and in-situ networks. There are four organizations with only data exploitation capacities.

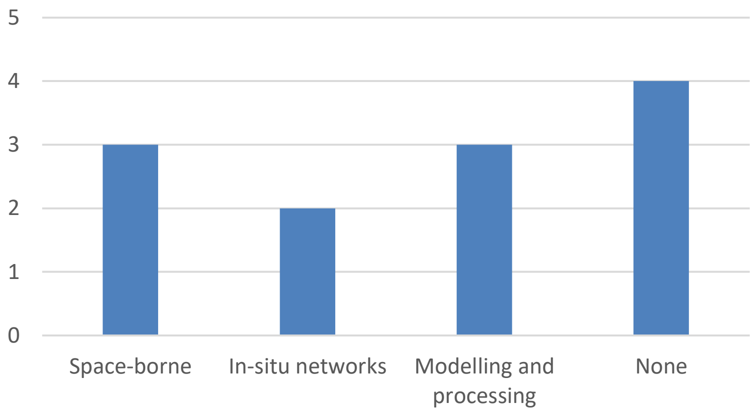


Figure 4-676. Additional EO capacities of Turkish organizations active in data exploitation.

Products/services offered by the organizations surveyed, largely cover agriculture, ecosystems, land-use/coverage, urban areas. The survey did not reach organization in Turkey that offer EO products in Climate and Marine ecosystem (see Figure 4-677).

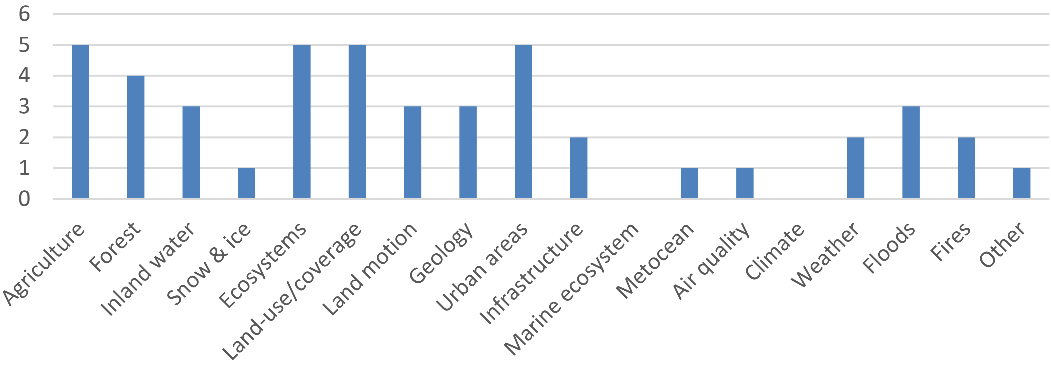


Figure 4-677. Activity areas of EO products/services of Turkish organizations.

National activities

The majority of respondents (60%) perceive that funding for EO activities is available in Turkey (see Figure 4-678). As shown in Figure 4-679, it is perceived that funding is most available for R&D.

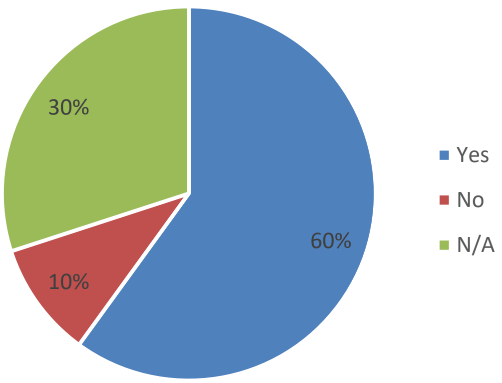


Figure 4-678. Turkish EO actors' perception of the availability of national funding for EO.

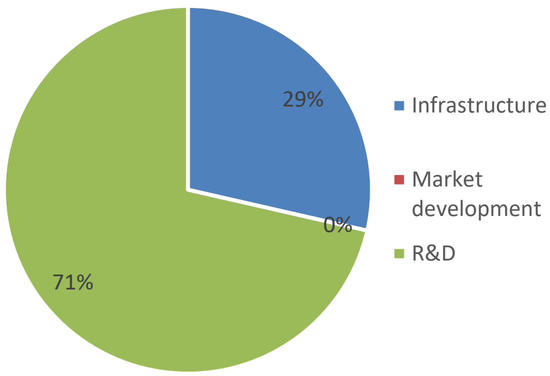


Figure 4-679. Turkish EO actors' perception of areas for which national EO funding is available.

Most respondents confirmed that a national space policy/strategy exists in Turkey (see Figure 4-680). In addition, the survey results also show that most respondents are aware of a national space program in Turkey (see Figure 4-681).

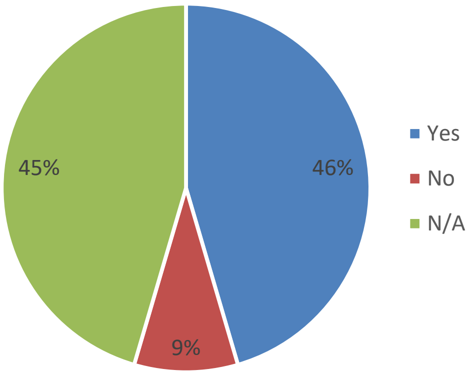


Figure 4-680. Turkish EO actors' awareness of a space strategy in Turkey.

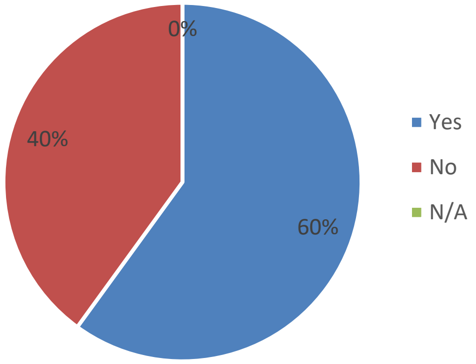


Figure 4-681. Turkish EO actors' awareness of a space program in Turkey.

The level of coordination of EO activities in Turkey is largely perceived as basic. Only 9% of respondents perceived this type of coordination as fully integrated (see Figure 4-682). The level of interaction between the EO community and decision makers in Turkey mostly exists in specific thematic areas, however. Another group of respondents perceives this interaction as fully engaged (see Figure 4-683).

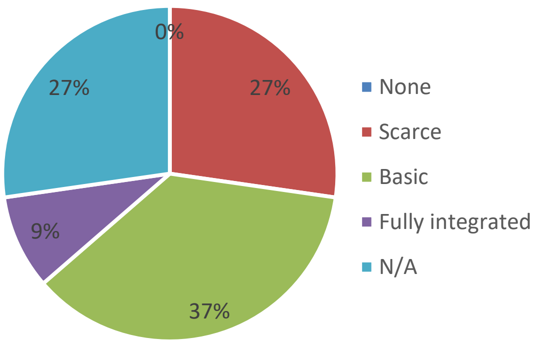


Figure 4-682. Turkish EO actors' perception of national coordination of EO activities in Turkey.

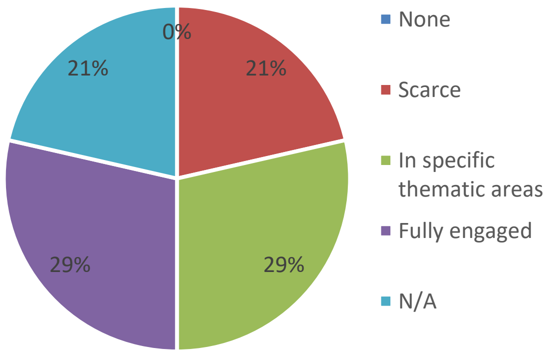


Figure 4-683. Turkish EO actors' perception of interaction with decision makers in Turkey.

A large majority of respondents (75%) would contribute with their capacities to a regional initiative of GEO and/or Copernicus, addressing regional needs in the domains of Climate Change, Access to Raw Materials, Energy, Food Security and Water (see Figure 4-684).

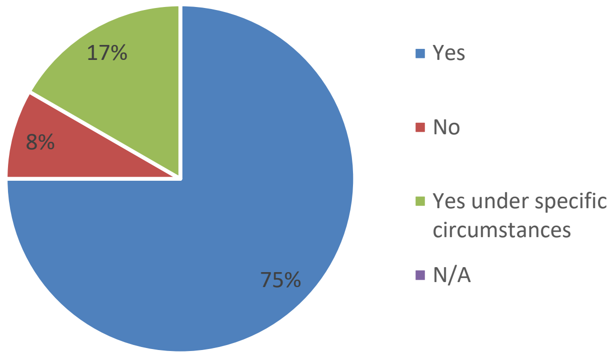


Figure 4-684. Turkish EO actors' willingness to contribute their capacities to a regional initiative of GEO/Copernicus.

End-user awareness of Copernicus and GEO

No end-user interviews could be provided for Turkey.

4.11.3. *Gap analysis*

No end-user interviews could be provided for Turkey. Therefore, an assessment of the country's EO Maturity will be done at M26 of the GEO-CRADLE project as part of Task 3.2 (instead of 3.1).

4.12. Overviews of Additional Countries – Saudi Arabi and UAE

4.12.1. *Saudi Arabia*

EO activities in the Arabian Gulf region have received large governmental and public attention during and after the second Gulf War and Kuwait oil fields burning on 1991. Few years after the war, and with the sharp increase in oil prices reaching its record peak on 2008, the government of Saudi Arabia has assigned large part of its budget towards education and research. The government encouraged universities and public sector to participate in EO activities by having a five year national plan to build research infrastructure within public research institutes and universities. Five public entities have been identified to provide EO products, principally for research activities.

Barriers to development of EO in Saudi Arabia

One barrier is funding agencies' bureaucracy in handling financial matters during purchasing equipment and establishing new facilities. EO projects' managers usually have limited authority on approving project budgets and they always need to go through tedious approval processes for equipment procurement.

High security restrictions introduce another barrier in importing equipment especially when it comes to data reception and transmission devices. Importing EO equipment requires researchers to go through a long process with Saudi customs, ministry of Communication, and ministry of Interior to release their equipment. It is true that researchers and projects managers have to deal with those governmental institutes themselves as their research institutes could provide only limited help.

High funding availability and lack of local research experience has made Saudi Arabia an attractive place for research collaboration with worldwide institutes. A large part of this collaboration was performed through transferring funds from Saudi public sectors to support few excellent research groups worldwide to perform EO research over Saudi Arabia with the collaboration of local researchers. Most of those projects, despite being successful, did not help much in technology transfer and training local researchers in establishing a strong EO program in Saudi Arabia as much of the work was performed outside the country. Another part was done through establishing world-class research institutes in Saudi Arabia that attracted high qualified EO researchers to come and work in Saudi Arabia, for example the establishment of the King Abdallah city of Science & Technology (KAUST) research facility. A third part is performed through local research groups who started establishing small EO facilities through available funding and using international collaborations.

EO data in Saudi Arabia is either owned by individual research groups who are mainly using it for publication purposes. They do not usually share these data except through research collaboration, or through large oil and industrial firms like Saudi ARAMCO who are always reserved in sharing any data. High security around those industrial firms make it even more difficult for outside researchers to establish a collaboration with their R&D departments despite their efforts to advertise their research activities.

Last two years, Saudi Arabia has observed significant reduction in oil prices in addition to being directly and indirectly involved in the political conflicts in Yemen and Syria, which caused the government to apply restrictive financial rules. This directly affects EO research budget as many of the research national plans are currently on hold. This results in stopping funding for many international collaborations and a major restriction in purchasing new equipment.

Saudi Arabia needs an effort to enhance data sharing between research institutes. It is also essential to establish an electronic hub to include equipment and research infrastructure facilities at different public and private sectors. Most of the research institutes and mega industrial entities rarely share any information publically on their websites. Researchers mostly count on their personal relationship for data collection.

Saudi Arabia is considered a high-income country and that makes its researchers ineligible to receive EU financial support. This makes Saudi Arabia researchers seek funds only through local governmental channels, which restrict their funding to national priorities and sometimes put restrictions on travel and data collection activities. A more consolidated mechanism allowing targeted pooling of resources in support of individual groups who are actively involved in EO activities in Saudi Arabia, would allow them to actively participate in projects related to the EU activities.

Besides the example of Saudi ARAMCO research activities, the Saudi government has financially supported the establishment of EO research groups in King Abdullah City for Science & Technology (KAUST), for example the Atmospheric and Climate Modeling group. They actively engage public institutions and private companies, to which they provide data products, and have developed long-term working relationships with several national and international institutes

4.12.2. *UAE*

The domain of EO in the UAE revolves around the public sector predominantly. Private sector use of EO data or development of EO geo-information products is rather limited. In addition, part of the private sector contribution is focused on providing employees as contractors for public institutions in support of their projects.

Public Institutions

The use and applications of EO based data are primarily focused within government institutions, local and federal. Such use is found mostly within municipal departments of the different emirates. Other government departments that are regular users of EO data towards the development of information products for decision making include environmental agencies, urban planning bodies and utility companies. The UAE Space Agency is predominantly a regulatory body and supports space applications in general. There is no actual use of EO data within the agency. The other major institution is the Mohamed Bin Rashid Space Center. This center operates DubaiSat1 and DubaiSat2 and is currently active in the design of KhalifaSat1 and the body behind the Emirates Mars Missions where a satellite is expected to be launched by 2020 for Mars atmosphere studies. The center does not process or produce any information products. In addition to building and operating the satellites the center provides its data for a fee for the private sector and some government agencies.

The private sector presence in the EO domain is rather limited. Local companies mostly act as employee providers for major government departments or respond to procurement from the government.

The interest in geo-informatics is growing within the UAE educational institutions as well. At the UAE university geography department, the geo-informatics track receives more applicants per year than other tracks within the same department. This is predominantly because the chances of finding a job within the government bodies in the field of GIS is much higher than other aspects of geography. Most of the students graduate and find employment within the GIS municipalities departments.

Financial Support

Major infrastructure projects that involve the use of EO data are currently on hold. Active projects have been downscaled due to the significant decline in oil prices and government revenues.

Manpower

Almost in all government institutions that utilize EO data there is a significant number of foreign expatriates. While the hiring of qualified local citizens has recently intensified it still falls short from the government targets. This is primarily due to the country's low population and lack of presence of specialized experts in the fields. Local citizens' capacity building and training efforts are not very well established and pose huge future risk for work sustainability with the departure of the expatriate expertise.

Furthermore, long term staff retention remains a challenge. The foreign staff in the UAE are lured by the high paying position, zero taxes and excellent benefits. While they significantly contribute to the mandate of their respective departments, most expatriate staff move from one position to another and their long term retention is rather difficult. This presents a major problem as they move and are continuously replaced with new incoming staff, resulting in inefficient processes of adapting to the local organization culture and modes of work. Furthermore, the departure of foreign expatriates outside the country upon the end of their contracts means the departure of acquired technical knowhow and expertise as the focus of technology transfer, training of local citizens in carrying the expat tasks in not very strongly stressed. This will likely present a major problem for the sustainability of the departments making it continuously dependent on foreign expertise.

The local citizen staff are also not immune from this long term retention problem. Most citizens move from one government department to another as higher managerial positions or better paying position are offered to them.

Hardware/Software

Most of the government departments have advanced hardware in relation to its EO usage. There exists an excellent state of the art infrastructure for most departments for carrying their tasks in terms of both hardware, software and mapping equipment.

Data Sharing

Data sharing among the different government departments is a painful process. It requires a lengthy process of approvals and memorandums of understandings. The culture of data sharing (both raw and processed data products) is not mature enough. No serious efforts exist in addressing this issue within the concerned parties. There is plenty of room for improving this issue to allow the free exchange of information and knowledge.

Funding Opportunities

Government funding for research and development in the EO domain has been significantly curtailed by the decline in oil prices and budgetary cuts. Basic research in the EO domain remains limited within educational institutions from their operating budgets.

Streamlining EO data usage for decision support

At the municipal institutions level, there seems to exist a well-established trend of stream lining EO data information products in decision making. However, this trend is very limited in other departments.

5. Conclusion

The results of the gap analysis suggest several commonalities between countries, as well as stark differences – discernable patterns that emerge. On this basis, the document makes a grouping of countries based on commonalities that are considered important in the context of its drafting; this does not discount that other groupings can be formed, particularly if the analytical focus is different.

The grouping is to a high degree influenced by the historical experience of countries in regards to development of their EO sector. In the Balkans, the EU has exerted a large influence on the development of the EO sector in the past two decades. There is evidence in the results of the gap analysis that membership, beyond the accession process, greatly empowers this development. In the Mediterranean countries of North Africa and the Middle East included in the gap analysis, development of the EO sector was mostly endemic. Israel is a special case in this region, as it has developed a very advanced EO sector. In comparison, Gulf countries have a shorter history of space-related activities, but one marked by rapid growth.

It is important to note that the groups do not indicate a difference in maturity between them, and hence do not indicate capacities: they are above all a reflection of gaps and developmental trajectory that can be discerned. Likewise, the groups are not homogenous or mutually exclusive. In addition, it should be noted that gaps between sectors within countries can be larger than between countries. In fact, the meteorological sector is generally advanced in the RoI; applying/using EO for collecting data about soil attributes is generally still very basic. The divergence within countries was echoed in the results of previous projects, as seen in **Section 3 – Gaps Identified in Previous Projects.**

The groups discerned are the following:

Western Balkan countries: Albania, FYROM and Serbia.

These countries have only basic space-borne capacities, consisting of a weather data receiver antenna owned by the national hydro-meteorological institute in the case of Serbia and FYROM. Serbia is a member of GEO, while Albania and FYROM are not. Several end-users do use satellite imagery in their work, which they source predominantly from small commercial companies. There is cooperation with international actors that provide data from satellite sources – e.g. Albanian and Serbian cooperation with CIMA through DEWETRA for predicting flooding.

It can be discerned that in-situ networks need further development to advance the EO sector. Some observational gaps were identified in existing networks: meteorological, atmospheric composition and hydrometric. On the other hand, data for soil attributes, radiation and energy is predominantly sourced manually and ad-hoc/sporadically. End-users did not outright identify unmet needs that would require an update of these networks, which implies that these are not currently a pressing need; nonetheless it is assumed that more advanced capacities in these networks could improve the quality of models and products. This assumption was validated by a research institution that provides EO products and services in Serbia.

Modelling and processing capacities that deal with meteorology, atmospheric composition, hydrometry, soil-attributes, radiation and energy were identified. Their data needs were not considered by the survey, yet it seems likely that soil, radiation and energy models would benefit from higher-quality data from more advanced in-situ networks. This was validated to some degree by insufficient quality/quantity of data reported by end-users that use model output.

Exploitation of data generates data products and services across a diverse range of the topics measured by GEO-CRADLE, particularly for natural disaster products.

EO is dominated by the public sector, both institutional organizations and public companies. It is common for organizations with developed geospatial departments to source satellite data from small commercial companies, or to source from an institution which itself sources from these commercial vendors. Research groups are highly active in EO and have linkages to local and international EO actors is several instances.

Structural and capacity gaps within the EO ecosystems are pronounced. Structural gaps are of the most basic kind: unsatisfactory sharing of available data between organizations and limited knowledge of what data is collected by other actors. Cooperation is usually catalyzed through projects and is rooted on personal relationships (often facilitated through projects) rather than a clear legal framework. There is a lack of community identity in EO, and poor networking. The INSPIRE directive is in the process of being implemented in all countries, which has the potential to alleviate structural problems to some degree. Capacities are to the largest degree restricted by human capital limitations, although inability to access needed equipment was also cited by some end-users.

The structural and capacity gaps in these countries are aggravated by the prolonged financial crisis of the past decade. Consequent fiscal consolidation has tightened budgets of the public sector, wherein the EO sector in these countries is concentrated. Organizations are unable to purchase data in the quality that they require, and they are unable to hire enough human resources and expertise. In Serbia's case, this is due to a freeze to hiring in the public sector since 2012 in large part. However, as one end-user in the country said, it is hard for the public sector to offer competitive salaries and benefits; a similar situation was found in FYROM. The financial restrictions are already threatening maintenance and operation of existing EO in-situ networks in FYROM.

EU financial instruments (IPA, cross-border projects, Horizon2020, etc.) and funds made available for EO by other donors have generated the opportunity for individual organizations to advance compared to the state of the art described in previous projects. This includes capacity building, equipment purchases, pilot projects, research, etc. However, results vary to a large degree as some initiatives had only transient benefits that ended shortly after funding. EU Accession has generated reforms in high-level public institutions in a manner that has boosted the need for geospatial data.

EU Member States in the Balkans: Bulgaria, Cyprus, Greece, Romania

These countries are all members of GEO. They all have some space-capacities, although at significantly different levels. They all own satellite receiving stations. Bulgaria and Romania both have their own space-programs defined: in Romania there is significant progress while in Bulgaria this has largely stalled. Romania and Greece are ESA members while Cyprus and Bulgaria are cooperating states. Greece has the most developed capacities: they are a long-term ESA member and have established international cooperation in this field. Romania's engagement in ESA is growing.

Structural gaps of the kind found in the previous typology are very pronounced in Bulgaria (seemingly more than in Serbia), and to a minor degree in Romania. Avoidance of data sharing is still embedded in organizational culture, despite implementation of the INSPIRE directive. This provides a reflection on the limitations of INSPIRE to address these gaps for the previous typology, where it is being currently implemented. In Cyprus, comparable structural gaps cannot be identified through the end-user interviews. In Greece, structural gaps are very specific, i.e. easy access to municipal/regional data, and not on the general level as found in Romania and Bulgaria.

There are indications that in-situ networks and modelling and processing capacities are in general more advanced than in the previous typology. EO capacities have benefitted from EU membership through access to Structural Funds and other EU financial instruments, and through greater integration with European level organizations. End-users have more specific needs – e.g. higher quality EUTMETSAT data, highly localized meteorological data, better radiation in-situ networks, need for an EO strategy for agriculture – than those found in the previous typology.

It was observed in the results of the GEO-CRADLE survey, that data exploitation occurs across a wide range of areas, similar to the situation found in the previous typology.

Romania has made large strides compared to the state of the art presented in other projects. Bulgaria has made smaller but important steps, e.g. implementation of INSPIRE. Unlike Bulgaria, Romania has a coordinated effort to promote its EO and space-related sector through the STAR program of its space-agency, involving both project-financing, coordination and dissemination activities. There is evidence of coordination to promote participation in ESA and other European level initiatives.

Greece and Cyprus have both been hard-hit by the economic crises of the past decade and this has had large consequences for EO capacities. Public EO actors expressed a need for more human resources, both in terms of quantity and available expertise, which they cannot access due to a lack of funds and a freeze of hiring in the public sector. The lack of funds also impacts the quality of data that they can access. In Greece, participation in ESA optional programs has ceased completely. The private sector in both countries has suffered as a result of general economic malice and diminishing business from government contracts/projects.

EO in the private sector in Romania and Greece has diversified beyond serving the public sector, and there are companies active in EO software and hardware development. Despite large setbacks since 2008, Greece still maintains an advanced EO sector.

Independent space programs: Egypt, Tunisia and Turkey

All the countries are members of GEO. In contrast to the previous two groupings, the development of EO in these countries was in large part endemic. All three have stated space strategies several decades old. Egypt and Turkey have both launched their own EO satellites into space as part of a space program. Tunisia does not have its own satellite-based capacities but receives data from SPOT, LANDSAT and others through its ground-based segments.

Turkey demonstrates a large capacity in its in-situ networks, modelling and processing capacities and data exploitation activities through the survey. Results of the survey indicate a noted degree of cooperation in the ecosystem. In general, the sector is focused on the country and there are indications that it is less integrated into EU networks than the previous typology. The country has continued a rapid pace of development of its EO sector noted during earlier projects. No end-user interviews could be conducted and thus there were no gaps identified.

Egypt is a large country with large EO capacities, yet the system is limited by pronounced structural gaps and a low general level of ecosystem connectivity. This not only clogs up the flow of data through the ecosystem, but also of information about what data exists. Astonishingly, the ecosystem was not aware that the country had a space program. Reluctance to share information also affected the quality of survey results, where a very minimal picture of their capacities was provided by most respondents.

For both Egypt and Tunisia, burdensome bureaucratic procedures create a barrier to sharing data between organizations. In regards to internal operations, inventorying results from both countries show a lack of sufficient human resources and expertise. For example, a Tunisian end-user claimed to have more administrative staff than technical staff. Similar to the previous typologies, the economic crises have resulted in budget tightening and aggravates this problem. Similarly, financial constraints in Tunisia were noted to limit acquisition of needed instruments.

Tunisia’s in-situ networks operate predominantly on the local level and are not sufficiently integrated. This observational gap makes verification of satellite-data difficult and lowers precision.

Advanced ecosystem: Israel

Israel is a member of GEO. The country has by far the most advanced capacities in the RoI, as validated in the survey. No major gaps were found through the GEO-CRADLE methodology. The end-user interviews demonstrate advanced commercial exploitation of EO in the country. Moreover, they have a comparative advantage in developing micro-/nano-satellites on the global market.

EO upstart countries: Saudi Arabia and UAE

Inventorying results are insufficient for the GEO-CRADLE gap analysis methodology to be used to identify gaps for these countries. Nonetheless, the overview provided by associated partners and high-quality end-user interviews do provide some validated preliminary conclusions regarding gaps that exist in their EO ecosystems.

UAE is a member of GEO while Saudi Arabia is not. The EO sector in these countries experienced rapid growth since the early 1990s, developing from a low-level to an advanced level due to prioritization in policy and high availability of public funding. Both have space agencies, and the UAE has launched satellites. Indicative of its advanced research capacity, UAE plans to send a satellite mission to Mars related to atmospheric composition. Falling oil prices have negatively impacted government revenues in both countries, and have led to fiscal consolidation. In turn, this has also impacted the EO sector, lowering funds available for further development.

The countries face large bureaucratic barriers that generate large structural gaps: there are indications that sharing of data between organizations is restricted. Similarly, bureaucratic barriers also complicate importing of EO equipment due to stringent security requirements.

Both countries have a notable capacity gap: they lack sufficient expertise in the local labor pool due to low interest at the university level in relevant science, technology, engineering and mathematics fields. In turn, they depend on foreign experts either through outsourcing or relocation. The problem of retention is mentioned for experts that relocate to the country.

Correlation between gaps and maturity

Preliminary results from *T3.2 Maturity Indicators* **suggest that there is a correlation between gaps and maturity**. This is to a large degree intuitive: advances in maturity entail systemic changes in capacities and needs. It was found that gaps move from being more general, e.g. lack of access to collected data, to being more specific, e.g. lack of access to municipal data from a central database.

As countries mature, the **EO sector shifts from closely gravitating around the public sector towards exploitation of EO technologies by the private sector to create value across industries**. An example of this was seen in Israel with an agricultural end-user. The private sector is an important consideration for the sustainability of the EO sector. GEO-CRADLE follows a global economic recession and turbulence in the RoI: fallout from severe austerity measures in Greece and Cyprus, the Arab Spring in Egypt and Tunisia, an attempted coup d'état in Turkey, etc. Shrinking public budgets have been noted in almost all countries surveyed, and this has aggravated and generated gaps in the EO sector. Without a private sector to structure demand and generate additional revenue in the ecosystem, development is withheld to a large degree, and even reversed in some cases. In turn, **promoting a private EO sector is difficult**: targeted top-down policy tools are lacking, invariably they relate to promotion of a better business climate and availability of technical knowledge. Moreover, private sector promotion fits into a concerted effort to promote the entire EO sector, through dedicated instruments for companies to experiment with and develop applications of EO. One opportunity to overcome this complex and large undertaking does exist: consortium experience shows that **supporting bottom-up innovation through incubator and accelerator programs can energize a varied array of SME/startup actors to explore novel approaches to apply underutilized technologies**.

The groupings presented in this section **suggest that EU membership has had a positive impact on the EO sector** in Member States in the Balkans. This is even stronger where an operational involvement in ESA programmes exists. This suggested causality is not simple or absolute. It is clear that Membership ensures greater ***access to finance*** for the sector through EU financial instruments, particularly structural funds. However, this element alone is not sufficient. Projects can have transient impact, as was noted in FYROM. Secondly, throughout the gap analysis there is a sharp contrast between successive instances of high barriers to sharing data/information and the principles of free and open access to public data promoted by the EU, e.g. through INSPIRE and Copernicus. Functional flow of data through the value chain is clearly important, and needs to be regulated through a ***formal enabling framework***.

Surely, data sharing is not the only aspect that has to be addressed for the EO sector, this one example is one of the primary focuses of this document. Thirdly, EU membership promotes ***connectivity*** within the country and across the continent. In general, the second grouping had higher local and international cooperation with other EO actors. Membership is also correlated with greater integration in trans-European associations highly relevant to the EO sector, particularly ESA. Connectivity allows for pooling of resources, knowledge transfer and many other capacity-enhancing benefits. Also, connectivity and access empowers individuals and groups whose interest is in the long-term progress of the EO sector in a sustained manner, and they are able to seize upon this opportunity. Finally, EU accession as a process provides a ***coordinated effort*** to develop the EO sector, albeit indirectly. The EU provides a clear vision for governments and public institutions to operate on the basis of informed decision making, for which EO has great inherent value. However, a comparison of Bulgaria with Romania in this document shows that EU Membership alone is insufficient to drive high maturity – its enabling role has to be seized upon by the local ecosystem and decision makers. The activities of Romania's ROSA and its STAR program are particularly commendable.

An explicit EO strategy that systematically addresses all the key issues presented above would chart a straighter path to greater EO maturity. Space strategies have done so for all of the most mature countries in the RoI: Israel, Greece and Turkey.

Why is a developed EO sector desirable? EO represents a set of data-driven tools for informed decision-making that can help societies in the RoI address large challenges in the near future, including those identified as the thematic areas of GEO-CRADLE.

GEO-CRADLE thematic areas

Survey results show that meteorological capacities are the most developed in the RoI. Atmospheric composition and hydrometric capacities are also established, while soil attributes, radiation and energy capacities are less developed. All countries use satellite-derived data.

These results suggest a large capacity to engage in ***climate change*** activities. The survey and end-user interviews were able to identify dedicated research and mandated institutional groups in most countries.

These capacities are also important for ***food security***. However, they were not complemented by soil attribute/spectra in-situ networks; this capacity will have to be developed for more accurate models and higher quality data products/services. GEO-CRADLE found two organizations in Serbia and Greece that are establishing an in-situ network for soil parameter measurements. Most countries had dedicated research groups dealing with the subject and Egypt had a mandated institutional group.

In regards to **access to raw materials**, the clear potential of EO to contribute to the mining sector was not fully realized, even in countries where the government was using EO for monitoring. In forest management, there is a wide divergence between organizations; this was seen during the first session of the GEO-CRADLE Novi Sad workshop which included three forest management agencies from the Balkans. Water is also a critical resource, and one for which considerable EO infrastructure exists, e.g. hydrometrical capacities. Cooperation and data sharing between public resources companies is of clear interest to all parties and should be encouraged.

EO capacities for **energy** were only found in a country with comparatively mature EO: Greece. It is known that EO is used by public companies active in the sector in Saudi Arabia, Egypt and Serbia but they could not be reached by the survey. As this sector dominated in the RoI by public companies, a top down approach would probably be appropriate to expand capacities.

A lack of sufficient personnel and expertise was found in all countries (except Israel) resulting from budget tightening. This negatively effects EO capacity across all thematic areas.

Similarly, structural gaps present a significant barrier for most countries in the RoI. GEO-CRADLE thematic areas are complex phenomena that require many different sources of data, typically collected and processed by different organizations. Structural gaps significantly limit the ability to address such complex phenomena.

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