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 D3.3 Priorities Action Plan

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Prepared by	Hend Ben Hadji, Houcem Tebber, Igor Milosavljevic, MajaZikic, StrahinjaSavic, Jasna Komatovic, Grigoris Chatzikostas, Haris Kontoes, Alexia Tsouni, Anna Polychroniou, Evangelos Gerassopopulos, Lefteris Mamais, Hesham El-Askary, Eyal Ben Dor, Yaron Ogen, Diofantos Hadjimitsis, Rodanthis Mamouri, Aziz Koru, Hristo Nikolov, Ordan Chukaliev, Daniela Mane, Emirjeta Adhami, Slobodan Nickovic, Zoran Mijic, Livio Belegante, Jeni Vasilescu, Georgios Karafergias, Sladjana Vecerinovic, Abdelgadir Abuelgasim, Ashraf Farahat					
Quality Assurance	Lefteris Mamais – Technical and Quality Assurance Manager					
Contact Person	Hend Ben Hadji			T3.3 Leader		
	Parc Technologique El-Ghazala, Ariana 2088, Tunisia					
	Email	hend.benhji@cert.mincom.tn	**Phone**	+216-941669513	**Fax**	+216-70835835

Executive summary

The report on regional priorities action plan is one of the outcomes of the GEO-CRADLE project, funded under the H2020 Framework Program of the European Union. The overarching objective of the GEO-CRADLE project is to create a multi-regional (Balkans, North Africa and Middle East) coordination network, support the effective integration of Earth Observation (EO) capacities, provide the interface for the engagement of the complete ecosystem of EO stakeholders, promote the uptake of EO services and data in response to regional needs and, finally, contribute to the implementation of GEOSS (Global Earth Observation System of Systems) and Copernicus in the Region of Interest (RoI).

The report builds on the results of end user needs, a gap analysis and maturity assessments for Earth Observation capacities in the RoI, and provides the framework for the necessary actions both at regional and national level. At its core, the priorities action plan articulates a set of priority actions in response to national/regional needs. Priority actions are grouped into two constituent groups: thematic actions and support actions. The latter actions are inferred from recurrent constraints, proclaimed by stakeholders in interviews and surveys and target: strengthening of human capacity, raising awareness among stakeholder communities about the value and benefits of EO services and data, the improvement of data policy principles towards free and open data sharing at national and regional level. On the other hand the former actions are deemed to be promoting the establishment of operational services in relation to the thematic areas covered by the project: Adaptation to climate change, Improved food security, Access to raw materials, and Access to energy, and that could be compounded by capacity building and/or awareness activities.

Project Information

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Table of Contents

Acronyms and Abbreviations

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
ENSO	El Niño Southern Oscillation
EO	Earth Observation
EU	European Union
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
GIS	Geographic Information System
NENA	Near East North Africa
MENA	Middle East North Africa
SBA	Social Benefit Areas
SEE	South East Europe
T*x.y*	Task *y* from Work Package *x*
RoI	Region of Interest
WMO	World Meteorological Organization
WP	Work Package

List of Tables

List of Figures

1 Introduction

1.1 Aims of the report

GEO-CRADLE has proactively engaged in a number of consultation activities including surveys, interviews, bilateral exchanges, events. These activities are directed at different categories of regional stakeholders, ranging from data providers, to end users and decision makers. The objective of GEO-CRADLE, among others, is to gain knowledge on regional needs and insights for action.

GEO-CRADLE brings together key players representing the whole (Balkans, North Africa and Middle East) region of interest and the complete EO value chain, with the overarching objective of establishing a multi-regional coordination network that will **(i)** support the effective integration of existing EO capacities (space/air-borne/in-situ monitoring networks, modeling and data exploitation skills, and past project experience), **(ii)** provide the interface for the engagement of the complete ecosystem of EO stakeholders (scientists, service/data providers, end users, governmental orgs, and decision makers), **(iii)** promote the concrete uptake of EO services and data in response to regional needs, relevant to the thematic priorities of the Call (adaptation to climate change, improved food security, access to raw materials and energy), and **(iv)** contribute to the improved implementation of and participation in GEO, GEOSS, and Copernicus in the region.

The report aims to outline both national and regional priorities action plans to address the EO issues and needs highlighted in end user interviews and formulated in the gaps analysis with a focus on four priority thematic areas: Improved food security, Adaptation to climate change, Access to raw materials, Access to energy. While the national action plans focus on the EO challenges and issues of each country member of the GEO-CRADLE consortium, the regional action plan builds on those plans a regional dimension which federates strengths of the countries to address regional challenges and boost the uptake of EO market.

The priorities action plan, either national or regional, aims to identify the quick-win actions to deliver on the national/regional priorities. Quick-win actions are selected because they could be launched immediately and could result into significant outcomes within a 1-3 years' timescale. The priority actions include thematic actions (pilot and experimental projects, feasibility studies for long-term projects, etc.), along with support actions which address cross-cutting issues, such as capacity

building and awareness activities. The objective is to spell out the priorities of the RoI and to give insights into potential pilot activities envisaged in the GEO-CRADLE project.

The report does not claim to be exhaustive. Rather, it presents a compilation of inputs from end user interviews, gap analysis and maturity indicators. By combining these findings with country proposals, new insights for action are obtained and incorporated into action plans.

1.2 Methodology

The aim of this work is to devise both national and regional priorities action plans to address the inadequacy of the current EO capacities to meet the end user needs. The priorities action plans provide guidance in setting priorities for the development of EO in the RoI.

We defined two main categories of quick-win actions, namely, **thematic actions** and **support actions**:

- **The thematic actions** aim to support the necessary improvements to thematic gaps identified in the gap analysis. These actions are mainly driven from country demands and verified against a national priority framework to decide on national priorities.
- **The support actions** are chosen because they are critical, common to all thematic actions. They are discerned from identified gaps or have been proposed by partners. They are focused on improving international cooperation for EO, developing and maintaining on-going working relationships with Copernicus and GEOSS, and finally, raising awareness of the value of EO.

1.3 Organization of the report

This document is organized as follows: **Section 1** sets the objectives, the scope, and the methodology for the preparation of the regional priorities action plan. **Section 2** presents the background and the context including the 4 thematic priority areas and the flagship EU initiatives. **Section 3** provides an overview of the EO challenges faced by the RoI and presents the key findings in regards to end user needs, gap analysis, and maturity indicators. **Section 4** highlights national proposals as received from GEO-CRADLE country partners. **Section 5** verifies these proposals against a national priority framework to decide on the national priorities. **Section 6** builds upon the national priorities and the regional priorities by looking at the commonalities within the RoI, and by taking into account the specificity of the region. Finally **Section 7** concludes the report.

2 Background and context

This section provides an overview of the EO challenges faced by the regions of North Africa, the Middle East, and the Balkans in four priority areas: Adaptation to climate change, Improved food security, Access to raw materials, Access to energy. It also includes a brief presentation of flagship EU initiatives in the EO sector, namely GEO/GEOSS and Copernicus.

2.1 Thematic priority areas

2.1.1 Food Security

According to the United Nations Food and Agricultural Organization (FAO), the world population is expected to reach to 9.6 billion in 2050[1]. Increase in population and income growth rate are expected to leave an impact on food security. The FAO's definition of food security sets out that *food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*[2].The definition provides an organizational framework, suggesting that people will only be food secure when food is available, they have access to it, and it is well utilized.

To date, one of the few comprehensive indicators for the measurement of food security is the Global Food Security Index (GFSI).According to the 2015GFSI[3], the MENA countries made the largest strides in food security. The 2.4-point increase in the region's average overall score was driven primarily by gains in Affordability, owing to a combination of lower household spending on food and higher GDP per capita in 83% of countries. Lower levels of food loss and increased access to high-quality protein resulted in marked improvements in the other two categories, Availability, and Quality & Safety, as well. The political environment also has been stabilized in most countries.

Despite the achievement of MENA countries, there are still setbacks in meeting food security. These setbacks are mainly due to structural problems of land and water scarcity, high rates of population growth, and climate change that limits production increases and widens the gap between domestic production and consumption requirements. Furthermore, the food insecurity in the region is

[1] FAO, 2015. Regional overview of food insecurity: Near East and North Africa.
[2] World Health Organization, Food Security, Available from http://www.who.int/trade/glossary/story028/en/.
[3] The Economists Intelligence Unit, An annual measure of the state of Global Food Security Index 2015, Available from http://foodsecurityindex.eiu.com/

aggravated by regional instabilities, civil insecurity, conflicts and population movements. The multi-faceted nature of food security calls for collaborative efforts, partnership and networking among key stakeholders for fulfillment of food security.

According to the findings of the GEONetCab[4] project, EO professionals need to deliver:

- Accurate and reliable crop production information;
- Spatial distribution of cultivated area;
- crop growth models;
- Good quality of meteorological data;
- Capacity building to enable correct use and integration of products and services.

In general EO services for crop modeling include:

- Early warning service;
- Crop yield forecasting;
- Agriculture mapping;
- Precision agriculture.

2.1.2 Access to Energy

Energy access is defined both as the provision of adequate amounts of high-quality and reliable modern energy supplies, such as electricity, gas and liquid fuels as and when needed, and as the ability of individuals to purchase such supplies in the amounts deemed necessary for their daily use. It is instrumental in reducing poverty and ensuring sustainable development. Access to sustainable energy must therefore be available to all[4].

Universal access to affordable, reliable, sustainable and modern energy services is embraced in the seventh Sustainable Development Goal (SDG) of the 2030 Agenda for Sustainable Development. Energy access is intertwined with many other development issues including poverty, social inclusion, food security and the environment. While progress has been made in recent years towards closing

[4]G20 2016 China, Enhancing Energy Access in Asia and the Pacific: Key Challenges and G20 Voluntary Collaboration Action Plan, Available from https://ec.europa.eu/energy/sites/ener/files/documents/

the gap, in 2012 about 1.1 billion people worldwide lacked access to electricity and 2.9 billion people lacked access to non-solid fuels for cooking[5].

The main challenges for the region are high energy intensity, greenhouse gas emissions, and use of finite fossil fuel reserves. Combined with water scarcity concerns, these challenges, if not addressed, could threaten the region's energy security and environmental sustainability. Recently, many MENA countries have increased their attention for renewable energy and energy saving, focusing on improving energy efficiency and diversifying their economies and energy mixes. Renewable energy sources include solar energy, wind energy, hydropower, and geothermal energy.

According to GEONet CAB, the category of EO products/services for access to energy include:

- Resource assessment for (renewable) energy;
- Energy resource exploration support;
- Pipeline monitoring;
- Optimization of biofuel production.

In general, EO offers the following comparative advantages:

- Increased accuracy;
- Cost reduction/increase in revenue;
- Better planning of energy operations;
- Innovation in assessment of resources and monitoring.

2.1.3 Climate Change

Climate change has an impact in all parts of the world, but the Arab countries of the Middle East and North Africa are certainly among those most affected. Some of the most significant effects of climate change which have already affected or will affect most of the 340 million people in the Arab region are average temperature increase, less or more erratic precipitation and sea level rise, in a region which already suffers from aridity, recurrent drought and water scarcity[6].

[5] Author calculation based on international Energy Agency (IEA) and the World Bank. 2015. "Sustainable Energy for All 2015—Progress Toward Sustainable Energy" (June 2015), World Bank, Washington, DC. Doi: 10.1596/978-1-4648 -0690-2.

[6] Arab Environment: Climate Change Impact of Climate Change on Arab Countries. 2009. Report of the Arab Forum for Environment and Development (AFED)

Climate change is impeding the efforts for poverty reduction and economic growth because it restricts the fulfilment of human potential and disempowers people and communities, posing constraints to their ability to protect and enrich their livelihoods. With population increase, population densities and activities in the Arab MENA region, as well as high urbanization rates, urban areas, especially in the coastal zone, are particularly vulnerable to the impact of climate change. In addition, the degree of warming from climate change is generally expected to be higher at more northerly latitudes, and this warming is projected to result in many more frequent and more severe extreme weather events.

Current weather extremes already affect millions of people, putting food and water security at risk, and threatening agricultural supply chains and many coastal cities. Without further action to reduce extreme poverty, provide access to basic services, and strengthen resilience, climate impacts could push an additional 100 million people into poverty by 2030. Agriculture, which plays a crucial role in ensuring global food security, nutrition, and poverty alleviation, is highly vulnerable to the effects of climate change because of its dependence on the weather. Globally, ensuring food security in a changing climate is one of the major challenges of the coming decades.

2.1.4 Access to Raw Materials

Raw materials are defined as materials or substances used in the primary production of goods. According to EU, raw materials are often referred to the access to non-energy and non-agriculture raw materials, which are bought and sold on commodities exchanges around the world. In this sense, raw materials are crucial for the world economy and quality of life[7]; increasing resource efficiency will be key to securing economic growth. It will bring major economic opportunities, improve productivity, drive down costs and boost competitiveness.

The potential of minerals exploitation and mining activity in the RoI, and their corresponding socio-economic benefits is high. More than 30% of the world's global mineral reserves are found in Africa, yet less than 5% of the total global ore deposits exploration and minerals extraction budget is invested in the continent[8]. The potential for a productive and sustainable mining industry across the

[7] DG ENTR. 2015. Report on critical raw materials for the EU. Available from http://www.catalysiscluster.eu/wp/wp-content/uploads/2015/05/2014_Critical-raw-materials-for-the-EU-2014.pdf

[8] Mining in Africa and the Middle East: A legal overview, Available from https://www.dlapiper.com/

Middle East and Africa remains challenging, but highly prospective. Reports by leading global consultants suggest that private-public-investments should be actively encouraged and sought to meet the demands for developing appropriate exploitation processes. The countries, as part of the quest to diversify and capitalize upon their minerals, face the need to establish modern, open and transparent regulatory frameworks and concerted actions for best practices, maximizing the environmental, societal and economic benefits.

The main challenge is to ensure accessibility, availability and sustainable use of raw materials. In fact, securing an uninterrupted access to resources will become a strategic economic challenge for some critical materials. The rationalized exploitation of minerals through a coordinated and integrated approach with clear awareness of environmental treaties and society needs, facilitates resource efficiency, and supports environmental, industrial, and business development sectors.

2.2 Flagship EU initiatives

2.2.1 GEO/GEOSS[9]

The Group on Earth Observation (GEO) was created as a result of the Summit Of Evian in 2003. It is an international partnership between countries and international organizations, working together to establish a Global Earth Observation System of Systems (GEOSS). Currently, GEO is a partnership of 102 Member governments and the EC; and 95 Participating Organizations comprised of international bodies with a mandate in and/or use of Earth observations. Together, the GEO community is creating a GEOSS to better integrate observing systems and share data by connecting existing infrastructures using common standards.

GEOSS is a set of coordinated, independent Earth observation, information and processing systems that interact and provide access to diverse information for a broad range of users in both public and private sectors. GEOSS links these systems to strengthen the monitoring of the state of the Earth. It facilitates the sharing of environmental data and information collected from the large array of observing systems contributed by countries and organizations within GEO. Further, GEOSS ensures that these data are accessible and interoperable to support the development of tools and the

[9] http://www.earthobservations.org/

delivery of information services. Thus, GEOSS increases our understanding of Earth processes and enhances predictive capabilities that underpin sound decision-making.

The purpose of GEOSS is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behavior of the Earth system. GEO has chosen to work by structuring around major societal themes:

- **Risks:** Reducing loss of life and property from natural and human-induced disasters,
- **Health:** Understanding environmental factors affecting human health and well-being,
- **Energy:** Improving management of energy resources,
- **Climate:** Understanding, assessing, predicting, mitigating, and adapting to climate variability and change,
- **Water:** Improving water resource management through better understanding of the water cycle,
- **Weather:** Improving weather information, forecasting, and warning,
- **Ecosystem:** Improving the management and protection of terrestrial, coastal, and marine ecosystems,
- **Agriculture:** Supporting sustainable agriculture and combating desertification,
- **Biodiversity:** Understanding, monitoring, and conserving biodiversity.

2.2.2 Copernicus[10]

Copernicus (formerly known as Global Monitoring for Environment and Security, GMES) is a joint initiative of the EU and ESA developing and operating an operational European EO capacity. It delivers efficient information services supporting public and private services for environment and security. Copernicus is seen as a flagship of European space programmes, alongside GALILEO. It is among Europe's main contributions to GEOSS.

The information gathered and relayed by Copernicus helps in improving the management of natural resources, monitoring the quality of water supplies, monitoring and forecasting air pollution, supporting town planning and preventing urban sprawl, easing the flow of transportation, optimizing

[10]http://www.copernicus.eu/

agricultural activities and promoting the development of renewable energy sources. Copernicus also supports European economic growth by enabling companies to explore new development opportunities via downstream applications. Copernicus is based on the following services:

- **Land monitoring service** provides geographical information on land use and on bio-geophysical variables related to, for example, the state of vegetation or to the water cycle. It allows applications in a wide range of fields such as land use planning, forest management, water management, agriculture and food security, etc.
- **Marine environment monitoring service** provides regular and systematic reference information on the physical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas.
- **Atmosphere monitoring service** provides daily information on the composition of the global atmosphere by monitoring and predicting constituents such as greenhouse gases (carbon dioxide and methane), reactive gases (carbon monoxide, Oxidized nitrogen compounds, sulfur dioxide, and stratospheric ozone) and aerosols.
- **Emergency management service** provides all actors involved in the management of natural or technological disasters and humanitarian crises with sufficiently accurate geo-spatial information derived from satellite remote sensing and supplemented by other available in situ or model data sources.
- **Security service** aims to support the policies of the EU in the key areas: border surveillance, maritime surveillance; and support for the external action of the EU.
- **Climate change service**: The Copernicus Climate Change Service (C3S) is still in the development phase and will combine observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide.

The space component is coordinated by the ESA with contributions from the European Organization for the Exploitation of Meteorological Satellites EUMETSAT. ESA is responsible for the development, realization and launching of satellites and, together with EUMETSAT, is responsible for the operation and maintenance of the Sentinels satellites and instruments dedicated to Copernicus with the associated reception and processing centers. It collects and makes available their data and those of the contributing missions necessary for Copernicus services.

In addition to the Sentinels instruments, the in situ component is coordinated by the EEA. It builds on the networks of existing in situ observations of Member States and on international networks to meet the needs of the Copernicus services. The cost of these networks supported by the Member States is of an order of magnitude comparable to that of the space component of the program.

3 Key findings/Inputs

This section outlines the challenges of the region in relation to the priority areas: Food security, Adaptation to climate change, Access to energy and Access to raw materials. It also provides a review of the findings in regards to end user needs, gap analysis, and maturity indicator, as framed in D2.5 "User Need Analysis Report", D3.1 "Gap Analysis" and D3.2 "Maturity Indicators", respectively.

3.1 End user needs

The end user needs are primary inputs to the priorities action plan. The needs expressed by end users were formalized in the deliverable D2.5 of the GEO-CRADLE project. The document provides some insights into the market segment situated at the end of the value added chain. It thus informs the analysis of the value-added chain itself, and offers some recommendations in regards to the pilot activities (case-studies) envisaged in the GEO-CRADLE project.

The analysis was focused on groups of two or more countries to outline regional patterns in needs, in line with the objectives of GEO-CRADLE to serve regional (rather than simply national) objectives. On this basis, in each group of countries the following aspects were investigated:

- **General observations:** on the use of geo-information in the region, especially in terms of patterns in the needs of the interviewees, and how these connect to those in the pairing countries.
- **Information needs:** list of geo-information and data needs as quoted by the interviewees.
- **Data sources:** list of data sources quoted by the end users; where available, specifications as to the format of the data used (format specifications are limited in the report). However, should partners need to investigate further, it was a way to underline that the information exists, in some cases.
- **Constraints:** specifically, non-technical constraints in accessing the information, procuring it, but also any type of constraints and objectives beyond the strict use of geo-data e.g. lack of policies on climate change, insufficient implementation of rules and regulations, red tape, lack of financing and so on.
- **Awareness of GEO/COPERNICUS**.
- **Funding schemes:** when listed as having enabled the end user to procure geo-information.
- **Potential benefits from a data hub**.

Remark: Key findings in regards to end user analysis focus herein on the geo-information needs, the constraints faced by end users, and the recommendations for pilot projects.

3.1.1 Constraints faced by end users

The Table 1 summarizes mainly the constraints that hinder stakeholders to achieve their missions.

Table 1: Constraints quoted by end users

Group of countries	Constraints (as quoted by end users)
Serbia, Romania, Bulgaria	**Government data is seldom open and free** in Romania. Limited access to data produced by the National Geodetic Authority.
	Lack of staff with adequate skills and expertise in data processing in different sectors (e.g.; Group for Viticulture and Wine Production, Ministry of Agriculture and Environmental Protection, and in geological risks, notably landslides (Min. Energy, Serbia.))
	Financial constraints to hire skilled staff, or procure geo-information or software.
	Lack of staff for the collection and further analysis of the data, **lack of computer resources**, lack of professional GIS software and databases, lack of GPS measuring devices (Serbia)
	The need to generate public awareness on climate change and sustainability. For instance, some climate change mitigation strategies and plans are not well understood by the general publican Serbia.
	Data quality/quantity short time series especially in some sectors e.g. biodiversity, health and availability. In some cases (forestry, agriculture), seasonal limitations are noted: only data from spring to autumn can be used. Increased cloudiness during spring and autumn also poses physical limits. Summertime is dry and cloud cover is not problematic.
	Data delivery delays (e.g., Romanian Air traffic Administration, General iOsiguranje Serbia) sometimes due to connectivity
	Lack of multi-stakeholder consultation and operational coordination; politics are often an obstacle.
	Other constraints include lack of agriculture land to be purchased (or sufficient information about it); land fragmentation, or ownership fragmentation which prevents agriculture on a large scale; organic production costs very high, but a real market opportunity; natural crop risks. In the case of Mountain Rescue Service Serbia—distance from victims to rescue, insufficient rescue gear societal constraints about the use of pesticides in agriculture (Serbia)

FYROM, Albania	**Lack of personnel:** A lack of professional personnel in the IT sector has also been identified. Countries have reported constraints related to the lack of permanent skilled and trained staff, together with the lack of periodical training programs for the staff on advanced techniques of geo-data processing.
	Budget constraints: Limited budgets to purchase geo-information data and equipment, together with the lack of technical capacities to conduct field work.
	Lack of cooperation: An insufficient interaction with other departments regarding data sharing has been highlighted by interviewed candidates. In the case of FYROM, respondents have commented on their restricted access to other public agencies' data, such as, the Real Estate Agency database, Soil Information System database, Hydro met Service or the Spatial Planning Agency.
	Data gaps and limited formats: Both countries have underlined the low quality of existing national data sets and the lack of standardization procedures in data collection between public institutions. The Spatial Planning Agency of FYROM reports that less than 40% of the data it needs from other public institutions is received in an appropriate format. A lot of the public data is still available only in an analogue format.
	Burdensome public tendering procedures: Entities in FYROM highlighted that the long tender procedures affect the timeliness of their activities and the quality of the prepared data.
Greece, Cyprus, Turkey	**Legislation constraints:** Lack of a coherent national agricultural strategy. In Northern Greece, agricultural cooperatives have pointed out the government's lack of support towards helping them promote their products externally. Furthermore, like in Cyprus, EU CAP subsidies drive the crops farmers will favor, since agriculture in Greece is heavily dependent on legislation and funding. This may lead to soils losing qualities and therefore weaker yields.
	Lacks of standards and protocols: The environmental sector in Cyprus generally lacks standards and protocols. Competition is tough and the market is rapidly changing.
	Budget constraints: The majority of Greek interviewees have underlined the short to long-term negative effects of their country's austerity measures. For example, some end users believe that the current economic crisis in Greece has shifted social interest from environmental issues to financial issues. Furthermore, the need to cut costs has pushed organization to cut staffing.
	Lack of awareness & know-how on the use of EO for Environment and Agriculture. End users have little knowledge of geo-information data and its potential, thus targeted awareness campaigns and greater support should be offered to them by either private or governmental bodies.
	Serious data gaps: In Greece, interviewed authorities have underlined the government's lack of incentive to digitalize national data sets and archives from municipalities and decentralized

	administration offices. In addition, some of the interviewees have highlighted serious gaps in nationally archived and collected data.
	Lack of cooperation: Among the interviewees, several public authorities have underlined the existing difficulties with regards to internal communication and interaction between departments within national ministries.
	Burdensome public tendering: public tender procedures are seen not as an opportunity but rather as a burdensome process that creates delays and issues for both private and public entities.
	Lack of capacities: respectively, technical equipment and specialized personnel.
Tunisia, Morocco, Egypt	**Data quality/quantity:** Data on natural resources is difficult to collect and hard to verify. Besides, data changes quickly and is sometimes inaccurate
	Legal constraints: In Tunisia legally every tender must go through the CNCT for validation and approval. This often causes too much red tape and delays.
	Lack of staff and expertise: Lack of GIS expertise, limited staff in Tunisia and Morocco. **Data cost:** In Egypt, some research centers could spend up to 60% of their budget on data.
	Struggling political environment in Egypt has led to a weak implementation of environmental protection and conservation laws and policies. Interviewees have reported industry irregularities with respect to legal standards coupled with the inability of public authorities to monitor breaches due to budget cuts and lack of monitoring capabilities.
	Outdated rules and legislations in Egypt obstruct the use and development of geo-information use within the public sector. It is regarded as an endemic obstacle to economic growth.
	Lack of cooperation: The Egyptian Environment Agency reports that inter-departmental cooperation is an issue within the ministries, together with lack of data collection standards and data sharing.

3.1.2 Recommendations

In regards to thematic priorities, the end user analysis results suggest the following recommendations for pilot projects definition (see Table 2):

Table 2: Recommendations in regards to pilot projects

Thematic priorities	Recommended countries	Arguments	Potential stakeholders
Improved Food Security and Water Extremes	- **Greece** could provide the critical user mass for a pilot study into the potential for geo-information sources to support agriculture practices and to decrease the impact of extremes on agriculture. - **Greece**, **Albania**, **Serbia**, **Tunisia** and **Turkey** are good candidates for feasibility studies related to water extremes.	- End user analysis showed a good balance of private and institutional organizations. - Strong cooperation between I-Bec and end users, so in a good position to take their needs into account. - These countries were subjected in the past to water extremes with consequent adverse impacts and damages to agriculture and crop production.	Stakeholders are not just farms, but also insurance companies, farming consultancies, land planning authorities, public authorities which manage subsidies.
Adaptation to Climate Change and Water Extremes Management	- **Morocco** could provide the critical user mass for a pilot study into the potential for geo-information to support climate change assessment, monitoring and mitigation. - **Morocco**, **Tunisia**, **Egypt**, **Israel**, **Turkey** and **Saudi Arabia** can be concerned by a pilot project about water resources and water pressure factors and water risks.	- The Water Basin Agencies are quite experienced in the use of different geo-information sources; - A large network of stakeholders; - Close working relationships with the CRT (Geo-information and data providers).	- **Morocco**: **Water Basin** Agencies - **Tunisia**: **SONEDE** (the National Water Distribution Utility) and **APAL** (the Agency of Protection and Coastal Planning); - **EGYPT**: **Ministry of Agriculture and Irrigation and General Authority for Fisheries**; - **Saudi Arabia**: **NWC** (the National Water Company).
Access to Energy	- Greece, Egypt, Romania, Tunisia, Morocco and Saudi Arabia can be potential candidates on the topic of energy.		- **Greece**: **IPTO** or **ADMIE** (Independent Power Transmission Operator), **Public Power Corporation S.A.**, **the Ministry of Environment - Hydroelectric Generation Department**, **YPEKA** (Energy and Climate Change), **CRES** (Centre for Renewable Energy Sources and Savings) - **Egypt**: **the Ministry of Electricity Renewable Energy**

			- **Romania**: **CEZ Trade** (the electricity distribution company) and **Tractebel Engineering SA GDF SUEZ** (an engineering and energy consultancy) - **Tunisia**: **STEG** (the Tunisian Electricity and Gas company) - **Morocco**: **the National Electricity Office and** electricity distributors - **Saudi Arabia** : **ARAMCO** (Saudi Arabian Oil Company
Access to Raw Materials	Morocco can be a candidate on the topic of Access to Raw Materials.	The Oum-Rabian Water River Basin Agency presents a significant phosphate mining site in the basin.	- **Morocco**: **Oum-Rabian Water River Basin Agency**

3.2 Gap analysis

The gap analysis, which was preceded by the inventory of capacities, was carried out by the *T3.1. GAP Analysis* for 4 months. The methodological aspects for gap analysis are: EO capacities (identified through inventorying of key EO actors in the region); EO end user needs (identified through in-depth end user interviews of a representative sample); maturity indicators (characterize identified gaps and pinpoint where in the value chain they occur).

The identification of gaps was conducted by tracking the end user needs, carried out in T2.4 "User Needs Analysis" and framed in D2.5 "User Need Analysis Report", against the results from the inventorying of EO capacities. The identification and characterization of gaps was done using an analytical framework for EO capacities to provide reflection on EO capacities. The main constituent categories of the framework are as follows:

- **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 availability of data to flow freely within organizations or networks.
- **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 personal to make use of it.

Table 3 summarizes the gap analysis results by country taken into the aforementioned framework.

Table 3: Summary of identified gaps

Country	Identified gaps
Albania	**Observational gaps:** In-situ network operated by a public institute was offline due to financing issues.
	Structural gaps: EO data in need is not updated on a regular basis; EO data are not free, illegal means are used by several end users to obtain data, mainly due to budget shrink.
	Quality/quantity gaps: Insufficient detail and quality of information/data received.
	Capacity gaps: Human resource limitations; lack of training and expertise in the EO related tasks; Lack of national fund and governmental support for EO activities; and cooperation

	between decision makers is largely perceived as scarce.
Bulgaria	No end user interviews were concluded in the first phase but will be conducted in the second one, it is most probable that large **structural gaps** are present in the country.
Cyprus	**Structural gaps:** No gaps were identified from collected data (survey and end user interviews).
	Quality/quantity gaps: Lack of funds to purchase data at the temporal/spatial resolution required by public end users; lack of standards and protocols or quality of METADATA.
	Capacity gaps: Compounded by a freeze in the public sector, there is a lack of sufficient personnel needed to complete the breadth of EO related tasks.
	Thematic gaps: 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.
Egypt	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.
	Structural gaps: Data sharing between organizations is scarce, as most data collected and processed is kept in-house (an aversion towards data sharing; Lack of cooperation between organizations.
	Quality/quantity gaps: Lack of access to affordable and high resolution EO images (near real-time or real-time information)
	Capacity gaps: Human resource limitations, including lack of training and relevant skills available; No national financing for EO.
Greece	**Observational gaps:** Need for denser in-situ network coverage for highly localized data, particularly for metrological data and radiation data. e.g. better radiation coverage data for solar power generation models and algae cultivation.
	Quality/quantity data: Freely available data is of a low quality, while the data with commercial licenses offers better quality; tight budget for public end users to acquire high quality, reliable data.
	Capacity gaps: Lack of staff cited to complete the breadth of tasks in EO activities and a lack of EO specific expertise, leading to a low performance and low ability to develop value-added services/products to support decision-driven management systems. Due to economic crisis, Greece faces many challenges: notable deficit in available expertise and the inability to acquire new equipment, as well as the quality and quantity of data they require due to austerity measures taken by the government; Financial restrictions prevent entrepreneurs to grow their business; Difficulty to secure EU financing.
	Thematic gaps: Gaps are specific, e.g. O3 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.
Israel	Highly developed country in regards to EO. There is a large and mature public and private EO sector in the country.
FYROM	No **geographic** or **observational gaps** could be discerned from end user interviews.
	Structural gaps: Sharing data between organizations is at a low level, sharing, if it does occur, is subject to a complicated legal framework that results in delays.
	Quality/quantity gaps: End users relied on data with quality significantly below their needs, including data that is not up to date. Data received is often in analogue form and non-standardized GIS data, resulting into low quality of data products.
	Capacity gaps: Lack of skilled staff to conduct field, analytical and IT functions. It is likely that the public sector is not able to attract needed skills facing budget cuts. Unlike private sector public institutions do not have access to the equipment and software they require due to a lack of funds.
	Thematic gaps: Insufficient information from end user interviews to make thematic area specific conclusions. From the capacities, the hydro-meteorological capacities can be noted as the most advanced, and that data for soil, energy and radiation is largely conducted manually where necessary.
Romania	Neither **geographic** nor **observational** gaps were identified in Romania
	Several structural gaps: Coordination with decision makers in Romania is typically perceived as basic, implying difficulty to interact with authorities when obtaining authorization for protected areas; Data is typically license restricted; Communication with local EO actors is poor, and is usually seen as a source of complications in administrative procedures.
	Quality/quantity gaps: Temporal resolution represents a major gap: the data reception is not regular.
	Capacity gaps: Lack of qualified personnel; a constant need for personnel training and education, as well as for staff mobility.
Serbia	**No geographic gaps** identified. Although Serbia does not have any space-borne capacity, satellite images are purchased from commercial providers and local resellers.
	Observational gaps: Available in-situ networks have insufficient observational capacities in

	mountainous regions, implying low resolution of data (particularly metrological data); No automated, in-situ capacities exist for soil attributes or radiation/energy
	Structural gaps: Barrier to access to data, even between public sector actors, due mainly to the reluctance to share data in the organizational structure and the heavy bureaucratic procedures; Lack of cooperation with local actors.
	Quality/quantity gaps: 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. Some data are not in a digital format and sometimes outdated and requires an effort to conduct corrections; Inability of end users to purchase better quality/quantity (desired resolution) of data due to lack of funding; Inaccessibility to costly data.
	Capacity gaps: Insufficient human resources and expertise to provide missing expertise in geospatial groups of organizations; Lack of funding and a freeze in hiring in the public sector; Lack of investment in expansion of in-situ networks and insufficient funds for maintenance of current capacities.
	Thematic gaps: The country has 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.
Tunisia	**Observational gaps:** The current network of ground segment facilities is scarce and does not provide sufficient coverage, particularly in the thematic area of energy. Only meteorological/climatic facilities have national coverage, and no organization confirmed their ownership of energy/radiation facilities.
	Structural gaps: Lack of coordination between different entities of one authority, leading often to duplicated research efforts; legal constraints, resulting in complicated procedures with several levels of approval needed for data sharing to take place.
	Quantity/quality: Data is hardly verifiable in practice because of the lack of METADATA.
	Capacity gaps: Human resource limitation (more administrative than technical staff, and there is an overall lack of qualified staff specialized in GIS)**;** Limited public fund resulting into low levels of interaction with decision makers, and poor resources available for modeling and computing.
Turkey	No end user interviews could be provided for Turkey.

3.3 Maturity indicators

The assessment on the maturity level per country is based on the outcomes from the survey and the gap analysis. The methodology uses the following techniques: desk research, semi-structured interviews with country partners, validation of findings by experts, and comparative assessment per country level. By assessing the maturity of different aspects, it gives some information on the country strengths and weaknesses and where improvements are needed.

41 maturity indicators were used across the value chain: geographical, observational, structural, qualitative/quantitative, capacity for use. The indicators are grouped by capacities, cooperation, and uptake. For each indicator a table was created providing description, parameters, constraints, and gap analysis. Five maturity levels are defined: initial, basic, intermediate, advanced, and optimized.

Preliminary maturity cards for each country were developed to illustrate the implementation of the maturity model assessment. With a first assessment, countries are placed in different maturity categories:

- **Advanced quasi optimized:** Israel
- **Advanced:** Romania, Turkey and Greece
- **Intermediate:** Serbia, Tunisia, Cyprus and Egypt
- **Basic:** Bulgaria
- **Initial:** FYROM and Albania

3.4 Linkage of end user needs, gap analysis and maturity indicators

Linkage of end user needs, gap analysis results and maturity indicators serves to establish a common understanding of GEO-CRADLE country challenges and discern country-specific priorities. The linkage is underpinned by the following aspects:

- **Infrastructure capacity** is related to the hardware, software and other technology required to access, use and develop geo-information data and products for decision making;
- **Institutional capacity** is focused on developing and fostering an environment for the use of Earth observations to enhance decision making. This includes building policies, programs and organizational structures in governments and organizations aimed at enhancing the understanding of the value of Earth observation data and products;

- **Human capacity** refers to the education and training of individuals to be aware of, access, use and develop Earth observation data and products;
- **Financial capacity** refers to the financial support to all EO activities;
- **Data access** refers to the availability, affordability (cost) and usefulness (quality and quantity) of EO data.
- **Thematic priorities** cover the government priorities in relation to the four thematic areas: Adaptation to climate change, Improved food security, Access to raw materials, and Access to Energy.

Table 4: Linkage of end user needs, gap analysis to maturity indicators

Country	Parameter	Identified gaps	End user needs	Maturity degree
Albania	**Infrastructure capacity**	No **geographic** or **observational gaps** were identified for Albania.	An in-situ network operated by a public institute was offline due to financing issues.	**INITIAL**
	Institutional capacity	**Structural gaps:** Illegal means are used by several end user to obtain data, mainly due to budget shrink.		
	Human capacity	**Capacity gaps:** Human resource limitations; lack of training and expertise in the EO related tasks; and cooperation between decision makers is largely perceived as scarce.	**Lack of personnel:** lack of permanent skilled and trained staff, together with the lack of periodical training programs for the staff on advanced techniques of geo-data processing. A lack of professional personnel in the IT sector has also been identified.	
	Financial capacity	Lack of national fund and governmental support for EO activities.	**Budget constraints**: Limited budgets to purchase geo-information data and equipment, together with the lack of technical capacities to conduct field work.	
	Data access	**Quality/quantity gaps:** data in need is not updated on a regular basis; EO data are not free; Insufficient detail and quality of information/data received.	**Data gaps and limited formats**: low quality of existing national data sets and the lack of standardization procedures in data collection between public institutions.	
	Thematic priorities areas		**Climate change is an emerging theme**; efforts are only now beginning to include the notion of climate change in national policies and regulations.	
Cyprus	**Infrastructure capacity**		**Lack of technical capacities**	**INTERMEDIATE**
	Institutional capacity	**Structural gaps:** no gaps were identified from collected data (survey and end user	**Lack of cooperation:** Several public authorities have underlined the difficulties of	

		interviews).	internal communication and interaction between departments within ministries. **Burdensome public tendering:** public tender procedures are seen not as an opportunity but rather as a burdensome process that creates delays and issues for both private and public entities.	
	Human capacity	**Capacity gaps:** Lack of sufficient personnel needed to complete the breadth of EO related tasks.	**Lack of specialized personnel**	
	Financial capacity	**Freeze in the public sector**		
	Data access	**Quality/quantity gaps:** Lack of funds to purchase data at the temporal/spatial resolution required by public end users; lack of standards and protocols or quality of METADATA.	**Lacks of standards and protocols:** the environmental sector in Cyprus generally lacks standards and protocols.	
	Thematic priorities areas	**Thematic gaps** were not identified because of inactive inputs from end users.		
Egypt	**Infrastructure capacity**	No **geographic** or **observational gaps** were identified for Egypt.	Basic telecom infrastructure are sometimes not offered (internet connection, phone)	**INTERMEDIATE**
	Institutional capacity	**Structural gaps:** data sharing between organizations is scarce, as most data collected and processed is kept in-house (an aversion towards data sharing; Lack of cooperation between organizations.	**Lack of cooperation:** The Waste Management Department within the Egyptian Environment Agency reports that inter-departmental cooperation is an issue within the ministries. **Outdated rules and legislations** in Egypt obstruct the use of EO data and the development of geo-information use within the public sector. **Poor networking** in the EO ecosystem and a	**INTERMEDIATE**

			lack of awareness about activities in other organizations.	
	Human capacity	**Capacity gaps:** Human resource limitations, including lack of training and relevant skills available.		
	Financial capacity	**Capacity gaps:** No national financing for EO.		
	Data access	**Quality/quantity gaps:** Lack of access to affordable and high resolution EO images (near real-time or real-time information)	An aversion towards data sharing. Lack of data collection, data sharing, and interoperability (standards)	
	Thematic priorities areas	Climate change adaptation, Access to Energy and Food security are the most challenging areas.	Several topics about agriculture, food security and energy were quoted in the surveys.	
FYROM	**Infrastructure capacity**	No **geographic** or **observational gaps** could be discerned from end user interviews		**INITIAL**
	Institutional capacity	**Structural gaps:** Sharing data between organizations is at a low level, sharing that does occur is subject to a complicated legal framework that results in delays	**Burdensome public tendering procedures**: the long tender procedures affect the timeliness of their activities and the quality of the prepared data.	
	Human capacity	**Capacity gaps:** the one private company interviewed does not have a gap with available equipment or with the capacity of its human resources.	**Lack of personnel:** lack of permanent skilled and trained staff, together with the lack of periodical training programs for the staff on advanced techniques of geo-data processing. A lack of professional personnel in the IT sector has also been identified.	
	Financial capacity		**Budget constraints**: Limited budgets to purchase geo-information data and equipment, together with the lack of technical capacities to conduct field work.	

	Data access	**Quality/quantity gaps:** End users relied on data with quality significantly below their needs, including data that is not up to date. Data received is often in analogue form and non-standardized GIS data, resulting into low quality of data products.	**Data gaps and limited formats**: low quality of existing national data sets and the lack of standardization procedures in data collection between public institutions. Both individual and legal entities have **access to the data based on a Cooperation Memorandum or on request by the end user** (individuals and legal entities). For these services they charge certain fees.	
	Thematic priorities areas		**Forestry exploitation:** the imperative of keeping a steady supply of wood through re-growth, intelligent plantations and cuts, disease and stress warnings	
Greece	**Infrastructure capacity**	**Observational gaps:** Need for denser in-situ network coverage for highly localized data, particularly for metrological data and radiation data.		**ADVANCED**
	Institutional capacity	**Structural gaps:**	**Lack of cooperation:** difficulties with regards to internal communication and interaction between departments within national ministries. **Burdensome public tendering:** public tender procedures are seen not as an opportunity but rather as a burdensome process that creates delays and issues for both private and public entities.	
	Human capacity	**Capacity gaps:** Lack of staff to complete the breadth of tasks in EO activities and a lack of EO specific expertise, leading to a low	**Lack of specialized personnel**	

		performance and low ability to develop value-added services/products to support decision-driven management systems.		
	Financial capacity	**Financial crisis and budget cuts**	**Financial crisis coupled with tight austerity measures** has considerably affected the purchasing power of new EO data/products by public institutions and has pushed organization cut staffing budget.	
	Data access	**Quality/quantity data:** Freely available data is of a low quality with commercial licenses offering better quality.	**Serious data gaps**: Government's lack of incentive to digitalize national data sets and archives from municipalities and decentralised administration offices. Serious gaps in nationally archived and collected data.	
	Thematic priorities areas	**Thematic gaps:** are largely related 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.	In the agriculture and environment sectors, many users are dependent on external EU funding and subsidies.	
Romania	**Infrastructure capacity**	Neither **geographic** nor **observational** gaps were identified in Romania		**ADVANCED**
	Institutional capacity	**Structural gaps:** Coordination with decision makers in Romania is typically perceived as basic, implying difficulty to interact with authorities when obtaining authorization for protected areas; Data is typically license restricted; Communication with local EO actors is poor, and is usually seen as a source	**Lack of multi-stakeholder consultation and operational coordination;** politics are often an obstacle. **Data delivery delays**– sometimes due to connectivity.	

		of complications in administrative procedures.		
	Human capacity	**Capacity gaps:** Lack of qualified personnel; a constant need for personnel training and education, as well as for staff mobility.	**Lack of staff** with adequate skills and expertise in data processing (Group for Viticulture and Wine Production, Ministry of Agriculture and Environmental Protection).	
	Financial capacity		**The sustainability of projects is not clear.** Research and other kinds of institutional funding support projects on a case by case basis.	
	Data access	**Quality/quantity gaps:** Temporal resolution represents a major gap: the data reception is not regular.	**Government data is seldom open and free** to access in the country	
	Thematic priorities areas		**Forestry exploitation:** the imperative of keeping a steady supply of wood through re-growth, intelligent plantations and cuts, disease and stress warnings.	
Serbia	**Infrastructure capacity**	**Observational gaps:** Available in-situ networks have insufficient observational capacities in mountainous regions, implying low resolution of data (particularly metrological data); No automated, in-situ capacities exist for soil attributes or radiation/energy; 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.	Lack of computer resources, lack of professional GIS software and databases, lack of GPS measuring devices.	**INTERMEDIATE**
	Institutional capacity	**Structural gaps:** Barrier to access to data, even between public sector actors, due	**Heavy administrative procedure** (issuing mining authorization of mining from National	

		mainly to the reluctance to share data in the organizational structure and the heavy bureaucratic procedures; Lack of cooperation with local actors.	Geodetic Authority (national mapping agency) is an illustrative example of such a problem. **Lack of multi-stakeholder consultation and operational coordination**; politics are often an obstacle.	
	Human capacity	**Capacity gaps:** Insufficient human resources and expertise to provide missing expertise in geospatial groups of organizations.	**Lack of staff with adequate skills and expertise in data collection, processing and analysis** in different sectors (e.g.; Group for Viticulture and Wine Production, Ministry of Agriculture and Environmental Protection; and in geological risks, notably landslides (Min. Energy, Serbia.))	
	Financial capacity	Lack of funding and a freeze in hiring in the public sector; Lack of investment in expansion of in-situ networks and insufficient funds for maintenance of current capacities.	**Financial constraints to hire skilled staff**, or procure geo-information or software.	
	Data access	**Quality/quantity gaps:** Some data are not in digital format and sometimes outdated and require an additional effort to conduct corrections; Inability of end users to purchase better quality/quantity of data due to lack of funding; Inaccessibility to costly data.	**Limited access to data** produced by the National Geodetic Authority. **Low resolution of data** (particularly for metrological data). **Insufficient and imprecise geo-referenced data** in wine and gapes production sector.	
	Thematic priorities		**Forestry exploitation:** the imperative of keeping a steady supply of wood through re-growth, intelligent plantations and cuts, disease and stress warnings	
Tunisia	**Infrastructure capacity**	**Observational gaps:** The current network of ground segment facilities is scarce and does		**INTERMEDIATE**

		not provide sufficient coverage, particularly in the thematic area of energy. Only meteorological/climatic facilities have national coverage.		
	Institutional capacity	**Structural gaps:** Lack of coordination between different entities of one authority, leading often to duplicated research efforts; Legal constraints, resulting in complicated procedures with several levels of approval needed for data sharing to take place.	**Legal constraints:** In Tunisia legally every tender must go through the CNCT for validation and approval. This often causes too much red tape and delays.	
	Human capacity	**Capacity gaps:** Human resource limitation (more administrative than technical staff, and there is an overall lack of qualified staff specialized in GIS).	**Lack of staff and expertise:** Lack of GIS expertise, limited staff in Tunisia.	
	Financial capacity	**Limited public fund** resulting into low levels of interaction with decision makers, and poor resources available for modelling and computing.		
	Data access	**Quantity/quality:** Data is hardly verifiable in practice because of the lack of METADATA.	**Data quality/quantity:** Data on natural resources is difficult to collect and hard to verify. Beside, data changes quickly and is sometimes inaccurate.	
	Thematic priorities	Tunisian organizations with data exploitation capacities are active in all GEO-CRADLE thematic areas, particularly in the area of food security and climate change.	Water management, land use, climate change, access to energy.	

3.5 Summary

An in-depth analysis of the linkage between the end user needs, the gap analysis and maturity indicators, revealed the following:

The level of infrastructure capacity in EO in the region varies considerably:

- Western Balkans (non-EU members), such as FYROM and ALBANIA, are small countries with almost no capacities (no space program or space agency), and therefore low uptake of EO services/applications can be seen. Research and academics are usually the main drivers of change in such a case. In this sense, a strong cooperation between academia and industry is needed to boost the development of EO services/products.
- Advanced countries in the region like Greece and Romania have more developed EO capacities. It could be argued that the major factor contributing to such advancement is the EU membership of these countries, which has allowed these countries to benefit through access to structural funds and other EU financial instruments, and through a greater integration with organizations at European level.

The countries in the region are diverse in institutional structures and EO capabilities:

- In countries with low and intermediate degree of maturity, the EO sector is mostly dominated by the public sector, including both institutional organizations and public companies. Structural gaps within the ecosystem of these countries are pronounced: Reluctance to share data between organizations, lack of educational capacities, etc. Egypt, for instance, has large capacities which are hampered by structural gaps. These are caused by human capital limitations while the financial crisis further aggravates them. EU financial instruments and other support measures are identified as an opportunity to narrow the identified gaps.
- Israel, which registered large degree of maturity in the RoI, has a comprehensive framework for the development of a national space sector, accompanied by substantial investment in the sector. The private sector in EO is growing across the country. This is demonstrated by advanced commercial exploitation of EO in the country on one hand, and the uptake of micro-/nano-satellite market niche on the global scale, on the other; the difference with the other countries in the region is therefore quite large.
- Both Saudi Arabia and UAE have also advanced space programs that have seen rapid development over the past two decades. They actively engaged with public institutions and private companies, to which they provide data products, and have developed long-term working

relationships with several national and international institutes. This development has been spurred by strong government investment. However, recent political and economic contexts have lowered available EO funding. Continued efforts are therefore needed to lessen the bureaucratic obstacles and develop local expertise for EO development in both countries.

Data access for all, in terms of accessibility, affordability and usefulness, is mentioned as the major constraint:

- Countries rated low have underlined the low quality of existing national data sets and the lack of standardization procedures in data collection between public institutions. A lot of the public data is still available only in an analogue format; The Spatial Planning Agency of FYROM reported that less than 40% of the data it needs from other public institutions is in digital format.
- Countries that are rated intermediate (i.e., Tunisia, Egypt, Cyprus and Serbia) struggle to access useful data at an affordable cost, owing to bureaucratic obstacles and outdated legal and legislation frameworks. In this sense, a free and open regional data hub can be a great opportunity for those countries. For instance, Tunisia and Morocco with CNCT (National Mapping and Remote Sensing Center of Tunisia) and CRTS (Royal Remote Sensing Centre of Morocco) , respectively, can be key entry points for end users and federate needs, give access to relevant data, serve as a platform for users with common stakes, and open up new business opportunities for private sector.
- Countries with more or less advanced maturity adopted free and open data policy like Greece and Romania. However 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 higher quality data that they require.

Lack of skilled staff and lack of awareness on the value of EO in institutional organizations and public sector:

Most of the countries, with varying stages of maturity, have expressed the skilled personnel requirements for EO related activities in institutional organizations and public sector. Educational and training capacity must be therefore strengthened in the public sector which dominates the EO sector in the RoI.

4 Country proposals

The present section overviews the country proposals, as received from GEO-CRADLE partners, expressed in the end user interviews and/or from their knowledge of the local environment. The proposals will be analyzed in the subsequent section against the national priority framework and priorities to be incorporated in the present edition of the country-specific plans.

4.1 Overview of proposals

While developing country-specific plans, CERT sought input from GEO-CRADLE country partners through recommendation of 2 to 3 national projects that are perceived to be priorities in their countries, with a focus on the four priority thematic areas (Adaptation to climate change, Access to raw materials, Access to energy, and Improved food security).

A guideline was provided to country partners for project description and country priorities analysis. On the basis of the guideline, partners prepared country proposals, either from their expertise in the domain and the knowledge of the local environment or through exchange with national stakeholders. The country proposals were prepared in accordance to a project template which includes the following information (see Table 5):

- **Project title** and the **priority areas** it addresses;
- **Type of the project:** operational service, capacity building, awareness activity, etc.;
- **Stakeholders:** beneficiaries and institutions/actors involved in the project;
- **Pre-requisite** for the realization of the project (skills, capacities and infrastructures);
- **Motivation** behind initiating the project;
- **Description of the project** in terms of scope, objectives, and expected outcomes;
- **Methodologies** and technologies to be used;
- **Action plan:** the phases, milestones, deliverables, timeline;
- **Impact** and mechanisms of measurement;
- **Finance:** estimated budget and possible funding sources (State budget, donors, etc.)

Each project sheet was submitted along with a priority matrix to justify the proposal with regards to many dimensions: relevance to end user, degree of feasibility, sustainability, etc. to decide on their priorities and integrate them in the respective priorities action plan (ample details about the priority framework will be given in Section 5).

Table 5: Project template

Project name		**Type of activity** *Operational services* *Capacity building* *Awareness activities…*	
Priority area		**Beneficiary**	
Pre-requisite *For the realization of the project*		**Stakeholders** *Institutions/ actors involved*	
Motivation			
- Explain why do you think the proposed pilot project is relevant? - Do you think the pilot project can be implemented within the lifetime of the GEO-CRDALE project?			
Description			
- Describe the pilot project by providing an answer to the following elements: • Scope of the project • Objectives • Expected outcomes • Components (IT and non IT infrastructure) • Technologies to be used			
Action plan			
- Sketch out a preliminary project schedule (phase, actions, milestones, deliverables, ...)			
Impacts *What will be the impact of the project ?and how to measure it?*	*Explain the impact in terms of magnitude and sustainability over the medium and long term (see Table 1 "Priority Criteria Definition")*	**Risks**	*What are the factors that may impede implementation of the project (governance, capacities, ...)?*
Estimated budget **(Optional)**		**Possible funding sources** *State Budget, Donors* **(Optional)**	

CERT received 34 proposals from 11 countries in the region, except for FYROM which did not submit any recommendation by the extended deadline. Overall, 17 proposals were received from Balkan countries, 9 from the Middle East and 8 from North Africa. This can be obviously explained by the representativeness of the countries in the region. In terms of timeframe, the projects vary from 6 to

36 months and focused largely on 3 main priority activities: Raising awareness, Operational services, and Capacity building. From the perspective of thematic areas, the received proposal included 19 projects related to Adaptation to climate change, 12 projects for Food security, 9 Access to raw materials, and 6 Access to energy.

Out of the 34 proposals, 2 proposals were not retained for priority analysis as they are not quick-win projects (they exceed a three-year period), whilst two more proposals which are still in ideation phase and their objective(s) and expected outcome(s) are not well established. However, they have been incorporated in the action plans as potential candidate projects as they bear relevance for the country needs. The table 6 sets out the country proposals. Details include the country, thematic areas and timing.

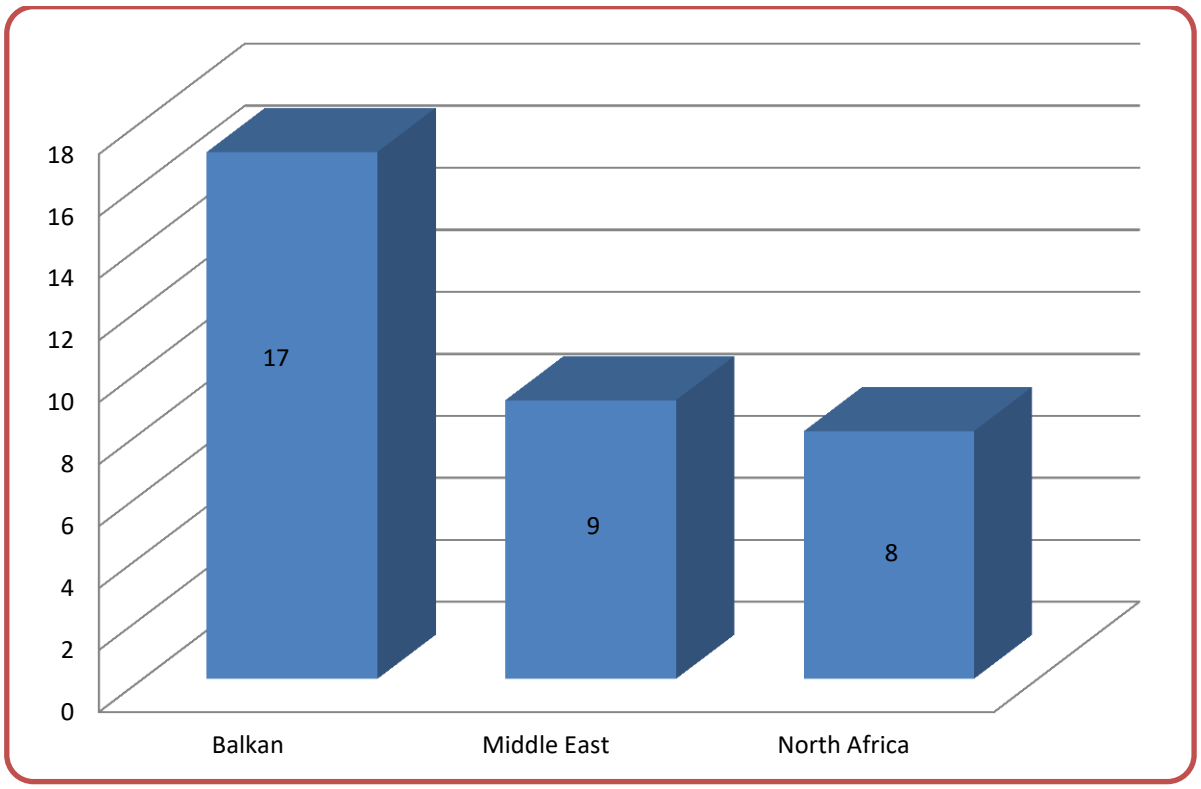

Figure 1: Number of project proposals by region

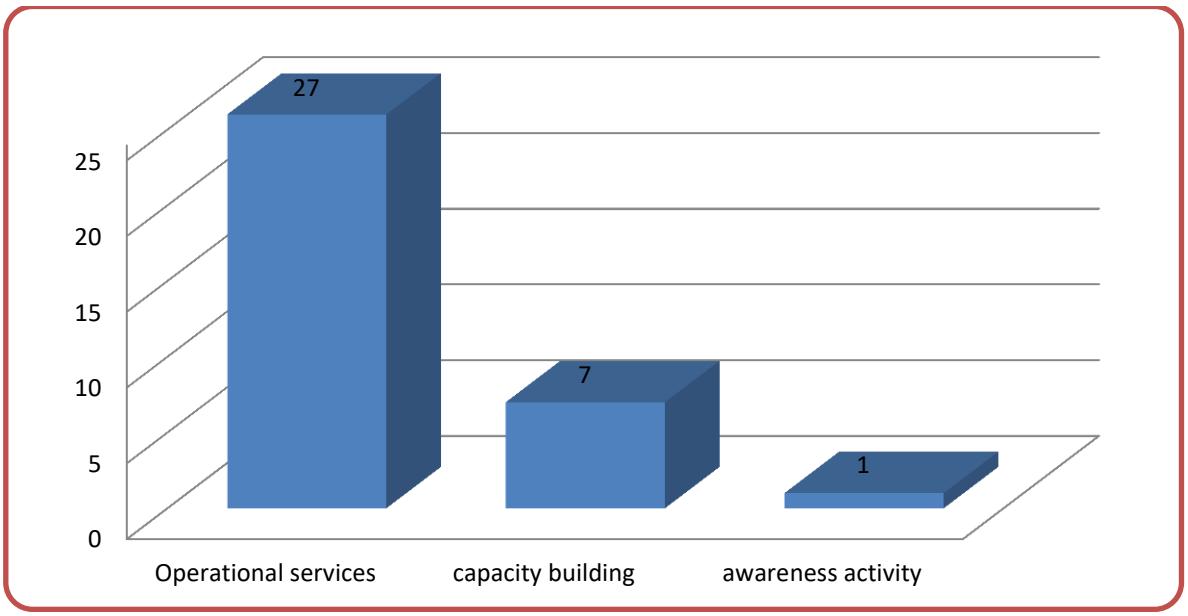

Figure 2: Number of project proposals by action type

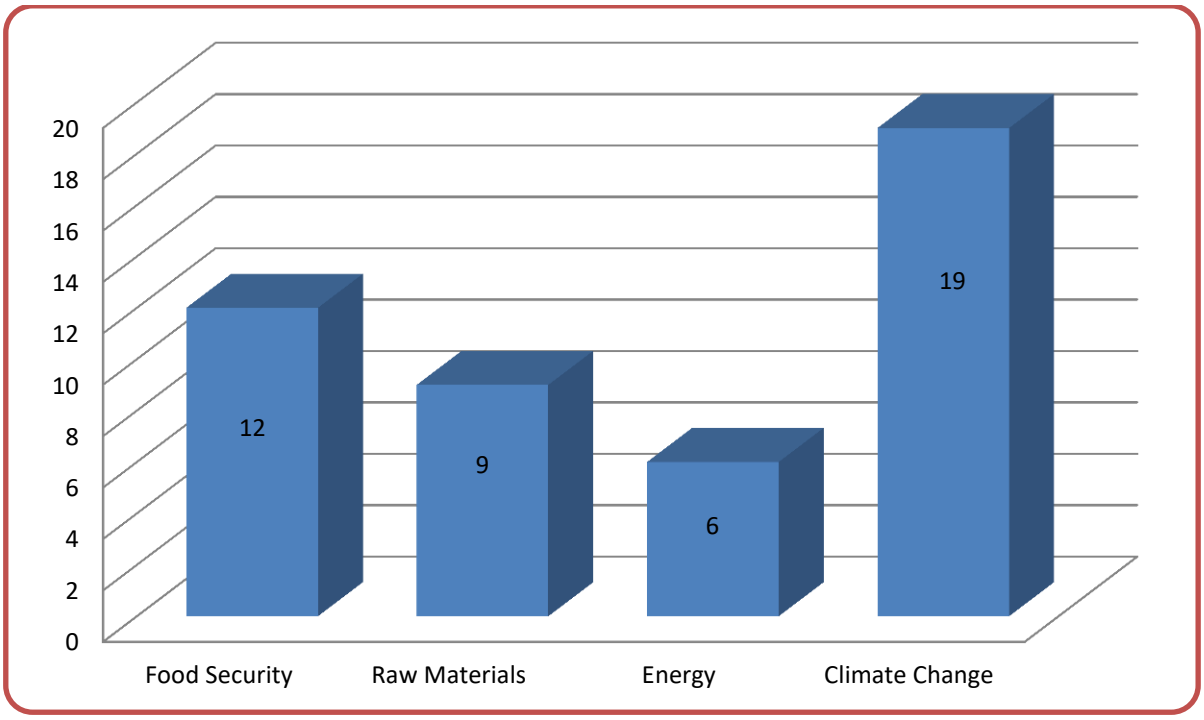

Figure 3: Number of project proposals by thematic area

4.2 Listing of proposals

Table 6: List of country proposals

Country	Project name	Thematic areas	Project type	Project nature
Albania	Establishing and implementing the Government Standards on Technical Specification for Geospatial Information in Albania	All fields (energy, access to raw materials, food security, climate change)	Capacity building Awareness activities	Quick-wins (<6month)
Bulgaria	Improving the capacity of Bulgarian EO oriented authorities with regards to INSPIRE implementation, GEO participation, etc. towards creation of national Space policy and inclusion of industry partners	Improve EO data exploitation and information services	Capacity building and awareness Activities	
	Establishment of national repository for Sentinel-1/2 data targeted at creation of products aimed at better regional and local policy in agriculture and water management	Improve EO data exploitation and information services	Capacity building	
Cyprus	Establish an integrated EO and modelling system for the real time monitoring and forecast of dust transport with a special focus on the provision of user specific information in SE Europe, N Africa and the Middle East	Climate Change Adaptation	Operational services / Capacity building / Awareness activities	Quick-wins (2years)
	Monitoring of ground deformation /stability in the under restoration of the Asbestos Mine.	Raw Materials	Operational services, capacity building, and awareness activity	Quick-wins (2 years)
	Environmental Monitoring of the operating Skourriotissa Mine that it is coming to its closure - Skourriotissa Village	Raw materials	Operational service	Quick-wins (2 years)
	Prospecting secondary minerals from the Kokkinopezoula abandoned mine - Mitsero Village	Raw materials	Operational service	Quick-wins (2 years)
Egypt	Long-term analysis of ENSO (El Niño Southern Oscillation) relation with climate change and its impact on the crop yield	Climate change and crop yield production	Capacity building and awareness activity	Quick-wins

	production in Egypt using high performance computing approaches			
	Spatial and temporal variability of aerosols over delta region	Climate change	Operational services	Quick-wins (2 years)
	Awareness of the value of earth observation operational services	ALL	Awareness activities	Quick-wins (one year)
	Development of the solar atlas of Egypt and a -state-of-the-art nowcast system of solar radiation to assist energy planning, distribution and efficient photovoltaic installations from available sources (remote-sensing, Copernicus atmosphere monitoring service, etc)	Energy	Operational services and climatologically services	Quick-wins (2years)
Greece	Applying soil spectroscopy for precision agriculture	Food security	Operational services/capacity building/awareness activity	Quick-wins (1 year)
	Development and evolution of a nowcast and forecast system of spectral solar radiation to assist energy planning, distribution and application from available sources (remote-sensing, Copernicus atmosphere monitoring service, etc) in real-time	Energy	Operational services, capacity building, and awareness activity	Quick-wins (2 years)
	Climate change impacts with the aid of Essential Climate Variables (ECVs) and climate indices within the frame of regional scale projections of future climate.	Climate change	Operational services/capacity building/awareness activity	Quick-wins (2 years)
	Establish an integrated EO and modelling system for the real time monitoring and forecast of dust transport with a special focus on the provision of user specific information in SE Europe, N Africa and the Middle East	Climate change adaptation	Operational services/capacity building/awareness activity	Quick-wins (2 years)
	Development of Monitoring Service for Illegal Quarrying	Raw Materials	Operational services, capacity building, and awareness activity	Quick-wins (3-4 years)

	Environmental Monitoring of Ayios Filippos Abandoned Public Mine of Mixed Sulphide Ores – Kirki Village (North Greece)	Raw materials	Operational service	Quick-wins (2 years)
Israel	Monitoring of planted forests in semi-arid climate and assess their environmental impact using Sentinel-2	Food security and climate change	Operational services and awareness activity	Quick-wins (1 year)
	Mapping wheat and corn fields for evaluating their state of stress using hyperspectral imaging spectroscopy	Food security	Operational services and awareness activity	Quick-wins (1 year)
	Monitoring oil contamination - Land and water	Food security	Operational services and awareness activity	Quick-wins (1 year)
Romania	Development of a European HSRL airborne facility (MULTIPLY)	Climate change	Capacity building and operational services	Quick-wins (3 years) 2014-2017
	Romanian Cluster for Earth Observation	Climate change	Support strategy	Quick-wins
Saudi Arabia	Natural and Anthropogenic Aerosols Transport over the Arabian Gulf	Climate change	Air quality analysis	
	Long Range transport of dust across the Middle East and the Gulf region and its impact on the marine environment	Climate change	Dust storms activity	
	Studying Air Quality Dynamics using Remotely Sensed Atmospheric Parameters	Climate change	Dust Deposition , Remote sensing, Cloud Properties	
Serbia	Demystifying model data for better adaptation - DeMA	Climate change adaptation	Capacity building	
	LandSense (A citizen observatory and innovation marketplace for land use and land cover monitoring). Demonstration case: Monitoring agricultural land use and provision of value-added agricultural services	Food security	Product development: defining end user needs, product development, testing and validation in an operational environment	
Tunisia	Olive tree health monitoring based on remote sensing observation	Food security and access to raw materials	Operational services	Quick-wins (1 year)
	Mix IOT metrological data with satellite Imagery to determine best site for solar electricity production in high growth socio-economic area AND produce energy predictions	Energy	Operational services, capacity building, and awareness activity	Quick-wins (3 years)

	Rivers floods data mining, early state detection, prevision and modelling with the use of big data, BI, imagery and IOT systems.	Climate change	Operational services, capacity building, and awareness activity	Quick-wins (2 years)
	Inventory of forests by remote sensing INFOTEL	Food security and adaptation to climate change	Cartography (Land use and others) Geometrics, Statistics Forestry	Quick-wins (2 years)
Turkey	Determination of Crop Types in Southern Eastern Anatolia Region of Turkey with Sentinel-1 and Sentinel-2 Imagery	Improved food security	Operational services, capacity building, and awareness activity	Quick-wins (1year)
	Monitoring of Crop Development and Water Stress with Drones Using Multispectral and Thermal Sensor Data Fusion	Improved Food Security and water resource management	Operational services, capacity building, and awareness activity	Quick-wins (1year)
	Classification of Forest Areas Using Remote Sensing Techniques	Adaptation to Climate Change	Operational services, capacity building, and awareness activity	Quick-wins (1year)

5 Country-specification plan

5.1 Considerations and approach

Drawing on end user needs, identified gaps, country maturity indicators as well as country proposals, this section aims to investigate the national priorities for each country – present in the RoI and part of GEO-CRADLE project. To that end, we devised a "National Priority Framework" which is a conceptual framework setting out the aspects to be considered while analyzing priorities. It entails five dimensions: Relevance, Impact, Feasibility, Sustainability, and Synergy with GEO/Copernicus; Details about the framework will be given in the section 5.2.1. This is shown in Figure 4.

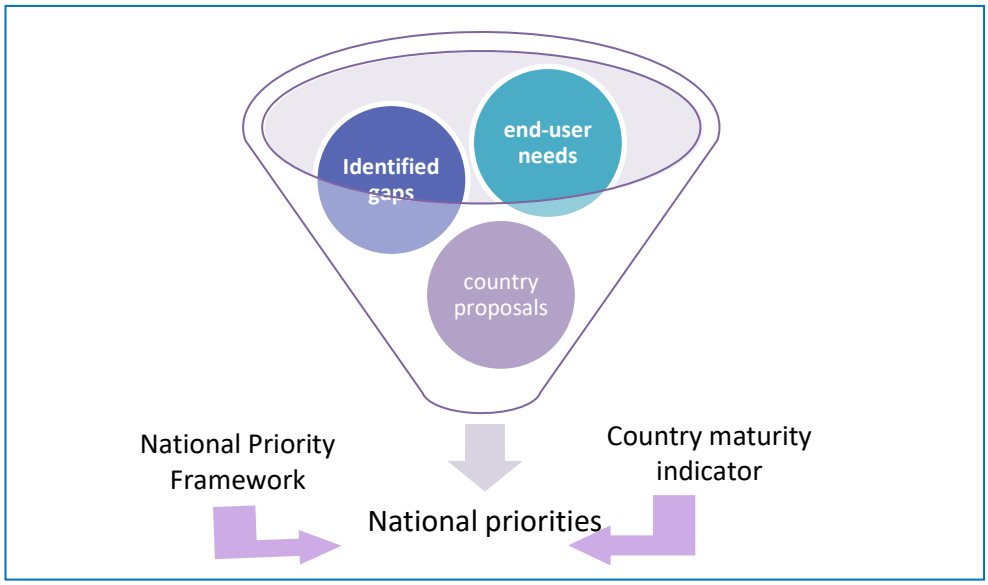

Figure 4: Inputs of national priorities

5.1.1 Considerations

Given that national priorities action plans lay their foundations on the EO capacities, end user needs, the gap analysis, and country maturity indicators, action plans are not deemed exhaustive. In fact, they are set to highlight the priorities expressed implicitly or explicitly by EO stakeholders through various means: surveys, interviews and country demand.

When it comes to identify the priority actions, it is important to distinguish between thematic action and support action. The latter will look at a multitude of dimensions obstructing the priority areas to achieve their objectives regardless of the theme involved, while the former will be drawn on a collection of national projects collected from the RoI (North Africa, Middle East, and Balkans) as part of project activities.

5.1.2 Priority framework criteria

The priority framework is underpinned by 5 constituent categories: Relevance, Impact, Feasibility Sustainability, and synergy with GEO and Copernicus. Each category is further divided into criteria, as shown in Table 7:

- **Relevance:** specifies whether the project is relevant to the thematic areas of interest and needs of end users. Also, it explores the extent to which a project could become visible and attract strong interest of the decision makers, and/or receive the strong political interest in the countries in which it runs.
- **Impact**: covers the aspects related to the magnitude and the degree of impact for addressing the challenge. Beyond this, the speed of implementation and the replicability & scalability are also highlighted.
- **Feasibility:** highlights legal aspects and the technological and scientific capacities needed to support the successful achievement of the project within the specified timeframe.
- **Sustainability:** In addition to that, the sustainability is of paramount importance for the success of the project. Finance to develop geo-information services is an issue for EO stakeholders, this criteria considers the funding, the investment opportunities and market uptake.
- **Synergy with GEO and Copernicus**: It identifies the areas of intersection with the existing initiatives, particularly GEOSS and COPERNICUS.

Table 7 displays each priority criterion that is proposed to investigate the priorities and formulate later on the national priorities action plan.

Table 7: National priority framework

Criterion	Sub-criteria	Description
RELEVANCE	**Links with end user needs**	- Does the project meet specific end user requirements that have been promoted as common in the region according to the results of T2.4?
	Contribution to solving gaps	- Does the project contribute to solving identified gaps?
	Visibility	- Has the project any chances to become visible and by this attract the strong interest of the decision makers, and/or receive strong political interest?

IMPACT	**Magnitude**	- What is the magnitude of the project's impact on addressing the challenge?
	Replicability and Scalability	- How easy is it to replicate the same pilot project and how easily can it be scaled to a national or even regional level.
	Speed of implementation	- How long will it take for the design, implementation and realization of the project's impact?
	Adverse effect	- What is the magnitude of negative impact?
FEASIBILITY	**Time constraints**	- Is the project feasible from timeline perspective?
	Capacity& skills	- Is there adequate capacity and skills to plan, implement, and monitor the solution within the timeframe of GEO-CRADLE project?
	Additional factors	- What are additional factors that may impede the implementation of the solution?
SUSTAINABILITY	**Funding**	- Will the government and partners be able to maintain the solution over the medium and long term? - Will additional funding be required for the pilot project to continue?
	Market uptake	- Does the project showcase the possibility for EO market uptake in the thematic area it treats?
	Investment opportunities	- Could the potential project be a starting point or linked with existing or future investments, towards and beyond the implementation of GEO, GEOSS activities?
SYNERGY WITH GEO & COPERNICUS	**Synergy with GEO and Copernicus**	- Does the project make use of existing GEO and Copernicus infrastructures, and data, and/or core products and services?
	Contribution to GEOSS initiative	- How is the project expected to contribute to the advancement of the RDH and the GEOSS portal by making available datasets and relevant metadata?

GEO-CRADLE partners were asked to submit their proposals, according to the project sheet depicted in Table 5, along with the priority criteria matrix.

5.2 Albania

5.2.1 Overview of proposals

Only one proposal was submitted by the representative partner; it is a support action that encompasses both capacity building and awareness activities.

Table 8: Albania project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Establishing and implementing the Government Standards on Technical Specification for Geospatial Information in Albania	All	Capacity building Awareness activities		

5.2.2 Support actions

Implementation of the Government Standards for Geospatial Information in Albania

The project consists of the implementation of the Government Standards for Geospatial Information in Albania for the benefit of State Authority for Geospatial Information (ASIG). The expected outcome of the project is to learn from best practices on how to control the data conformity to the standards and improve the methodologies. The stages for implementation include: (1) Creation of the conceptual model of standards in accordance with the Inspire Directive; (2) Implementation of standards; (3) Harmonization of geospatial data; (4) Control of conformity to standards; and finally (5) Institutional awareness on the implementation of the project.

Maintain and support infrastructure

In the gap analysis, it was mentioned that an in-situ network operated by a public institute was offline due to financing issues. This strongly advocates the priority of maintaining necessary infrastructure to operate, manage, deploy, and support needed EO services/applications in a cost effective way.

5.3 Bulgaria

5.3.1 Overview of proposals

Two proposals were received from the country partner, one is intended for Bulgarian EO capacity building and the other targets awareness activities. No information on the timeline is provided.

Table 9: Bulgaria project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Improving the capacity of Bulgarian EO oriented authorities with regards to INSPIRE implementation, GEO participation, etc. towards creation of national Space policy and inclusion of industry partners	All	Capacity building Awareness activity		
Establishment of national repository for **Sentinel-1/2 data targeted at creation of products aimed at better regional and local policy in agriculture and water management**	All	Awareness activity		

5.3.2 Support actions

Improving the capacity of Bulgarian EO oriented authorities towards creation of national Space policy and inclusion of industry partners

One of the main obstacles for wide adoption of EO data and resulting services in Bulgaria is the lack of National policy for EO data exploitation by the industry, government and academia. Presently an inter-ministerial commission is in charge of coordinating space EO activities. The objective of this project is to consolidate into one unit and to reinforce the capacities available in the administrations having as final target to form an improved capacity in the area of EO management and provision. Other goal that will be achieved is that the public sector – industry, educational units, etc. – will be provided with one reliable source of data in the area of geo sciences. Currently there is a gap in the administration, industry and education concerning the possibilities offered by initiatives such as GEOSS or INSPIRE. In the dissemination activities foreseen strong emphasis is put on demonstration at different levels of the opportunities presented by the availability of data and software with open licenses provided under the Copernicus program. As stated by the ESA officials the accumulated benefits of the Copernicus program between 2014 and 2021 will amount to nine billion Euros and 15,500 new full-time jobs have already been created.

Establishment of national repository for Sentinel-1/2 data targeted at creation of products aimed at better regional and local policy in agriculture and water management

The potential of the data provided by the operational EO satellites Sentinel-1A/B and Sentinel-2A run by Copernicus program is under exponential expansion. Those data are distributed under open license giving the research community and industry more possibility to obtain validated high quality products for large areas in Bulgaria from different sensors which complement each other. Normally those products can be downloaded from the official repositories maintained by ESA, one of them being the Scientific Data Hub. In most cases, users from Bulgaria request data concerning the region of the country and this why a copy of those data and derived products if kept in national repository would decrease the time needed to access them. This issue will be perceived more tangibly in the future as the number of Sentinel missions increases. This provides grounds for establishing national mirror for Sentinel data and derived products offering industry, academia and other potential users reliable and fast access to them.

5.4 Cyprus

5.4.1 Overview of proposals

As shown in Table 10, four project proposals were received from Cyprus; one is a regional project for climate change and three national projects dealing with the raw materials theme. The projects' types are operational services with a 24 month timeframe.

Table 10: Cyprus project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Establish an integrated EO and modelling system for the real time monitoring and forecast of dust transport with a special focus on the provision of user specific information in SE Europe, N Africa and the Middle East	Climate change	Operational service	Quick wins (2 years)	To be included in regional projects
Monitoring of ground deformation /stability in the under restoration of an Asbestos Mine.	Raw materials	Operational service	Quick wins (2 years)	
Environmental Monitoring of the operating Skourriotissa Mine that it is approaching closure - Skourriotissa Village	Raw materials	Operational service	Quick wins (2 years)	
Prospecting secondary	Raw materials	Operational service	Quick wins	

minerals from the Kokkinopezoula abandoned mine - Mitsero Village			(2 years)	

5.4.2 Support actions

According to the country maturity assessments, Cyprus is rated intermediate similar to Tunisia and Egypt. This calls for the implementation of similar support actions proposed for Tunisia and Egypt, namely improvement of data policy and human capacity building in data analysis and processing as well as GIS.

5.4.3 Thematic actions

Monitoring of ground deformation /stability in the under restoration of the Asbestos Mine

The project proposal falls under the access to raw materials thematic area and aims to establish efficient and consistent monitoring processes to assess the stability of reprofiled waste dumps in an Asbestos mine, under restoration, and take the necessary measures, if needed, in order to handle environmental pollution and possible subsidence/landslides.

The objective of the project is to identify any environmental impacts from the piles of materials such as pollution and possible subsidence / landslides. This information **need was expressed by Cypriot end users in interviews** conducted as a part of the GEO-CRADLE project. The main stakeholders to be involved in the proposal are GSD, CUT, Ministry of Agriculture, Rural Development and Environment, and EGS. The main stakeholders are GSD, CUT, Ministry of Agriculture, Rural Development and Environment, and EGS. Restoration of abandoned mines has a large **impact**. It will allow for waste dumps to be secured from possible landslides, and it will allow for environmental rehabilitation. The use of EO techniques to identify possible instabilities in the waste dumps enables mitigation measures to be taken in order to prevent any disaster caused by a landslide.

The feasibility study of the project will run for 2 years and the realization of the pilot will be achieved after 3-4 years of succeeding funding. By using space-borne and in-situ data of the Geological Survey, the project will evaluate the stability of the rehabilitation works at the Asbestos mine that were carried out so far and any environmental pollution in the surrounding area. If any instabilities are identified, they shall be faced to prevent any landslides or other instabilities and take into account the findings and incorporate them in the ongoing and future rehabilitation works. The achievement

of the project relies on the availability of space-borne and in-situ data as well as the availability of Geologists, GIS experts, Modelers, and In SAR software.

As for **sustainability**, the project's author stressed that the product of the project will be a service that will be able to run in the long term, but the initial development of the project will require funding. No information on estimated budget was given. Also, no information on the use of existing **GEO and Copernicus** infrastructures, data, and/or core products and services was provided, but the contribution to GEOSS can be done through the availability of know-how and relevant software.

Environmental Monitoring of the operating Skourriotissa Mine

Similar to previous project, the second proposal falls under the access to raw materials thematic area and aims to achieve environmental monitoring of an operating mine, called Skourriotissa, which is near closure. The project aims to identify the mineralogy of the waste dumps using EO techniques and to produce a prospect map for secondary minerals. This information need was highlighted by Cypriot end users in interviews. Involved stakeholders are GSD, CUT, Ministry of Agriculture, Rural Development and Environment, and EGS.

The project will have a great **impact**: it will help assess the environmental impacts (pollution and subsidence) and propose measures for the proper closure and rehabilitation of the surrounding environment. Thus it will improve the quality of life of citizens in nearby region. Space-born data, if available, will be used to assess the existing field data and develop a protocol for the restoration and closure of the mine preventing any environmental pollution of the surrounding area. The project results rely on the availability of space-borne and in-situ data as well as the availability of Geologists, GIS experts, Modellers, and In SAR software. For **sustainability** and **synergy with Copernicus/GEO**, the same information as first proposal was supplied.

Prospecting secondary minerals from the Kokkinopezoula abandoned mine - Mitsero Village

In continuity with previous proposal, the third proposal aims to identify the mineralogy of the waste dumps with possible recovery of secondary minerals. The project aims to identify the mineralogy of the waste dumps (low grade ore versus waste material) and produce a prospect map for secondary minerals. The main stakeholders are same as for previous proposals.

From the **impact** perspective, the project will help assess the mineralogy of the waste dumps and evaluate the possibility of recovery of secondary minerals with the parallel restoration of the abandoned mine. The produced prospect map for secondary minerals will be used in association of other data to calculate the exploitable volume for secondary minerals.

For the case of Kokkinopezoula, space-borne data, if provided, will be used to map the waste dumps and abandoned mine and their stability. Based on the mapping an exploration program will be carried out in order to evaluate the potential re-opening of the mine for exploitation for both primary and secondary mineral resources with parallel environmental restoration. The realization of the project relies on the availability of space-borne and in-situ data as well as the availability of Geologists, GIS experts, Modellers, and In SAR software. Also, the same information as for the other proposals was provided for **sustainability** and **synergy with Copernicus** and **GEO**.

5.5 Egypt

5.5.1 Overview of proposals

Four proposals were received from Egypt, two of which focus on adaptation to climate change, one deals with Access to Energy and one is a support action in relation to all the thematic priorities. All projects received are quick-wins with a timescale varying from 1 to 2 years.

Table 11: Egypt project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Long-term analysis of ENSO relation with climate change and its impact on the crop yield production in Egypt using high performance computing approaches	Climate change and crop yield production	Capacity building and awareness activity		
Spatial and temporal variability of aerosols over the delta region	Climate change	Operational services	Quick wins (2 years)	
Awareness of the value of EO operational services	ALL	Awareness activities	Quick wins (one year)	
Development of the solar atlas of Egypt and a-state-of-the-art now cast system of solar radiation to assist energy planning, distribution and efficient	Energy	Operational services	Quick wins (2years)	

photovoltaic installations from available sources (remote-sensing, Copernicus atmosphere monitoring service, etc)				

5.5.2 Support actions

Update of the legislation that governs EO

Egypt has large capacities, as stated in the gap analysis report, which are hampered by structural gaps. This is mainly caused by outdated rules and legislation that obstruct the use and development of geo-information data within the public sector. It becomes, thus, vital to update the legislation background that governs EO to improve the inter-departmental cooperation between ministries and support the economic growth.

Generate awareness on the value of Earth observations among decision makers

Decision makers and users tend to get lost in the myriad of options that EO seems to offer and do not have a clear insight on how EO can help them solve their problems, as perceived in surveys. Raising awareness about the potential of observation is therefore needed. Communication campaigns could be an interesting tool to gain knowledge about the beneficial value of EO products/services.

Open and free data hub

End user interviewees from Egypt reported poor quality of existing datasets (outdated data, wrong formats and wrong corrections on geographical locations) and the difficulty to access to data. Thus, Egypt would greatly benefit from using free and open data hub.

5.5.3 Thematic actions

Development of the solar atlas of Egypt and a state-of-the-art now cast system of solar radiation to assist energy planning, distribution and efficient photovoltaic installations

In light of efforts made by the Government of the Arab Republic of Egypt to achieve the desired economic growth while preserving the environment, the government tries to address the demand for energy efficiency through the use of renewable energy sources. Despite scarce data on energy in surveying and end user interviews, desk research and country demands revealed a strong push towards the use of renewable energy sources in Egypt like Near East North Africa countries, particularly solar energy. Towards this direction, the main objective of this project is the effective

dissemination of the high precision and resolution now casting and Atlas-based solar energy services for the **fulfilment of the local needs**. It will take advantage of the nowadays satellite data, efficient envision of new but crucial model inputs and state-of-the-art real time solar energy system capabilities. The main stakeholders involved are CEDARE, Alexandria University, Egyptian Meteorological Agency, Solar-energy-applications-related SMEs, Copernicus Atmosphere Monitoring Service and Meteosat operational data providers.

The project comes to fulfill the needs for optimum solar energy exploitation and for active and effective integration of innovative technologies to the national sustainable development economies and strategies. In terms of **impact**, the project will improve the local energy exploitation and it will increase the use of renewable energy sources, notably solar energy. This impact can be measured by the percentage contribution of the renewable sources to the total energy produced in Egypt.

From project's author point of view, the project is seen as **feasible** within 24 months as it will make use of the existing infrastructure of the pilot Solar Energy Nowcasting SystEm (SENSE) and tailor it to the user needs of private photovoltaic initiatives and the Egyptian Ministry of Electricity and Renewable Energy. SENSE is capable of producing maps of spectrally-integrated irradiances of the order of 10^4 to 10^5 pixels within 1 minute and hence provides the capability needed to serve high precision solar power applications for energy planning. Supplementary to the real-time services, a method for the development of Solar Atlases based on climatologically radiation data from EUMETSAT's Satellite Application Facility on Climate Monitoring (CM SAF) will be applied.

The project has a strong chance to be **sustained** as long as the Egypt Government supports the use of renewable energy sources and renewable penetration to the Egyptian energy market is being sought. The total budget is estimated at 600.000 Euro and possible sources of financing include EU, private sector relative to renewable, US and World Bank. As noted in the project sheet, Copernicus Atmosphere Monitoring Operational Service and Data and Meteosat Data will be used. The project will be a starting point for energy related short future investments towards and beyond the implementation of GEO, GEOSS and Copernicus Energy activities. The project aims to contribute to GEOSS through the availability of multiple products dealing with energy, health fields, etc.

Long Term Analysis of ENSO relation with Climate Change and its Impact on the Crop Yield Production in Egypt Using High Performance Computing Approaches

Climate change and variability in the early 21st century proved to be a high threat with great impacts on agriculture and food sectors as well as natural ecosystems, due to the exacerbated increase in temperature. This would have a direct impact on the Egyptian economy, since the agriculture sector in Egypt contributes 14.5% of the gross domestic product (GDP) and provides28% of all jobs, yet still shows a significant future potential for expansion with the government's plan of increasing farmland area by 20% through reclaiming 6300 km² (1.5 Million feddans) in five years.

The project proposes to investigate the response of agricultural ecosystems and crop productions in the Egyptian territories to climate variability and change and associated extreme weather events utilizing an array of Big Data analysis techniques, numerical simulations and predictive models using high performance computing. The **relevance** of such a study was quoted in the geo-information needs defined by end users. Main stakeholders involved in the project are experts on climate model data, Ministry of Agriculture, data providers.

The project consist of studying the link between extreme weather events driven by El Niño and/or La Niña and the changing climate over the Delta region to forecast future impact on crop yield production as a crucial sector. It will accomplish this by providing a transferrable end-to-end system based on observations, models and computational technologies. Accordingly, the project is **feasible** when expertise on climate and crop modelling, computational tools, HPC, IT infrastructure for web and application development are there.

In terms of **impact**, the proposed study will expand the domain knowledge by providing essential information, on risk management, to the agriculture and food industry on major crop types, of economic values such as wheat, facing extreme climate and water resources conditions in Egypt. The respondent proposes to measure the project impact by the increased use of the proposed forecasts and through published research and reports.

The project has strong chance to be **sustained** as long as the Government supports the use of renewable energy sources. The budget estimated for such a study is about 600.000 EUR and possible financing sources include EU, World Bank, UN. The priority matrix did not provide information on how the project will make use of existing GEO and Copernicus infrastructures, and data, and/or core products and services and what the contribution to GEOSS looks like.

Spatial and Temporal variability of aerosols over the delta region

The changing of climate is becoming a fact that is driven by the population growth and other human impacts of pollution sources. The availability of free satellite data and open source models could be a good enabler to spatially map the variability of the climate and its impact on human health. The project will meet one of thematic priority areas, which is variability from climate change. It aims to provide an operational system that could generate regular maps of the air quality and aerosols within the territory of Cairo and Nile Delta. This kind of application is **relevant** to the application of remotely sensed data and models for understanding the aerosols and its relation with the air quality that negatively impacts human health. CEDARE, NARSS, Alexandria University, Egyptian Meteorological Agency are the main stakeholders.

As regards **feasibility**, the project will span over 24 months and risks such as limited qualified human resources capable to run the model, unavailability of the streamline of the data or limited in-situ data for validation have to be analyzed beforehand, to avoid any time delays or a budget overrun. According to the project description, there will be a positive **impact** on the environment agency since end user and decision makers are in need for regular maps of the air quality in Cairo. There will not be any negative impact. No information on the use of existing **GEO** and **Copernicus** infrastructures, data, and/or core products/services as well as the contribution to GEOSS, though the priority matrix confirmed that.

5.6 FYROM

No proposals associated to the thematic priority areas were submitted by the country partner. Also it is hard to derive priorities from end user interviews, as they are highlighting Geo-information data (sources, quality, format, cost), rather that EO services and products in need.

5.6.1 Support actions

In regards to common support actions, two priorities have to be looked for:

(1) the need for improvement of the observational capacities, and

(2) the need for integrating complementary existing digital databases (like, Real Estate Agency database, Soil Information System database), harmonize them in alignment with the INSPIRE Directive, and improve their visibility to end users.

5.7 Greece

5.7.1 Overview of proposals

As depicted in Table 12, 6 project proposals were submitted by Greece, two of which focus on climate change, two on access to raw materials, one on Access to Energy and on food security. The projects are operational services with a 24 month time frame. In addition to these proposals two more priorities are inferred from the gap analysis.

Table 12: Greece project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Applying soil spectroscopy for precision agriculture	Food security	Operational services/capacity building/awareness activity	Quick wins	
Development and evolution of a now cast and forecast system of spectral solar radiation to assist energy planning, distribution and application from available sources (remote-sensing, Copernicus atmosphere monitoring service, etc) in real-time	Energy	Operational services	Quick wins (2years)	
Climate change impacts with the aid of Essential Climate Variables (ECVs) and climate indices within the frame of regional scale projections of future climate.	Climate change	capacity building/awareness activity	Quick wins (2 years)	
Establish an integrated EO and modelling system for the real time monitoring and forecast of dust transport with a special focus on the provision of user specific information in SE Europe, N Africa and the Middle East	Climate change	Operational services/capacity building/awareness activity	Quick wins (2 years)	To be included in regional projects
Development of Monitoring Service for Illegal Quarrying	Raw materials	Operational service	2 years	
Environmental Monitoring of Ayios Filippos Abandoned Public Mine of Mixed Sulphide Ores – Kirki Village (North Greece)	Raw materials	Operational service	2 years	To be included in regional projects

5.7.2 Support actions

Engage in stakeholder-driven open data innovation

Given the good balance between private and public sectors in Greece, engaging in stakeholder-driven open data innovation is likely to showcase diverse benefits by encouraging innovations for collection, exploitation, and wider use of EOs based on improved availability of open data, including new applications, new services, citizen science, and crowd sourcing.

Most interviewees have sensed the opportunity and feel that the government should strengthen the dissemination and availability of EO data to potential end users by establishing a transparent and user friendly interface with key contact points for different market sectors. However, without government support and environment conducive to fostering entrepreneurial activity (like helping the agriculture cooperatives promote their products externally), innovation cannot take place and the economic returns from EO market are likely to remain unattractive.

Raise awareness & know-how

Raise awareness and know-how regarding the use of EO for Environment and Agriculture. As expected, end users have little knowledge of geo-information data and its potential, thus targeted awareness campaigns and greater support should be offered to them by either private or governmental bodies. A Greek company also suggested that the "*state should strengthen the dissemination and availability of EO data to the potential end users by establishing a transparent and user friendly interface with key contact points for different market sectors*".

Climate change impacts with the aid of Essential Climate Variables (ECVs) and climate indices within the frame of regional scale projections of future climate

Tourism and agricultural sectors in Greece are considered as key elements of the national economy, accounting for 15.2% and 3.9% of the country's GDP, respectively. Additionally, natural hazards have significant implications on human health, national economy and private investors such as insurance companies, across all lines of business (health, life, property). The National Bank of Greece estimated that the total economic damage due to climate change will be 701 billion Euros by the year 2100, if the global greenhouse emission rates remain the same (rcp85). The awareness of the potential impacts of climate change on the abovementioned activities is critical in the direction of policy decision making and strategies.

5.7.3 Thematic actions

Development and evolution of a now cast and forecast system of spectral solar radiation to assist energy planning, distribution and application from available sources in real-time

Greece has large solar energy potential and its exploitation is critical for sustainable development of the country. The current solar energy EO capacities in Greece are degraded and, as a result, this field needs a complete and comprehensive revision and promotion in order to be established as a main contributor to national portfolios. The proposed project meets needs to increase the efficiency of solar energy exploitation, and to actively and effectively integrate these technologies into a national sustainable development strategy. The objectives of this project are: **(1)** Effective dissemination of the high precision and resolution now casting and forecasting solar energy services for the fulfilment of the local and regional needs, by taking advantage of the nowadays satellite data, efficient envision of new but crucial model inputs and state-of-the-art real time solar energy calculating system capabilities; **(2)** Development of reliable, high resolution solar atlases and broader climatology studies for Greece; and **(3)** Engraving strategy methods of how to integrate such a solar energy now casting system into a wider GEOSS driven system in the local and international scale, making the whole effort of this project ''a possession for all time.''

The potential **impacts** of this project concern the entire Greek population as dependent end users of renewable energy. It will improve the local and regional energy planning and it will increase the use of renewable. This impact can be measured by the percentage contribution of the renewable sources to the total energy produced in Greece. Main beneficiaries of the project are Public Electric Power Transmission Operator, Ministry of Electricity and Renewable Energy, solar energy investors and health protection sector. From respondent's point of view, the project is **feasible** within 24 months because it will make use of existing infrastructure from the SENSE pilot and the SOLEA applications (www.solea.gr), both tailored to the user needs of private photovoltaic initiatives and the independent power transmission operator of Greece (www.admie.gr). Further information on SENSE pilot project can be found in Section 5.3.3.

The project has a strong chance to be **sustained** as long as the government supports renewable penetration to the national energy market. The total budget is estimated at 300.000 EUR and possible sources of financing include the EU and private sector relative to renewable. The project will make use of **Copernicus** Atmosphere Monitoring Operational Service and Data, Meteosat Data,

expertise on radiative transfer modelling and neural networks, IT infrastructure for applications development. It aims to contribute to **GEOSS** through the availability of multiple products dealing with different fields, such as energy, health fields, etc.

5.8 Israel

5.8.1 Overview of proposals

As shown in the Table 13, 3 project proposals were collected from Israel, two of which are devoted to Food security and the other one on Access to energy. The projects are operational services with 9 months' timeframe.

Table 13: Israel project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Monitoring of planted forests in semi-arid climate and assess their environmental impact using Sentinel-2	Food security and climate change	Operational services and awareness activity	Quick-wins	
Mapping wheat and corn fields for evaluating their state of stress using hyper spectral imaging spectroscopy	Food security	Operational services and awareness activity	Quick-wins	
Monitoring oil contamination - Land and water	Food security	Operational services and awareness activity	Quick-wins	

5.8.2 Support actions

It was mentioned earlier that Israel is an advanced country, and given that end user needs is lacking in the report, we were not able to infer the support actions needed. However, we believe that international cooperation is key for sharing know-how.

5.8.3 Thematic actions

Monitoring of planted forests in semi-arid climate and assess their environmental impact using Sentinel-2 data

In the past decades, scientists come to a conclusion that our world is changing due to climate change which is affected by two main factors: the amount of greenhouse gasses which is released to the atmosphere (in both natural and anthropogenic processes), and the greenhouse gasses absorption capacity (in this case, forests). Natural forests thrive in tropical, Mediterranean and temperate climates where sufficient rainfall exists for maintaining the forest ecosystem, compared to a semi-arid climate zone.

The project will monitor and evaluate the impact of planted forest on the micro (inside the forest) and macro (the entire forest and its surroundings) scales in semi-arid climates with the objective of evaluating the effect of forests on climate characteristics. In addition, it will assist environmental planners and decision-makers for proper planning and integrating planted forests with residential areas in semi-arid climates.

The expected outcome is a map of the forest's regional impact on the climate. This map is seen to be **relevant**, as it will provide good integration of knowledge among decision-makers. Main stakeholders are the Israel Ministry of Environmental Protection and universities. The project will run over 9 months and is seen to be **feasible**: the pre-requisites (Sentinel-2 images, and ENVI software) are available and data collection and field measurements are possible. According to the proposal's description, the project will make use of **Copernicus Sentinel-2**imagery; however, no information about the contribution to **GEOSS** was mentioned.

Mapping wheat and corn fields for evaluating their state of stress using hyperspectral imaging spectroscopy

Food security plays an important role at the beginning of the 21st century as human population grows at an exponential rate, in contrast to the linear growth rate of food production. The motivation for this project is to prevent a shortage in basic food such as wheat and corn. The project proposes to evaluate the impact of stress on the wheat and corn's agricultural fields and their productivity in order to prevent food shortage with the increasing world population. The expected outcome is a map of the agricultural fields where crops are in stress condition. As expressed in the interviews, this map is **relevant** to the end user needs, which is the Israel Ministry of Agriculture and farmers.

The proposed project will monitor the impact of environmental stress (climate, water shortage, soil) on the production of wheat and corn. Looking at the **impact**, the resultant map may supply farmers a

tool for monitoring the crops growth and evaluating the areas where additional care is needed regarding the crops in order to prevent a decline in their yield. The project will run over 9 months and is seen to be **feasible** since the pre-requisites (Sentinel-2, Landsat, drones, and ENVI software) are available and field spectrometer, soil and crops measurements are achievable. The project will make use of **Copernicus Sentinel-2** image; however, no information about the contribution's contribution to **GEOSS** was mentioned.

Monitoring oil contamination – Land and water

Soil and water oil contamination might result in an environmental catastrophe. Monitoring the impact of the contamination, cleaning procedures and their effect of the environment is a key factor for protecting the environment. The project will assess the environmental impact of oil contamination on land and water areas.

The expected outcome is a thematic map of the contaminated areas and the contamination progress using change detection methods, which is **relevant** to Israel Ministry of Environmental Protection and Ministry of National Infrastructures, Energy and Water Resources. The **impact** of the project will be significant on environmental protection and its sustainability.

The project's timeline is 9 months and is seen to be **feasible** since the pre-requisites (Sentinel-2, Landsat, drones, and ENVI software) are available and field spectrometer, soil and crops measurements are achievable. It will make use of **Copernicus Sentinel-2** image; however, no information about the contribution's contribution to **GEOSS** was mentioned as previous proposals.

5.9 Romania

5.9.1 Overview of proposals

2 project proposals were submitted by Romania. One project which deals with support-strategy was accepted, while the other was considered invalidated as it was already launched in October 2014 and expected to finish in 2017.

Table 14: Romania project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Romanian Cluster for Earth Observation	EO/Climate change	Support-strategy		
Development of a European HSRL airborne facility	EO/Climate change	Capacity building Operational services	Oct.2014 - Oct. 2017	Not validated

5.9.2 Support actions

Romanian Cluster for Earth Observation

Understanding the interactions and the changes in the atmosphere, water, soil and vegetation, as well as quantifying their impact on the Earth's climate system, requires multi-instrument and multi-disciplinary networking and long-term observations. In this respect, Romania has valuable assets that could be exploited, but lacks experience, self-confidence and efficiency. Except for the initiatives coordinated by, and involving the Romanian Space Agency directly, most of the contracts are narrow in scope and targeted, addressing the very exclusive expertise of one or two Romanian institutions. As such, multi-disciplinary and large activities remain inaccessible to Romanian actors. Insufficient access to information about existing capacities and expertise, coupled with a lack of tradition in collaboration has a negative impact on the investments as well, many institutions building (with significant costs) similar infrastructures, instead of sharing resources.

The overall scope of the project is to increase the capacity of Romanian organizations to contribute to ESA's EO programs and projects, by setting-up the Romanian Cluster for Earth Observation, a formal association of organizations, with its own statute and agenda. The main roles of the cluster are:(1) to promote (to ESA and other space-relevant organizations) the specific interests and relevant capacities at national level, and attract more investments and contracts for the Romanian institutions; (2) to improve the provision of services to end users by joining complementary skills and expertise; (3) to ensure the sustainability of the EO sector in Romania by enabling EO market development.

Romania's participation in EO programs can be optimized by creating a proper framework of collaboration between the different actors (space competence centers, universities, research institutes, private companies) in the EO field. By overcoming the fragmentation of the industry and promoting joint initiatives, it is foreseen that Romania will become an important player in EO activities in Europe, in the same time boosting the use of EO data in various economic sectors at national level. The RO-CEO project addresses this aspect specifically. Project success will be measured by achieving a critical mass of organizations participating in the Romanian Cluster for Earth Observation - at least one key player representing each aspect of the EO: atmosphere, water, land, vegetation, technology development, data treatment, data distribution, service provision.

5.10 Saudi Arabia

5.10.1 Overview of proposals

Table 15 shows three proposals received by the partner representing Saudi Arabia. All proposals are operational services in relation to adaptation to climate change.

Table 15: Saudi Arabia project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Natural and Anthropogenic Aerosols Transport over the Arabian Gulf	Climate change adaptation	Operational service Capacity building		
Long Range transport of dust across the Middle East and the Gulf region and its impact on the marine environment	Climate change adaptation	Operational service		
Studying Air Quality Dynamics using Remotely Sensed Atmospheric Parameters	Climate change adaptation	Operational service		

5.10.2 Thematic actions

Natural and Anthropogenic Aerosols Transport over the Arabian Gulf

Gulf Cooperation Council (GCC) countries are subjected to numerous dust storms along with local emissions and/or transported from biomass burning or industrial activities. A combination of these aerosols results in poor air quality and poses significant health hazards. The overall objective of the proposed research is to gain a comprehensive understanding of the aerosol sources, seasonality, trajectories, composition, properties, and impacts on the air quality, weather, and climate of the Arabian Gulf Region.

The **impact** of the project is large; According to the author of the proposal, current research will have an immediate and significant impact on the oil/petrochemical sector. This industry is affected by dust storms and they will be interested in modelling storms and analyzing dust nature. Saudi Health Ministry and the Presidency of Metrology and Environment will also be very interested in research outcomes as dust storms affects millions of people living in Saudi Arabia and the Arabian Gulf region.

Studying Air Quality Dynamics using Remotely Sensed Atmospheric Parameters

A dust storm is a meteorological phenomenon common on the great plains of North America, Arabian Peninsula and the Sahara Desert of northern Africa. Dust and sand storms start when wind carries sand particles from deserts, sand dunes, loose dirt and industrial pollution. The dust picked up in such a storm can be carried thousands of kilometers and can significantly reduce visibility, making travel impossible. On October 2009 a blinding sandstorm swept through Kuwait and parts of Saudi Arabia disrupting air traffic as well as oil exports. The storm raged for several hours. Visibility dropped to zero at the international airports in Riyadh, and in Kuwait. Drivers in both areas were forced to stop or slow down as the sand turned skies into an orange brown. Besides disrupting travel, sandstorms can cause respiratory problems for everybody. They can also damage power plants. In general, dust storms are a serious environmental hazard and are characterized by their dynamic behaviour as in no time particle size, distribution, and direction varies significantly.

The objective of the project is to have a clear understanding of dust storm distribution, trajectories and climatology over the Kingdom of Saudi Arabia and especially over the eastern provinces of the Kingdom. The study is expected to reveal a clear understanding on the complicated pattern of aerosol production and transport over the Kingdom of Saudi Arabia. It will also reveals cross correlations and correspondence between aerosol conditions in different cities of the Kingdom and other countries in the region. The relationship between water vapor and aerosols formation near the Saudi Arabian coastal cities will be also investigated. The main beneficiaries are the petrochemical sector, presidency of metrology and environment, and Saudi health ministry.

The project will make use of synergistic and integrated multi-sensor data from multiple missions (both passive and active remote sensing sensors), dust models and ground data to analyze dust storms and its impact over Kingdom of Saudi Arabia and its surroundings. The seasonal aerosol and cloud climatology and regional trend will be prepared over the study region, using daily aerosol data obtained from the Moderate Resolution Imaging Spectrum radiometer (MODIS) and other sensors, over the area under investigation starting from March 1st 2000 till present.

The study is expected to reveal a clear understanding on the complicated pattern of aerosol production and transport over the Kingdom of Saudi Arabia. It will also reveals cross correlations and correspondence between aerosol conditions in different cities of the Kingdom and other countries in the region. The relationship between water vapor and aerosols formation near the Saudi Arabia coastal cities will be investigated. The project will utilize the available ground data

AErosolROboticNETwork (AERONET) and Microtops to validate the space based observations. The climatology of dust transport path, trajectories, will be prepared over the Arabian Peninsula using Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) model.

5.11 Serbia

5.11.1 Overview of proposals

Two proposals were submitted by partners, one covers the food security topic, while the other the adaptation to climate change.

Table 16: Serbia project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Demystifying model data for better adaptation - DeMA	Climate change adaptation	Capacity building		
LandSense (A citizen observatory and innovation marketplace for land use and land cover monitoring), Demonstration case: Monitoring agricultural land use and provision of value-added agricultural services	Food security	Product development: defining end user needs, product development, testing and validation in an operational environment		

5.11.2 Support actions

Results from the gap analysis stress the need to generate public awareness of climate change and sustainability. In fact, some climate change mitigation strategies and plans are not well understood by the general public in Serbia. In this direction, a common support action was proposed to cope with capacity building in the climate change theme.

Demystifying model data for better adaptation - DeMA

Climate model data is crucial in the adaptation planning process. Even though climate data is used for this purpose for many years, still many different actors involved in the planning process are not fully aware of all data aspects. For example, there are often confusions between climate projection and climate scenario, or between model error and model uncertainty, or misunderstanding when bias correction should be applied and when that is unnecessary, or what advantages of multi-model

ensemble are. One of the reasons for this is probably because this kind of knowledge was not a part of academic curriculum in the past, resulting in many actors involved in adaptation planning process with no formal education in this area. This kind of unawareness potentially can be a barrier to more widespread use of data.

In this direction, developing a set of online material and interactive tools which will help a broad range of actors in adaptation planning process to gain better understanding of data modelling, different methodologies related to data processing and analysis becomes a priority today. The expected outcomes of this priority action, as expressed by the author of the proposal, are (1) Better understanding of relevant topics related to climate modelling and data analyses without expertise and formal education in this field; (2) Closing the gap between data providers and potential data users; (3) Increased use of model data and appropriate derived data analyses; and (4) Improved quality of adaptation planning, thru more frequent use of relevant model data.

5.11.3 Thematic actions

LandSense (A citizen observatory and innovation marketplace for land use and land cover monitoring), Demonstration case: Monitoring agricultural land use and provision of value-added agricultural services

The objective of the project is to provide ground truth regarding land use and land cover in agriculture to increase the quality of satellite-derived data, and thus its potential value for the agriculture sector. The project is **relevant** to decision makers in agriculture and food production sector because it helps provide significantly more accurate and dynamic crop maps as well as better yield prediction. Targeted stakeholders are farmers, different users within PA4ALL (Precision Agriculture Living Lab), the MARS unit of the JRC, government bodies, European and national mapping/space agencies, agricultural research institutes, businesses related to agricultural production, fertilizers, pest and disease prevention, food processing industry, and SMEs.

The **impact**'s magnitude of the project is large; It will cover agricultural regions in Serbia, and Slovenia. Potential expansion to Brazil, through an existing farmer network via the CAP-BAN23 project of IIASA, is advocated. Furthermore, the project has Europe-wide dissemination efforts put in place throughout its lifetime; it is expected that it will roll out into several other European countries. As a long-term impact, the project will be a low-cost method for improvement of pixel-based

classification approaches in agriculture, and will provide significantly more precise information for policy making.

As regards **feasibility**, crowd sourcing of data requires particular mechanisms to be put in place to safeguard privacy and personal data. These safeguards are technically and procedurally in place for the product and the project. They will continually re-examined in accordance with EU standards on these issues. The project, which has currently started, builds off a previous proof of concept project conducted on the level of the province in Serbia. However, farmer uptake of technology and trust are considered major challenges to adoption. For that reason, the project will co-develop the solution in close cooperation with these end users. By design, it delivers free of charge data and thus value to their operations as an incentive for adoption. Other end user groups are also targeted to hedge risk: agroextension services, agroinput sales networks, etc.

Concerning **sustainability**, the project's author stressed that the solution will be maintained by the creator of the project. A sustainable business model has been already developed and will be refined and validated over the project timeframe. It is worth note that the project is making use of **Sentinel data** derived from the project and is projected to contribute to better quality products downstream that will contribute to **GEOSS** initiatives.

5.11.4 Candidate priorities

Forestry exploitation

One end user reported that is imperative to develop EO service to keep a steady supply of wood through re-growth, intelligent plantations and cuts, disease and stress warnings.

5.12 Tunisia

5.12.1 Overview of proposals

From Tunisia we received 4 proposals, two of which address more than one thematic areas, one deals with Access to energy and one focuses on Adaptation to climate change. All projects received are quick-win geo-information services with a timescale varying from 1 to 3 years and are capacity building and outreach activities, three of which include two more components.

Table 17: Tunisia project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Olive tree health monitoring based on remote sensing observation	Food security and access to raw materials	Operational services	Quick wins (1year)	Validated
Mix IoT metrological data with satellite imagery to determine the best location for solar electricity production in high growth socio-economic area AND energy yield predictions	Energy	Operational services, capacity building, and awareness activity	Quick wins (3years)	Not validated (the project is on ideation phase)
Rivers floods data mining, early state detection, prevision and modeling with the use of Big Data, BI, imagery and IoT systems.	Climate change	Operational services, capacity building, and awareness activity	Quick wins (2years)	Validated
Inventory of forests by remote sensing INFOTEL	Food security and adaptation to climate change	Operational service, capacity building		Validated

5.12.2 Support actions

Improve EO data access in terms of availability, affordability and usefulness

A critical issue fundamentally affecting the development of the EO sector in Tunisia is not so much the technology, rather it is data collection, accessing, and sharing. The conditions which govern access to the data, distribution of the data and the price of the data are not convenient for the exploitation of this important environmental data resource. For that reason, a data hub with open and free access is seen as a good opportunity to streamline access, use and sharing of data, strengthening the coordination between local entities, and integrating national data in a single portal; and will also decrease delays in data collection and use.

Human capacity building development in Agriculture sector

Qualitative and quantitative information provided by EO for agriculture needs special human capacity for acquiring, analyzing and interpreting the related data, as stated by end users. Hence, focused and concerted efforts towards strengthening national capacity of public institutions, including harmonization of methods and procedures, are highly needed for the uptake of EO market in the agricultural sector.

Public awareness of the national space strategy

Awareness of the national space strategy and program is almost evenly split for both cases between those that are aware and those that are not. A key strand of the EO long-term development is to engage with stakeholders and continue to build global awareness around the beneficial impact of continued EO development in the country, as well as the availability of open and free data.

5.12.3 Thematic actions

Health Tree Monitoring

The proposal attempts to contribute to the theme of food security, it consists of monitoring olive tree health and early detection of anomalies using optical remote sensing technique. The proposal involves the inversion of series of remote sensing measurements in order to retrieve the olive tree biophysical parameters and therefore monitor their health. Its originality is to rely on the physical modelling of optical remote sensing measurements. It is noteworthy to mention that due to the use of only physical parameters, such an approach is easier to be replicated than the empirical approaches, which are based on in-situ measurements of the biophysical parameters of interest.

As reported in the deliverable *D2.5: end user analysis report*, country like Tunisia was subjected in the past to water extremes with consequent adverse impacts and damages to crop production. This project will **contribute to end user needs' satisfaction** in the thematic areas of food security, particularly in protection of olive trees from diseases. The Tunisian government as well as farmers will be very interested in such a project since it will allow them to monitor olive tree health over a region or the country all along the year, and detect diseases at an early stage –therefore reducing the damage and ensuring food security. The main stakeholders to be considered are: the Ministry of Agriculture, oil industry and farmers.

In terms of **impact**, by contrast to the empirical approach based on ground truth measurement and free parameter fitting, the key idea of this project is to develop a physically based methodology dealing just with physical properties. Soil and trees are simulated using the 3-D model DART which links the tree biophysical features to the measured signal. Therefore, inverting remote sensing signal allows retrieving the corresponding biophysical properties. Consequently, it is possible to replicate the project to larger scales: national or even Mediterranean.

For project **feasibility**, the researchers of the Remote Sensing for Smart Agriculture (RSSA) Team from national school of ENIS are expert on radiative transfer direct and inverse modelling as well as on satellite processing, therefore it will be possible to plan, implement and monitor the solution within 9 months. Ground truth data should be taken over the studied area in order to detect unhealthy olive trees. This data are needed for approach validation. Satellite image series pre-processing (level 2-B) is also required before inversion. However, for each region, the structural and biophysical properties of every kind of olive trees and the different disease effects should be known. Different skills are needed: optical remote sensing, radiative transfer modelling, inversion techniques, image processing, IT development. Concerning the infrastructures, a desk and one personal computer core i7 are required.

The project can be **sustained** as long as the satellite sensors remain in activity. If one has to change sensors, new sensitivity analysis should be done and the different detection method parameters should be fitted to the new sensor properties. In terms of budget, image series could be free if we use Sentinel or Landsat sensors. However, higher resolution sensors are charging. Moreover, image pre-processing is required (level 2-B) and should be done by experts.

Inventory of forests by remote sensing INFOTEL

The benefits of a healthy forest resource are numerous and affect several sectors, including the production of timber and other products from existing forest species, the environment, biomass and its impact on carbon cycle and gas emissions, ecology, Ecotourism. Therefore, a rational management of this resource is of a paramount importance as it will protect this resource, guarantee a good exploitation, and address adaptation to climate change.

In Tunisia, the **forestry sector is very prominent**, not only because it was quoted by end users interviews, but because it affects several sectors, as was highlighted earlier. To date, the contributions of the forestry sector to sustainable development, either directly or indirectly, have not been precisely known by decision makers. They need to be consolidated by appropriate policy and adequate implementation strategy on the basis of good knowledge of forest resources. In this direction, the project aims to implement a methodology based on different technologies of sensing (optic and LIDAR) to monitor and assess forest resources. The main stakeholders to be considered include the General Direction of Forest, the Centre of Cartography and Remote Sensing, forest product investors, environmental sector, and tourism sector.

The proposed project aims to bring beneficial values to the forestry sector through the implementation of a new methodology based on the exploitation of multi-source, multi-sensor data to plan and support the national forest inventory for long-term monitoring of forest resources and better management of them. It will span over 24 months. In terms of **feasibility**, the project will be done by Tunisian research labs specialized in LIDAR technology, geology, etc. in collaboration with CNCT. The project will leverage on Tunisian skills to implement a methodology based on multi-sensor data (optic and Lidar) fusion to monitor and assess the forest resources. Two pilot sites were already identified in agreement with the General Direction of Forest for implementation of the methodology and extraction of remote sensing information needed within the given timeline.

The project can be **sustained** as long as the satellite sensors remain in activity. If one has to change sensors, new sensitivity analysis should be done and the different detection method parameters should be fitted to the new sensor properties. In terms of budget, image series could be free if we use Sentinel or Landsat sensors. However, higher resolution sensors are charging. Moreover, image pre-processing is required (level 2-B) and should be done by experts. It is worthwhile mentioning that the project intends to make use of biomass available for forest monitoring. The project aims to contribute to GEOSS by making in-situ measurement available.

5.12.4 Potential candidate actions

Potential candidate actions include, but not limited to:

- Mixing IoT metrological data with satellite Imagery to determine best site for solar electricity production in high growth socio-economic area AND produce energy generation predictions.

5.13 Turkey

5.13.1 Overview of proposals

Three proposals were submitted by Turkey; two of which focus on improved food security and water extremes, and one deals with climate change. All projects received are quick-wins with a timescale varying from 1 to 2 years, and are operational services with capacity building perspective.

Table 18: Turkey project proposals

Project name	Thematic areas	Project type	Timeline	Observation
Determination of Crop Types in Southern Eastern Anatolia Region of Turkey with Sentinel-1 and Sentinel-2 Imagery	Improved food security	Operational services, capacity building, and awareness activity	Quick wins (2years)	
Monitoring of Crop Development and Water Stress with Drones Using Multispectral and Thermal Sensor Data Fusion	Improved Food Security and water resource management	Operational services, capacity building, and awareness activity	Quick wins (2years)	
Classification of Forest Areas Using Remote Sensing Techniques	Adaptation to Climate Change	Operational services, capacity building, and awareness activity	Quick wins (1year)	

5.13.2 Thematic actions

Determination of crop types in Southern Eastern Anatolia, Turkey

In regards to food security, Turkey is a major agricultural producer. The country is suitable for the production of various products resulting from its climate and land. The share of the crop production in agricultural production is 73.5%, the share of wheat in grains is 67%. For that reason the Government sees crop production as a priority for food security and economic growth. The project deals with an important concern of the world, food security. It consists of developing remote sensing algorithms for crop mapping of wheat, corn and cotton in the Harran Plain. Continuously collected data by Sentinel-1 and Sentinel-2 satellites will be used to monitor the Harran Plain in Southern Eastern Region of Turkey where crops are irrigated with canals. The main stakeholders are Ministry of Development the Southeastern Anatolia Project (GAP) Regional Development Administration, the Ministry of Food Agriculture and Livestock, and General Directorate of Agricultural Reform.

The project is considered **feasible** in 12 months. It will be based on the on-going study with the beneficiary & stakeholder cited below, entitled Widespread Application of Sustainable Precision Agriculture Practices in South-eastern Anatolia Project Region (HASSAS) project. The project aims to study development of precision agriculture practice in South-eastern Anatolia Project region. Multi-spectral satellite imagery and aerial hyperspectral data along with ground measurements will be collected to analyze data in an information system. Project will study feasibility of precision agriculture application in a pilot area. TUBITAK UZAY has organized several meetings with officials

from the South-Eastern Anatolia Project Regional Development Administration and consensus was obtained through the implementation of a project “HASSAS” on precision agriculture and the promotion of sustainable applications in the region by means of EO and in-situ data.

As for **impact**, the project is a multi-sectorial and integrated regional development project based on the concept of sustainable development for people living in the South-Eastern Anatolia region of Turkey. Current activities under GAP include sectors such as agriculture and irrigation, hydroelectric power production, urban and rural infrastructure, forestry, education and health. Sustainable monitoring of crop fields will provide more accurate planning and estimation of yields. For replicability, there is another region we could implement this pilot project at the end: Republic of Turkey Ministry of Development Konya Plain Project (KOP) Regional Development Administration.

As noted earlier, the project will use Sentinel-1 and Sentinel-2 data to monitor crop production; however, the usage of existing **GEO** and **Copernicus** infrastructures, data, and/or core products and services will also be examined by the help & synergy with GEO-CRADLE partners.

Monitoring of Crop Development and Water Stress with Drones Using Multispectral and Thermal Sensor Data Fusion

The proposed project consists of monitoring crop development and water stress with drones using multispectra land thermal sensor data fusion. It is intended to be implemented in collaboration with TÜBİTAK UZAY Space Technologies Research Institute and Ankara University Faculty of Agriculture. The main objectives are the development of a data fusion methodology for monitoring water stress and collection of multi-temporal data at different phenological stages.

The project will be conducted for a one-year period. Data fusion of multispectral and thermal sensors on drone systems will be developed to monitor the crop development and water stress efficiently. Thus, pursuing efficient data fusion strategy will enable sustainable water resource management. The main capacities needed here are agricultural facilities, drones, multispectral camera, thermal camera, and skilled staff in image processing and remote sensing. The use of inexpensive drone systems in irrigation management will be evaluated, particularly, the data fusion methodologies for use of electro-optic and thermal cameras. However, weather conditions, climate changes and pesticides are pointed by the author as project risks.

Classification of Forest Areas Using Remote Sensing Techniques

The main objective of this pilot project is to monitor forests and determine crop species. As outcomes, the project is will ensure the mapping of tree species in a forest with advanced hyperspectral cameras, provide the Ministry of Forestry and Water Affairs and the General Directorate of Forestry with a tool for the analysis of forests in order to prevent from future diseases, and provide spectral library of forest area by using hyperspectral camera mounted on a drone system.

As aforementioned, the Ministry of Forestry and Water Affairs and the General Directorate of Forestry are excellent beneficiaries. Showing the importance of the usage of remote sensing will enable greater projects afterwards. In addition use of regional/worldwide EO monitoring infrastructures, GEO&Copernicus will be a good example for other governmental organizations. Through access to reliable data resulting from this project, both farmers and policy-makers will be able to make more informed investment decisions that are conducive to the preservation and sustainable management of soils, weather conditions and climate changes.

6 Regional priorities action plan

This section outlines the regional criteria to be used to identify and shed light on the regional priorities that will promote the uptake of EO services and data in response to regional needs, relevant to the thematic priorities: adaptation to climate change, improved food security, access to raw materials and access to energy; and contribute to the improved implementation of and participation in GEO, GEOSS, and Copernicus in the region.

6.1 Considerations and approach

6.1.1 Considerations

The national action plan is country need-driven; the priority actions are distilled from known needs, identified gaps, national maturity indicators, and country proposals, whereas, the regional priorities action plan is a combination of bottom-up proposals from country partners and a top-down push for regional strategic coherence and synergistic capacities.

Regional priorities differ from national priorities in that they respond to regional challenges, serve more than one country, demonstrate clear relevance to GEO/Copernicus objectives, the selected countries have a certain maturity level to coordinate existing capacities for the provision of timely and accurate services over the RoI, etc.

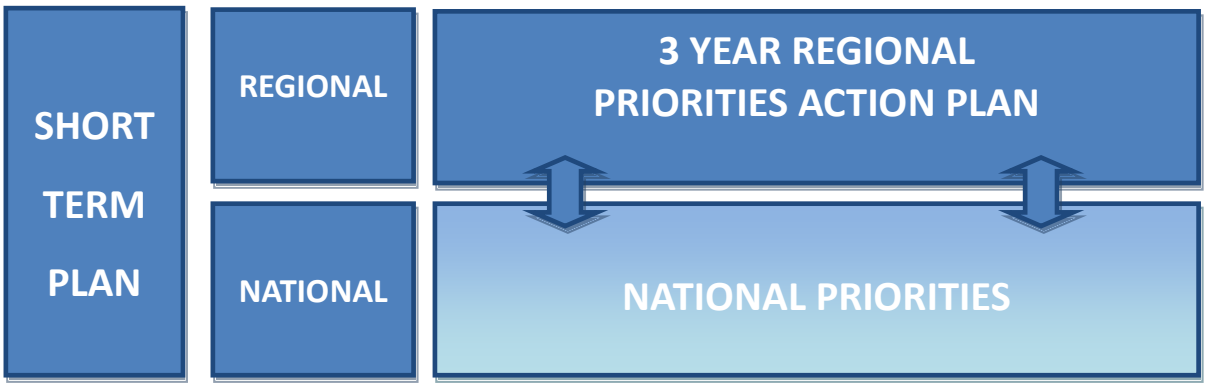

Figure 5: Regional priorities action plan's approach

The regional action plan focuses on quick-wins, namely on projects with timescale varying from 6 to 36 months. The priority actions are focused around two groups of activities: support actions and thematic actions.

6.1.2 Regional priority framework

The criteria to determine the regional priorities must meet all the criteria defined in the national priority framework. In addition, regional coverage and investment & marketability are looked for (see Table 19).

Table 19: Regional priority framework

Criterion	Sub-criteria	Description
REGIONAL DIMENSION	**METADATA/Standards**	- Does the project create methodological standards and generate qualified and comparable information which can be extended to cover larger areas at regional level?
	Synergies between countries/stakeholders	- Does the project showcase complementary use of capacities and skills from the region and synergies between countries/ stakeholders for achieving its goals?
	Use of regional/worldwide EO monitoring infrastructures	- Does the project make use of regional/worldwide EO monitoring infrastructures (space and/or in-situ)?

6.2 Common support actions

The regional support actions – as perceived from the perspective of end user needs, identified gaps and maturity assessments – are actions that respond to common, recurrent constraints across countries.

Raise awareness of the value of EO operational services

One of the significant gaps common across countries is the lack of knowledge at the level of stakeholders, researchers and graduates. Awareness activities could be efficient to define this technology and its capabilities for development of countries in the RoI through natural resources management in the domains of food security, prediction of the implications of climate change, getting access to energy, etc. This could be undertaken through a series of workshops combined with other dissemination activities. Such public awareness workshops would help in widening the interest areas of EO applications and the related technologies to the current end users and create new users by introducing EO to new fields with potential for application of these technologies.

Synergies should be sought with the newly established Copernicus Relays, including prospects for the participation of key organizations in the RoI. In the same spirit, the establishment of national GEO

offices could act as a facilitator. Therefore, the practical perspectives of establishing either Copernicus Relays and/or national GEO offices should be further analyzed (this is expected to be undertaken within Task 1.2 and 5.3 of GEO-CRADLE).

Improve human capacity to develop value-added services and support decision-driven management systems

Given that human resources are a major contributing factor to the development of value-added services/products and the support of decision-driven management systems, more attention should be given to the development of technical staff, mainly in public organizations which often dominate the EO sector, to contribute to capacity building in climate change adaptation, access to energy, access to raw materials, and improving food security. It is often reported by interviewees from different countries that training is dependent on externally-funded projects and organizations are not mandated for continuous training provision outside the project scope.

The most required expertise, as quoted by end users, are GIS and data analysis and processing in relation to climate change. Training program should therefore focus on the analysis, processing and production of data products/services, but also on their use by different stakeholders. The guiding principle for training is that every group of countries with more or less the same human competencies should establish a strategy to improve the skills and competencies of its technical staff and sustain the skills over time. This includes the development and implementation of standardized training curricula/modules based on country needs assessments. Maturity assessment and a gap analysis, like those conducted in GEO-CRADLE, could help to identify and specify training needs in each country. GEO-CRADLE provides a solid foundation on which to build this work. Lessons learned and synergies with activities foreseen under the newly established Copernicus Academy should be sought.

Create a regional data hub on the principles of free and open data

The need for improving data gathering, access, and use has been largely quoted by end users from different fields of work and different countries. Regional data hub with free and open policy is an appealing opportunity for local and regional stakeholders to make their data available for free in the hub and in accordance with international standards and good practices. This would remove the barriers users quoted in accessing data, including red tape (which is considerable), as well as facilitate the local EO community to build upon it new businesses of wider interest in the RoI.

The GEO-CRADLE data hub intends to take a first bold step. However, a few caveats, already quoted by end users in the interviews, have to be taken into account while creating the GEO-CRADLE data hub: **(1)** It should be complementary to other sources of data; **(2)** The hierarchy of the level of the processing of the data (from raw to geo-information products (maps) should also be made clear, since most end users will need to rely on a service provider to be able to benefit from such a data hub; Finally **(3)** It should be recognised as a standard, legitimate source of data by users.

In addition to that, a mechanism for coordination should be sought to ensure the ability to reach out to and involve all relevant subsectors (crops, energy, natural resources, etc), but also to ensure sustainability over long time. It is worthwhile noting that for the case of public organizations, unlike private organizations, the use of free and open data sources may be limited by their obligation to comply to their legal and legislative frameworks in effect for data access.

Establish regional coordination mechanism

Even though the regional priorities action plan encompass quick-wins actions, it is important to establish a regional coordination strategy to ensure the continuity of the whole actions included in the plan beyond the timeframe of the GEO-CRADLE project. This is a necessary condition for regional pilot projects to be implemented and sustained as well as for feasibility studies to be followed by concrete implementations.

6.3 Thematic actions/Regional pilot projects

As seen in the previous chapters, regional priorities can be addressed through the execution of targeted pilot activities. The objective of the pilot activities is not to develop new services or technologies, but to build on the integration of existing capacities (infrastructure, datasets, models, etc.) and skills within the relevant group of project partners involved in providing improved EO Services in the RoI. Thus, combining the work that was carried out at proposal preparation phase with the proposal of country partners and the needs specified by end users, the project has decided to go forward with some of the identified quick-win pilots. These pilots will span over a period of 15 months, and the final results will be presented to relevant stakeholders (especially decision makers) during a dedicated workshop.

Adaptation to Climate Change (ACC)

Relevance to the RoI

The RoI has been recognized as one of the region most sensitive and vulnerable to climate change on the planet[11]. Climate change is governed to a large extent by atmospheric processes, in particular the interaction between radiation and atmospheric components (e.g. aerosols, clouds, greenhouse, and trace gases), some of which also contribute significantly to air quality degradation. In this context, continuous atmospheric monitoring from space and from the ground in the RoI needs to be well distributed and coordinated in order to be used in an optimal way for future climate projections and forecasts of atmospheric components and climate driven natural hazards.

The pilot project aims to provide the necessary support and coordination to existing infrastructures, to deliver consolidated information and knowledge for long term strategic planning on adaptation and mitigation to climate change and its side effects (e.g. air quality) that is of high importance for the RoI. 3 relevant services will be provided for the benefit of the region: **1)** accurate desert dust forecasting; **2)** regional climate change services; and **3)** air quality services. Special effort will be dedicated to service optimization (which are currently not as timely and accurate as required by users), and tailoring the services to the user needs (through continuous interaction with end users from targeted ACC representative sectors and respective target groups).

Desert Dust Forecasting

The core activity for the ACC dust service pilot is the organization of the intensive experimental campaign PRE-TECT that will take place during 1-30 April 2017 at the Greek atmospheric observatory of Finokalia in Crete (Figure 6). The ACC dust forecast service will be validated against dust and radiation measurements that will be performed from ground and air over Greece and Cyprus.

PRE-TECT is clustered with a number of relevant projects and initiatives that contribute in an unprecedented amount of atmospheric information for the realization of ACC services:

- The D-TECT ERC project, aiming to assess the impact of particle electrification on desert dust dynamics and long-range transport.
- The A-LIFE ERC project, aiming to provide fundamental new understanding on aerosol absorption and its impact on dynamics.
- The LACROS facility of TROPOS in Cyprus.
- The ACTRIS ground-based stations at Finokalia and Limassol

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

- The CAMS Copernicus Atmospheric Service, aiming to provide continuous data and information on atmospheric composition, supporting applications in a variety of domains including health, meteorology and climatology.
- The ECARS TWINNING EU project, aiming to boost INOE's research capacity in the domain of atmospheric remote sensing and create a pole of excellence in East Europe.
- The EUropean Facility for Airborne Research (EUFAR) to provide airborne atmospheric measurements during the campaign.

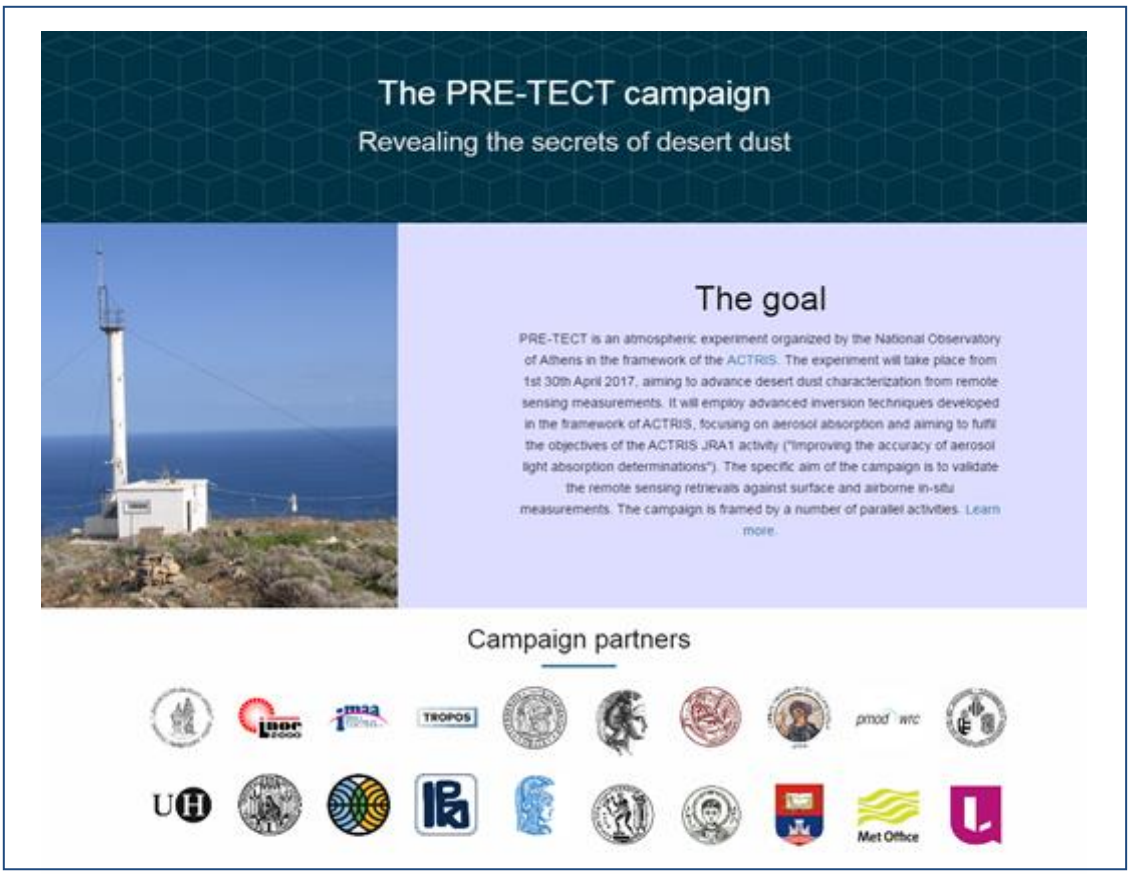

Figure 6: PRE-TECT web site[12]

Regional climate change services

For ACC in the RoI it is essential a reliable and convenient open access of future climate data from high resolution model projections based on Regional Climate Models (RCMs) to support decision makers, stakeholders, intermediary users and end-users on climate change mitigation and adaptation policies. Hence it was proposed the design of a user friendly interactive web tool that visualizes and

[12] http://climate-projection.weebly.com/

provides essential climate variables and climate indices using high horizontal resolution regional climate model simulations. This interactive web tool will be assessed in specific end-to-end pilot studies in the RoI for the sectors of tourism, agriculture as well as natural hazards and water management. The interactive web tool makes use of free access high resolution regional climate data acquired from the Coordinated Regional Downscaling Experiment (CORDEX) research program[13]. Specifically, the RCM data have a high spatial resolution (0.11°) and cover a time period from 1950 to 2100. The historical period of each experiment refers to 1950-2005, while the future projection period (under the influence of three specific greenhouse emission scenarios; rcp26, rcp45, rcp85) is 2006-2100. The reference historical period for all simulations is defined as 1975-2004. The experiments are a product of various Regional Climate Models (RCMs) driven by numerous Global Climate Models (GCMs). The climate projections interface products are indented for end-users of the broader public/private sectors of tourism, agriculture as well as insurance companies and water resources and management, all vital sectors for RoI. The impact of the project can be assessed by the number of end-users visiting the web tool application. A draft design of the interactive web application tool is presented in Figure 7 for a specific selection of a meteorological variable at a grid point of RoI through the web application.

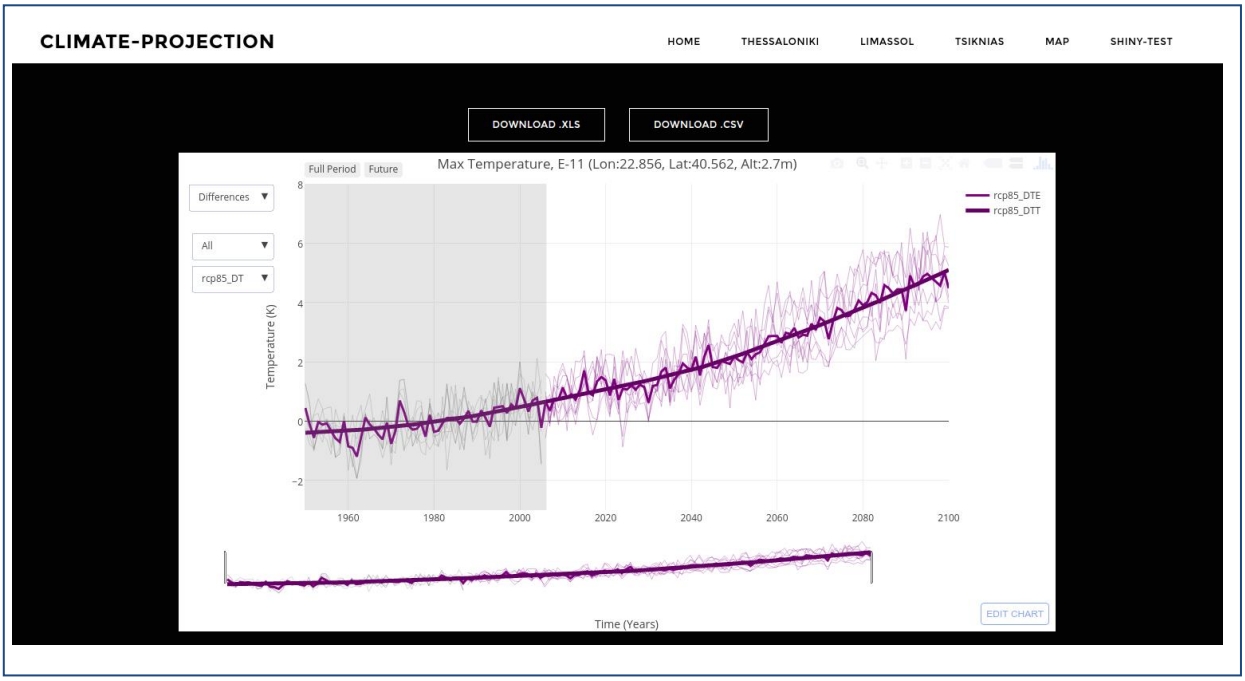

Figure 7: Ensemble of high resolution regional climate projections from 1950 to 2100 for a specific meteorological variable at a specific grid point of RoI through the web application tool.

[13] www.cordex.org

Air quality services

Air pollution is one of the challenging environmental problems in GEO-CRADLE's RoI. The refinement of the ACC pilot with respect to air pollution was based on the common user requirements, as identified by the analysis of the user needs (D2.5 and D4.1). These include aerosol information, greenhouse gases, emission sources and transport paths. Thus, the exploitation of the air quality forecasts of Copernicus Atmospheric Monitoring Service (CAMS) is designed, which cover all the above aspects. In particular, CAMS provides European-scale air quality (aerosols, greenhouse gases, etc.) forecasts and analysis by a number of Eulerian atmospheric models.

The selected CAMS products (according to the needs of the RoI), will be evaluated against the PRE-TECT campaign (cf. above), thus the project will provide an added value to them. Besides, they will be tailored to the RoI through the project's portal, which will increase their visibility, discoverability and accessibility and will in turn support the public and health sectors, as well as the general public of the RoI, towards the built up of resilient societies.

Regional dimension

The specific pilot site for the Eastern Mediterranean was considered as representative of the RoI area for developing the services according to the user needs and optimizing their accuracy through synergistic data use and evaluation against ground/air truth data. Available models will be used along with the instruments and input data (space/airborne/in-situ) gathered by 3 European Research Infrastructures (ICOS, EUFAR, ACTRIS). The successful implementation of ACC pilot will strengthen the interplay between the Earth Observing System and modelling activities to deliver consolidated information and knowledge for long term strategic planning on adaptation and mitigation to climate change and air quality for the RoI in line with the standards and vision of GEOSS and Copernicus for information extraction and climate services.

Impact

The impact of the pilot is significant: **(1)** support the sustainability of regional EO infrastructures and trigger needed synergies; **(2)** improve knowledge on current regional climate adaptation policies; and **(3)** provide reliable assessments on the level of needed coordination and future investment needed towards the implementation of GEO, GEOSS and Copernicus in the RoI. The outcomes from ACC have impacts on several sectors at the ROI including Weather and Climate Services, Ministry of environment, Energy Sector, Fishery Sector, Aviation Sector, Health Sector, Agriculture and Tourism. Dissemination of ACC results will lead in long term impacts on the above sectors.

Sustainability

In terms of investment, the pilot will run without further funds. The sustainability of the project relies on end-user engagement, which includes herein the tourism sector (TEMES and Costa Navarino for dust forecasting), meteorological agencies (Cyprus for dust forecasting), aviation (Egypt Air for dust forecasting), insurance companies (AXA for climate change services), the agriculture sector (Ministry in Serbia for climate change services), and local authorities for services related to air quality services (CAMS). Conclusions on sustainability will be drawn from the pilot.

Contribution to GEOSS/Copernicus

The project (through the ACC pilot) makes use of the existing Copernicus products from the Atmosphere Monitoring Service (CAMS). The pilot project will contribute to the achievement of GEOSS targets and the uptake of relevant EO based Copernicus services in the RoI. The scientific critical mass in the pilot, together with the identified stakeholders and users (Research Institutes, Academia, Environmental Industry, Service Providers, Public Sector) will trigger the formation of a solid Community of Practice (CoP) that will be sharing common interest within the scope of atmospheric and climate relevant hazards, as well as adaptation and mitigation policies.

Improved Food Security

Relevance to the RoI

Food security depends on many factors such as water abundance and extremes (flooding and drought), vegetation stresses, yield monitoring, soil quality and sustainability. Guaranteeing food security requires the systematic mapping of soils and minerals which are beneficial for agricultural production; the monitoring of mining waste sites for the prevention of acid mine drainage impacting the quality and quantity levels of food; the systematic assessment of meteorological aspects and climatic forecasts; etc. Such actions will allow the soil and water resources to be preserved from further degradation, and the agro technical activities to be adapted according to microclimatic conditions, securing the abundance of healthy crops and yield production yearly.

The overarching objective of the pilot is the development of datasets, data analytics, and indicators that will enable the integration for the Nexus approach to benefit the food SDGs (Sustainable Development Goal) as well as other SDGs that are sensitive to those targets**.** The project consists of monitoring and automatically mapping natural, physical and chemical properties of the soil, using the

maps of soil attributes to combat soil degradation, and spatially detecting soil contamination and water capacity.

Regional dimension

Soil spectroscopy will be used to provide standards and protocols, Soil Spectral Library building capacity, as well as Data Mining and learning machinery. The myDEWETRA platform will be implemented to collect and systematize various kinds of data and model outputs, automatically or manually recorded, previously stored in the data-hub or in the myDEWETRA GEO serve. This will allow for their combination and display on the same web based interface. The plan of action will include 3 common major attributes for all partners, 2 unique region specific attributes picked by and for each partner, and 100+ samples sent by each partner, in addition to the samples of the LUCAS spectral library. Contemporary knowledge and know-how regarding soil spectroscopy will be disseminated to the partners, who will be educated in soil spectroscopy through 2 webinars (on soil sampling, acquisition of soil spectra, creating a SSL with its assorted metadata, building of models, applying to EO data). Additionally, Copernicus EO data will be utilized in order to create regional thematic maps and derive information regarding the status of the soil in the wider region, showcasing the immense potential of this pilot.

Impact

The impact of soil spectral libraries and satellite imagery can be large: they contribute to the low input sustainable agriculture and progressive improvement of soil quality by enhancing the understanding of the soil properties (and thus leading to informed decisions in the field), they offer reliable EO data adhering to the same standards as the Open Geospatial Consortium (derived from Copernicus images), and information and data facilitating in decision making for a number of different domains can be provided. They can additionally act as a catalyst for regional stakeholders, empowering them to enrich and utilize their regional spectral libraries, by creating EO services for the end-users (be it farmers, industry or governmental authorities). The results of the pilot will be fully reproducible, as the standards and methods applied can easily be scaled to cover the whole region within a reasonable amount of time.

Contribution to GEOSS/Copernicus

Provides enriched, open to the public, soil spectral libraries to the GEOSS from the ROI, which has been under-represented in other efforts (e.g. the LUCAS spectral library). The data generated will be in complete accord with the standards of the Open Geospatial Consortium, and contain full

metadata. Moreover, the pilot actions complement the Copernicus services by providing information and tools, which can be used to augment the produced satellite data, and transform raw data to products for the end-user.

Sustainability

In terms of investment, the pilot will run without further funding. The data and methodologies developed could easily be integrated and exploited by interested parties, in order to provide augmented EO maps as a service for end-users.

Access to Raw Materials

Relevance to the RoI

The potential of minerals exploitation and mining activity in the RoI, and their corresponding socio-economic benefits is high. The potential for a productive and sustainable mining industry across the Middle East and Africa remains challenging. The RoI, as part of the quest to diversify and capitalize upon their minerals, need to establish modern, open and transparent regulatory frameworks and set up concerted actions for best practices, maximizing the environmental, societal and economic benefits. The rationalized exploitation of minerals through a coordinated and integrated approach with clear awareness of obligations established in environmental treaties and social needs, facilitates resource efficiency, and supports environmental, industrial, and business development sectors.

The aim of this pilot project is to conduct a feasibility study to establish a roadmap for better long-term monitoring, mapping, and management of mineral deposits in a severely under-explored RoI, using elaborated EO methodologies to reduce the impact on the surrounding areas. In regards to this, the existing regional capacities and skills will be used to: **1)** develop a protocol to evaluate the level of impact for the selected pilot test sites, **2)** map the waste of materials in abandoned mines, and **3)** monitor ground deformation during/after mining. The pilot will include identification, collection, assessment and use of EO based and in-situ data; and it will enrich the information content of the Regional Data Hub.

Regional dimension

Three pilots are identified, one in each part of the ROI The first pilot, in Balkans, is the Monitoring of Illegal Quarrying in Greece, with the objective to use EO data & techniques to select suitable sites for quarrying, monitor reforestation, support land use planning, monitor land cover and illegal quarrying,

assess “waste” and possible instabilities, and finally support restoration actions. The second pilot, in Middle East, is in Cyprus, and includes abandon, under restoration **Abestos mine**.

The expected outcomes of this pilot are: **1)** mapping of waste materials and low grade ores left over in abandoned mines that could potentially re-open by exploiting both primary and secondary mineral resources with parallel environmental restoration, **2)** long-term monitoring of ground deformation/stability during or after mining activities in order to handle environmental pollution and possible subsidence/landslides, **3)** evaluation of the environmental impact, together with feasibility assessment for the potential of the extractive or mining waste to become exploitable as secondary resources, **4)** mitigation measures to handle environmental pollution in abandoned mines in order to fulfil certain obligations derived from the EU Water Framework Directive 2000/60/EC. The third pilot will be placed in North Africa, but detail localization is not defined yet.

The selected test sites represent the problems that accrues in the mineral resources sector and that are listed above (1), 2), 3)). Within the pilot, the feasibility study will be developed for each of the selected areas in order to demonstrate the use of EO methods to improve the existing situation and usefulness for better management of the mining and post-mining areas as well as reducing their impact on the surrounding areas. It is expected that the methodologies elaborated on the examples pilot sites will have a universal character and could be applied for other similar sites in RoI.

Contribution to GEOSS/Copernicus

During the pilot projects the information upon existing and used EO datasets (space borne radar and optical images, air borne hyper and multi-spectral images, airborne lidar, DEMs and in-situ measurements) will be collected from Geological Surveys, relative Ministries and mining companies. In this sense the pilot projects will contribute to the achievement of GEOSS targets and the uptake of relevant EO based Copernicus services in the RoI. In addition test processing will be performed using available Copernicus datasets. This scientific input of the pilots, together with the identified stakeholders and users (Research Institutes, Ministries, Environmental Agencies, mining companies) will lead to valuable use of the proposed methodology for future real projects aimed at improving the management of raw materials sector.

Sustainability

In terms of investment, the pilots are feasibility studies. In order to sustain results and outcomes of the study, additional funding source is needed, which ensure implementations of the proposed

methodologies. Further development and practical use of the study relies on the end-users, which are in this case mining companies, public authorities, public and private organizations related to the environmental management and protection, urban planners and geology related institutions. Conclusions on sustainability will be drawn from the pilot.

Access to Energy

The Solar Energy Nowcasting SystEm (SENSE) produces state-of-the-art solar energy applications and is based on the synergy of Neural Networks (NN), Radiative Transfer (RT) simulations and real-time satellite retrievals. NN is trained on a large-scale (2.5 million record) look-up table (LUT) of clear and cloudy sky radiative transfer simulations to convert satellite cloud and aerosol products directly into solar radiation spectra. As a result, SENSE is capable of producing maps of spectrally-integrated irradiances of the order of 104 to 105 pixels within 1 minute and hence provide the capability needed to serve high precision solar power applications for energy planning. Surface spectra for Direct Normal Irradiance (DNI), which applies to Concentrated Solar Plants (CSP), as well as Global Horizontal Irradiance (GHI), which applies to PhotoVoltaic (PV) installations, are produced at high resolution (1nm, 5 km, 15 minutes) using input data from Copernicus Atmosphere Monitoring Service (CAMS) for aerosols impact and from Spinning Enhanced Visible and InfRared Imager (SEVIRI) onboard the Meteosat Second Generation (MSG) for clouds impact. This inclusion of cloud and aerosol effects means that this approach is ideal for correct assessments of solar power operational loads [3]. Supplementary to the real-time services we applied a method for the development of Solar Atlases based on climatological radiation data from EUMETSAT's Satellite Application Facility on Climate Monitoring (CM SAF). Therefore, the SENSE pilot is appropriate for:

- Location studies for the placement of CSP and PV installations;
- Large-scale and precise solar energy calculations to assist Public Authorities in energy planning policy;
- Supporting the work of various scientific communities; and
- Provision of specialized data of high spectral precision for private and public sectors dealing with health protection (UV-Index, Vitamin D effective dose, etc), energy consumption and solar energy exploitation.

Relevance to the RoI

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. The RoI is characterized by high year round insulation; however it presents a complex and highly variable climatology, in terms of clouds and aerosol patterns that directly affect sunlight. Therefore, regional solar energy networks require accurate, timely and gapless information on incoming surface radiation. A continuous synergistic effort between satellite and ground-based remote sensing communities is imperative towards acquiring and analyzing the relevant atmospheric data. However, the radiation-related EO capacities in the RoI are modest and are further threatened in terms of sustainability.

The purpose of the pilot project is the provision of (tailored to end-user) now-casting of solar radiation and solar energy, long-term solar energy atlases for various areas with high temporal and spatial detail, as well as solar radiation-related products (real-time and forecasts) related with health (UV index/melanoma, DNA damage, Vitamin D efficiency), agriculture (photosynthesis), and research. This pilot is considered relevant to the RoI because it aims to strengthen capacity building and enforce hands-on service demonstration of the great solar energy potential to unlock regional interest and resources in the use of EO towards this goal.

SENSE pilot products cover a broad dimension of end–user interests including energy traders, energy management system services, renewable energy solar parks, agricultural activities, health related impacts on over-exposure or under-exposure of humans, animals and plants on solar radiation. Through the implementation of three sub-pilot activities and their provision on-line, SENSE is going to demonstrate within Geo-Cradle the potential use of the specific services to and areas of the ROI. The visibility of the SENSE study is mainly up to regional Geo-Cradle assigned representatives. SENSE outputs such as high resolution of solar atlas under any area of the RoI is possible to be provided in any area within the RoI.

Regional dimension

Three pilots will be implemented in the region: **1) Solar Energy now-casting, forecasting & Solar Atlas in Greece** (user: Independent Power Transmission Operator), **2) Now-casting & Solar Atlas in Egypt** (user: Ministry of Electricity and Renewable Energy), and **3) Solar UV Index in the Aegean and Adriatic seas** (user: Superfast ferries).

SENSE pilot hierarchy and described methodology provide the opportunity of using the now-casting and the solar radiation maps/past time series, to all the areas of the RoI. The high temporal and

spatial resolution provides the opportunity of studies on a regional level (e.g. North Africa), national level, down to the city level or few kilometer dimensions of solar parks and PV installations.

The three pilots have been defined based on the SENSE diversity results and aims at showcasing the potential (diverse) end users. SENSE uses capacities and skills from the RoI as it can be tailored to different needs of each country/region. Synergies between countries/stakeholders could be demonstrated through international companies (e.g. Blue star ferries) linking Italy, Greece and Cyprus.

The project uses a number of EO related parameters including atmospheric parameters with different spatial and temporal resolution. In addition, it uses CAMS related products and finally in-situ atmospheric products for product improvement through an online validation (Baseline Surface Radiation network, Aerosol Robotic Network, Global Atmospheric Watch PFR network).

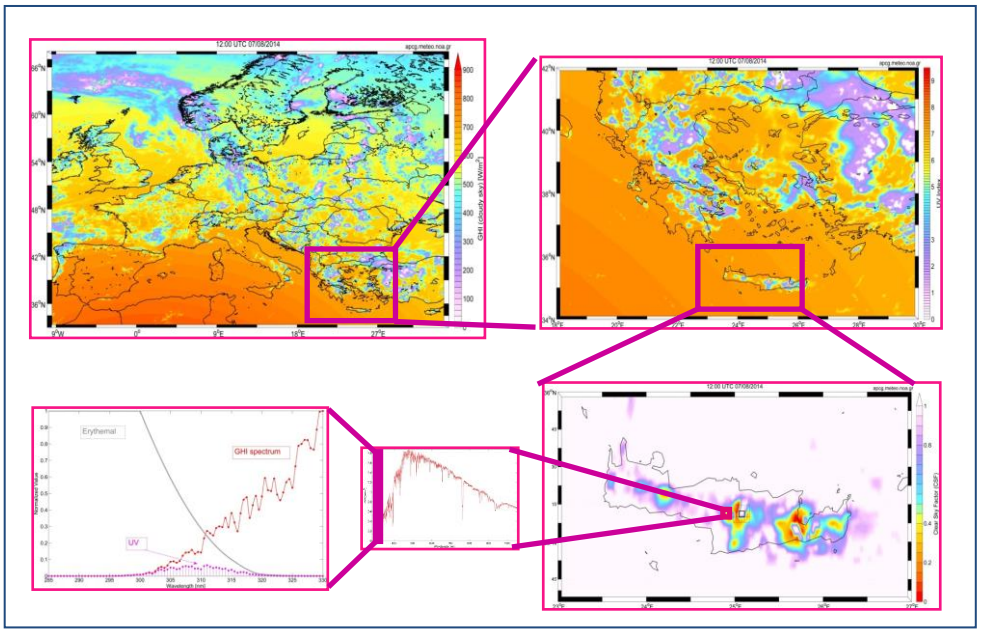

Figure 8: A zoom sequence showing a selection of the solar energy products. Going clockwise: the GHI for Europe, the UV index for Greece, the clear sky factor in the island of Crete, the insolation spectrum in a single pixel, and finally, the spectrally-weighted UV radiation spectrum.

Impact

The pilot will seek to demonstrate ways to maximize benefits and impacts on the RoI and create synergies with public and private sector (solar plants, energy distributors, solar energy related end-users). We note that the SENSE system can be implemented anywhere in the RoI with tailored

products and it is also a spin-off opportunity, which can be promoted through GEO-CRADLE, new projects, conferences etc.

The project aims on maximizing its impacts on the RoI by:

- Demonstrating the possibility on Including information for any area of the RoI;
- Including high spatial and temporal information providing the possibility to cover different spatial user-oriented needs; and
- Providing solar radiation spectral information which provides the opportunity to include different outputs targeting different end-user communities (Energy sector, health sector, agricultural sectors).

In terms of replicability, as already mentioned, using EO geostationary information provides the opportunity to replicate in any area and scale it from regional to 5 by 5 kilometer grid/levels.

Contribution to GEOSS/Copernicus

The SENSE pilot will draw conclusions on the feasibility of efficiently and sustainably operating relevant EO activities, in terms of existing skills and observational infrastructures, and will provide quantitative and qualitative assessments on the required level of coordination and future investment to be carried out towards the implementation of GEO, GEOSS, and Copernicus Energy activities in the RoI. More specific, SENSE pilot using various products from the Copernicus Atmospheric Monitoring Service (solar radiation and aerosol products) helps on creating a link among Copernicus and GEO, for the duration of the project but also for future energy related initiatives.

SENSE contributes towards promoting the implementation of technologies and the uptake of best practice to enhance space data access in support of the evolution of the GEOSS, particularly focusing on solar radiation related products. In addition the project aims at addressing critical gaps in energy-related Earth observations and increase their use in all energy sectors in support of energy operations, as well as energy policy planning and implementation, to enable affordable energy with minimized environmental impact while moving towards a low-carbon footprint.

The projects aims to target the strategic plans of GEO/Energy towards:

- improved energy management related systems, including balance between energy demand and supply;

- safe, efficient and affordable development and operation of existing and new energy resources, with emphasis on minimizing environmental and societal impact while moving towards a low-carbonfootprint; and
- advancement of the application of data, systems and tools.

Sustainability

In terms of investment, the pilot will run without further funds. The sustainability of the project relies on end-user engagement, which includes herein the tourism sector (Blue star Ferries Aegean and Adriatic sea), ministries (the Egyptian ministry of Energy), National energy transmission systems (the Greek Independent Power Transmission Operator, and local authorities for services related to energy and solar radiation related health aspects using CAMS products. Long term funding in this domain of science towards applications could be found from the private sector (direct or indirect), the public sector (energy operators, EPAs, public information sectors e.g. weather and meteorology related bodies), government-based initiatives, EU projects (GEOS related, user oriented products, case studies), bilateral calls, as well as Copernicus-related calls.

Government related authorities have been already showed their interest on long-term collaboration for energy now-casting services. SENSE is going to operate without additional funding required for the Geo-Cradle defined pilot period (1.1.2017 – 31.12.2017).

There are specific opportunities to fund EO related market uptake projects like SENSE. These opportunities come from private stakeholders and also from the EU related energy efficiency funding opportunities such as €100M that are available in the Horizon 2020 Energy Efficiency Call 2017, where coordination and support actions will be funded. The SENSE pilot project has the potential to be linked with existing Geo and GEOSS investments related with Geo Energy and Geo Agriculture.

SENSE structure have been defined aiming on engaging and working with governments, national and international energy agencies, the energy industry, research communities and other stakeholders aiming at:

- understanding and mapping the user needs and requirements for specific energy datasets (e.g. solar energy and atmospheric related data);
- developing the bestpracticesfortheintegrationofinformationaswellassupportcapacitybuilding.

The use of EO related data together with the real time energy product that is derived from SENSE provides the opportunity of collaborating with Copernicus related satellite ground segments using the advantage of the rapid/online information flow that can be provided.

6.4 Plan outcomes

The regional priorities action plan provides a baseline of regional priorities and outlines the steps for the implementation of both thematic and support actions within the GEO-CRADLE timeline. The thematic actions consist of four pilot projects related to the thematic priorities: adaptation to climate change, improved food security, access to raw materials and access to energy, responding to regional needs, and contributing to the improved implementation of and participation in GEO, GEOSS, and Copernicus in the region. While the support actions are deemed to be operational services compounded by capacity building and/or awareness activities, the support actions are inferred from common, recurrent constraints, proclaimed by stakeholders in interviews and surveys and target the enforcement of human capacity building in almost the four thematic priorities, the awareness generation among stakeholder communities about the value and benefits of EO services and data, the improvement of data policy principles towards free and open regional data hub.

Table 20: Regional priorities action plan

Priority action	Thematic area	Objective	Region/Country	Timeline
SUPPORT ACTIONS:				
Raise awareness of the value of EO operational services	ALL	The project is targeting the stakeholders and managers to raise their knowledge and skills of EO capabilities and EO applications for developmental issues and decision making	FYROM, Albania, Tunisia, Egypt, Turkey, Serbia, Cyprus and Greece.	12 months
Improve human capacity to develop value-added services/products to support decision-driven management systems	All thematic areas are concerned, but adaptation to climate change is the most cited one.	Establish regional training program devoted to technical staff in public organizations. The main specialties: GIS and data analysis, processing and modelling.	By group of countries with more or less same level of competencies.	24 months
Regional data hub with free and open data policy	ALL	Encourage stakeholders' community to make their data available in the data hub under the condition of open and free data.	Whole region.	12 months
Establish a regional coordination strategy	ALL	Establish a regional coordination strategy to ensure the sustainability of the projects included in the regional action plan beyond the GEO-CRADLE timeframe.	To be decided within the study.	12 months

Priority action/project	Priority area	Objective	Pilot sites	Timeline
THEMATIC ACTIONS: Pilot projects				
Adaptation to Climate Change (ACC)	Adaptation to Climate Change (ACC)	- Accurate desert dust forecasting - Regional climate change services - Air quality services	Eastern Mediterranean	16 months (October 2016 - January 2018)
Improved Food Security	Improved Food Security	- Soil spectral libraries and satellite imagery for low input sustainable agriculture and progressive improvement of soil quality - Offering reliable EO data, adhering to the same standards as the Open Geospatial Consortium - Provision of information and data facilitating in decision making	TBC	12 months (December 2016-November 2017)
Establishing a roadmap for long-term monitoring, mapping, and management of mineral deposits in a severely under-explored ROI.	Access to Raw Materials	- Future use of Earth Observation data & techniques for mapping and monitoring “Quarries”: - Creation of a database to include satellite data and other thematic, physical, environmental, geomorphic, geologic, socio-economic information pertaining to factors that affect post-	Greece	12 months (November 2016-February 2018)

		mining restoration activities. - Mapping of waste materials and low grade ores left over in abandoned mines. - Long term monitoring of ground deformation /stability during or after mining activities. - Evaluation of the environmental impact, together with feasibility assessment for the potential of the extractive or mining waste. - Take mitigation measures to handle environmental pollution in abandoned mines in order to fulfil certain obligations derived from the EU Water Framework Directive 2000/60/EC.		
A Solar Energy Now-Casting System +	Access to Energy	- Demonstrate ways to maximize value and benefits at the RoI. - Create synergies with public and private sector (solar plants, energy distributors, solar energy related end users).	Greece, Egypt, and Aegean and Adriatic sea.	12 months (January 2017 – December 2017)

7 Conclusions

The combined picture provided by the outputs of the gap analysis and the benchmarking of the different countries according to the maturity indicators, has paved the way for the definition of priorities in relation to regional challenges, focusing mainly on quick-win actions that are covered by the GEO-CRADLE project. Thus, the defined priorities are addressing the identified gaps in existing infrastructure and capacities, improving awareness amongst decision makers, triggering the involvement of EO service providers, and ensuring regional GEO and Copernicus uptake.

The choice of the end users and surveyed organizations has undoubtedly shaped the focus of these priorities action plans. This does not pose a problem, since their objectives were not to develop exhaustive action plans, but to identify priorities out of the reached organizations which could help the consortium understand the context in which regional coordination can be relevant and useful.

The regional action plan states quick-win actions drawn on regional needs and gap analysis. The regional priorities action plan provides a baseline of regional priorities and outlines the actions for implementation of both support and thematic and actions across countries and within the GEO-CRADLE timeline. The support actions are inferred from common, recurrent constraints, proclaimed by stakeholders in interviews and surveys and include:

- **Raise awareness of the value of EO operational services.** Lack of knowledge of the beneficial value of EO at the level of stakeholders, researchers and graduates, awareness tools is seen as an efficient tool to define this technology and its capabilities for development of countries in the RoI. This could be undertaken through a series of workshops combined with other disseminating tools. Such public awareness workshops would help in widening the interest areas of EO applications and the related technologies to the current end users and create new users by introducing EO to new fields with potential for application of these technologies.

- **Improve human capacity to develop value-added services and support decision-driven management systems.** Given that human resources are a major contributing factor to the development of value-added services/products and the support of decision-driven management systems, more attention should be given to the development of technical staff, mainly in public

organizations which often dominate the EO sector, to contribute to capacity building in climate change adaptation, access to energy, access to raw materials, and improving food security. The most required expertise, as quoted by end users, is GIS and EO data analysis and processing in relation to climate change topic. Training program should therefore focuses on the analysis, processing and production of data products/services, but also on their use by different stakeholders. Maturity assessment could help to identify and specify training needs in each country.

- **Create a regional data hub on the principles of free and open data.** The need for improving data gathering, access, and use has been largely quoted by end users from different fields of work and different countries. Regional data hub with free and open policy is an appealing opportunity for local and regional stakeholders to make their data available for free in the hub and in accordance with international standards and good practices. This would remove the barriers users quoted in accessing data, including red tape (which is considerable), as well as facilitate the local EO community to build upon it new businesses of wider interest in the RoI. The GEO-CRADLE data hub intends to take a first bold step.

- **Establish a regional mechanism for coordination.** Even though the regional priorities action plan encompass quick-wins actions, it is important to establish a regional coordination strategy to ensure the continuity of the whole actions included in the plan beyond the timeframe of the GEO-CRADLE project. This is a necessary condition for regional pilot projects to be implemented and sustained as well as for feasibility studies to be followed by concrete implementations.

While the support actions are deemed to be cross-cutting issues that target capacity building, data access, governance model, etc. the thematic actions consist of four pilot projects, responding to regional needs and contributing to the improved implementation of and participation in GEO, GEOSS, and Copernicus in the region.

- **Adaptation to climate change.** The pilot project aims to provide the necessary support and coordination to existing infrastructures, to deliver consolidated information and knowledge for long term strategic planning on adaptation and mitigation to climate change and its side effects that is of high importance for the RoI. Three relevant services will be provided for the benefit of the region: 1) accurate desert dust forecasting; 2) regional climate change services; and 3) air

quality services. The specific pilot site for the Eastern Mediterranean was considered as representative of the RoI area for developing the services according to the user needs and optimizing their accuracy through synergistic data use and evaluation against ground/air truth data.

- **Improved food security.** Many countries in the RoI are engaged in food security activities. However, they were not complemented by soil attribute/spectra in-situ networks. This pilot project consists of monitoring and automatically mapping natural, physical and chemical properties of the soil, using the maps of soil attributes to combat soil degradation, and spatially detecting soil contamination and water capacity.

- **Establishing a roadmap for long-term monitoring, mapping, and management of mineral deposits in a severely under-explored ROI.** 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. The aim of this pilot project is to conduct a feasibility study to establish a roadmap for better long-term monitoring, mapping, and management of mineral deposits in a severely under-explored RoI, using elaborated EO methodologies to reduce the impact on the surrounding areas. 3 specific pilots were considered (2 from Greece and one from Cyprus).

- **A Solar Energy Now-Casting System +**The pilot project is about the Solar ENergy now-casting SystEm SENSE with EO inputs (satellite data, Copernicus Atmospheric Monitoring Service, radiative transfer models and neural networks). It aims to strengthen capacity building and enforce hands-on service demonstration of the great solar energy potential to unlock regional interest and resources in the use of EO towards this goal. Three pilots will be implemented in the region: 1) Solar Energy now-casting, forecasting & Solar Atlas in Greece, 2) Nowcasting & Solar Atlas in Egypt, and 3) Solar UV Index in the Aegean and Adriatic seas.

The outcomes of these pilot activities as well as other key aspects outlined in this report (e.g. the need for a Regional Data Hub), will shape together with the analysis performed here an important input for the **Roadmap for future implementation of GEOSS and Copernicus in the RoI** (D5.7).

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