EXCELSIOR – EARTH OBSERVATION OPPORTUNITIES FOR EXCELLENCE IN THE EMMENA REGION

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ABSTRACT

The ERATOSTHENES Centre of Excellence for Earth Surveillance and Space-Based Monitoring of the Environment (ECoE) that will be established through the EXCELSIOR project will provide cutting-edge Earth Observation (EO) research in Cyprus, the Eastern Mediterranean, Middle East and North Africa (EMMENA) region, Europe and Internationally for the benefit of the environment and society. The ECoE will focus on the thematic clusters of Environment and Climate, Resilient Society and Big Earth Data Analytics and conduct research and develop applications within the focus areas of climate change monitoring, disaster risk reduction, access to energy, water resources management and big EO data analytics. The ECoE can serve as an innovation gateway for Cyprus and EMMENA in the areas of Earth observation and remote sensing, thereby providing applications and services for issues that are unique to the EMMENA region. The success indicators to measure the ECoE's sustainability are also discussed.

Keywords: EXCELSIOR, Centre of Excellence, Cyprus, EMMENA, Earth Observation, Remote Sensing

1. INTRODUCTION

The EXCELSIOR project aims to upgrade the existing ERATOSTHENES Research Centre, into an autonomous and sustainable Centre of Excellence for Earth Surveillance and Space-Based Monitoring of the Environment (ECoE), which will provide the highest quality of related services on the National, European and International levels [1-5]. The project focuses on conducting basic and applied research and innovation in the areas of the integrated use of remote sensing and space-based techniques for monitoring the environment. The integration of novel Earth Observation (EO), space and ground-based integrated technologies, can contribute to a more sustainable and systematic monitoring of the environment, the timely detection of societal risks/threats and the growth of vital economic sectors.

1.1 Consortium partners

The project consortium forms a highly complementary team that possesses the full range of skills and expertise necessary to technically assist and carry out the proposed activities successfully [1-2]. The Consortium partners (CPs) will provide knowledge exchange and capacity building in the fields of land, water and maritime security, in the form of joint development research projects and staff exchanges. The CP will assist in developing new infrastructure, provide expertise for big data EO management and provide access to EO networks.

1.2 Advantages of a Centre of Excellence in Cyprus

There exist several advantages to develop a Centre of Excellence in Cyprus [3-4]. Cyprus has favourable environmental, weather and climatic conditions of Cyprus to conduct cutting-edge research with impact in various sectors, including climate change, marine, solar energy, etc. Cyprus has approximately 300 days of sunshine per year and clear skies, which is ideal for EO research activities. As well, Cyprus has an optimal location for the establishment of an Earth Observation data receiving antenna and hosting further antennas, providing coverage of three continents and critical maritime areas in the Middle East. Currently, none of the European Union/ESA member states antenna facilities have

such unique coverage and based on legal EU-territory, especially for near real time (NRT) services for maritime situational awareness. As a result of Cyprus' unique location in the South East region of Europe, it can become a Regional Digital Innovation Hub (DIH) for Earth Observation which can generate bottom-up digital innovations involving all industrial sectors. The ECoE, as a regional DIH, will become a competent Centre that will foster National and regional innovation through technology infrastructure, knowledge, and expertise in support to Open Innovation, and Open Science practices [5]. In addition, the ECoE can use big data management and analytics to effectively utilise the vast amount of EO data at their disposal in order to develop applications, products and services that are needed by the stakeholders as well as drive significant efficiencies in various business processes, most especially in data management. Big data can also highlight gaps and opportunities in the EO market which need to be addressed.

The Government of the Cyprus promotes a space strategy that can be exploited for further EO research and applications, especially in terms of (i) the positioning of Cyprus in the space scenario in respect to various sectors, such as Telecommunications, Meteorology, EO, space exploration, navigation, ii) application domains, (iii) innovative satellite technologies, (iv) networking at an International level and (v) diffusion and dissemination of space opportunities. The ECoE will enable the provision of tailored and/or new, highly innovative products and services for the benefit of National, regional and International public and private sectors, in the Space and Earth Monitoring sectors. This will be achieved through research and innovation excellence in the respective scientific and technological disciplines and collaborating with other EO industries, through which the ECoE will develop a pool of scientific expertise and engineering capability as well as technical facilities [2]. This is expected to attract further investment in Cyprus, develop a critical mass in specific areas of specialisation, contribute to greater national and European competitiveness and reduce disparities between Cyprus and other countries with respect to Research and Innovation and commercial competitiveness. The EXCELSIOR project serves as a strategic growth path that points to national and regional long-term opportunities for socio-economic development, including access to competitive funding and markets and therefore ensures the ECoE's sustainability.

2. ECOE AS A DIGITAL INNOVATION HUB

The ECoE will also act as a Digital Innovation Hub (DIH), which will include three cutting-edge Thematic Clusters for sustained excellence in research of the ECoE, namely: Atmosphere and Climate, Resilient Societies and Big Earth Data Management (figure 1). In particular, the following application domains will be addressed within each Thematic Clusters:

Environment and Climate, including climate change, precipitation, pollution, agriculture, such as irrigation, precision farming and targeted agriculture, water resources, water quality, etc.

Resilient Society, including critical infrastructure/disasters, such as early warning systems to monitor risk reduction, renewable energy, smart cities - built environment, cultural heritage, mineral and hydrocarbon exploitation, marine security and almost real-time satellite data.

Big Earth Data Analytics, including Big Data management and analytics, modelling, forecasting, as well as state-of-the-art sensors and infrastructure which are also in line with the Smart Specialisation Strategy for Cyprus' (S3Cy) horizontal and vertical priorities.

Figure 1. Thematic Clusters

The thematic clusters will then be focused in the areas of Climate Change Monitoring, Disaster Risk Reduction, Access to Energy, Water Resources Management and Data Management and Analytics [3-4] (figure 2). This will be achieved through research experience, knowledge of EO data processing techniques and the ability to integrate various methods of EO in research, innovation, services and education. The CPs will provide expertise and capacity building to develop excellence in the five focus areas. They will also assist in facilitating the skills needed to effectively work in the thematic clusters and focus areas, including technical excellence, innovation uptake, entrepreneurial mentality and extraversion. (figure 2).

ENVIRONMENT & CLIMATE
Climate Change Monitoring, by establishing an active remote sensing supersite in Cyprus monitoring climate, including aerosols, clouds, dust and pollution in the Eastern Mediterranean, Middle East and North Africa (EMMENA) region.

RESILIENT SOCIETY
Disaster Risk Reduction, through EO-based monitoring of natural disasters.
Access to Energy, by combining EO data, with physical modelling and machine learning to focus on energy nowcasting, projections, and short-term forecasting.
Water resource management, resulting from climate change variables, including droughts, water shortages, water quality, freshwater aquifers and land desertification.

BIG EARTH DATA ANALYTICS
Data management and analytics, for researching explorative algorithms to improve information retrieval from petabytes of remotely sensed data.

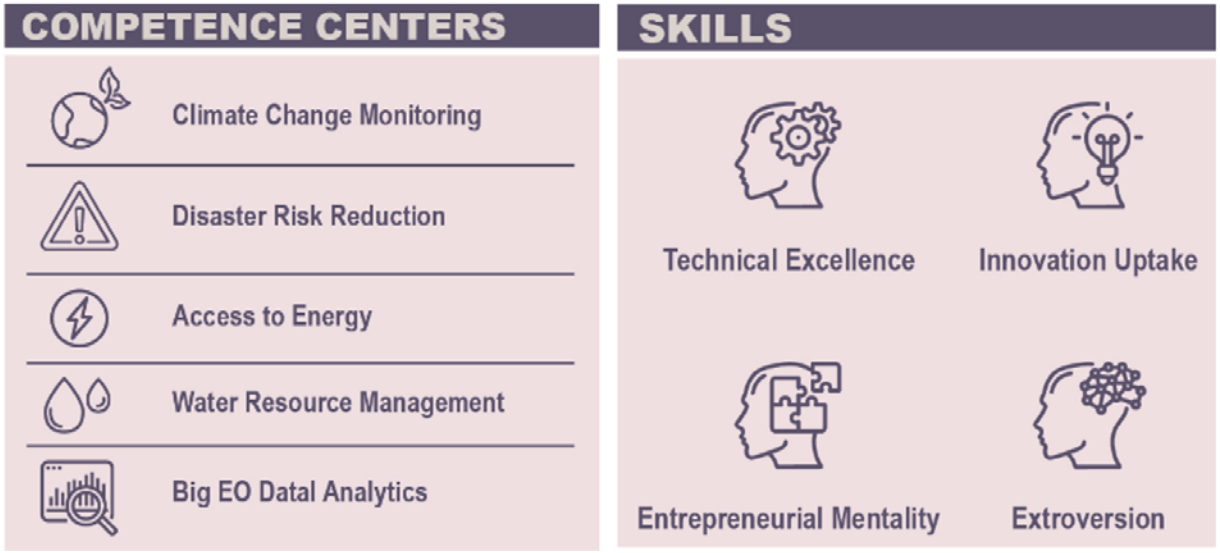

Figure 2. Focus areas and skills necessary

In order to promote the research and innovation resulting from the thematic clusters and focus areas, the ECoE will promote a regular series of lectures and activities on subjects related to its thematic areas to inform and engage the wider public, especially the beneficial impact of the research conducted in the ECoE for the environment, the society and the economy [2]. These activities are expected to raise awareness on e.g., Adaptation and Mitigation to Climate Change, Disaster Risk Reduction and Water Resources Management. The dissemination of the research, applications and innovations developed through the ECoE will be through lectures on a range of topics including food security, sustainable agriculture and forestry, marine and maritime and inland water research, air quality monitoring, climate change, disaster risk reduction, cultural heritage, resource efficiency and raw materials, secure clean and efficient energy, Big Earth data analytics, as well as geo-informatics. In addition, the ECoE will develop and promote in EO science

culture within primary and secondary education levels in collaboration with the Copernicus Academy, NASA Training Centre and Ministry of Education.

3. EXCELSIOR AND EMMENA

The goal of the ECoE is to become a world-class Digital Innovation Hub and a Research Competence Centre for Earth Observation and Geospatial Information by offering education, research, innovation and application services for Cyprus, the Eastern Mediterranean, Middle East and North Africa (EMMENA) region, Europe and Internationally. The scientific focus of the ECoE is on the integration of novel EO, space and ground based integrated technologies for the efficient systematic monitoring of the environment. The ECoE has the potential to become a catalyst for facilitating and enabling regional, European and International cooperation. The ECoE can act as a gateway that links EO capacities and technological solutions with regional needs, priorities and challenges. The starting point for fostering regional scientific collaboration and exploiting untapped market opportunities in EMMENA are several EO and remote sensing (RS) networks as well as the network chains from the CPs. Such access to active networks of EO stakeholders will utilise the existing capacities of EO assets and identify gaps, priorities, and regional challenges in Europe. Collaboration with the EO and RS networks of which the EXCELSIOR partners are members is vital for sustaining the ECoE's development and operations, since active and mature networks can be utilised in Cyprus as a European gateway to exploit untapped scientific collaboration and commercial market opportunities at the regional, European and International levels. The ECoE seeks to ultimately become a European focal point for cutting-edge EO research and a catalyst for facilitating and enabling International cooperation in EMMENA. This includes an ecosystem of stakeholders that consists of the European scientific community and industry as well as the EMMENA user community in economic and Public Sectors.

3.1 EMMENA Opportunities

The ECoE can become a significant player in the EO domain, in both research and innovation and at the same time place Cyprus and the EMMENA region in a competitive position in the global value chain due to several factors. First, the geographic location and landscape of the area provide an excellent location to examine cohesive areas of uniform needs, contexts and common environmental concerns economy [1-2]. The countries of the EMMENA region share several characteristics, thereby providing opportunities for the ECoE to establish collaborations, partnering schemes and mutually exploiting the developed innovation. As the EMMENA region is a fairly new segment for Earth Observation (EO) activities, there are tremendous opportunities available in Adaptation to Climate Change, Food Security, Exploitation of Minerals and Raw Materials, Access to Renewable Energy Resources, and Disaster Risk Reduction in this region.

Due to its unique location as a European country in the EMMENA region, Cyprus is able to strategically position itself as an enabler between Europe, Africa and the Middle East and benefit from partnerships in these areas which will lead to basic and applied research results that can be utilised by decision-makers and end-users. The unique geographic position of Cyprus (as the most South-Eastern EU Member State) enabling direct acquisition of EO satellite data over the Middle East, the Red Sea and the Persian Gulf, as well as its favourable weather and climatic conditions, enabling cutting-edge research with impact in diverse sectors, including climate change, atmosphere marine, solar energy, etc. As well, a regional Digital Innovation Hub for EO in Cyprus, equipped with a satellite ground receiving station and a supersite for aerosol and cloud monitoring, can provide targeted EO data on a national, regional and European level economy [3-5]. In this way, the ECoE can ensure a sustainable agenda in safeguarding the environment, while influencing and shaping national and European policies regarding public health and citizen welfare to benefit the community and improve the quality of life.

3.2 Networks

The need for EO activities was examined through the GEO-CRADLE network, which was very successful in creating a network in the EMMENA region. The ECoE is strategically positioned as the state-of-the-art centre of EO technologies in EMMENA, by capitalising on the GEO-CRADLE network, thereby integrating EO-capacities, sustaining the network of stakeholders, consolidating the needs and paving the road for establishing the EO market and innovation in the regions of Middle East, North Africa and the Balkans. In addition, the ECoE will expand it with well-established networks such as GEO, NASA, EARSeL, ISPRS, EARLINET, ACTRIS, AERONET, etc. Access to active networks of EO

stakeholders provides access to existing capacities of EO assets as well as identify gaps, priorities, and regional challenges in Europe and EMMENA. Collaboration with the EO and RS networks of which the CPs are members is vital for sustaining the ECoE's development and operations, since active and mature networks can be utilized in Cyprus as a European gateway to exploit untapped scientific collaboration and commercial market opportunities in the EMMENA region.

The active participation of the ECoE in well-established international networks will help the Centre to remain in the forefront of cutting-edge research. It will provide access to new technologies and techniques, ease access to information for solving different kind of issues (e.g., technical guidance), open opportunities to participate in or organize large research campaigns, attract high-esteemed scientists and advanced infrastructure from collaborating institutes. Networking, combined with experience in proposal preparation/coordination, and strong links as well as deep engagement of different stakeholders, is the key for continuous funding attraction and maintenance and enhancement of capacities.

4. REGIONAL POTENTIAL OF THE ECOE

Various factors can be used to identify the success of the ECoE within the first seven years of its operation. These indices include sustainable scientific excellence, innovation, sustainability and autonomy of the ECoE and the potential growth in the region.

In terms of sustained **Scientific Excellence**, it is expected that the ECoE will recruit approximately 90 researchers within the first seven years of operation. The members of the Consortium will provide scientific, technical and engineering capacity building and knowledge transfer to the staff of the ECoE. As well, the ECoE will acquire necessary state-of--the-art scientific equipment, including a Near-Real-Time Receiving station, Supersite for atmospheric and cloud monitoring for calibration and validation, Geodetic equipment, field equipment, etc. Through the ECoE Digital Innovation Hub, the ECoE will be able to develop scientific products, mature and new processing chains, models and methodologies. The Centre will enable sustainable skills development through invited speakers by experts and training activities, as well as promote scientific awareness of the ECoE through journal and conference presentations and research proposals.

The **innovation potential** of the ECoE will result from the development of the Digital Innovation Hub for EO, which will exploit untapped market opportunities in research, education and entrepreneurship in Cyprus, Europe and the EMMENA region. The innovation of the ECoE is indicated through its generation of higher level EO products, added-value products and end-to-end services as well as its exploitation of the synergies with industry.

The **sustainability and autonomy** of the ECoE will result from its ability to attract funding from national (RPF) and EU Framework Programmes. Considering the high number of researchers that will be employed by the ECoE, it is expected that the ECoE will be able to attract funds through research projects. It is also expected to generate income from applied research activities, scientific infrastructure capabilities and targeted applications developed by the Centre. The Centre will also receive income from educational and skills development programs in the fields of EO and RS.

To ensure **growth in the region**, the ECoE needs to align with the priorities for Smart Specialisation Strategy for Cyprus (S3Cy) as well as develop entrepreneurial mechanisms to encourage open innovation and stimulate the creation of new businesses in EO in Cyprus. In addition, the ECoE will outreach to the European and EMMENA ecosystem of stakeholders regarding EO products, services and applications, in order to nurture connectivity within the European and EMMENA industrial and stakeholder network. The untapped market opportunities in the National and EMMENA region in relation to SDG-related priorities through the DIH for EO and networking activities will be exploited. Last, the Centre will provide access to the ECoE Asset Sharing Unit, including infrastructure, education, ECoE networking and knowledge hub applications, services and an entrepreneurship service area.

Partnership and networking are vital to the sustainability of the ECoE. Therefore, the ECoE will collaborate with the Consortium partners in a co-exploitation model to benefit from knowledge and skill transfer. A regional stakeholders networking hub is critical to the success of the ECoE, including stakeholders, colleagues, potential collaborators, etc. The ECoE will participate in technological cluster initiatives as well as European or International Scientific

Infrastructure Network. It will expand its visibility to the National, regional and European stakeholders in basic and applied research through workshops, meetings, seminars, conferences, etc. The ECoE will also engage the organisations that have already committed to collaborate and provide resources in various forms in a business-to-business asset sharing model.

5. CONCLUSION

The aim of the proposed TEAMING project is to further promote the existing ERATOSTHENES Research Centre (ERC), established within the Cyprus University of Technology (CUT) into a sustainable, viable and autonomous Centre of Excellence (CoE) for Earth Surveillance and Space-Based Monitoring of the Environment, which will provide the highest quality of related services on the National, Regional, European and International levels. The long-term aim of the upgraded centre is to create new opportunities for innovative ground-breaking research and promote Cyprus to the European Research Area in the field of systematic monitoring of environment using Earth Observation, space and ground based integrated technologies. use of remote sensing and space-based techniques for monitoring the environment.

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