The Establishment of the EXcellence Research Centre for Earth Surveillance and Space-Based Monitoring of the Environment (EXCELSIOR) for the Eastern Mediterranean Region

Hadjmıtsıs D.G.[1], Kontoes H.[2], Schreıer G.[3], Ansmann A.[4], Komodromos G.[5], Themıstocleous K.[1]*, Mamourı R.[1], Mıchaelıdes S.[1], Nısantzı A.[1], Papoutsa C.[1], Mettas C.[1] And Tzouvaras M.[1]

[1]Cyprus University of Technology, Department of Civil Engineering and Geomatics, ERATOSTHENES Research Centre, Cyprus.

[2]National Observatory of Athens, Greece.

[3]German Aerospace Center, Germany.

[4]Leibniz Institute for Tropospheric Research, Germany.

[5]Department of Electronic Communications, Ministry of Transport, Communications and Works, Cyprus

*corresponding author:

e-mail: k.themistocleous@cut.ac.cy

Abstract

The aim of this paper is to present our vision to upgrade 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 (EXCELSIOR), which will provide the highest quality of related services on the National, European and International levels. The implementation of the vision will be addressed through a robust Business Plan that will be developed with in Phase 1 of EXCELSIOR project and will establish the foundations for the development of a competitive and high competence profile to expand the Centre's visibility beyond the national level and develop transnational regional cooperation. The Business Plan is key to ensure the sustainability of the CoE and will also provide the necessary guarantees for a self-sustained operation. The long term aim of the upgraded Centre is to create new opportunities for conducting basic and applied research and innovation (R&I) in the areas of the integrated use of remote sensing and space-based techniques for monitoring the environment.

Keywords: Center of Excellence, remote sensing, Cyprus, environmental monitoring

1. Introduction

Earth Observation technologies are vital for providing reliable up-to-date information to better observe, understand, protect, monitor and predict environmental parameters that regard land, water and air. Such valuable inputs are crucial for more informed decision-making oriented towards the protection and management of environment and resources. Earth observation utilizes technological solutions including satellite observation, navigation and positioning systems. To date, conventional methods are employed for the detection of threats/risks related to pollution events in air, land and water, including the use of physicochemical sampling campaigns and site visits. These techniques are time consuming and require extensive use of manpower and, the same time, create additional environmental issues. The existing ERATOSTHENES Research Center (ERC) conducts state-of-the-art research, integrating novel technologies in the areas of Remote Sensing and space-based earth observation techniques, along with the use of Geographic Information Systems (GIS), to develop sustainable and systematic monitoring of areas of interest and the on-time detection of risks. The ultimate goal of the CoE will be the protection of the environment, providing critical information, through end user products; not only to policy makers but also to other local, national and regional authorities. The ERC has demonstrated its innovation and dynamics in the field of Earth Observation over the past 10 years of its existence and is now focused on upgrading the existing ERC into a Center of Excellence (CoE), which will address the national, regional and international needs regarding remote sensing and Earth Observation. The ERC has received funding for over 60 competitive research programs and funded projects since 2007, with funding Sources from the European Union (EU), the Cyprus Research Promotion Foundation (RPF) and industry. The recent projects of ERC are focused on the Remote sensing applications in the fields of i) Environmental and Climate Research (EU- FP7: BACCHUS, EU-H2020: GEO-CRADLE, RPF: AIRSPACE, RPF: WEBAIR) ii) build environment protection and monitoring (RPF-JPI: PROTHEGO, RPF-JPI: CLIMA, RPF: ICAROS) iii) agricultural and ecosystems (EU-FP7: CASCADE iv) water management and resources (RPF: WATERLEAKS, HYDRAULICS) and v) innovation and efficiency in built environment (RPF: STEELCOR, EU-FP7: ANAGENNISIS, and INTEREG: MARITIME SPATIAL PLANNING and v) training and transfer of knowledge EU-H2020: ATHENA and EU-ERASMUS+: ITRAPRISE,

EU: RISE) among others (see http://www.cyprusremotesensing.com/research-rants). The EXCELSIOR project is built upon the vision for the upgrading of the existing ERC to a sustainable CoE. The upgrade will regard the expansion of this vision to systematic monitoring of environment using Earth observation, space and ground based integrated technologies focusing on land, air and water related applications. The main pillar will be on conducting basic and applied research to bring innovation in the areas of the integrated use of remote sensing and space-based techniques for monitoring the environment. Five partners that already have strong collaborations with each other have united in EXCELSIOR project with the common vision to upgrade the existing ERC to become a world-class innovation, research and education center, actively contributing to the European Research Area (ERA). These five partners include the Cyprus University of Technology (CUT, acting as the coordinator), the German Aerospace Centre (DLR- partner in ATHENA), the National Observatory of Athens (NOA – partner in GEO-CRADLE), the German Leibniz Institute for Tropospheric Research (TROPOS – partner in BACCHUS) and the Cyprus' Department of Electronic Communications of the Ministry of Transport, Communications and Works (DEC-MTCW – strong collaboration for SPACE issues).

2. Areas of Expertise of ERATOSTHENES

The current ERATOSTHENES Research Center is built upon the following areas of expertise, namely: (i) Land Section (Land); (ii) Water Section (Water) and (iii) Atmospheric Section (Air) mainly based on the use of the space-born observations and Remote Sensing techniques for the protection and the monitoring of the environment. The present research capacities of ERATOSTHENES are given in the following:

2.1. Land Section

The current state-of-the-art includes characteristic services such as the monitoring and forecast of natural environment (forests drylands, crops) and natural geo-hazards (including desertification, earthquakes, landslides, flooding, fire). The research activities of the ERC focus on crop prediction, soil monitoring, pest control and sustainable land use. Additionally, the monitoring of archaeological and built cultural heritage sites for purposes of their better conservation and valorisation are one of the main activities of the Centre. Indeed through the Athena Twinning Horizon 2020 project, the Centre deals with new research issues of remote sensing in cultural heritage and archaeology such as interferomotry and hyperspectral techniques. Systematic services of Land use/land change are of particular importance for urban growth and the built environment (Agapiou *et al*., 2015; Neocleous *et al*., 2016). Economic sectors affected by Land Section in Cyprus are hence mainly Agriculture (with focus on Infrastructure and Planning for urban and rural areas) (Papoutsa *et al*., 2016; Themistocleous *et al*., 2014a), the built environment (Themistocleous *et al*., 2012; Themistocleous *et al*., 2014b) and the efficiency constructions.

2.2. Water Section

The current state-of-the-art focuses on water management as one of the more important priority sectors for Cyprus, since the island has a long history of water challenges, including severe water scarcity problems for centuries. The ERC aims to support public authorities, stakeholders and private interest to retrieve useful information for optimizing water management by using available satellite data. Some of the major research sectors of the Centre, monitoring water quality in dams using satellite remote sensing, with the aim to protect and preserve the quality of available water as well as monitoring coastal areas, and identifying water leakages in urban and rural areas through passive and active remote sensing techniques (Agapiou *et al*., 2014; 2016). Additional research includes examining drought events due to climate change through earth observation systems as well as Marine Spatial Planning (Hadjimitsis *et al*., 2015), which focuses on coastal and maritime tourism and the promotion of sea based cargo and passenger transportation are some of the crucial areas included.

2.3. Atmospheric Section

The current state-of-the-art of the Atmospheric sector of ERC are primarily focused on (1) provision of useful tools and knowledge for the discrimination of manmade from natural sources of pollution, for subtracting the contribution of natural sources before comparing ambient air pollutant concentrations with relevant legally binding limit values (Nisantzi *et al*., 2014; Nisantzi *et al*., 2015; Mamouri and Ansmann, 2014), (2) minimization of agricultural losses and efficient planning through better understanding of precipitation and hail initiating processes, since the on-line knowledge of the background aerosol content in terms of freezing nuclei can provide a valuable source of information for future rainfall enhancement and/or hail suppression operations (Mamouri and Ansmann 2015; 2016), and (3) alert mechanisms for high aerosol concentrations (e.g., dust events, volcanic eruptions), for enabling timely information of the public, minimize exposure and reduce hospital admission and other health related costs (health, tourism) (Hadjimitsis *et al*., 2013a; 2013b; 2013c; Mamouri *et al*., 2016) and to improve safety in aviation (transport) .

3. Smart Specialization Strategy (S3Cy)

The EXCELSIOR's project vision of the significant upgrade of the ERC into a CoE in Earth Surveillance and Space-Based Monitoring of the Environment, is fully aligned with the Smart Specialization Strategy (S3Cy) for Cyprus. The S3Cy has been esteblished by the Government of Cyprus (Government of Cyprus, 2015), based on priority sectors that have been selected for future sustainable economic growth in Cyprus. The strong background and individual experience of the ERC in the area of remote sensing and space technologies, combined with the synergy that will be established with the partners of the project, can result in the implementatin of a sustainable CoE, which will address crucial research and innovation (R&I) problems of great societal benefit. The research fields of Earth Observations and space technology have matured to the point that many challenges lie in the capitalisation of existing knowledge and

technologies to enable advances in many diverse application areas stated in the S3Cy, such as health, tourism, agriculture, cultural heritage, transport, blue growth etc. The R&I activities of the upgraded ERATOSTHENES CoE are planned to be directly linked with the thematic areas of the horizontal priorities of Environment and Information & Communication Technologies of S3Cy, through future collaboration with the industry.

4. Conclusions

The objective of the first phase of the EXCELSIOR project is the development of a detailed and robust Business Plan for upgrading the ERC. Such a Business Plan will target the long term vision to transform ERATOSTHENES itself into an EXcellence Research Centre for Earth SurveiLlance and Space-Based MonItoring Of the EnviRonment by enhancing the scientific and R&I capabilities of the existing center. This enhancement will enable the provision of new, highly innovative products and services to national, regional and international public and private sector, in the Space and Earth Monitoring sectors. The development of the Business Plan is key to ensure the sustainability of the CoE and will also provide the necessary guarantees for its long term self-sustained operations. The Business Plan will establish the foundations for the development of a competitive and high competence profile to expand the Centre's visibility beyond the national level and develop transnational regional cooperation.

References

Agapiou A., Alexakis D.D., Themistocleous K. and Hadjimitsis D. G. (2014), Water Leakages Detection Using Remote Sensing, Field Spectroscopy and GIS in Semiarid Areas of Cyprus, *Urban Water Journal*, DOI: 10.1080/ 1573062X.2014.975726.

Agapiou A., Alexakis D.D., Lysandrou V., Sarris A., Cuca B., Themistocleous K. and Hadjimitsis D.G (2015), Impact of Urban Sprawl to Archaeological Research: The Case Study of Paphos Area in Cyprus. *Journal of Cultural Heritage*, Available at: http://dx.doi.org/10.1016/j.culher.2014.12.006.

Agapiou A., Alexakis, D., Themistocleous K. and Hadjimitsis, D.G. (2016), Water leakage detection using remote sensing, field spectroscopy and GIS in semiarid areas of Cyprus. *Urban Water Journal*, **13 (3)**, 221-231.

Government of Cyprus (2015), Smart Specialisation Strategy For Cyprus. Available at: http://www.dgepcd.gov.cy/dgepcd/dgepcd.nsf/6966F1D9F8511C00C2257C7D0048701E/$file/S3CY_FINAL%20corrections%2031032015.pdf (in Greek).

Hadjimitsis D.G., Themistocleous K. and Nisantzi, A. (2013a), Air Pollution Monitoring Using Earth Observation and GIS, Book Chapter "Air Pollution - Monitoring, Modelling and Health" edited by M. Khare, InTech, ISBN 978-953-51-0424-7.www. intechopen.com/books/air-pollution-monitoring-modelling-and-health/ air-pollution-monitoring-using-earth-observation-gis.

Hadjimitsis D. G., Mamouri R.-E., Nisantzi A., Kouremerti N., Retalis A., Paronis D., Tymvios F., Perdikou S., Achileos S., Hadjicharalambous M., Athanasatos S., Themistocleous K., Papoutsa C., Christodoulou A., Michaelides S., Evans J., Abdel Kader M. M., Zittis G., Panayiotou M., Lelieveld J. and Koutrakis P. (2013b), Air Pollution from Space, Book Chapter "Remote Sensing of Environment - Integrated Approaches" edited by D.G. Hadjimitsis, InTech, ISBN 978-953-51-1152-8, www.intechopen.com/ books/remote-sensing-of-environment-integrated-approaches/air-pollution-from-space.

Hadjimitsis, D.G., Agapiou, A., Themistocleous, K., Achilleos, C. Nisantzi, A., Mamouri, R.E. Panayiotou, C. and Kleanthous, S. (2013c). Air Pollution Monitoring Based on Remote Sensing and Simultaneous Ground PM 10 and PM2.5 Measurements: The 'WebAir-2 Project'. Advances in Meteorology, Climatology and Atmospheric Physics, Springer Atmospheric Sciences, 987-993. DOI: 10.1007/978-3-642-29172-2_138.

Hadjimitsis, D., Agapiou, A., Mettas, C., Themistocleous, K., Evagorou, E., Cuca, B., and Xagoraris, Z. (2015), Marine spatial planning in Cyprus. In: Third International Conference on Remote Sensing and Geoinformation of the Environment (pp. 953511-953511). International Society for Optics and Photonics.

Mamouri, R. E. and Ansmann, A. (2015), Estimated desert-dust ice nuclei profiles from polarization lidar: methodology and case studies, *Atmospheric Chemistry and Physics*, 15, 3463-3477, doi:10.5194/acp-15-3463-2015.

Mamouri, R. E. and Ansmann, A. (2014), Fine and coarse dust separation with polarization lidar, *Atmospheric Measurement Techniques*, **7**, 3717-3735, doi:10.5194/ amt-7-3717-2014.

Mamouri, R.-E. and Ansmann, A. (2016), Potential of polarization lidar to provide profiles of CCN- and INP-relevant aerosol parameters, *Atmospheric Chemistry and Physics*, 16, 5905-5931, doi:10.5194/ acp-16-5905-2016.

Mamouri, R.-E., Ansmann, A., Nisantzi, A., Solomos, S., Kallos, G., and Hadjimitsis, D. G. (2016), Extreme dust storm over the eastern Mediterranean in September 2015: satellite, lidar, and surface observations in the Cyprus region, *Atmospheric Chemistry and Physics*, 16, 13711-13724, doi:10.5194/acp-16-13711-2016.

Neocleous, K., Christofe, A., Agapiou, A., Evagorou, E., Themistocleous, K. and Hadjimitsis, D. (2016). Digital mapping of corrosion risk in coastal urban areas using remote sensing and structural condition assessment: case study in Cyprus. *Open Geosciences*, **8** (1), 662-674.

Nisantzi A., Hadjimitsis D., Agapiou A., Themistocleous K., Michaelides S., Tymvios F., Charalambous D., Athanasatos S., Retalis A., Paronis D., Perdikou S., Koutrakis P., Evans J.S. and Achilleos, S. (2013), Study of Air Pollution with the Integrated Use of MODIS data, LIDAR, Sun Photometers and Ground PM Sampler Measurements in Cyprus, Advances in Meteorology, Climatology and Atmospheric Physics, Springer Atmospheric Sciences, 1133-1139, DOI: 10.1007/978-3-642-29172-2_158.

Nisantzi, A., Mamouri, R. E., Ansmann, A., and Hadjimitsis, D. (2014), Injection of mineral dust into the free troposphere during fire events observed with polarization lidar at Limassol, Cyprus, *Atmos. Chem. Phys*., **14**, 12155-12165, doi:10.5194/acp-14-12155-2014.

Nisantzi, A., Mamouri, R. E., Ansmann, A., Schuster, G. L., and Hadjimitsis, D.G. (2015), Middle East versus Saharan dust extinction-to-backscatter ratios, *Atmospheric Chemistry and Physics*, **15**, 7071-7084, doi:10.5194/acp-15-7071-2015.

Papoutsa, C., Kouhartsiouk, D., Themistocleous K., Christoforou M. and Hadjimitsis, D.G. (2016), Monitoring of land degradation from overgrazing using space-borne radar and optical imagery: a case study in Randi Forest, Cyprus. Proceedings of SPIE 10005, Earth Resources and Environmental Remote Sensing/GIS Applications VII, 1000516, 26-29 September, 2016, Edinburgh, Scotland.

Themistocleous K., Nisantzi A., Agapiou A., Alexakis D.D., Hadjimitsis D.G., Lysandrou V., Perdikou S., Retalis A. and Chrysoulakis N. (2012), Long Term Monitoring of Air Pollution on Monuments and Cultural Heritage Sites in Cyprus Using Satellite Remote Sensing, *International Journal Heritage in the Digital Era*, 1(1), 145-167.

Themistocleous, K., Christofe, A., Neocleous, K., Agapiou, A., Tzouvaras, M., Achillides, Z., Panayiotou M. and Hadjimitsis, D.G. (2014a), The Development Of Structural Integrity Maps Of High Risk Areas In Cyprus Due To Corrosion Of Steel Reinforcement Using GIS: The 'Steelcor' Project. *South- Eastern European Journal of Earth Observation and Geomatics*, **7** (**25**) 733-736.

Themistocleous, K., Papadavid, G., Christoforou, M., Agapiou, A., Andreou, K., Tsaltas, D. and Hadjimitsis, D.G. (2014b), Detecting land cover changes from overgrazing using remote sensing techniques: a case study of Randi Forest, Cyprus. *South-Eastern European Journal of Earth Observation and Geomatics*, **7**(**25**) 729-732.