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# SeaTecHub: Croatia-Cyprus Excellence Hub on Eco-Innovative Technologies for Healthy and Productive Seas

Barbara Arbanas Ferreira<sup>1,\*</sup>, Nikola Miskovic<sup>1</sup>, Marina Loizidou<sup>2</sup>, Mateo Ante Bosnic<sup>3</sup>, Ivana Bujas Rupic<sup>4</sup>, Hrvoje Cizmek<sup>5</sup>, Anna Foka<sup>6</sup>, Demetris Hadjigeorgiou<sup>7</sup>, Nicolas Ioannou<sup>8</sup>, Mateo Ivanac<sup>9</sup>, Marios Josephides<sup>10</sup>, Josip Madunic<sup>11</sup>, Demetra Orthodoxou<sup>12</sup>, Damir Slamlic<sup>13</sup>, Konstantinos Smagas<sup>14</sup> and Ioannis Kyriakides<sup>2</sup>

**Abstract**—Blue Economy represents an important economic source in Croatia and Cyprus with around 10% of jobs in each country being related to Blue Economy. Thinking on this fact, the main goal of the SeaTecHub project is to strengthen Croatian and Cyprus place-based innovation ecosystems and improve access to excellence for R&I actors by cross-border collaboration on a common strategy and alongside value adding chains within the area of eco-innovative technologies for healthy and productive seas, focusing on sectors 1. Aquaculture and fisheries, 2. Smart ports, 3. Maritime security and protection, 4. Research and Education, and 5. Maritime technologies. To do so a set of measures including joint strategy, action and investment plans, joint R&I projects and knowledge exchange activities is being implemented. This paper reports on the initial project work related to the joint strategy and other activities during the first months of the project.

**Index Terms**—Blue Economy, innovation, R&I, maritime technologies

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<sup>1</sup>University of Zagreb Faculty of Electrical Engineering and Computing, Unska 3, ZAGREB 10000, Croatia

\*Corresponding author: B. Arbanas Ferreira, barbara.arbanas@fer.hr

<sup>2</sup>Cyprus Marine and Maritime Institute (CMMI), Vasileos Pavlou Square, P.O. Box 40930, LARNACA 6023, Cyprus

<sup>3</sup>Ministry of Science and Education (MZO), Donje Svetice 38, ZAGREB 10000, Croatia

<sup>4</sup>AgriFood Croatia (AFC), PUT GIMNAZIJE 2, SIBENIK 22000, Croatia

<sup>5</sup>20000 Leagues (20kL), PUT BOKANJCA 26A, ZADAR 23000, Croatia

<sup>6</sup>The Cyprus Chamber of Commerce and Industry (CCCI), GRIVA DIGENI 38 & DELIGIORGI 3, LEFKOSIA 1066, Cyprus

<sup>7</sup>Fameline Energy Ltd (FML), FAMELINE BUILDING 2, 8 SPATHARIKOU, LIMASSOL 4004, Cyprus

<sup>8</sup>The Shipping Deputy Ministry (SDM), Kyllinis Street, Mesa Geitonia, LEMESOS 4007, Cyprus

<sup>9</sup>The Croatian Chamber of Economy (CCE), Rooseveltov trg 2, ZAGREB 10000, Croatia

<sup>10</sup>The Department of Fisheries and Marine Research (DFMR), Athalassa, NICOSIA 1417, Cyprus

<sup>11</sup>IN2 Ltd, MAROHNICEVA 1/1, ZAGREB 10000, Croatia

<sup>12</sup>AKTI KENTRO MELETON KE EREVNAS (AKTI), 95 KERYNEIAS AVENUE GROUND FLOOR AGLANTZIA, LEFKOSIA 2113, Cyprus

<sup>13</sup>Sibenik-Knin County, Trg Pavla Subica I. 2, SIBENIK 22000, Croatia

<sup>14</sup>GEOimaging Ltd, PERIKLEOUS 47 STROVOLOS, LEFKOSIA 2021, Cyprus

## I. INTRODUCTION

Croatia and Cyprus are excellent examples of Mediterranean EU Member States that are highly dependent on their marine environment and maritime transport and are similar in many respects despite their minimal geopolitical proximity or co-operation. Croatia's coastline occupies nearly 20% of its land area and is a critical factor in the country's economy. Cyprus, the third largest Mediterranean island, has a robust maritime sector that generates about 1 billion euros annually. The blue economy contributes significantly to the ecosystems of both countries, accounting for 8.2% of gross value added (GVA) and 9.8% of jobs in Croatia, while in Cyprus it accounts for 6.1% of GVA and 10.3% of jobs in the national economy. Both countries rank high among the EU widening countries in terms of dependence on blue economy sectors [1].

However, the marine environment is becoming increasingly vulnerable to the impacts of economic activities that are intensifying, creating an ever-increasing environmental footprint through blue sector industries. Eco-innovative maritime technologies have the potential to reduce this environmental footprint while promoting sustainable economic growth in blue economy sectors.

Both Croatia and Cyprus have laid foundations for the introduction of such technologies in their ecosystems: a research community experienced in marine technology, companies based on blue economy sectors, civil society organizations dedicated to protecting the marine environment and ocean literacy education, and public authorities that promote and support responsible use of marine resources.

The main objective of the SeaTecHub [2] project is to enhance the regional innovation ecosystems of Croatia and Cyprus while promoting access to excellence for research and innovation (R&I) actors through cross-border collaboration within a common strategic framework. The project will achieve both economic growth and environmental sustainability by addressing national and EU policy goals (e.g. European Green Deal and Digital transition<sup>1</sup>, and RIS3 [3]) and extending collaboration in place-based innovation ecosystems

<sup>1</sup>[https://joint-research-centre.ec.europa.eu/jrc-science-and-knowledge-activities\\_en](https://joint-research-centre.ec.europa.eu/jrc-science-and-knowledge-activities_en)

to cross-border collaboration between two remote widening countries.

The methodology followed to achieve the main goal is detailed in Section II while Section III presents preliminary results. Then, Section IV presents the know-how exchanges and broad networking activities that took place/are planned to the near future. Finally, Section V concludes the paper.

## II. METHODOLOGY

The SeaTechHub consortium covers the quadruple helix stakeholders (science, policy, industry, and society) [4] of Croatia and Cyprus ecosystems: 2 research institutions, 4 public authorities, 5 economic actors and 3 non-governmental organizations (NGOs), as illustrated in Figure 1. A strong willingness to actively participate was also expressed by 49 institutions who have provided Letter of Support. The project lasts for 4 years and has a total funding of 5 Million Euros.

As shown in Fig. 2, the project focuses its efforts on *five priority sectors* of the blue economy, which were chosen based on their placement within the Smart Specialization Strategies (S3) [3] of both Croatia and Cyprus as well as being significant aspects of the Green Deal:

- **Aquaculture and Fisheries** play a critical role in the blue economy and feeding a growing population. However, they can have significant environmental impacts if growth is uncontrollable. Promoting sustainable practices and innovations in these sectors will curb marine pollution from fishing vessels, including discarded fishing gear and ghost fishing.
- **Smart Ports**, including marinas and fishing ports, can improve efficiency and sustainability by using smart digital solutions and autonomous systems to optimize traffic flows and cargo handling, and contribute to decarbonization.
- **Maritime Security and Protection.** Monitoring and protecting heritage sites has both social and financial implications. Marine Protected Areas (MPAs) require the use of sensors and robots for monitoring and protection, as well as citizen education and awareness.
- **Maritime Technologies.** The application areas are vertically aligned with a horizontal topic of environmental monitoring for sustainability. R&I work includes cross-cutting technologies that apply to multiple scenarios.
- **Research and Education.** Europe has invested significantly in infrastructure and R&D, as well as in education and training, resulting in highly innovative and sustainable maritime technologies and strongly promoting cross-border cooperation between research institutions and industry.

The objectives of the SeaTechHub project are:

- to facilitate long-term cross border and inter-sectoral collaboration to advance eco-innovative technologies for healthy and productive seas;
- to perform joint research work to close knowledge gaps, consolidate and reinforce quadruple-helix linkages, and validate strategy and action and investment plans (AIPs);

- to implement a set of mutual learning and skills development measures;
- to raise visibility of Croatian-Cyprus innovation ecosystems by implementing strategic measures in the form of organizing networking, knowledge and experience transfer events.

Focusing on these five critical sectors and to answer to the objectives aimed at strengthening the innovation ecosystems of Croatia and Cyprus, the project encompasses the following key activities:

- 1) *A joint R&I strategy and common action and investment plans* that address the challenges and seize the opportunities in the territorial context of the common sea. Emerging digitalization technologies are transforming strategy and plans to remove geographic, political, and regulatory barriers and accelerate green and digital transition;
- 2) *R&I activities* focused on eco-innovative maritime technologies that will consolidate linkages within the cross-border and cross-sectoral quadruple helix stakeholders;
- 3) *Pilots and demonstrators* relevant to the identified sectors of the blue economy and aligned with needs in both ecosystems;
- 4) A set of *accompanying measures* that support transferable strategic partnerships and community-building capabilities and enable a paradigm shift in the development of territorially extended, place-based innovation.

## III. PRELIMINARY RESULTS

In the initial phase of the SeaTechHub project, partners are working together to formulate a **unified R&I strategy and create joint action and investment plans** (AIP). The methodology includes: literature review, use of social sciences standards for the analysis, drawing of conclusions and recommendations based on evidence and not only on perceptions, comparison among and with other EU regions, involvement of local quadruple helix. The first task was to collect key data from the five relevant sectors of the blue economy (see Fig. 2) and perform a needs and gaps diagnosis. Within each sector, the working groups compiled a database of over 500 entries listing all relevant actors in both countries. This database provides comprehensive information on each stakeholder and allows for the creation of an initial overview of the social and human capital, critical infrastructure, and key actors in each sector in both countries.

A comprehensive report (over 200 pages) has been published as the first deliverable towards the joint strategy, action and investment plan<sup>2</sup>. This report performs a cross-border joint R&I diagnosis in the five sectors and presents needs and gap analysis per each sector.

Needs and gaps were analyzed in terms of infrastructure, human capital, social capital, financial resources, Innovation

<sup>2</sup>[https://drive.google.com/file/d/1VLq-H8TrJp4YdLe29deeh9\\_\\_ESPAb6a/view?usp=sharing](https://drive.google.com/file/d/1VLq-H8TrJp4YdLe29deeh9__ESPAb6a/view?usp=sharing)

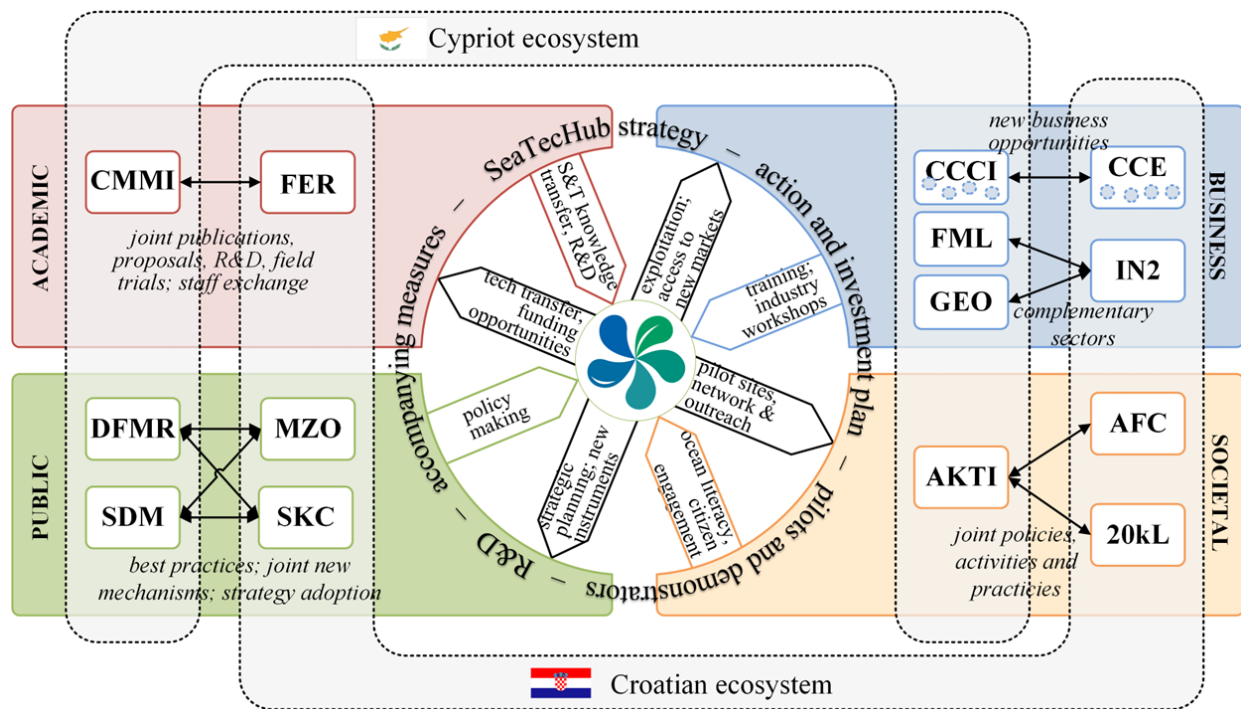


Fig. 1. SeaTechHub Quadruple helix partners and their interconnections



Fig. 2. SeaTechHub sectors and activity pillars

ecosystem orchestrator and key players, Smart Specialization Strategy and quadruple helix level of implementation.

Without entering the vast amount of detail that the report includes, regarding the needs and gaps, several common themes were identified across sectors and countries. In particular, lack of coordination and optimization of infrastructure, a need for better financial instruments/funding for industry and start-

ups, a lack of skills (especially technological), delayed digital transformation (including cybersecurity awareness), lack of interest from young generations, low degree of collaboration academia-industry (and lack of funding for this type of collaboration), lack of engagement among the community/stakeholders and lack of tools/platforms to enable such engagement, lack of knowledge transfer and continuous training, need to think more in terms of environmental sustainability, need for more agile legislation to keep the pace with the latest innovations and lack of citizen engagement.

After this diagnosis, the work continues using working groups. These groups involved key stakeholders through questionnaires, creating a strong network of diverse quadruple helix representatives (academia, policy, industry, and society). These stakeholders will collaborate to refine the R&I strategy, action plans, and investment strategies. This process identifies vital technology gaps to achieve the project's core objectives: economic growth and environmental sustainability in Croatia and Cyprus ecosystems.

As enabling technologies to be developed under the joint research project include a *Marine Spatial Planning (MSP)* tool, which uses smart data processing to allocate zones for maritime activities, and *low-cost Maritime Internet of Things (IoT)*s, which will streamline data collection about the natural environment and human activities. These serve as the basis of future research but can be expanded depending on the identified needs and the define strategy, action and implementation plan. The MSP tool (an example shown in Fig. 3) will be developed by integrating open-access tools and

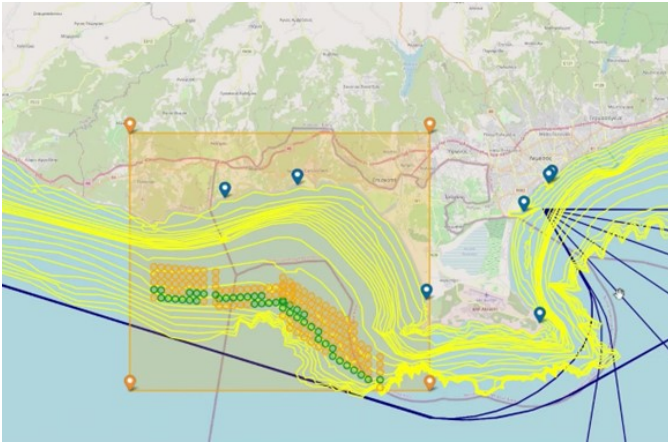


Fig. 3. MSP tool example



Fig. 4. IoT buoys

open-access databases and will be tested in various use cases related to planning, such as the installation of new aquaculture facilities or marine renewable energy farms. Access to features and assets will be granted via tokens. Using technologies such as Non-Fungible Tokens (NFTs) will simplify co-ownership and asset exchange and reduce bureaucracy. The low-cost maritime Internet of Things (IoTs) is envisioned to enable wider technology uptake leading to the increase of marine environment data and awareness of blue economy needs. Examples of static, mobile, and diver-related IoTs can be found in Figures 4, 5 and 6.

#### IV. KNOW-HOW EXCHANGES AND BROAD NETWORK ACTIVITIES

To develop skills and transfer knowledge between the two countries ecosystems, a series of measures are being used:

- expert visits and trainings on Science and Technology (S&T) and ocean literacy;
- innovation trainings;
- mutual staff exchanges.

The first activity is not only cross-border but also cross-sectorial, i.e. a partner from Croatia from a given quadruple helix area visits a partner in Cyprus from a different quadruple helix area (and vice-versa). A total of 24 visits on S&T and 19 on ocean literacy are expected. These visits include both lectures and practical activities such as tutorials. Some of these



Fig. 5. mobile IoT buoy



Fig. 6. diver IoT device

already took place with the first staff coming from Cyprus Marine and Maritime Institute (CMMI) to the University of Zagreb Faculty of Electrical Engineering and Computing (FER) and from FER to CMMI.

Innovation trainings on R&I management, technology transfer, and entrepreneurship are essential for a common understanding of the challenges related to innovation and to train partners that may not have had access to this kind of training previously.

Finally, staff exchanges include both short-term (2 weeks) staff exchanges between non-academic partners and long-term (2 months) between academic partners. These staff exchanges contribute not only to an exchange of best practices and better cooperation but also to a stronger cohesion between the partners from different countries and sectors.

The other activities that contribute to better connection between ecosystems, between sectors, and with external stakeholders are broad network events. These include participation in conferences and industrial fairs but above all include the organization of two workshops series that are widely recognized within the European marine robotics landscape: the Workshop



Fig. 7. One of the demos at sea during BTS 2023.

on EU-funded Marine Robotics and Applications (EMRA) and the International Interdisciplinary Field Workshop of Maritime Robotics and Applications - Breaking the Surface (BTS) [5].

EMRA started in 2014 with the goal of connecting industry, policy makers, and academia and the 2023 edition [6] has been co-organized by two of the SeaTecHub partners: FER and IN2. SeaTecHub was also presented during the event and participated in a roundtable related to the WIDERA program from the EU. The roundtable was moderated by Dr. Adeline Kroll, an EU policy officer, and joined 5 different WIDERA projects to discuss the challenges and opportunities of this program. EMRA' 2023 was the first, successful, post-pandemic, fully in-person edition of EMRA, and it reached 100 participants from 13 countries. The program was divided into 16 EU project presentations, 5 industry presentations, and 2 roundtables with policy makers. To disseminate the knowledge not only among SeaTecHub partners but also contribute to the wider community and following open science principles, the proceedings have been published online with open access [7]. Currently, preparations are ongoing for the upcoming EMRA 2024 workshop [8], scheduled for May 28-29 in Arenzano, Italy, and co-organized by project partner Faneline Energy.

The other main event, Breaking the Surface, has been organized by the partner FER for the past 14 years and will be now co-organized with Cypriot partners as well. The goal of this workshop over the years has been the building of connections with end-users and stakeholders in the areas of marine biology, marine archaeology, oceanography, and marine security. Four field workshops/summer schools will be held during the project's lifespan building upon the success of the 14 previous editions [5]. The first Breaking the Surface co-organized by SeaTecHub partners took place in September 2023 and it gathered 206 participants. The program consisted of:

- 16 lectures where the latest scientific research and results were presented;

- 9 field demonstrations that showcased the latest technology achievements made by research groups and companies (see for instance Fig. 7);
- 6 tutorials which offered hands-on experience with complex and modern underwater systems;
- an acoustic localization challenge - where the participants were tasked to locate a submerged pinger using passive acoustic receivers and a fast boat;
- a 3 minutes/1 slide only pitch competition for students.

The field workshops provide opportunities to collaborate, promote knowledge transfer, and above all, have practical experience, much needed to advance research and innovation. The success of the BTS workshops shows their relevance to achieving those goals, and it is expected that the following BTS workshops will continue to build on this success.

## V. CONCLUSION

The SeaTecHub project was created to enhance research and innovation capacity and economic growth in Croatia and Cyprus, protect the seas, and develop clean solutions to the growing problems of the blue economy. In the coming years, we expect to see increased collaboration between these two ecosystems and some interesting technical solutions that can be applied not only in the two countries but throughout the Mediterranean. In the first few months of the project, the goal was to identify R&I needs and gaps to perform a full diagnosis that can now inform our strategy and action plans and joint R&I projects. Moreover, we had several broad networking events both to exchange knowledge between the partners and to disseminate the project to external stakeholders. In the future, we will continue with defining the joint strategy, action and investment plans as well as joint R&I projects and in parallel, we will keep organizing the EMRA and BTS workshops as well as a high-profile conference/industry fair.

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