D.3.2.3 Technology and market forecast

Project title: Mediterranean Innovation Alliance for sustainable blue economy
Acronym: BLUE BIO MED

Priority Axis 4: Enhancing Mediterranean Governance
4.1: To support the process of strengthening and developing multilateral coordination frameworks in the Mediterranean for joint responses to common challenges

https://blue-bio-med.interreg-med.eu/

Deliverable 3.2.3	**Technology and market forecast**
Description	The report highlights the technology and market future trends for the different sectors pertaining the blue bioeconomy and their linkages with the Sustainable Development Goals. The deliverable is structured into different sections: **1.*Introduction*** 2. *How to read this document* 3. *Technology forecast and importance of SDGs in Blue Bioeconomy* 4. *Complete report on patent and NPL analysis* - *Part I: Fishery and Aquaculture* - *Part II: Blue Biotechnology* - *Part III: Blue Sustainable Development* 5. *Key points on Patent and NPL* 6. *Final remarks*
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Due date of Delivery/Actual date of Delivery (if different)	October, 2021
Status (draft, version, final)	Final
Language	English
Delivery Date:	December, 2021
Distribution	Public

1.Introduction

The **blue economy** includes all those activities that are marine-based or marine-related[1]. Those activities can be defined as:

- Marine-based activities, which include the activities undertaken in the ocean, seas and coastal areas, such as marine living resources (capture fisheries and aquaculture), marine minerals, marine renewable energy, desalination, maritime transport and coastal tourism;
- Marine-related activities, which use/produce products and services derived from ocean, seas and coastal areas for activities like seafood processing, biotechnology, shipbuilding and repair, port activities, technology and equipment, digital services, etc.

Both areas encompass established sectors (e.g., fishery, aquaculture, shipbuilding, etc.) and emerging ones (e.g., blue biotechnology and Costal & Environmental protection), which are evolving fast over the time.

Within the blue economy, the European Commission identified some new and sustainable marine activities as blue bioeconomy defined as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy" (European Commission, 2012)[2].

The blue bioeconomy is gaining increasing importance in the global market and in the Mediterranean Sea. The countries facing the basin are very diverse, in terms of economical indexes, cultural heritage, historical development and exploitation of natural resources, creating a strong boundary between its northern and southern shores. Considering this, being the Mediterranean Sea, a "shared" ecosystem providing goods and services to such complex societal system, there is an utmost need to come up with a joint management and coordination between innovation policies[3].

The ever-growing technological development points to the utilisation of marine resources in a sustainable way (Sustainable Blue Growth), thus employing as much as possible renewable energy and materials, developing processes with a limited carbon footprint, exploiting resources at a pace that permits renovation or reduce at most the impacts.

As regards the Euromediterranean region, the innovation policies referred to the blue bioeconomy sectors call for a better governance to be planned with a transnational approach, possibly focusing on fulfilling the Agenda 2030 Sustainable Development Goals (SDGs)[4]. Against this background, the *BlueBiomed project* aims at bridging the transnational governance frameworks active in the Euromediterranean area with the territorial policy making level.

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[1] European Commission (2021). The EU Blue Economy Report. 2021. Publications Office of the European Union. Luxembourg.

[2] https://ec.europa.eu/info/research-and-innovation/research-area/environment/bioeconomy/blue-bioeconomy_en

[3] Depellegrin, D., Venier, C., Kyriazi, Z., Vassilopoulou, V., Castellani, C., Ramieri, E., ... & Barbanti, A. (2019). Exploring Multi-Use potentials in the Euro-Mediterranean sea space. Science of the Total Environment, 653, 612-629.

[4] The 2030 Agenda for Sustainable Development was adopted by all Member states in 2015. The Agenda provides a shared blueprint for peace and prosperity for people and the planet through the identification of 17 Sustainable Development Goals (SDGs) and 169 targets. The SDGs represents an urgent call for action by all countries in a global partnership to end poverty, improve health and education, reduce inequality and spur economic growth all while tackling climate change and preserving the oceans and the forests (THE 17 GOALS | Sustainable Development (un.org)).

In this regard, the analytic activities developed within the project aim to set a coherent framework and prepare the ground to bridge territorial innovation policies with MED transnational strategies, with a focus on blue bioeconomy. Specifically, the project analytic activity aims at:

- developing a shared approach on the role of innovation for the development of blue bio economy in the Euromediterranean area;
- highlighting the contribute of blue bioeconomy in the transition towards the achievement of the Sustainable Development Goals (SDGs);
- mapping the territorial innovation trends and priorities related with blue bioeconomy and their contribution to SDGs in the Euromediterranean area;
- highlighting connections/ disconnections between transnational strategies and initiatives (i.e., UfM, UNEP-MAP, EUSAIR, WestMed, Bluemed Initiative, etc.) on one hand and territorial policies - including case by case sectoral strategies on blue bioeconomy and RIS3 - on the other;
- highlighting common innovation priorities area across regional and national borders.

Specifically, the report on "***Technology and Market Forecast***" is expected to disclose the technology and market forecasts for the three following sectors pertaining blue bioeconomy and their contribution to foster Sustainable Development Goals (SDGs) in the Euromediterranean area.

The ***Fishery and Aquaculture*** section considers the increasing role that seafood products are having as a source of proteins for human consumption and in the market. This is contrasting with the critical situation of several Mediterranean wild stocks[5] and with a general understanding of the Mediterranean as a system heavily subjected to a series of multiples stresses[6]. Therefore, it is of paramount importance to consider innovations that can efficiently support the use of marine products as a food resource reducing as much as possible the impacts. On one side fishery is facing a particular situation where innovations spam from new technologies and apparatus for optimal harvesting to market-oriented innovations for facilitating selling and valorization of the products[7]. On the other side marine fish farming requires feed to grow the animals; 25% of total fish production worldwide is transformed into feed for fish farms. This approach is high questionable because wild fish stocks are overexploited and because of the inherent inefficiency of having carnivorous fish[8]. Therefore, other than multi-trophic aquaculture, highly automatized feeding and precision aquaculture, an important sector is represented by the fish feed industry and related innovations[9]. This implies looking for new formulations, including alternative mixtures of fish feed or other products aiming to reduce

[5] FAO. 2020. The State of Mediterranean and Black Sea Fisheries 2020. General Fisheries Commission for the Mediterranean. Rome. https://doi.org/10.4060/cb2429en

[6] Micheli, F., Halpern, B. S., Walbridge, S., Ciriaco, S., Ferretti, F., Fraschetti, S., ... & Rosenberg, A. A. (2013). Cumulative human impacts on Mediterranean and Black Sea marine ecosystems: assessing current pressures and opportunities. *PloS one*, *8*(12), e79889.

[7] e.g.: Penca, J., Said, A., Cavallé, M., Pita, C., & Libralato, S. (2021). Sustainable small-scale fisheries markets in the Mediterranean: weaknesses and opportunities. *Maritime Studies*, 1-15.

[8] Naylor, R. L., Goldburg, R. J., Primavera, J. H., Kautsky, N., Beveridge, M. C., Clay, J., ... & Troell, M. (2000). Effect of aquaculture on world fish supplies. *Nature*, *405*(6790), 1017-1024.

[9] Nogales-Mérida, S.; Gobbi, P.; Jozefiak, D.; Mazurkiewicz, J.; Dudek, K.; Rawski, M.; Kieronczyk, B.; Jozefiak, A. Insect meal in fish nutrition. Rev. Aquacult. 2018, 1–14.

the content of fish and increase the content of proteins and oils from alternative sources (insects, vegetables, discards from the meat industry). Particular attention regards also unmanned underwater vehicles that might serve to several purposes in this sector, from safely and sustainably monitoring the environment to carry on otherwise costly operations.

The ***Blue Biotechnology*** section is based on consideration that marine environments provide several ecosystem services that lead to societal benefits. Among the vast array of evolutionary traits present in marine organisms, the production of biomolecules (secondary metabolites, enzymes, biopolymers, etc.) is one of the most exploited[10] and promising due to the fact that most of the oceans interior is still to be explored[11] (e.g. the deep sea). These biological products have a great potential in applications that span a wide spectrum of industrial activities. Among these, a growing attention is addressed to pharmaceutical, nutraceuticals and cosmeceuticals[12] as well as towards compounds necessary to the production of biofuels[13]. In addition, biopolymers and biomaterials are at the base of the emerging market of bioplastics.[14] These products are fueled by the controlled production of new biomass by marine organisms; nevertheless, the active functioning of algae and microbes and behavioral characteristics of invertebrates contribute to the blue bioeconomy in the sector of bioremediation[15].

The ***Blue Sustainable Development*** section is built around innovative technologies that serve as tools for monitoring, observing, preserving, and managing marine systems. The improvement of devices for spatial localization and mapping (both surface, water column and seafloor) is particularly important for the marine spatial planning and the maritime sector as a whole[16]. Concomitantly there has been an urgent need in the provision of data at temporal and spatial scales that are beyond man-based capability. For this reason, automated sensors for physical, chemical, and biological parameters to be operated remotely and unmanned underwater vehicles represent a large market share in this sector[17]. Furthermore, in terms of anthropogenic pressure reduction on the marine environment, a great attention is addressed to plastics at sea. In order to decrease the current and future presence of microplastics in the marine

[10] e.g.: Eswara Rao T, Imchen M, Kumavath R (2017) Marine enzymes production and applications for human health. Adv Food Nutr Res 80, 149-163

[11] Danovaro et al (2014). Challenging the paradigms of deep-sea ecology. Trends in Ecology and Evolution 29, 8.

[12] e.g.: Corinaldesi C, Barone G, Marcellini F, Dell'Anno A, Danovaro R (2017) Marine microbial-derived molecules and their potential use in cosmeceutical and cosmetic products. MArine Drugs 15, 118

[13] Singh J, Dhar DW. (2019) Overview of carbon capture technology: microalgal biorefinery concept and state-of-the-art. Frontiers in Marine Science 6, 29

[14] Zanchetta E, Damergi E, Patel B, Borgmeyer T, Pick H, Pulgarin A, Ludwig C (2021) Algal cellulose, production and potential use in plastics: challenges and opportunities. Algal Research 56, 102288

[15] Nikolavitis E, Dimarogona M, Fokialakis N, Topakas E (2017) Marine derived biocatalysis: importance accessing, and application in aromatic pollutant bioremediation. Frontiers in Microbiology 8, 265; Cecchi G, Cutroneo L, Di Piazza S, Vagge G, Capello M, Zotti M (2019) From waste to resource: mycoremediation of contaminated marine sediments in the SEDITERRA project. Journal of Soils and Sediments 20, 2653-2663

[16] Wolfl A-C, Snaith H, Amirebrahimi S, Devey CW, Dorschel B, Ferrini V, Huvenne VAI, Jakobsson M, Jencks J, Johnston G, Lamarche G, Mayer L, Millar D, Pedersen TH, Picard K, Reitz A, Schmitt T, Visbeck M, Weatherall P, Wigley R (2019) Seafloor mapping - the challenge of a truly global ocean bathymetry. Frontiers in Marine Science 6, 283

[17] Terzic E, Mirò A, Organelli E, Kowalczuk P, D'Ortenzio F, Lazzari P (2021) Radiative transfer modeling with biogeochemical-Argo float data in the Mediterranean Sea. Journal of Geophysical Research Oceans 126, e2021JC017690

environment, potential technical solutions are represented by mechanical cleaning systems and by improved technologies for the production of bio-derived and biodegradable polymers[18]. Supporting the sustainable development of the Euromediterranean areas is one of the main challenges of the Blue Bio Med project. By following this approach, the technology forecasting activity developed in this report will assume the Agenda 2030 SDGs as a main reference, thus adding a new interpretative layer to the analysis and contributing to the alignment of the new innovation policies related to the blue bioeconomy in the directions outlined by the SDGs. In detail, the report will explore the potential alignments of sectors and subsectors identified by the BLUE BIO MED project with several SDGs and targets. Right during the preparatory process that led to the 2030 Agenda, the concept of the blue economy emerged as the proper application of the green economy to the oceans, seas and coastal countries. According to the Agenda 2030 approach, the blue economy should pursue the improvement of human well-being and social equality while significantly reducing environmental risks and ecological scarcities through the reduction of carbon emissions, improvement of resource efficiency and social inclusion. For this reason, the interconnections between social-economic development and environmental protection standing at the core of blue economy are perfectly aligned with the aims of the 2030 Agenda. In the end, this technology and market forecast report could be considered as a powerful decision-making tool supporting public policy makers in the definition of reliable innovation plans and for the adoption of targeted funding programmes in the field of blue bioeconomy.

[18] Schmaltz E, Melvin EC, Diana Z, Gunady EF, Rittschof D, Somarelli JA, Virdin J, Dunphy-Daly MM (2020) plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. Environment International 144, 106067