




**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
<b>Description</b>	<p>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:</p> <ol style="list-style-type: none"> <li>1. <i>Introduction</i></li> <li>2. <i>How to read this document</i></li> <li>3. <i>Technology forecast and importance of SDGs in Blue Bioeconomy</i></li> <li>4. <i>Complete report on patent and NPL analysis</i> <ul style="list-style-type: none"> <li>- <i>Part I: Fishery and Aquaculture</i></li> <li>- <i>Part II: Blue Biotechnology</i></li> <li>- <i>Part III: Blue Sustainable Development</i></li> </ul> </li> <li>5. <b>Key points on Patent and NPL</b></li> <li>6. <i>Final remarks</i></li> </ol>
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## Index

5. Key points on Patent and NPL .....	4
FISHERY AND AQUACULTURE .....	4
1 KEYPOINTS: THE MARKET .....	4
2 KEYPOINTS: THE LEGAL STATUS .....	4
3 KEYPOINTS: THE TECHNOLOGIES .....	5
4 KEYPOINTS: THE NPL DIVULGATION .....	5
5 PLAYERS TO BE MONITORED .....	6
BLUE BIOTECHNOLOGY a) Healthcare and Pharmaceuticals .....	8
1.a KEYPOINTS: THE MARKET .....	8
2.a KEYPOINTS: THE LEGAL STATUS .....	9
3.a KEYPOINTS: THE TECHNOLOGIES .....	9
4.a KEYPOINTS: THE NPL DIVULGATION .....	10
5.a PLAYERS TO BE MONITORED .....	10
BLUE BIOTECHNOLOGY b) Agriculture, Livestock, Food processing → Soil fertilization .....	11
1.b KEYPOINTS: THE MARKET .....	11
1.b KEYPOINTS: THE LEGAL STATUS .....	12
3.b KEYPOINTS: THE TECHNOLOGIES .....	12
4.b KEYPOINTS: THE NPL DIVULGATION .....	12
5.b PLAYERS TO BE MONITORED .....	12
BLUE BIOTECHNOLOGY c) Industrial processes and manufacturing → Sea organisms' genetics .....	12
1.c KEYPOINTS: THE MARKET .....	13
2.c KEYPOINTS: THE LEGAL STATUS .....	13
3.c KEYPOINTS: THE TECHNOLOGIES .....	13
4.c KEYPOINTS: THE NPL DIVULGATION .....	13
5.c PLAYERS TO BE MONITORED .....	14
BLUE BIOTECHNOLOGY d) Biofuels .....	14
1.d KEYPOINTS: THE MARKET .....	14
2.d KEYPOINTS: THE LEGAL STATUS .....	14
3.d KEYPOINTS: THE TECHNOLOGIES .....	15
4.d KEYPOINTS: THE NPL DIVULGATION .....	15
5.d PLAYERS TO BE MONITORED .....	15
BLUE BIOTECHNOLOGY e) Bio-monitoring and bio-remediation → Seawater purification, remediation .....	16
1.e KEYPOINTS: THE MARKET .....	16
2.e KEYPOINTS: THE LEGAL STATUS .....	16



3.e KEYPOINTS: THE TECHNOLOGIES .....	17
4.e KEYPOINTS: THE NPL DIVULGATION .....	17
5.e PLAYERS TO BE MONITORED .....	17
BLUE SUSTAINABLE DEVELOPMENT: a) Monitoring and Observing systems for Marine Environment .....	19
1.a KEYPOINTS: THE MARKET .....	19
2.a KEYPOINTS: THE LEGAL STATUS .....	20
3.a KEYPOINTS: THE TECHNOLOGIES .....	20
4.a KEYPOINTS: THE NPL DIVULGATION .....	20
5.a PLAYERS TO BE MONITORED .....	21
BLUE SUSTAINABLE DEVELOPMENT b) Marine environmental technologies.....	23
1.b KEYPOINTS: THE MARKET .....	23
2.b KEYPOINTS: THE LEGAL STATUS .....	23
3.b KEYPOINTS: THE TECHNOLOGIES .....	23
4.b KEYPOINTS: THE NPL DIVULGATION .....	24
5.b PLAYERS TO BE MONITORED .....	24
BLUE SUSTAINABLE DEVELOPMENT c) Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure .....	24
1.c KEYPOINTS: THE MARKET .....	24
2.c KEYPOINTS: THE LEGAL STATUS .....	25
3.c KEYPOINTS: THE TECHNOLOGIES .....	25
4.c KEYPOINTS: THE NPL DIVULGATION .....	25
5.c PLAYERS TO BE MONITORED .....	25
SUMMARY OF THE DATASETS COMPOSITION .....	27



# 5. Key points on Patent and NPL

## FISHERY AND AQUACULTURE

### 1 KEYPOINTS: THE MARKET

- The increment of the patent filing events is quite impressive when analyzing the trends of the most recent years, especially as far as the sectors “Fish meal” and “Seafood processing” are concerned.
- When focusing on overlapping timeframes referred to individual sub-sectors, it can be noticed that several initiatives related to basic research are concentrated within the EU, whereas the exploitation of the results demanded to the legal protection of the inventions seems quite uncertain in general, and not easily predictable, in particular as far as the countries bordering the Mediterranean Sea are concerned.
- Upon analyzing the situation of the countries bordering the Mediterranean Sea, it may be worth of consideration the trend of the patent applications’ numbers filed to the French and Spanish patent authorities, respectively, however such trends may appear discontinuous. Other European patent authorities, despite hosted in countries not bordering the Mediterranean Sea (for example Switzerland, Germany or the UK) receive a quite consistent number of patent applications, likely because worldwide notorious players, especially those relevant as far as the food sector is concerned, are headquartered in the European countries mentioned above.

### 2 KEYPOINTS: THE LEGAL STATUS

- Despite the number of applicants appears comparable in each subsector of the Fishery & Aquaculture field, the dimension of the patents’ datasets concerning the fish meal products and the seafood processing are significantly larger than the dimension of each of the other two datasets (fishery and aquaculture, respectively). It can be argued that for the time being the legal protection of innovative elements concerning both the fish meal administration and the seafood processing is considered strategically relevant for the exploitation of technologies aimed at the transformation of seafood, feeding of marine animals and the subsequent transformation of marine organisms into edible products.
- For each sub-sector analyzed it can be noticed that the number of patent applications filed to the CNIPA<sup>1</sup> is higher than the number of patent applications filed to any other authority, either national or supranational. Nonetheless, the attitude toward extending the legal protection outside the national boundaries is usually scarce in the case of applicants headquartered or resident in Eastern countries, especially China. Instead, the legal protection strategy adopted by players located in Western countries is aimed at establishing an IPRs exclusivity in a multiplicity of countries, thus implying a consistent economic effort for maintaining the exclusive rights alive in a quite large market. As consequence the commitment of the players appears significant, thus suggesting that the know-how implemented in the Western countries, especially in the European region, might positively affect the competitiveness of such region.
- In general, when the number of patent families owned by applicants located in countries bordering the Mediterranean Sea is evaluated, the commitment of such players toward the legal protection appears scarce. However, at least in the case of the fish meal and seafood processing sub-sectors, there may be European corporates (headquartered in the Northern Europe in several cases) that base their profit on the transformation of the fish by-products into edible matter, while - on the other hand – the elaboration of the fish by-products for farming applications may deserve attention as well.

<sup>1</sup> China National Intellectual Property Administration

- As far as the fish feeding products are concerned, in Europe and therefore also in the countries bordering the Mediterranean Sea awareness **of the prohibition<sup>2</sup> of the use of blood meal, bone meal, feather meal and other types of meal produced from other slaughterhouse waste, for example chicken meal in the production of feeds for food-producing animals and fish** seems an important incentive for conceiving fish meals based on the availability of alternative sources, usually vegetable based products and more recently insects and other species.

### 3 KEYPOINTS: THE TECHNOLOGIES

- As far as the fishery sector is concerned, little information about the technologies may be argued considering the technology fields defined by WIPO<sup>3</sup>, since most patent families are classified as “Other special machines”. However, the IPC<sup>4</sup>/CPC<sup>5</sup> classification codes allow to argue additional details regarding the protected products/technologies, in most cases dealing with stationary catching devices, drawn nets or fences, enclosures, corrals, etc. A relatively small fraction of the results concerns implementations achieved by including digital computing or data processing equipment or methods. Therefore, consistently with a relatively low growth rate of the patent applications filed to national/supranational authorities, the innovativeness of the techniques legally protected seems limited.
- When considering the aquaculture sector, like in the case of fishery, little information about the technologies may be argued considering the technology fields defined by WIPO, since most patent families are classified as “Other special machines”. However, a consistent fraction of the patent families deals with food chemistry. Consistently, several patent families may be identified by patterns of IPC/CPC classification codes identifying the feeding devices. Moreover, a not negligible fraction of the results corresponds to classification codes identifying the receptacles for live fish, e.g. aquaria.
- As in the sector regarding the fish meal inventions, the kind of WIPO technology fields or the IPC/CPC classification codes seems not clearly distinguishable from the classification concerning the seafood processing sector. However, in the case of fish meal little or no use of the IPC/CPC classification codes identifying the diet supplements is made, moreover, the frequency of assignment of the A23K subclass (fodder) is significantly higher than in the case of the seafood processing sector.
- The technology field “food chemistry” is prevalent as far as the patent documents dealing with the seafood processing and with the fish meal subsectors are concerned, however the technical context of both such fields might differ from that specifically regarding the aquaculture sector, because, especially in the seafood processing case a relevant fraction of IPC/CPC classification codes might refer to the food compositions and to the agro-alimentary sector.
- To better differentiate each subsector from the others (excluding the fishery) from the technical point of view, it may be advisable to inspect the individual documents of each dataset considering the corresponding list of technical concepts extracted from Orbit Intelligence. It may be worth reminding that for the purpose of the present report each patent family is displayed in association with only 9 technical concepts however longer lists of technical concepts associated to each patent family may be delivered upon request.

### 4 KEYPOINTS: THE NPL DIVULGATION

- Among the European countries bordering the Mediterranean Sea, France and Spain host the players who have recently filed patent applications, though the number of patent applications is generally marginal. Quite

<sup>2</sup> EP1981352A1

<sup>3</sup>World Intellectual Property Organization

<sup>4</sup> International Patent Classification

<sup>5</sup> Cooperative Patent Classification

consistently those are the countries where the highest number of NPL<sup>6</sup> publications have been produced in the last two decades, with few exceptional cases.

- The number of NPL publications produced as far as the fishery and aquaculture sectors are prevalent if compared to each of the other sectors and the role played by Italy, France and Spain appears quite consistent.
- It is noteworthy that the number of publications regarding the seafood processing sector is quite modest, to the contrary the number of patent applications is consistent. Such trends suggest that there may be a relevant margin for implementing the number of initiatives involving the European players, especially those residents along the Mediterranean Sea.

## 5 PLAYERS TO BE MONITORED

A list of the players whose activity, based on the evaluation of the legal protection propensity in one or more sub-sectors, may be worth of consideration and periodical monitoring follows:

- **BYKS** ([BYKS AS - OceanGlobe](#))
- **THE NEW ZEALAND INSTITUTE FOR PLANT AND FOOD RESEARCH** ([Seafood Technologies: Plant & Food Research \(plantandfood.co.nz\)](#))
- **XYLECO** (<https://www.xyleco.com/impacts/>)
- **DSM NUTRITIONAL PRODUCTS** (<https://www.dsm.com/corporate/about/businesses/dsm-nutritional-products.html>)
- **KIVERDI, Inc.** (<https://www.kiverdi.com/>)
- **HAUGE AQUA** (<https://haugaqua.com/>)
- **GENOCEAN** (<https://opencorporates.com/companies/fr/518466305>)
- **KRAFT FOODS** (<https://www.kraftheinzcompany.com/>)
- **TRUE ORGANIC PRODUCTS Inc.** (<https://true.ag/>)
- **MARINE TECHNO**  
([https://marinetechno.tradekorea.com/main.do;JSESSIONID\\_TK=8Uhw6vu8rUdNcBeZ69A0fVM2saYlcu5o-nCmEkic\\_0057K206CRk!-798423004!1742867100](https://marinetechno.tradekorea.com/main.do;JSESSIONID_TK=8Uhw6vu8rUdNcBeZ69A0fVM2saYlcu5o-nCmEkic_0057K206CRk!-798423004!1742867100))
- **NESTEC** (<https://www.eitfood.eu/partners/partner/nestec>)
- **YNSECT** ([Ynsect, Premium Natural Feed](#))
- **ADISSEO** ([Nutrition animale | Adisseo](#))
- **FERMENTALG** ([Home - Fermentalg - Algae you can trust](#))
- **NIREUS AQUACULTURE** ([Homepage | NIREUS AQUACULTURE](#))

## SECTOR RELATED EU FUNDED PROJECTS:

### Fisheries

1) **A Holistic Opto-Acoustic System for Monitoring Marine Biodiversities (SYMBIOSIS)**. We present the SYMBIOSIS project to provide a mature, cost effective autonomous optico-acoustic prototype for the characterization, classification, and biomass evaluation of six target pelagic fish that are important to the fishery industry and that reflect on the health of the environment. The processing will be made in a real-time fashion onsite, and the results will be sent to a shore station.

Grant agreement ID: 773753

<https://cordis.europa.eu/project/id/773753>

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<sup>6</sup> Non Patent Literature

**2) Paradigm for Novel Dynamic Oceanic Resource Assessments (PANDORA).** The Blue Growth of European fisheries is at risk due to over-exploitation, unforeseen changes in stock productivity, loss of markets for capture fisheries due to aquaculture, future trade agreements opening European markets to external fleets, and fluctuations in the price of oil and other business costs. All of these risks need to be considered when providing advice needed to sustainably maximize profits for the diverse array of fisheries operating in European waters and to help safeguard the benefits this sector provides to the social coherence of local, coastal communities.

(Grant agreement ID: 773713)

<https://cordis.europa.eu/project/id/773713>

## Aquaculture

**1) Sustainable innovation of microbiome applications in food system (SIMBA).** The objective of SIMBA project is to harness complex soil and marine microbial communities (microbiomes) for the sustainable production of food. SIMBA will focus on two interconnected food chains, i.e. crop production, aquaculture....Microbiome-tailored interventions will be specifically developed including soil, plant, fish, aquaculture and food/feed processing towards optimal layout as defined in the modelling step, as follows: i) Identified optimal microbiome consortia will be designed and tested in lab, pot and field trials to improve plant productivity and health; ii) Marine microbiomes will be applied to facilitate sustainable aqua and agriculture; iii) Optimal microbe/microbe consortia will be used to convert raw-materials and residuals to high quality food, feed or finally to energy.

Grant agreement ID: 81843

<https://cordis.europa.eu/project/id/818431>

**2) Mediterranean Aquaculture Integrated Development (MedAID).** Production and productivity of Mediterranean marine fish aquaculture, mainly seabass and seabream, are stagnating or growing slowly as a result of multiple and interrelated causes. To accomplish the objective of improving its competitiveness and sustainability, MedAID is structured in a first interdisciplinary WP to assess technical, environmental, market, socioeconomic and governance weaknesses, and in several specialized WPs exploring innovative solutions, followed by an integrating WP, which will provide codes of practice and innovative tool-boxes throughout the value chain to enhance the sector performance holistically. Biological performance (nutrition, health and genetics) will be scrutinized to identify and quantify the relevant components to improve Key Performance Indicators (KPIs: growth rates, mortality and feed efficiency), thus contributing to increase production efficiency.

Grant agreement ID: 727315.

<https://cordis.europa.eu/project/id/727315>

## Seafood processing

**1) Convenience Food Enriched with Marine based Raw Materials (ENRICHMAR).** Recent process improvements have created new possibilities for the use of marine based ingredients in functional foods. Consumers tend to favour functional foods over supplementary pills as means to prevent diseases. The market for these types of products is one of the fastest growing markets in the world. By adding marine-based bioactive ingredients from low value by-products and underutilised raw material to foods they obtain added value, both economical, for health and more sustainable use of resources. Few natural food antioxidants are commercially available on the market. Due to strong market demand and very positive preliminary tests it is believed that seaweed food antioxidant extracts can be highly competitive on the market and find various uses in food. A unique new tasteless omega-3 powder ingredient is new on the market with the ability to both regulate and maintain the body's omega-6/omega-3 fatty acid balance while simultaneously safeguarding the daily need for omega-3 from fish and protective biological antioxidants from olives (flavonoids). The aim is to increase the value of convenience food by enriching seafood, cereal and dairy products with bioactive compounds; powder of fish oil and seaweed extracts with confirmed bioavailability. The functional properties of the enriched products will be studied via dietary intervention

(Grant agreement ID: 606023).

<https://cordis.europa.eu/project/id/606023>



## Fish meal

1) **Sustainable management of mesopelagic resources (SUMMER)**. The SUMMER project will explore recent findings that suggest that the mesopelagic zone of oceans contains 90 % of the planet's fish biomass. Even if a fraction of this is correct, the exploitation potential in fishmeal production, nutraceuticals and pharmaceuticals is enormous. However, as the role of mesopelagic fish is not understood in terms of the ecosystem, it is first necessary to establish tools to accurately estimate their biomass and the interspecies impact at that level. Using eDNA<sup>7</sup>, acoustics and gut analysis among other tools, SUMMER will also investigate the environmental repercussions of such exploitation. The resulting outcome will provide a better idea of the mesopelagic commercial potential and its impact on ecosystem balances.

Grant agreement ID: 875429

<https://cordis.europa.eu/project/id/817806>

2) **Intelligent Fish feeding through Integration of ENabling technologies and Circular principle (iFishIENCi)**. iFishIENCi will deliver breakthrough innovations supporting sustainable aquaculture, based on enabling technologies and circular principles, thereby providing the European aquaculture industry with the competitive advantage and growth stimulation needed to be a mover in revolutionizing global efficiency in fish production and meet society's needs for food from the ocean.

Grant agreement ID: 818036

<https://cordis.europa.eu/project/id/818036>

3) **INSECTS FOR A SUSTAINABLE AQUACULTURE 2 (IFASA 2)**. Fish feed manufacturers and fish farmers are seeking innovative ways to increase the nutritional value of their products while reducing the environmental impact of their supply chain. Insect protein stands out as one of the best solution to address this need and drive the development of sustainable aquaculture. Insect protein has demonstrated excellent nutritional performance with less pollutants than fishmeal (heavy metals, pesticides residues, PCBs, dioxins), restoring a natural diet for farmed fish that eat insects in the wild (e.g. salmon, trout, seabass). InnovaFeed's insect protein is an alternative source of quality protein that will address the fish feed challenge and support the aquaculture sector's growth.

Grant agreement ID: 823566

<https://cordis.europa.eu/project/id/823566>

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## BLUE BIOTECHNOLOGY a) Healthcare and Pharmaceuticals

### 1.a KEYPOINTS: THE MARKET

- The increment of the patent filing events is quite impressive when analyzing the trends regarding the most recent years, especially as far as the sectors "Cosmetics" and "Nutraceuticals" are concerned. The use of the marine biomass resources appears less consistent as far as the applications specifically tailored to the pharmaceuticals sector are concerned. Excluding such sector, in the other two the exploitation of innovations appears significant during the last thirty years, while it appeared relatively neglected earlier. There is growing interest in the pharmacology sector too, yet the rate of patent applications is not as relevant as in each of the other two fields.
- When focusing on overlapping timeframes referred to individual sub-sectors, it can be noticed that several initiatives related to basic research are concentrated within the EU, whereas the exploitation of the results

<sup>7</sup> The theme was also addressed in the section "Industrial Processes and Manufacturing" of the Blue biotechnology section.





demanded to the legal protection of the inventions seems not easily predictable, especially as far as the countries bordering the Mediterranean Sea are concerned. However, meaningful proportions of patent applications filed to the French or the Spanish patent authorities may be detected. Excluding the pharmacology sector, in the other two technical fields quite consistent numbers of patent applications are filed to the EPO or to the WIPO, thus suggesting that the exploitation of such innovations implies a considerable number of territories as potential markets.

- Other European patent authorities, despite hosted in countries not bordering the Mediterranean Sea (for example Switzerland, Germany or the UK) receive a quite consistent number of patent applications, likely because worldwide notorious players, especially those relevant as far as the food sector or the cosmetics is concerned, are headquartered in the northern Europe.

## 2.a KEYPOINTS: THE LEGAL STATUS

- As already observed when analyzing the market scenario for each of the three sub-sectors, the number of patent owners/applicants identified is higher in the fields of cosmetics and nutraceuticals than in the sector specifically dealing with the pharmaceuticals.
- However, comparing the overall grant rate specific for each-subsector, no substantial difference emerged, being the rate around 40% in each case.
- As can be noticed following a deeper inspection of the patent documents, in the pharmaceuticals sector there may be applications dealing with needs, for example satisfied by anti-aging products, that may be as well covered by results emerging when focusing the analysis on the cosmetics sector. Likewise, there may be players such as the French company FERMENTALG who own patents retrieved either investigating the pharmaceuticals sector (FR3085962A1, a patent application regarding the extraction of poly-unsaturated fatty acids from marine animals to be used for pharmaceutical, cosmetic or food composition) or the nutraceuticals dataset.
- As far as the cosmetics sector is concerned, a multiplicity of companies may be detected, including the renowned corporate L'OREAL, each having filed recently at least one patent application to the French patent authority. However, upon analyzing the residual validity of the respective patents it turns out that on average the residual validity of L'OREAL patents is low, thus suggesting that it may be worth investigating the activities of competitor companies who likely try to legally protect technical elements that could be more innovative.
- As already argued from the inspection of the sector Fishery and Aquaculture, when focusing on the patent family dimension, even if the coverage of such data may be partial, in general the strategy of the Asian applicants differs from that characterizing the US and European applicants, because in the latter case a multiplicity of patent applications is usually filed to protect simultaneously the same invention in different territories.

## 3.a KEYPOINTS: THE TECHNOLOGIES

- As far as the analysis of the technologies of the sub-sectors “Cosmetics”, “Pharmaceuticals” and “Nutraceuticals” are concerned, the IPC/CPC classification codes A61K31/00, referring to Medicinal preparations containing organic active ingredients and A61K36/00, referring to Medicinal preparations of undetermined constitution containing material from **algae**, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicines, are present in each of the sectors mentioned above. The granularity of the classification codes allows often to identify the type of algae, being a significant proportion of patent documents associated to classification codes identifying the brown algae or the red algae.
- However, each sector appears characterized by peculiar classification codes (either IPC or CPC). As in the case of “Cosmetics” specific classification codes are dealing with Cosmetics or similar toilet preparations (A61K8/00), preparations for care of the skin (A61Q19/00) and drugs for dermatological disorders (A61P17/00). As far as the “Pharmaceuticals” sector is concerned, specific classification codes are dealing with Antineoplastic agents (A61P35/00) and drugs for disorders of the blood or the extracellular fluid (A61P7/00). In the case of the



“Nutraceuticals” sector, several patent families are associated to the A23L subclass (Food, foodstuff, etc.), with the A23V2002 main group (Food compositions, function of food ingredients or processes for food or foodstuffs) and with the A23L33 main group (Modifying nutritive qualities of foods; Dietetic products; Preparation or treatment thereof).

- Further detail may be argued from the frequency of co-assignment of classification codes (either IPC or CPC) and from the lists of nine technical concepts associated to each and every patent family identification number.

#### 4.a KEYPOINTS: THE NPL DIVULGATION

- Among the European countries bordering the Mediterranean Sea, usually France and Spain host the players who have recently filed patent applications, though the number of patent applications may be significant especially as far as the cosmetics sector is concerned, while it remains quite low as soon as the focus of the analysis is shifted towards other subsectors such as the pharmaceuticals and the nutraceuticals. However, France and Spain, along with Italy and occasionally Greece, are among those Mediterranean Sea bordering countries where the highest number of NPL publications have been produced in the last two decades, with few exceptional cases.
- It may be worth considering that as far as the cosmetics sector is concerned, the institutions and industries headquartered in France demonstrate a high commitment toward the legal protection of technical innovations and the share of patents is slightly lower if compared to the other modalities of divulgation taken together. This is maybe the most exceptional picture, since in all other sectors the NPL divulgation is the preferred modality used by most of the players headquartered in the European countries located along the Mediterranean Sea.
- As far as the pharmaceuticals sector is concerned, consistent and almost equivalent numbers of NPL publications are delivered by residents of Italy, France and Spain, however, in the last two countries relevant consideration for the opportunities related to the IPR protection is detectable.
- It is noteworthy that the number of publications regarding the nutraceuticals’ sector is on average relatively modest, but a quite consistent number of publications delivered in recent years can be detected when focusing the analysis on countries such as Italy and France.

#### 5.a PLAYERS TO BE MONITORED

- FITOPLANCTON MARINO ([Fitoplancton Marino - Home](#))
- GREENALTEC S.L. ([GREENALTECH - Biotechnology by Greenaltech. Improving healthspan and wellbeing.](#))
- GELYMA ([Gelyma](#))
- L'OREAL ([L'Oréal, world leader in beauty : makeup, cosmetics, haircare, perfume \(loreal.com\)](#))
- FERMENTALG ([Home - Fermentalg - Algae you can trust](#))
- BIOTECHMARINE ([BiotechMarine | SEPPIC](#))
- ALGAHEALTH ([AlgaHealth – Fucoxantin from microalgae – \(alga-health.com\)](#))
- CUTECH ([Screening Services - Cutech](#))
- SIGEA ([SIGEA - Mastering and Creating](#))
- ARC MEDICAL DEVICES ([ARC Medical Devices Inc. |](#))
- TAIYO KAGAKU COMPANY ([TAIYO \(taiyokagaku.com\)](#))
- HELIAE DEVELOPMENT ([Heliae Development - Sustainable & Regenerative Agriculture Solutions](#))
- TAKARA BIO ([Takara Bio—Home](#))
- METABOLIUM ([Metabolium : Compléments alimentaires innovants, 100% naturels](#))

#### SECTOR RELATED EU FUNDED PROJECTS:

##### Cosmetics

1) Development of microalgae-based natural UV Sunscreens and Proteins as cosmeceuticals and nutraceuticals (AlgaeCeuticals). The proposed project will combine both basic and applied research in the fields of –omics 10/27



technologies, biochemistry, applied and enzyme biotechnology in order to exploit microalgae resources for the development: 1) Natural UV sunscreens, based on algae mycosporine-like aminoacids, 2) Algae-based nutraceuticals as functional foods and food supplements, 3) Algae-derived proteases with applications in cosmetic (skin repair enzymes) and food industry. The implementation of the project will offer to the involved academic and SMEs the opportunity to translate scientific research into well defined knowledge-based 'green' products and analytical tools.

Grant agreement ID: 778263

<https://cordis.europa.eu/project/id/778263>

## Pharmaceutics

**1) Regenerative Medicine Innovation Crossing - Research and Innovation Staff Exchange in Regenerative Medicine (REMIX).** Natural materials in biomedical field are investigated for clinical use, as materials for the fabrication of biomedical prostheses, for the stimulation of regenerative medicine patterns, or as carriers for drug release, and have acquired increasing relevance in the past years, being recognized their intrinsic bioactive properties and the possibility to repair and overcome diseases with the use of Tissue Engineering and Regenerative Medicine (TERM) based procedures. Different kinds of natural materials like silks from silkworms, chitins and chitosan from crustacean, corals, collagen from marine organisms, polymers derived from plants or algae have found or are investigated for clinical use. Research activities will be directed to the exploitation and validation of natural materials for tissue engineering applications.

Grant agreement ID: 778078.

<https://cordis.europa.eu/project/id/778078>

**2) Dinoflagellate phytotoxins exploitation (Dinophyte).** Dinoflagellates are microalgae which produce a wide range of toxins. These toxins are mostly unknown (only 1% have been identified) but they have proven to be efficient in different market application: biopesticides, drug discovery and food safety testing. Biopesticides and drug discovery are seeking for new active compounds which may come from dinoflagellate toxins

Grant agreement ID: 866736.

<https://cordis.europa.eu/project/id/866736>

## Nutraceuticals

**1) Integrated on-farm Aquaponics systems for co-production of fish, halophyte vegetables, bioactive compounds, and bioenergy (AQUACOMBINE).** Fresh water shortages and salinisation processes in farmland increase concerns related to food security. Farmers are seeking salt-tolerant solutions as well as synergies for better results.

Grant agreement ID: 862834.

<https://cordis.europa.eu/project/id/862834>

**2) Optimal utilization of seafood side-streams through the design of new holistic process lines (WASEABI).** WASEABI project aims at creating new storage solutions, sorting technologies, decision tools and other technological solutions to boost the exploitation of seafood side-streams. Their aim is to ensure the valorisation of these raw materials into marketable products that transform side-streams into a source of income. WASEABI will take a whole chain perspective to succeed with high quality production of bioactive peptides for nutraceutical, food and feed applications as well as protein-based food ingredients, savoury ingredients and mineral supplements.

Grant agreement ID: 837726.

<https://cordis.europa.eu/project/id/837726>

## BLUE BIOTECHNOLOGY b) Agriculture, Livestock, Food processing → Soil fertilization

### 1.b KEYPOINTS: THE MARKET

- Even if the analysis has been limited to the most recent years, the number of patent documents retrieved is consistent and the patent applications represent the preferred form of divulgation of the technical implementations if compared to other forms (NPL).



- The Asian countries, especially China, delimit the territories in which the opportunity of exploiting the marine resources applicable to the agriculture field appears highly considered.
- Despite the above statements, several players headquartered in the USA (e.g. KIVERDI or CISBAY GLOBAL) might be interested in the legal protection of innovative products or technologies enabling the implementation of the agriculture applications, whereas little or no involvement of European players can be noticed, at least in case the analysis is focused on the filing of patent applications.

### 1.b KEYPOINTS: THE LEGAL STATUS

- Having already noticed that most patent applications have been filed to the Asian patent authorities, especially to the CNIPA/SIPO, it seems not much surprising that a consistent portion of information regarding the legal status is missing.
- Consistently with the analysis of the market scenario, from the scarce legal status information is arguable that some players resident in the North America (USA → KIVERDI and Canada → INOCUCOR TECHNOLOGIES) and Australia (INJEKTA ENVIRONMENTAL) have filed a consistent number of patent applications, while only few players among those headquartered in the Asian countries scored comparable amounts of patent applications filing events, most of them having filed at most one or two patent applications.

### 3.b KEYPOINTS: THE TECHNOLOGIES

- As already observed, a consistent number of patent applications are filed to the Asian patent authorities in most cases by Asian applicants, thus it appears that the use of sea biomass, especially of fish, aimed at the production of fertilizers is mainly exploited in the Asian markets and in several patent documents it is reported that the fertilizers are based on fish meal or fishbone meal. As confirmed by the frequency of assignment of the IPC/CPC classification codes and by the ranking of the technical concepts, the whole dataset concerns the production/use of fertilizers, being the use of fish clearly mentioned in a pretty restricted pool of patent documents. The data suggest that the use of fishery byproducts for agricultural purposes may be not yet fully exploited.

### 4.b KEYPOINTS: THE NPL DIVULGATION

- The number of patent applications filed by the European residents appears scarce, having noticed that there is a consistent commitment toward the exploitation in the Asian Pacific region. The trend emerging from the analysis of the publications of the last two decades has been evaluated focusing the assessment on Italy, France and Spain. Consistently with the trends arguable from the patent applications, the divulgation of technical concepts by alternative means is also poorly represented, having found only one article for each one of the three European countries. Consistently, commitment evaluated at global scale is similarly modest, being the patent documents the preferred form of divulgation, therefore huge margin of implementation of such technologies is foreseen.

### 5.b PLAYERS TO BE MONITORED

- KIVERDI (<https://www.kiverdi.com/revive-soil>)
- CISBAY GLOBAL (<https://cisbay.com/>)
- CONCENTRIC (<https://www.concentricag.com/>)
- KALMBACH FEEDS (<https://www.kalmbachfeeds.com/>)

**BLUE BIOTECHNOLOGY** c) Industrial processes and manufacturing → Sea organisms' genetics



### 1.c KEYPOINTS: THE MARKET

- The biotechnology applications should deserve a deeper analysis of larger pools of patent documents however the risk is that the quality of the analysis might be affected by “contaminating” results because the biotechnologies rely on several different technical principles. Despite our choice has been rather that of limiting the scope of the survey to the applicability of the genomics data, the trend argued from the number of applications filed to the national and supranational authorities suggest that this kind of information could positively affect the technical implementations relying on the marine biomass use.
- Even if some Asian countries, especially China, demonstrate relevant interest for exploiting the value inherent to the genomics information, basic research is performed worldwide, appearing relevant the contribution of the USA and even higher the contribution of the EU countries.
- Despite the above statements, several players headquartered in South Korea and USA seem interested in the legal protection of innovative products or enabling technologies, while for the time being the most representative European player include few corporates such as BASF PLANT SCIENCES GmbH and UNILEVER. No significant presence of players headquartered in the countries bordering the Mediterranean Sea has been detected.

### 2.c KEYPOINTS: THE LEGAL STATUS

- Having already mentioned that the dataset concerning the genetics of the sea organisms is one of the smallest datasets analyzed, it seems not much surprising that a consistent portion of information regarding the legal status is missing. This situation may be also determined by the fact that most of the patent applications are filed to the CNIPA/SIPO authority.
- Nevertheless, the analysis of the legal status evidenced that several players of the western countries (e.g. DANISCO, BASF PLANT SCIENCE and UNILEVER) are included among the players who scored the highest numbers of patent applications and the highest grant rate.
- Additional players, either headquartered in eastern countries (HAINAN UNIVERSITY, KOCHI UNIVERSITY or in western countries (BASF PLANT SCIENCE, COVIDIEN) own patents claiming relevant applicability of different approaches all based on the biotechnologies.

### 3.c KEYPOINTS: THE TECHNOLOGIES

- Although the dataset consists of a relatively small number of documents, the technical focus appears well defined, concerning in a significant number of cases the application of the biotechnologies to detect or identify the organisms. On the other hand, technical implementations concern the generation of information based on polymorphic markers and the regulation of gene expression through genetic engineering methodologies. All such steps may be crucial for implementing industrial processes based on the exploitation of marine bio-resources.

### 4.c KEYPOINTS: THE NPL DIVULGATION

- Among the European countries bordering the Mediterranean Sea, Italy France and Spain appear as the countries most frequently involved in national/international collaborations aimed at the divulgation of technical information by means of NPL.
- It is quite evident that most collaboration activities involve universities or research centers while the commitment of enterprises is marginal, perhaps because of the relevant costs of the technologies.
- As far as the ranking of the countries based on the number of publications is concerned, Spain scores the highest number being followed by France, Italy and Greece. Quite surprisingly the commitment of the several institutions headquartered in Israel appears modest.

## 5.c PLAYERS TO BE MONITORED

- **ALGENTECH** ([Algentech – Plant Gene Technology](#))
- **GENOBIOTECH COMPANY** ([Genobiotech Co., Ltd. - Company Profile \(ec21.com\)](#))
- **CHROMAXOME CORPORATION** ([www.innovation.com](#) | ...realizing the value of SBIR-STTR technologies and capabilities)

### SECTOR RELATED EU FUNDED PROJECTS:

1) **New insights into the genetic mechanisms underlying behavioural variation in wild marine fish (WildFishGenes).** The EU-funded WildFishGenes project intends to study the basic genetic mechanisms underlying fish behavioural types. It will combine a pioneering behavioural data set based on fish tracking data collected in situ for hundreds of wild fish at groundbreaking spatio-temporal resolution, with advanced genomic techniques. The project will give rise to new fields of research in behavioural molecular ecology, thus enhancing fisheries management and behavioural biology research.

Grant agreement ID: 891404.

<https://cordis.europa.eu/project/id/891404>

2) **Using global marine metagenomics to understand MERCURY microbial associated processes: finding a CURE for mercury contaminated environments (MER-CURE).** Millions of people are exposed to harmful levels of the potent neurotoxin mercury (Hg), concretely to the organic form methylmercury (MeHg) that bio-accumulates in organisms and biomagnifies in marine food webs. Understanding Hg transformations in the ocean is critical because commercial fish are mainly marine species. While it is well known that both MeHg formation and degradation are genetically mediated by prokaryotes, there are still sizable gaps in the fundamental understanding of the organisms and mechanisms involved in Hg transformations in the environment and therefore a clear lack of available techniques for Hg removal based on the action of these genes. MER-CURE aims at filling this gap by providing the first Hg reference gene catalogue at a global ocean scale and by quantifying the individual and/or combined effect of the activity of these genes in a pilot Hg removal system.

Grant agreement ID: 749645.

<https://cordis.europa.eu/project/id/749645>

## BLUE BIOTECHNOLOGY d) Biofuels

### 1.d KEYPOINTS: THE MARKET

- Even if the data referring to the NPL divulgation show a trend indicating an increasing interest in recent years, especially when considering the publications delivered by institutions located in western countries (either USA or EU), the trend arguable from the patent applications indicates that there is a progressive decline in the number of initiatives aimed at the legal protection of innovations in the biofuel field, at least in case the production relies on the use of marine resources.
- The relevant players are usually headquartered in the USA or South Korea however few other renowned players might be identified in some European countries (such as Spain and France) located along the Mediterranean Sea.
- It could be worth analyzing the situation of alternative forms of energy production, such as the tidal energy or the wind energy sectors to assess whether a greater commitment may be revealed possibly because implementations based on these alternative energy resources could determine the replacement of the biofuels' resources.

### 2.d KEYPOINTS: THE LEGAL STATUS

- Even if it may seem that there is a progressive decline of the patent applications, while a countertrend emerges from the NPL documents, many players, usually headquartered in the USA or in South Korea, own patents showing a consistent residual lifespan, therefore the commitment toward the legal protection of technologies aimed at the production of biofuels obtained from the marine biomass is still consistent.





- The above statement is corroborated by the fact that several players are also included in the list of the triadic families, being the player HELIAE DEVELOPMENT owner of 11 patent families included among the triadic families. According to the technology described in several patent documents (EP2555631, EP2556136, etc.) the goal is that of using the algal biomass to separate the proteins to be incorporated in food products from lipids to be used as renewable fuels.
- Similar approaches are followed by other players (e.g., ALLTECH Inc.), while alternative approaches may be based on the fermentation enhanced by microorganisms (e.g., BIOGENIC INNOVATIONS, EP2494059, the use of algae for enhancing the fermentation is claimed). To discover alternative modalities of biofuel production a deeper examination of the list including the triadic families is recommended.

### 3.d KEYPOINTS: THE TECHNOLOGIES

- It has been noticed that, as far as the biofuel production is concerned, the number of patent applications is progressively decreasing, yet the applicability of biotechnologies is significantly exploited, as also suggested by the high numbers of IPC/CPC classification codes assigned and especially identifying biotechnology-based procedures aimed at producing solid and liquid fuels.
- Differently from the trend evidencing a decline of the number of patent applications dealing with the biofuel production, the applicability of biotechnologies to the marine biomass shows a steadily growth, thus confirming the versatility of the technologies based on the genetic information, especially if aimed at targeting the marine biomass. Despite a consistent share of patent families belonging to the biofuel sector corresponds to classification codes identifying biotechnological methods, as already observed the applicability of the biotechnologies may concern multiple sectors, ranging from the cosmetics to the agriculture sectors and the remediation technologies. However, in these specific sectors the contribution of the biotechnologies to the development of innovative procedures or products appears more marginal if compared to the context of the biofuel production.

### 4.d KEYPOINTS: THE NPL DIVULGATION

- Among the European countries bordering the Mediterranean Sea, Italy France and Spain appear as those countries most frequently involved in national/international collaborations aimed at the divulgation of technical information by means of NPL. The number of publications produced by each country is almost the same and reveals that the interest has not decreased over time, differently from what is arguable from the rate of patent applications. Apparently, R&D based on basic research is going on, while the cause of the consistent decline of the patent applications number observed in the last decade remains to be ascertained.

### 5.d PLAYERS TO BE MONITORED

- HELIAE DEVELOPMENT ( [Heliae Development - Sustainable & Regenerative Agriculture Solutions \(heliae-global.com\)](http://heliae-development.com))
- KIVERDI ([Kiverdi, Inc.](http://kiverdi.com))
- ENN RESEARCH INSTITUTE ([enn energy research institute \(ennresearch.com\)](http://enn-research.com))
- ADVANCED BIOMASS R&D CENTER ([Advanced Biomass R&D Center](http://advanced-biomass.com))
- KOREA INSTITUTE OF ENERGY RESEARCH ([KOREA INSTITUTE OF ENERGY RESEARCH \(kier.re.kr\)](http://kier.re.kr))
- SOLAZYME ([Solazyme | At Solazyme we transform microalgae, the smallest of organisms, into solutions for the worlds biggest problems. \(solazymeindustrials.com\)](http://solazyme.com))
- NESTE OIL ([Products | Neste](http://products.neste.com))

### SECTOR RELATED EU FUNDED PROJECTS:

1) **FUTURE EUROPEAN LEAGUE 4 MICROALGAL ENERGY (FUEL4ME)**. The EU funded FUEL4ME (FUTURE EUROPEAN LEAGUE 4 MICROALGAL ENERGY) project was established to evaluate microalgae as potential sustainable source for second-generation biofuels that can compete with fossil fuels. To realise this an increase in the scale of microalgae production needed to be matched with a simultaneous decrease in production costs. The FUEL4ME project has achieved significant decreases in production costs of algal lipids, but the production costs for algal biodiesel are still (more than) an order of magnitude too high to make this process commercially attractive in the short term.

Grant agreement ID: 308983.

<https://cordis.europa.eu/project/id/308983/reporting>

## **BLUE BIOTECHNOLOGY** e) Bio-monitoring and bio-remediation → Seawater purification, remediation

### **1.e KEYPOINTS: THE MARKET**

- While the analysis of the legal protection of the technologies aimed at the seawater purification has been limited to the most recent priority years, no limitation has been imposed to the timeframe of patent applications focusing on the remediation techniques (not necessarily restricted to the issue dealing with the seawater contamination). In the former case the amount of patent applications filed to supranational authorities appears quite modest, despite 400 patent applications have been recently filed to the Chinese patent authority. Instead, the interest for the remediation technologies seems widespread, although a slight decline in the number of patent applications could be noticed after the year 2015.
- As far as residents of the European countries bordering the Mediterranean Sea are concerned, a small number of applicants/assignees is detectable in France (VEOLIA WATER TECHNOLOGIES and EXOCHEMS ENVIRONNEMENTS), while several others may be headquartered in the USA. Quite often the development of remediation technologies may be based on the use of enzymes (e.g., nitrilase), which may function in harsh condition (high salinity, temperature above 100 °C, like in the case of deep-sea thermal vents, or below 0°C in arctic waters) to be used for the detoxification of waste (studied by VERENIUM, currently belonging to BASF). Another US company active in the same field is NEOZYME INTERNATIONAL, dedicating efforts for developing enzymes preventing issues originating by the treatment of the sewage sludge.
- The commitment of the European players appears quite remarkable, essentially in case the divulgation of technical principles is achieved by means of NPL documents, either considering the technologies specifically aimed at the seawater decontamination or those aimed at the remediation technology. It is then likely that the European institutions are rather involved in basic research initiatives and seldom foresee the possibility of exploiting the technical solutions developed.

### **2.e KEYPOINTS: THE LEGAL STATUS**

- Even if the pool of results specifically dealing with the “seawater purification” field is restricted to the patent applications filed in recent years, the commitment of the patent assignees seems significant, likewise the commitment of the assignees arguable from the “remediation” data is significant as well.
- Although in both fields the ideal prerequisite of the innovation relies on the use of natural resources available from the marine environment to decontaminate the seawater or the soil, the share of results fulfilling this requisite appears modest, being estimated around 16% in the “seawater purification” field and 22% in the “remediation field”.
- In both cases most applicants are headquartered in the Asian countries. One hypothesis to be further assessed concerns the observation that in Western countries the decontamination may still rely on the applicability of physical-chemical methods and seldom be based on a biotechnological approach, at least as far as the technical content of most patent documents would suggest.



### 3.e KEYPOINTS: THE TECHNOLOGIES

- The biomonitoring and bioremediation sector includes two sub-sectors dealing with the seawater purification and the remediation, the latter context not necessarily implying the remediation of marine resources but dealing also with soil remediation performed by the exploiting the marine resources.
- The technical field “Environmental Technologies” as defined by WIPO is prevalent in both sectors, therefore further dissection to detect more specific technologies depends significantly on the improved granularity provided by the IPC/CPC classification codes assigned.
- As far as the seawater purification sector is concerned, it can be argued from the clustering analysis that several IPC or CPC C02F subclasses regarding treatment of water are assigned to the patent families, while the technologies for (waste)water treatment are also identified by means of the CPC Y02A and Y02W subclasses. Having already determined that the use of natural resources to decontaminate the water concerns around 16% of the patent families, some cases of co-occurrence of the IPC classification codes C12N1 and C12R1, both referring to processes where microorganisms are used, can be detected.
- Instead, as far as the remediation sector is concerned, it can be argued from the clustering analysis that not only the IPC subclass C02F (referring to treatment of water) is assigned to the patent families, but quite frequently also the subclass B09B (referring to soil remediation) is assigned and often both these classification codes are co-assigned to a given patent family. As already observed in this context, about 22% of the patent families concern processes where natural resources are contemplated, therefore it is not surprising that IPC codes referring to fermentation (C12M) and use of apparatuses for enzymology or microbiology (C12P) may be detected when analyzing the co-occurrence of the IPC classification codes.

### 4.e KEYPOINTS: THE NPL DIVULGATION

- Among the European countries bordering the Mediterranean Sea, Italy France and Spain appear as those countries most frequently involved in national/international collaborations aimed at the divulgation of technical information by means of NPL. The number of publications produced by each country is almost the same, either considering the seawater purification or the remediation technologies.
- However, the commitment of each of the countries mentioned above toward the seawater purification seems slightly higher if comparing the number of publications produced by each country to the number of publications dealing with the remediation sector. It is worth considering the commitment of Greece as revealed by the NPL production as far as seawater purification is concerned, whereas the number of NPL publications dedicated to the problem of remediation is meaningful though quite lower than the number of publications produced by France, Italy and especially Spain as far as the same sector is concerned.

### 5.e PLAYERS TO BE MONITORED

- SAMSUNG HEAVY INDUSTRIES ( <http://www.samsungshi.com/eng/deFault.aspx>)
- EBARA CORP. (<https://www.ebara.co.jp/en/>)
- AMOGREENTECH COMPANY (<http://www.amogreentech.com/wp/>)
- HODU COMPANY (<http://www.hoducompany.com/eng/>)
- KURITA WATER INDUSTRIES (<https://www.kurita.co.jp/english/>)
- VEOLIA WATER SOLUTIONS (<http://www.veoliawaterst.it/>)
- XYLECO ([Xyleco, Inc. | Leading the Sustainable Industrial Revolution™](#))
- VERENIUM ([Enzymes \(basf.com\)](#))
- BRGM ([French geological survey | BRGM](#))
- EXXOCHEMS ENVIRONMENT ([Exochems Environnement](#))

#### SECTOR RELATED EU FUNDED PROJECTS:



## Seawater purification

1) **A compact, unmanned, renewables-powered and self-sufficient vessel able to pick up marine litter and to treat it on board for volume reduction and energy recovery (Sea Litter Critters).** The project intends to explore the feasibility of introducing to the market Sea Litter Critters, a compact, unmanned, renewables-powered and self-sufficient marine litter collection and treatment vessel based on a patent pending device treating waste thermally with plasma technology and no harmful emissions. This device is designed to operate near the shores especially nearer tourist facilities substituting the mechanical collection of litter currently adopted. By picking up litter (plastic debris mostly) near the point of entry, Sea Litter Critters contribute to minimising the pollution risks linked to plastic in the sea, where plastic items become brittle and break down into small particles, but basically never dissolve.

Grant agreement ID: 717863.

<https://cordis.europa.eu/project/id/717863>

2) **Cleaning Litter by developing and Applying Innovative Methods in european seas (CLAIM).** CLAIM focuses on the development of innovative cleaning technologies and approaches, targeting the prevention and in situ management of visible and invisible marine litter in the Mediterranean and Baltic Sea. Two innovative technological methods will be developed, a photocatalytic nanocoating device for cleaning microplastics in wastewater treatment plants and a small-scale thermal treatment device for energy recovery from collected litter on board ships and ports.

Grant agreement ID: 774586.

<https://cordis.europa.eu/project/id/774586>

3) **POLLuted Site DecontaminatiON – PCP (POSIDON).** The project gathers 5 European procurers facing similar problems in the sites they manage, affected by analogous pollutants (2 front-runners-Trieste, IT and Bilbao, ES-and 3 observers - Spaque, BE; Vitoria Gasteiz, ES; Baja do Tejo, PT), leveraging public demand to identify fit-for-purpose and cost-effective innovative and sustainable solutions to soil contamination. The common challenge faced by the buyers' group is identifying a new, life-cycle cost-effective technology for soil and groundwater remediation, capable of decontaminating heterogeneous anthropic soils in brownfields with a mixture of industrial waste (blast furnace slags, construction & demolition waste, filling soils polluted by petroleum hydrocarbons) and soils consisting of clays and sands of marine origin, highly polluted by petroleum hydrocarbons (TPHs and PAHs) and heavy metals (arsenic and lead).

Grant agreement ID: 776838.

<https://cordis.europa.eu/project/id/776838>

4) **A gelatinous solution to plastic pollution (GoJelly).** The objective of the GoJelly project is to develop, test and promote a gelatinous solution to microplastic pollution by developing a TRL 5-6 prototype microplastics filter (GoJelly) for commercial and public use, where the main raw material is jellyfish mucus. In doing so, the consortium addresses two environmental issues with one approach by removing the commercially and ecologically destructive sea and coastal pollution of both jellyfish and microplastics. This innovative approach will ultimately lead to less plastic in the ocean, municipal demand (and thereby competitive prices) for jellyfish raw material to fill the "mucus-need" by filter developers, and in turn more jobs for commercial fishers in off-seasons.

Grant agreement ID: 774499.

<https://cordis.europa.eu/project/id/774499>

## Remediation

1) **Strategies of circular Economy and Advanced bio-based solutions to keep our Lands and seas alive from plastics contamination (SEALIVE).** Europe's efforts to reduce plastic pollution on land and in the sea aim for sustainable business practices, compatible with the principles of the circular economy. Consequently, the use of organic materials (bioplastics) or degradable materials (biodegradable) is encouraged. The EU-funded SEALIVE project proposes advanced circular strategies that prevent and substantially limit pollution. This solution will be tested in Cyprus, Denmark, France and Ireland. It will be developed under recycling, biodegradability and composting norms for advanced systems. The project



aims to develop circularity techniques and end-of-life solutions that will support sustainable bio-based plastics solutions. The solutions will be tested in eight cases representing high pollution potential for land and sea.

Grant agreement ID: 862910.

<https://cordis.europa.eu/project/id/862910>

**2) Integrated Marine Pollution Risk assessment and Emergency management Support Service In ports and coastal enVironmEnts (IMPRESSIVE).** IMPRESSIVE project focuses in developing a universal-relocatable platform for real time management of marine pollution events in the wider area of EU harbors and their vicinities, easy to manipulate and use from the harbor control post. EO monitoring and advanced modeling of these areas are of great interest as the large ship activity, ship traffic and ship refueling, addresses them as highly risky for pollutant spills and waste waters.

Grant agreement ID: 821922.

<https://cordis.europa.eu/project/id/821922/reporting>

**3) Assessment of riverine litter (plastics) inputs to the marine environment (LitRivus).** Under the pressure of climate change, scientists are searching for new, more effective ways to protect marine fauna and flora. Pollution is a huge obstacle. Plastic litter is one of the biggest causes of pollution for rivers, seas and oceans. Millions of tonnes of plastic enter the oceans, with much of this coming from land-based sources through rivers. Anthropogenic riverine litter is emerging as a major global environmental concern. The EU-funded LitRivus project will shed new light on riverine litter. It will evaluate international data, collaborate with experts, and review policy and decision-making frameworks. The aim is to guarantee a science-policy knowledge transfer to improve plastic mitigation measures.

Grant agreement ID: 846843.

<https://cordis.europa.eu/project/id/846843>

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## **BLUE SUSTAINABLE DEVELOPMENT: a) Monitoring and Observing systems for Marine Environment**

### **1.a KEYPOINTS: THE MARKET**

- As far as all subsectors belonging to the “Monitoring and Observing systems for Marine Environment” sector are concerned, it appears relevant how often the patent applications are directly filed to the national authorities, especially the CNIPA/SIPO<sup>8</sup> and the USPTO<sup>9</sup>, without neglecting the KIPO<sup>10</sup> and the JPO<sup>11</sup>, while the numbers of applications filed through harmonized procedures is lagging behind.
- As will be better ascertained through the analysis dedicated to the legal data, one possible explanation is that in each subsector the technical implementations described in the patent documents are usually innovative, therefore the definition of the territorial coverage is still not complete.
- Although relevant players may be headquartered in the USA or in South Korea, the advice is to include, among the players to be periodically monitored, also some French (especially THALES, as far as the maritime surveillance subsector is concerned) or several Spanish ones.
- As usually observed, the initiatives of the European players can be better appreciated when the assessment is based on the NPL divulgation forms. The UUV<sup>12</sup> subsector may provide an exceptional picture in which a restricted pool of countries results particularly involved in the R&D<sup>13</sup> activities, the role of the eastern countries – excluding China - appearing marginal if compared to the situation of the EU and of the USA.

<sup>8</sup> State Intellectual Property Office

<sup>9</sup> United States Patent and Trademark Office

<sup>10</sup> Korean Intellectual Property Office

<sup>11</sup> Japan Patent Office

<sup>12</sup> Unarmed Underwater Vehicles

<sup>13</sup> Research & Development



## 2.a KEYPOINTS: THE LEGAL STATUS

- As arguable from the market data, the increment of the patent filing events is quite impressive when analyzing the trends regarding the most recent years, no matter what subsector dealing with Monitoring and Observing systems is examined.
- As far as the average patents' grant rate is concerned, the values range from almost 32% to almost 50%.
- There margin of implementation of the key enabling technologies of each sub-sector is consistent since in most cases the numbers of days before expiry is quite relevant and the fraction of patent expired is small in any of the sub-sectors analyzed. Therefore, the patent documents should refer in general to innovative technologies or products.
- The evaluation of the patent family dimension reveals that, as already noticed as far as other technical sectors are concerned, in general the strategy of the Asian applicants, in particular the Korean ones, differs from that characterizing the US and European applicants, because in the latter case a multiplicity of patent applications is usually filed to protect simultaneously the same invention in different territories.
- As far as the maritime surveillance subsector is concerned there are several European players worth of consideration, especially French applicants, the most representative being THALES who owns 40 patent families.

## 3.a KEYPOINTS: THE TECHNOLOGIES

- The information arguable from the analysis merely based on the technical fields defined by WIPO is consistent for each of the four sub-sectors, however, the scarce granularity suggests that the evaluation of the frequency of assignment of IPC/CPC classification codes may be the most appropriate approach.
- The clustering of the patent documents highlights a different trend if the "Monitoring and Observing systems for Marine Environment" sector is compared to the other sectors examined. Indeed, in the former case the composition of the patterns based on IPC/CPC codes is seldom characterized by more than one classification code. Consistently, when examining the co-occurrence of the classification codes it turns out that despite each dataset includes several hundreds of non-duplicated patent families, the frequency of associated classification codes is quite low. These results suggest that the technologies characterizing each subsector belonging to the "Monitoring and Observing systems for Marine Environment" sector can be precisely identified by just one or few specific IPC/CPC classification codes, whereas patterns comprising several classification codes are usually necessary to properly identify and differentiate the technologies of the other sectors.
- Excluding the G01S subclass (RADIO DIRECTION-FINDING; RADIO NAVIGATION; DETERMINING DISTANCE OR VELOCITY BY USE OF RADIO WAVES; etc.), characterizing both the "Maritime surveillance" and the "Marine mapping" subsectors, each of the four subsectors analyzed may be identified by means of specific classification codes, either IPC or CPC, not shared with any of the remaining three sub-sectors.
- As far as the "Seawater sensors" sub-sector is concerned, it turns out that IPC/CPC classification codes identifying treatments aimed at cleaning the polluted water are frequently assigned to the patent families. It appears that **vessels specially adapted for collecting pollution from open water** may be suitable for the environmental remediation and that a related issue may be not only represented by the contamination caused by the exhaust gas of the vehicle engines but also by the noise pollution.

## 4.a KEYPOINTS: THE NPL DIVULGATION

- As far as the "maritime surveillance" subsector is concerned, as already emerged from the patent analysis and confirmed by the NPL documents the number of initiatives in which the French company THALES is involved is worth of consideration and monitoring in the future.

- As far as the “marine mapping” is concerned, the number of initiatives evaluated upon examining the NPL divulgation in the countries located along the Mediterranean coast seems relevant, thus revealing a gap specifically concerning the lack of strategies based on the legal protection of innovative technologies or products.
- As far as the “seawater sensors” sector is concerned, the needs highlighted by the Marine Strategy Framework Directive seem at least in part satisfied by technical implementations described and claimed in patent applications, especially those concerning the environmental and the acoustic pollution.
- As far as the implementation regarding the unmanned underwater vehicles is concerned, a consistent margin of implementations is foreseen. For the time being the scarcity of NPL divulgation might either reveal a market niche or depend on the fact that the legal protection of innovative devices or technologies is considered by the players the most appropriate approach being the enabling technologies relatively new.

## 5.a PLAYERS TO BE MONITORED

- RAYTHEON TECHNOLOGIES (<https://www.rtx.com/>)
- INSITU (<https://www.insitu.com/>)
- AEROVIRONMENT (<https://www.avinc.com/>)
- PRYSMIAN (<https://it.prysmiangroup.com/>)
- SELEX (<http://selex-es.com/>)
- THALES ALENIA SPACE (located in Italy, <https://www.thalesgroup.com/it/italia/global-presence-europe/italia>)
- W-SENSE (<https://wsense.it/>)
- SCIO SOFT SL (<https://www.scioit.es/inicio-eng/>)
- THALES ([Thales - Building a future we can all trust \(thalesgroup.com\)](https://www.thalesgroup.com/))
- GEOCEAN (<https://www.entrepose.com/fr/geocan/>)
- SAFRAN (<https://www.safraan-group.com/>)
- ETME PEPPAS KAI SYNERGATES EE (<https://etme.gr/>)
- WIRELESSWERX Corp. (<https://www.crowdvision.com/>)
- TEVEL ADVANCED TECHNOLOGIES (<https://www.tevel-tech.com/technology/>)
- TOMTOM International (<https://developer.tomtom.com/products/tracking-api>)
- MICROSOFT CORP. (<https://www.microsoft.com/it-it/>) see: <https://www.microsoft.com/en-us/maps>
- NAVIONICS (<https://www.navionics.com/ita/>)
- BLUE DNA COMPANION ([BlueDNA companion - Rapid Microbiology - Oncology Diagnostics](https://www.bluedna.com/))
- SUEZ EAU FRANCE ([SUEZ Eau France SAS - Company Profile and News - Bloomberg Markets](https://www.suez.com/))
- INDUSTRIE DE NORA ([Home | De Nora - Electrode and Water Technologies that work!](https://www.industrie-de-nora.com/))
- CAMBRIAN INNOVATION ([Wastewater treatment systems and services | Cambrian \(cambrianinnovation.com\)](https://www.cambrianinnovation.com/))
- AAT BIOQUEST ([Home | AAT Bioquest](https://www.aatbioquest.com/))
- LIQUID ROBOTICS (<https://www.liquid-robotics.com/markets/environmental-assessment/>)
- RECONROBOTICS (<https://reconrobotics.com/>)
- BLUEROBOTICS (<https://bluerobotics.com/about/>)
- HADAL Inc. (<https://www.dnb.com/business-directory/company-profiles/hadal.dab25e9bd7adfc9b3f89a3dd2d46899b.html#company-info>)
- MARINE INSTRUMENTS Co. (<https://www.marineinstruments.es/>)
- SEYS MEDIOAMBIENTE SL (<http://www.seysmedioambiente.com/apartado/1677/innovacion>)

## SECTOR RELATED EU FUNDED PROJECTS:

### Maritime surveillance

1) **Maritime Integrated Surveillance Awareness (MARISA).** Combating irregular migration, human smuggling, terrorism at sea, piracy, as well as arms and drug trafficking has become a high priority on Europe's security agenda. Securing

the sea requires a day-to-day collaboration activities among European actors of maritime surveillance, Member States' administrations and European agencies principally, and a significant number of initiatives are being taken at EU level to address this challenge.

Grant agreement ID: 740698

<https://cordis.europa.eu/project/id/740698>

2) **RADARS for loNG distance maritime surveillancE and SaR opERations (RANGER)**. RANGER aims at re-enforcing EU by combining innovative Radar technologies with novel technological solutions for early warning, in view of delivering a surveillance platform offering detection, recognition, identification and tracking of suspicious vessels, capabilities exceeding current radar systems.

Grant agreement ID: 700478

<https://cordis.europa.eu/project/id/700478>

3) **GALILEO-BASED PASSIVE RADAR SYSTEM FOR MARITIME SURVEILLANCE (spyGLASS)**. This proposal brings forward a passive bistatic radar (PBR) based on Galileo transmissions for maritime surveillance. The exploitation of existing transmissions for PBR applications is becoming increasingly attractive due to their low costs, covert operation, and reduced environmental pollution.

Grant agreement ID: 641486

<https://cordis.europa.eu/project/id/641486>

### Marine mapping

1) **"BOTTOM TRAWLING AS A DRIVER OF DEEP SEASCAPE TRANSFORMATION (TrawledSeas)**. The EU-funded project TrawledSeas provides a thorough reading of the impact of bottom trawling in terms of extent, rates, and volume change on the morphology of different geological and climatic deep (>200 m) seafloor settings. Their interdisciplinary approach combines quantitative analysis of high-resolution multibeam data with geophysical and sedimentological information, in situ observations and satellite-based vessel tracks.

Grant agreement ID: 867471

<https://cordis.europa.eu/project/id/867471>

2) **"The Politics of Marine Biodiversity Data: Global and National Policies and Practices of Monitoring the Oceans (MARIPOLDATA)**. Marine biodiversity data will play a central role: Firstly, in supporting intergovernmental efforts to identify, protect and monitor marine biodiversity. Secondly, in informing governments interested in particular aspects of marine biodiversity, including its economic use and its contribution to biosecurity. In examining how this data are represented and used, this project will create a novel understanding of the materiality of science-policy interrelations and identify new forms of power in global environmental politics as well as develop the methodologies to do so. This is crucial, because the capacities to develop and use data infrastructures are unequally distributed among countries and global initiatives for data sharing are significantly challenged by conflicting perceptions of who benefits from marine biodiversity research. Despite broad recognition of these challenges within natural science communities the political aspects of marine biodiversity data remain understudied.

Grant agreement ID: 804599

<https://cordis.europa.eu/project/id/804599>

### Seawater sensors

1) **Micro AIS Shore Station (MASS)**. Automatic Identification System (AIS) is a VHF based system which is designated to enhance the safety of life and goods at sea by also assuring navigational and environmental improvements. The coverage of national AIS networks is limited because of many reasons (geography, weather conditions, insufficient number of stations etc.) and due to these limitations relevant authorities have difficulties to track and manage the marine traffic properly; causing safety and security weaknesses at sea which also means increased threats of accidents, illegal fishing, immigration & smuggling and water pollution.

Grant agreement ID: 775636

<https://cordis.europa.eu/project/id/775636>





## **BLUE SUSTAINABLE DEVELOPMENT b) Marine environmental technologies**

### **1.b KEYPOINTS: THE MARKET**

- Considering the number of non-duplicated families (269), the dataset concerning the Precision Aquaculture is one of the smallest along with the Sea organisms' genetics and the Microplastics sectors. Patent applications concern a niche sector since referring to technical implementations tailored to the Aquaculture needs, moreover based on innovative technologies such as the IoT<sup>14</sup> or the AI<sup>15</sup>.
- A steep increase of the number of applications can be observed between year 2009 and 2010, being the ramp-up determined by a simultaneous increase of the patent applications filed to the USPTO, to the KIPO, to the EPO and to the WIPO. Little contribution to such increase seems provided by players headquartered in the countries bordering the Mediterranean Sea, despite data referring to divulgation forms alternative to patent documents reflect a relevant contribution from institutions hosted in several EU countries, presumably referring to basic research activities.

### **2.b KEYPOINTS: THE LEGAL STATUS**

- As already pointed out in the sector concerning the "Monitoring and observing systems for the marine environment", also in the case of the subsector specifically referring to the "Precision Aquaculture" the residual validity of the granted patents is noticeable, thus indicating that there is a remarkable margin for the exploitation and the implementation of such technologies.
- However, it seems that, excluding the players resident in the USA or in South Korea, little contribution to innovation is provided by applicants headquartered in the other countries. The US company McAlister Technologies owns the highest number of applications and granted patents.

### **3.b KEYPOINTS: THE TECHNOLOGIES**

- Although a CPC classification code specific for aquaculture exists (Y02A40/81), the framing of the "precision aquaculture" field in terms of patent description and claims remains quite elusive for the time being, therefore the co-occurrence of aquaculture and one or more enabling technologies, such as those based on artificial intelligence, internet of things, robotics or sensor networks has been focused on in the present analysis.
- Despite the limited dimension of the dataset, the IPC classification code A01K61/00 referring to culture of aquatic animals has been frequently assigned, yet the technical context associated to the aquaculture products/technologies seems variegated, at least upon examining the WIPO technical fields. Consistently, a rough estimation highlights that about 10% of the patent families do share the technical concept "Internet of Things", while the monitoring devices concern just 8% of the patent families. It might be argued that this sub-sector represents a niche when referring to the marine environmental context.
- As argued from the market analysis, the filing rate of the patent applications is not constant, an effect that may be correlated to the vague identification of the technical context rather than to a scarce innovativeness of the technologies.

<sup>14</sup> Internet of Things

<sup>15</sup> Artificial intelligence



## 4.b KEYPOINTS: THE NPL DIVULGATION

- As pointed out earlier, although the scope of the precision aquaculture is to apply control-engineering principles to the production, to direct farmers to a better monitoring, control, and documentation of biological processes in fish farms, this subsector seems not extensively targeted either considering the patent documents or the NPL divulgation forms. The number of players, especially those located in Europe, is scarce and it seems that for the time being basic research activity predominates over applied research. One EU funded project has been detected being the development of biosensors fundamental.

## 5.b PLAYERS TO BE MONITORED

- AQUABYTE Inc. (<https://www.aquabyte.ai/index.html>)
- SEA CONTROL HOLDINGS (<https://www.israelbizreg.com/de/sea-control-holdings-ltd>)

### SECTOR RELATED EU FUNDED PROJECTS:

#### 1) Development and field validation of biosensor methods for the assessment of the effects of pollution and solar uv radiation on commercially and ecologically important marine invertebrates (UVTOX)

The main goal of this research project is to introduce novel cellular biosensor (marine invertebrate cell culture) and molecular biosensor techniques for the estimate of the health state of ecologically and/or commercially important marine invertebrates at their natural habitats (sponges and sea urchins) or held in aquaculture (bivalves).

Three molecular biosensors will be developed:

- immunosensor,
- DNA affinity biosensor, and
- DNA damage biosensor. These biosensors will be used to determine and to quantify the impact of cosmic (UV-B radiation) and ecosystem (xenobiotics) factors, and their combinations on marine invertebrates (laboratory experiments and field studies). This project will contribute to a sustainable exploitation of the sea. Commercialisable products (biosensor chips for environmental monitoring) will be developed and distributed throughout the world.

Grant agreement ID: EVK3-CT-1999-00005

<https://cordis.europa.eu/project/id/EVK3-CT-1999-00005>

## BLUE SUSTAINABLE DEVELOPMENT c) Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure

## 1.c KEYPOINTS: THE MARKET

- Considering the number of non-duplicated families (241), the dataset concerning the Microplastics is one of the smallest collections of patent documents. Nevertheless, a consistent increment of the number of patent applications filed in recent years can be detected, the commitment of Germany toward the exploitation of the technologies appearing relevant. As far as the bioplastics sector is concerned, the contribution of European players, especially those headquartered in France, Spain and Italy, appears meaningful.
- Quite surprisingly, upon examining the countries bordering the Mediterranean Sea, no player can be detected as far as the microplastics sector is concerned. Moreover, the trend arguable from the worldwide examination of the NPL divulgation, confirms that EU countries as well as the USA play only a marginal role, being the initiatives of Chinese institutions clearly prevalent over the rest of the world. To the contrary, the commitment of the EU players is significant as far as the bioplastics sector is concerned. In this context, the NPL data from the US or Chinese players reveals an important contribution, though the proportion of publications delivered is not as high as that corresponding to the EU players.





## 2.c KEYPOINTS: THE LEGAL STATUS

- The legal information regarding the patent documents concerning the prevention of environmental issues caused by microplastics confirms that in western countries the sensitization toward this important threat needs a substantial improvement, having retrieved mainly German applicants active in this specific sector.
- Instead, as far as the production of the bioplastics is concerned, several European players can be detected, moreover the technologies claimed in the patent documents may be quite innovative because the residual validity of the granted patents is in general relevant. If the US player BIOLOGIQ is excluded, several European players worth of consideration include the French companies CARBIOS and CARBIOLICE, the Swiss company OMYA and the Finnish company PAPTIC.

## 3.c KEYPOINTS: THE TECHNOLOGIES

- Although from the analysis of the patent applications it may appear that the awareness of the environmental issues caused by the microplastics is still scarce, the ranking of the technical concepts confirms that a relevant fraction of the patent documents selected deals with such relevant issue, the accuracy of the search criteria being confirmed by the assignment of specific classification codes, either IPC or CPC, identifying the technologies aimed at the recovery/recycling of plastics (such as B29B17 or Y02W30/62). As far as the bioplastics' sector is concerned, specific IPC or CPC classification codes may be detected, especially the CPC C08L2201/06 that refers to biodegradable matter.
- Considering the small rate of legal protection, either in Europe or USA, of technical solutions regarding purifications methodologies aimed at reduction/removal of microplastics, it might be argued that the implementations seem not appealing for the commercial exploitation, maybe because the TRL is still low or maybe because the performance needs to be further improved. To the contrary, as far as the bioplastics sector is concerned, there are many patent families clearly assigned to the Macromolecular chemistry technology field, being the exploitation of materials such as PLA, PHA and other natural compounds (starch, cellulose) relevant (see, for example, [Bioplastics – European Bioplastics e.V. \(european-bioplastics.org\)](https://european-bioplastics.org/)).

## 4.c KEYPOINTS: THE NPL DIVULGATION

- As pointed out in the above paragraphs, the relevance of technical implementations regarding the environmental threat caused by the microplastics is not adequately mirrored if considering the patent applications filed. Consistently, a restricted number of players, often academic institutions hosted in Italy, France and Spain, are as well producing a little number of NPL publications.
- Instead, as far as the bioplastics sector is concerned, not only the initiatives aimed at the legal protection of technical innovations but also the alternative divulgation by means of NPL appears significant at least as far as Italy, France and Spain are concerned. Moreover, activities in which companies are involved are frequently detectable. Italy scores the highest number of NPL publications.

## 5.c PLAYERS TO BE MONITORED

- CARBIOS ([Carbios - Innovating for a true circular economy in plastics](#))
- CARBIOLICE ([Carbiolice ≡ Compostable plastic solutions](#))
- CABAMIX ([CABAMIX, producer of CARBOMAX and CARBOMAX BIO, calcium carbonate base additive](#))
- VALAGRO CARBONE RENOUEVABLE POITOU ([Home - Valagro Research and Development \(valagro-rd.com\)](#))
- PATENT SHOES S.L. ([Patent Shoes – Science for design \(patent-shoes.com\)](#))
- ADERCARTA SpA ([Carte e sacchetti alimentari | Adercarta](#))
- MIXCYCLING Srl ([Mixcycling srl - Brand di design Italy | Fuorisalone.it](#))
- BIOLOGIQ ([BioLogiQ](#))
- DANIMER BIOPLASTICS ([Home - Danimer Scientific](#))



- TETHIS ([Home \(tethis.com\)](http://tethis.com))
- HOPE TREE INTERNATIONAL GmbH ([Hope Tree International GmbH - Umwelteinrichtung Für Erneuerbare Natürliche Ressourcen in Holzkirchen \(business.site\)](http://Hope Tree International GmbH - Umwelteinrichtung Für Erneuerbare Natürliche Ressourcen in Holzkirchen (business.site)))
- SPC SUNFLOWER PLASTIC COMPOUND ([SPC-Biopolymere](http://SPC-Biopolymere))
- PORVAIR SCIENCES ([Porvair Sciences Limited](http://Porvair Sciences Limited))
- SOLUBLUE ([SoluBlue - The Clear Alternative to Plastic Packaging](http://SoluBlue - The Clear Alternative to Plastic Packaging))
- DOIL ECOTEC ([Doil Ecotec Co., Ltd.](http://Doil Ecotec Co., Ltd.))
- ALCHEMYTH ([Alkermis \(alchemyth.com\)](http://Alkermis (alchemyth.com)))
- OMYA ([Welcome to Omya](http://Welcome to Omya))
- PAPTIC ([Sustainable Alternative to Plastic Materials in Packaging - Paptic](http://Sustainable Alternative to Plastic Materials in Packaging - Paptic))

## SECTOR RELATED EU FUNDED PROJECTS:

### Microplastics

#### 1) Baseman- Defining the baselines and standards for microplastics analyses in European.

The project, which brings together 24 research partners from 11 European countries, is intended to produce uniform standards for measuring and assessing microplastic. For one thing, group experiments are planned, in which the different partners will all analyse the same microparticle sample.

<http://jpi-oceans.eu/sites/jpi-oceans.eu/files/public/Press%20release/Short%20description%20BASEMAN.pdf>

### Bioplastics

**1) Developing and Implementing Sustainability-Based Solutions for Bio-Based Plastic Production and Use to Preserve Land and Sea Environmental Quality in Europe (BIO-PLASTICS EUROPE).** The project BIO-PLASTICS EUROPE addresses the topic „Sustainable solutions for bio-based plastics on land and sea“ (Topic identifier: CE-BG-06-2019), within the focus area „Connecting economic and environmental gains - the Circular Economy (CE)“ and will focus on sustainability strategies and solutions for bio-based products to support the Plastics Strategy. This shall include innovative product design and business models facilitating efficient reuse and recycling strategies and solutions, including ensuring the safety of recycled materials when used for toys or packaging food stuffs. In line with the EU strategy on international cooperation in research and innovation and in order to encourage the further replication, the European consortium is complemented by a partner in Malaysia, providing an added value and helping them to address the many problems they face.

Grant agreement ID: 860407

<https://cordis.europa.eu/project/id/860407>

**2) Strategies of circular Economy and Advanced bio-based solutions to keep our Lands and seas alive from plastics contamination (SEALIVE).** Europe's efforts to reduce plastic pollution on land and in the sea aim for sustainable business practices, compatible with the principles of the circular economy. Consequently, the use of organic materials (bioplastics) or degradable materials (biodegradable) is encouraged. The EU-funded SEALIVE project proposes advanced circular strategies that prevent and substantially limit pollution. This solution will be tested in Cyprus, Denmark, France and Ireland. It will be developed under recycling, biodegradability and composting norms for advanced systems. The project aims to develop circularity techniques and end-of-life solutions that will support sustainable bio-based plastics solutions. The solutions will be tested in eight cases representing high pollution potential for land and sea.

<https://cordis.europa.eu/project/id/862910>

Grant agreement ID: 862910

**3) Providing the switch from plastic to paper packaging (PAPER SOLUTIONS).** Plastic is an important and ubiquitous material. It is cheap, durable and has multiple functions. However, plastic products are taking their toll on the environment. For instance, the million tons of plastic litter that end up in the oceans every year are a cause of growing public concern. Therefore preventing plastic waste is a top priority in Europe. The EU has banned certain plastics and the preference for paper-based alternatives is high. To assist in the shift to paper-based packaging, the EU-funded PAPER SOLUTIONS project will bring to the market a suite of innovative retrofit technologies that can convert plastic packaging machinery to paper packaging. Its target market is the global packaging industry. The end goal is to contribute to a cleaner environment and increase profits by promoting an eco-friendly model of business.

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## SUMMARY OF THE DATASETS COMPOSITION

	Dataset	ND Patent families	Applications		ND Patent families	Applications
Fishery and aquaculture	Fishery	357	688		2196	4812
	Aquaculture	467	717			
	Fish feed	809	2037			
	Seafood processing	563	1370			
		2196	4812			
Blue Biotechnology	Cosmetics	833	2778		3754	11313
	Pharmaceutics	191	433			
	Nutraceuticals	654	2623			
	Soil fertilization	530	631			
	Sea organisms' genetics	203	364			
	Biofuels	364	1219			
	Seawater purification	503	875			
	Remediation	476	2390			
		3754	11313			
Blue sustainable development	Maritime surveillance	470	1050		3290	6083
	Marine mapping	309	886			
	Seawater sensors	897	1329			
	UUV	504	724			
	Precision aquaculture	269	669			
	Microplastics	241	327			
	Bioplastics	600	1098			
		3290	6083			
					9240	22208