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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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4. Complete report on patent and NPL analysis

Part II: Blue Biotechnology

Part II: BLUE BIOTECHNOLOGY

1 BLUE BIOTECHNOLOGY: MARKET SCENARIO

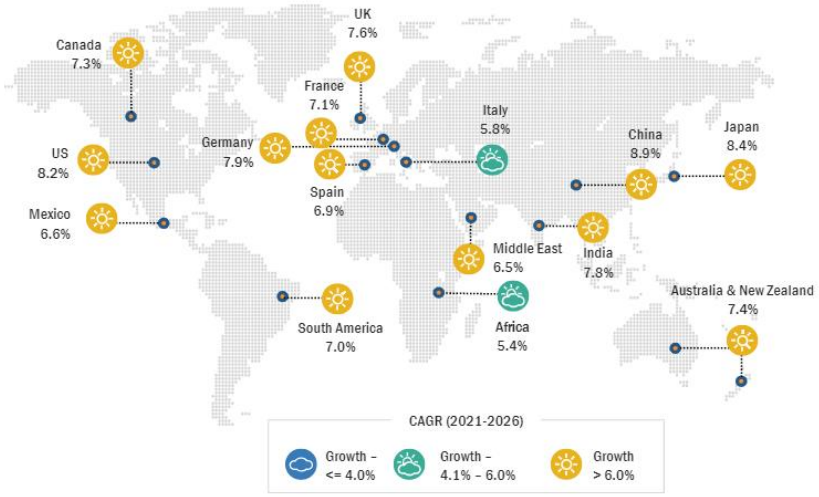
a1) Healthcare and Pharmaceuticals → Cosmetics

The **blue biotechnology sector** usually refers to the non-traditionally exploited groups of marine organisms and their commercial implications. The main species considered belong to macroalgae (seaweed), microorganisms (microalgae, bacteria, and fungi) and invertebrates. These different organisms are currently used for the extraction of high-value bioactive compounds with high market potential [1].
Specifically, the blue biotechnology sector can include **three industries** that generate different products and services, namely:

- The **cosmetics industry** developing functional ingredients (UV filter, viscosity control agents, preservatives) and raw materials (colourants, pigments, fragrances);
- The **pharmaceutical industry** which uses marine organisms to produce medicines (drugs, novel antibiotics, wound healing, anti-inflammatory, immunomodulatory agents) and biomaterials (bio-adhesives, dental-medical biomaterials, disinfectants);
- The **nutraceutical industry** generating new food supplements (prebiotics, ω3 supplements), food products (stabilizer- suspending-bending-foaming agents) and nutraceuticals (antioxidants, anti-inflammatory, anti-HIV) [2].

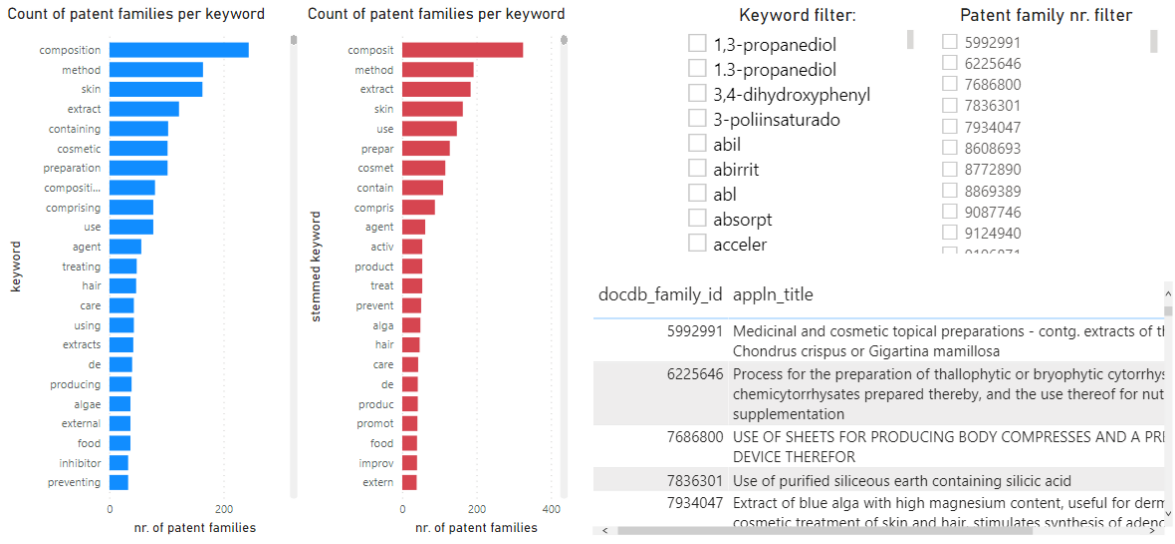
The **cosmetics** industry based on marine biomass is also identified as one of the fast-growing market segments among the blue biotechnology sectors. This growth is related to the large panel of new applications. For example, the **marine collagens** derived from the different parts of marine organisms are compounds largely used in cosmetics products for the regeneration of the skin or as antiaging. Hence, marine collagen has witnessed a relevant growth in the last five years thanks to its wide application, the benefits for the health and the higher bioavailability if compared to other collagen types. Globally the **global marine collagen market** is projected to reach the value of USD 1,137.3 million in 2026, with a CAGR of 7.9% in the forecast period 2020 - 2026. In **Europe**, the market is estimated to reach the value of USD 367.3 million in the forecast period 2020 – 2026. Among the **Mediterranean area**, France, Italy and Spain are currently the main producers [5].

Figure 1 Marine Collagen Market size by Region, CAGRs in the Period 2021-2026



From the perspective of the patent analysis, a dataset consisting of 833 non-duplicated patent families corresponding to 2778 patent applications has been analysed. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 2

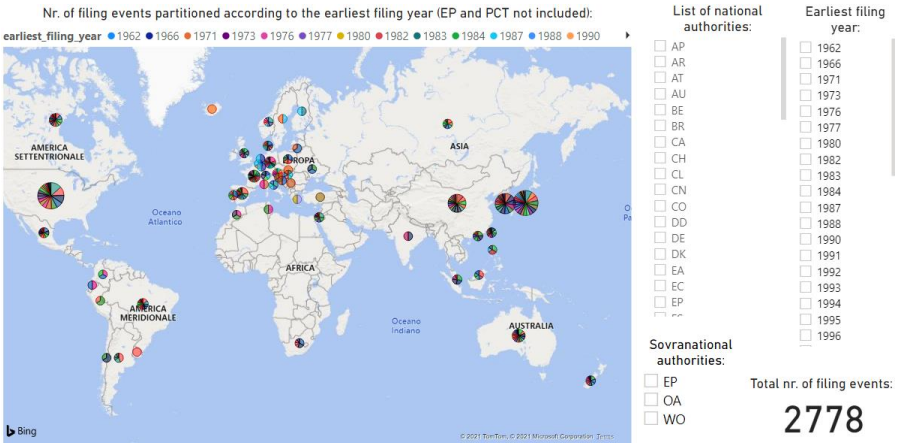
Figure 2 Cosmetics: keywords' frequency



As already observed and mentioned in "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding the cosmetics industry based on marine biomass. The patent authorities located in the Asian Pacific region, especially in China, as well as the USPTO score the highest numbers of filing events. In the Mediterranean region, the patent authorities of Spain, France and Germany score 68, 61 and 44 patent applications, respectively (Figure 3). Looking at the number of patent applications

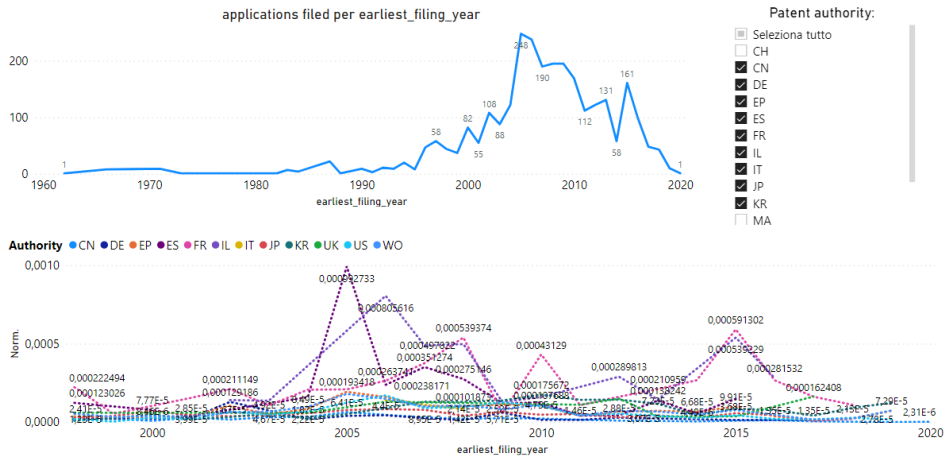
registered by EPO (214) and WIPO (236), the data suggests that the protection of technical innovation in a multiplicity of territories by means of harmonized filing procedures deserves relevant consideration.

Figure 3 Cosmetics: Map of national/supranational patent authorities



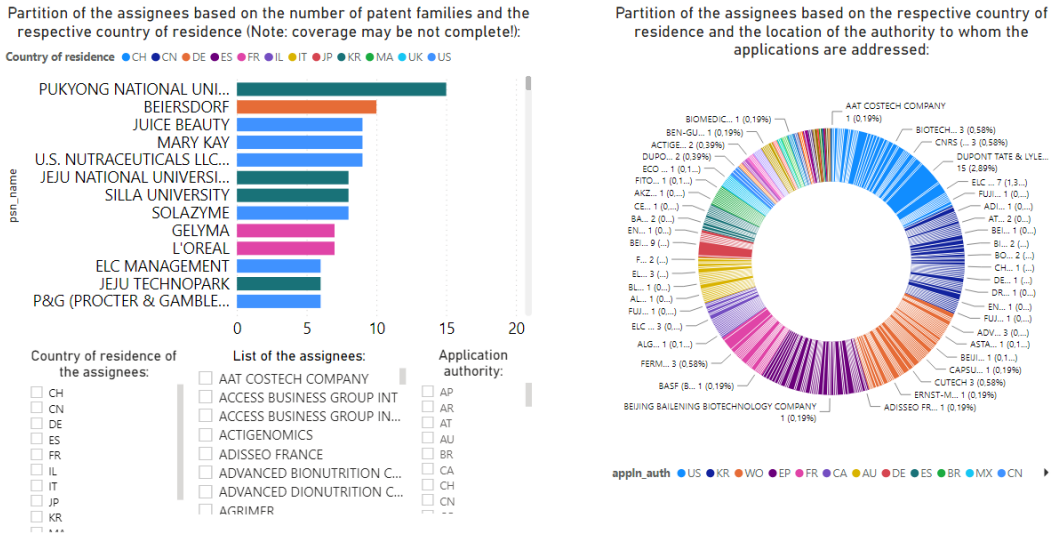
As can be noticed in Figure 4, the increase of the total number of patent applications seems remarkable, especially after yr. 1990, and peaking around year 2005. The decline observed after 2005 is reflected also by the normalized values (the normalized data regarding especially patent authorities located in European countries, such as Spain, France, Italy, Germany and UK). Even if the absolute number of patent applications filed to the CNIPA is equivalent to the total number of applications filed to the EPO (236) and the number of applications filed to the USPTO is 446, about 15 years ago the patent authorities hosted in Spain and Israel could be identified as relevant addressees of patent applications. In most recent times, the Israel patent authority still deserves the attention of the players, being an equivalent trend characterizing the applications filed to the French patent authority, while the rate of the patent applications filed to the Spanish authority declined, especially after yr. 2015.

Figure 4 Cosmetics: Normalization of patent applications



As far as the territorial distribution of the applicants' premises is concerned, **many applicants located in France, several ones located in Spain and in Italy can be detected**. The rightmost pie diagram of Figure 5 provides valuable information regarding the protection strategies, confirming that the European applicants take in due consideration the possibility of filing applications either to the EPO or to the WIPO.

Figure 5 Cosmetics: Legal protection strategy



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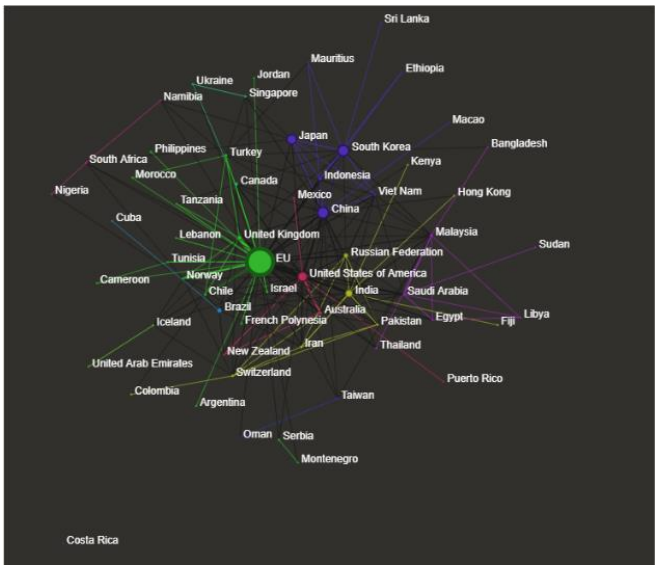
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries such as China, Japan and South Korea (Figure 3) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, books, reviews, conference proceedings and EU funded projects, appear as well ongoing worldwide, the highest proportion being ascribed to EU countries, as evident from Figure 6.

Figure 6 Cosmetics: NPL data worldwide

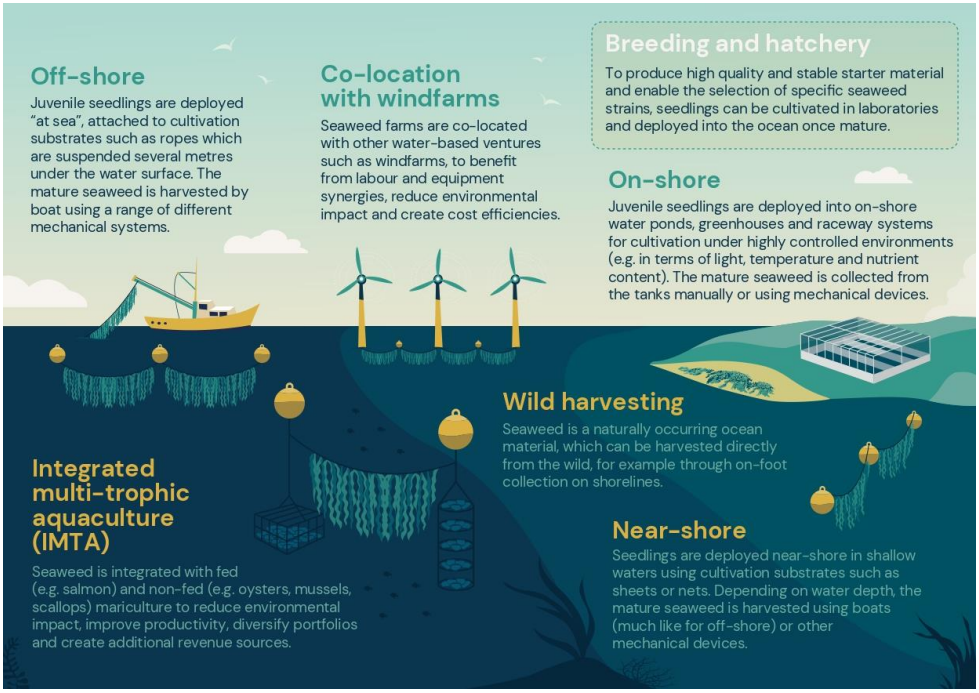


a2) Healthcare and Pharmaceuticals → Pharmaceutics

Overall, **algae** are the most exploited marine organisms in these industries thanks to their several applications. The term "algae" include both macro and microalgae, ranging from seaweeds to single-celled organisms. Key ingredients that can be extracted from algae are carrageenan, carotenoids, lipids, alginate, algal protein, algal flour, agar, and biologically active molecules for use in human and animal health. Other alternative marine biomasses are undergoing several studies aimed at understanding their future possible applications, but so far, the **algae sector** is the most relevant in Europe, and, up to date, the most developed among the emerging sectors of the Blue Bioeconomy. Algae biomass production has increased globally since 1950, reaching almost 32.67 Mt in 2016, with China, Indonesia and South Korea leading the market. In Europe, which accounted for 0.57% of the total production, algae biomass is mainly supplied by Norway followed by Ireland and France. Globally in 2016, up to 96.5% of the total algae biomass was obtained from farmed algae, whereas only a small percentage was harvested from wild stocks. Instead, in Europe, algae biomass was primarily obtained from wild stocks [1]. In the **Mediterranean area** Spain and France are the countries in Europe with the largest number of **macroalgae** companies and **microalgae** producers. France dominates the production landscape with 65% of the mapped production units in Europe.

While algae represent naturally occurring materials, which can be simply harvested from the wild, global trends seem to indicate that soon algae biomass will be mainly cultivated in aquaculture farms. **Seaweed or macroalgae culture** is very convenient because algae generally do not require any freshwater, fertiliser or other external inputs. There is also no need to repurpose or clear land. Moreover, the regenerative nature of seaweed and their contribution to biodiversity and ecosystem services, makes their farming a particularly promising industry [6].

Figure 7 Different type of Seaweed production [6]



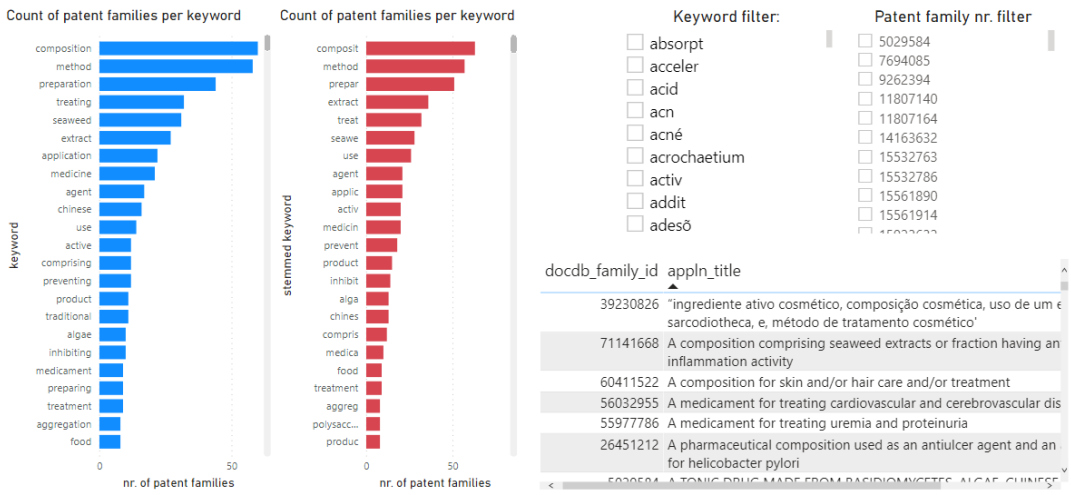
Microalgae can also be **cultivated** in open or closed systems. Open systems are more convenient due to the lower installation and operation costs. In those systems microalgae grow directly in contact with the atmosphere either in ponds that are stirred mechanically or in "raceway ponds" which are stirred by a paddle wheel. Closed systems can be photobioreactors or fermenters and are far more expensive. However, they assure a higher volumetric productivity and more controlled conditions, including prevention of contamination, better control of the cultivation conditions (pH, temperature, nutrient supply, etc.), reduction of water use and CO2 losses [7].

Figure 8 Photobioreactor microalgae production [7]

In the **pharmaceutical industry**, algae are used as antimicrobials, antivirals and antifungals, neuroprotective products, and therapeutic proteins and drugs. Moreover, alginates extracted from marine kelp find applications in the medical field for wound healing, tissue engineering and regenerative medicine, and dental health applications. The **global market for algae products for pharmaceutical applications** is expected to reach the value of USD 442.6 million by 2023, growing at a CAGR of 5.7% in the period 2018 – 2023. Asia Pacific and North America are the main contributors to the market. For the **European** region, the algae products market for pharmaceuticals is forecasted to grow to the value of USD 83.1 million by 2023, at a CAGR of 5.3% in the period 2018 – 2023. France, Italy, and Spain are the main countries active in this market in the Mediterranean area.

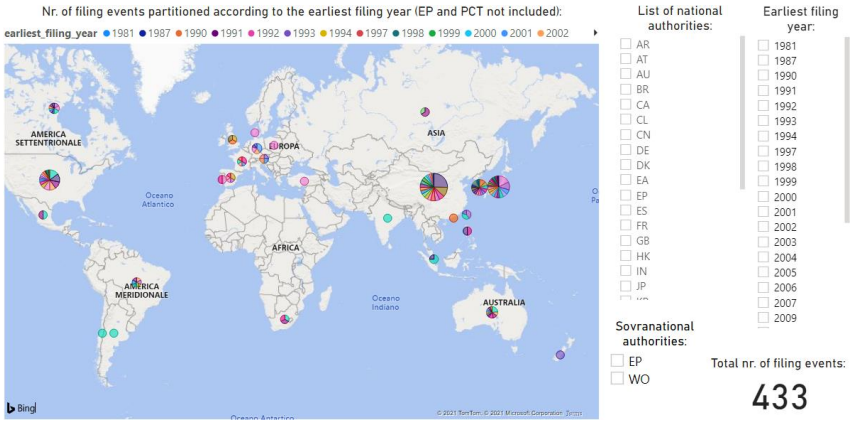
As far as the specific subsector is concerned, a dataset consisting of 191 non-duplicated patent families corresponding to 433 patent applications. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 9.

Figure 9 Pharmaceutics: keywords' frequency



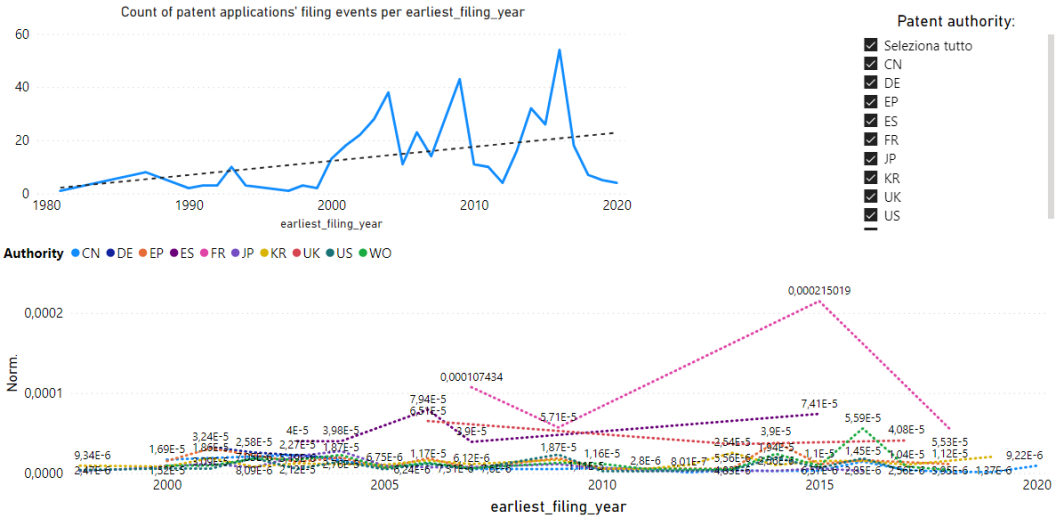
As already observed and mentioned in "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding the drugs industry based on marine biomass. The patent authorities located in the Asian Pacific region, especially in China, Japan and South Korea as well as the USPTO score the highest numbers of filing events. In the Mediterranean region, the European patent authorities of Spain and France emerge as the most representative ones. Relatively little numbers of patent applications have been filed to the EPO (34) or to the WIPO (44) authorities. Such information may be argued upon a deeper analysis of the data of Figure 10.

Figure 10 Pharmaceutics: Map of national/supranational patent authorities



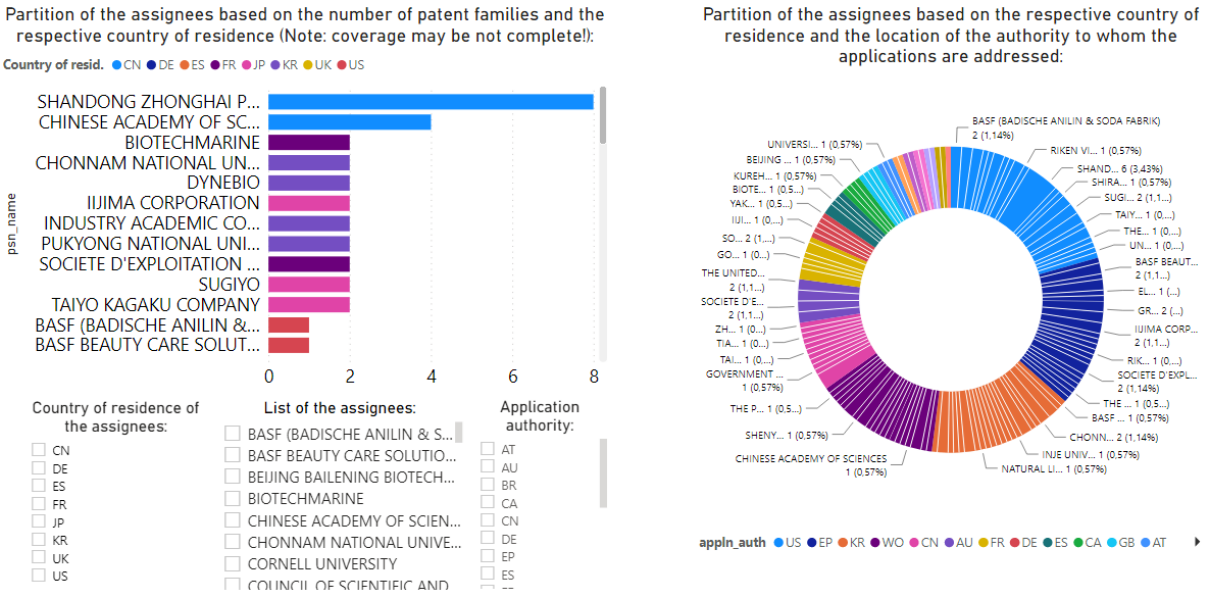
Being such patent dataset quite smaller if compared to the number of patent applications filed in the case of the cosmetics sector, it is likely that the utilization of the marine resources specifically aimed at the formulation of drugs is not largely exploited for the time being. Nevertheless, the data of Figure 11 show a net increase of the number of patent applications over time. Moreover, from the normalized data it seems worth of consideration the fact that the proportion of patent applications filed in recent years to the French patent authority shows a trend that is not equalised by other patent authorities, however such trend appears interrupted after yr. 2018.

Figure 11 Pharmaceutics: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, several ones located in France may be identified while only one Spanish player (Greenaltech) can be detected. The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 12.

Figure 12 Pharmaceutics: Legal protection strategy



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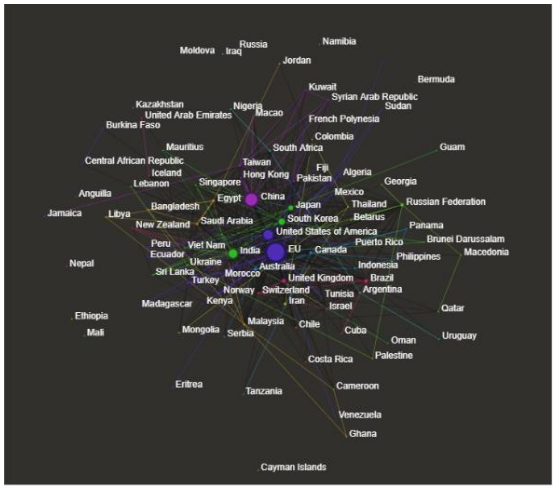
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries such as China, Japan and South Korea (Figure 10) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects appear as well ongoing worldwide, the highest proportion being ascribed to the EU countries, as evident from Figure 13.

Figure 13 Pharmaceutics: NPL data worldwide



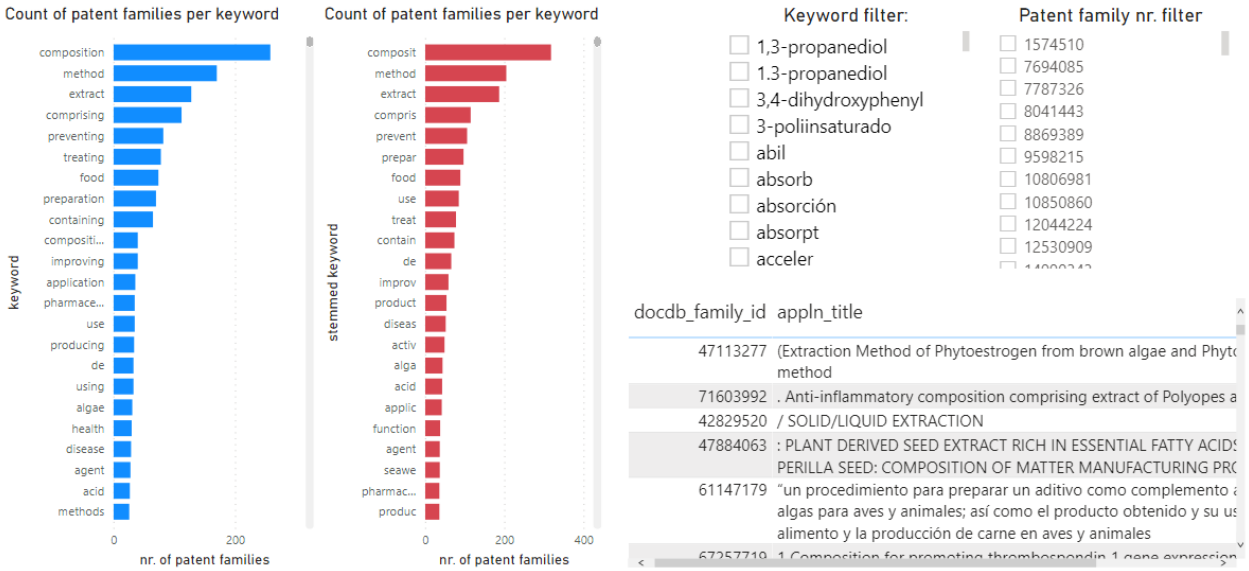
a3) Healthcare and Pharmaceuticals → Nutraceuticals

In the **European region**, the main exploited **macroalgae species** for **food industries and cosmetics** are *Laminaria hyperborea, Laminaria digitata* and *Ascophyllum nodosum* which are primarily harvested mechanically by boat.
Concerning the **microalgae**, the main species used for healthy food, nutritional supplements, and antioxidant pigments is *Dunaliella*, which is mostly produced in aquaculture farms [3]. Specifically, JRC reported that there are around 250 Spirulina farms operating in EU, and among them, 150 are hosted in France [1]. As far as the **food market** is concerned, the microalgae are mainly sold as dried-algae and their demand is increasing constantly thanks to their high-value nutrients content including carotenoids, phycobilins, fatty acids, and antioxidants. The sector is mainly driven by the growing trend of natural cosmetic and **nutraceutical products** and the rising popularity of new generation foods [2]. According to JRC the micro and macroalgae farmed or harvested in Europe are predominantly sold for food related uses (i.e., food supplements and nutraceuticals) and cosmetics.
Globally the **nutraceutical** is one of the fastest growing industry thanks to the rising demand of foods products that provide health and medical benefits, including functional foods and dietary supplements. This industry is forecast to grow considerably and is expected to reach the global market value of USD 336.1 billion by 2023, at a 7.8% CAGR from 2018 to 2023. Within the nutraceutical market, **plant-based functional food** is expected to reach the global value of USD 119.9 billion in 2025, growing at a CAGR of 8.6% from 2020 to 2025. Looking at the **European region**, there is a mix of more mature markets in the western countries, whereas eastern markets hold greater future growth potential. In the Mediterranean area, France is leading the sector followed closely by Italy and Spain thanks to the growing health and wellness consciousness among consumers and the boosting demand for organic products [4].

Figure 14 Algae biomass commercial uses of European Economic Area (EEA) companies. HP: Hydrocolloid production; B: Bioremediation (European Commission (2020). The EU Blue Economy Report. 2020. Publications Office of the European Union. Luxembourg)

As far as the specific subsector is concerned, a dataset consisting of **654 non-duplicated patent families** corresponding to **2623 patent applications**. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 15.

Figure 15 Nutraceuticals: keywords' frequency



As already observed and mentioned in "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding the nutraceuticals based on marine biomass. The patent authorities located in the Asian Pacific region, especially in China, Japan and South Korea as well as the USPTO score the highest numbers of filing events. In the Mediterranean region, the European patent authorities of Spain and France emerge as the most representative ones. A significant number of patent applications have been filed to the EPO (235) or to the WIPO (262) authorities. Such information may be argued upon a deeper analysis of the data of Figure 16.

Figure 16 Nutraceuticals: Map of national/supranational patent authorities

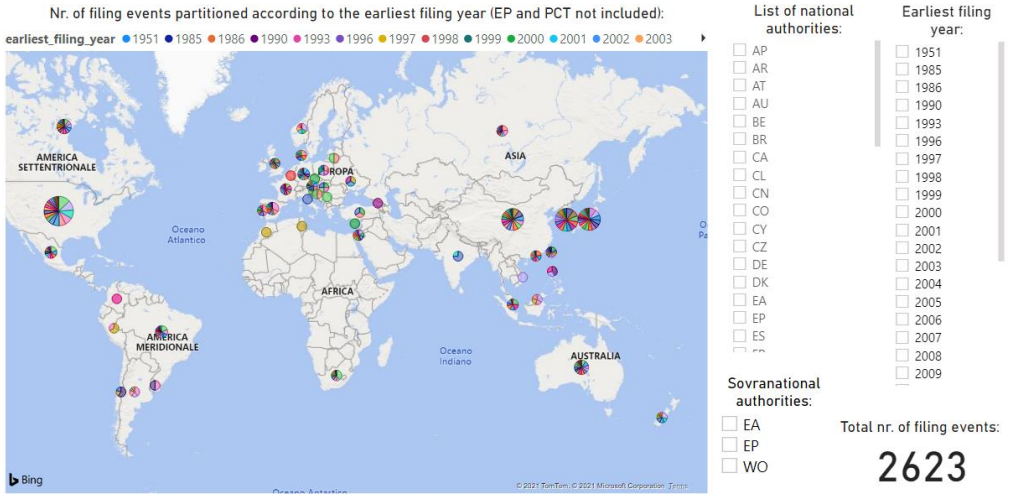
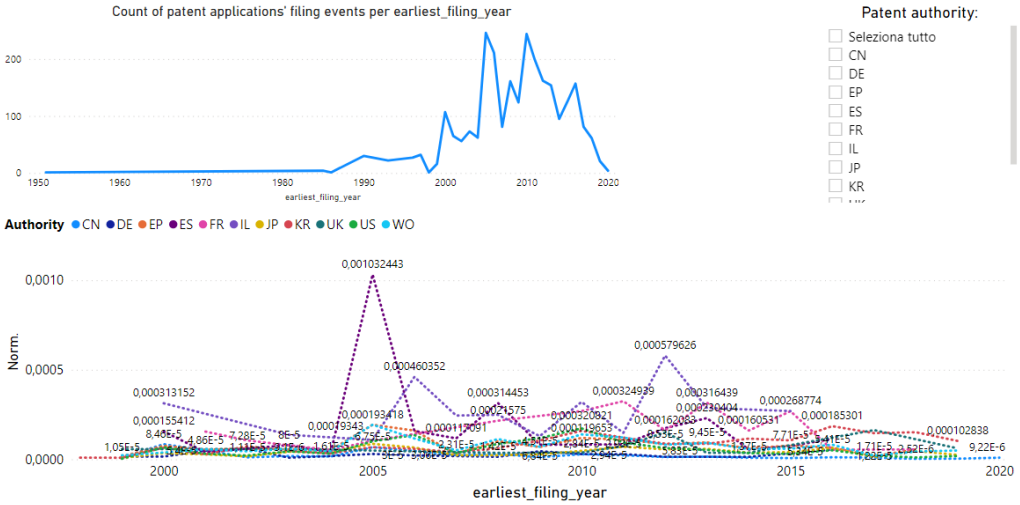


Figure 17 show a consistent increase of the number of patent applications over time. The trend shows quite clearly that until thirty years ago little attention was deserved to the legal protection of innovations. Moreover, from the

normalized data it appears that the proportion of patent applications filed in recent years to the French and Spanish patent authorities is meaningful, being both slightly higher if compared to the proportion of applications filed to the EPO or the WIPO authorities.

Figure 17 Nutraceuticals: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, several ones located in France and Spain may be identified, although players resident in the USA or in Asian countries score the highest numbers of patent families. The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 18.

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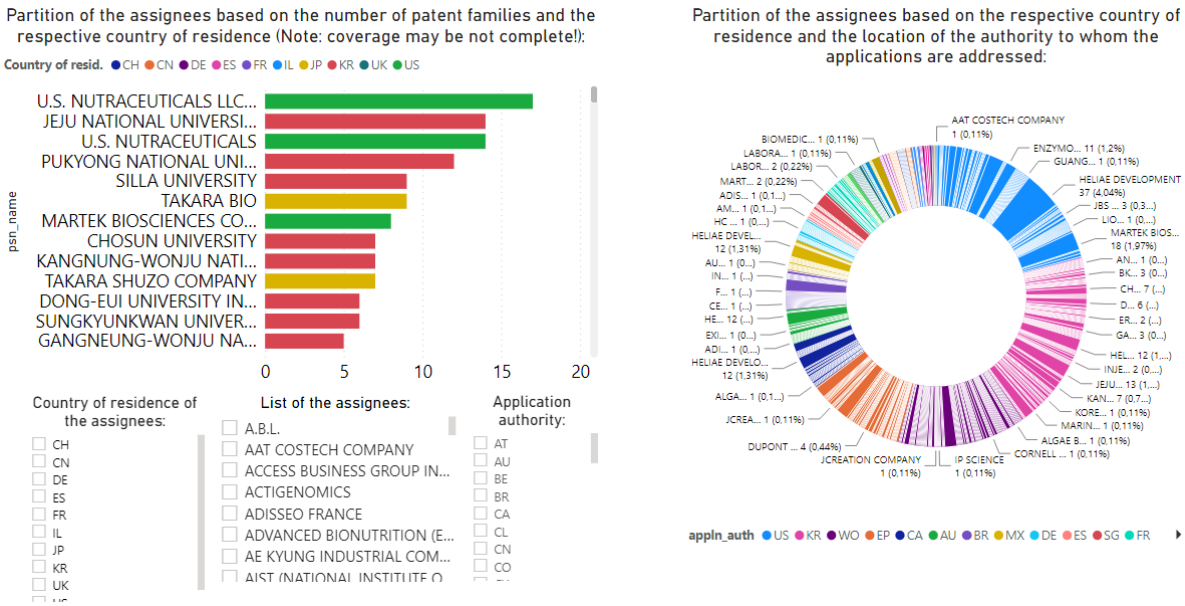
Figure 18 Nutraceuticals: Legal protection strategy



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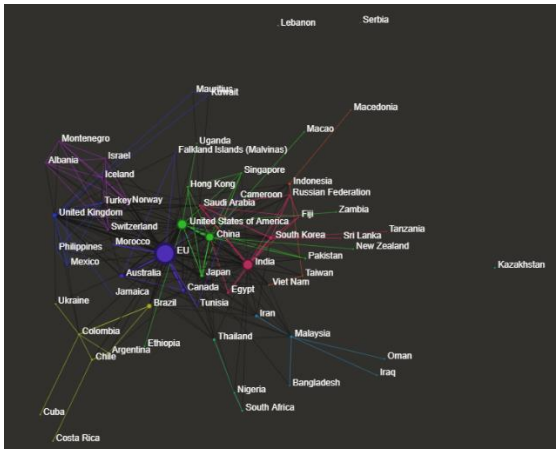
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries such as China, Japan and South Korea (Figure 16) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects, appear as well ongoing worldwide, the highest proportion being ascribed to the EU countries, as evident from Figure 19.

Figure 19 Nutraceuticals: NPL data worldwide



1.a KEYPOINTS

- 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 pharmaceutics 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 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.

b) Agriculture, Livestock, Food processing → Soil fertilization

In addition to the applications previously analysed, the **blue biotechnology sector** might have a relevant impact also on the improvement of **animal feed** (nourishment, food supplements), **veterinary products** (antibiotics, antiseptics, and vaccines) and **agricultural products** (biofertilizers). Several factors are positively affecting the growth of these sectors such as:

- the increasing demand of natural products aimed at reducing the use of synthetic pesticides and antibiotics,
- the search for natural animal food with high nutritional value,
- the need to increase plant and animal health reducing the environmental impacts,
- the rising need of reducing the presence of allergens in the food.

The high diversity of **marine microorganisms** and their ability to withstand extreme conditions are evidencing several opportunities for the discovery and further development of peculiar compounds applicable both to the Agriculture and the Livestock sectors [1].

Agriculture is one of the major sources of environmental pollution especially due to the runoff of synthetic fertilizers. For this reason, the use of new and less environmentally harmful fertilizers obtained from marine organisms such as algae, seaweeds, and fish derivates is needed to reduce the long-term alteration in the acid-base balance (pH), osmotic pressure, conductivity and improve the water holding capacity and fertility of the soil.

The blue biotechnology emerging sectors are currently focusing on **agrochemicals,** such as **biofertilizers** and **biostimulants**, created with the purpose of protecting crops from diseases without harming the surrounding environment.

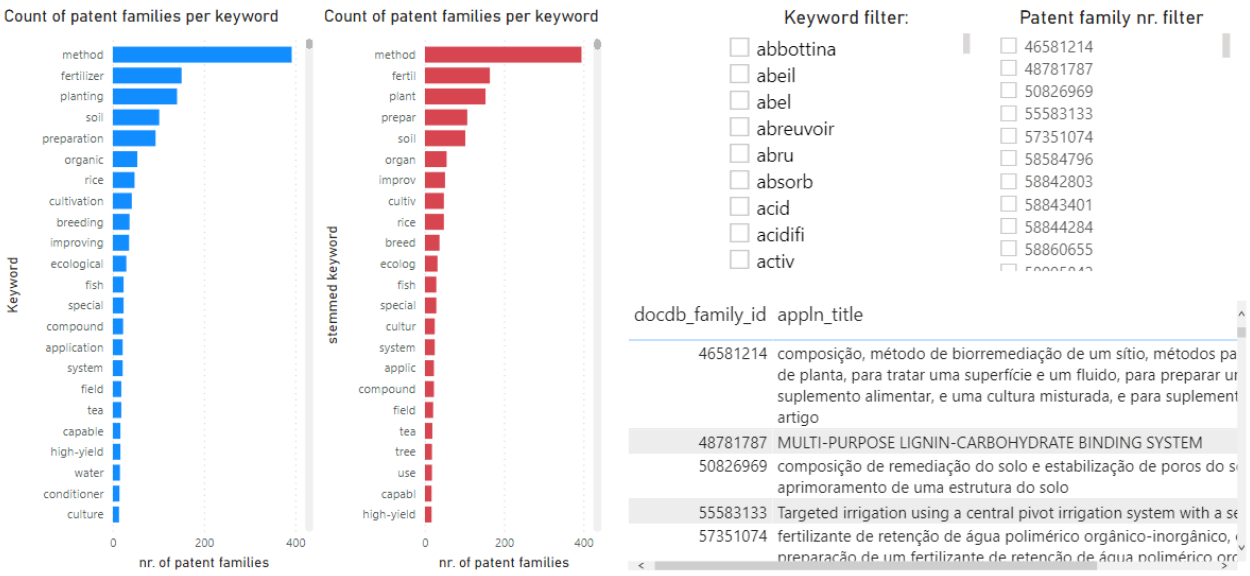
Agrochemicals refer to all specifically engineered chemical products used in agriculture and include a broad range of **pesticides** and **fertilizers**. Fertilizers are further segmented into synthetic and bio-based nitrogenous, phosphatic

and potassic fertilizers. Pesticides are further segmented into synthetic and bio-based fungicides, herbicides, insecticides and other pesticides, including pyrethroids, organophosphates, rodenticides, bactericides, neonicotinoids and others.
Agrochemicals are manufactured with a combination of three nutrients (nitrogen, potassium and phosphorus) in different proportions to fulfill the nutrient profile of a particular soil. The main purpose of agrochemicals is to optimize biological efficacy by supplying essential nutrients and protecting crops from various diseases without harming the surrounding environment. A proper and adequate use of agrochemicals is necessary for the reduction of crop loss.
As the world population increases, croplands are unable to meet the growing demand for food without some method of crop enhancement. This factor is driving the market for agrochemicals [4].
The global market of **Biofertilizers** is estimated to reach a value of USD 173 million in 2024, with a projected CAGR of 9.1% from 2019 to 2024. The European region is currently the second-largest revenue-generating market for agrochemicals, with a substantial increase in the market's growth in Italy in the last years [3].
Pesticide sales have decreased over the past few years in countries such as France and the U.K., mainly due to the drop in herbicide and fungicide sales. However, there was a substantial increase in the market's growth in countries such as Italy, Hungary, and Germany after rebounding from a downturn in recent years. Fertilizer sales are currently witnessing a positive trend, particularly in eastern and central Europe, contributing to the increase in overall growth. Nevertheless, several synthetic pesticides have been banned in Europe over the years owing to stringent environmental regulations [4].
The intensive research in the **biostimulants' sector** and **plant nutritional products** has increased the awareness about the benefits that can be ascribed to the application of the seaweed extracts in agriculture. Currently, extracts from marine algae are used in the agriculture industry and commercially exploited as **seaweed extracts**. The most widely used seaweeds for agricultural purposes are related to the group of red algae [2]. Seaweed extracts act as biostimulants mainly due to the presence of **plant hormones**. Hormones usually present in seaweed extracts are auxins, cytokinins, gibberellins, abscisic acid, and ethylene. Moreover, **seaweed extracts** enhance soil fertility and increase crop productivity under various environmental stress conditions. The application of seaweed extracts improves soil structure and aeration, increases biotic and abiotic stress tolerance, enhances seed germination, and stimulates root growth, flower set, and fruit production. Seaweeds and seaweed extracts are vital components of organic farming, which achieve yield maximization through their biostimulatory role on crop plants. Application of seaweed extracts in agriculture not only reduces the side effects of harmful agrochemicals but also helps in protecting the environment. According to the FAO data, the total seaweed produced in 2005 was 14.7 million tonnes, while in 2015, the production was doubled to 30.4 million tonnes, which makes seaweeds available for companies to formulate biostimulant products.
The global **biostimulants** market is currently dominated by **Europe**, in terms of value, due to the adoption of modern agricultural technologies such as precision farming, plant biotechnology and organic – based active ingredients [4].
Another new application for marine biomass is **animal therapeutics**, involving the production of vaccines, anti-infectives and antifungals, and food supplements [2].
The global market for **veterinary products** is expected to reach the value of USD 66.5 billion by 2024, with pharmaceutical products leading the sector followed by feed additives, vaccines and diagnostics' products. Animal food supplement, defined as an ingredient or a combination of ingredients added to the basic feed mix, is characterized by a stable market trend with a global projected value of USD 23,295 million in 2024, and an estimated CAGR of 5.0 % from 2019 to 2024. The **European region** represents now the second-largest market, with France the country leader of this sector in the region [3].

As far as the specific subsector is concerned, a dataset consisting of **530 non-duplicated patent families** corresponding to **631 patent applications**. The analysis of the patent applications has been limited, i.e. considering the priority

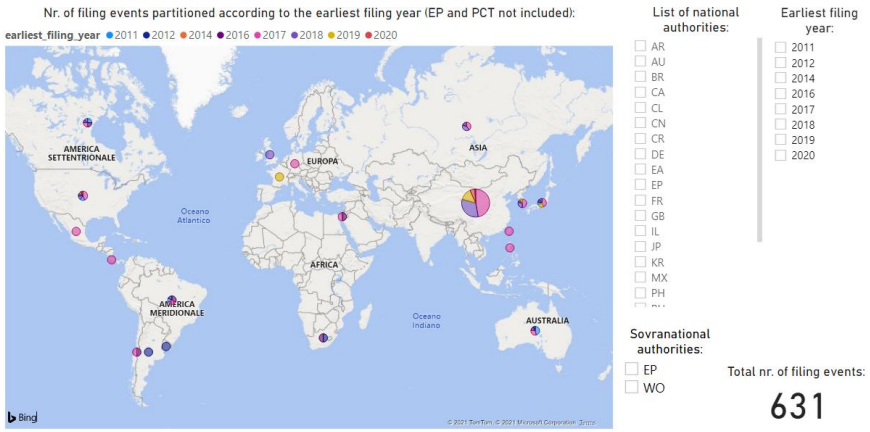
year starting from 2017 onwards. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 20.

Figure 20 Soil fertilization: keywords' frequency



The patent authorities located in the Asian Pacific region, especially the CNIPA/SIPO in China score the highest numbers of filing events, while a significantly lower number of patent applications is filed to the USPTO. In the Mediterranean region, the European patent authorities are not significantly addressed, consistently the number of patent applications have been filed to the EPO (8) or to the WIPO (17) authorities is very modest. Such information may be argued upon a deeper analysis of the data of Figure 21.

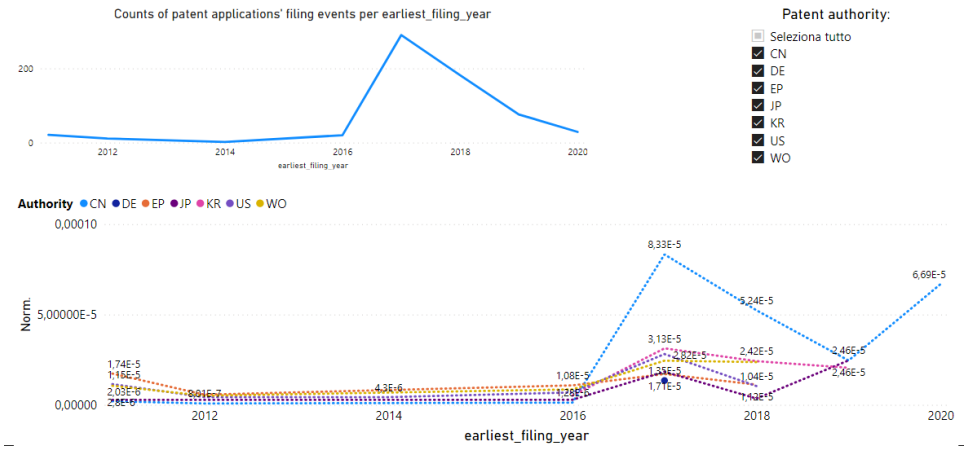
Figure 21 Soil fertilization: Map of national/supranational patent authorities



The data of Figure 22 show a consistent increase of the number of patent applications especially in recent years. Moreover, from the normalized data it appears that the proportion of patent applications filed in recent years

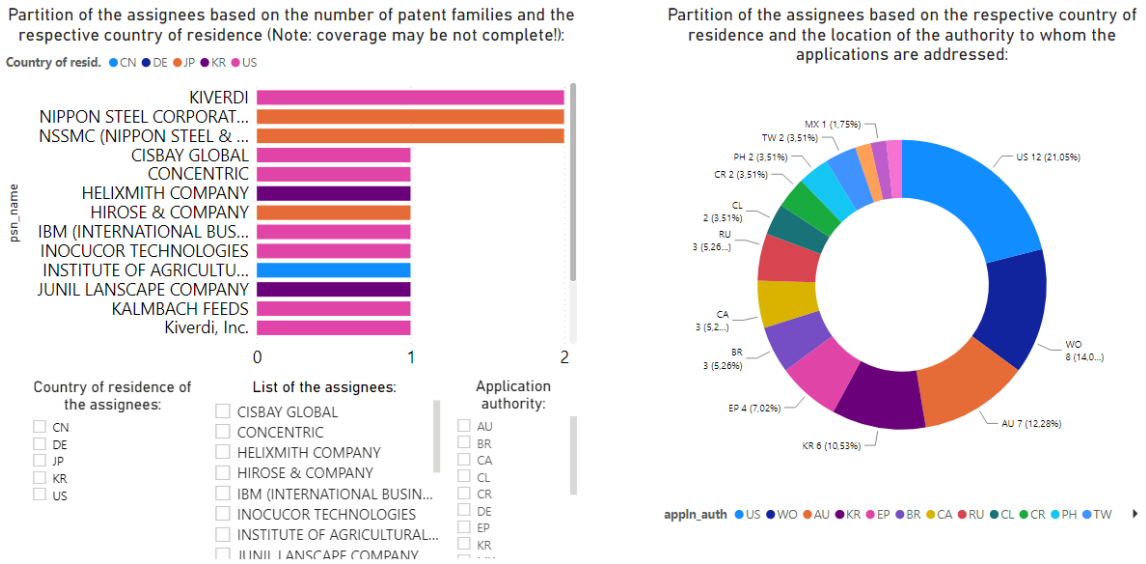
to the CNIPA/SIPO patent authority is meaningful, while as far as each of the other patent authorities are concerned the proportion of applications regarding the soil fertilization appears quite modest.

Figure 22 Soil fertilization: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, no meaningful data can be retrieved. The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 23.

Figure 23 Soil fertilization: Legal protection strategy



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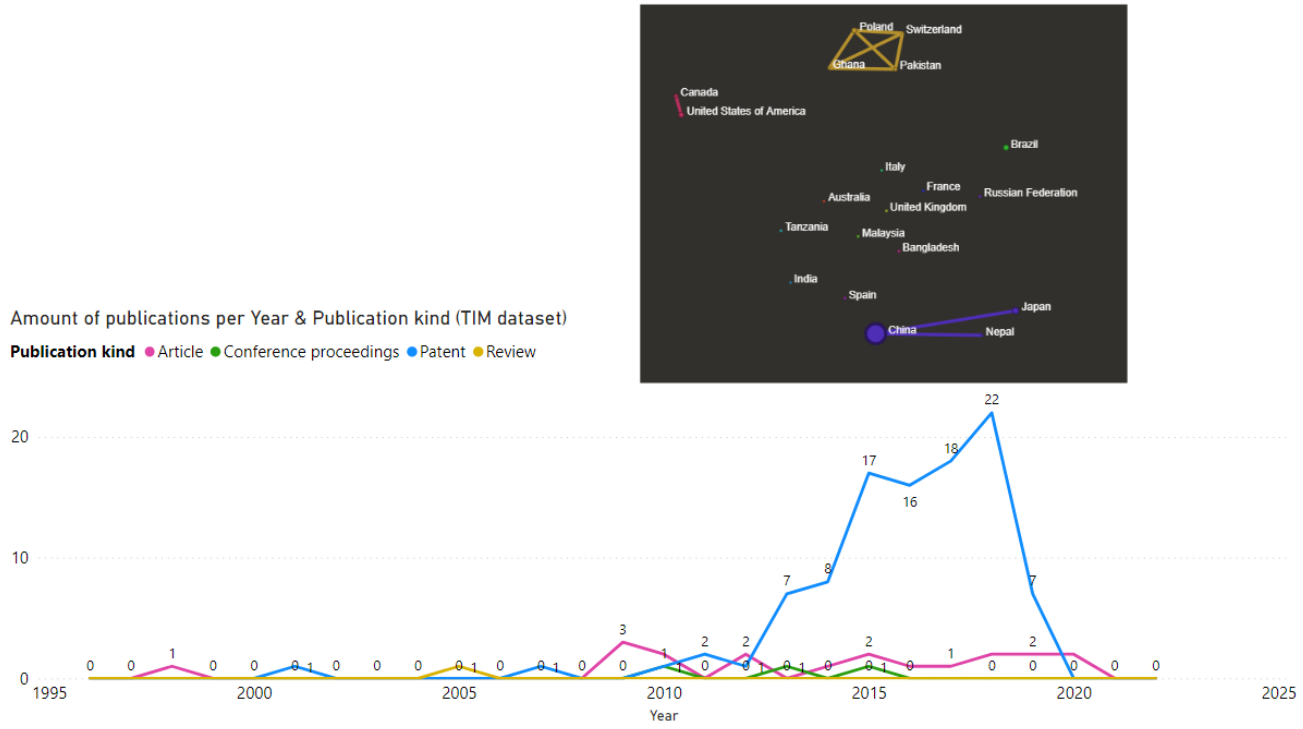
Despite from the analysis of the patent data a quite relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as those of the Asian countries, for example China, (Figure

21) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects appear relatively scarce, being the divulgation of technical information achieved through patent applications predominant over NPL forms, as evident from Figure 24.

Figure 24 Soil fertilization: NPL data worldwide and trend of the different modalities of divulgation



1.b KEYPOINTS

- 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.

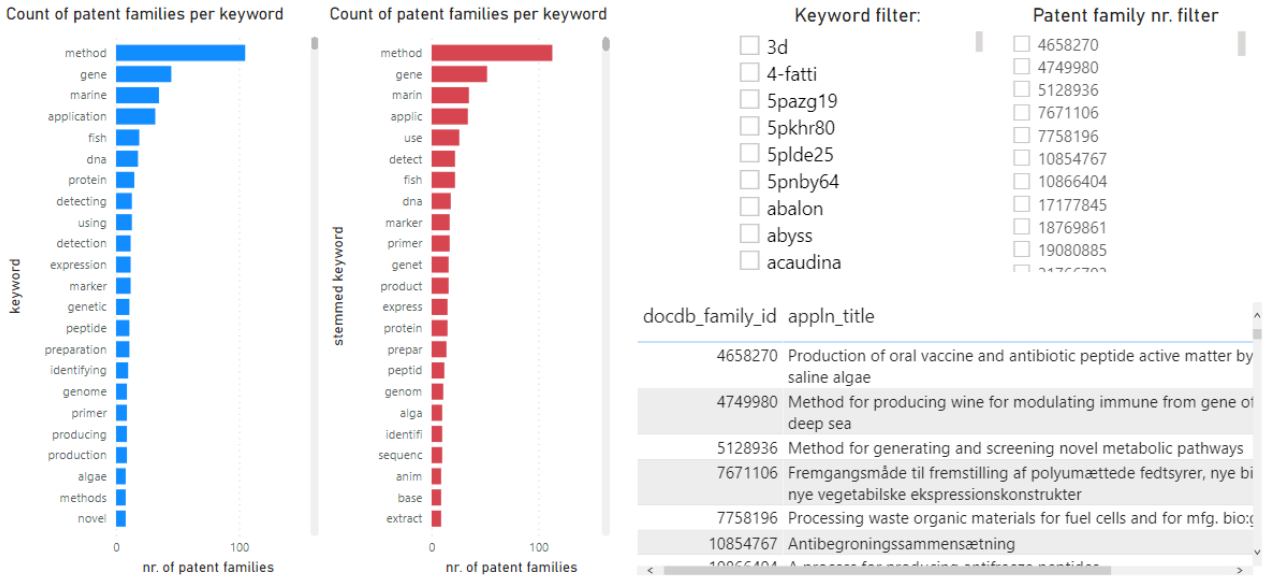
c) Industrial processes and manufacturing → Sea organisms' genetics

In recent years several implementations of technologies based on the **genomes' information** applied to the exploitation of the marine resources have been developed.

Genomics is a branch of molecular biology that involves the study of the structure, function, evolution, and mapping of genomes. It applies the techniques of genetics, molecular biology, and bioinformatics to sequence, assemble, and analyze the function and structure of the genome of a selected organism. Genomics is widely used in diagnostics, drug discovery and development, animal and agricultural research, forensics and aquaculture research industry sectors.
The market segment for these applications is expected to reach the value of USD 703.3 million in **Europe** in 2025, starting from the value of USD 523.6 million in 2020, with an estimated CAGR of 6.1% in the period 2020 – 2025. Among the **Mediterranean area** France, Greece, Italy and Spain are the regions in which the genomics market opportunities are highly considered.
Researchers are currently using sequencing (especially *Next – Generation Sequencing* (NGS)) and gene expression analysis in applications such as nucleotide polymorphism and copy number variant detection in marine organisms used as feedstock crop for biofuel production (e.g., Switchgrass (*Panicum virgatum*)). NGS technology is also used for **DNA barcoding** to identify **fish larvae and eggs** and provide the complete description of a defined fish population in the marine environment. Genomics technologies are also used in **aquaculture** and **fisheries**. Genomics in aquaculture helps in enhancing productivity, improving the fish health, preserving the fish populations, and maintaining ecosystem integrity. However, the use of genomics in this application segment is still in the nascent stage [1].

As far as the specific subsector is concerned, a dataset consisting of **203 non-duplicated patent families** corresponding to **364 patent applications** has been analysed.
No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued from the frequency of citations of specific keywords present in the patent titles', as shown in Figure 25.

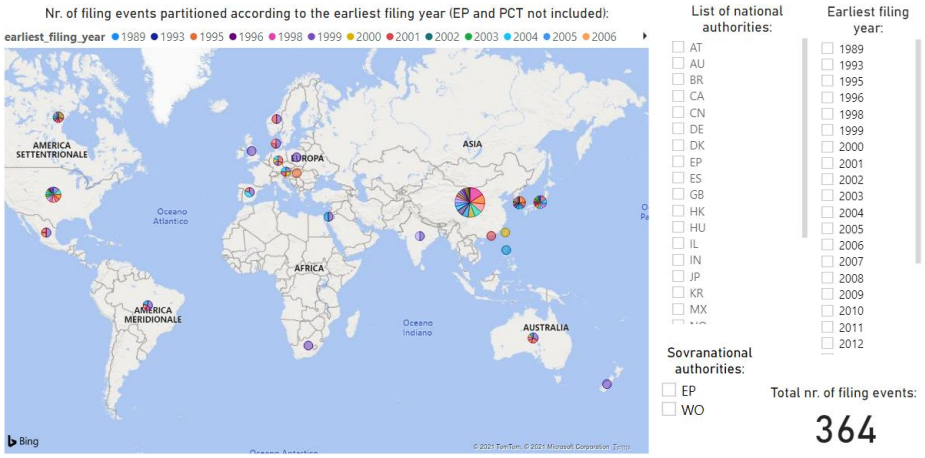
Figure 25 Sea organisms' genetics: keywords' frequency



The patent authorities located in the Asian Pacific region, especially the CNIPA/SIPO in China score the highest numbers of filing events, while a significantly lower number of patent applications is filed to the USPTO. In the Mediterranean region, the European patent authorities are not frequently addressed by the assignees/applicants, consistently

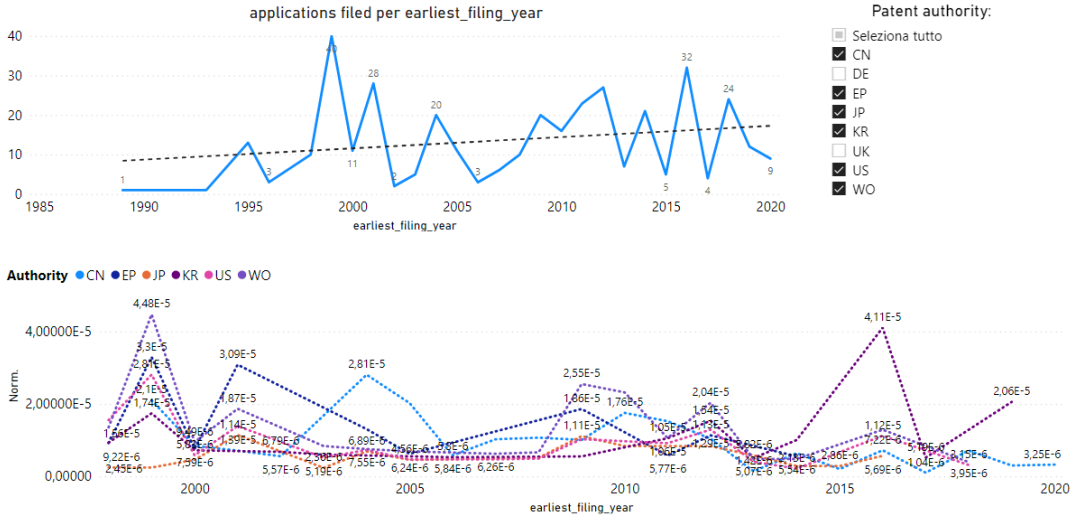
the number of patent applications filed to the EPO (8) or to the WIPO (17) authorities is very modest. Such information may be argued upon a deeper analysis of the data of Figure 26.

Figure 26 Sea organisms' genetics: Map of national/supranational patent authorities



The data of Figure 27 show a consistent increase of the number of patent applications whose filing has begun just before the end of last century. Moreover, from the normalized data it appears that the proportion of patent applications filed in recent years to the Korean patent authority is meaningful, while as far as each of the other patent authorities are concerned the proportion of applications declined, especially when analysing the EPO (19 patent applications) or WIPO (36 patent applications).

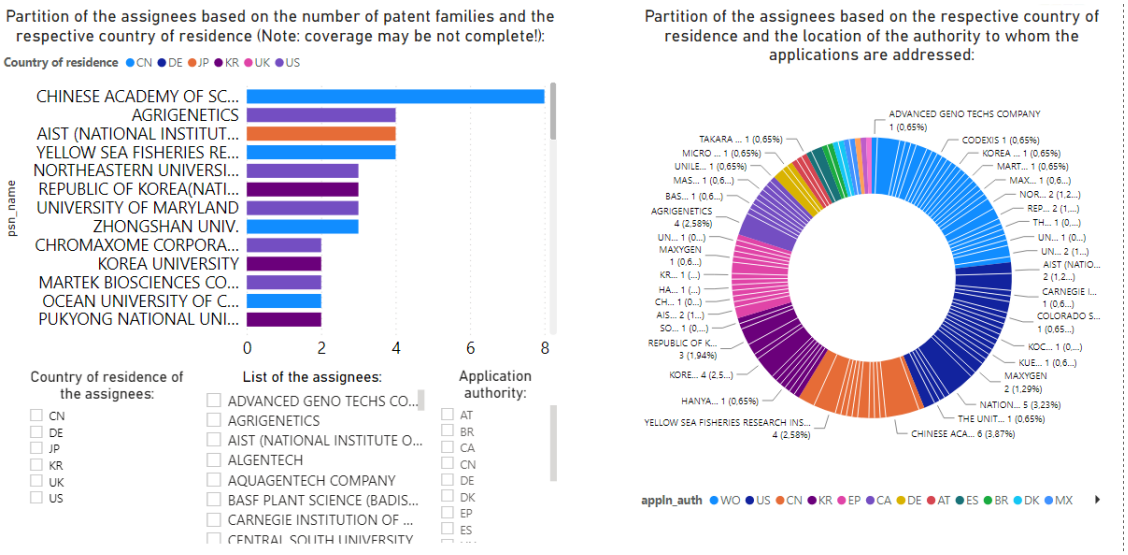
Figure 27 Sea organisms' genetics: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, no meaningful data can be retrieved. The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in

Figure 28.

Figure 28 Sea organisms' genetics: Legal protection strategy



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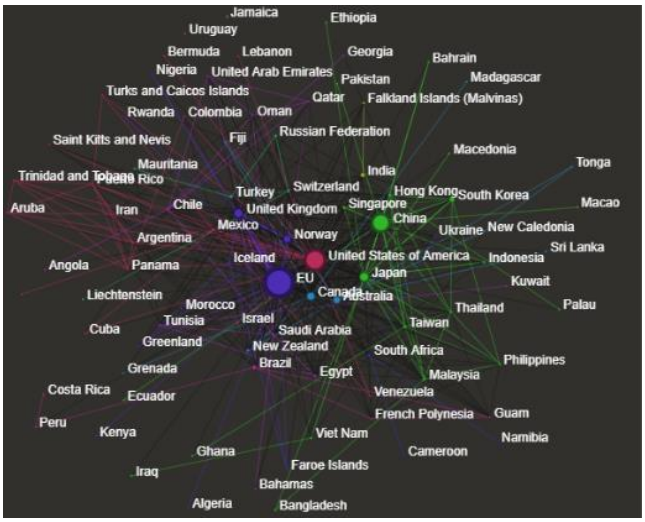
Despite from the analysis of the patent data a quite relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as those of the Asian countries, for example China, (Figure 26), being also relevant the commitment of Korean players, may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects reveal the relevant commitment of EU and US institution as well as the Chinese players, as evident from Figure 29.

Figure 29 Sea organisms' genetics: NPL data worldwide



1.c KEYPOINTS

- 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.

d) Biofuels

Biofuels include solid, liquid, or gaseous matters derived from recently dead biological materials. This type of fuel is different from fossil fuels since in the latter case the source is long dead biological materials. In the last century, the adverse impacts caused by the extensive consumption of traditional fossil fuels, such as Greenhouse Gases (GHGs) emission, has led to an increment in the production of biofuels. This increase is driven by several factors such as the growing number of projects and initiatives focusing on the improvement of these products and by the rising interest of the exploitation of renewable energy sources. The European Commission promotes the use of biofuels and bioenergy to accomplish various climate and energy targets, such as the 20% reduction of the GHGs emission, increasing the energy consumption from renewable sources, and promoting the research and innovation focused of new environmentally friendly biofuels [1].

Considering the **Blue biotechnology sector**, the main source of biofuels among marine organisms are **algae**. Biofuels obtained from algae are usually defined as third-generation biofuels [2]. Algae are considered attractive feedstocks with many advantages over terrestrial crops. Algae biomass lacks the recalcitrant lignocellulosic components, therefore it can be converted to fuels more easily than lignocellulosic feedstocks. Moreover, algae have a higher oil content compared to farmland crops which can yield 90.000 litres per hectare compared to soybean which can produce about 450 litres of oil per hectare. Also, algae are photosynthetic eukaryotes characterized by high growth rate and high population densities, thus implying rapid accumulation of feedstock. Finally, they can be used to develop a wide range of biofuels such as diesel, petrol, and jet fuel.

Macroalgae can be transformed into biomethane, bioethanol and biobutanol through fermentative processes due to their lower concentration of lipids/oils. Microalgae can be rather processed to obtain biodiesel, biomethane, bioethanol, bio-oil (or bio-crude) and bio-hydrogen obtained through fermentation or thermochemical processes thanks to the higher lipids' accumulation capacity of the microalgae [1]. The algae currently under study for their suitability as a mass-oil producing crop include mainly the **aquatic unicellular green algae** (Chlorophyceae; including *Nannochloris sp*.), Diatoms (Bacilliarophyta), members of the class Haptophyta and others (e.g., *Botryococcus braunii*, *Dunaliella tertiolecta*, *Isochrysis galbana*, *Prymnesium parvum*, *Spirulina* sp *and Tetraselmis chui*).

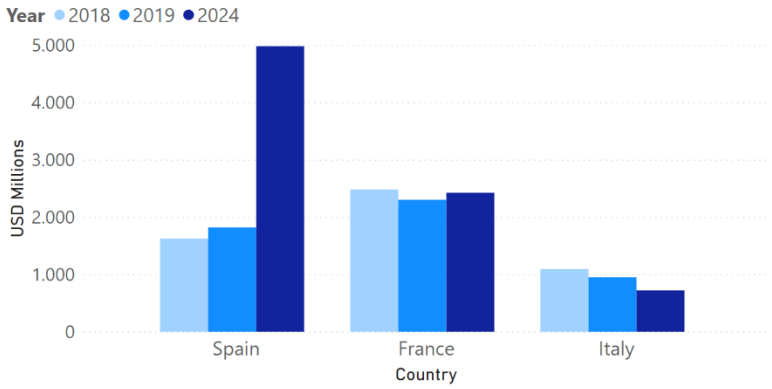
Algal biomass contains three main components: carbohydrates, proteins, and lipids/natural oils, and the bulk is made of the natural oil in the form of triacylglycerol, the right kind of oil for producing biodiesel. This is another reason for the strong focus on algae for biodiesel production. The table below shows some forms of **microalgae** that are used as feedstock for biodiesel production and their oil content. It is important to note that while some forms of algae have low oil content, their growth rate of doubling in 24 hours means huge feedstock availability. Further, it is observed that during the peak growth phase, some microalgae can double every 3.5 hours [3].

Table 1 Microalgae and Oil Content (% Dry Weight)

Microalgae	Oil Content
Botryococcus braunii	25–75
***Chlorella* sp.**	28–32
Crypthecodinium cohnii	20
***Cylindrotheca* sp.**	16–37
***Nitzschia* sp.**	45–47
Phaeodactylum tricornutum	20–30
***Schizochytrium* sp.**	50–77
Tetraselmis suecia	15–23

The **global market for liquid biofuels** is constantly increasing and is forecast to grow at a CAGR of 2.5% to USD 153.8 billion in 2024, with most of the growth coming from biodiesel and advanced biofuels such as cellulosic ethanol. In fact, biodiesel market has a projected value of USD 78,646 million in 2024 at a 3.2% CAGR evaluated in the timeframe 2019 - 2024. Globally, the greatest market growth will be registered in the EU member states whereas the Asian-Pacific, South America, Africa, and Middle East regions will not see significant growth due to the lack of investment [2].
Europe has also shown some interest in biodiesel through algae. BDI-BioEnergy International, a technology company based in Austria, is currently working on developing an efficient extraction and biodiesel production process through algae [3]. At the **European level**, the **total production of biofuels** is expected to reach USD 32,987 million litres in 2024. Limiting the forecast to the **biodiesel**, the market is expected to increase to USD 26.7 billion in 2024, being the CAGR 7.6% in the timeframe 2019 - 2024. In the **Mediterranean Area** the main consumers are Spain, France and Italy [2].

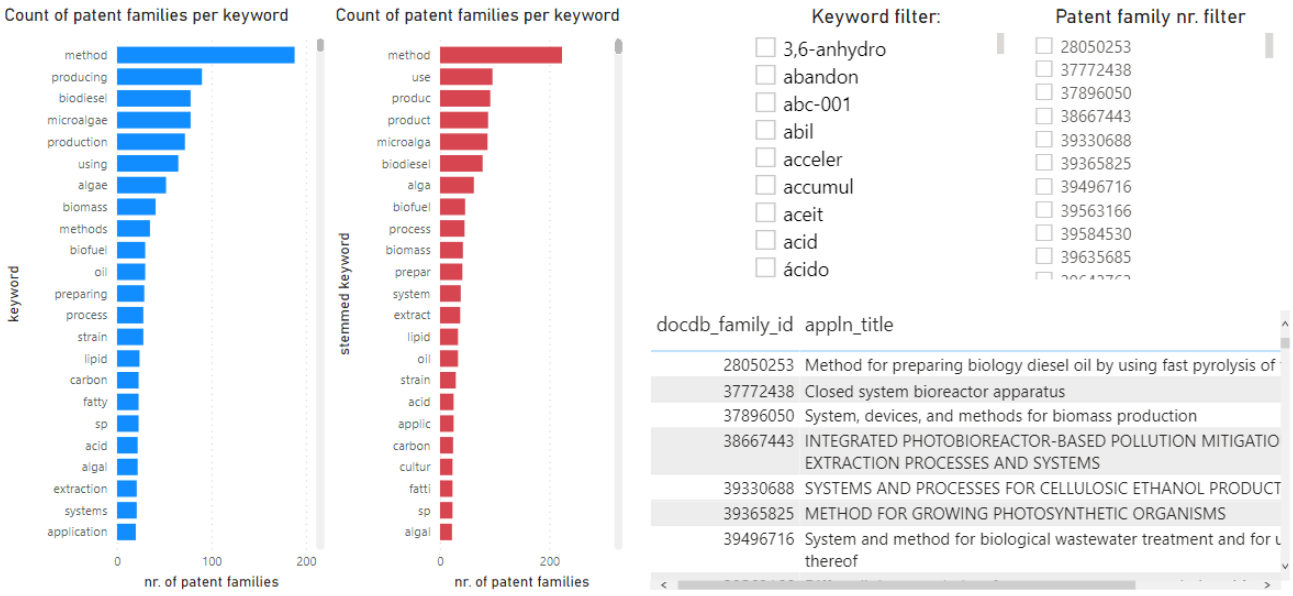
Figure 30 Biodiesel Consumption Market Value in the Mediterranean Area, by Country, Through 2024 (USD Millions)



As already observed and mentioned in "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding **the biofuels obtained using**

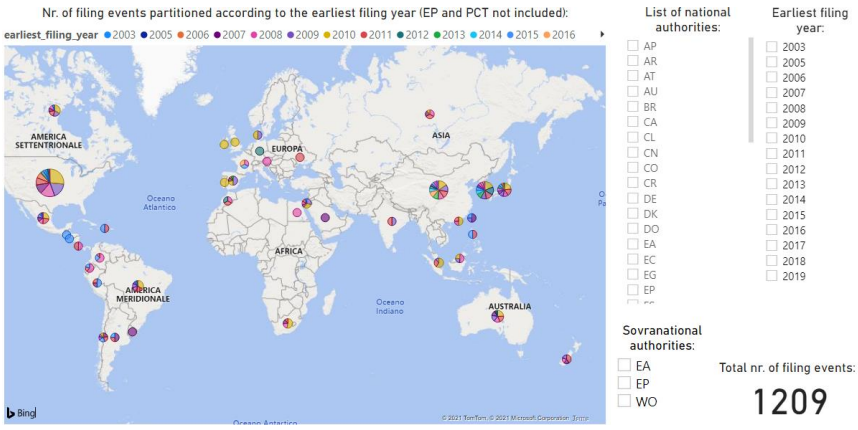
the marine biomass, especially the algae. As far as the specific subsector is concerned, a dataset consisting of **364 non-duplicated patent families** corresponding to **1219 patent applications** has been analysed. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 31.

Figure 31 Biofuels: keywords' frequency



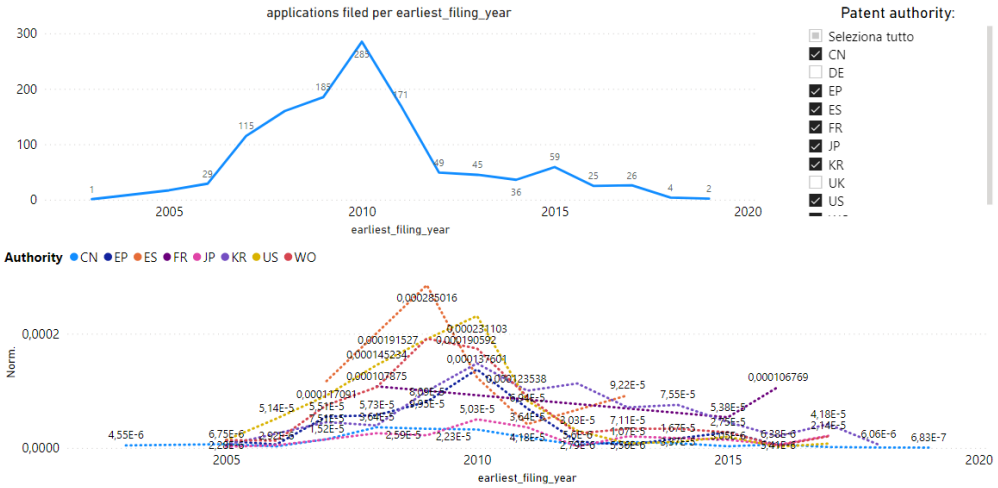
The number of patent applications filed to the USPTO is remarkable, whereas considering the Mediterranean region, a not negligible number of patent applications have been filed to the Spanish and French patent authorities, respectively. Relatively consistent number of patent applications have been filed to the EPO (79) or to the WIPO (140) authorities. Such information may be argued upon a deeper analysis of the data of Figure 32.

Figure 32 Biofuels: Map of national/supranational patent authorities



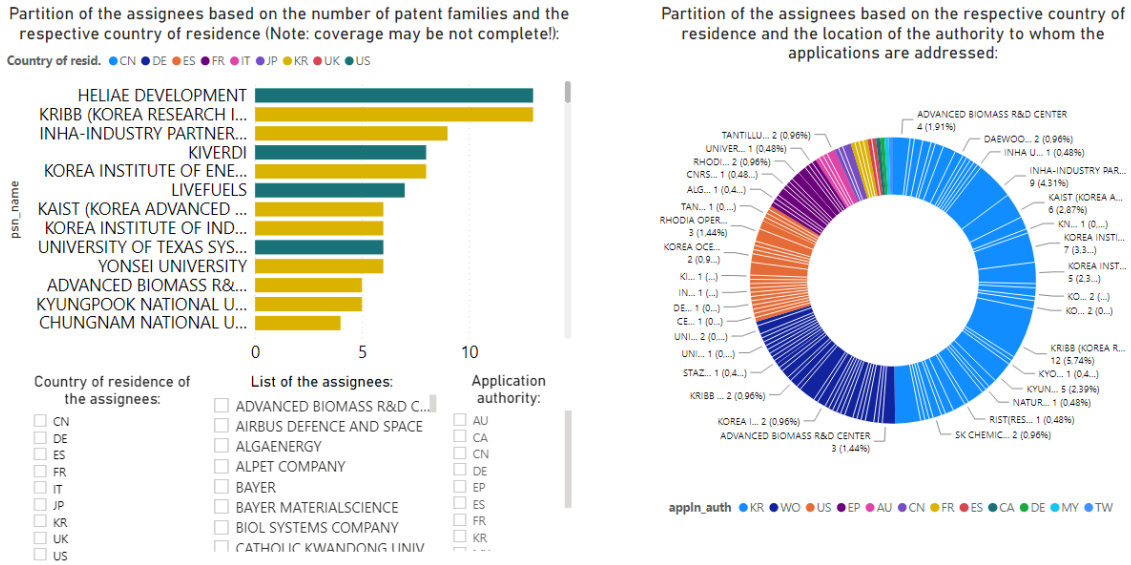
The data of Figure 33 show a consistent increase of the number of patent applications peaking around year 2010. **A persistent decline of the number of patent applications can be observed afterwards**. Moreover, from the normalized data it appears that around year 2010 the proportion of patent applications filed to the Spanish patent authority is meaningful, a similar trend characterising also the applications filed to the USPTO and the PCT applications. A decline is evident after year 2010.

Figure 33 Biofuels: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, few players are headquartered in Spain (eg. ALGAENERGY) and several in France (RHODIA OPERATIONS and other academic institutions). The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 34.

Figure 34 Biofuels: Legal protection strategy



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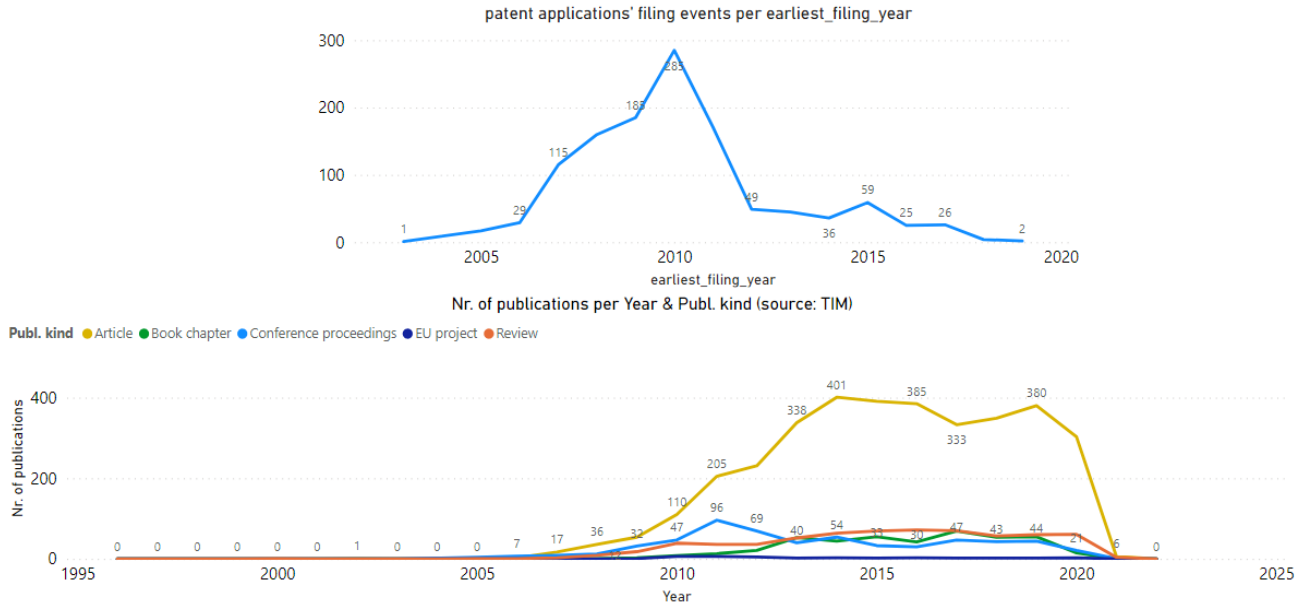
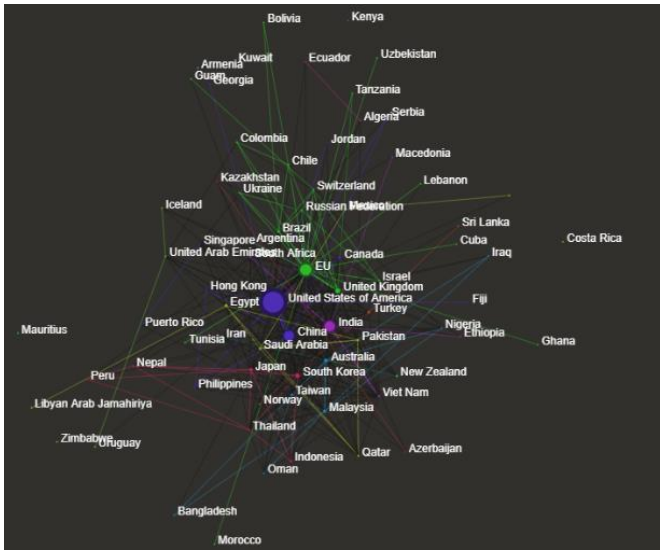
Despite from the analysis of the patent applications it appears that impact on the commercialization of innovative technical solutions is declining worldwide, the basic research seems still consistent according to the NPL (especially articles) divulgation (Figure 35).

Figure 35 Biofuels: Comparison of the trends of the patent applications vs. other divulgation modalities (NPL)



Most of the NPL results are produced by players located within the USA or the EU countries, as evident from Figure 36.

Figure 36 Biofuels: NPL data worldwide



1.d KEYPOINTS

- 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.

e1) Bio-monitoring and bio-remediation → Seawater purification

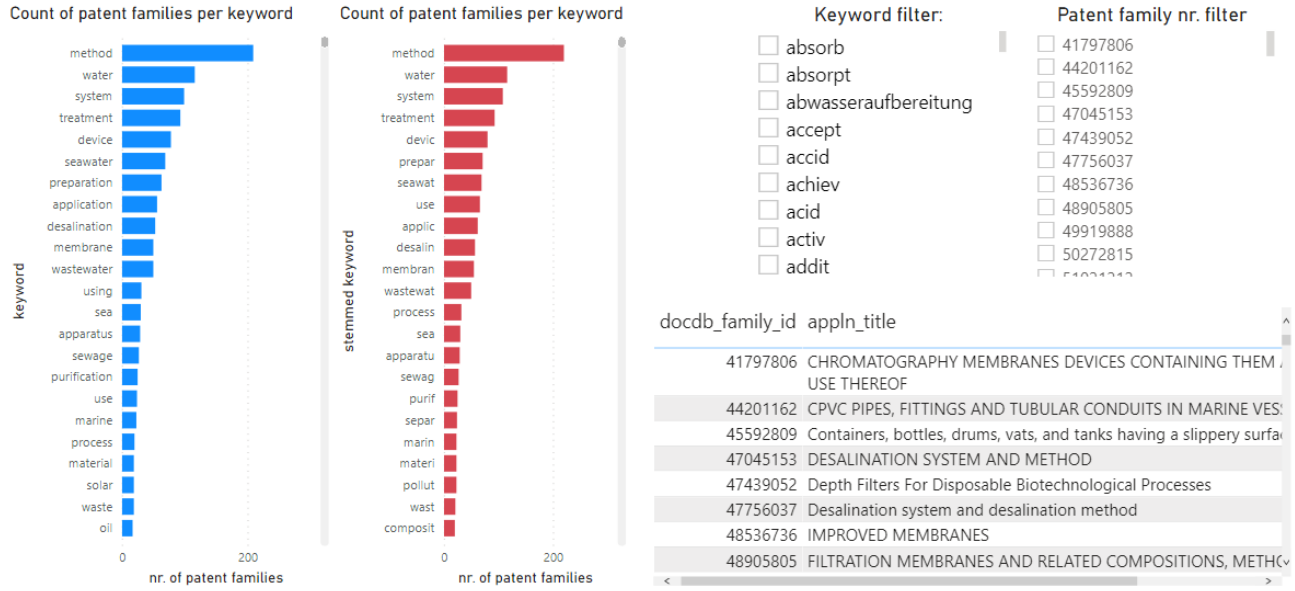
The blue biotechnology for **bio-monitoring** and **bio-remediation** involve the application of marine organisms to track, determine, quantify and remove contaminants and pollutants released in the marine ecosystems. The use of marine organisms for monitoring and remediation purposes presents several advantages, such as the use of native organisms to gain information concerning the marine environment status and the possibility of providing information helpful to protect coastal activities or the resources upon which marine-related economic and social activities depend. Moreover, the use of marine microorganisms and their derived products is beneficial to the environment since such compounds are biodegradable, non-toxic and highly stable [1].

Water purification is the process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from the water. Several municipalities and individuals are focused on reducing water consumption and contamination. Coupled with an increasing demand for high purity water from other industries, several industries are seeking technological solutions, such as **seawater** desalination and process/wastewater recycling, to fulfil their water needs. Advanced green technology can enable them to reclaim wastewater sewage for reuse purposes, including drinking water. Technologies, such as **internet of things (IoT)** and **digital twin**, have the potential to enhance the efficiency of water purification processes. Digital twin is increasingly being implemented in the water sector and offers benefits, such as direct cost savings related to decreased waste, increased efficiency, and reduced downtime, and enhanced and faster decision-making. Companies and government agencies are working on Research and Development (R&D) projects to explore the use cases of a digital twin for water purification.

The **global water purification market** is expected to reach the total value of USD 855 million by 2025, at a CAGR of 28.7% in the period 2020 – 2025. **Europe** is expected to reach the value of USD 254 million in 2025, growing at a CAGR of 27.8% from an estimated value of USD 75 million in 2020 [2]

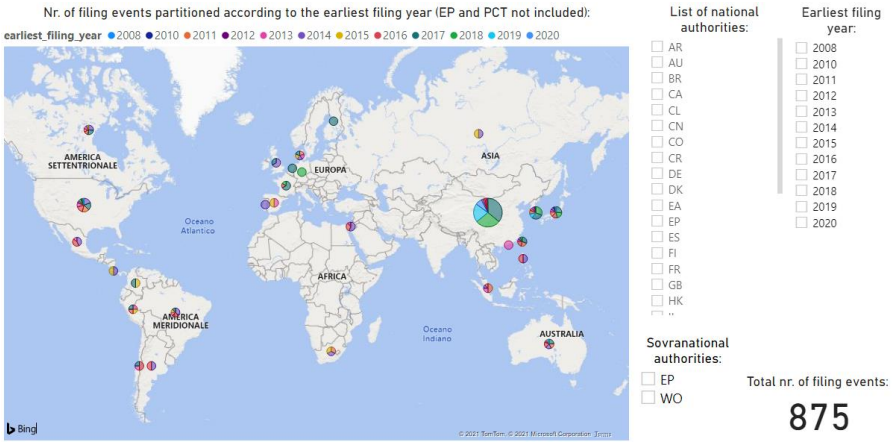
As far as the specific subsector of the seawater decontamination is concerned, a dataset consisting of **503 non-duplicated patent families** corresponding to **875 patent applications** has been analysed. The analysis of the patent applications has been limited, i.e. considering the priority year starting from 2017 onwards. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 37.

Figure 37 Seawater purification: keywords' frequency



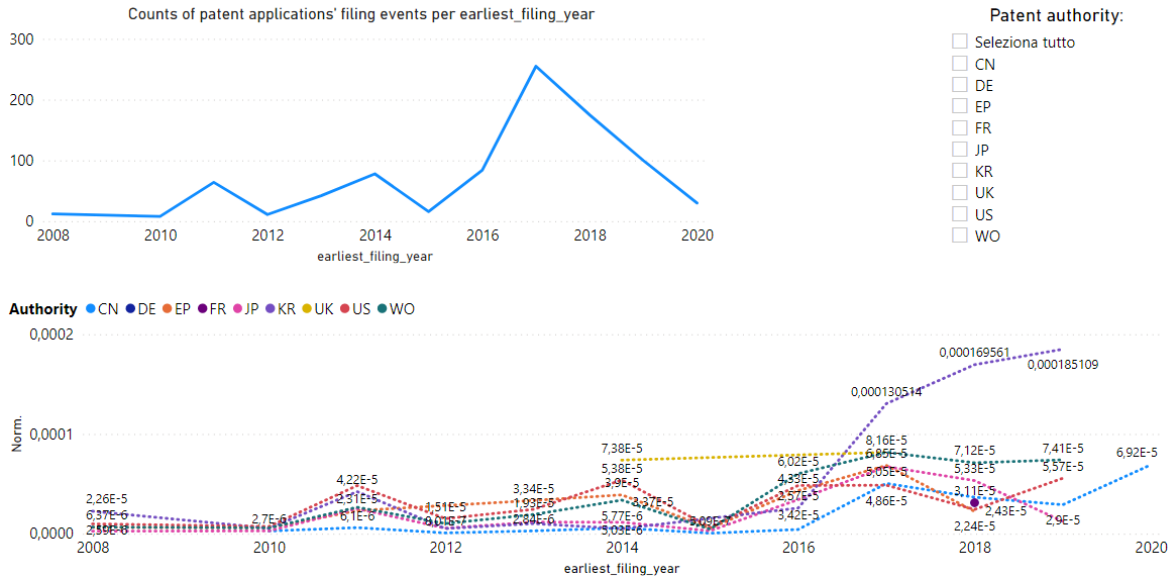
The number of patent applications filed to the CNIPA/SIPO is remarkable, whereas considering the Mediterranean region, a not negligible number of patent applications have been filed to the Spanish and French patent authorities, respectively. Relatively consistent number of patent applications have been filed to the EPO (32) or to the WIPO (76) authorities. Such information may be argued upon a deeper analysis of the data of Figure 38.

Figure 38 Seawater purification: Map of national/supranational patent authorities



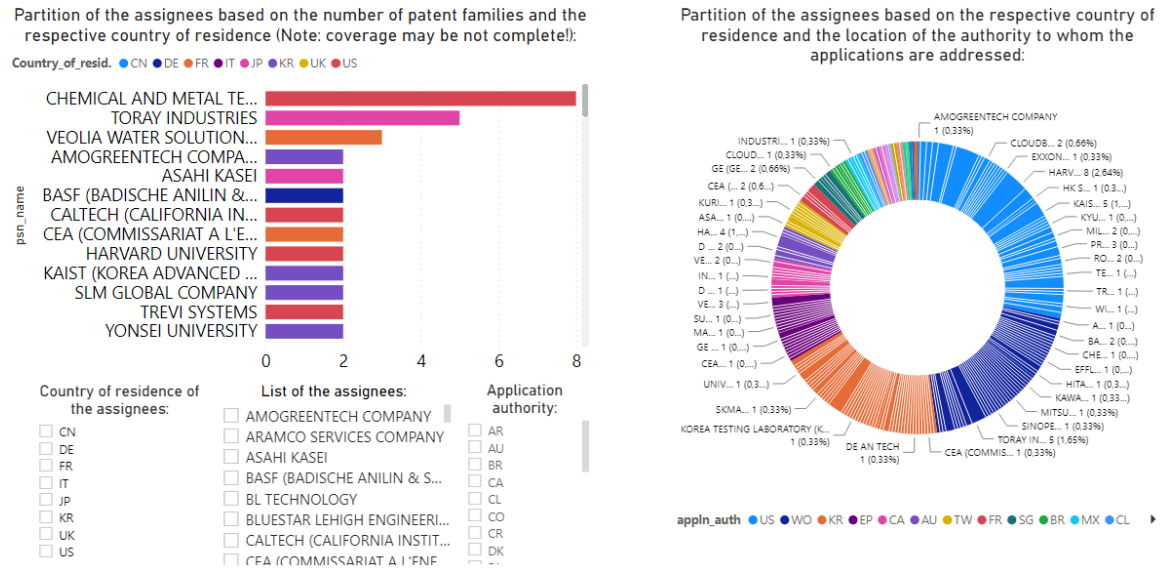
As can be expected the data of Figure 39 show a consistent increase of the number of patent applications peaking around year 2017. Moreover, from the normalized data it appears that the proportion of patent applications is relevant especially in South Korea.

Figure 39 Seawater purification: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, few players are headquartered in France (VEOLIA WATER TECHNOLOGIES plus other academic institutions) and one (INDUSTRIE DE NORA) in Italy. The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 40.

Figure 40 Seawater purification: Legal protection strategy



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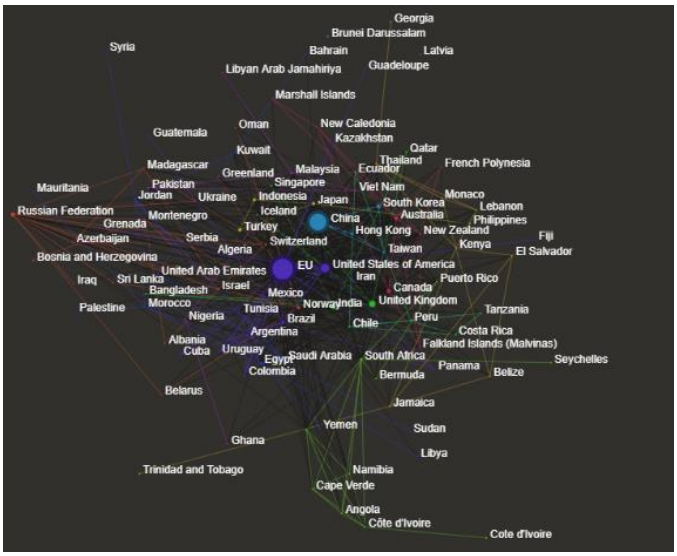
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the Asian countries such as China and South Korea (Figure 38) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects appear as well ongoing worldwide, the highest proportion being ascribed to the EU countries, being the role played by the Chinese institution almost equivalent, as evident from Figure 41.

Figure 41 Seawater purification: NPL data worldwide



e2) Bio-monitoring and bio-remediation → Remediation

Bioremediation implies the use of biological resources such as plants, algae, or microorganisms to eliminate or reduce the contaminants in polluted environments. The effectiveness and the remediation rate of the method depend on several factors, such as the contaminant types and concentrations and site-specific characteristics (e.g., temperature, moisture content, availability of nutrients, pH of the medium and microbial community). However, this sector is consistently evolving due to several factors. Firstly, the rising concentration of polluted areas contributes to increase the demand of more cost-effective initiatives aimed at the recovery of contaminated water. Secondly, the problem of water scarcity is rising the demand for new methods aimed at restoring the aquatic environments. Finally, the increasing number of the industrial activities offering bioremediation services are pushing the market toward significant investments in R&D activities helpful to counteract the diffuse environmental degradation.

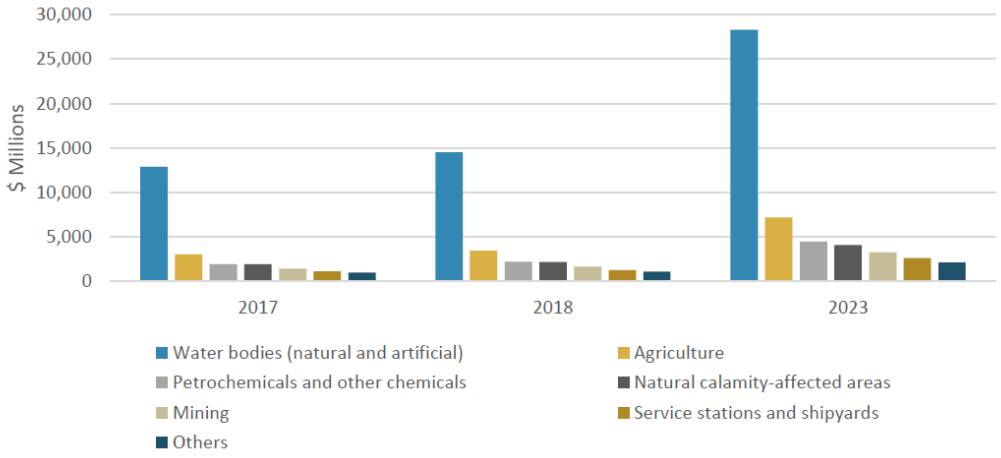
Globally, the **bioremediation market** is projected to reach USD 186,300 million in 2023, with a CAGR of 15.4% in the forecasted period (2017-2023). Bioremediation technology has numerous applications for treating industrial wastewater and sewage, lakes, ponds, rivers and streams, and aquacultures. The use of natural beneficial microbes in water bioremediation accelerates the digestion of chemicals and hydrocarbons, resulting in a rapid and safe removal of toxins present in water bodies. Notably, the application of bioremediation technology in **water bodies** is expected to be considered a market priority in the following years.

New bioremediation techniques focused on the treatment of freshwater and marine ecosystems are favouring the growth of several market opportunities. **Phytoremediation**, which involves the use of plants or algae to

reduce or eliminate the toxic elements from the environment, have held the largest market share in the past years. Hence, this market is expected to grow up to USD 41.9 billion by 2023 with a projected CAGR of 13.7%. The water bodies segment is dominant in the global phytoremediation market, followed by natural calamity affected areas. The water bodies segment application for phytoremediation is expected to reach globally USD 41.9 billion by 2023.

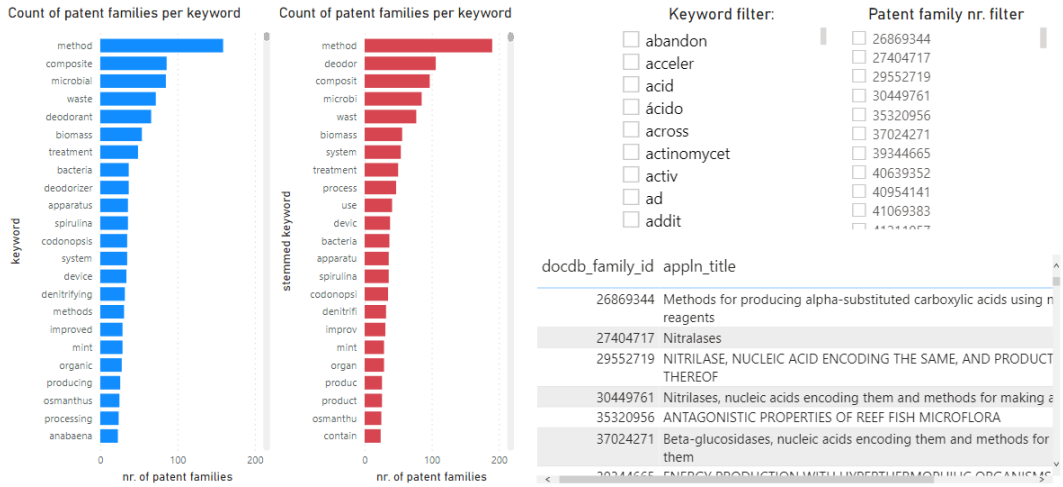
Overall, site remediation activity is increasing in **Europe**. Several full-scale projects have been carried out, leading to better understanding the advantages of bioremediation, especially for contaminated soils. Phytoremediation technology is expected to reach USD 23.4 billion by 2023. The **Water bodies** segment application for bioremediation in Europe is expected to reach USD 28.3 billion by 2023 [3].

Figure 42 European Bioremediation Market, by Application, 2017 - 2023 (USD Millions)



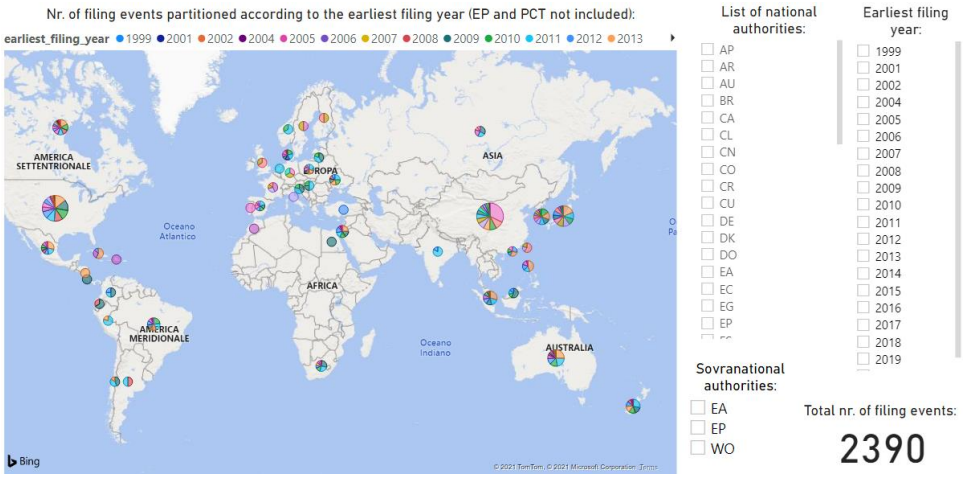
As far as the specific subsector of the remediation (not necessarily of contaminated seawater) is concerned, a dataset consisting of 476 non-duplicated patent families corresponding to 2390 patent applications has been analyzed. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 43.

Figure 43 Remediation: Keywords' frequency



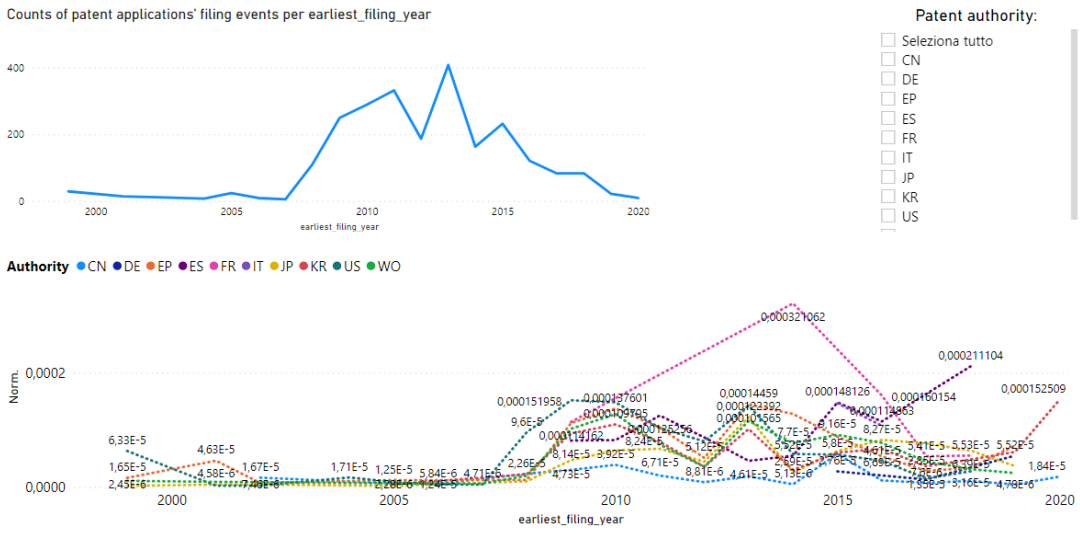
The number of patent applications filed to several national patent offices, especially the CNIPA/SIPO but also the USPTO, the KIPO and the JPO is remarkable, whereas considering the Mediterranean region, a not negligible number of patent applications have been filed to the Spanish and French patent authorities, respectively, but also to the Italian and Slovenian patent offices. Relatively consistent number of patent applications have been filed to the EPO (157) or to the WIPO (167) authorities. The data taken altogether suggest that the topic is considered of utmost importance almost everywhere. Such information may be argued upon a deeper analysis of the data of Figure 44.

Figure 44 Remediation: Map of national/supranational patent authorities



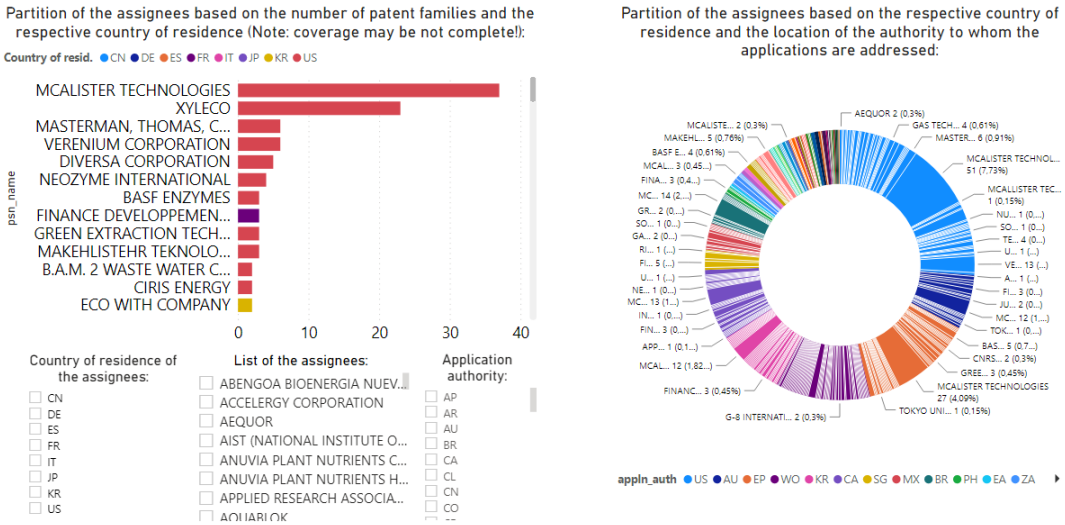
As can be expected the data of Figure 45 show a consistent increase of the number of patent applications peaking in the timeframe 2010 ÷ 2015. Moreover, from the normalized data it appears that the proportion of patent applications is relevant especially in South Korea, but in recent years the proportion of patent applications filed to the Spanish patent office has been as well considerable.

Figure 45 Remediation: Normalization of patent applications



As far as the European applicants of particular interest, i.e. those headquartered in one of the countries bordering the Mediterranean Sea are concerned, few players are headquartered in France (EXOCHEMS ENVIRONNEMENTS plus other academic institutions). The main data regarding the players' location as well as the strategy followed by each one as far as the legal protection is concerned may be visualized in Figure 46.

Figure 46 Remediation: Legal protection strategy



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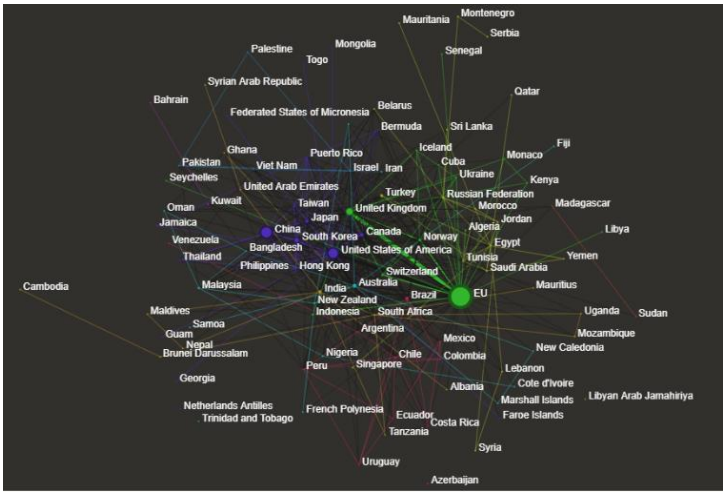
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide (Figure 44) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects appear as well ongoing worldwide, the highest proportion being ascribed to the EU countries, being the role played by the Chinese institution almost equivalent, as evident from Figure 47.

Figure 47 Remediation: NPL data worldwide



1.e KEYPOINTS

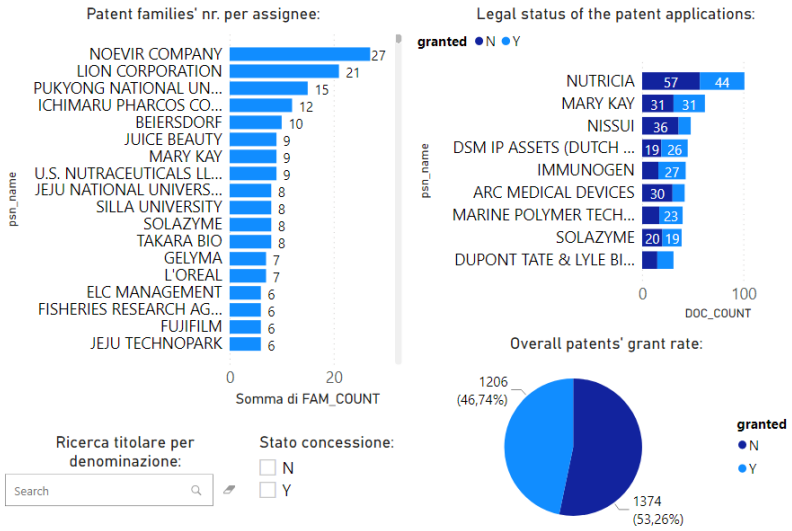
- While the analysis of the legal protection of the technologies aimed at the seawater purification has been limited to the most recent priority years, no limitation has been imposed to the timeframe of patent applications focusing on the remediation techniques (not necessarily restricted to the issue 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 BLUE BIOTECHNOLOGY: THE LEGAL INFORMATION ARGUABLE FROM THE PATENTS' DATASETS

a1) Healthcare and Pharmaceuticals → Cosmetics

Although the number of the patent owners can be estimated on the order of several hundreds, a selection of the top players is displayed in Figure 48. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is almost 47%.

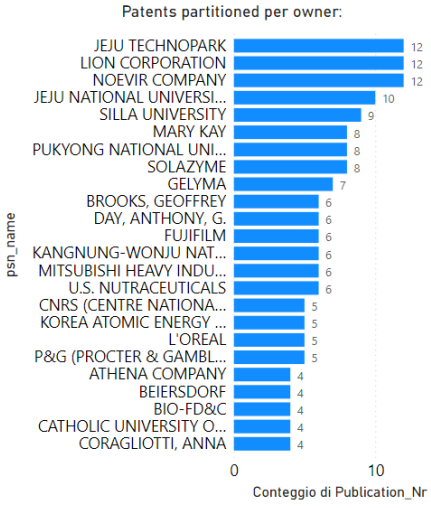
Figure 48 Cosmetics: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – *How to read this document*). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 49. There are several French companies owning patents whose lifespan is considerably higher if compared to the patents owned by renowned French players such as L'OREAL.

Figure 49 Cosmetics: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
FERMENTALG	FR3085962	2	6385
SEPROSYS	FR3084836	3	6347
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR3072877	3	6062
LESSONIA	FR3072877	3	6062
ODYCEA	FR3072292	3	6052
JYMSEA	FR3066917	4	5920
LESSONIA	FR3066917	4	5920
GREENPHARMA	FR3061013	5	5754
BIOTECHMARINE	FR3056907	4	5671
SOCIETE D'EXPLOITATION DE PRODUITS POUR LES INDUSTRIES CHIMIQUES SEPPIC	FR3056907	4	5671
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR3055550	4	5643



The results of the assessment of the triadic families are shown in Figure 50.

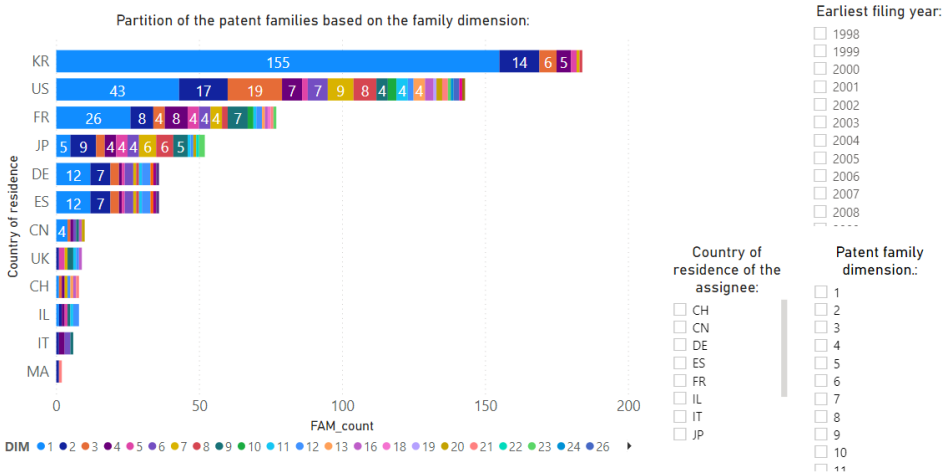
Figure 50 Cosmetics: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di famiglie
ALGENIS	CL	EP1824488	1
ALGUES ET MER	FR	EP0926956	1
ANSELL HEALTHCARE PRODUCTS	US	EP1581051	1
ARC MEDICAL DEVICES	CA	EP2459200	1
ARC MEDICAL DEVICES	CA	EP3300737	1
BAI, DONG GYU	KR	EP1848401	1
BASF (BADISCHE ANILIN & SODA FABRIK)	US	EP2919751	1
BASF (BADISCHE ANILIN & SODA FABRIK)	US	EP3127535	1
BASF (BADISCHE ANILIN & SODA FABRIK)	US	EP3574893	1
BASF BEAUTY CARE SOLUTIONS	US	EP2066299	1
BASF BEAUTY CARE SOLUTIONS	US	EP2633851	1
BAXALTA	CH	EP2532686	1
BAXALTA	CH	EP3409694	1
BAXALTA	US	EP2532686	1
BAXALTA	US	EP3409694	1
BAXTER	US	EP2121767	1
BAXTER HEALTHCARE	CH	EP2121767	1
BEIERSDORF	DE	EP1578391	1

There are plenty of patent applicants corresponding to triadic patent families. These data taken altogether suggest that there is a consistent margin of implementation of technologies/products based on marine biomass resources.

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 51 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Although some information may be missing, as in the case of applicants headquartered in eastern countries, quite often the patent families corresponding to patent applications filed to the Asian patent authorities consist of one member only (cases of utility models are not included in the analysis), being equivalent patent applications seldom filed to foreigner patent authorities. This is quite evident in the case of patent applications filed to the KIPO. On the other hand, the patent families of the applicants located in Western countries include several members corresponding to applications filed to a multiplicity of patent authorities and this option is particularly evident as far as the US applicants are concerned.

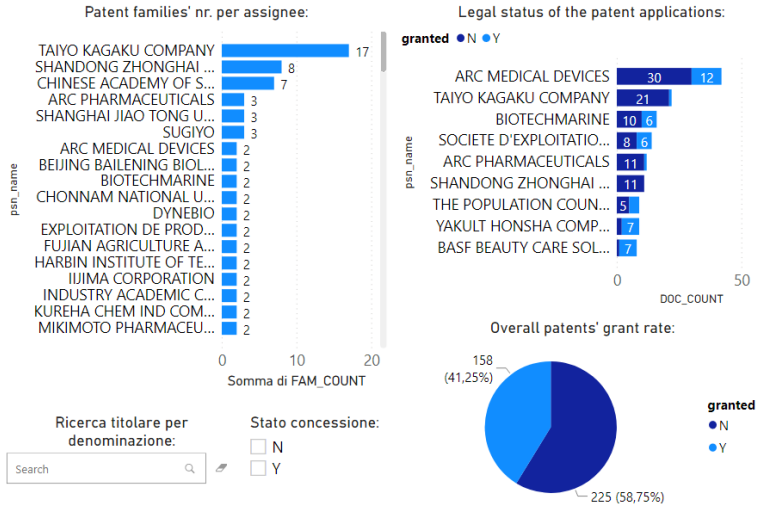
Figure 51 Cosmetics: Ranking of the country of residence of the players based on the patent family dimension



a2) Healthcare and Pharmaceuticals → Pharmaceutics

Although the number of the patent owners can be estimated on the order of one hundred, a selection of the top players is displayed in Figure 52. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is slightly higher than 40%.

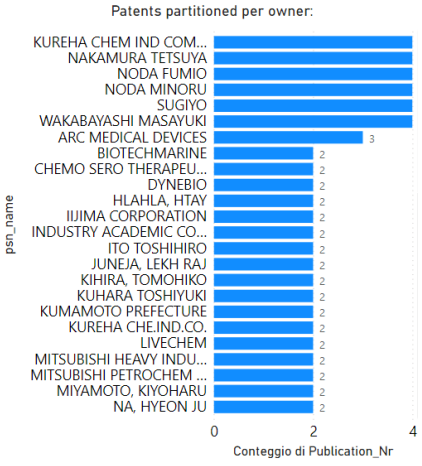
Figure 52 Pharmaceutics: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – *"How to read this document"*). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 53.

Figure 53 Pharmaceutics: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
FERMENTALG	FR3085962	2	6396
LU, CHUEN WEI	US9572783	4	5324
BIOTECHMARINE	FR3034780	6	5143
SOCIETE D'EXPLOITATION DE PRODUITS POUR LES INDUSTRIES CHIMIQUES SEPPIC	FR3034780	6	5143
BIOTECHMARINE	FR3032879	6	5098
SOCIETE D'EXPLOITATION DE PRODUITS POUR LES INDUSTRIES CHIMIQUES SEPPIC	FR3032879	6	5098
INDUSTRY ACADEMIC COOPERATION OF GWANGJU UNIVERSITY	KR101565287	5	4665
INDUSTRY ACADEMIC COOPERATION OF GWANGJU UNIVERSITY	KR20150071226	5	4665
OH, HYE SOOK	KR101381147	6	4464



The results of the assessment of the triadic families are shown in Figure 54.

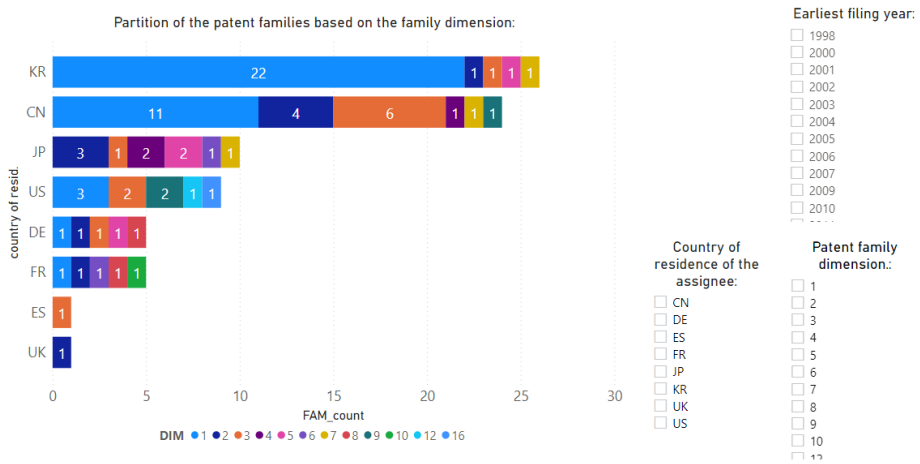
Figure 54 Pharmaceutics: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di famiglie
ARC MEDICAL DEVICES	CA	EP2459200	1
ARC MEDICAL DEVICES	CA	EP3300737	1
BAI, DONG GYU	KR	EP1848401	1
BASF (BADISCHE ANILIN & SODA FABRIK)	US	EP3127535	1
BASF BEAUTY CARE SOLUTIONS	US	EP2066299	1
BASF BEAUTY CARE SOLUTIONS	US	EP2633851	1
BEIJING BAILENING BIOTECHNOLOGY COMPANY	CN	EP3006034	1
BIOTECHMARINE	FR	EP3261727	1
DAMYANGKUN	KR	EP1848401	1
FIRMENICH	CH	EP3174548	1
IIJIMA CORPORATION	JP	EP1312370	1
IIJIMA CORPORATION	JP	EP1312375	1
PINGHU SCISCAPE BIO-PHARMACEUTICAL TECHNOLOGY COMPANY	CN	EP3006034	1
SHENYANG KESI HIGH-TECHNOLOGY COMPANY	CN	EP2778178	1
SOCIETE D'EXPLOITATION DE PRODUITS POUR LES INDUSTRIES CHIMIQUES SEPPIC	FR	EP3261727	1
SUZHOU SCISCAPE BIO-PHARMACEUTICAL TECHNOLOGY COMPANY	CN	EP3006034	1

Excluding some patents owned by ARC MEDICAL DEVICES (already included in a small pool of case histories), other players characterized by a relevant commitment include BASF and BIOTECHMARINE, rather involved in the production of anti-aging compositions. However, there may be also applications aimed at glucose reduction in the blood (eg. EP3174548 owned by FIRMENICH) or at the prevention of chronic hepatitis (eg. EP1312370) or cancer (EP1312375), being both patents owned by IIJIMA CORPORATION.

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 55 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Although some information may be missing, as in the case of applicants headquartered in eastern countries, quite often the patent families corresponding to patent applications filed to the Asian patent authorities consist of one member only (cases of utility models are not included in the analysis), being equivalent patent applications seldom filed to foreigner patent authorities. This is quite evident in the case of patent applications filed to the KIPO. On the other hand, the patent families of the applicants located in Western countries include several members corresponding to applications filed to a multiplicity of patent authorities and this option is particularly evident as far as the US applicants are concerned.

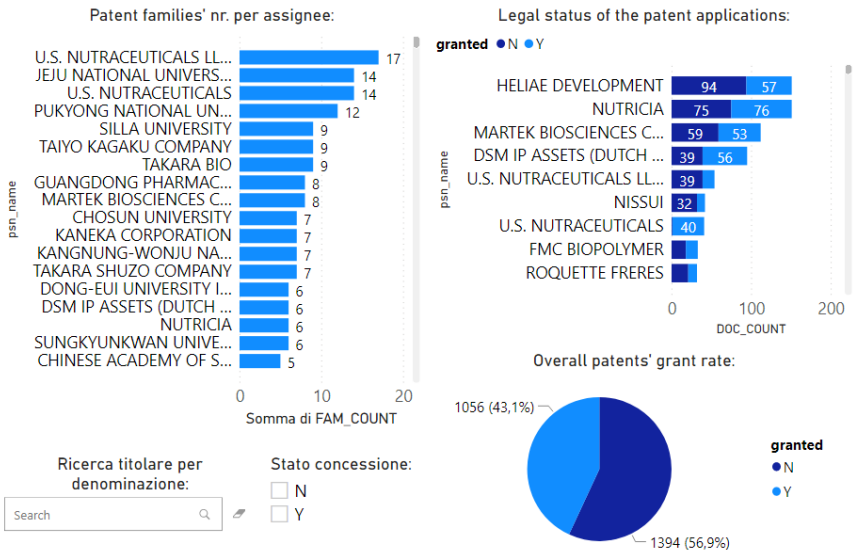
Figure 55 Pharmaceutics: Ranking of the country of residence of the players based on the patent family dimension



a3) Healthcare and Pharmaceuticals → Nutraceuticals

Although the number of the patent owners can be estimated on the order of several hundreds, a selection of the top players is displayed in Figure 56. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is around 43%.

Figure 56 Nutraceuticals: Ranking of the applicants based on the patent application number and grant rate

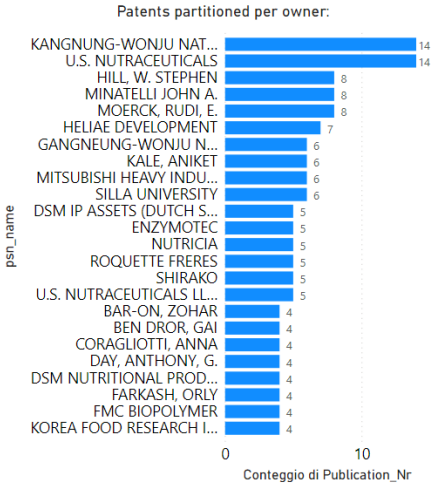


Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific

applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 57.

Figure 57 Nutraceuticals: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
FERMENTALG	FR3085962	2	6378
NATIONAL INSTITUTE OF OCEAN TECHNOLOGY	EP3403662	3	5878
CALLEJA PIERRE	FR3056885	4	5669
GUILLOU ALAIN	FR3056885	4	5669
METABOLIUM	FR3045069	5	5373
LABORATOIRE NUTERGIA	FR3040881	5	5278
ADISSEO FRANCE	FR3038913	6	5223
FERMENTALG	FR3038913	6	5223
FERMENTALG	FR3038914	6	5223
NA, CHIN KEOL	KR101611954	4	5206
CHODANG UNIVERSITY INDUSTRY-ACADEMIC COOPERATION FOUNDATION	KR101725261	4	5156
CHODANG UNIVERSITY INDUSTRY-ACADEMIC	KR20160132692	4	5156



The results of the assessment of the triadic families are shown in Figure 58.

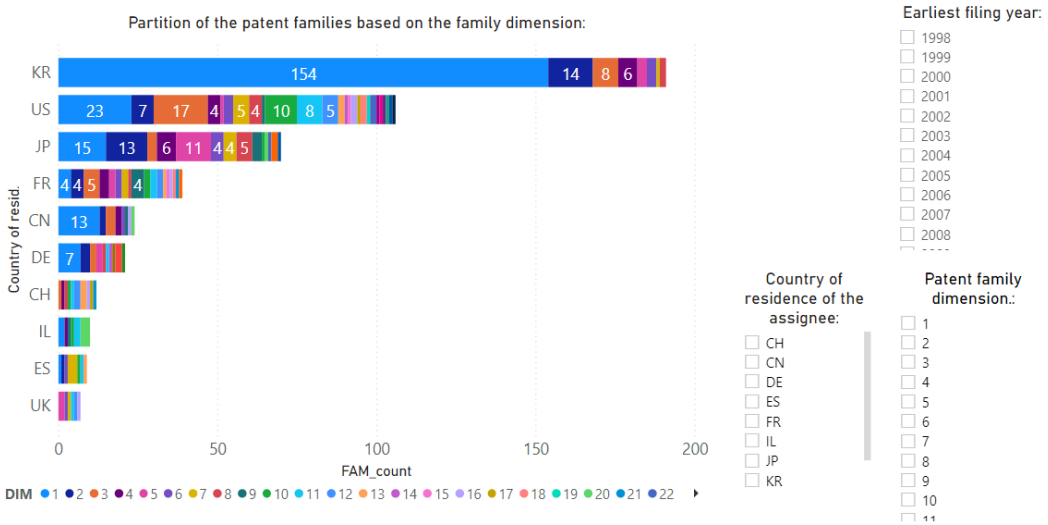
Figure 58 Nutraceuticals: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di famiglie
AQUACAL	IE	EP0966295	1
ASCUS BIOSCIENCES	US	EP3400285	1
BAI, DONG GYU	KR	EP1848401	1
BEIJING BAILENING BIOTECHNOLOGY COMPANY	CN	EP3006034	1
BIOMEDICAL RESEARCH GROUP	JP	EP1676908	1
BIOMEDICAL RESEARCH GROUP	JP	EP1961823	1
BIOMEDICAL RESEARCH GROUP	JP	EP2444480	1
BOTANIC CENTURY (BEIJING) COMPANY	CN	EP2477639	1
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP2919797	1
CORBION BIOTECH	US	EP3082459	1
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	IN	EP2063721	1
DAMYANGKUN	KR	EP1848401	1
DSM IP ASSETS (DUTCH STATE MINES IP ASSETS)	NL	EP1251744	1
DSM IP ASSETS (DUTCH STATE MINES IP ASSETS)	NL	EP2338974	1

Having already remarked that the documents included in the triadic patent families should have relevant technical elements, it is noteworthy that in the EP0967295 (AQUACAL) it is claimed the production of foodstuff whose content is rich of mineral substances extracted from *Corallinaceae* (red algae). Seaweeds also contain substances, administered as foodstuff, used to stimulate the immune response as in the case of BIOMEDICAL RESEARCH GROUP (EP1676980, EP1961823, EP2444480).

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 59 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Although some information may be missing, as in the case of applicants headquartered in eastern countries, quite often the patent families corresponding to patent applications filed to the Asian patent authorities consist of one member only (cases of utility models are not included in the analysis), being equivalent patent applications seldom filed to foreigner patent authorities. This is quite evident in the case of patent applications filed to the KIPO. On the other hand, the patent families of the applicants located in Western countries include several members corresponding to applications filed to a multiplicity of patent authorities and this option is particularly evident as far as the US applicants are concerned.

Figure 59 Nutraceuticals: Ranking of the country of residence of the players based on the patent family dimension



2.a KEYPOINTS

- 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 pharmaceutics.
- 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 pharmaceutics 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 pharmaceutics 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

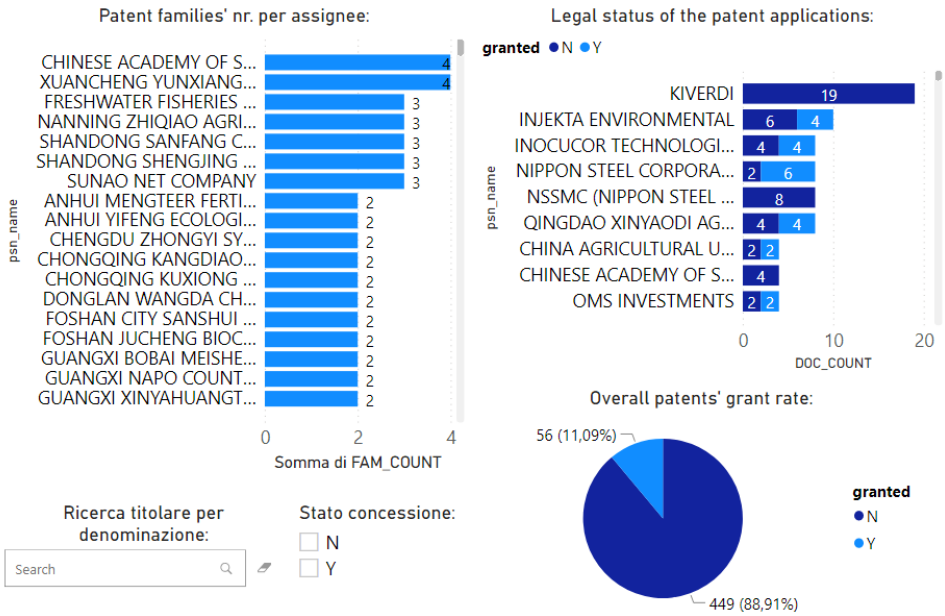
authority. However, upon analyzing the residual validity of the respective patents it turns out that on average the residual validity of L'OREAL patents is low, thus suggesting that it may be worth investigating the activities of competitor companies who likely try to legally protect technical elements 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.

b) Agriculture, Livestock, Food processing → Soil fertilization

Although the number of the patent owners can be estimated on the order of several hundreds, a selection of the top players is displayed in Figure 60. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is quite low (around 11%). It is worth reminding that the dataset consists of 530 non duplicated patent families, yet the timeframe has been limited considering the priority years from 2017 onwards, therefore several patent applications may currently undergo the examination procedure.

Figure 60 Soil fertilization: Ranking of the applicants based on the patent application number and grant rate



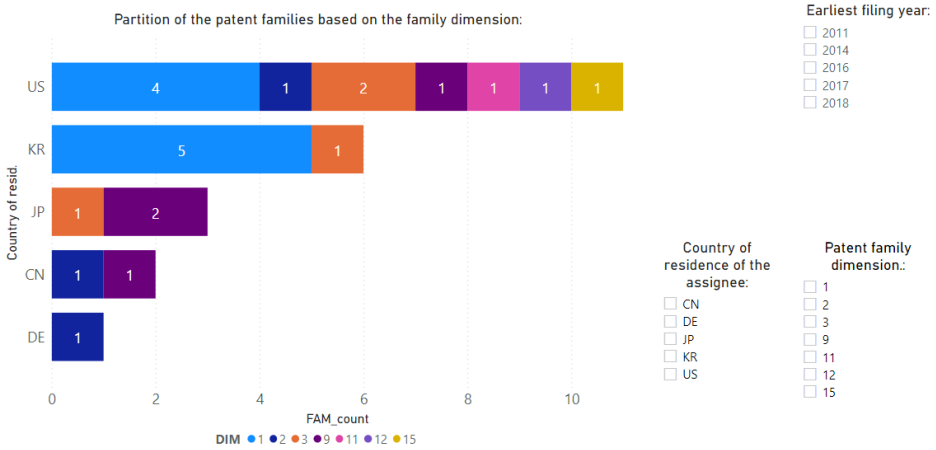
Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 61. As explained above, it is not much surprising that the number of patent documents is quite small. For the same reason no data are currently available regarding the Triadic patent families.

Figure 61 Soil fertilization: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
BYWATER-EKEGARD, MARGARET	US2014120601	3693	4
BYWATER-EKEGARD, MARGARET	US9175258	3693	4
COCHRAN, KEITH	EP2694456	3777	9
FITZSIMMONS, ANANDA	US2014120601	3693	4
FITZSIMMONS, ANANDA	US9175258	3693	4
INOCUCOR TECHNOLOGIES	US2014120601	3693	4
INOCUCOR TECHNOLOGIES	US9175258	3693	4
MALCOM, DOMINI	EP2694456	3777	9
THOMPSON, HAROLD E.	EP2694456	3777	9
XENIKIS, TOULA	EP2694456	3777	9

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 62 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Although some information may be missing, as in the case of applicants headquartered in eastern countries, quite often the patent families corresponding to patent applications filed to the Asian patent authorities consist of one member only (cases of utility models are not included in the analysis), being equivalent patent applications seldom filed to foreigner patent authorities. Even if a similar trend is revealed, more data are required to corroborate such conclusion.

Figure 62 Soil fertilization: Ranking of the country of residence of the players based on the patent family dimension



2.b KEYPOINTS

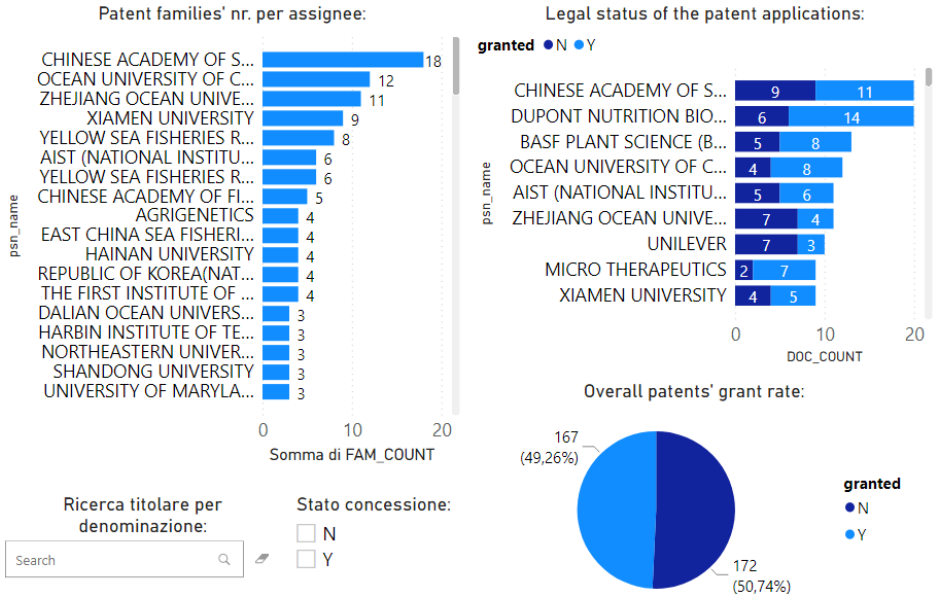
- Having already noticed that most patent applications have been filed to the Asian patent authorities, especially to the CNIPA/SIPO, it seems not much surprising that a consistent portion of information regarding the legal status is missing.
- Consistently with the analysis of the market scenario, from 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.

c) Industrial processes and manufacturing → Sea organisms' genetics

The number of the patent owners is less than one hundred, a selection of the top players is displayed in Figure 63. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is almost 50%.

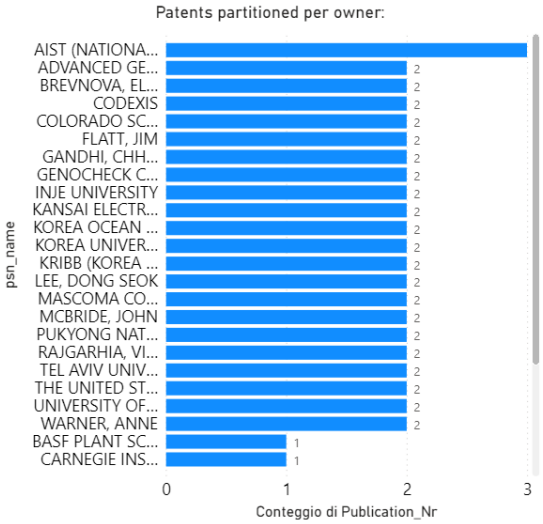
Figure 63 Sea organisms' genetics: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 64.

Figure 64 Sea organisms' genetics: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
PUKYONG NATIONAL UNIVERSITY INDUSTRY-UNIVERSITY COOPERATION FOUNDATION	KR101497525	6	4374
PUKYONG NATIONAL UNIVERSITY INDUSTRY-UNIVERSITY COOPERATION FOUNDATION	KR20140140317	6	4374
AIST (NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY) METI	EP2913400	8	4159
HAINAN UNIVERSITY	EP2889307	8	4079
CODEXIS	US2016244787	4	3970
CODEXIS	US9714437	4	3970
KOREA UNIVERSITY	KR101349436	7	3914
KOREA UNIVERSITY	KR20130097538	7	3914



The results of the assessment of the triadic families are shown in Figure 65.

Figure 65 Sea organisms' genetics: some of the Triadic families

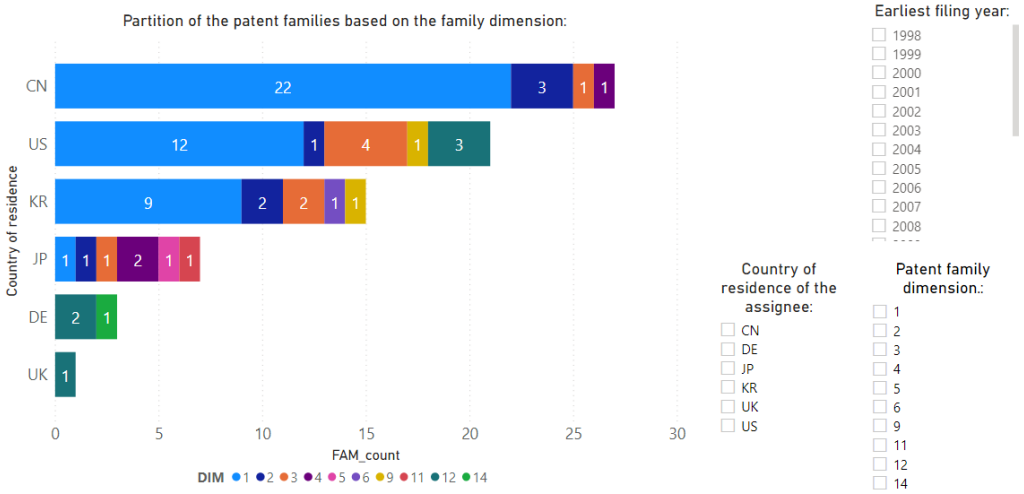
psn_name	person_ctry_code	PUB	Conteggio di Famiglie
BASF PLANT SCIENCE (BADISCHE ANILIN & SODA FABRIK PLANT SCIENCE)	DE	EP1356067	1
CHROMAXOME CORPORATION	US	EP0822990	1
COVIDIEN	US	EP2316355	1
HAINAN UNIVERSITY	CN	EP2889307	1
KOCHI UNIVERSITY	JP	EP2383337	1
MICRO THERAPEUTICS	US	EP1761178	1

Having already remarked that the documents included in the triadic patent families should have relevant technical elements, it is noteworthy that in the EP1356067 (BASF PLANT SCIENCES) it is claimed the analysis of the genomes of the algae useful to produce recombinant poly-unsaturated fatty acids (pls. refer also to the "Nutraceuticals" sub-sector, see the patent application of FERMENTALG regarding the PUFA production, FR3085962A1). The patent of CHROMAXOME CORPORATION (EP0822990) concerns the genetic screening of marine invertebrates to be used as source of novel compounds in the pharmaceutics sector, however from the dashboard referring to the residual validity of the patent it can be argued that the underlying technology may be out of date. The patent of HAINAN UNIVERISITY (EP2889307) concerns the production of a recombinant molecule (α-conotoxin, the natural form of such molecule being secreted by a carnivore mollusc living in the tropical seas) useful to modulate the action of several neuro-stimulator. The patent of KOCHI UNIVERSITY (EP2383337) claims about genetic engineering techniques applicable to the algae, while the patent of MICRO THERAPEUTICS (EP1761178) belongs to the same patent family of EP2316355 (COVIDIEN) and concerns the production of devices coated with biomolecules and useful to the treatment of aneurisms.

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of

countries. The diagram displayed in Figure 66 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Since the dataset regarding the genetics of sea organisms includes only 203 non duplicated patent families and considering that some information regarding the family dimension may be missing, the differentiation of applicants respectively resident in eastern and western countries is present but barely detectable.

Figure 66 Sea organisms' genetics: Ranking of the country of residence of the players based on the patent family dimension



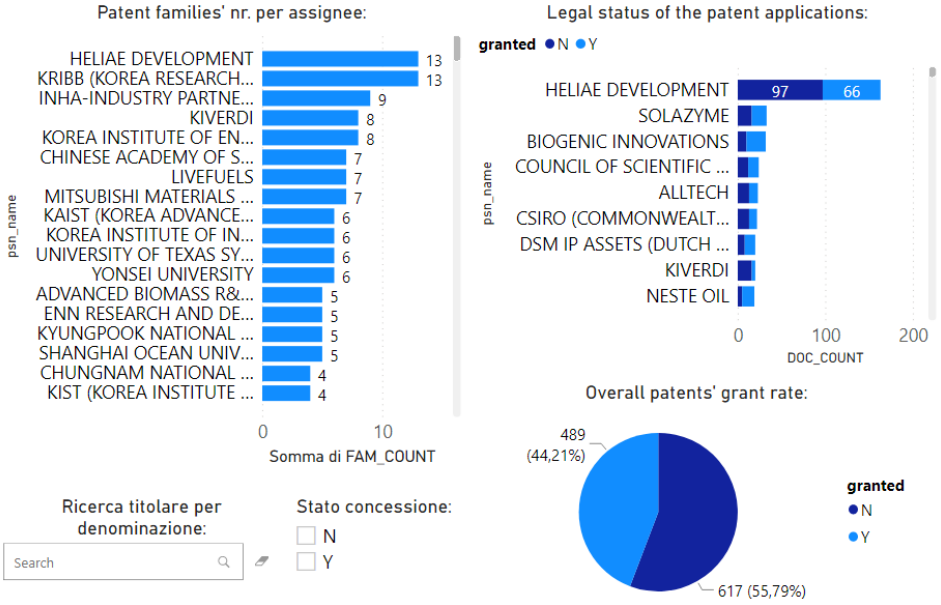
2.c KEYPOINTS

- 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 (eg. 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.

d) Biofuels

The number of the patent owners is several hundred, a selection of the top players is displayed in Figure 67. Such top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is 44%.

Figure 67 Biofuels: Ranking of the applicants based on the patent application number and grant rate

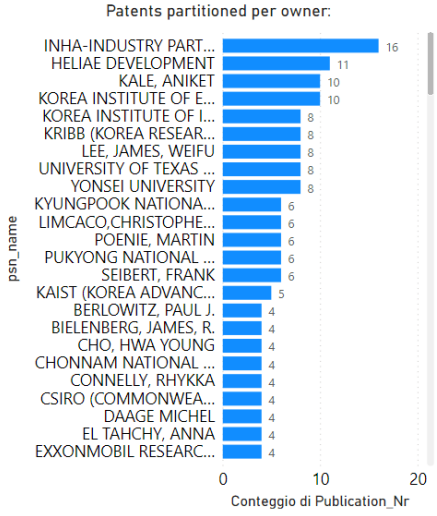


From the above diagram is quite impressive that despite HELIAE DEVELOMPENT owns a number of patent families comparable to those of the other top players, the number of applications filed by such player is much higher than the number of applications filed by each of the other competitors and the number of granted patents is consistent as well.

Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 68.

Figure 68 Biofuels: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR3058732	4	5739
UNIVERSITE PIERRE ET MARIE CURIE (PARIS 6)	FR3058732	4	5739
CEA (COMMISSARIAT A L'ENERGIE ATOMIQUE)	EP3199620	5	5446
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	EP3199620	5	5446
CEA (COMMISSARIAT A L'ENERGIE ATOMIQUE)	FR3041654	5	5324
INHA UNIVERSITY RESEARCH AND BUSINESS FOUNDATION	KR101678076	4	5171
INHA UNIVERSITY RESEARCH AND BUSINESS FOUNDATION	KR20160129198	4	5171
MYONGJI UNIVERSITY	KR101694711	4	5171



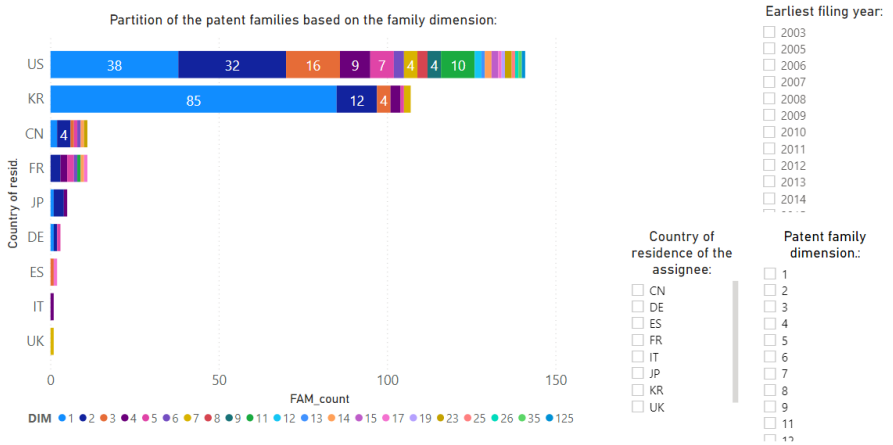
Quite interestingly, all the patents listed above have a consistent residual lifespan. This evidence appears rather surprising in virtue of the observation that the trend of the patent applications is progressively declining after yr. 2015 (pls. refer to the market scenario). The results of the assessment of the triadic families are shown in Figure 69. Even if not appearing in the table, there are several patent families owned by HELIAE DEVELOPMENT. Most owners are US residents.

Figure 69 Biofuels: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di famiglie
ALLTECH	US	EP2732025	1
BERGEN TEKNOLOGIOVERFORING	NO	EP2582776	1
BIOGENIC INNOVATIONS	US	EP2493464	1
BIOGENIC INNOVATIONS	US	EP2494059	1
COLORADO STATE UNIVERSITY	US	EP2097506	1
COLORADO STATE UNIVERSITY	US	EP2545157	1
CORBION BIOTECH	US	EP2670855	1
CORBION BIOTECH	US	EP3643774	1
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (AC	IN	EP2475776	1
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	IN	EP2619303	1
CSIRO (COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION)	AU	EP2798066	1
DEPARTMENT OF BIOTECHNOLOGY, MINISTRY OF SCIENCE & TECHNOLOGY	IN	EP3098318	1
DSM IP ASSETS (DUTCH STATE MINES IP ASSETS)	NL	EP2198038	1
ECHEVARRIA PARRES, ANTONIO JOSE	MX	EP2302019	1

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 70 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Having noticed from the analysis of the market scenario that most applications are filed by US resident applicants and applicants headquartered in South Korea, it is not surprising that both countries score the highest position. The main difference concerns the strategy of protection, as revealed by the different distribution of the respective patent family dimension. It is noteworthy that one patent family owned by one US applicant includes 125 family members.

Figure 70 Biofuels: Ranking of the country of residence of the players based on the patent family dimension



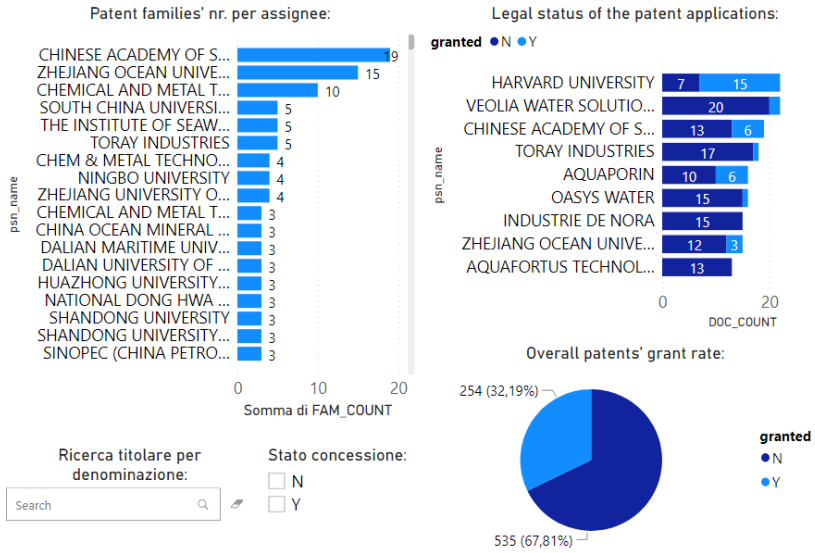
2.d KEYPOINTS

- 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 (eg. ALLTECH Inc.), while alternative approaches may be based on the fermentation enhanced by microorganisms (eg. 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.

e1) Bio-monitoring and bio-remediation → Seawater purification

The number of the patent owners is several hundred, a selection of the top players is displayed in Figure 71. Such top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is slightly less than 33%.

Figure 71 Seawater purification: Ranking of the applicants based on the patent application number and grant rate

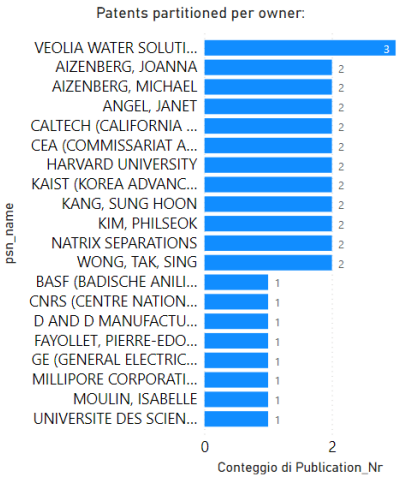


Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific

applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 72.

Figure 72 Seawater purification: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
CEA (COMMISSARIAT A L'ENERGIE ATOMIQUE)	FR3077069	6191	3
UNIVERSITE DES SCIENCES ET DE LA TECHNOLOGIE HOUARI BOUMEDIENE	FR3077069	6191	3
FAYOLLET, PIERRE-EDOUARD	FR3068689	5990	4
MOULIN, ISABELLE	FR3068689	5990	4
VEOLIA WATER SOLUTIONS & TECHNOLOGIES SUPPORT	FR3068614	5990	4
VEOLIA WATER SOLUTIONS & TECHNOLOGIES SUPPORT	FR3068615	5990	4
CEA (COMMISSARIAT A L'ENERGIE ATOMIQUE)	FR3061708	5809	4
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR3061708	5809	4



The results of the assessment of the triadic families are shown in Figure 73.

Figure 73 Seawater purification: some of the Triadic families

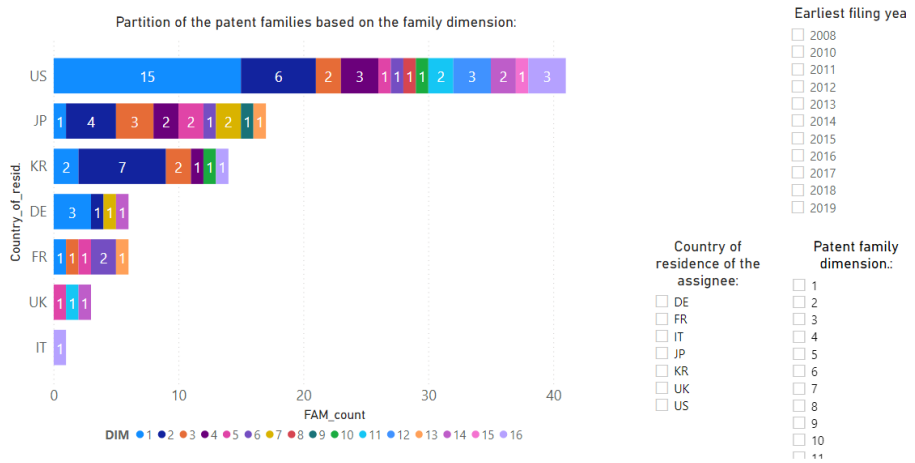
psn_name	person_ctry_code	PUB	Conteggio di famiglie
AQUAPORIN	DK	EP2958662	1
AQUAPORIN	DK	EP3524338	1
BASF (BADISCHE ANILIN & SODA FABRIK)	DE	EP3003540	1
CHENG XIAOLING	CN	EP3347310	1
EFFLUENT FREE DESALINATION CORPORATION	US	EP3237335	1
GE (GENERAL ELECTRIC COMPANY)	US	EP2768776	1
HARVARD UNIVERSITY	US	EP2665782	1
HARVARD UNIVERSITY	US	EP2665783	1

Upon a rapid examination of the list of the triadic families it can be argued that several inventions concern methodologies appropriate for removing contaminants from water, for example in the case of the patents owned by AQUAPORIN or BASF. However, it seems that the commitment of such players is rather based in the water purification irrespectively from the fact that **the technical principle may be not necessarily based on the biological treatment of water**. Despite the search query has been tailored to include those patent documents where a biologic agent is used to treat the contaminated water, the evidence suggests that this methodology may be mentioned in a relatively little number of patent documents that may be isolated from the dataset. A rough estimation reveals that **about 16% of the results deal with biologic agents used for purifying the water and in most cases the patent assignees are headquartered in the Asian countries**.

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 74 takes in consideration the applicants aggregated because of a common location

of the respective premises (the country of residence). Having noticed from the analysis of the market scenario that most applications are filed by US resident applicants and applicants headquartered in South Korea, it is not surprising that both countries score the highest position.

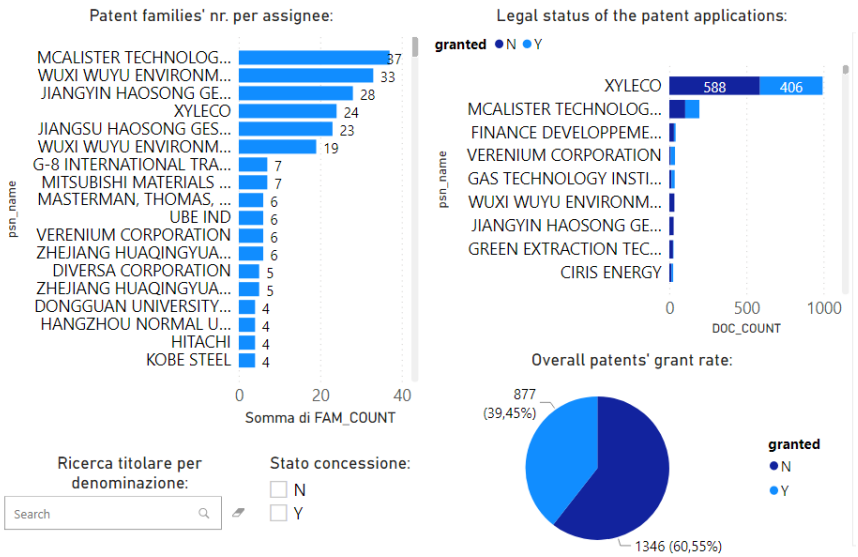
Figure 74 Seawater purification: Ranking of the country of residence of the players based on the patent family dimension



e2) Bio-monitoring and bio-remediation → Remediation

The number of the patent owners is several hundred, a selection of the top players is displayed in Figure 75. Such top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected upon combining the patent applications to the granted patents for each ranked applicant (rightmost bar diagram). The pie diagram includes aggregated data useful to estimate the average grant rate which is slightly less than 40%.

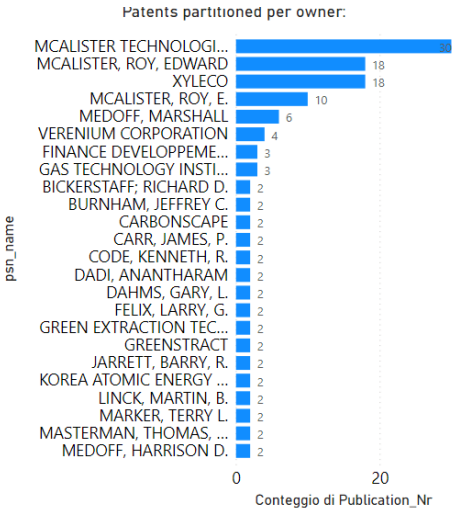
Figure 75 Remediation: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent documents of a specific applicant has been already anticipated (Figure 19 – "*How to read this document*"). A more synthetic indication reflecting the expected lifespan of the granted patents might be argued from the following Figure 76.

Figure 76 Remediation: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
EXOCHEMS ENVIRONNEMENT	FR3068688	4	5937
CYCL-ADD	EP3269526	4	5582
BRGM	FR3052171	5	5540
DONGWON ENGINEERING COMPANY	KR101695977	4	5487
HANYANG FILTERS & ENGINEERING CORPORATION	KR101653939	4	5396
CHOI, JIN-O	KR101619454	5	5378
YONSEI UNIVERSITY	KR101660469	4	5327
KOREA ATOMIC ENERGY RESEARCH INSTITUTE	KR101739725	4	5245
KOREA ATOMIC ENERGY RESEARCH INSTITUTE	KR20170020084	4	5245
MICROMAX	KR101739725	4	5245
MICROMAX	KR20170020084	4	5245



The results of the assessment of the triadic families are shown in Figure 77.

Figure 77 Remediation: some of the Triadic families

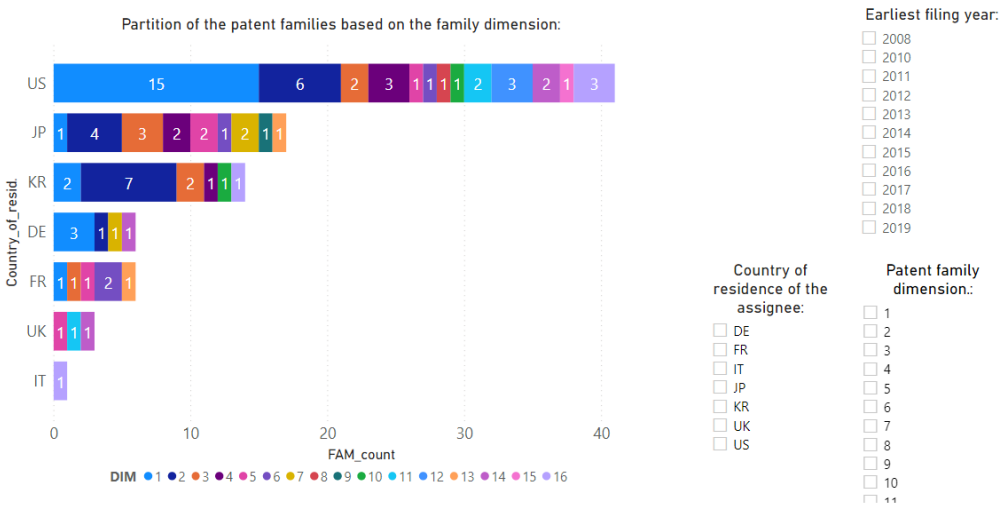
psn_name	person_ctry_code	PUB
AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION	AU	EP2715738
AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION	AU	EP3425639
JUPENG BIO	CN	EP3046996
JUPENG BIO	CN	EP3495453
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP2504096
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP3260196
UNIVERSITE MONTPELLIER 2 SCIENCES ET TECHNIQUES	FR	EP2504096
UNIVERSITE MONTPELLIER 2 SCIENCES ET TECHNIQUES	FR	EP3260196
NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES	JP	EP3406572
CARBONSCAPE	NZ	EP2782667
APPLIED RESEARCH ASSOCIATES	US	EP3481919
BP CORPORATION NORTH AMERICA	US	EP1861506
BP CORPORATION NORTH AMERICA	US	EP2949756
CHZ TECHNOLOGIES	US	EP3397604
CIRIS ENERGY	US	EP3256546
CIRIS ENERGY	US	EP3268453
DADI, ANANTHARAM	US	EP2864364
GAS TECHNOLOGY INSTITUTE	US	EP2739571
GAS TECHNOLOGY INSTITUTE	US	EP3164356

Despite the table shows a partial result, most of the triadic family patents are owned by XYLECO. Like in the sector regarding the "Seawater purification" also in the case of "Remediation" **only a fraction of the results**

deals with methodologies based on natural resources, for example the use of **algae extract** (slightly less than 22% of the patent families included in the dataset, **in most cases being claimed a deodorizing substance** of microbial origin).

Legal implications may also depend on the dimension of the patent families, which is another indicator of the commitment of a specific assignee/applicant toward ensuring the exclusivity of the IPRs in a multiplicity of countries. The diagram displayed in Figure 78 takes in consideration the applicants aggregated because of a common location of the respective premises (the country of residence). Having noticed from the analysis of the market scenario that most applications are filed by the US resident applicants and the applicants headquartered in the Asian countries, it is not surprising that US and Asian residents score the highest position.

Figure 78 Remediation: Ranking of the country of residence of the players based on the patent family dimension



Although the coverage of the data may be partial and despite the smaller number of patent families corresponding to the Japanese and the Korean applicants, it appears that, irrespectively from the country of residence, most players foresee the opportunity to legally protect the innovations by simultaneously filing equivalent patent applications that permit the exploitation in a multiplicity of countries.

2.e KEYPOINTS

- 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

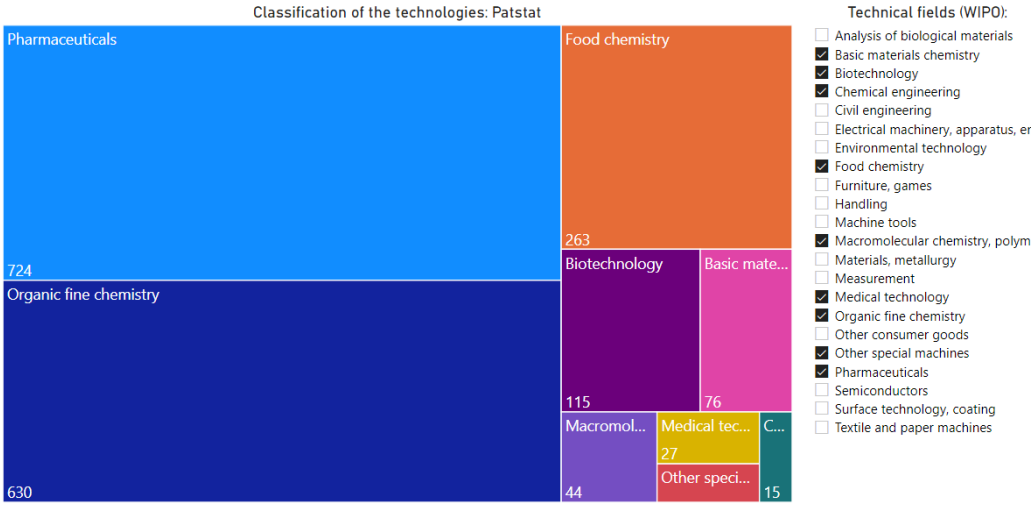
physical-chemical methods and seldom be based on a biotechnological approach, at least as far as the technical content of most patent documents would suggest.

3 BLUE BIOTECHNOLOGY: THE TECHNICAL INFORMATION

a1) Healthcare and Pharmaceuticals → Cosmetics

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 79.

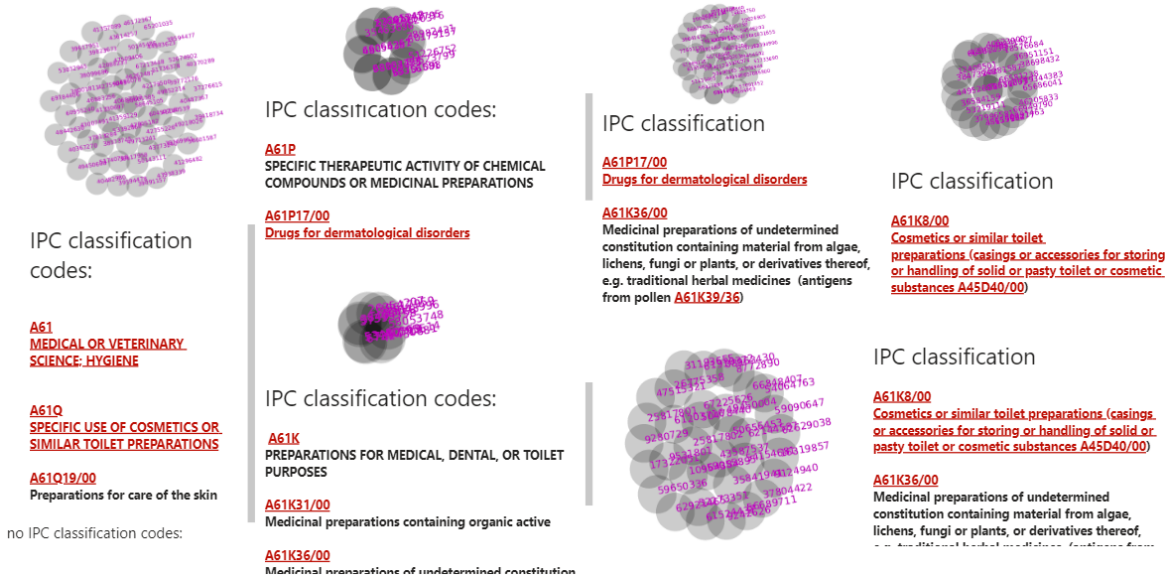
Figure 79 Cosmetics: Map of the technology fields defined by WIPO



The clustering of the patent documents according to patterns defined by one or more technical fields is consistent with the analysed topic and the identification of technologies specifically dealing with the sub-sector is possible. Clustering the documents of the same dataset may be based on the classification codes, either IPC or CPC.

The following figures (Figure 80 and Figure 81, respectively) are dealing with patterns of IPC/CPC classification codes:

Figure 80 Cosmetics: clustering of the patent families based on the identification of patterns of IPC classification codes

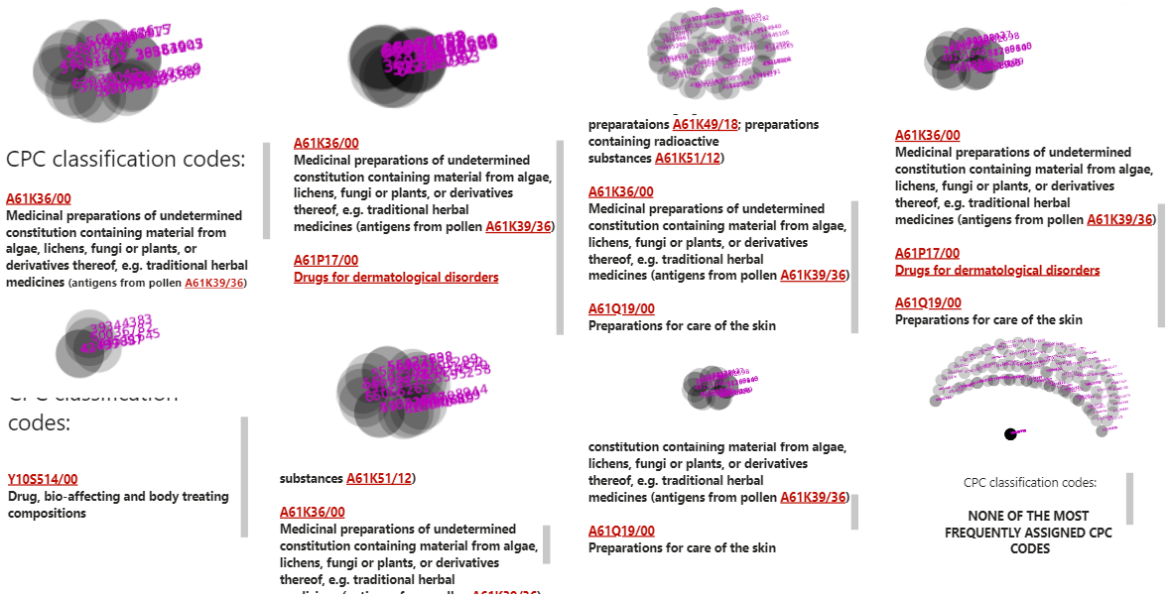


Excluding the documents not identifiable by means of IPC classification codes, the majority may be included in patterns characterized by the following codes (either considered individually or in combinations):

A61Q19/00, referring to **Preparations for care of the skin.**
A61P17/00, referring to **Drugs for dermatological disorders.**
A61K8/00, referring to **Cosmetics or similar toilet preparations.**
A61K31/00, referring to **Medicinal preparations containing organic active ingredients.**

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.**

Figure 81 Cosmetics: clustering of the patent families based on the identification of patterns of CPC classification codes



Likewise, most CPC codes correspond to the IPC codes assigned to the patent documents. In addition, one small cluster is characterized by the following CPC code:

Y10S514/00, referring to **Drug, bio-affecting and body treating compositions → Colloid systems and wetting agents; subcombinations thereof.**

The co-occurrence of two IPC or CPC classification codes identifying single patents families is consistent with the clustering data shown above and add further detail about the subgroups (Figure 82). Codes such as A61K8/97 (Cosmetics or similar toilet preparations → from algae, fungi, lichens or plants; from derivatives thereof), A61K8/9711 (Cosmetics or similar toilet preparations → from algae, fungi, lichens or plants; from derivatives thereof → Phaeophycota or Phaeophyta [brown algae], e.g. Fucus), and A61K36/02 (Medicinal preparations of undetermined constitution containing material from algae, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicines → Algae) or A61K36/03 (Medicinal preparations of undetermined constitution containing material from algae, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicines → Phaeophycota or phaeophyta (brown algae), e.g. Fucus) are frequently assigned.

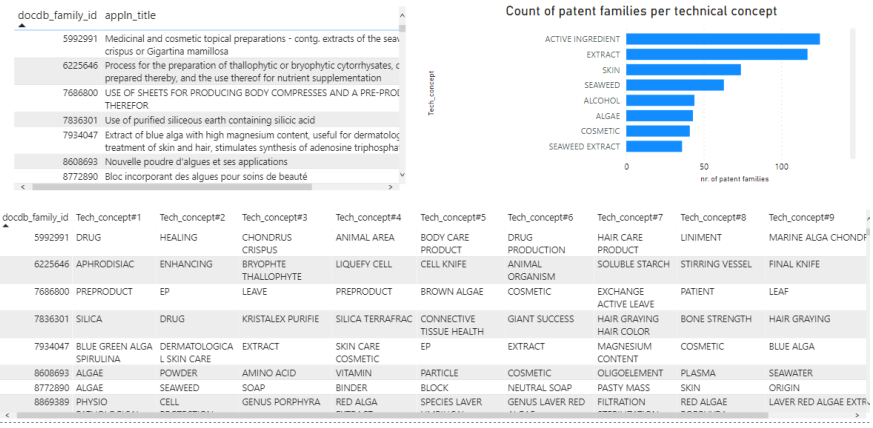
Figure 82 Cosmetics: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
270	A61Q 19/00	A61K 8/97
251	A61K 36/02	A61K 8/97
195	A61Q 19/00	A61K 36/02
143	A61P 17/00	A61K 36/02
124	A61P 17/00	A61K 8/97
123	A61Q 19/00	A61P 17/00
112	A61K 8/97	A61K 8/96
111	A61K 36/02	A61K 8/96
110	A61Q 19/08	A61K 8/97

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
114	A61K 36/03	A61K 8/9711
59	A61K 8/9789	A61K 8/9711
58	A61Q 19/00	A61K 8/9711
57	A61K 8/9794	A61K 8/9789
55	A61Q 19/00	A61K 36/03
49	A61Q 19/08	A61K 8/9789
48	A61Q 19/08	A61K 36/03
45	A61Q 19/08	A61K 8/9711
44	A61Q 19/00	A61K 36/02

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 83.

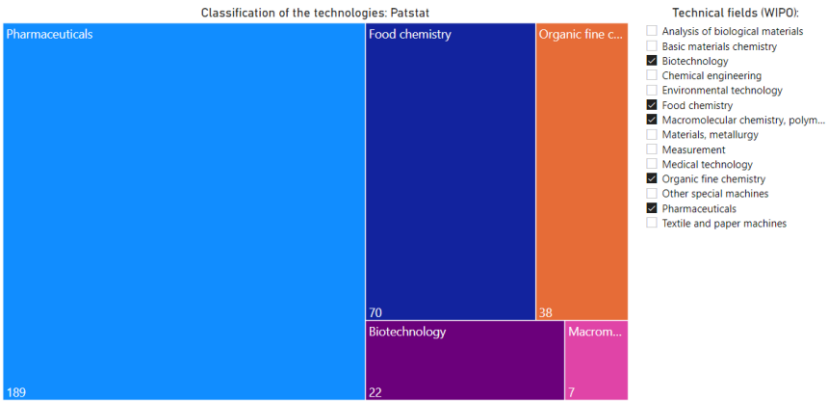
Figure 83 Cosmetics: List of technical concepts associated to each patent family of the dataset and ranking



a2) Healthcare and Pharmaceuticals → Pharmaceutics

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 84.

Figure 84 Pharmaceutics: Map of the technology fields defined by WIPO

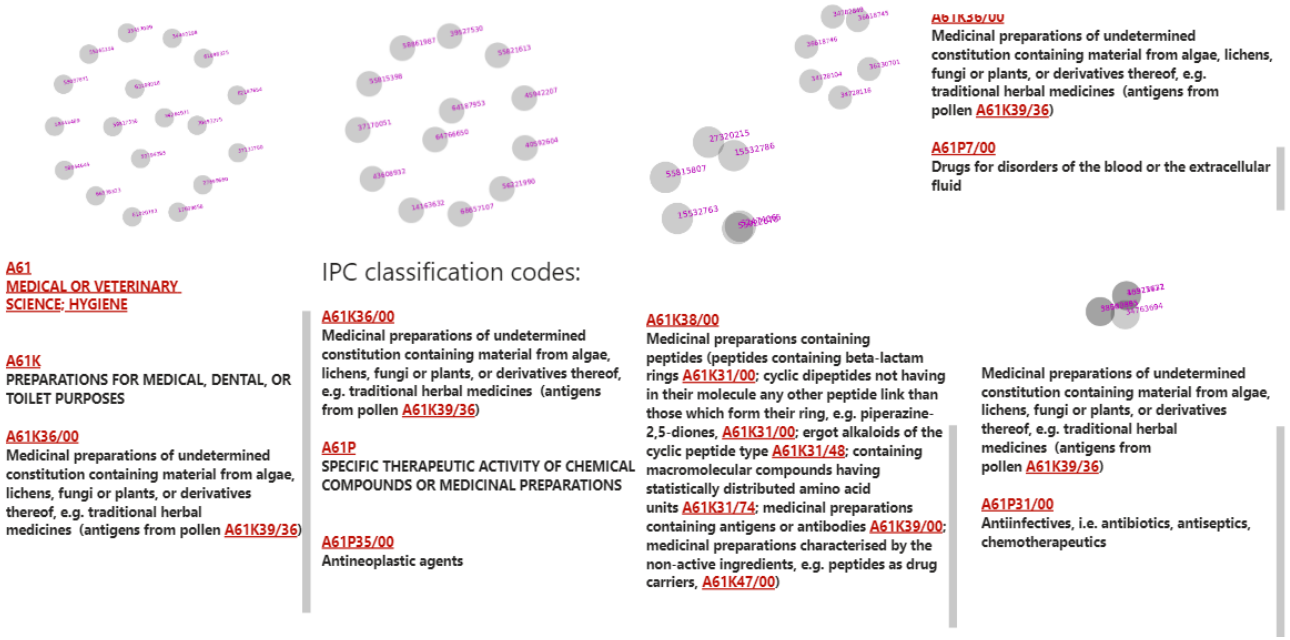


The evaluation based on the WIPO technology fields does not permit to properly differentiate sectors such as the "Cosmetics" and the "Pharmaceutics".

The clustering of the patent documents according to patterns defined by one or more technical fields is consistent with the analyzed topic and the identification of technologies specifically dealing with the sub-sector is advisable. Clustering the documents of the same dataset may be based on the classification codes, either IPC or CPC.

The following figure (Figure 85) shows the patterns of IPC classification codes:

Figure 85 Pharmaceutics: clustering of the patent families based on the identification of patterns of IPC classification codes



Excluding the documents not identifiable by means of IPC classification codes, several patent documents may be included in patterns characterized by the following codes (either considered individually or in combinations):

A61K31/00, referring to **Medicinal preparations containing organic active ingredients.**
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.**
A61K38/00, referring to **Medicinal preparations containing peptides.**
A61P35/00, referring to **Antineoplastic agents.**
A61P7/00, referring to **Drugs for disorders of the blood or the extracellular fluid.**
A23L1/00 or A23L2/00, referring to **Non-alcoholic beverages; Dry compositions or concentrates therefor; Their preparation.**

Likewise, most CPC codes correspond to the IPC codes assigned to the patent documents. In addition, one small cluster is characterized by the following CPC classification code:

A61K2236/00, referring to **Isolation or extraction methods of medicinal preparations of undetermined constitution containing material from algae, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicine.**

The co-occurrence of two IPC or CPC classification codes identifying single patents families () is consistent with the clustering data shown above and add further detail about the subgroups. Subgroups of the code A61K36 are frequently assigned, for example: A61K36/02 (Medicinal preparations of undetermined constitution containing material from algae, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicines → Algae), A61K36/03 (Phaeophycota or phaeophyta (brown algae), e.g. Fucus) or A61K36/04 (Rhodophycota or rhodophyta (red algae), e.g. Porphyra). The treatment of blood disorders is better defined by means of the code A61P7/02 (Antithrombotic agents; Anticoagulants; Platelet aggregation inhibitors).

Figure 86 Pharmaceutics: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

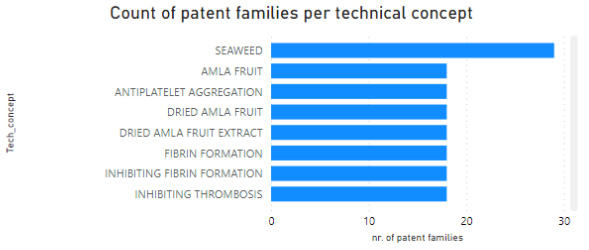
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
19	A61P 7/02	A23L 1/30
18	A61K 36/03	A61K 36/02
14	A61K 36/02	A23L 1/30
14	A61K 36/02	A23L 17/60
14	A61K 36/02	A61K 31/715
14	A61K 36/04	A61K 36/02
13	A23L 2/52	A23L 1/30
12	A61K 36/04	A61K 36/03
11	A61K 36/02	A61K 8/97
11	A61P 7/02	A23L 2/52
11	A61Q 19/00	A61K 8/97

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
22	A61K 36/03	A61K 36/02
16	A61K 36/04	A61K 36/03
13	A61K 36/04	A61K 36/02
12	A61K 36/03	A23L 33/105
12	A61K 36/03	A23V2002/00
12	A61K 36/05	A61K 36/02
12	A61K 36/05	A61K 36/04
12	A61K 36/704	A61K 36/02
11	A61K 36/05	A61K 36/03
11	A61K 36/704	A61K 36/315
10	A61K 36/02	A23V2002/00

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 87.

Figure 87 Pharmaceutics: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
5029584	A TONIC DRUG MADE FROM BASIDIOMYCETES, ALGAE, CHINESE HERBA THE METHOD THEREOF
7694085	COMPLEX ANTIOXIDANT PREPARATION
9262394	Medicaments contg. brown or red seaweed - for treatment of capillary fi permeability, and anti:aggregation agents
11807140	ANTIPHLOGISTIC AGENT
11807164	HEMORRHOID THERAPEUTIC AGENT
14163632	PRODUCTION OF ANTIOXIDIZING SUBSTANCE FROM SEAWEED
15532763	ANTIVIRAL AGENT
15532786	ANTIVIRAL AGENT
15561890	SEAWEED ASH-BASED ANTIMICROBIAL AGENT

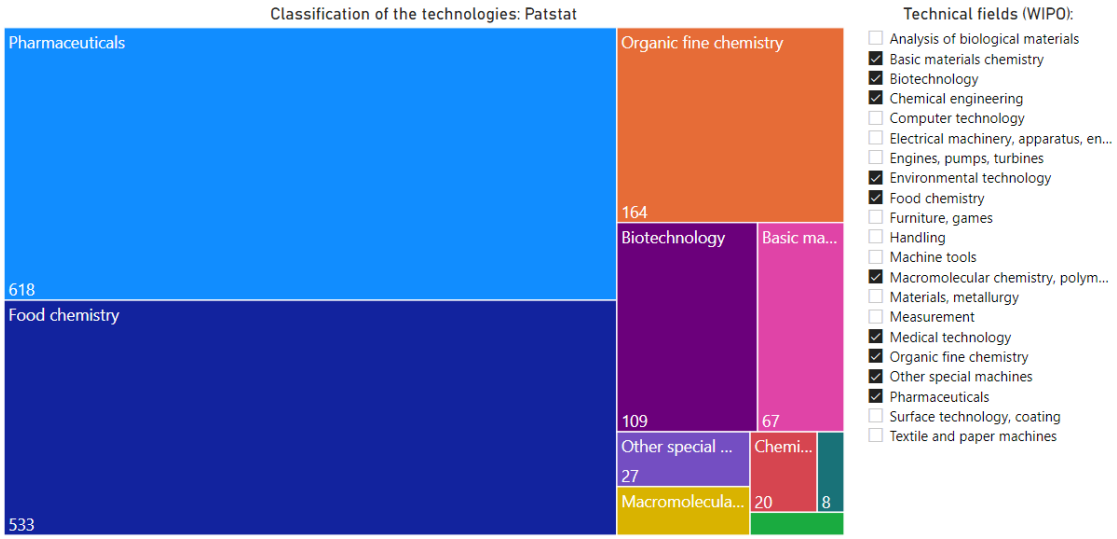


docdb_family_id	Tech_concept #1	Tech_concept #2	Tech_concept #3	Tech_concept #4	Tech_concept #5	Tech_concept #6	Tech_concept #7	Tech_concept #8	Tech_concept #9
5029584	RAW MATERIAL	FUNGUS	ALGAE	CHINESE HERBAL	PHARMACEUTICAL CARE	HEALTH PHARMACEUTICAL PREPARATION	LING ZHI PROTOPLASM IC	PHARMACEUTICAL CARE MATERIAL	PHARMACEUTICAL PF
7694085	CITRUS RUTIN	ORALLY INGESTIBLE CAPSULE	FRUIT POWDER ROSEHIP	CIGARET CARTON DIMENSION	SEAWEED FLOUR	CIGARET CARTON	INGESTIBLE CAPSULE	SEAWEED POWDER	VITAMIN ACETATE
9262394	BROWN ALGAE	DRUG	CREAM	RED ALGAE	FORMULATION	ALGAE EXTRACT	CAPILLARY PERMEABILITY	COSMETIC	DIETETICS
11807140	ALGAE GIRAFFE	BARB	CERAMIUM PANICULATU	CERAMIUM TENERRIMU	GI HEXAFLUOROSILCATE GIRAFFE	SKIN INFLAMMATORY MATERIAL	CERAMIUM JAPONICU	PEROXOL OXIDATION	BRUISE DISEASE
11807164	GIRAFFE	CERAMIUM PANICULATUM	CERAMIUM TENERRIMUM	EUCHEUMA DENTICULATUM	EUCHEUMA SERRA	ALGAE BARB	GI HEXAFLUOROSILCATE GIRAFFE	THERAPEUTIC AGENT HEMORRHOID	HEMORRHOIDAL SEA

a3) Healthcare and Pharmaceuticals → Nutraceuticals

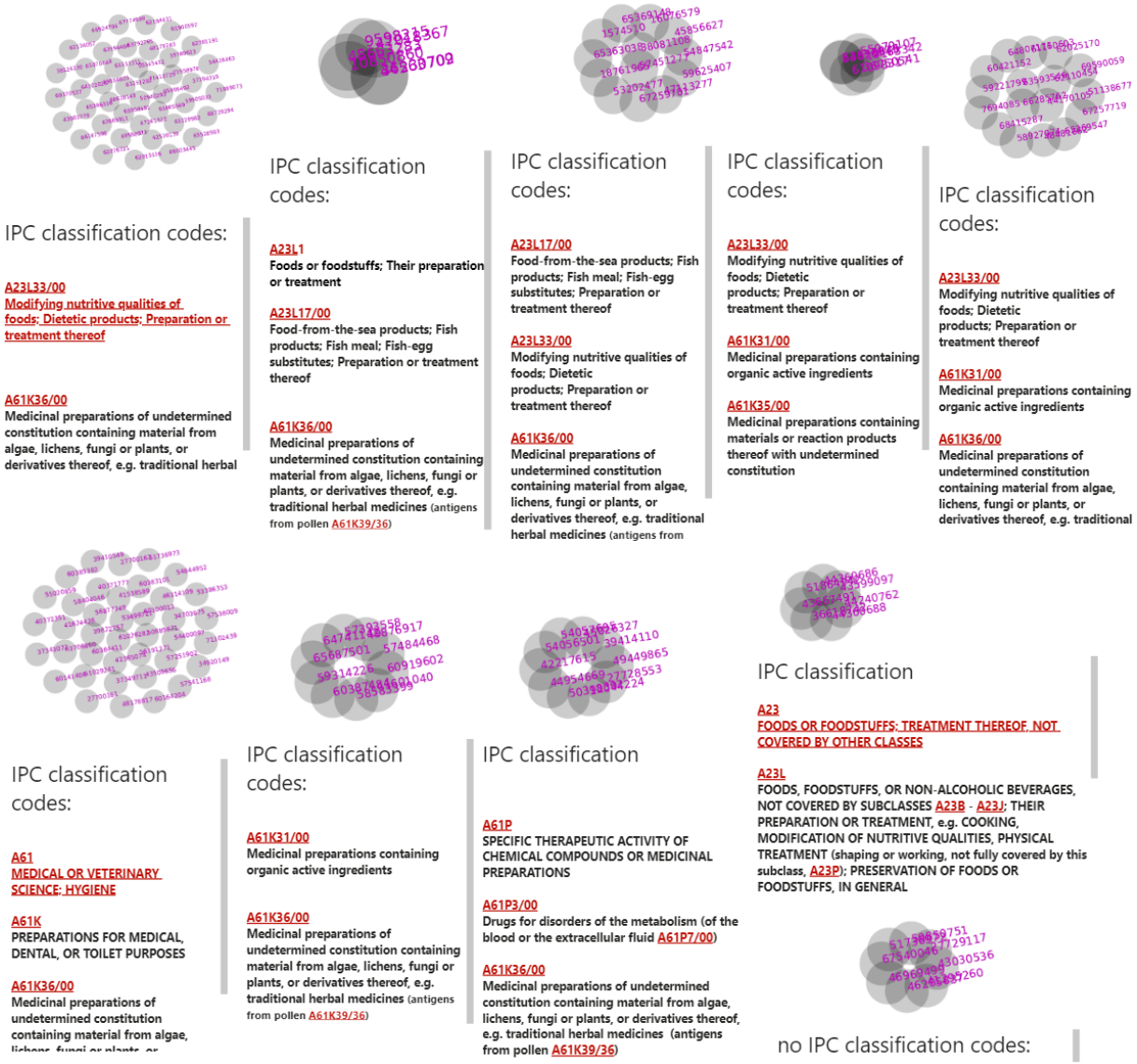
The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 88.

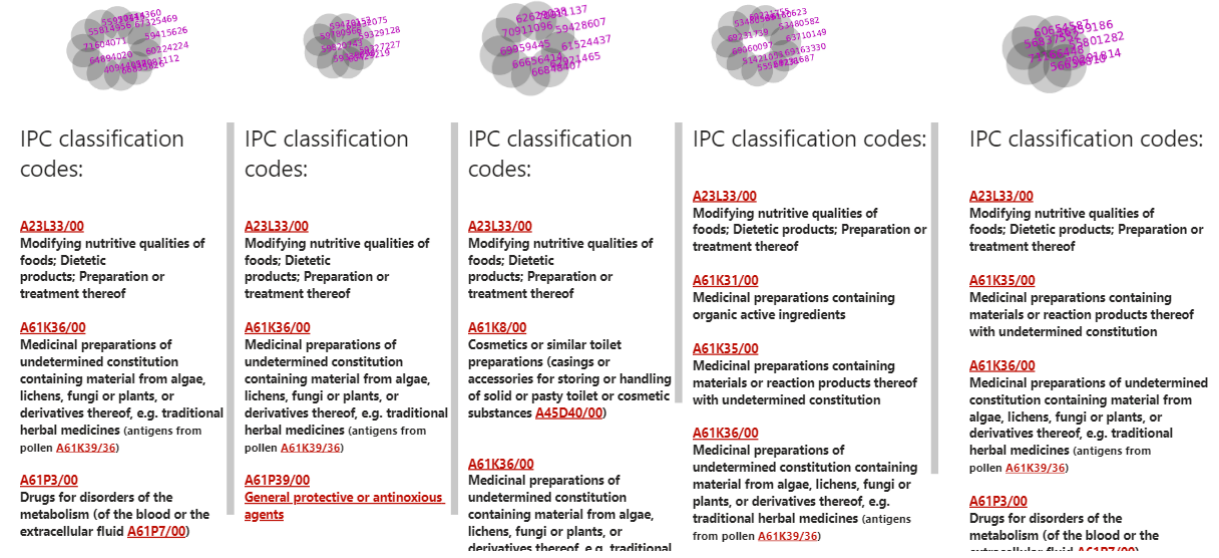
Figure 88 Nutraceuticals: Map of the technology fields defined by WIPO



As already observed in the sectors regarding the "Cosmetics" and the "Pharmaceutics", the evaluation based on the WIPO technology fields reveals several similarities characterizing the two sectors mentioned above and the "Nutraceuticals". Therefore, it is advisable to further differentiate the three sectors by analyzing the frequency of assignment of the IPC or CPC classification codes (Figure 89 and Figure 90, respectively).

Figure 89 Nutraceuticals: clustering of the patent families based on the identification of patterns of IPC classification codes

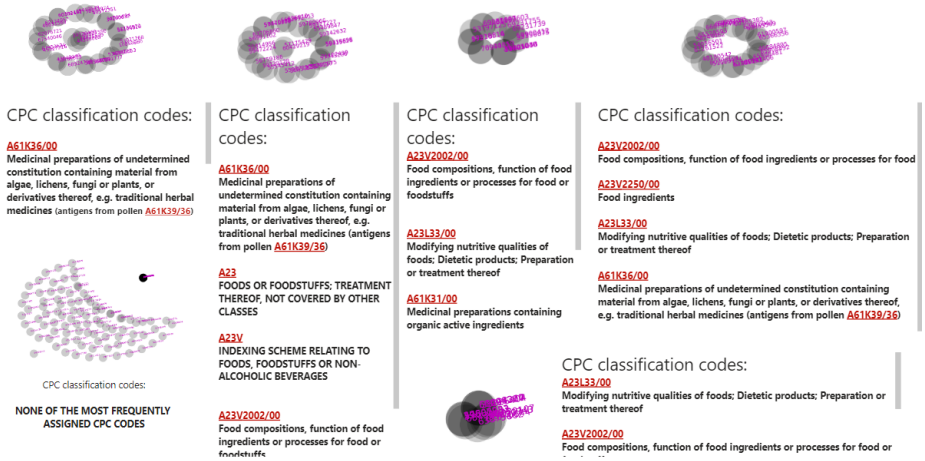




Some of the most frequently assigned IPC classification codes have been evidenced also in other sectors (such as the "Pharmaceutics"), however in most cases the presence of codes dealing with food composition and in particular the modification of the nutritive qualities is meaningful in the "Nutraceuticals" sector:

A23L1/00, referring to **FOODS, FOODSTUFFS, OR NON-ALCOHOLIC BEVERAGES, NOT COVERED BY SUBCLASSES A23B - A23J; THEIR PREPARATION OR TREATMENT, e.g. COOKING, MODIFICATION OF NUTRITIVE QUALITIES, PHYSICAL TREATMENT (shaping or working, not fully covered by this subclass, A23P); PRESERVATION OF FOODS OR FOODSTUFFS, IN GENERAL.**
A23L17/00, referring to **Food-from-the-sea products; Fish products; Fish meal; Fish-egg substitutes; Preparation or treatment thereof.**
A23L33/00, referring to **Modifying nutritive qualities of foods; Dietetic products; Preparation or treatment thereof**
A61P3/00, referring to **Drugs for disorders of the metabolism.**
(For the IPC codes A61K8, A61K31, A61K35, A61K36, pls. refer to the "Cosmetics" of "Pharmacology" sectors).

Figure 90 Nutraceuticals: clustering of the patent families based on the identification of patterns of CPC classification codes



In addition to CPC classification codes equivalent to several IPC classification codes already mentioned, among the specific CPC classification codes there is also the **A23V2002/00** (**Food compositions, function of food ingredients or processes for food or foodstuffs**).

The co-occurrence of two IPC or CPC classification codes identifying single patents families is consistent with the clustering data shown above and add further detail about the subgroups. A significant number of patent families is associated with the CPC code **A23V2002/00**, as evident from Figure 91.

Figure 91 Nutraceuticals: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

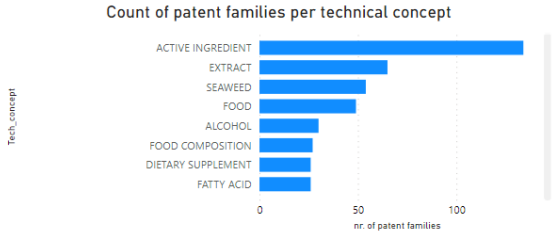
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
113	A61K 36/02	A23L 1/30
63	A61K 36/03	A23L 33/105

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
101	A61K 36/03	A23V2002/00
99	A23V2002/00	A23L 33/105

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 92.

Figure 92 Nutraceuticals: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
1574510	METHOD FOR PRODUCING A FOOD SUPPLEMENT MADE OF ESSENTIAL FORM
7694085	COMPLEX ANTIOXIDANT PREPARATION
7787326	Preparation for oral delivery of pharmaceutical or nourishing materials
8041443	Mittel als Fischersatzzubereitung
8869389	Product for inducing synthesis of stress protein, useful as food or cosme protection against heat shock, contains extract of red algae
9598215	Procédé pour l'obtention de produits destinés à remédier aux ?ences ali éléments
10806981	Calcareous material
10850860	Antiviral composition



docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
1574510	ESSENTIAL OIL	POWDER	FOOD SUPPLEMENT	DIETARY SUPPLEMENT	METHOD MILKING STALL	POWDER FOOD SUPPLEMENT	ALGA ESSENTIAL OIL	ALGAE ESSENTIAL OIL	CENTRIFUGATION
7694085	CITRUS RUTIN	ORALLY INGESTIBLE CAPSULE	FRUIT POWDER ROSEHIP	CIGARET CARTON DIMENSION	SEAWEED FLOUR	CIGARET CARTON	INGESTIBLE CAPSULE	SEAWEED POWDER	VITAMIN ACETATE
7787326	SILICA	ALGAE	LIME	FOOD SUPPLEMENT	ORALLY ADMINISTERED DRUG	ORAL ADMINISTRATION	POWDERED DRUG	LITHOGRAPHIC THAM	SPIRULINA PLATENSIS
8041443	FATTY ACID	IODINE	AGENT FISHERMAN	DIETARY SUPPLEMENT	MEDICAMENT	OMEGA FATTY ACID	POLYUNSATURATED DIETARY SUPPLEMENT	SOLID	NATURAL ORIGIN
8869389	PHYSIO PATHOLOGICAL ATTACK	CELL PROTECTION	GENUS PORPHYRA	RED ALGA EXTRACT	SPECIES LAVER UMBILICAL	GENUS LAVER RED ALGAE	FILTRATION STERILIZATION	RED ALGAE PORPHYRA	LAVER RED ALGAE EXTRA

3.a KEYPOINTS

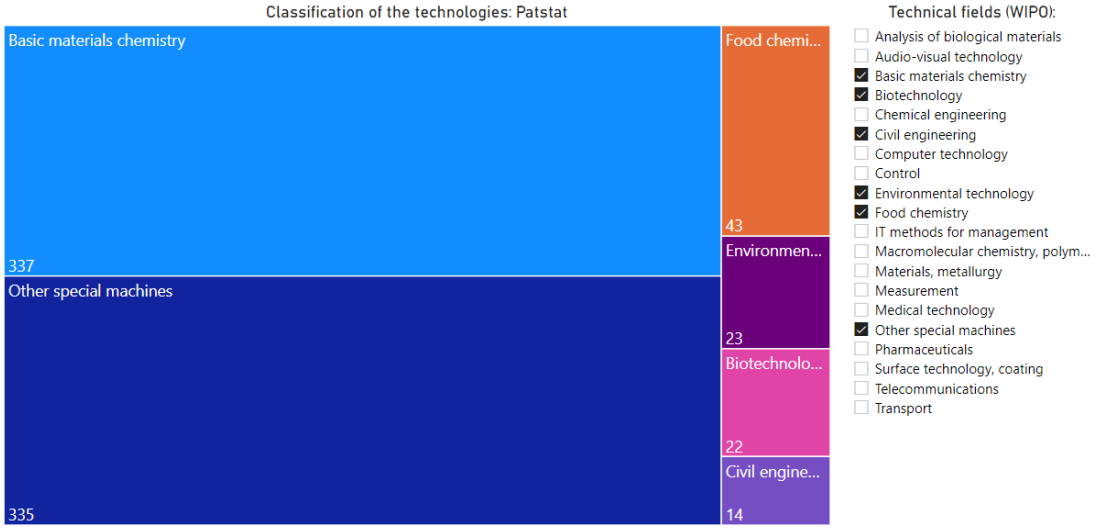
- As far as the analysis of the technologies of the sub-sectors “Cosmetics”, “Pharmaceutics” and “Nutraceuticals” are concerned, the IPC/CPC classification codes A61K31/00, referring to Medicinal preparations containing organic active ingredients and A61K36/00, referring to Medicinal preparations of 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 "Pharmaceutics" 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.

b) Agriculture, Livestock, Food processing → Soil fertilization

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 93.

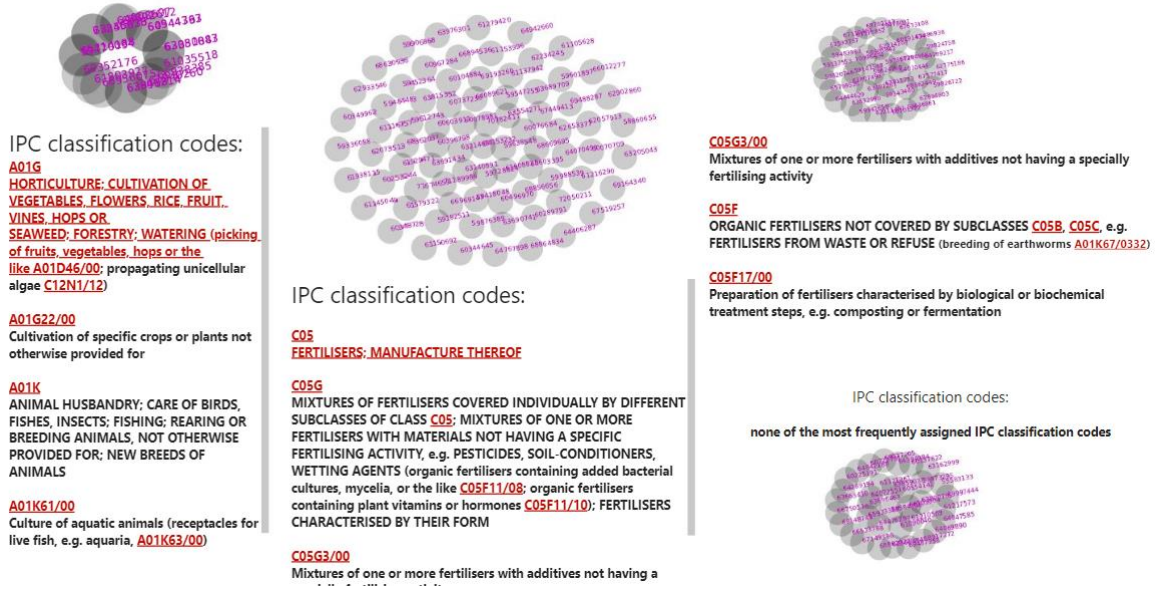
Figure 93 Soil fertilization: Map of the technology fields defined by WIPO



The evaluation based on the WIPO technology fields highlights that most patent families are dealing with the basic materials chemistry, however a more detailed picture may be produced upon clustering the patent documents according to the assignment of the IPC/CPC classification codes.

The following figure (Figure 94) shows the patterns of IPC classification codes:

Figure 94 Soil fertilization: clustering of the patent families based on the identification of patterns of IPC classification codes



The most representative IPC codes include:

A01G22/00, referring to **Cultivation of specific crops or plants not otherwise provided for**
C05B3/00, referring to **Fertilisers based essentially on di-calcium phosphate (C05B11/00 takes precedence)**
C05F17/00, referring to **Preparation of fertilisers characterised by biological or biochemical treatment steps, e.g. composting or fermentation**
A not negligible number of patent families are characterized by the simultaneous presence of the IPC A01G22/00 plus the following: **A01K61/00** (**Culture of aquatic animals**).

The co-occurrence of two IPC or CPC classification codes identifying single patents families is consistent with the clustering data shown above and add further detail about the subgroups (Figure 95).

Figure 95 Soil fertilization: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

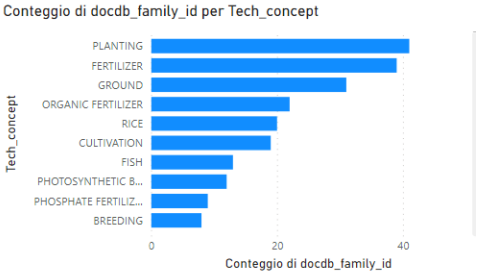
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
120	C05G 3/80	C05G 3/00
48	C05G 3/00	C05F 17/00
47	C05G 3/80	C05F 17/00
43	C05G 3/00	A01C 21/00
43	C05G 3/60	C05G 3/00
39	C05G 3/80	C05G 3/60
38	C05G 1/00	A01C 21/00
34	A01G 17/00	A01C 21/00
34	C05G 3/80	A01C 21/00
33	A01C 21/00	A01B 79/02
30	C05G 3/00	A01G 17/00

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
92	C05G 3/80	C05G 3/00
57	Y02W 30/40	C05F 17/00
47	C05G 3/00	C05B 7/00
41	Y02W 30/40	C05G 3/80
39	Y02A 40/81	A01K 61/10
37	Y02W 30/40	C05G 3/00
33	C05G 3/80	C05F 17/00
32	C05G 3/80	C05B 7/00
31	C05G 3/60	C05G 3/00
30	C05G 3/80	C05B 17/00
29	C05G 3/00	A01C 21/005

For example, among the IPC codes, the **C05G3/80** subgroup (Mixtures of one or more fertilisers with additives not having a specially fertilising activity) is frequently assigned. Among the CPC codes, the **Y02W30/40** is also quite frequently assigned and identifies the technologies for solid waste management, namely the bio-organic fraction processing and production of fertilisers from the organic fraction of waste or refuse. A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 96.

Figure 96 Soil fertilization: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
46581214	composição, método de biorremediação de um sítio, métodos para afetar crescimento uma superfície e um fluido, para preparar um artigo, um suplemento alimentar, e uma para suplementação de alimento, e, artigo
48781787	MULTI-PURPOSE LIGNIN-CARBOHYDRATE BINDING SYSTEM
50826969	composição de remediação do solo e estabilização de poros do solo e método de apri estrutura do solo
55583133	Targeted irrigation using a central pivot irrigation system with a sensor network
57351074	fertilizante de retenção de água polimérico orgânico-inorgânico, e, método para prepa fertilizante de retenção de água polimérico orgânico-inorgânico
58584796	Water body treatment construction and maintenance method and artificial lake
58842803	Factory-like rice-livestock-vegetable all-year circulation mechanized production metho



docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
46581214	MICROBIAL CULTURE	CULTURE MEDIUM	SUPPLEMENT MICROORGANISM METABOLISM	MICROORGANISM ENZYMATIC PATHWAY	BROWN PATCH ELIMINATION	MICROORGANISM	MICROBIAL CULTURE MICROORGANISM	INOCULATED MEDIUM	RHODOPSEUDOMON
48781787	GRANULE	FORMULATION	SUGAR ALCOHOL MIXTURE	RESISTANT GRANULE	CRUSH RESISTANT GRANULAR FERTILIZER	SOIL MOISTURE ENHANCER	LIGNOSULFONATE	MONOSACCHARIDE	SILICATE STRENGTHE
50826969	SOIL REMEDIATION	CNB	SOIL REMEDIATION	PORE CONNECTIVITY	POROSITY	SOIL PORE CONNECTIVITY	SYNTHESIZING ANIONIC ACRYLIC COPOLYMER	ETHOXYLATED QUATERNARY AZANIUM COMPOUND	HYDROLYZED CELLUL
55583133	CENTRAL PIVOT IRRIGATION	TARGETED IRRIGATION	SENSOR NETWORK	IRRIGATION SCHEDULE	WIRELESS MOTE	WHEELED FRAMED TOWER	VEGETATION DATA	FISH EYE LENS	CROP SPECTRALLY DI
57351074	ORGANIC	INORGANIC	BIOLOGICAL	PREPOLYMER	CROSSLINKING	COPOLYMER	MODIFYING AGENT	COPOLYMERIZATIO	BONE MEAL

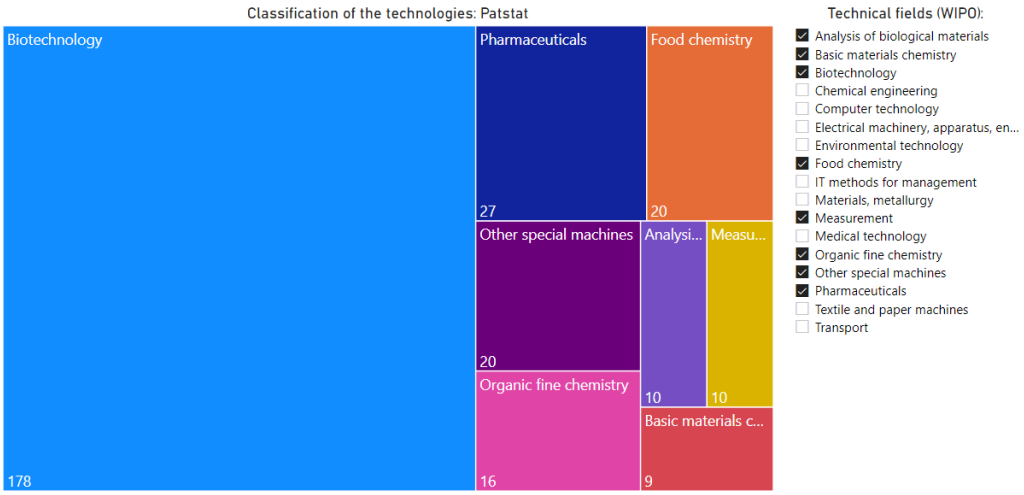
3.b KEYPOINTS

- 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.

c) Industrial processes and manufacturing → Sea organisms' genetics

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 97.

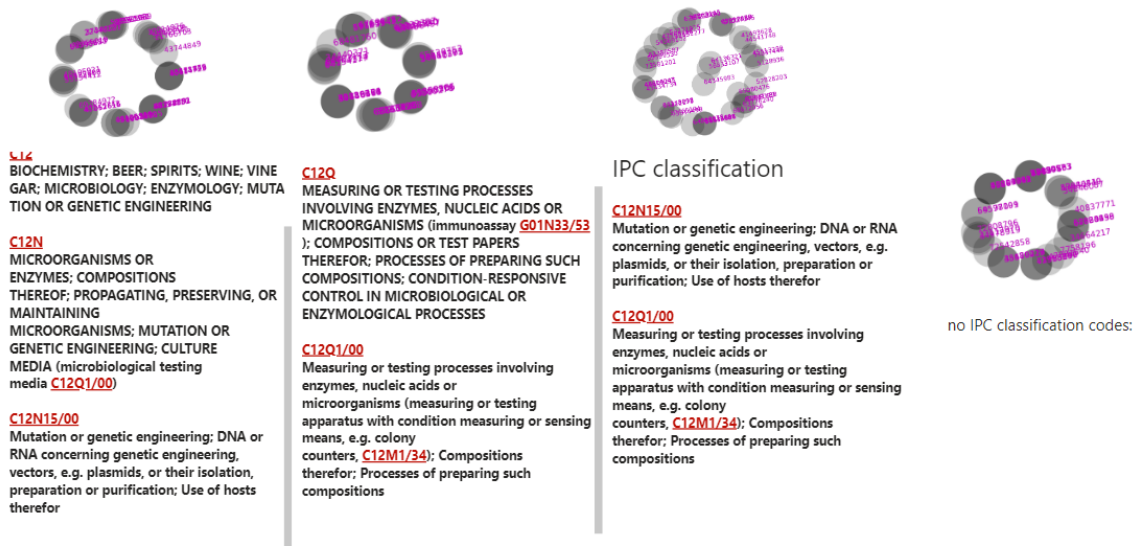
Figure 97 Sea organisms' genetics: Map of the technology fields defined by WIPO



As expected, the evaluation based on the WIPO technology fields highlights that most patent families are dealing with the Biotechnology sector, however a more detailed picture may be produced upon clustering the patent documents according to the assignment of the IPC/CPC classification codes.

The following figure (Figure 98) shows the patterns of IPC classification codes:

Figure 98 Sea organisms' genetics: clustering of the patent families based on the identification of patterns of IPC classification codes



The most representative IPC codes include:

C12N15/00, referring to **Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor…**

C12Q1/00, referring to **Measuring or testing processes involving enzymes, nucleic acids or microorganisms.**
The co-occurrence of two IPC or CPC classification codes identifying single patents families is consistent with the clustering data shown above and add further detail about the subgroups (Figure 99).

Figure 99 Sea organisms' genetics: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
18	C12Q 1/68	C12N 15/11
17	C12N 15/63	C12N 1/21
14	C12N 1/21	C12N 1/19
14	C12Q 1/6888	C12N 15/11
12	C12N 5/10	C12N 1/19
12	C12N 5/10	C12N 1/21
12	C12N 15/63	C12N 1/19
12	C12N 15/63	C12N 5/10
11	C12N 15/12	C07K 14/435
10	C12N 1/19	C12N 1/15
10	C12N 1/21	C12N 1/15
10	C12N 5/10	C12N 1/15
10	C12N 15/63	C12N 15/12

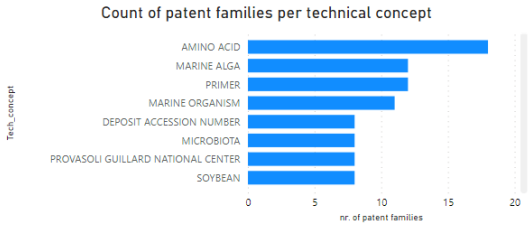
NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
18	C12Q2600/156	C12Q 1/6888
7	C12Q2600/124	C12Q 1/6888
6	C12Q2600/156	C12Q2600/124
5	C12Q 1/6888	C12Q 1/686
4	A01K2227/40	A01K 67/0275
3	A01K2267/02	A01K2227/40
3	C07K 14/43504	A61K 38/00
3	C12Q 1/66	C12N 9/0069
3	C12Q2600/156	C12Q 1/6858
3	C12Q2600/158	C12Q 1/6888
2	A01K2217/05	A01K 67/0275
2	A01K2227/40	A01K2217/05
2	A01K2267/02	A01K 67/0275

Indeed, codes such as C12Q1/68 (**Measuring or testing processes involving enzymes, nucleic acids or microorganisms → involving nucleic acids**), C12Q1/6888 (**Measuring or testing processes involving enzymes, nucleic acids or microorganisms → involving nucleic acids → for detection or identification of organisms**), C12Q2600/156 (**Oligonucleotides characterized by their use → Polymorphic or mutational markers**) and C12N15/63 (**Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor → Introduction of foreign genetic material using vectors; Vectors; Use of hosts therefor; Regulation of expression**) appear assigned to a significant number of patent families.

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 100.

Figure 100 Sea organisms' genetics: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
4658270	Production of oral vaccine and antibiotic peptide active matter by using algae
4749980	Method for producing wine for modulating immune from gene of ancie sea
5128936	Method for generating and screening novel metabolic pathways
7671106	Fremgangsmåde til fremstilling af polyumættede fedtsyrer, nye biosynte vegetabilske ekspressionskonstrukter
7758196	Processing waste organic materials for fuel cells and for mfg. biogas
10854767	Antibegroningssammensætning
10866404	A process for producing antifreeze peptides
17177845	INSULIN-LIKE GROWTH FACTOR-I



docdb_family_id	Tech_concept #1	Tech_concept #2	Tech_concept #3	Tech_concept #4	Tech_concept #5	Tech_concept #6	Tech_concept #7	Tech_concept #8	Tech_concept #9
4658270	SALINA CELL	ALGAE	GENE GUN	ELECTRICAL SHOCK	ORAL VACCINE	TRANSGENIC SALINE ALGAE	ACTIVE MATTER	ANTIBIOTIC PEPTIDE ACTIVE MATTER	FOREIGN GENE PRODUCT
4749980	DEEP SEA ANCIENT	DEEP SEA ANCIENT OREANISM	MARINE MICROALGAE SPECIES	WINE PRODUCTION	IMMUNOMODULATING WINE PRODUCTION	WINE PRODUCTION	FINISHED WINE	MICROALGAE SPECIES	MICROSTEP BIOCONVERSION
5128936	METABOLIC PATHWAY	CONSTRUCTING EXPRESSION	PATHWAY GENE EXPRESSION LIBRARY	SCREENING	COMBINATORIAL CHIMERIC PATHWAY	DNA CDNA	ORGANISM DNA CDNA GENOME	GENOMIC DNA CDNA	STREPTOMYCES LIVIDAN
7671106	FATTY ACID	NUCLEIC ACID	POLYUNSATURATED FATTY ACID	DOUBLE BOND	FATTY ACID ESTER	NUCLEIC ACID ISOLATION	BIOSYNTHESIS	INCREASED CONTENT	DELTA
7758196	REACTOR	FUEL CELL	METAL	OXYGEN	ENERGY	B SIDE	BIOMASS	SULFATE	COAL
10854767	ANTIFOULING COMPOUND	COATING SURFACE	ENZYME	MUSSEL DEGRADATION	MARINE ANTIFOUL	MICROBIAL CONTAMINATION	PEROXOL SUSTAINED RELEASE	OLIGOMER	OXIDASE

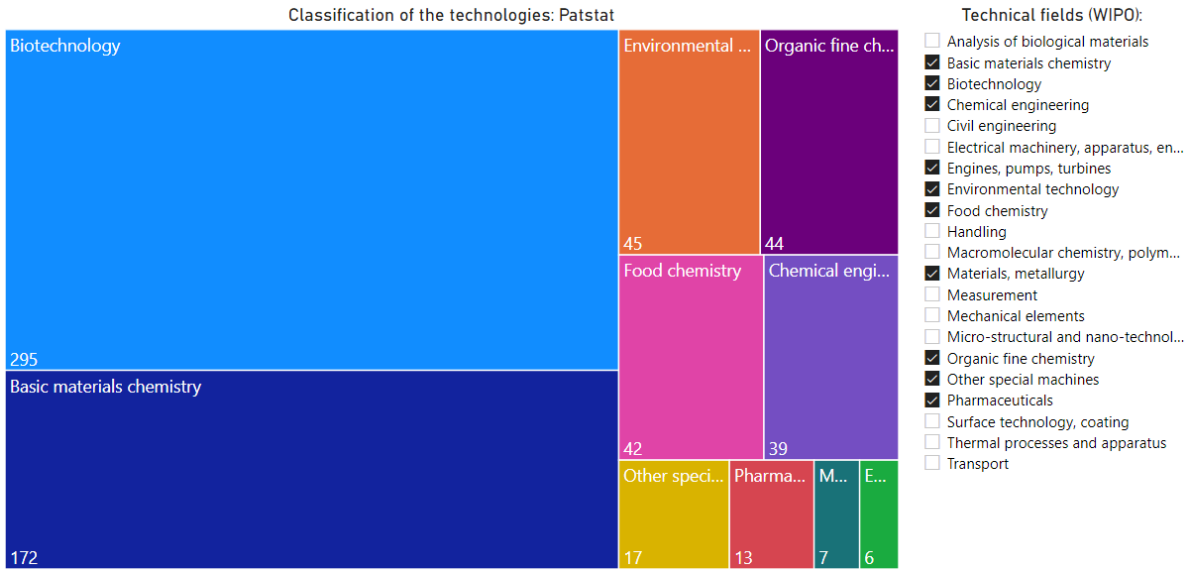
3.c KEYPOINTS

- 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.

d) Biofuels

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 101.

Figure 101 Biofuels: Map of the technology fields defined by WIPO

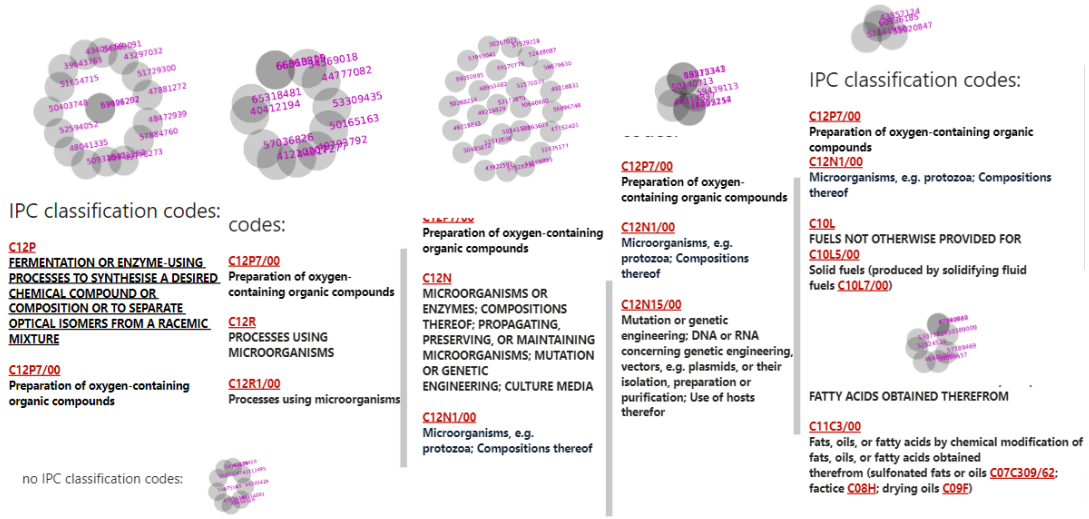


Although the classification based on the definition provided by WIPO about the technology fields may be not detailed, both in the case of the sea organisms' genetics and in the case of the biofuels most patent families are grouped within the Biotechnology technical field, which immediately highlights an industrial sector that can benefit from the exploitation of biotechnological techniques.

However, a more detailed picture may be produced upon clustering the patent documents according to the assignment of the IPC/CPC classification codes.

The following figure (Figure 102) shows the patterns of IPC classification codes:

Figure 102 Biofuels: clustering of the patent families based on the identification of patterns of IPC classification codes



As expected, several IPC codes refer to the production of oils, as the following ones:

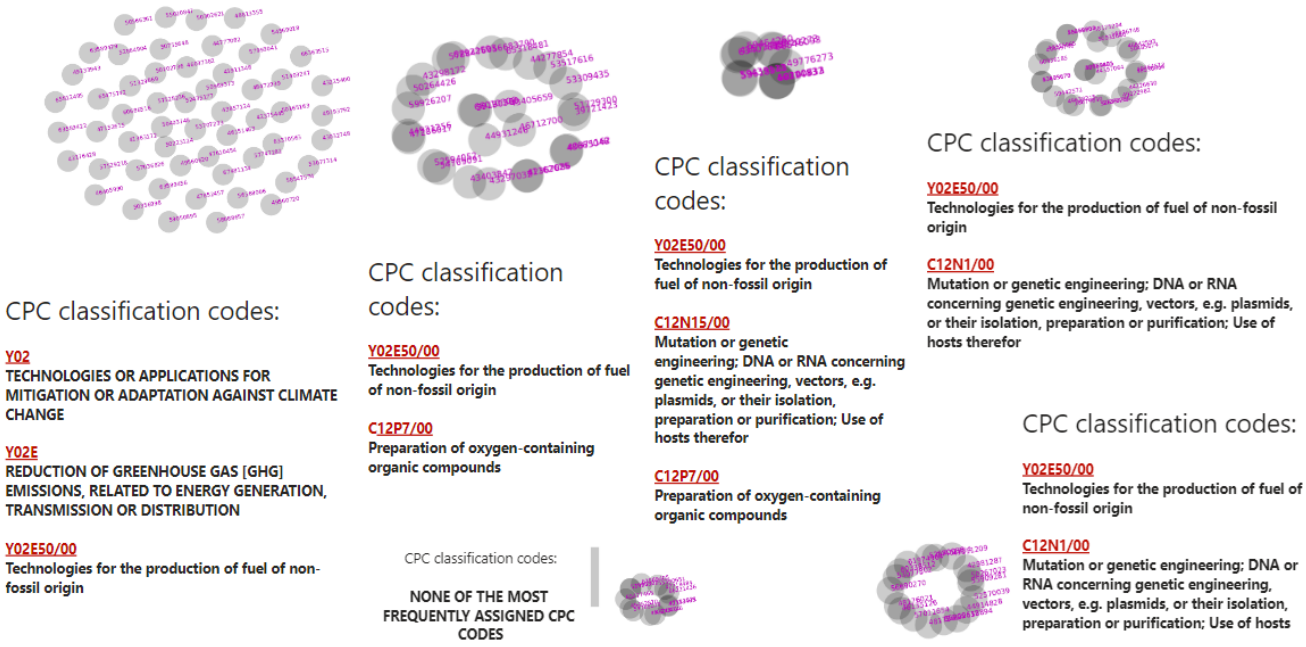
C10L5/00, referring to **Solid fuels (produced by solidifying fluid fuels C10L7/00).**
C10L1/00, referring to **Liquid carbonaceous fuels.**
C11B1/00, referring to **PRODUCING, e.g. BY PRESSING RAW MATERIALS OR BY EXTRACTION FROM WASTE MATERIALS, REFINING OR PRESERVING FATS, FATTY SUBSTANCES, e.g. LANOLIN, FATTY OILS OR WAXES; ESSENTIAL OILS; PERFUMES (drying-oils C09F).**
C11C3/00, referring to **Fats, oils, or fatty acids by chemical modification of fats, oils, or fatty acids obtained therefrom**…

Additional IPC codes may refer to biotechnology processes based on the use of microorganisms, as in the following cases:

C12P7/00, referring to **FERMENTATION OR ENZYME-USING PROCESSES TO SYNTHESISE A DESIRED CHEMICAL COMPOUND OR COMPOSITION OR TO SEPARATE OPTICAL ISOMERS FROM A RACEMIC MIXTURE → Preparation of oxygen-containing organic compounds.**
C12R1/00, referring to **Processes using microorganisms**.
C12N1/00, referring to **Microorganisms, e.g. protozoa; Compositions thereof**.
C12N15/00, referring to **Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor.**

The following figure (Figure 103) shows the patterns of CPC classification codes:

Figure 103 Biofuels: clustering of the patent families based on the identification of patterns of CPC classification codes



As expected, several CPC codes refer to the production of oils, being there a specific CPC classification code such as **Y02E50/00** referring to **Technologies for the production of fuel of non-fossil origin**.

The co-occurrence of two IPC or CPC classification codes identifying single patents families is consistent with the clustering data shown above and add further detail about the subgroups (Figure 104).

Figure 104 Biofuels: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

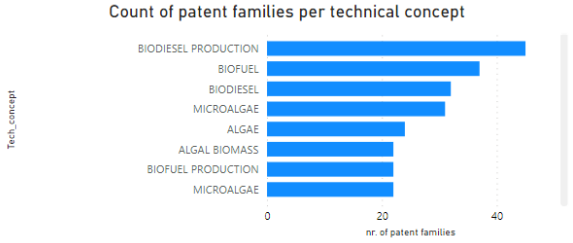
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
98	C12P 7/64	C12N 1/12
64	C12R 1/89	C12P 7/64
49	C12R 1/89	C12N 1/12
33	C12P 7/64	C10L 1/02
25	C12P 7/64	C12P 7/06
23	C11B 1/10	C10L 1/02
22	C12P 7/64	C11B 1/10
22	C12P 7/64	C12M 1/00
21	C12P 7/16	C12P 7/06
19	C12N 1/12	C12M 1/00
18	C12P 7/64	C12P 5/02
17	C11C 3/10	C10L 1/02
17	C12P 7/06	C12P 5/02
16	C12P 7/06	C12N 1/12
14	C11B 1/10	C11B 1/04

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
131	Y02E 50/10	C12P 7/649
96	Y02E 50/10	C12N 1/12
66	C12P 7/649	C12N 1/12
65	Y02P 30/20	Y02E 50/10
57	Y02E 50/10	C12P 7/6463
51	Y02E 50/10	C10L 1/026
51	Y02E 50/30	Y02E 50/10
36	C12P 7/649	C12P 7/6463
36	Y02E 50/10	C12R 1/89
35	Y02P 30/20	C10L 1/026
32	Y02E 50/10	C12M 21/02
32	Y02E 50/10	C12P 7/06
31	Y02E 50/10	C11B 1/10
31	Y02P 30/20	C12P 7/649
30	C12R 1/89	C12N 1/12

Additional details are provided by the above scheme, for example the use of the IPC classification code C12P7/64 implies that the fermentation procedures based on the production of oxygen-based compounds specifically **refers to the production of Fats; Fatty oils; Ester-type waxes; Higher fatty acids**, i.e. **having at least seven carbon atoms in an unbroken chain bound to a carboxyl group**; **Oxidised oils or fats**. A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 105.

Figure 105 Biofuels: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
28050253	Method for preparing biology diesel oil by using fast pyrolysis of tiny alg
37772438	Closed system bioreactor apparatus
37896050	System, devices, and methods for biomass production
38667443	INTEGRATED PHOTOBIOREACTOR-BASED POLLUTION MITIGATION AND PROCESSES AND SYSTEMS
39330688	SYSTEMS AND PROCESSES FOR CELLULOSIC ETHANOL PRODUCTION
39365825	METHOD FOR GROWING PHOTOSYNTHETIC ORGANISMS
39496716	System and method for biological wastewater treatment and for using th thereof
39563166	Diffuse light extended surface area water-supported photobioreactor
39584530	Integrated processes and systems for production of biofuels using algae



docdb_family_id	Tech_concept #1	Tech_concept #2	Tech_concept #3	Tech_concept #4	Tech_concept #5	Tech_concept #6	Tech_concept #7	Tech_concept #8	Tech_concept #9
28050253	FAST PYROLYSIS	MICROALGAE	GAS	BIODIESEL	PYROLYSIS	BIODIESEL PRODUCTION	LIQUID	SEPARATION	FAST PYROLYSIS N
37772438	ALGAE	BIODIESEL PRODUCTION	JP	ALGAE	TUBE	MEDIUM	BIODIESEL PRODUCTION	CLOSED SYSTEM	FLEXIBLE TUBE
37896050	BIOREACTOR	PHOTOSYNTHETIC ORGANISM	PHOTOSYNTHETIC ORGANISM CULTIVATION	BIOMASS PRODUCTION	CHAMBER ISOLATION	CULTIVATION MEDIA	BIOMASS	PHOTOSYNTHETIC ORGANISM DENSITY	CULTIVATE BIOMA
38667443	BIOMASS PRODUCTION	PHOTOTROPHIC ORGANISM SPECIES	GAS TREATMENT	GAS REMEDIATION	INTEGRATED OIL PROCESSING	OIL PRODUCTION INTEGRATION	PHOTOTROPHIC ORGANISM	PHOTOBIOREACTOR	GAS HEADSPACE
39330688	HYDROLYZED CELLULOSE STREAM	FUEL ALCOHOL	BIODIESEL	CELLULOSE	PROCESS INTEGRATION	CELLULOSE STREAM	PHYLUM NEOCALLIMASTIGO MYCOTA	CELLULOSIC TISSUE ORGANIC BREAKDOWN	RAW CELLULOSE
39365825	GROWING	IN-	FATTY ACID	BIOFUEL	GROWING	PHOTOSYNTHETIC	MICROALGAE	MARINE	CO

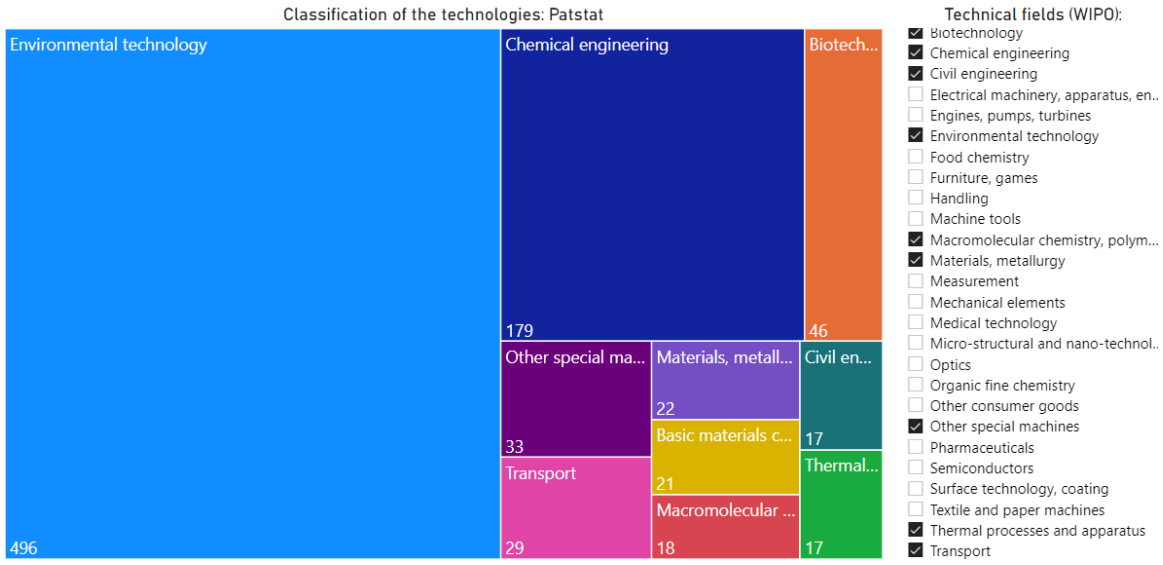
3.d KEYPOINTS

- 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.

e1) Bio-monitoring and bio-remediation → Seawater purification

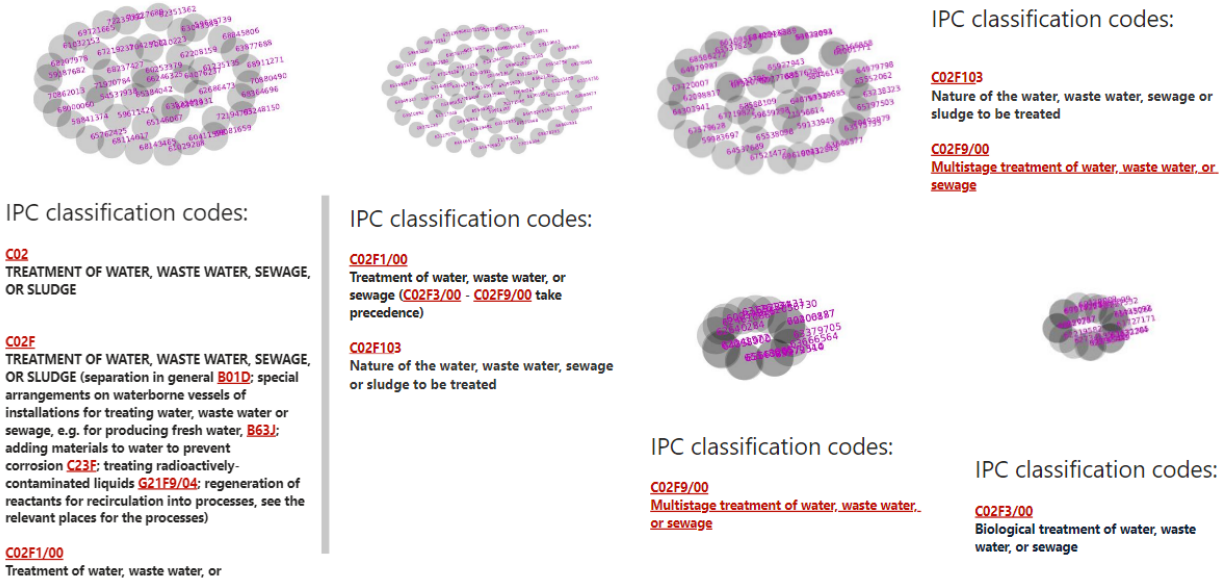
The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 106.

Figure 106 Seawater purification: Map of the technology fields defined by WIPO



As expected, the Environmental technology field is prevalent, followed by Chemical Engineering. To increase the granularity of such information it may be worth considering the clustering of the patent documents by means of the IPC/CPC classification codes patterns, as in Figure 107 (IPC codes) and in Figure 108 (CPC codes).

Figure 107 Seawater purification: clustering of the patent families based on the identification of patterns of IPC classification codes



IPC classification codes:

C02F1/00Treatment of water, waste water, or sewage (C02F3/00 - C02F9/00 take precedence)

B01
PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL

B01D
SEPARATION (separating solids from solids by wet methods....

B01D61/00
Processes of separation using semi-permeable membranes, e.g. dialysis, osmosis, ultrafiltration; Apparatus, accessories or auxiliary operations specially adapted therefor

IPC classification codes:

C12N1/00
Microorganisms, e.g. protozoa; Compositions thereof

C02F101
Nature of the contaminant

C02F3/00
Biological treatment of water, waste water, or sewage

C12R1/00
Processes using microorganisms

IPC classification codes:

C02F1/00Treatment of water, waste water, or sewage (C02F3/00 - C02F9/00 take precedence)

C02F101
Nature of the contaminant

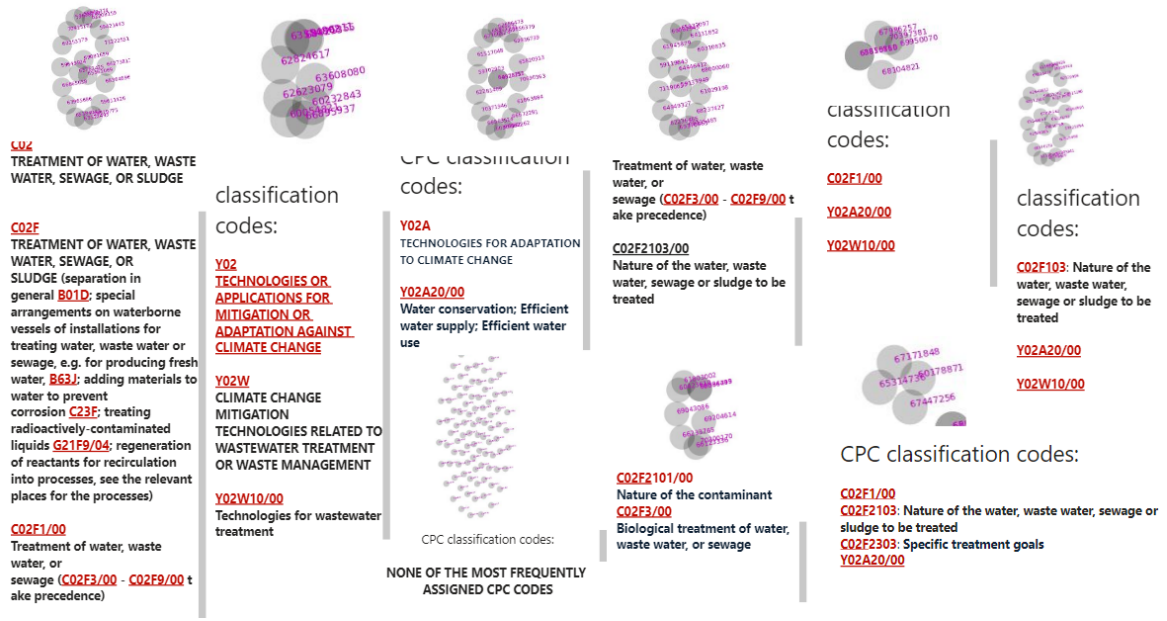
C02F3/00
Biological treatment of water, waste water, or sewage

C12R1/00
Processes using microorganisms

As expected, several IPC codes refer to the purification treatment of water, as the following ones:

C02F1/00, referring to **Treatment of water, waste water, or sewage (C02F3/00 - C02F9/00 take precedence).**
C02F103/00, referring to **Nature of the water, waste water, sewage or sludge to be treated.**
C02F9/00, referring to **Multistage treatment of water, waste water, or sewage.**
C02F3/00, referring to **Biological treatment of water, waste water, or sewage.**
C12R1/00, referring to **Processes using microorganisms.**
C12N1/00, referring to **Processes using microorganisms.**

Figure 108 Seawater purification: clustering of the patent families based on the identification of patterns of CPC classification codes



Excluding the CPC codes equivalent to the IPC classification codes already highlighted above, the following ones are specific as far as the CPC classification is concerned:

Y02W10/00, referring to **Technologies for wastewater treatment.**
Y02A20/00, referring to **Water conservation; Efficient water supply; Efficient water use**.
C02F2303/00, referring to **TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE → Specific treatment goals.**

The co-occurrence of two IPC or CPC classification codes identifying single patents' families is consistent with the clustering of data shown above and add further detail about the subgroups (Figure 109).

Figure 109 Seawater purification: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

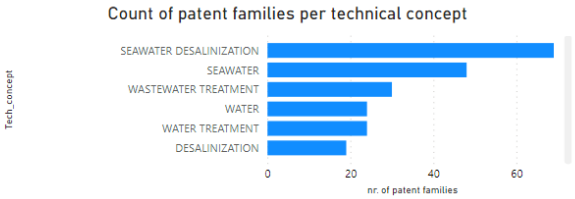
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
31	C02F 103/08	C02F 1/44
29	C12N 1/20	C02F 3/34
28	C02F 1/44	B01D 67/00
24	C12R 1/01	C12N 1/20
23	C12R 1/01	C02F 3/34
21	C02F 103/08	C02F 3/34
19	C02F 103/08	C02F 1/04
18	C02F 103/08	C02F 1/14
17	C02F 1/44	B01D 65/02
16	C02F 1/28	B01J 20/30
16	C02F 103/20	C02F 103/08

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
52	C02F 9/00	C02F 1/001
38	C02F2103/08	C02F 1/001
34	C02F2103/08	C02F 9/00
29	Y02A 20/124	C02F2103/08
28	C02F2301/08	C02F 9/00
27	C02F 9/00	C02F 1/441
25	Y02A 20/131	C02F2103/08
23	C02F2301/08	C02F 1/001
22	C02F2103/08	C02F 1/441
20	Y02A 20/212	C02F 1/14
19	C02F 1/441	C02F 1/001

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 110.

Figure 110 Seawater purification: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
41797806	CHROMATOGRAPHY MEMBRANES DEVICES CONTAINING THEM AND M THEREOF
44201162	CPVC PIPES, FITTINGS AND TUBULAR CONDUITS IN MARINE VESSELS
45592809	Containers, bottles, drums, vats, and tanks having a slippery surface
47045153	DESALINATION SYSTEM AND METHOD
47439052	Depth Filters For Disposable Biotechnological Processes
47756037	Desalination system and desalination method
48536736	IMPROVED MEMBRANES
48905805	FILTRATION MEMBRANES AND RELATED COMPOSITIONS, METHODS AN
49919888	SLIPPERY LIQUID-INFUSED POROUS SURFACES AND BIOLOGICAL APPLI
50272815	SYSTEM FOR WATER EXTRACTION

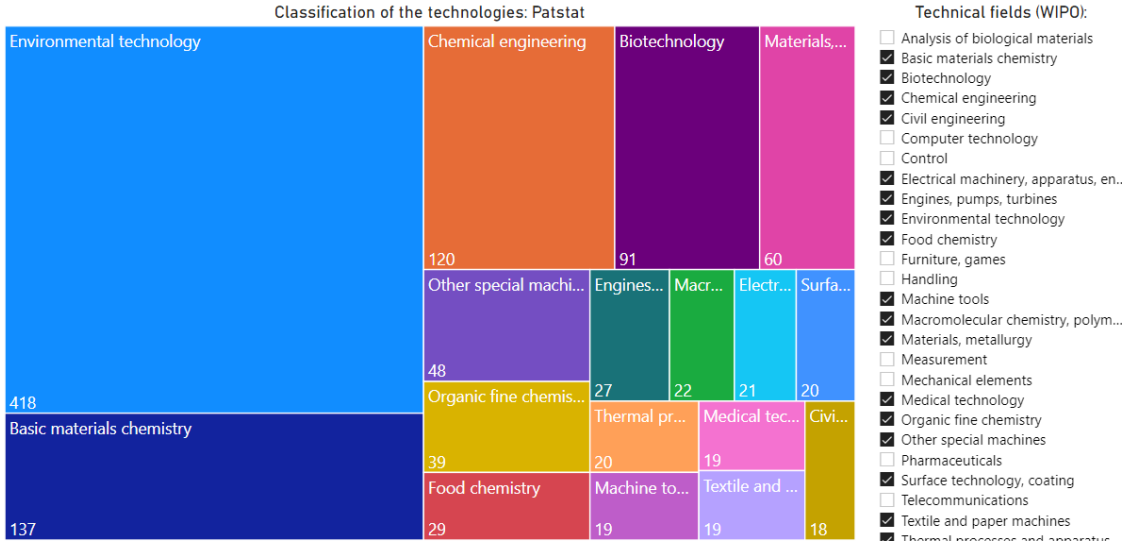


docdb_family_id	Tech_concept #1	Tech_concept #2	Tech_concept #3	Tech_concept #4	Tech_concept #5	Tech_concept #6	Tech_concept #7	Tech_concept #8	Tech_concept #9
41797806	FLUID	SUBSTANCE	NATURAL ORIGIN	MEMBRANE CHROMATOGRAPHY	RECOMBINANT HUMAN INTERLEUKIN	IMINODIACETIC ACID LIGAND	METAL AFFINITY LIGAND	BIOLOGICAL ION	ANIMAL ORIGIN
44201162	FITTING	MARINE VESSEL	BLACK WATER	CPVC PIPE	DRAIN	FTP CODE TOXICITY REQUIREMENT	TUBULAR CONDUIT	CPVC PIPING	MARINE VESSEL DEMONSTRATING AB
45592809	ARTICLE	SLIPPERY SURFACE	FOREIGN MATERIAL	PRESSURE STABILITY	BXCO BX AXCO AX	OPTICAL TRANSPARENCY	STABILIZED LIQUID OVERLAYER	LIQUID LUBRICANT	CHEMICAL FUNCTIONALIZING LAYER
47045153	DESALINIZATION	DESALINIZATION CELL	AQUEOUS STREAM	REMOVING ION	DESALINIZATION CELL ELECTRODE	HARDNESS ION REMOVAL	ION EXCHANGE RESIN	ANION EXCHANGE LAYER	DESALINIZATION CELL DISCHARGING
47439052	NOMINAL PORE	DEPTH FILTER	DEPTH FILTRATION	PRIMARY CLARIFICATION	CELLULAR DEBRIS	COLLOIDAL PARTICULATE	TARGET BIOMOLECULE	CLARIFICATION CENTRIFUGATION	FEED PRIMARY CLARIFICATION

e2) Bio-monitoring and bio-remediation → Remediation

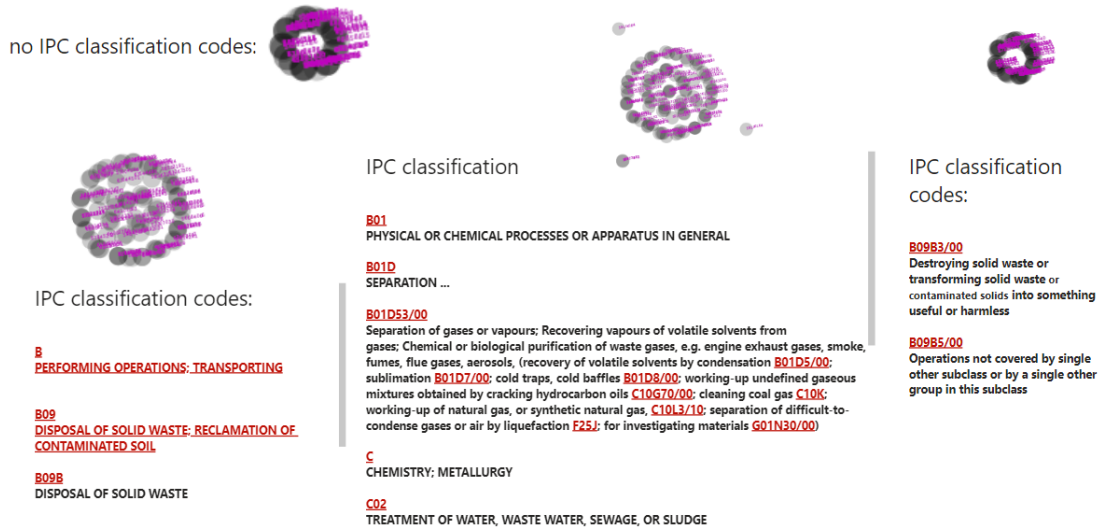
The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 111.

Figure 111 Remediation: Map of the technology fields defined by WIPO



As expected, the Environmental technology field is prevalent, followed by Basic Materials Chemistry and Chemical Engineering. To increase the granularity of such information it may be worth considering the clustering of the patent documents by means of the IPC/CPC classification codes patterns, as in Figure 112 (IPC codes) and in Figure 113 (CPC codes).

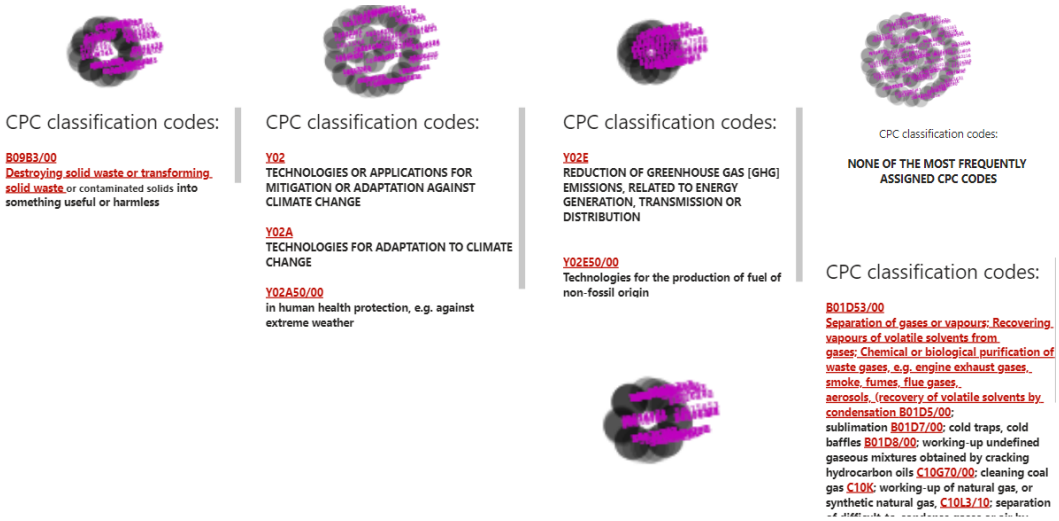
Figure 112 Remediation: clustering of the patent families based on the identification of patterns of IPC classification codes



As expected, several IPC codes refer to the purification treatment of water, as the following ones:

B09B3/00, referring to **DISPOSAL OF SOLID WASTE → Destroying solid waste or transforming solid waste or contaminated solids into something useful or harmless.**
B01D53/00, referring to **Separation of gases or vapours; Recovering vapours of volatile solvents from gases; Chemical or biological purification of waste gases, e.g. engine exhaust gases, smoke, fumes, flue gases, aerosols**.
C02F11/00, referring to **Treatment of sludge; Devices therefor.**

Figure 113 Remediation: clustering of the patent families based on the identification of patterns of CPC classification codes



Excluding the CPC codes equivalent to the IPC classification codes already highlighted above, the following ones are specific as far as the CPC classification is concerned:

Y02A50/00, referring to **TECHNOLOGIES FOR ADAPTATION TO CLIMATE CHANGE in human health protection, e.g. against extreme weather**
Y02E50/00, referring to **Technologies for the production of fuel of non-fossil origin.**

The co-occurrence of two IPC or CPC classification codes identifying single patents' families is consistent with the clustering of data shown above and add further detail about the subgroups (Figure 114).

Figure 114 Remediation: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

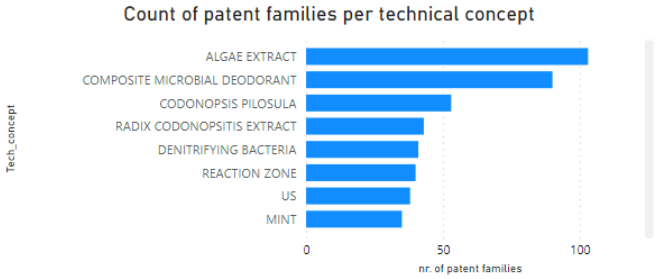
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
116	C02F 11/04	B09B 3/00
112	C02F 11/02	B09B 3/00
99	B09B 3/00	B01D 53/84
99	C02F 11/04	C02F 11/02
97	C02F 11/02	B01D 53/84
95	C02F 11/04	B01D 53/84
94	B09B 5/00	B09B 3/00
18	C02F 11/00	B09B 3/00
16	C12M 1/00	B09B 3/00
16	C12P 19/14	C12P 19/02

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
47	B09B 5/00	B09B 3/00
40	Y02A 50/20	B01D 53/84
39	C02F 11/04	B09B 3/00
38	B01D2251/95	B01D 53/84
38	B09B 3/00	B01D 53/84
38	C02F 11/02	B01D 53/84
38	C02F 11/02	B09B 3/00
38	Y02A 50/20	C02F 11/02
38	Y02E 50/30	Y02E 50/10
37	B09B 3/00	B01D2251/95

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 115.

Figure 115 Remediation: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
26869344	Methods for producing alpha-substituted carboxylic acids using nitrilase reagents
27404717	Nitralases
29552719	NITRILASE, NUCLEIC ACID ENCODING THE SAME, AND PRODUCTION A
30449761	Nitrilases, nucleic acids encoding them and methods for making and usi
35320956	ANTAGONISTIC PROPERTIES OF REEF FISH MICROFLORA
37024271	Beta-glucosidases, nucleic acids encoding them and methods for makin
39344665	ENERGY PRODUCTION WITH HYPERTHERMOPHILIC ORGANISMS
40639352	SYSTEM AND PROCESS FOR THE TREATMENT OF RAW MATERIAL
40954141	SISTEMAS Y METODOS PARA SEPARAR MATERIA PARTICULADA FINAME UNA CORRIENTE DE FLUIDO.



docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
26869344	NUCLEIC ACID	NITRILASE	SYNTHETIC	RECOMBINANT NUCLEIC ACID	ENCODING NUCLEIC ACID	POLYPEPTIDE NITRILASE	STEREOSELECTIVE ENZYME	NUCLEOTIDE	REASSORTMENT LOSS
27404717	SOIL CONDITIONING	EP	FERMENTATION SUPERNATANT	CONTAMINATED WATER	SACCHAROMYCES CEREVISIAE CULTURE	NONIONIC SURFACTANT	SURFACTANT MICROBUBBLE	ACTIVE ENZYME	ETHOXYLATED DODECYL DECANOL
29552719	NUCLEIC ACID	NITRILASE	SYNTHETIC	RECOMBINANT NUCLEIC ACID	ENCODING NUCLEIC ACID	POLYPEPTIDE NITRILASE	STEREOSELECTIVE ENZYME	NUCLEOTIDE	REASSORTMENT LOSS
30449761	NUCLEIC ACID	NITRILASE	SYNTHETIC	RECOMBINANT NUCLEIC ACID	ENCODING NUCLEIC ACID	POLYPEPTIDE NITRILASE	STEREOSELECTIVE ENZYME	NUCLEOTIDE	REASSORTMENT LOSS
35320956	MICROORGANISM	BIOFILM INHIBITING FORMATION	INHIBITING FORMATION	INHIBITING GROWTH	REEF FISH MICROFLORA	INFLAMED MUCOPERIOSTEAL LINING	BACTERIA	CANDIDA ALBICANS	PROSTATE GLAND BACTERIAL INFECTI
37024271	NUCLEIC ACID	CELLULASE	RECOMBINANT	RECOMBINANT	POLYPEPTIDE	POLYPEPTIDE	CELLOBIOHYDROLASE	GLUCOSIDASE	CELLULOSE DERIVATIVE

3.e KEYPOINTS

- 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 BLUE BIOTECHNOLOGY: THE NPL DIVULGATION FOCUSING ON THE COUNTRIES LOCATED ALONG THE MEDITERRANEAN SEA

a1) Healthcare and Pharmaceuticals → Cosmetics

The number of patent applications filed by the European residents is quite consistent and many French enterprises can be detected. However, to get a more detailed view of the Mediterranean scenario it may be worth considering that the divulgation of technical aspects through alternative means (NPL) may be widespread, being either used by enterprises or by academics. The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by Figure 116 to Figure 118, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 116 Cosmetics: data showing the national and trans-national collaborations (NPL research focusing on Italy)

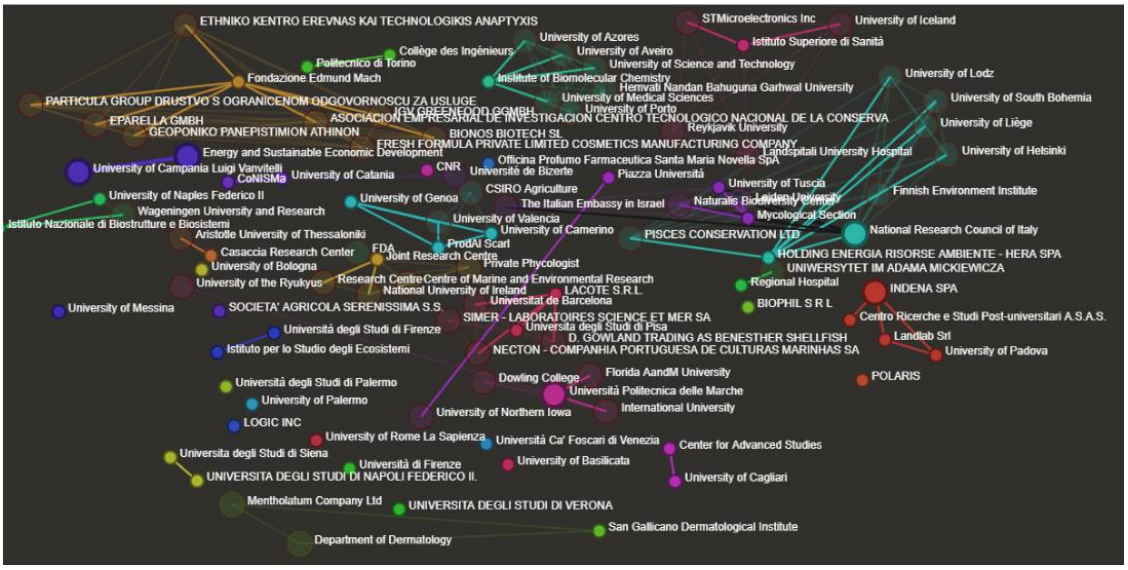


Figure 117 Cosmetics: data showing the national and trans-national collaborations (NPL research focusing on France)

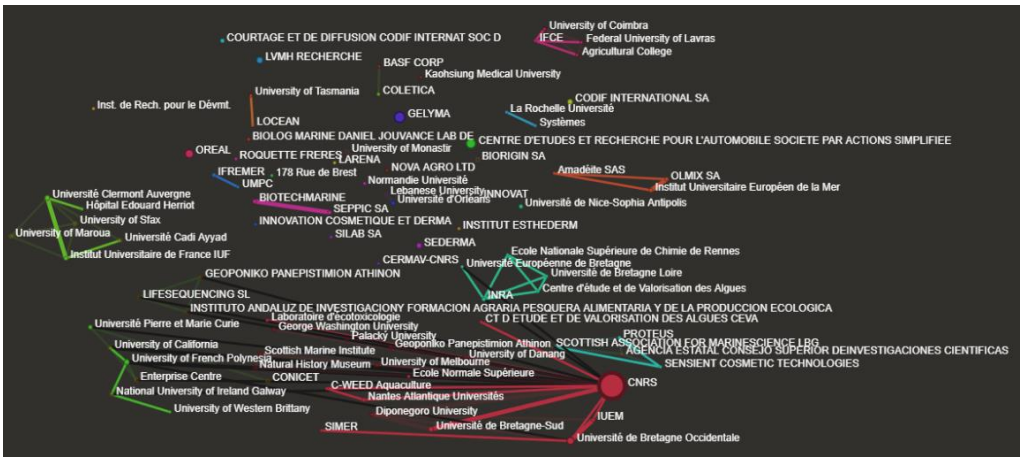
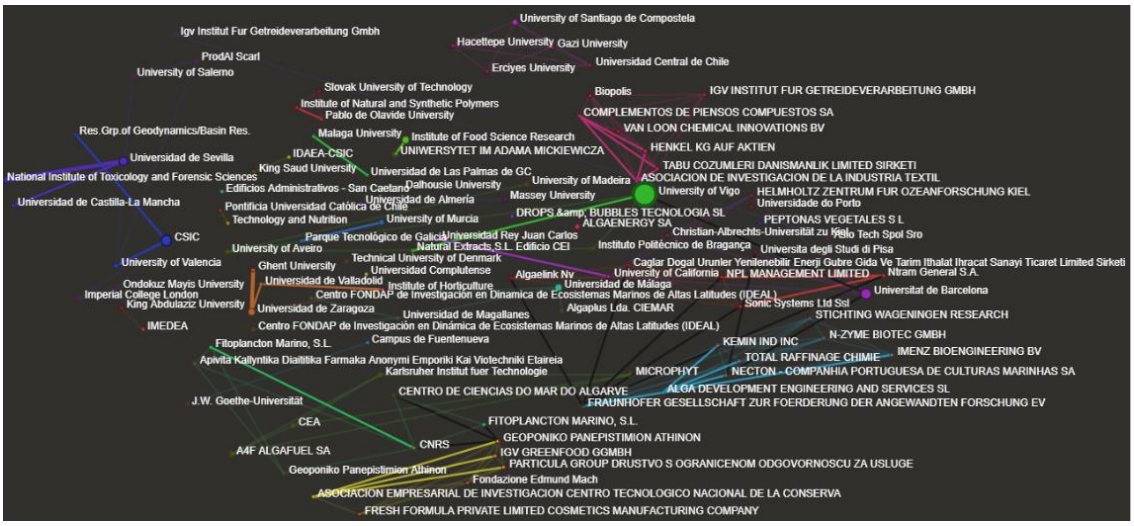


Figure 118 Cosmetics: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other European countries located along the Mediterranean Sea are concerned, namely Greece and Turkey.

For each of the countries mentioned above the analysis of the divulgation modalities confirms that, apart from the quite consistent number of patent applications filed by several players headquartered in European countries, different forms of divulgation can complement the technical information described in the patent documents. Figure 119 to Figure 121 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the cosmetics may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 119 Cosmetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

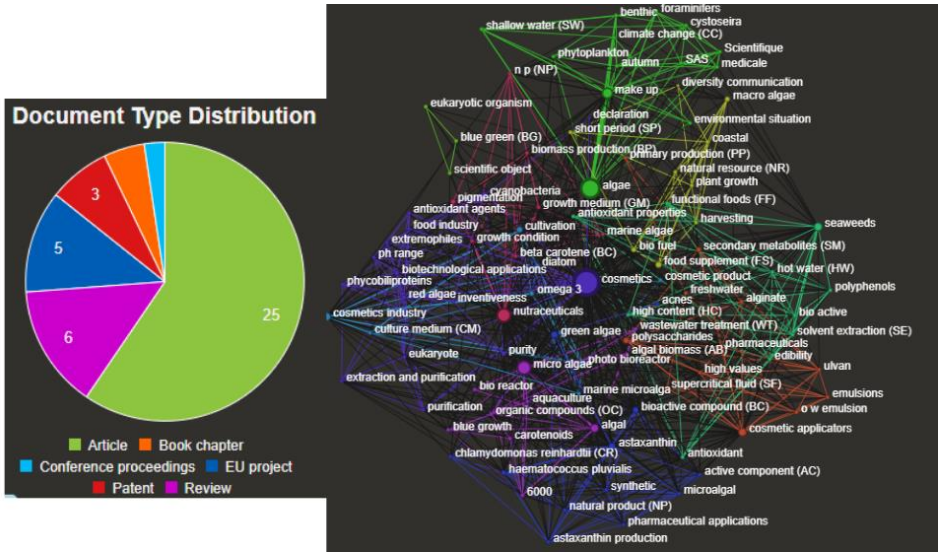


Figure 120 Cosmetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

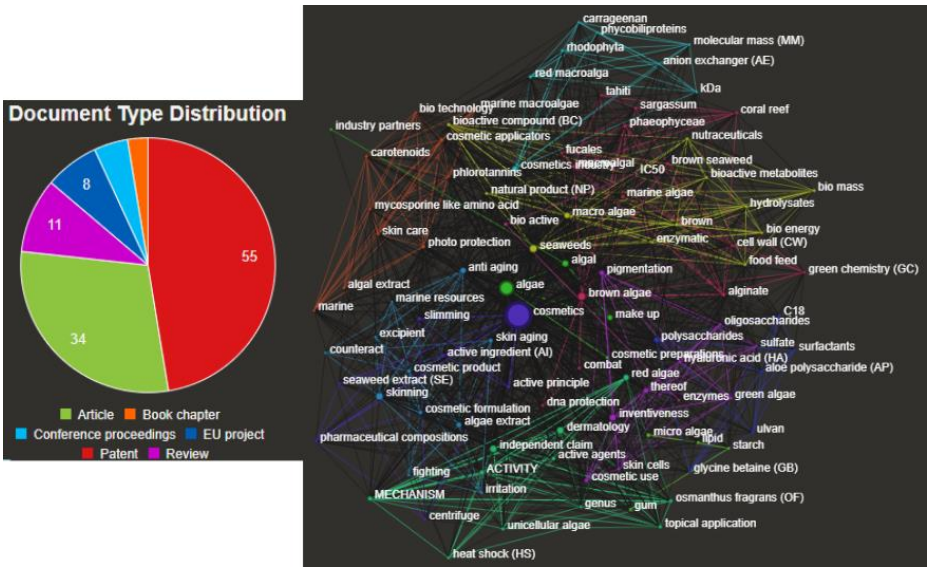
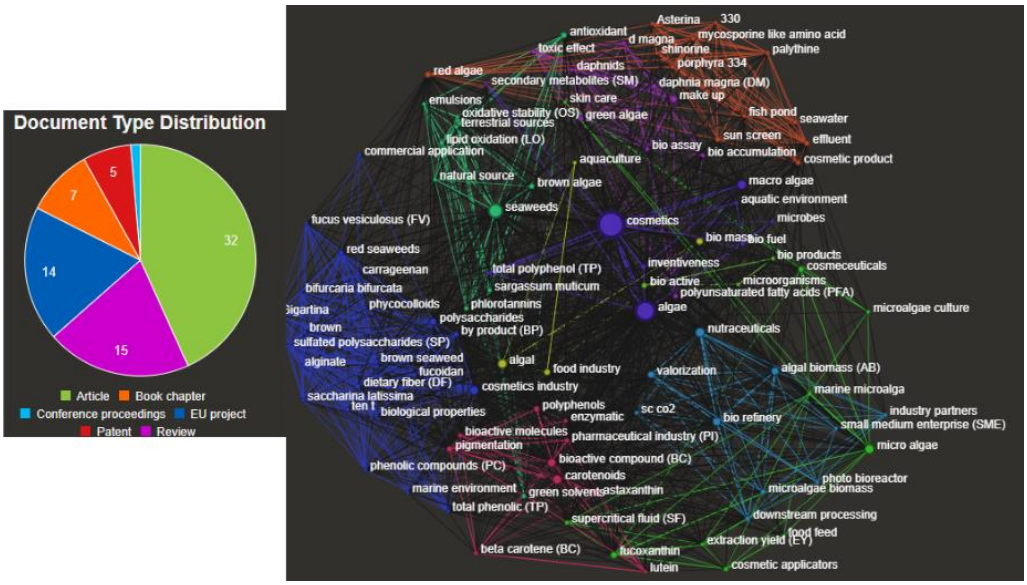


Figure 121 Cosmetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



a2) Healthcare and Pharmaceuticals → Pharmaceutics

The number of patent applications filed by the European residents is quite consistent and several French enterprises can be detected. However, to get a more detailed view of the Mediterranean scenario it may be worth considering that the divulgation of technical aspects through alternative means (NPL) may be widespread, being preferred either by enterprises or by academics. The trend emerging from the analysis of the publications of the last two decades

is particularly meaningful for Italy, France and Spain, as revealed by Figure 122 to Figure 125, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 122 Pharmaceutics: data showing the national and trans-national collaborations (NPL research focusing on Italy)

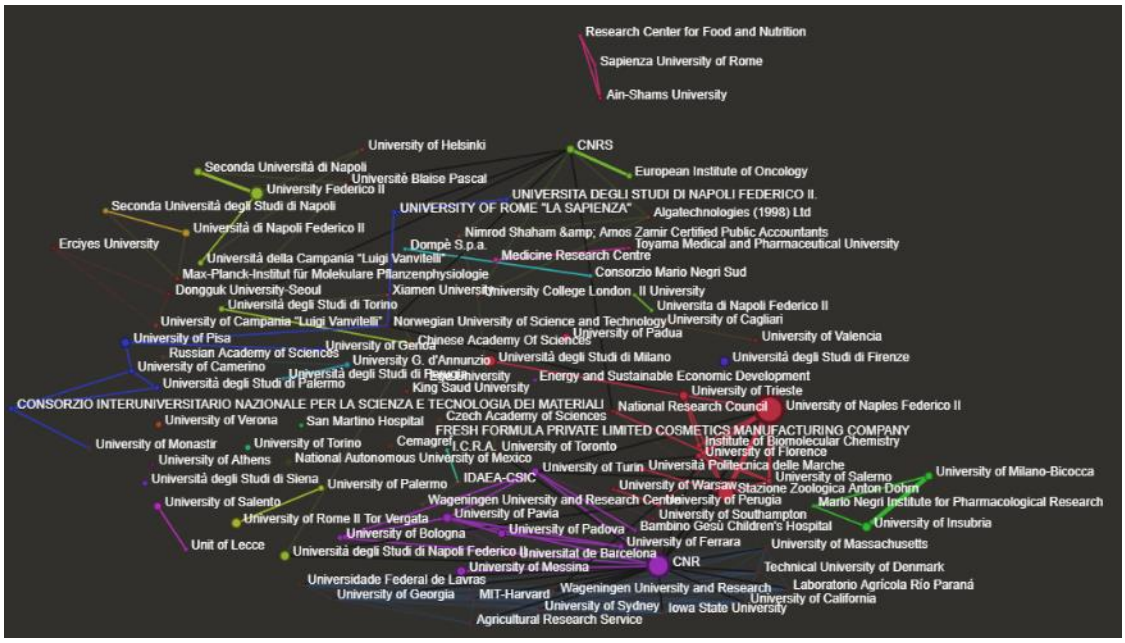


Figure 123 Pharmaceutics: data showing the national and trans-national collaborations (NPL research focusing on France)

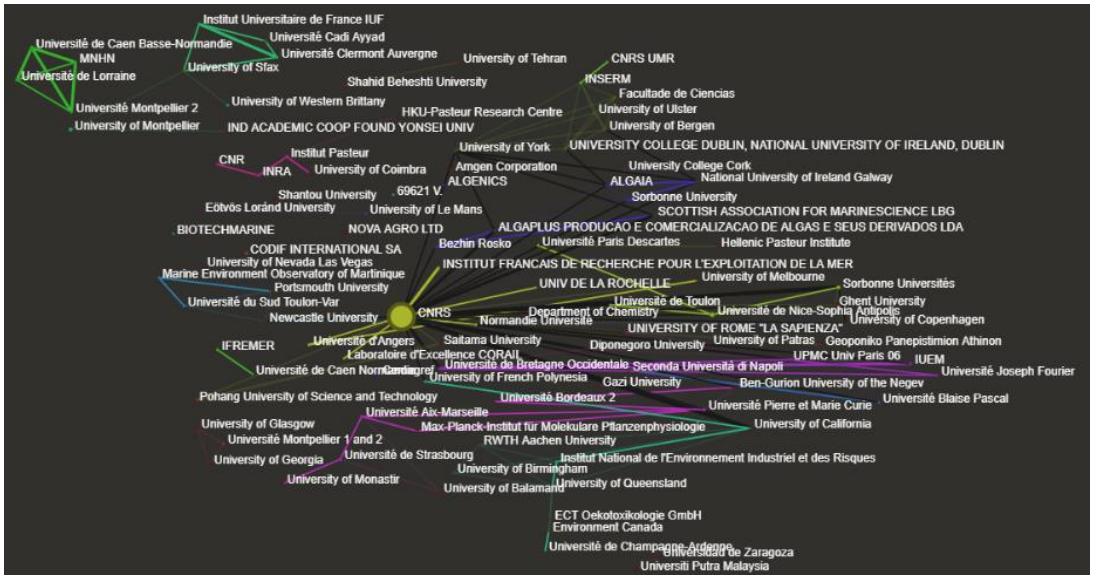


Figure 124 Pharmaceutics: data showing the national and trans-national collaborations (NPL research focusing on Spain)

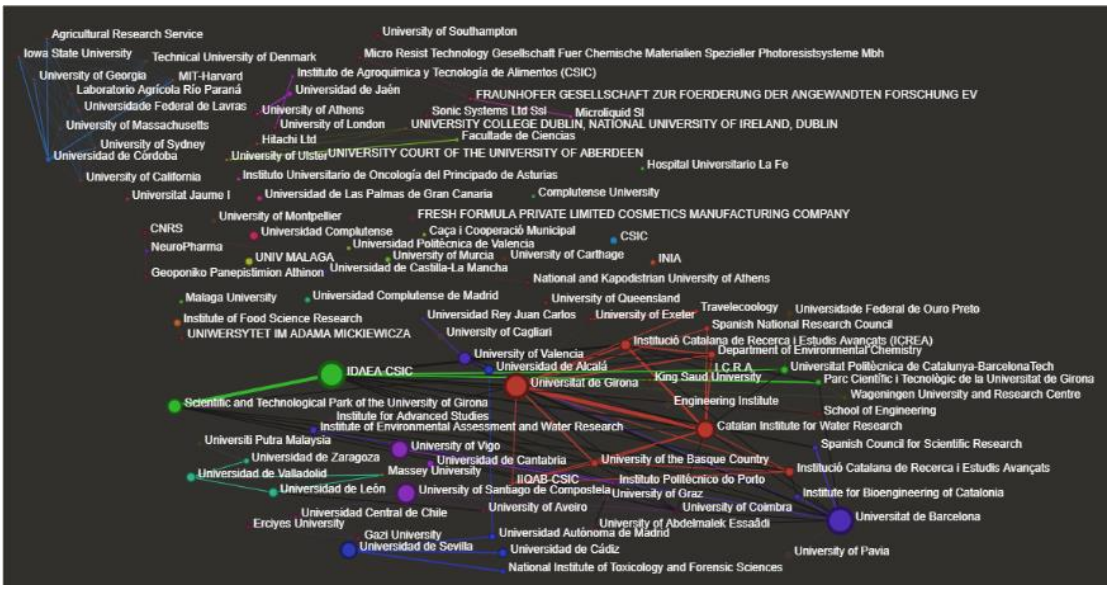
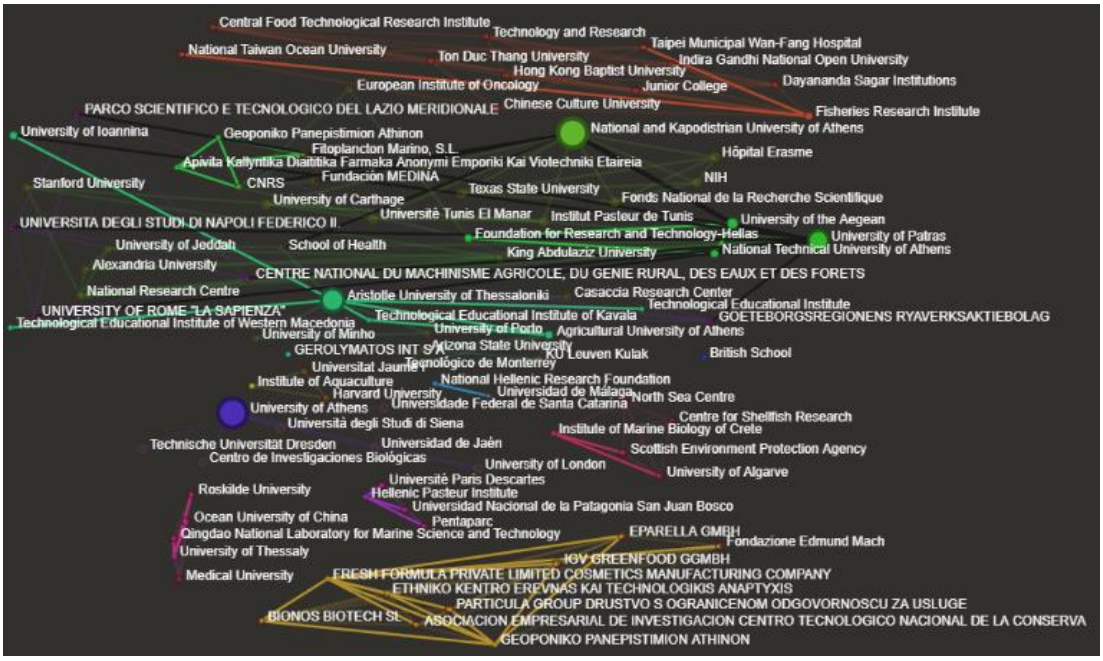


Figure 125 Pharmaceutics: data showing the national and trans-national collaborations (NPL research focusing on Greece)



Similar diagrams are available as far as other European countries located along the Mediterranean Sea are concerned, namely Slovenia, Croatia, Turkey and Tunisia.

For each of the countries mentioned above the analysis of the divulgation modalities confirms that, apart from not negligible numbers of patent applications filed by several players headquartered in European countries,

different forms of divulgation can complement the technical information described in the patent documents. Figure 126 to Figure 129 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the pharmaceutics may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map. It is usually consistent the number of publications mentioning the exploitation of the algae.

Figure 126 Pharmaceutics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

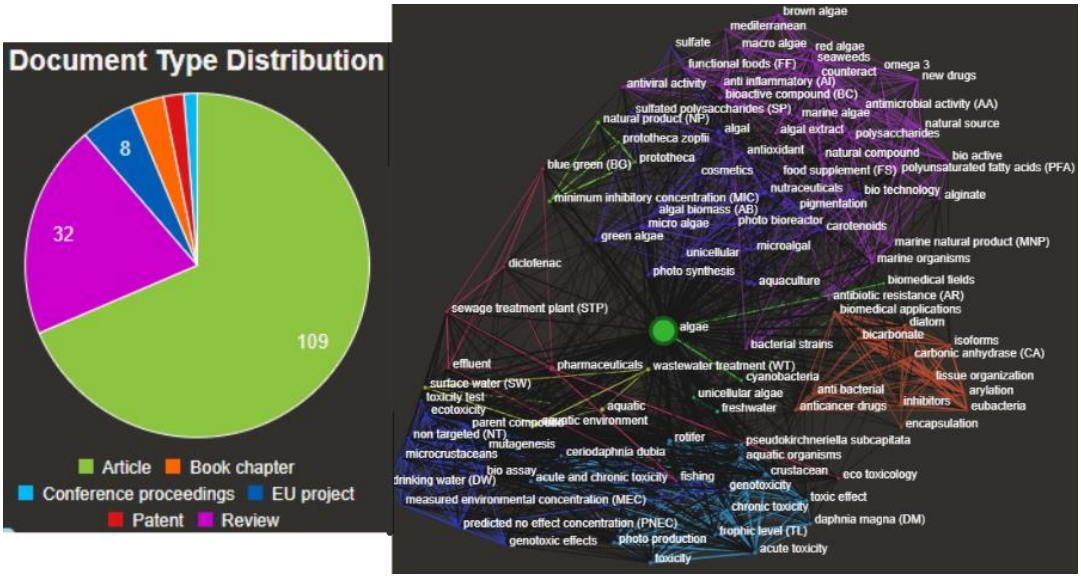


Figure 127 Pharmaceutics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

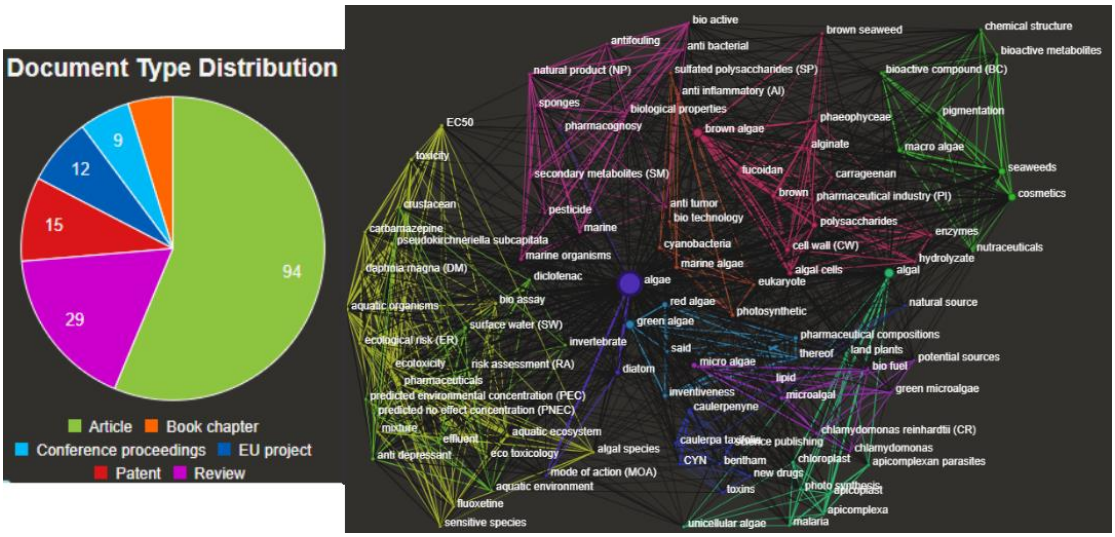


Figure 128 Pharmaceutics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)

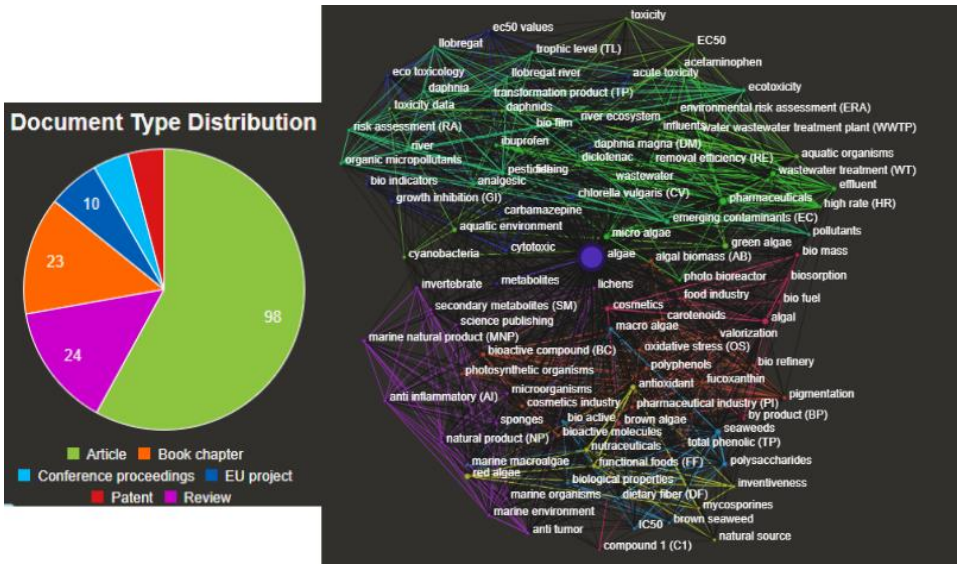
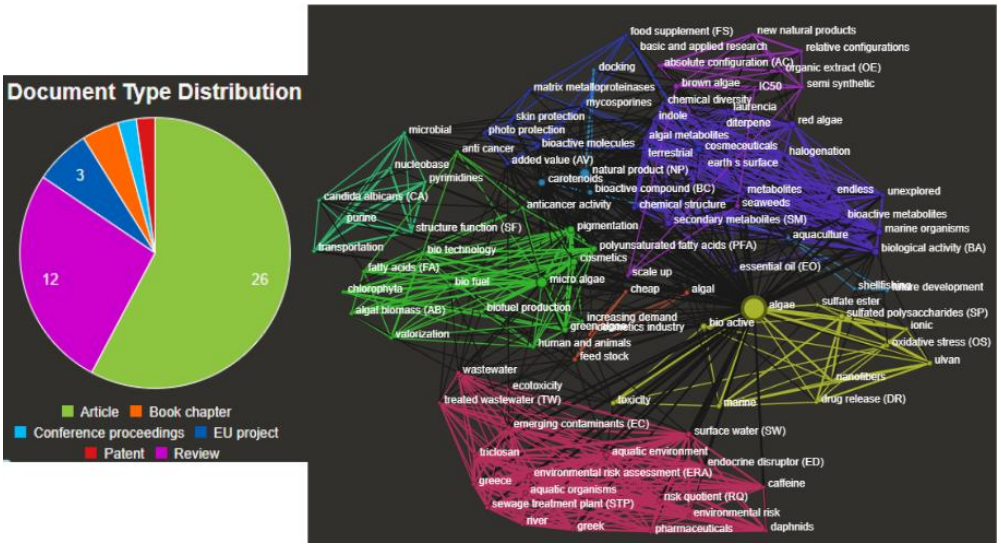


Figure 129 Pharmaceutics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Greece)



a3) Healthcare and Pharmaceuticals → Nutraceuticals

The number of patent applications filed by the European residents is quite consistent and several French and Spanish enterprises can be detected. However, to get a more detailed view of the Mediterranean scenario it may be worth considering that the divulgation of technical aspects through alternative means (NPL) may be widespread, being either used by enterprises or by academics. The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by Figure 130 to Figure 134, being

there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 130 Nutraceuticals: data showing the national and trans-national collaborations (NPL research focusing on Italy)

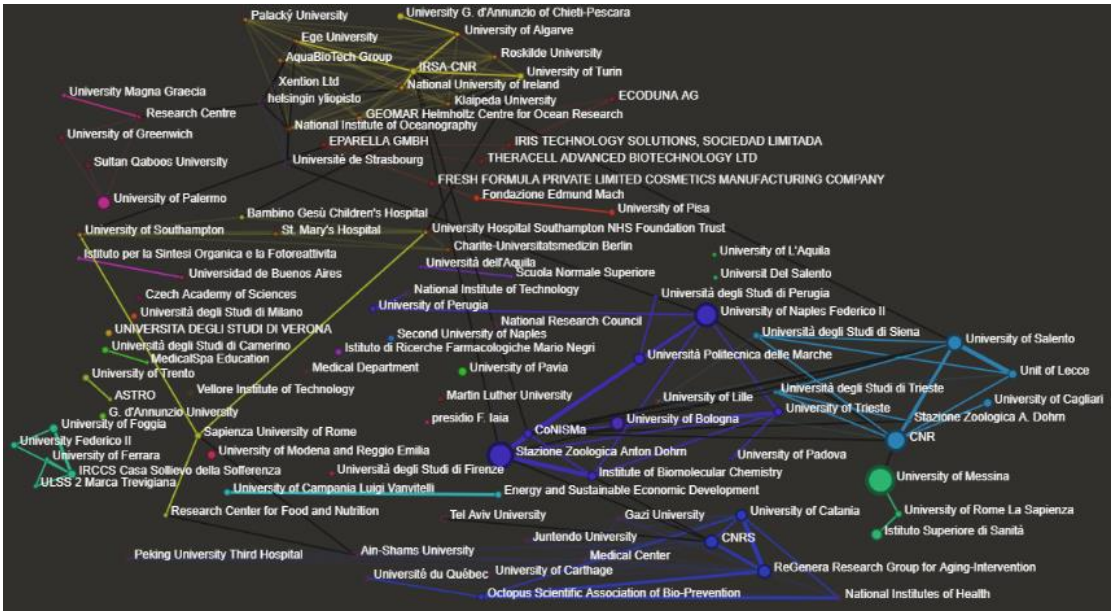


Figure 131 Nutraceuticals: data showing the national and trans-national collaborations (NPL research focusing on France)

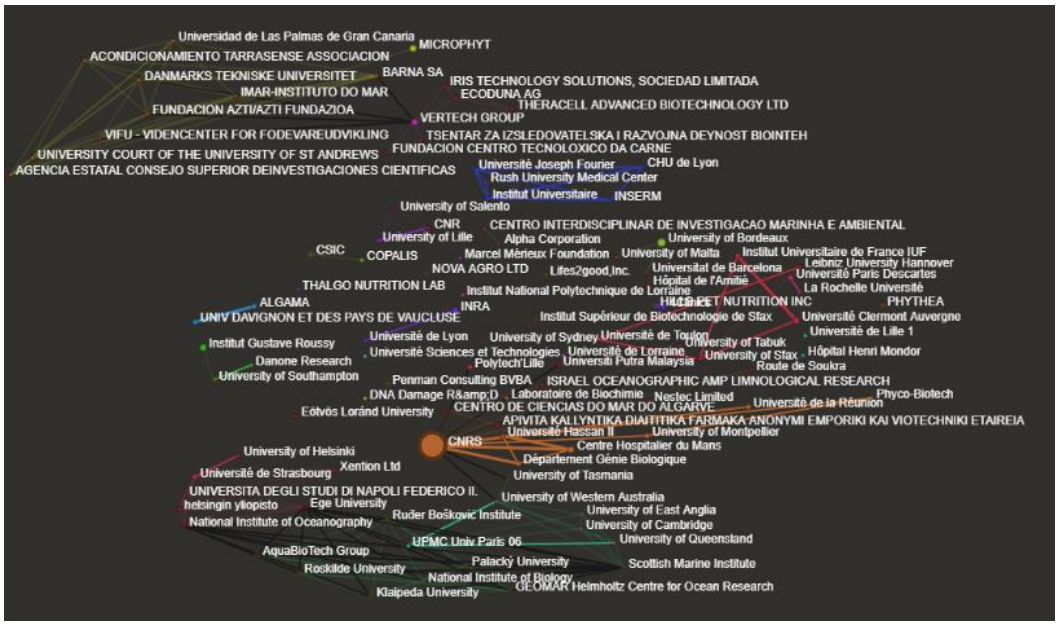


Figure 132 Nutraceuticals: data showing the national and trans-national collaborations (NPL research focusing on Spain)

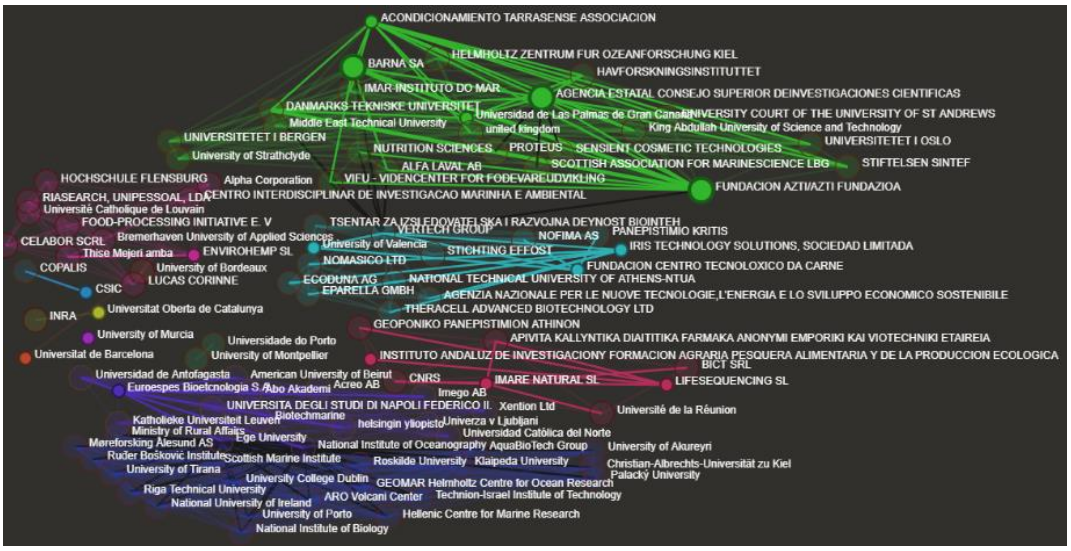


Figure 133 Nutraceuticals: data showing the national and trans-national collaborations (NPL research focusing on Greece)

Figure 134 Nutraceuticals: data showing the national and trans-national collaborations (NPL research focusing on Israel)

Similar diagrams are available as far as other European countries located along the Mediterranean Sea are concerned, namely Slovenia, Croatia and Turkey.

For each of the countries mentioned above the analysis of the divulgation modalities confirms that, apart from not negligible numbers of patent applications filed by several players headquartered in European countries, different forms of divulgation can complement the technical information described in the patent documents. Figure 135 to Figure 139provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the pharmaceutics may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map. It is usually consistent the number of publications mentioning the exploitation of the nutraceuticals' products.

Figure 135 Nutraceuticals: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

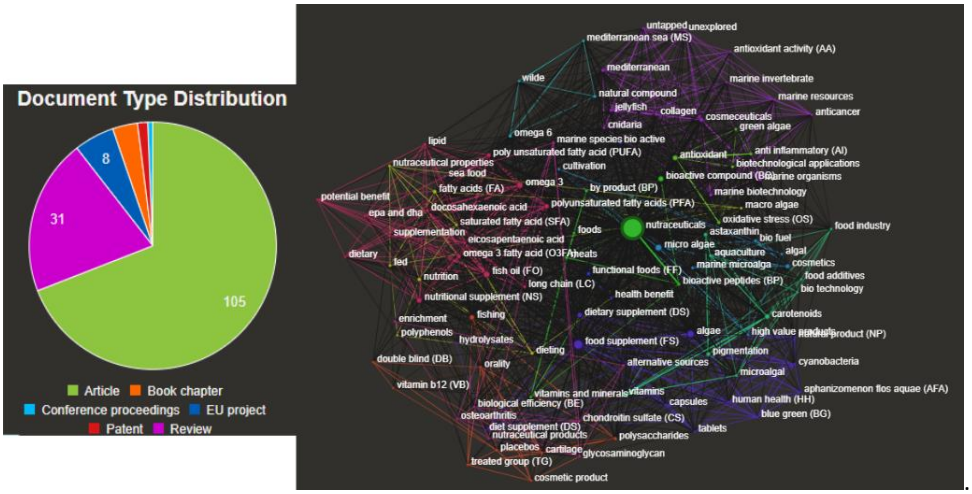


Figure 136 Nutraceuticals: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

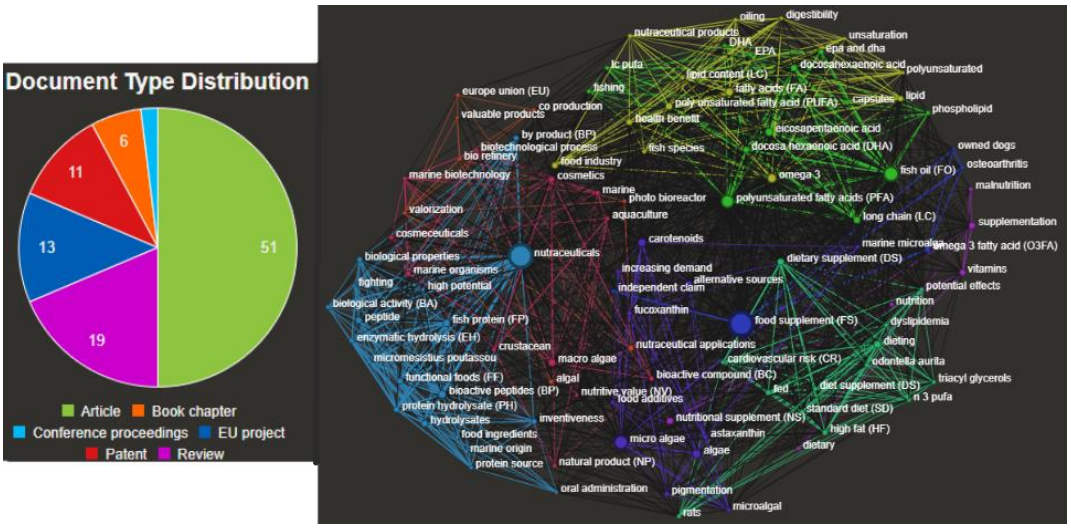


Figure 137 Nutraceuticals: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)

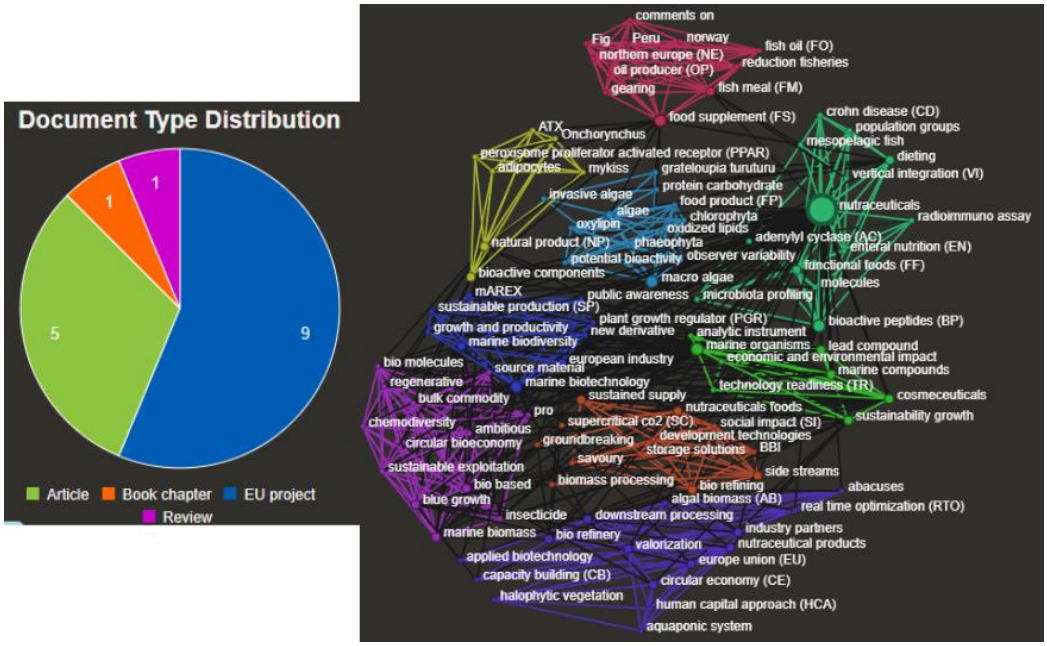


Figure 138 Nutraceuticals: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Greece)

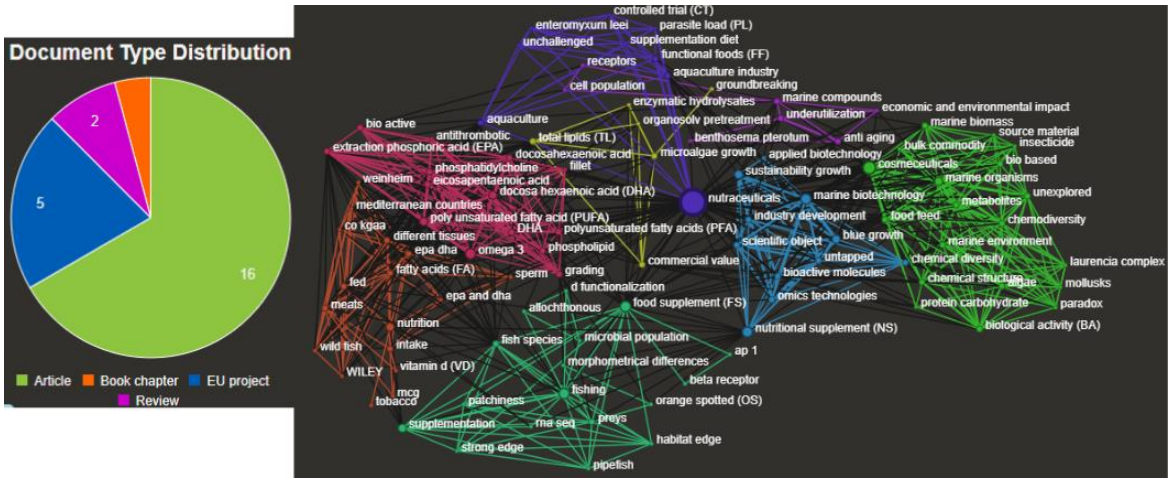
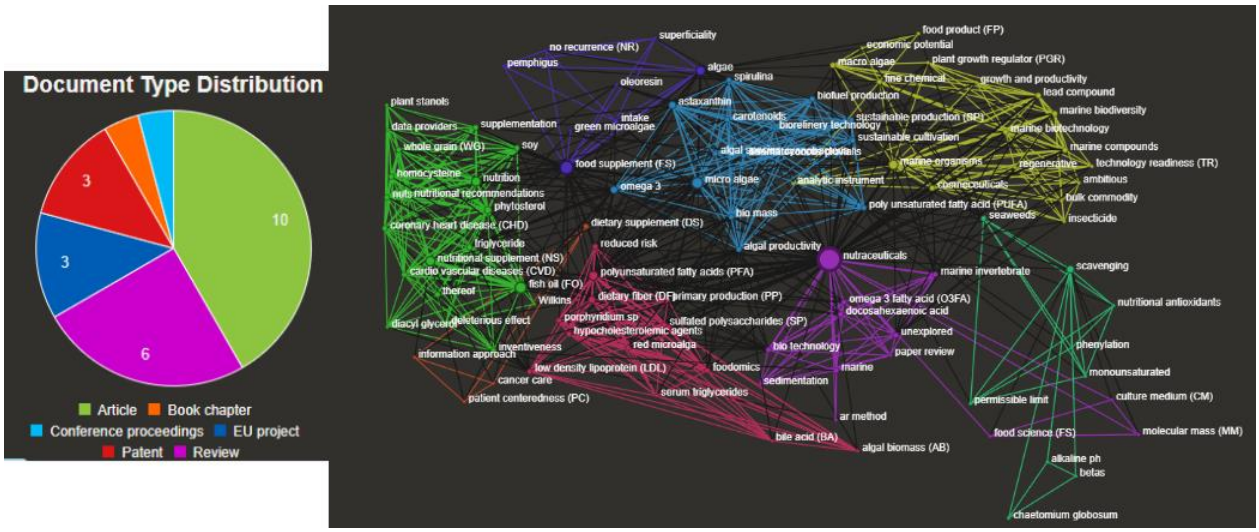


Figure 139 Nutraceuticals: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Israel)



4.a KEYPOINTS

- 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 pharmaceutics 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 pharmaceutics 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 AND EU FUNDED PROJECTS

- **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))
- **HELIA DEVELOPMENT** (Heliae Development - Sustainable & Regenerative Agriculture Solutions)
- **TAKARA BIO** (Takara Bio—Home)
- **METABOLIUM** (Metabolium : Compléments alimentaires innovants, 100% naturels)

SECTOR RELTATED 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 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 SMSs 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

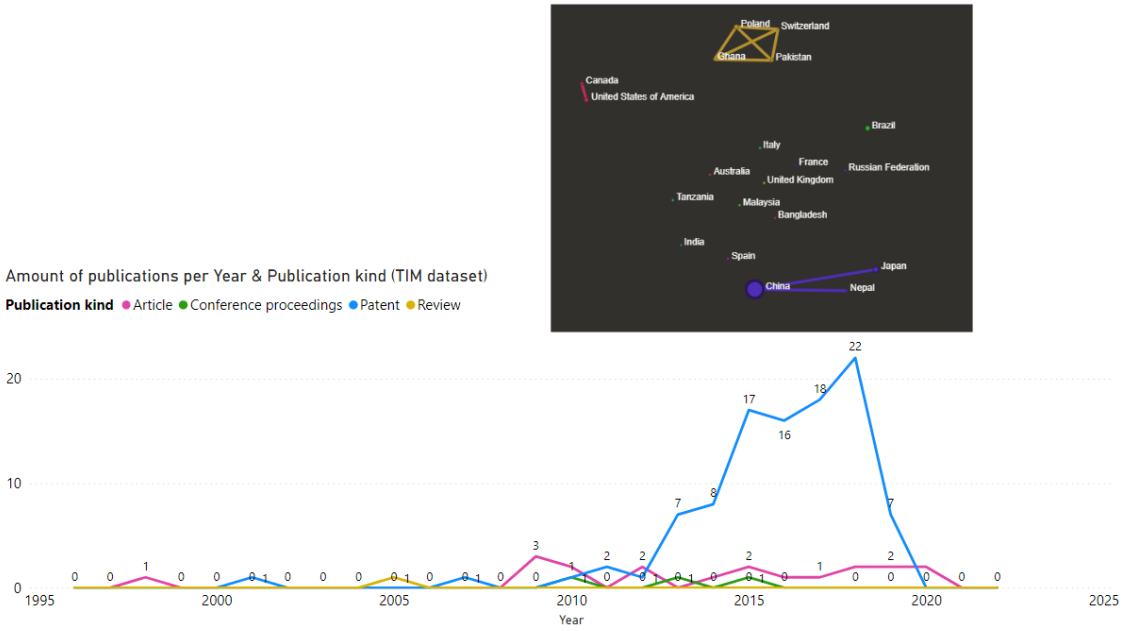
1) **Integrated on-farm Aquaponics systems for co-production of fish, halophyte vegetables, bioactive compounds, and bioenergy (AQUACOMBINE).** Fresh water shortages and salinisation processes in farmland increase concerns related to food security. Farmers are seeking salt-tolerant solutions as well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

b) Agriculture, Livestock, Food processing → Soil fertilization

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, as revealed by Figure 140.

Figure 140 Soil fertilization: data showing the national and trans-national collaborations (NPL data worldwide) and trend of the NPL divulgation modalities vs. trend of patent applications filed



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/)

c) Industrial processes and manufacturing → Sea organisms' genetics

The number of patent applications filed by the European residents does not appear consistent. Therefore, to get a more detailed view of the Mediterranean scenario it may be worth examining the rate of divulgation of technical aspects through alternative means (NPL). The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by Figure 141 to Figure 143, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 141 Sea genetics' organisms: data showing the national and trans-national collaborations (NPL research focusing on Italy)

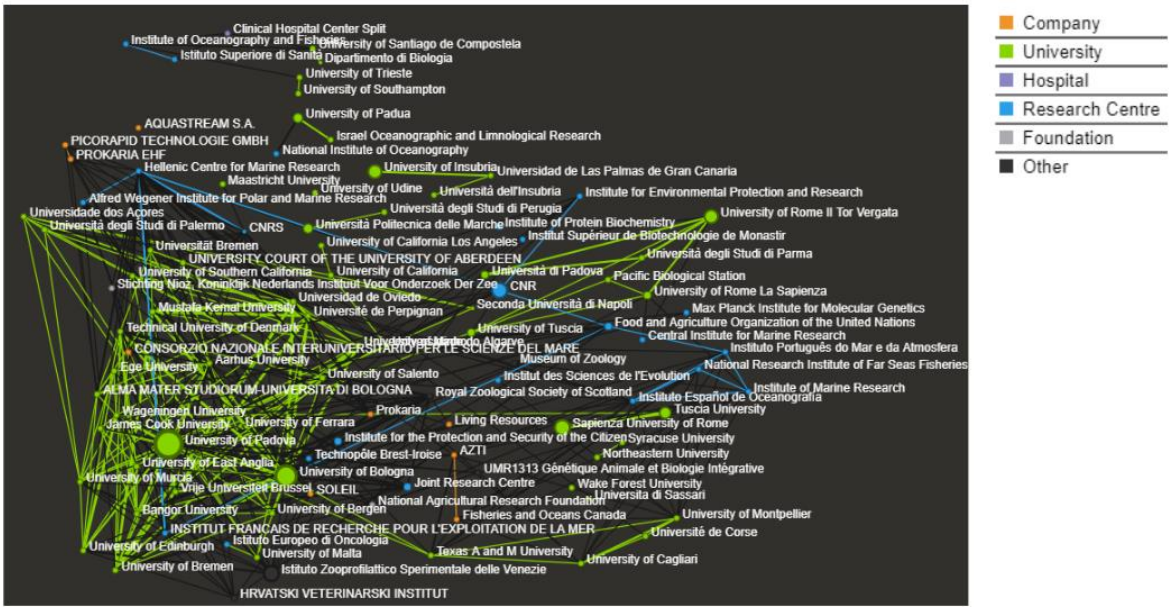


Figure 142 Sea genetics' organisms: data showing the national and trans-national collaborations (NPL research focusing on France)

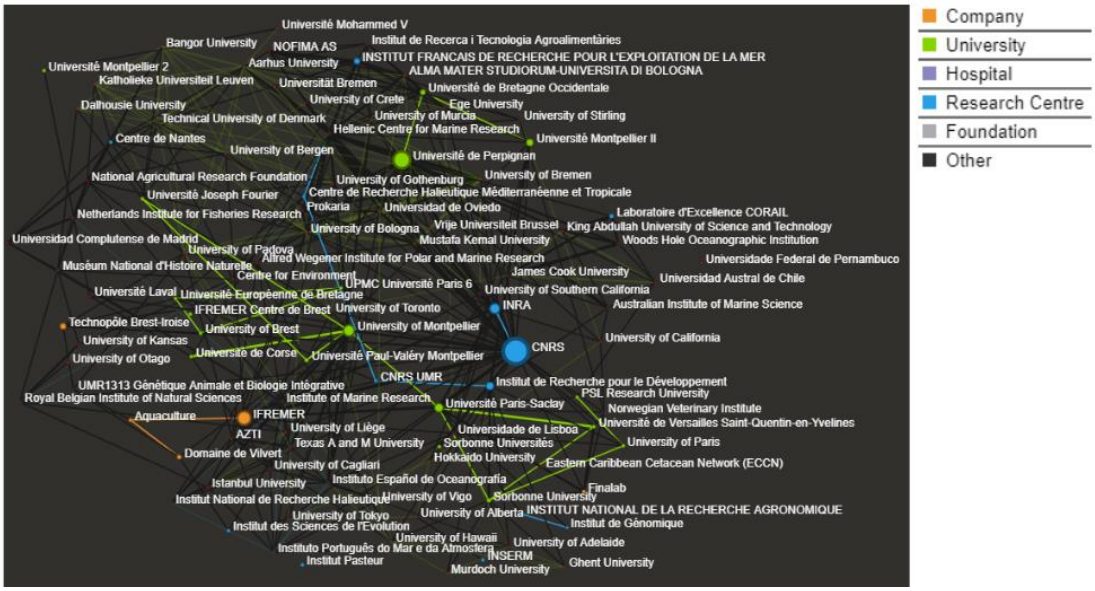
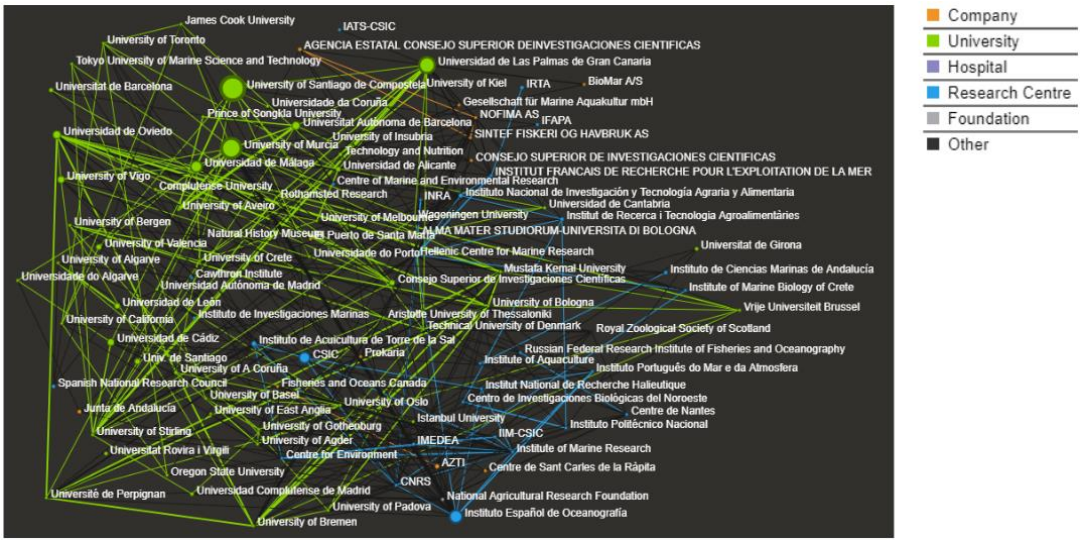


Figure 143 Sea genetics' organisms: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Greece, Slovenia, Croatia and Israel. For each of the countries mentioned above the analysis of the divulgation modalities confirms that alternative forms of divulgation are preferred to the patent applications.

Figure 144 to Figure 146 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the applicability of the genetics approach to the sea organisms may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 144 Sea organisms' genetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

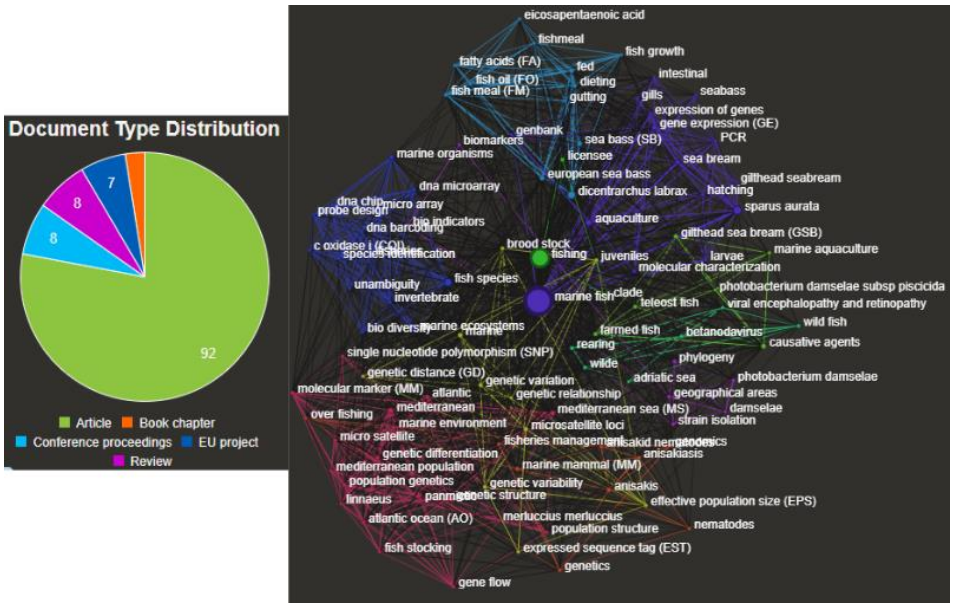


Figure 145 Sea organisms' genetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

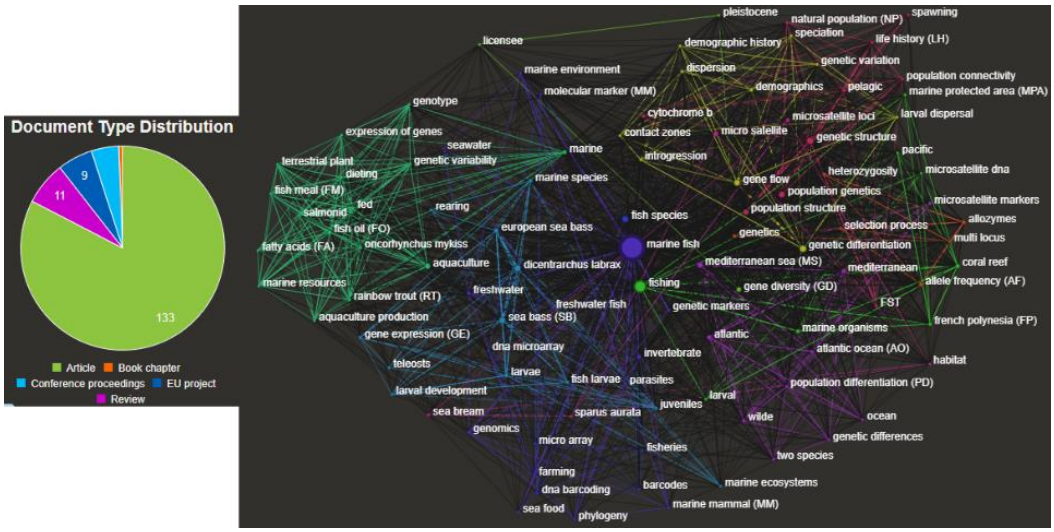
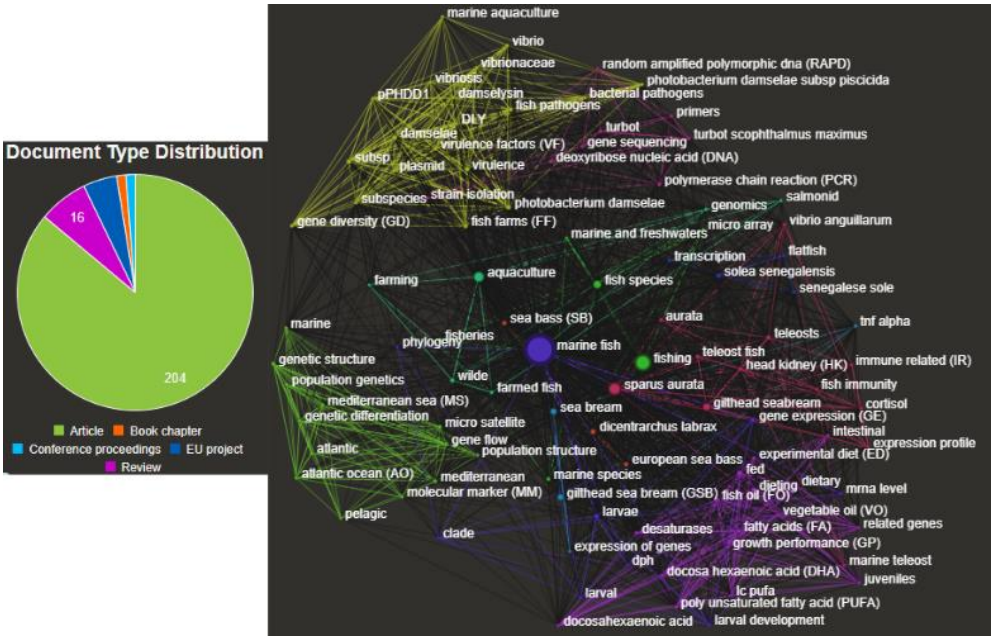


Figure 146 Sea organisms' genetics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.c KEYPOINTS

- 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 centres 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.inknowvation.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

d) Biofuels

The number of patent applications filed by the European residents appears significant. To get a more detailed view of the Mediterranean scenario it may be worth examining the rate of divulgation of technical aspects through alternative means (NPL). The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by Figure 147 to Figure 149, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 147 Biofuels: data showing the national and trans-national collaborations (NPL research focusing on Italy)

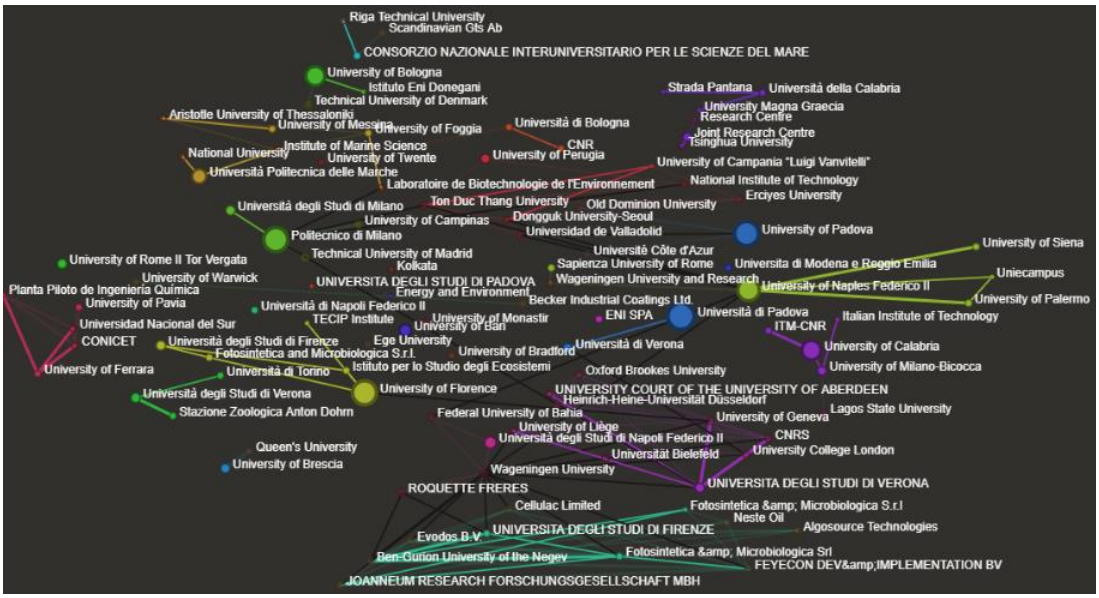


Figure 148 Biofuels: data showing the national and trans-national collaborations (NPL research focusing on France)

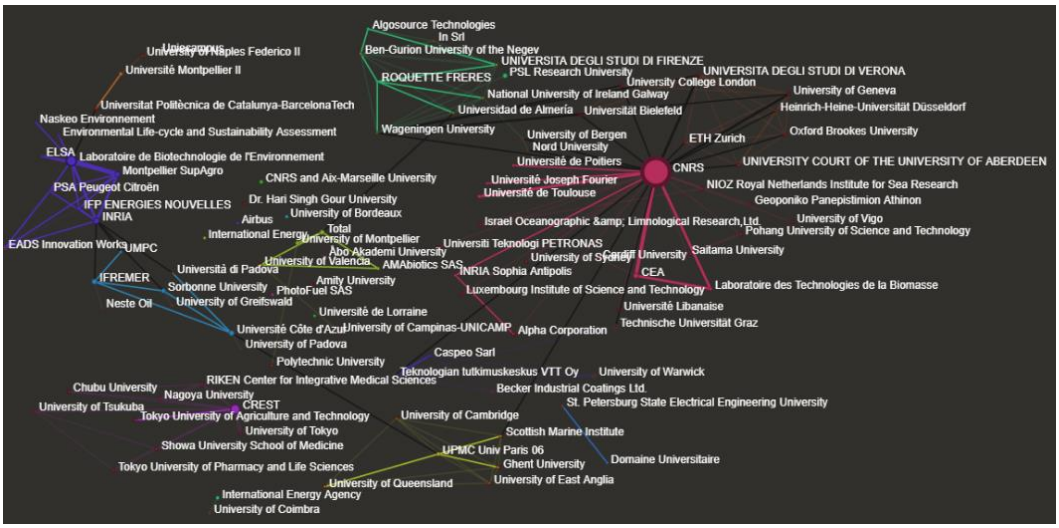
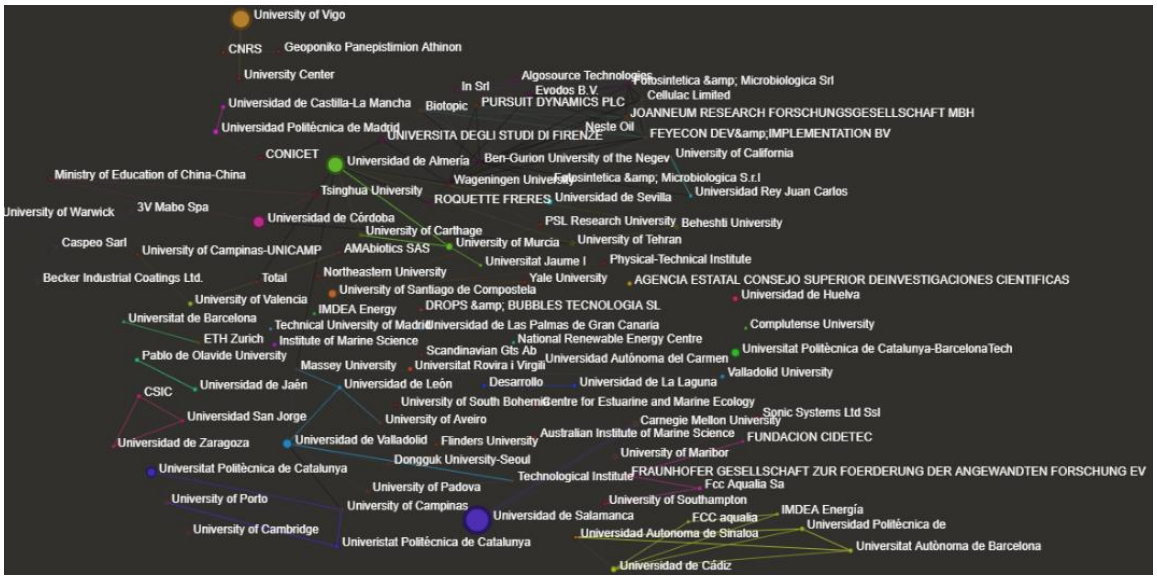


Figure 149 Biofuels: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Greece, Slovenia, Croatia and Cyprus.

For each of the countries mentioned above the analysis of the divulgation modalities confirms that alternative forms of divulgation are preferred to the patent applications. Figure 150 to Figure 152 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the applicability of the marine resources to the biofuel production may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 150 Biofuels: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

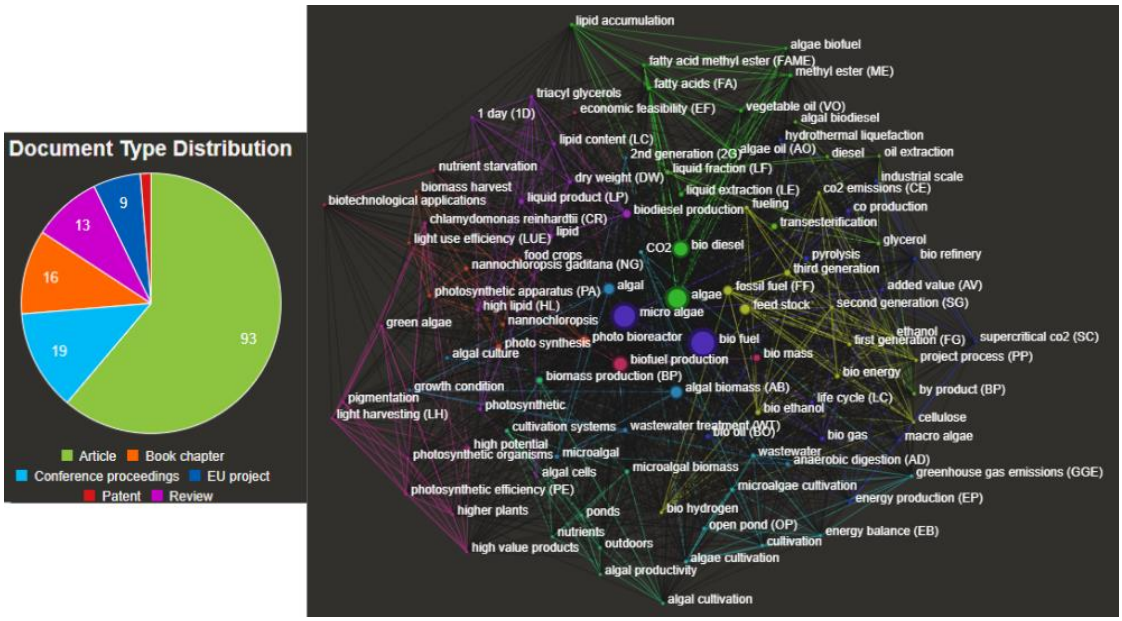


Figure 151 Biofuels: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

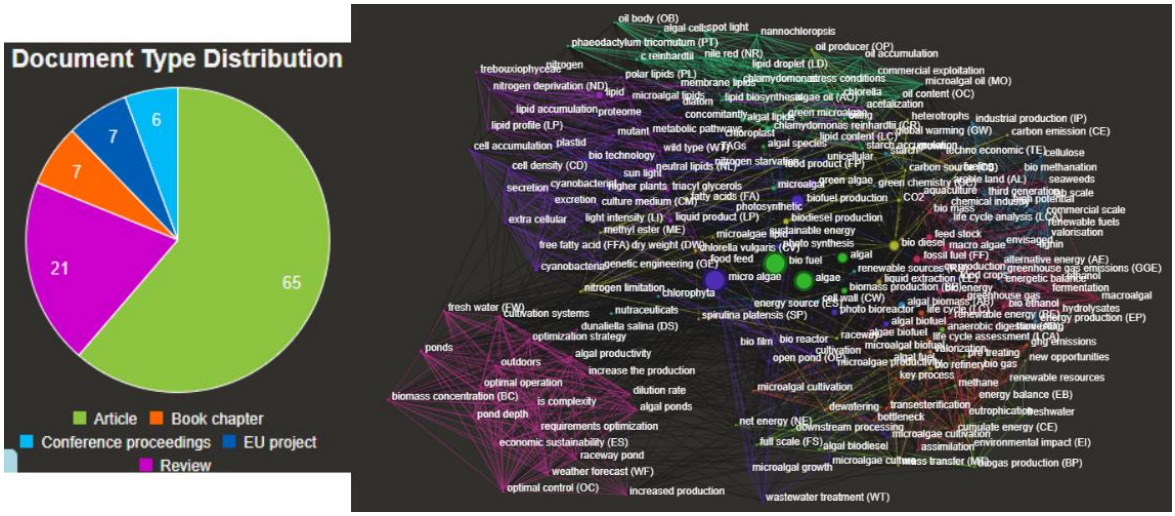
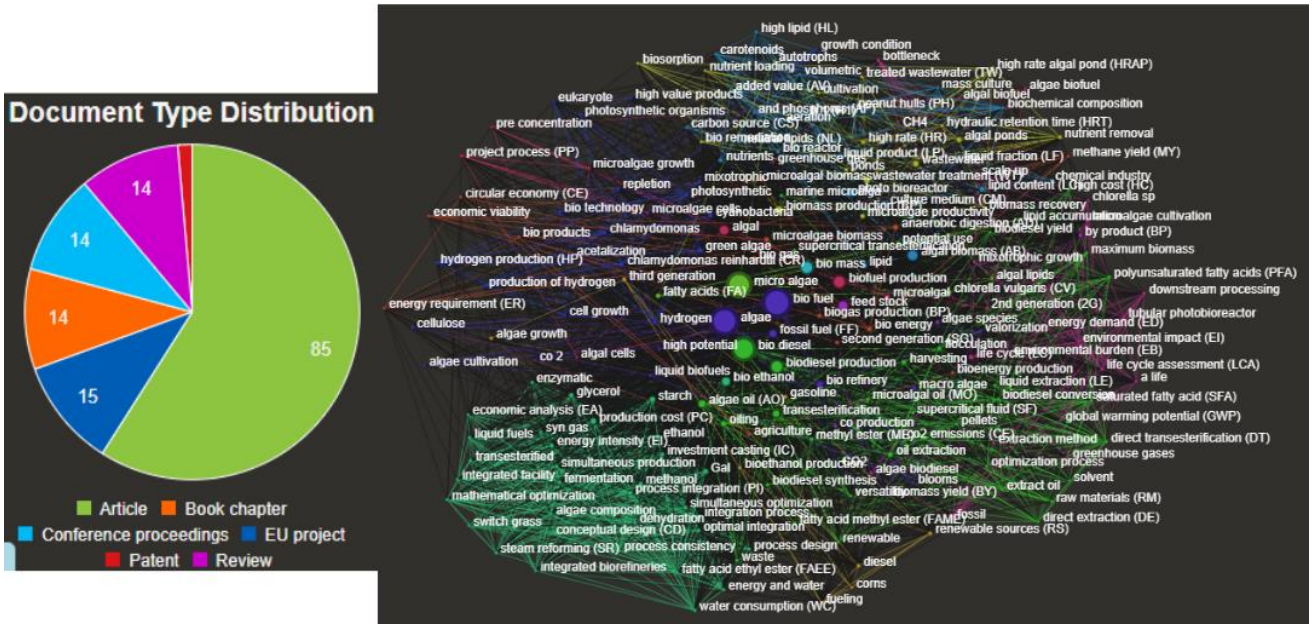


Figure 152 Biofuels: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.d KEYPOINTS

- 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 AND EU FUNDED PROJECTS

- **HELIAE DEVELOPMENT** (Heliae Development - Sustainable & Regenerative Agriculture Solutions (heliaeglobal.com))
- **KIVERDI** (Kiverdi, Inc.)
- **ENN RESEARCH INSTITUTE** (enn energy research institute (ennresearch.com))
- **ADVANCED BIOMASS R&D CENTER** (Advanced Biomass R&D Center)
- **KOREA INSTITUTE OF ENERGY RESEARCH** (KOREA INSTITUTE OF ENERGY RESEARCH (kier.re.kr))
- **SOLAZYME** (Solazyme | At Solazyme we transform microalgae, the smallest of organisms, into solutions for the worlds biggest problems. (solazymeindustrials.com))
- **NESTE OIL** (Products | Neste)

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

e1) Bio-monitoring and bio-remediation → Seawater purification

The number of patent applications filed by the European residents appears significant. To get a more detailed view of the Mediterranean scenario it may be worth examining the rate of divulgation of technical aspects through alternative means (NPL). The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by the Figure 153 to Figure 156, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 153 Seawater purification: data showing the national and trans-national collaborations (NPL research focusing on Italy)

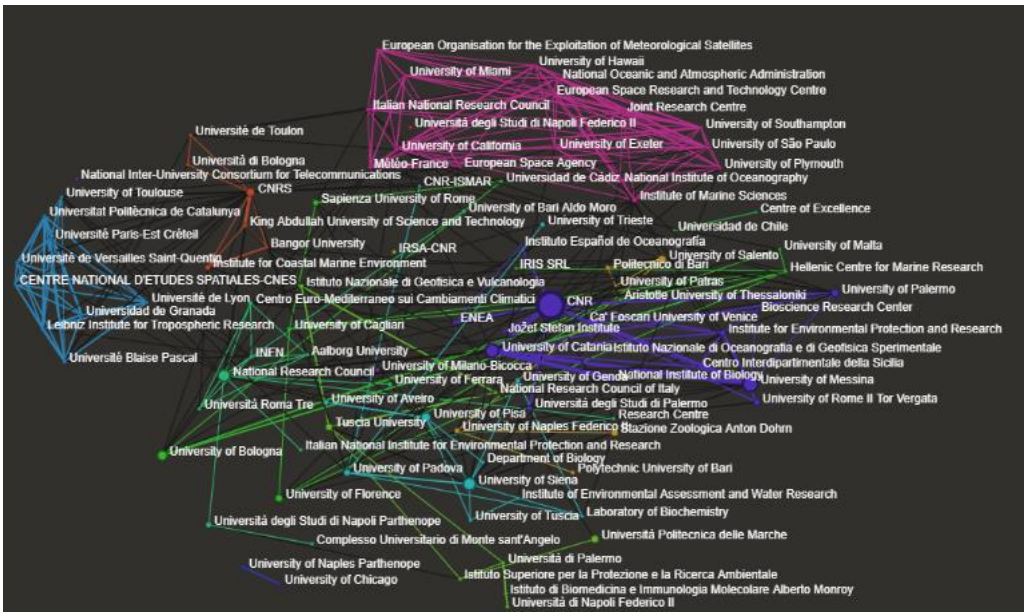


Figure 154 Seawater purification: data showing the national and trans-national collaborations (NPL research focusing on Greece)

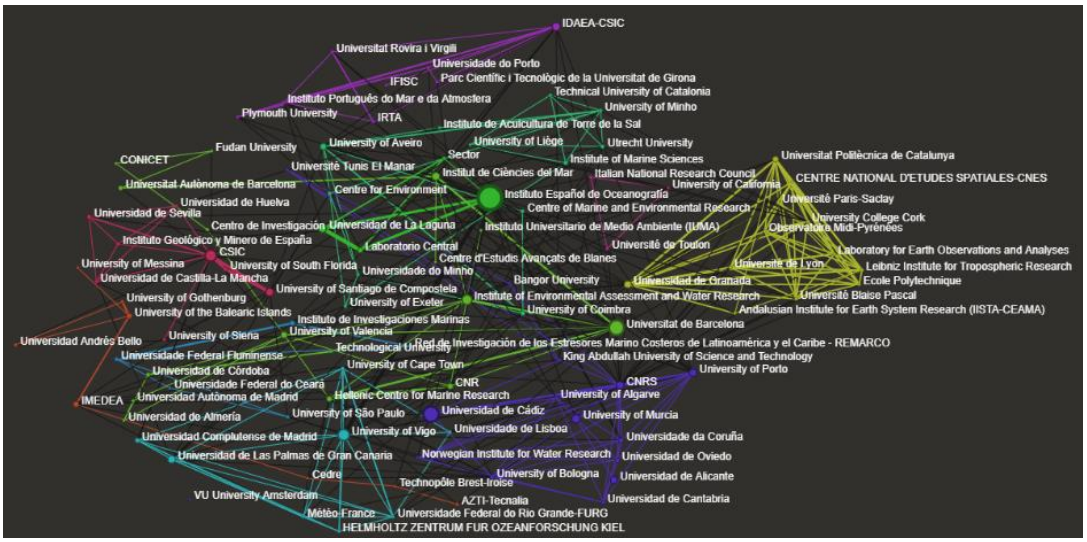


Figure 155 Seawater purification: data showing the national and trans-national collaborations (NPL research focusing on France)

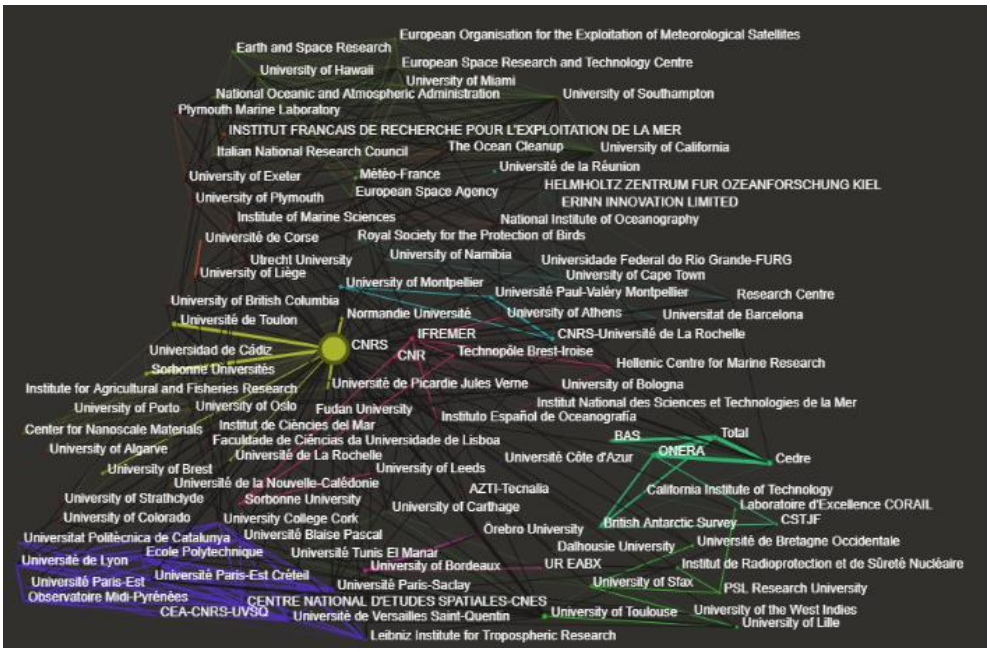
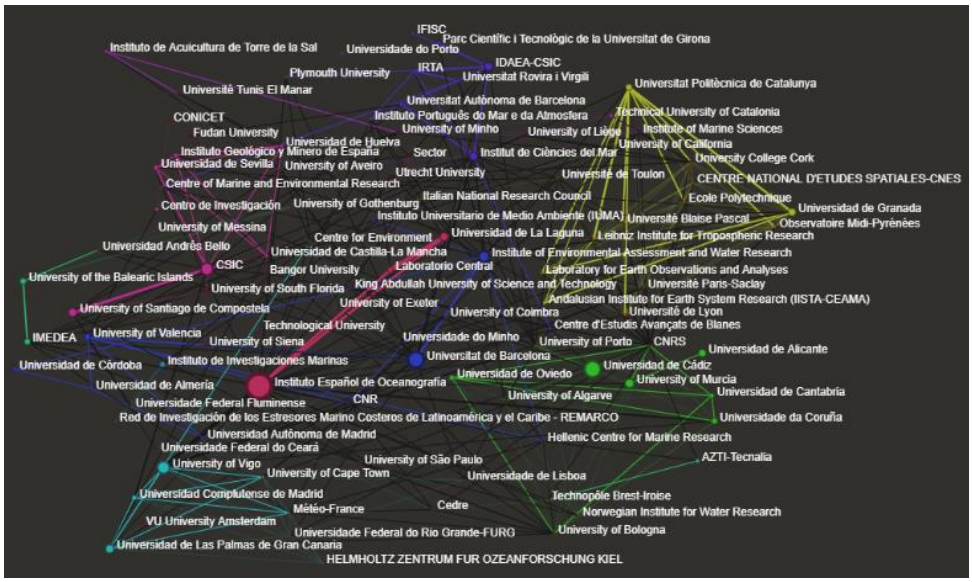


Figure 156 Seawater purification: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Slovenia, Croatia, Turkey and Israel. For each of the countries mentioned above the analysis of the divulgation modalities confirms that alternative forms of divulgation are preferred to the patent applications. Figure 157 to Figure 160 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the seawater purification may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map. The commitment of Greek institutions appears rather relevant.

Figure 157 Seawater purification: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

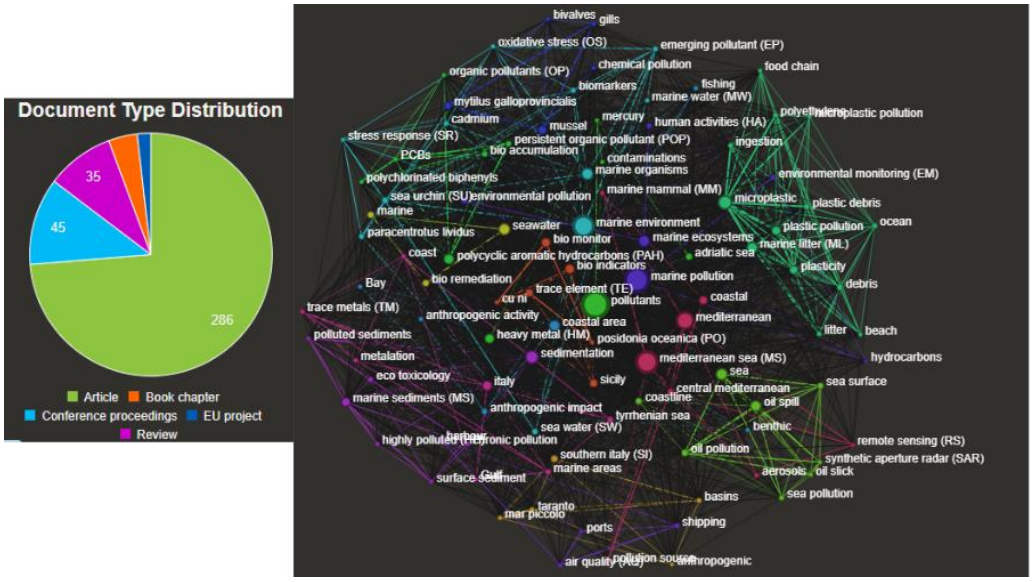


Figure 158 Seawater purification: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Greece)

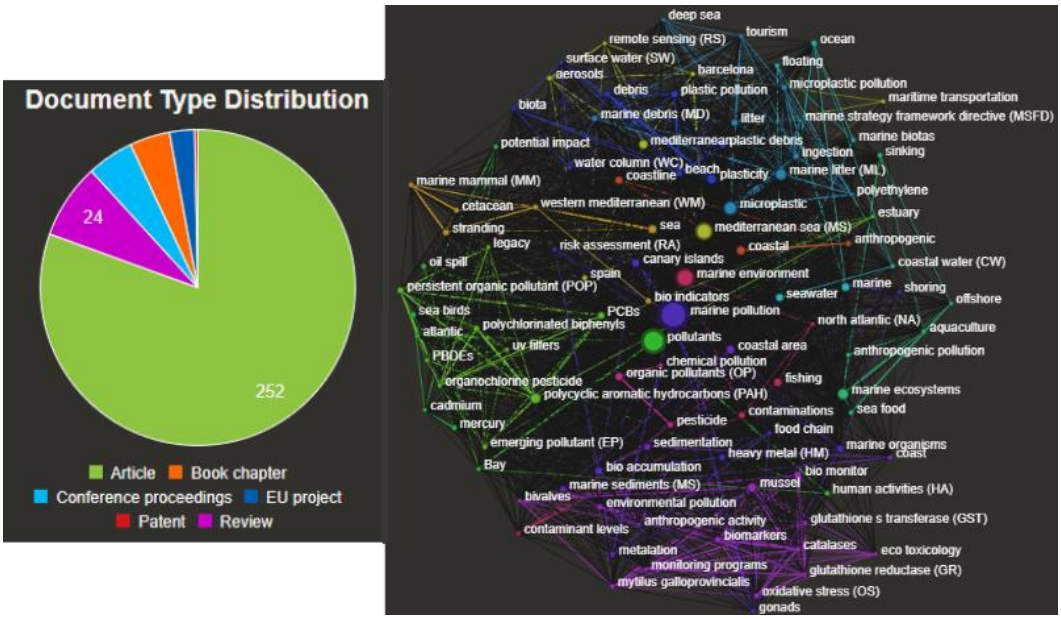


Figure 159 Seawater purification: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

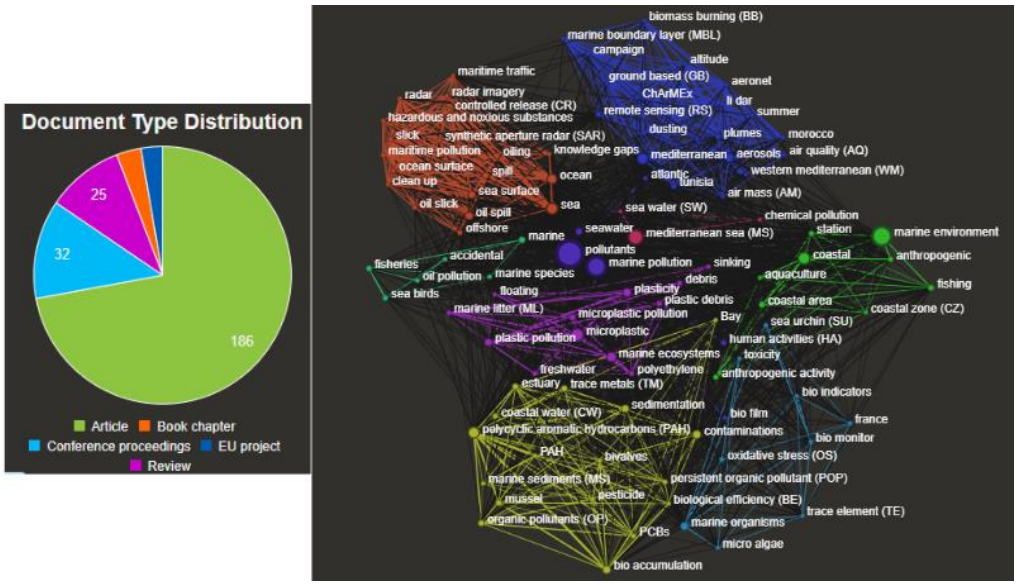
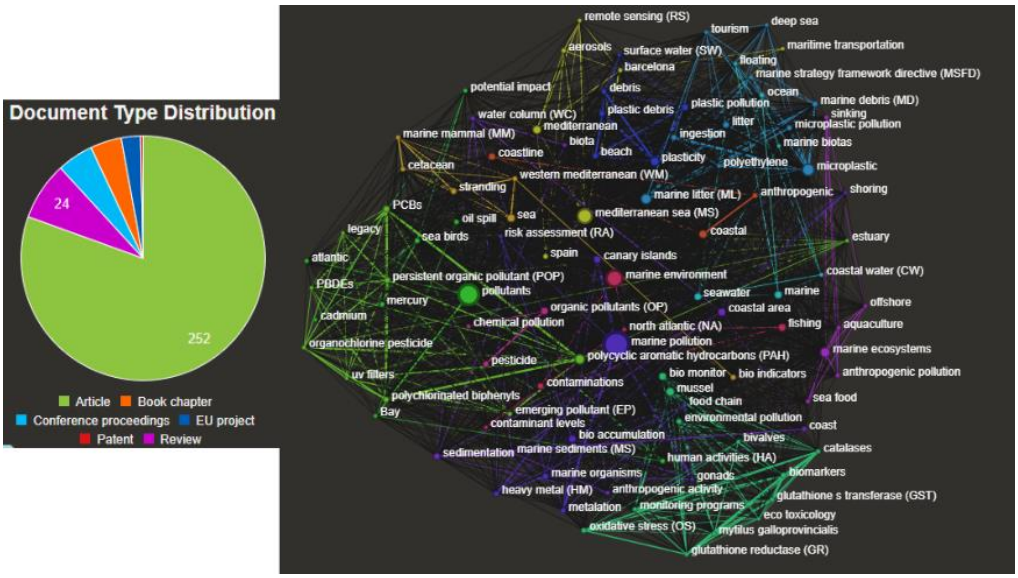


Figure 160 Seawater purification: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



e2) Bio-monitoring and bio-remediation → Remediation

The number of patent applications filed by the European residents appears significant. To get a more detailed view of the Mediterranean scenario it may be worth examining the rate of divulgation of technical aspects through alternative means (NPL). The trend emerging from the analysis of the publications of the last two decades is particularly meaningful for Italy, France and Spain, as revealed by Figure 161 to Figure 163, being there evidence of the national and also the trans-national collaborations between the institutes/enterprises located in each of the countries mentioned above.

Figure 161 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

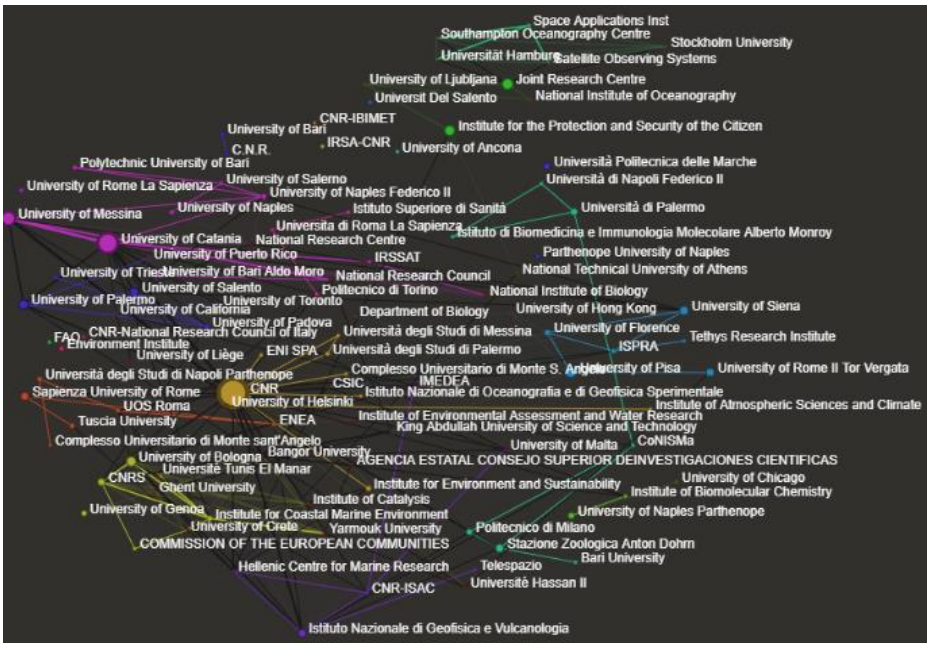


Figure 162 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

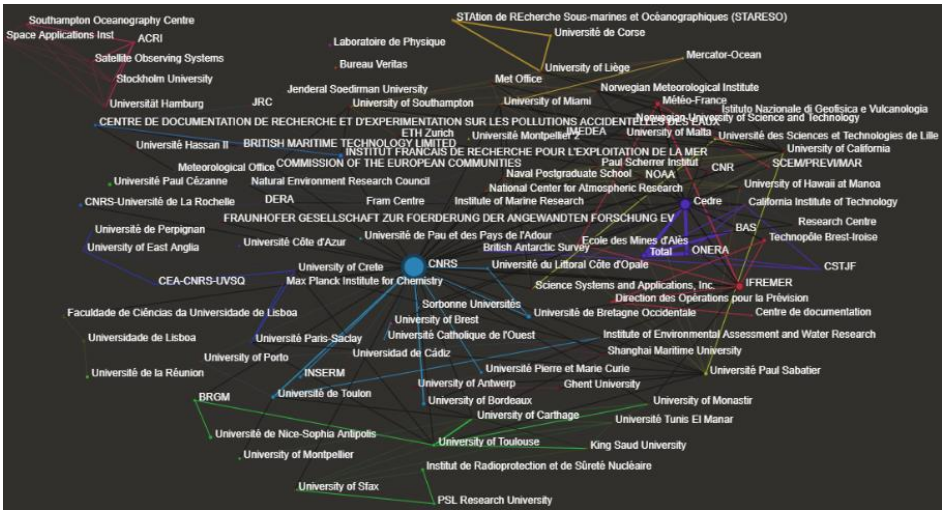
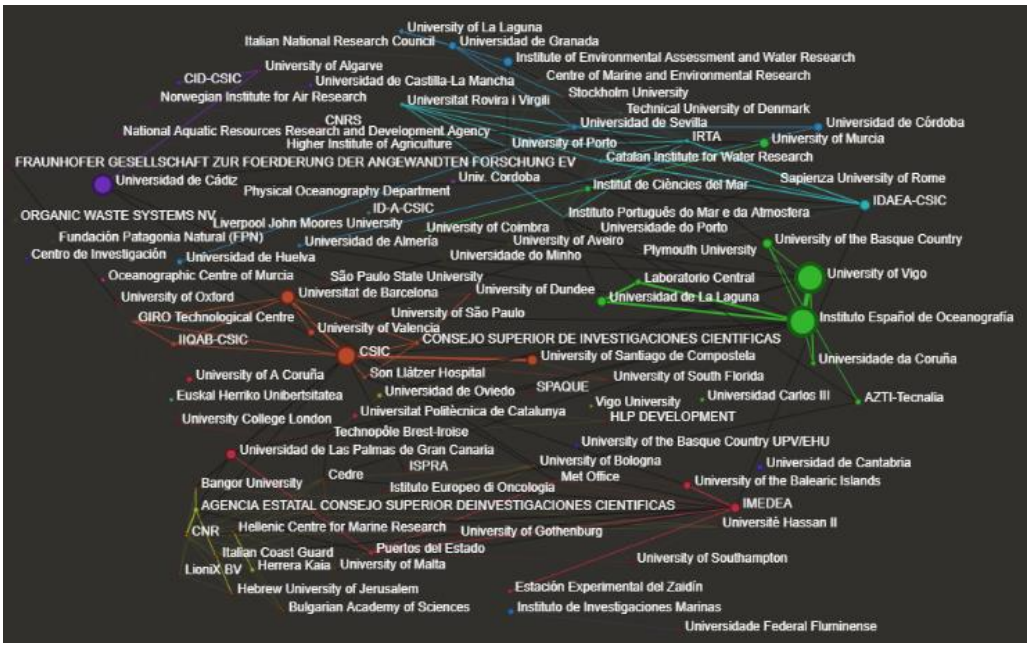


Figure 163 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Greece, Slovenia, Croatia, Turkey and Israel. For each of the countries mentioned above the analysis of the divulgation modalities confirms that alternative forms of divulgation are preferred to the patent applications. Figure 164 to Figure 166 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the remediation may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 164 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

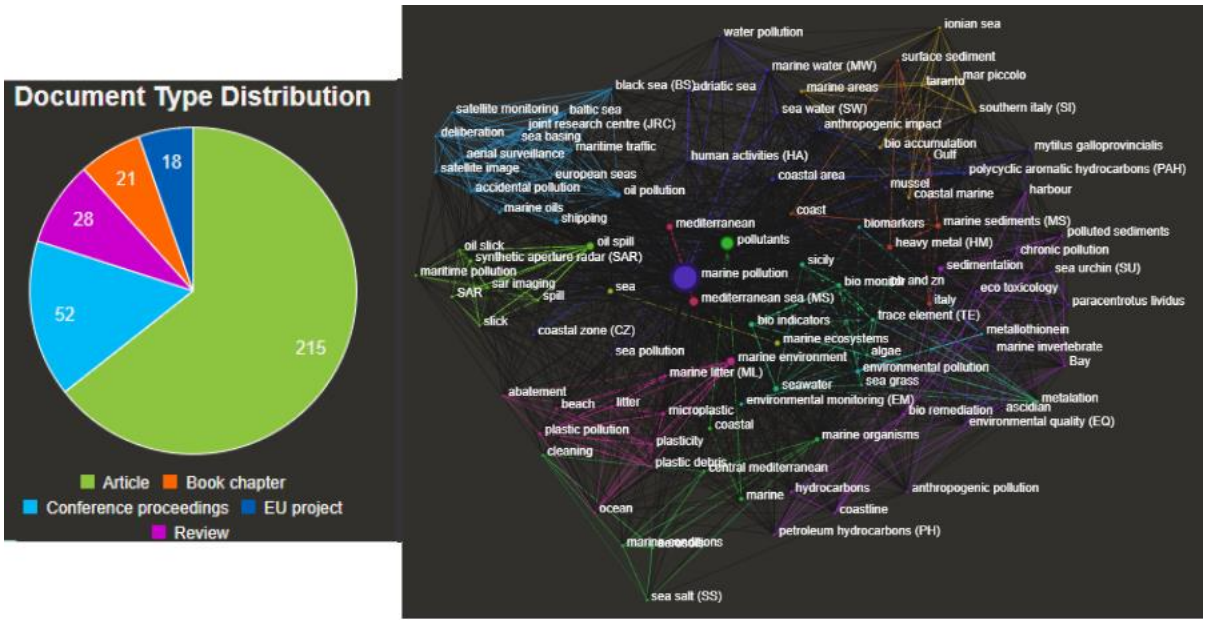


Figure 165 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

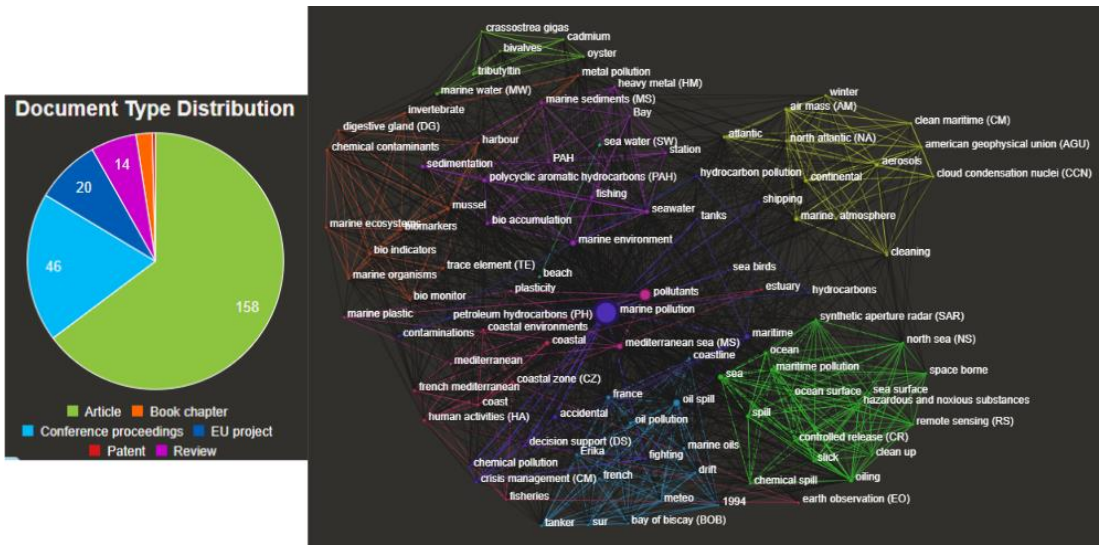
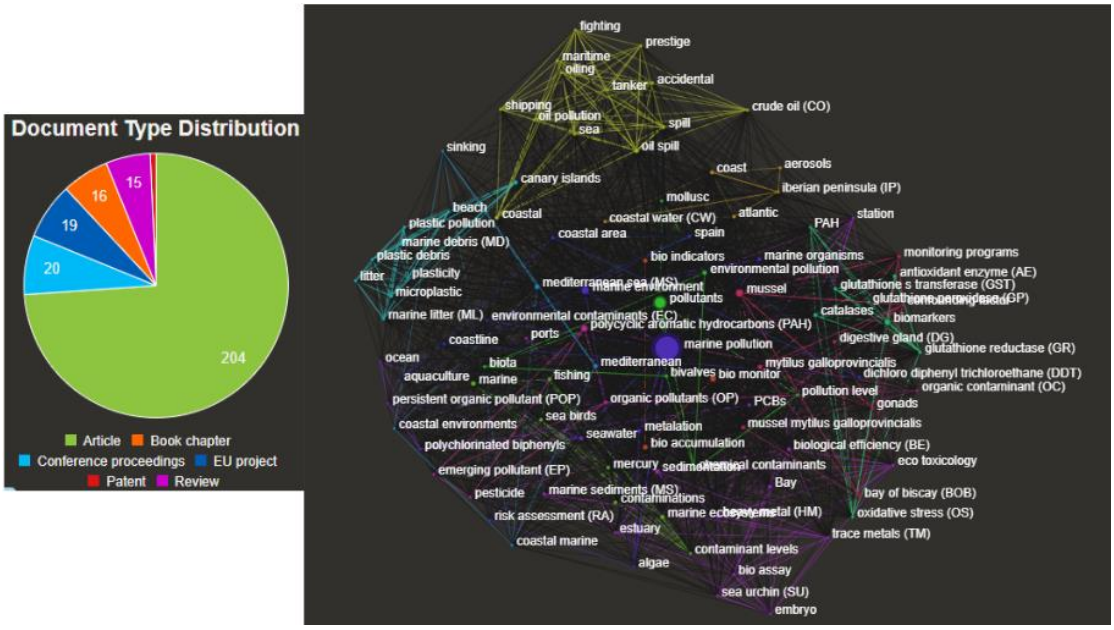


Figure 166 Remediation: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.e KEYPOINTS

- 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 AND EU FUNDED PROJECTS

- **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

6 Methodology in Brief

The selection of the patent documents has been performed using the database Orbit Intelligence (see also the report "*How to read this document* "and the chapter "References"). The queries are listed in the following table:

	Dataset	Orbit query (FamPat collection)	ND Patent families	Applications
Blue Biotechnology	**Cosmetics**	(+ALGA+ OR SEA_WEED+)/TI/AB/CLMS/ADB/ICLM/KEYW AND (A61K-036/02 OR A61K-036/03 OR A61K-036/04 OR A61K-036/05)/IPC/CPC (A61K-008 OR A61Q-019 OR A61P-017)/IPC/CPC ((SEA OR MARIN+ OR MARITIM+))/TI/AB/CLMS/ADB/ICLM/KEYW 2 AND 3 1 AND 4	833	2778
	Pharmaceutics	((DRUG+ OR ANTI_MICROB+ OR BIO_POLIM+ OR ENZYM+ OR MEDICAMENT+) 5D (SEA+ OR MARIN+ OR MARITIM+))/TI/AB/CLMS/ADB/ICLM/KEYW	191	433

		(+ALGA+ OR SEA_WEED+)/TI/AB/CLMS/ADB/ICLM/KEYW AND (A61K-036/02 OR A61K-036/03 OR A61K-036/04 OR A61K-036/05)/IPC/CPC 1 AND 2		
	Nutraceuticals	(+ALGA+ OR SEA_WEED+)/TI/AB/CLMS/ADB/ICLM/KEYW AND (A61K-036/02 OR A61K-036/03 OR A61K-036/04 OR A61K-036/05)/IPC/CPC ((SEA OR MARIN+ OR MARITIM+))/TI/AB/CLMS/ADB/ICLM/KEYW (A23V-2002 OR A23L-033)/IPC/CPC 3 AND 2 1 AND 4	654	2623

	Dataset	Orbit query (FamPat collection)	ND Patent families	Applications
Blue Biotechnology	**Soil fertilization**	(SOIL 2D (FERTIL+ OR IMPROVE+ OR CONDITION+))/TI/AB/CLMS/ICLM/OBJ (FISH)/CLMS/ICLM 1 AND 2 (3 AND (("GROUND")/KEYC OR ("ORGANIC FERTILIZER")/KEYC OR ("FERTILITY")/KEYC OR ("FERTILIZATION")/KEYC OR ("UREA")/KEYC OR ("SUPERPHOSPHATE")/KEYC OR ("WOOD ASH")/KEYC OR ("STRAW")/KEYC OR ("PHOSPHATE FERTILIZER")/KEYC OR ("PHOSPHORUS")/KEYC OR ("NITROGEN FERTILIZER")/KEYC OR ("SOIL NUTRIENT")/KEYC OR ("POTASSIUM FERTILIZER")/KEYC OR ("POTASSIUM PHOSPHATE")/KEYC OR ("FERTILIZER COMPOUND")/KEYC)) (4 AND (("GROUND")/KEYC OR ("FERTILIZATION")/KEYC OR ("BASE FERTILIZER")/KEYC OR ("COMPOST")/KEYC OR ("NITROGEN FERTILIZER")/KEYC OR ("PESTICIDE")/KEYC OR ("POTASSIUM FERTILIZER")/KEYC)) (4 AND ((("GROUND")/KEYC OR ("FERTILIZATION")/KEYC OR ("BASE FERTILIZER")/KEYC OR ("COMPOST")/KEYC OR ("NITROGEN FERTILIZER")/KEYC OR ("PESTICIDE")/KEYC OR ("POTASSIUM FERTILIZER")/KEYC) OR (("SOIL FERTILITY")/KEYC OR ("SOIL CONDITIONER")/KEYC OR ("SOIL AMENDMENT")/KEYC OR ("PLANT GROWTH")/KEYC))) 5 AND 6 2 AND 7 PRD >= 2017 8 AND 9	530	631
	Sea organisms' genetics	(MARIN+ OR MARITIM+ OR SEA_WATER) 2D (ORGANISM+ OR LIVING OR BIOLOG+ OR CREATUR+ OR ANIMAL OR SEA_WEED+ OR ALGA+ OR MICRO_ALGA+ OR +ALGA+ OR FISH)) 10D ((GENET+ OR GENOM+ OR GENE OR GENES))/TI/AB/CLMS/OBJ/ICLM/KEYW	203	364
	Biofuels	(((ALGA+ OR MICRO_ALGA+) 5D (BIO_DIESEL OR BIO_ETHANOL OR BIO_FUEL+))/TI/AB/CLMS/ICLM/ADB/KEYW AND (MARIN+ OR MARITIM+ OR SEA)/TI/AB/CLMS/OBJ/DESC/ODES/ADB/KEYW/ICLM/TX) AND (Y02E-050/10)/IPC/CPC	364	1219

	Dataset	Orbit query (FamPat collection)	ND Patent families	Applications
Blue Biotechnology	**Seawater purification**	(C02F-2101 OR C02F-2103 OR C02F-001 OR C02F-003 OR Y02W-010)/IPC/CPC ((SEA OR SEA_WATER) 5D (POLLUT+ OR CONTAMINAT OR WASTE_WATER OR SLUDGE))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW	503	875

		(REMED+ OR RECLAM+ OR CLEAN+ OR DE_CONTAM+ OR PURIF+)/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW PRD=2017-01-01:2020-12-21 1 AND 2 AND 3 AND 4		
	Remediation	(+ALGA+ OR SEA_WEED+)/TI/AB/CLMS/ADB/ICLM/KEYW (B09C-001 ORC09K-017 OR B09B-003)/IPC/CPC 1 AND 2 PRD=2015-01-01:2021-03-02 3 AND 4	476	2390
			3754	**11313**

7 Online visualizations

For each sector analyzed in this report, you can access to the online dashboards realized by means of the MS software Power BI at the following links:

Blue Biotechnology	BIOFUELS	https://app.powerbi.com/view?r=eyJrIjoiNTE5MDYwNzEtNDk4MS00MTQ5LTg4YTctZmIyNmMyZjY3MTdjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	COSMETICS	https://app.powerbi.com/view?r=eyJrIjoiY2NjZDUzZTctZjmNi00ODE5LTliNDUtZDAyNTY5OTU2ZDRjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	NUTRACEUTICALS	https://app.powerbi.com/view?r=eyJrIjoiM2ZiZGQ0MjctZDM1NC00NDVlLTgzZjMtNzI0NzEyZmM1Y2M4IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	PHARMACEUTICS	https://app.powerbi.com/view?r=eyJrIjoiMmYxNzYxMzQtMzA3ZC00ZGU0LTlhZmMtNzU5NWVjNzZhY2E4IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	ENVIRONMENTAL REMEDIATION	https://app.powerbi.com/view?r=eyJrIjoiNThmMDg4MzMtZDcxMy00MjNlLTg1OWYtZTE3YWIwN2EwODhlIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SEA ORGANISMS' GENETICS	https://app.powerbi.com/view?r=eyJrIjoiYWYyZmQ1NGItZTNiZC00ZTcyLWJhYzAtNDViNWRkMjJjZWRhIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9

	SEAWATER PURIFICATION	https://app.powerbi.com/view?r=eyJrIjoiMzdkNjZjNWItMzg2OS00YzQxLWFiNzItOTRhYmFjODM3YzJlIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SOIL FERTILIZATION	https://app.powerbi.com/view?r=eyJrIjoiY2Y5MWNiMmQtYWM0MS00YTQ3LWJiNGUtOTkxZWNkNjgyOTI5IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9

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b) Agriculture, Livestock, Food processing

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Book. State of the art assessment and overview on the most relevant drivers and opportunities in the Mediterranean Blue Economy. MISTRAL project, Deliverable D3.1.2; DOI 10.5281/zenodo.3242281
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[3] BCC Research (https://www.bccresearch.com/) report "Global Markets for Animal Therapeutics and Diagnostics", March 2020.
[4] BCC Research (https://www.bccresearch.com/) report "Global Markets for Agrochemicals", January 2020.

c) Industrial processes and manufacturing

[1] Markets and Markets Knowledge Store (https://www.mnmks.com/) report "Genomics Market - Global Forecast to 2025", January 2021.

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[3] BCC Research (https://www.bccresearch.com/) report "Biodiesel Feedstocks: Technologies, Synthesis, Efficiency and Policies", March 2020.

e) Bio-monitoring and bio-remediation

[1] Francocci F., Paifelman E., Ciappi E., Cedre A., Le Corff C., Ruel C., Efstratiou C., Falini G., Giannakourou A., Solano-Lopez J.M., Strogyloudi E., Raddadi N., Pistocchi R., Valentini S. and Barbanti A., 2019. MISTRAL Blue Growth Book. State of the art assessment and overview on the most relevant drivers and opportunities in the Mediterranean Blue Economy. MISTRAL project, Deliverable D3.1.2; DOI 10.5281/zenodo.3242281
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Patent Landscape datasets:

- **Derwent Innovation™** e **Derwent World Patents Index™ (DWPI)** - Patent database provided by Clarivate Analytics. DWPI covers more than 32.5 million inventions (patent deposits and families) for a total of more than 70 million patent documents (December 1, 2016). The experts in Derwent's editorial team manually analyze, summarize and index each patent record, making it easier and faster for analysts to find the information. Time coverage: from 1963 to the present. https://clarivate.com/derwent/about-derwent/).
- **Orbit Intelligence.** Patent database provided by Questel. It is a daily updated system that includes over 54 million patent families and 100 million patent documents with worldwide coverage. Further details can be found at URL: https://www.questel.com/data-coverage/.
- **Patstat Online.** The PATSTAT product line consists of two individual databases. They are available as a bulk data set or via PATSTAT Online (https://data.epo.org/expert-services/index.html), a web-based interface to the databases. PATSTAT Global contains bibliographical data relating to more than 100 million patent documents from leading industrialised and developing countries. It also includes the legal event data from more than 40 patent

authorities contained in the EPO worldwide legal event data (INPADOC). Patstat EP Register contains bibliographic and legal event data on published European and Euro-PCT patent applications. For the present analysis the Spring 2020 edition has been consulted.

- **Espacenet:** An instrument developed by the European Patent Office (EPO) and the member states of the European Patent Organisation, which contains more than 110 million patents from the 19th century to the present day, belonging to more than 90 patent authorities. The system is updated daily and is freely accessible (https://www.epo.org/searching-for-patents/technical/espacenet.html).

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