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

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

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

Deliverable 3.2.3	**Technology and market forecast**
Description	The report highlights the technology and market future trends for the different sectors pertaining the blue bioeconomy and their linkages with the Sustainable Development Goals. The deliverable is structured into different sections: 1. *Introduction* 2. *How to read this document* 3. *Technology forecast and importance of SDGs in Blue Bioeconomy* **4. *Complete report on patent and NPL analysis*** - *Part I: Fishery and Aquaculture* - *Part II: Blue Biotechnology* - ***Part III: Blue Sustainable Development*** 5. *Key points on Patent and NPL* 6. *Final remarks*
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Index

4. Complete report on patent and NPL analysis

Part III: Blue Sustainable Development

1.a BLUE SUSTAINABLE DEVELOPMENT → Monitoring and Observing systems for Marine Environment: MARKET SCENARIO

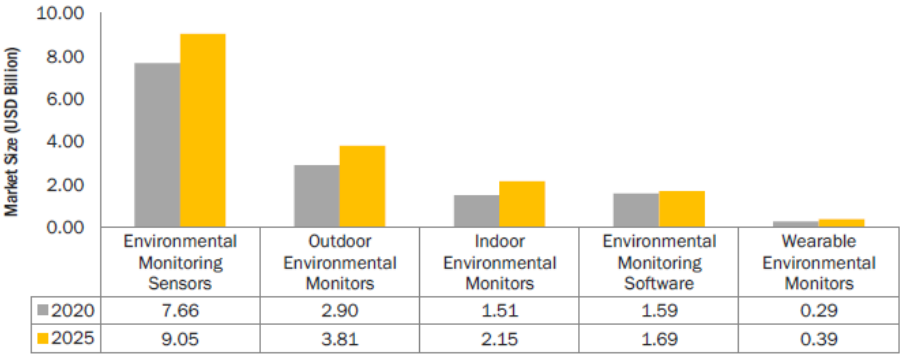
a1) Monitoring and Observing systems for Marine Environment → Maritime surveillance

The **Monitoring and Observing systems of the marine environment** sub-sector aims at the prevention and identification of activities that can cause different impacts on the marine environment such as pollution, oil spill and illegal fisheries. Moreover, it involves the active monitoring of human activities to assure a better management of marine based industries, for example fishery and aquaculture. Those services can be achieved through the integrated contribution provided by several maritime surveillance systems implemented thanks to a widespread database management and innovative applications of the information technologies.

The consistent growth of the **environmental monitoring** market is driven by several factors such as the constantly rising levels of pollution, a favourable regulatory scenario, the ongoing installation of environmental monitoring stations and the increasing public awareness about marine pollution.

Globally, the **environmental monitoring market** is projected to reach USD 17.10 billion by 2025 from USD 13.96 billion in 2020 at a CAGR of 4.1%% for the forecasted period 2020 - 2025. The market shares may be ascribed to different product types such as the monitoring sensors, software, and outdoor or indoor monitors. Overall, the environmental sensors segment, defined as remote sensing products used for indirect pollution assessment of inaccessible areas, holds the main market share, followed by the outdoor environmental monitoring systems [3].

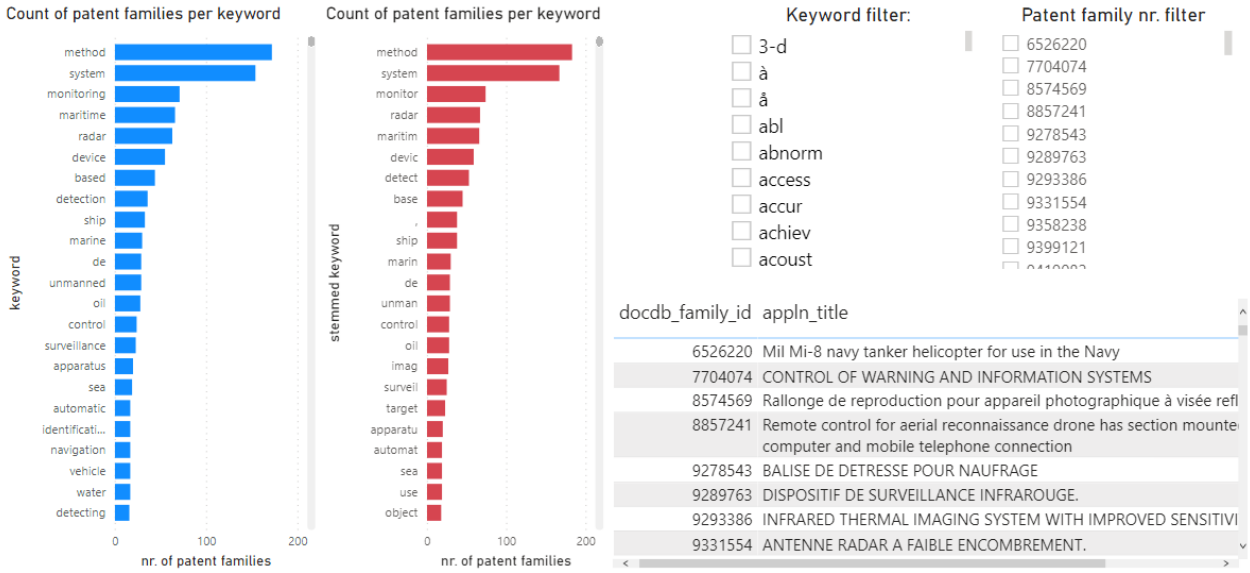
Figure 1 Environmental Monitoring Market, by Product Type, in the Period 2020 - 2025 valued in United States Dollar (USD) Billion



	Environmental Monitoring Sensors	Outdoor Environmental Monitors	Indoor Environmental Monitors	Environmental Monitoring Software	Wearable Environmental Monitors
2020	7.66	2.90	1.51	1.59	0.29
2025	9.05	3.81	2.15	1.69	0.39

From the perspective of the patent analysis, a dataset consisting of **470 non-duplicated patent families** corresponding to **1050 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 2.

Figure 2 Maritime surveillance: keywords' frequency

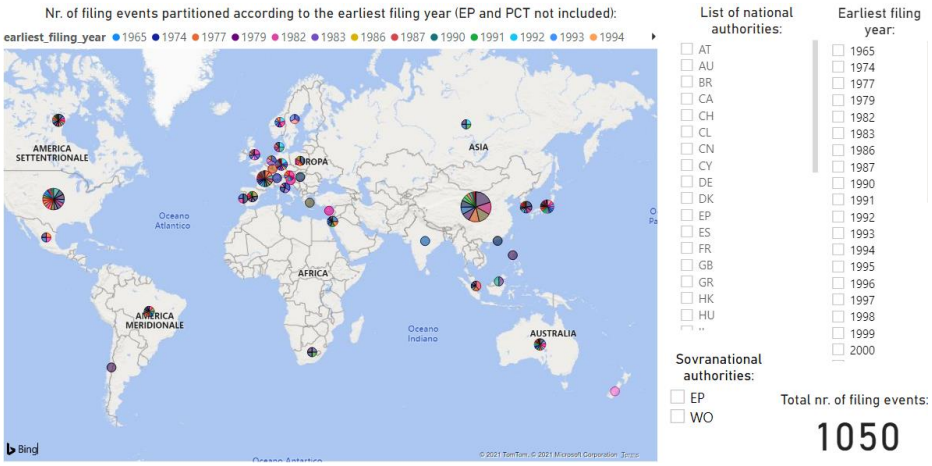


As already observed and mentioned in the document "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding **the maritime surveillance**. The patent authorities located in the Asian Pacific region, especially in China, as well as the USPTO[1] score the highest numbers of filing events. In the Mediterranean region, the French patent authority scores 85 patent applications, while several

[1] United States Patent and Trademark Office

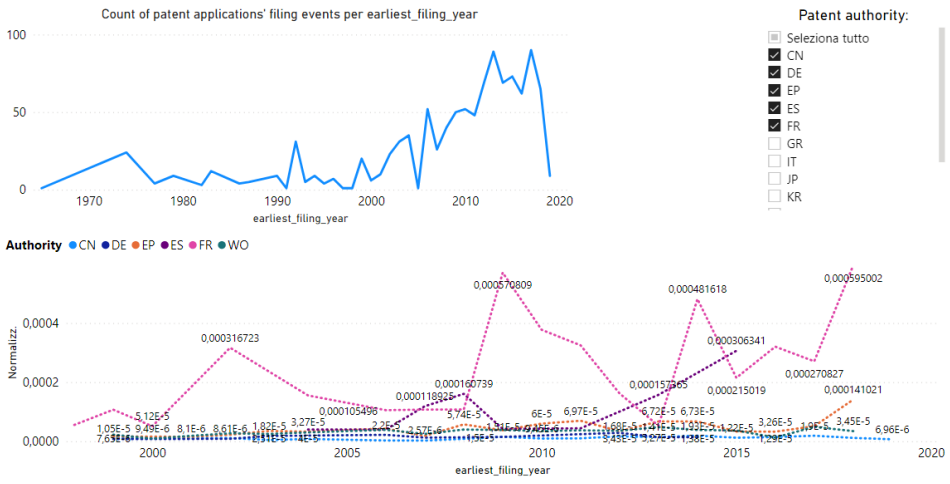
European patent authorities are addressee of patent applications. Looking at the number of patent applications registered by EPO (102) and WIPO (107), the data suggests that the protection of technical innovation in a multiplicity of territories by means of harmonized filing procedures deserves relevant consideration (Figure 3).

Figure 3 Maritime surveillance: 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, peaking between yr. 2013 and 2017. Even if the absolute number of patent applications filed to the CNIPA/SIPO (256) seems more relevant than the total number of applications filed to the EPO (102) or the number of applications filed to the French authority (85), the analysis of the normalized data reveals that the proportion of the applications filed to the French patent authority is by far more consistent than the proportion of patent applications filed to any other authority. A relatively higher proportion can be detected as far as the applications filed to the Spanish patent authority are concerned, but in this case the trend appears more discontinuous.

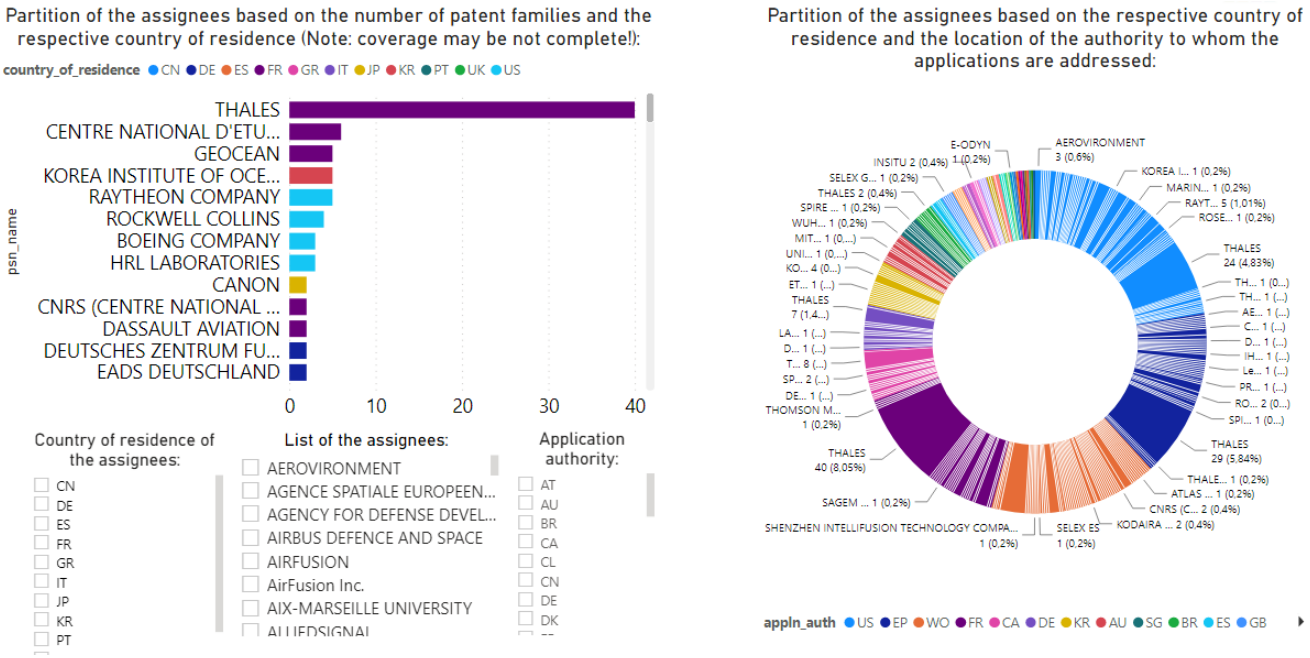
Figure 4 Maritime surveillance: Normalization of patent applications



As far as the territorial distribution of the applicants' premises is concerned, **many applicants located in France, several ones located in Italy and in Spain 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 Maritime surveillance: Legal protection strategy



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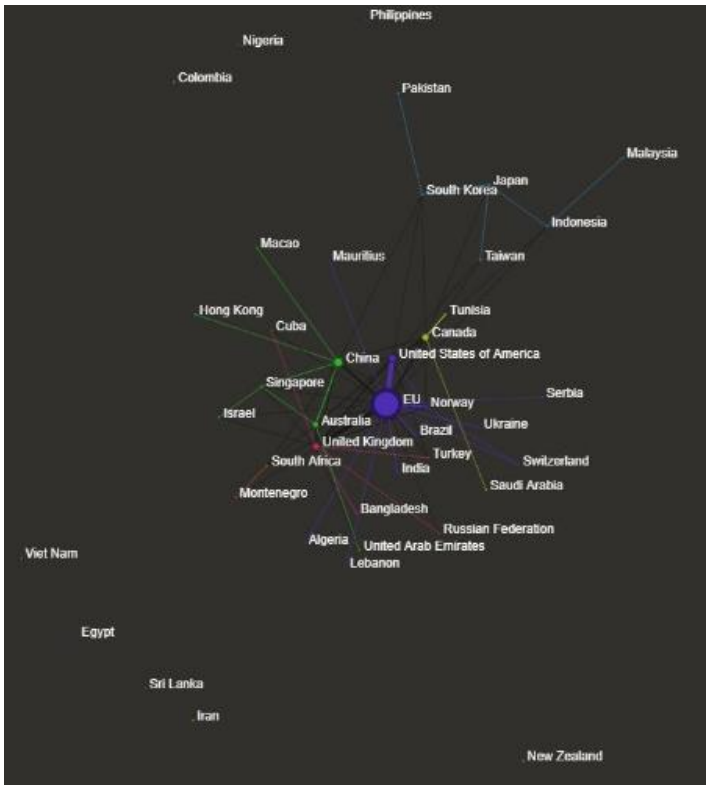
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries (Figure 3) may be argued, basic research activities, monitored by analyzing other divulgation modalities, 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 6.

Figure 6 Maritime surveillance: NPL data worldwide



a2) Monitoring and Observing systems for Marine Environment → Marine mapping

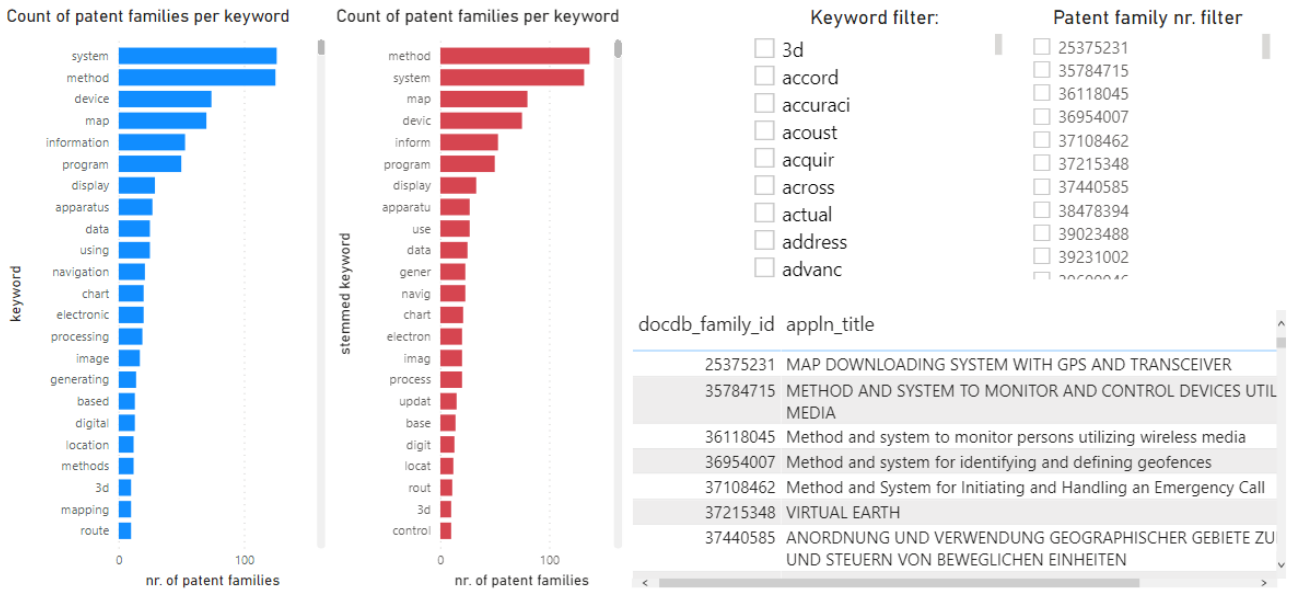
Oceanographic and river mapping study is a scientific application of unmanned surface vehicles. These vehicles record oceanographic data across a range of variables.
The global oceanographic and river mapping study segment is projected to grow at a CAGR[2] of 14.09% between 2018 and 2023, reaching a total value of USD 112.4 million [3].

From the perspective of the patent analysis, a dataset consisting of 309 non-duplicated patent families corresponding to 886 patent applications has been analyzed. The applications' filing timeframe has been chosen such that the priority year spans the interval 2015 ÷ oct. 2020. 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 7.

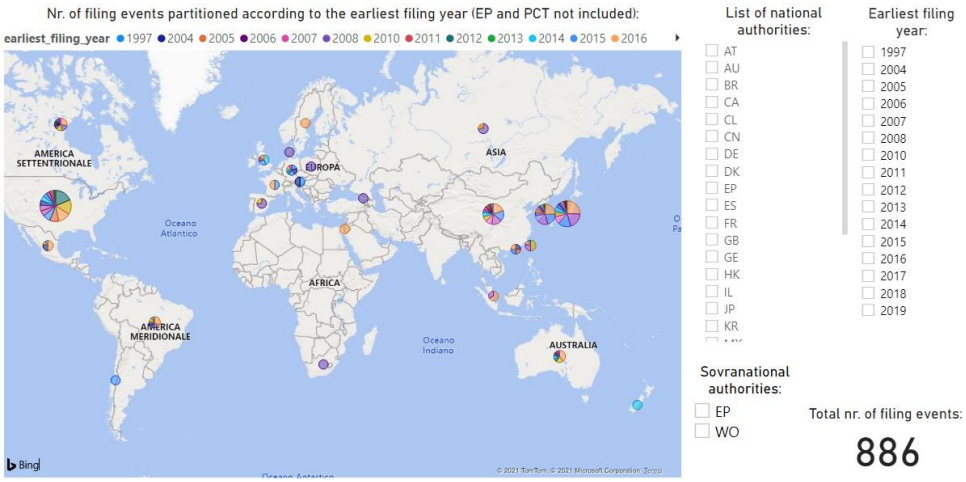
[2] Compound Annual Growth Rate

Figure 7 Marine mapping: keywords' frequency



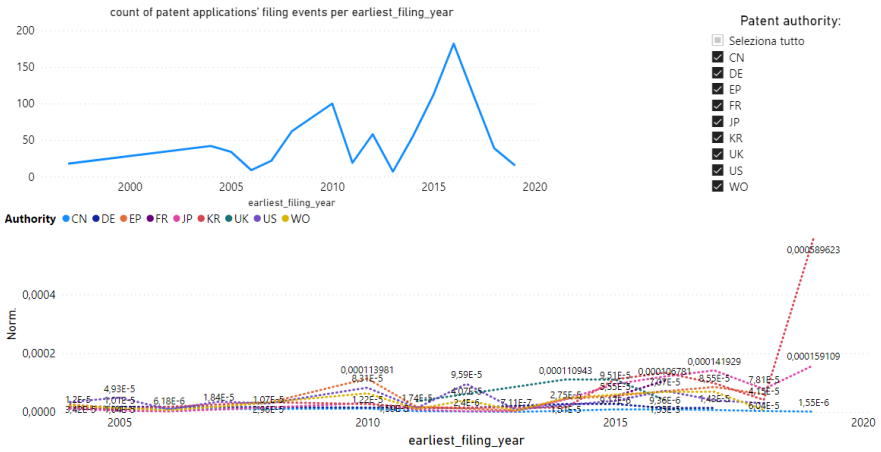
As already observed and mentioned in "*Technology forecast and importance of SDGs in Blue Bioeconomy*", the analysis has been focused on the legal protection of technical innovation regarding **the technologies dealing with geographical maps**.

Figure 8 Marine mapping: Map of national/supranational patent authorities



As can be noticed in Figure 9, the total number of patent applications seems remarkable, peaking in yr. 2016 (182 patent applications). The absolute number of patent applications filed to the CNIPA[3]/SIPO (107), to the Korean patent authority (102), to the Japanese patent authority (154) or to the USPTO (205) is higher than the applications filed through harmonized procedures such as the EP patent applications (71) or the PCT patent applications (94). Therefore, as far as the mapping technologies are concerned, specific territories may be considered appealing markets and it is possible that some players do not consider as a priority the protection of their invention in a multiplicity of territories. On the other hand, when examining the normalized data, the proportion of patent applications filed to each of the patent authorities mentioned above appears equivalent, therefore it can be argued that the commercial exploitation of the technical implementations may be considered appealing worldwide.

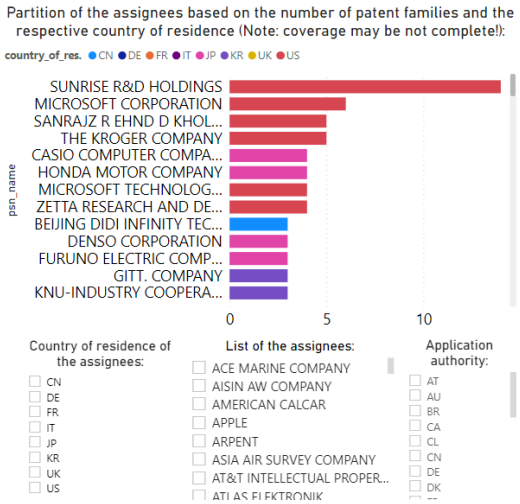
Figure 9 Marine mapping: Normalization of patent applications

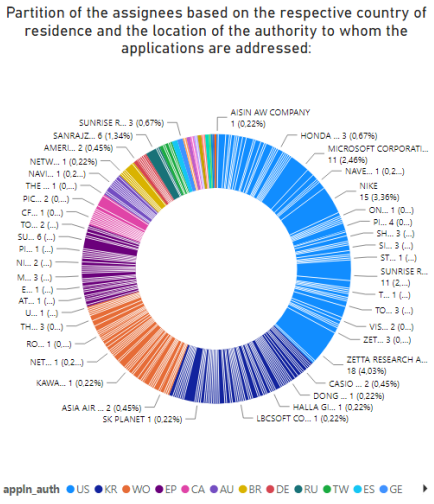


As far as the territorial distribution of the applicants' premises is concerned, few applicants located in France and in Italy can be detected. The rightmost pie diagram of Figure 10 provides valuable information regarding the protection strategies, confirming that the European applicants take in due consideration the possibility of filing applications either to the EPO or to the WIPO.

Figure 10 Marine mapping: Legal protection strategy

[3] China National Intellectual Property Administration





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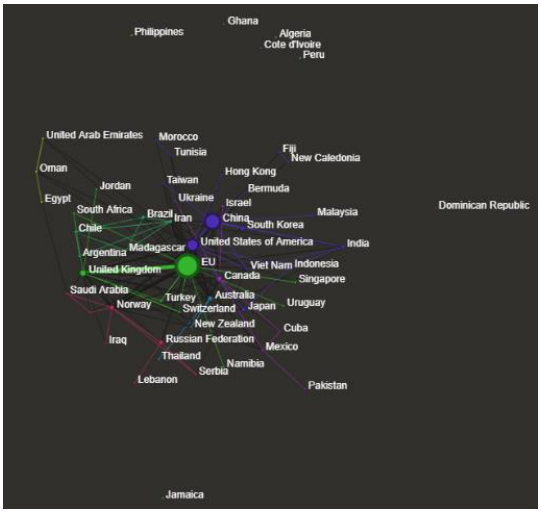
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries (Figure 8) may be argued, basic research activities, monitored by analyzing other divulgation modalities, 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 11.

Figure 11 Marine mapping: NPL worldwide data



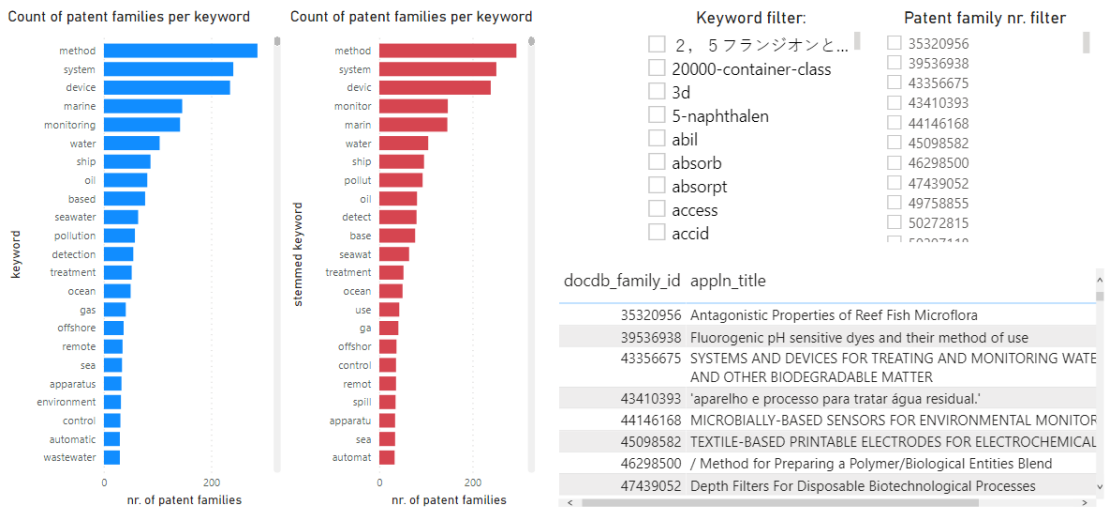
a3) Monitoring and Observing systems for Marine Environment → Seawater sensors

Among the Monitoring and Observing systems of the marine environment sector, **Unmanned surface vehicles (USV)** are used to measure water quality, temperature, salinity, pH values, and currents, in addition to understanding the dynamics of the ocean through the use of **sensors**. USVs can autonomously navigate and collect information with respect

to water quality, which is relayed back to operators on the shore in real-time. They also enable both inland and offshore hydrographic surveys by collecting high-quality and high-resolution ocean data. Currently there is increasing use of USVs for water quality monitoring and ocean data mapping, which, in turn, is expected to drive the growth of the unmanned surface vehicle market, globally. The **sensors market segment for USV** is expected to reach the value of USD 70.3 million in 2023 globally, growing at a CAGR of 14.8 % in the period 2018 – 2023. Other payloads include conductivity, Temperature and Depth (CTD) sensors, pollution monitoring sensors, warning systems, automatic target detection systems and wind sensors. The global market segment for these other types of sensors is projected to reach USD 19.7 million by 2023, at a CAGR of 12.24% between 2018 and 2023. In **Europe** the market for USV is expected to reach the value of USD 253 million in 2023, growing at a CAGR of 15.2% in the period 2018 – 2023. In the **Mediterranean area** the most relevant market players are France and Italy [3].
Focusing on the environmental applications, the **water pollution monitoring** sector is the second-largest market followed by the air pollution monitoring. In Europe, Germany is leading the sector, followed by France due to the relevant commitment of both countries in fields such as industry, military surveillance, smart city projects and healthcare [1].

From the perspective of the patent analysis, a dataset consisting of **897 non-duplicated patent families** corresponding to **1329 patent applications** has been analyzed. The applications' filing timeframe encompasses the priority year 2017 until jun. 2021. 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 12.

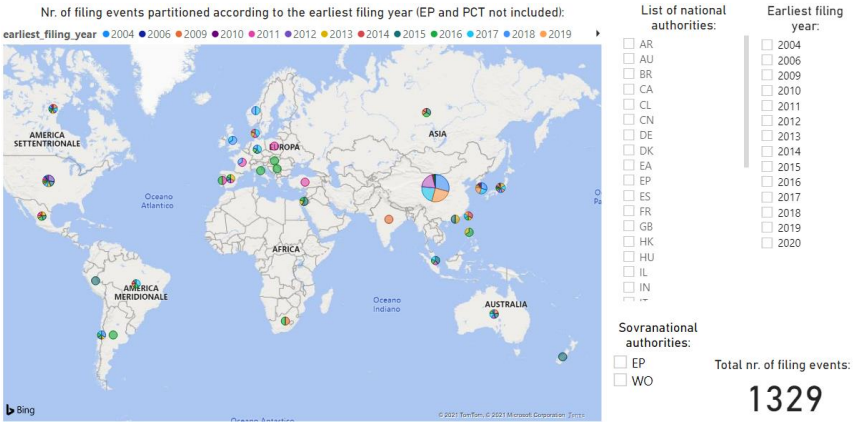
Figure 12 Seawater sensors: keywords' frequency



As can be noticed in Figure 13, the total number of patent applications seems remarkable, peaking between the years 2017 and 2019. The absolute number of patent applications filed to the CNIPA/SIPO (762), to the Korean patent authority (122), to the Japanese patent authority (48) or to the USPTO (136) is higher than the applications filed through harmonized procedures such as the EP patent applications (58) or the PCT patent applications (77). Therefore, as far as the technologies dealing with monitoring of sea by means of sensors are concerned, specific territories may be considered appealing markets and it is possible that some players do not consider as a priority the protection of their invention in a multiplicity of territories, a situation already observed in the sector concerning the geographic maps. On the

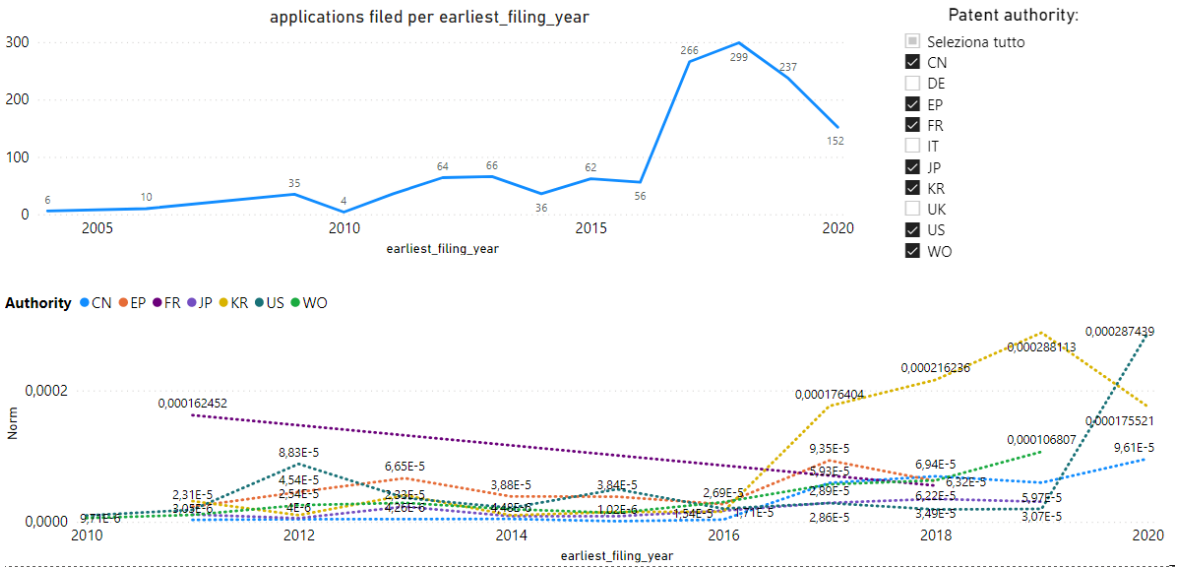
other hand, when examining the normalized data, when excluding the Korean authority, the proportion of patent applications filed to each of the patent authorities mentioned above appears equivalent, therefore it can be argued that the commercial exploitation of the technical implementations may be considered appealing worldwide. It appears that the proportion is particularly significant as far as the Korean authority is concerned.

Figure 13 Seawater sensors: Map of national/supranational patent authorities



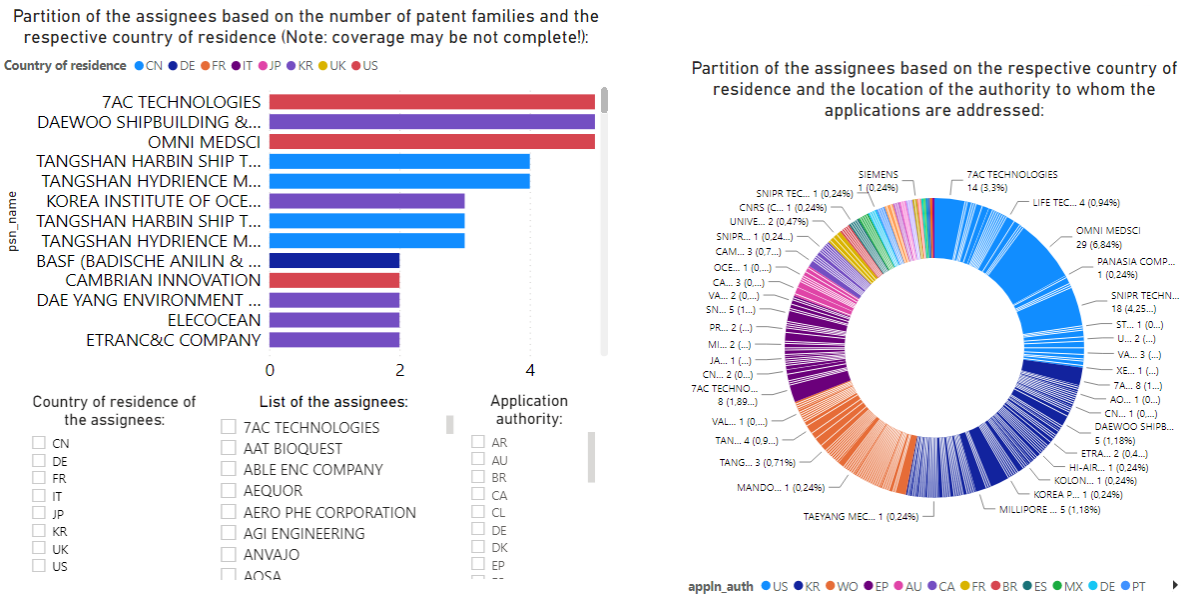
On the other hand, when examining the normalized data, when excluding the Korean authority, the proportion of patent applications filed to each of the patent authorities mentioned above appears equivalent, therefore it can be argued that the commercial exploitation of the technical implementations may be considered appealing worldwide. It appears that the proportion is particularly significant as far as the Korean authority is concerned (Figure 14).

Figure 14 Seawater sensors: Normalization of patent applications



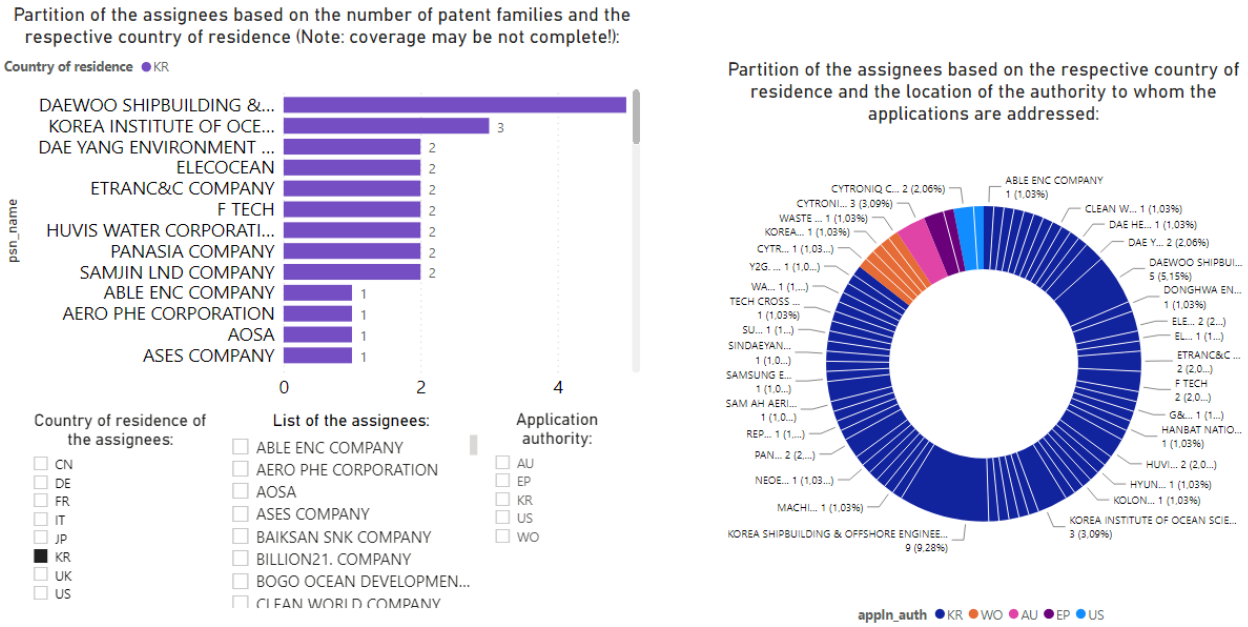
As far as the territorial distribution of the applicants' premises is concerned, **most applicants are headquartered in South Korea** and in the **USA**. The rightmost pie diagram of Figure 15 provides valuable information regarding the protection strategies, confirming that the European applicants take in due consideration the possibility of filing applications either to the EPO or to the WIPO.

Figure 15 Seawater sensors: Legal protection strategy



As far as the strategy adopted by most Korean players is concerned, is appears quite clearly that the patent applications are predominantly filed to the KIPO (Figure 16).

Figure 16 Seawater sensors: Legal protection strategy (focusing on South Korean applicants)



Few applicants may be detected being headquartered in European countries (Germany, UK, France and Italy).

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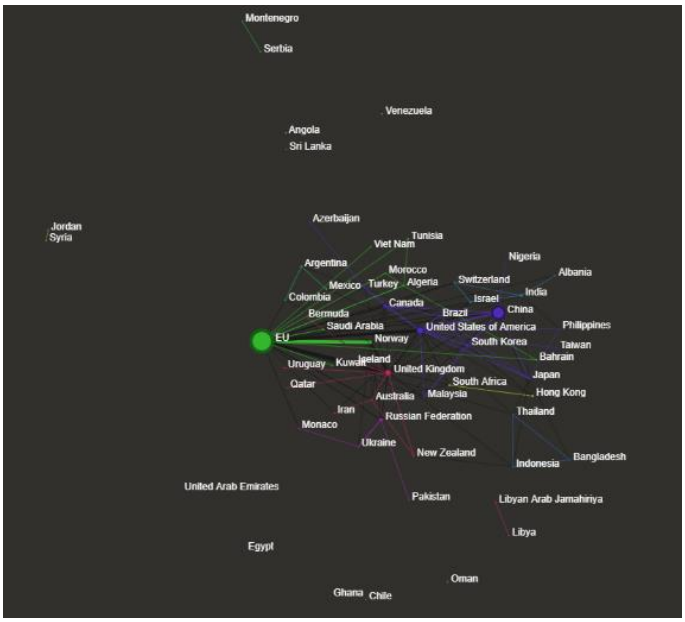
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or several Asian countries (Figure 13) may be argued, basic research activities, monitored by analyzing other divulgation modalities, 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 17.

Figure 17 Seawater sensors: NPL data worldwide



a4) Monitoring and Observing systems for Marine Environment → Unmanned underwater vehicles (UUV)

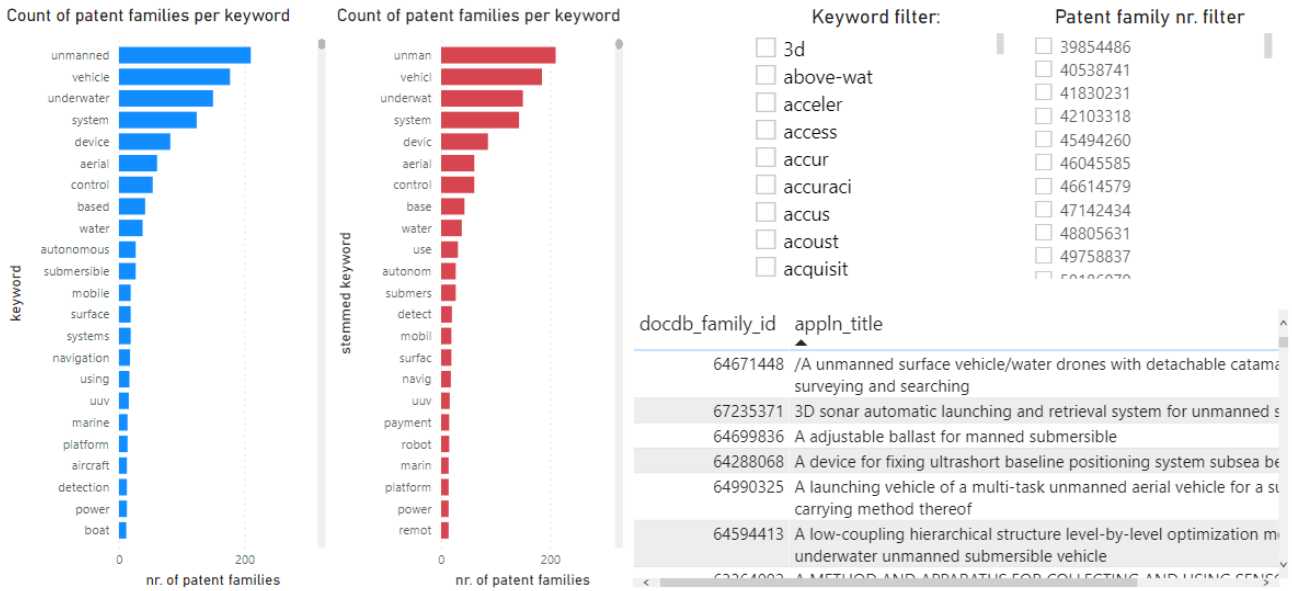
Another emerging sector related to monitoring and observation of the marine environment is based on the development of the **autonomous underwater vehicles (AUV)**, a category of **Unmanned Underwater Vehicles (UUVs),** based on devices that can travel underwater without requiring input from an operator. AUVs are fast becoming accepted as highly useful data gathering platforms within the worldwide marine science community, and are used for monitoring, geophysical surveys and oil and gas exploration. AUVs made more convenient the ocean exploration and sampling having importantly contributed to the increase of the availability, quality, and quantity of scientific marine data. These UVs contribute gather a wide series of information from the 3 dimensionality of the water masses and are efficiently used for oceanographic monitoring and mapping. In particular, AUVs can also be equipped with visual cameras and multibeam for high resolution images and seabed mapping that are used to inform oceanographic models, might help defining areas of great ecological relevance (essential fish habitats), support monitoring of reefs and managing deep sea issues (wrecks, accidents). Maritime industries are also utilizing UUVs for applications such as offshore oil production and exploration. Overall, the **market of AUVs** is valued at USD 3,260 million in 2020 with a projected value of USD 4,380 million in 2025 and a CAGR of 6.6% between 2020 and 2025. However, in **Europe** this market is still at its early-stage, while in contrast the USA and the Asian Pacific region are leading the sector. This market in Europe is expected to reach the total value of USD 908 millions by 2025, growing at a CAGR of 9.3 % during the forecast period 2020 – 2025 [2].

In the field of hydrographic survey, **Multi-Beam Eco Sounders** (MBES) are a type of sonar used to map the seabed. MBES have become an important tool for depth measurement purpose and hydrographic studies. (Hydrographic survey equipment market)

Anti-submarine Warfare (ASW) generally focuses on mitigating and eliminating enemy diesel-electric submarines from transit routes and protecting High Value Units (HVUs), such as amphibious warfare ships and logistic ships. For the naval forces of any country, establishing and maintaining highly effective anti-submarine warfare capabilities are crucial, which, in turn, leads to increased demand for unmanned surface vehicles. The anti-submarine warfare segment is projected to grow at a CAGR of 14.48% between 2018 and 2023 [3].

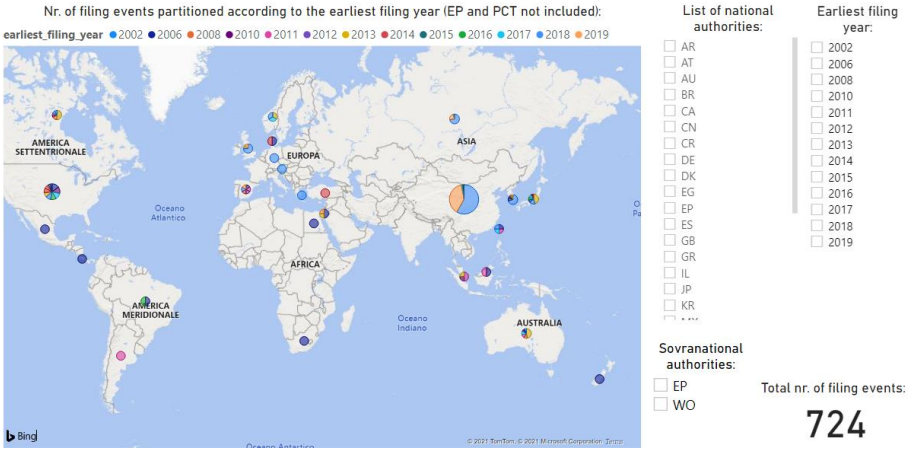
From the perspective of the patent analysis, a dataset consisting of **504 non-duplicated patent families** corresponding to **724 patent applications** has been analyzed. The applications' filing timeframe encompasses the priority year 2018 until sept. 2020. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 18.

Figure 18 UUV: Keywords' frequency



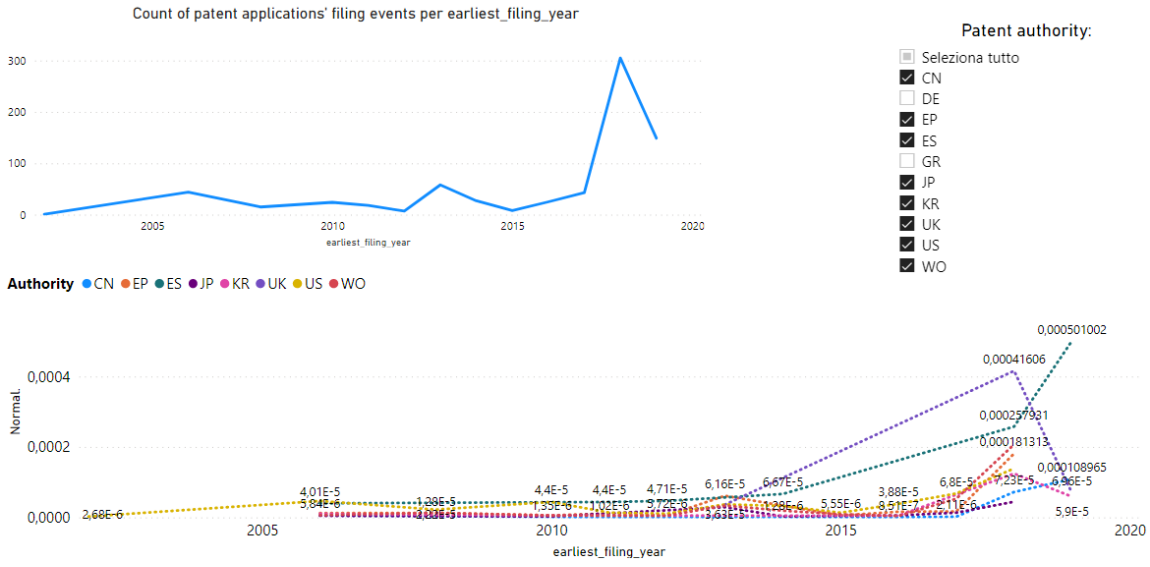
As can be noticed in Figure 19, the total number of patent applications seems remarkable, peaking between the years 2017 and 2019. The absolute number of patent applications filed to the CNIPA/SIPO (364) and to the USPTO (126) is higher than the applications filed through harmonized procedures such as the EP patent applications (36) or the PCT patent applications (63). Therefore, as far as the technologies dealing with UUV are concerned, specific territories may be considered appealing markets and it is possible that some players do not consider as a priority the protection of their invention in a multiplicity of territories, a situation already observed in the sectors concerning the geographic maps and especially in the sector dealing with the seawater sensors.

Figure 19 UUV: Map of national/supranational patent authorities



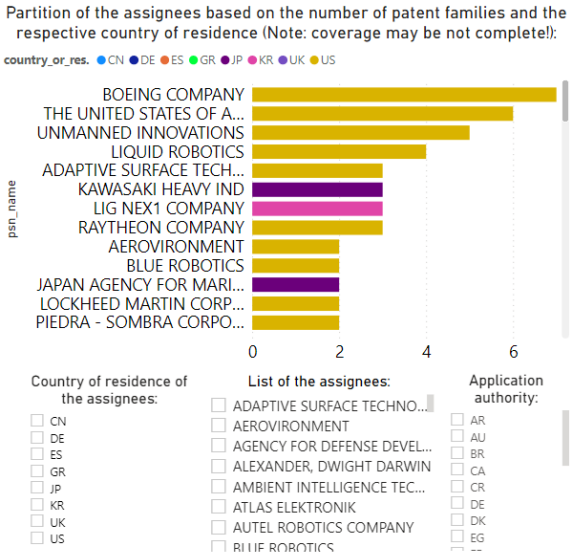
On the other hand, when examining the normalized data, it appears that the highest proportions of patent applications are filed to the Spanish and to the UK patent office, respectively (proportion refers to the number of patent applications specifically dealing with the UUV/number of patent applications whatever the technical sector is). (Figure 20).

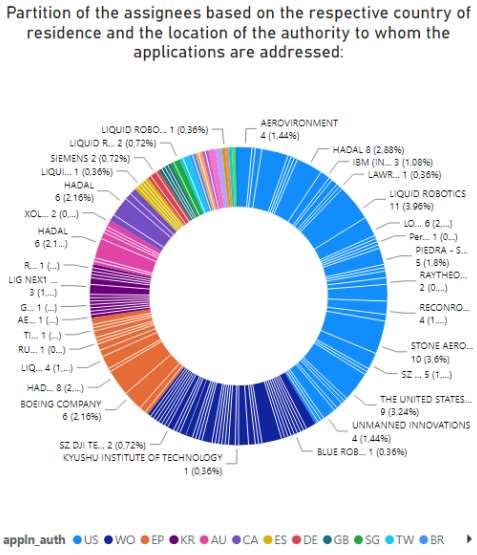
Figure 20 Normalization of patent applications



As far as the territorial distribution of the applicants' premises is concerned, **most applicants are headquartered** in the **USA**, yet some may be found in Greece and Spain. The rightmost pie diagram of Figure 21 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 21 UUV: Legal protection strategy





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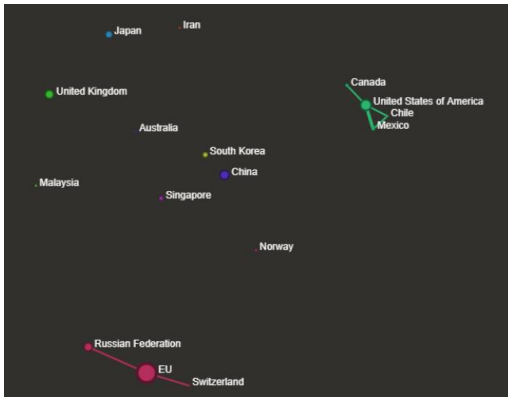
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the USA or China (Figure 19) may be argued, basic research activities, monitored by analyzing other divulgation modalities, such as the scientific publications, the books, the reviews, the conference proceedings and the EU funded projects appear as well ongoing but within a limited number of countries. On the one hand initiative may be concentrated in EU countries, Russian Federation and Switzerland, while on the other hand relevant initiatives are detectable in USA, Canada, Mexico and Chile, as evident from Figure 22.

Figure 22 UUV: NPL data worldwide



1.a KEYPOINTS

- As far as all subsectors belonging to the “Monitoring and Observing systems for Marine Environment” sector are concerned, it appears relevant how often the patent applications are directly filed to the national authorities, especially the CNIPA/SIPO and the USPTO, without neglecting the KIPO and the JPO, while the numbers of applications filed through harmonized procedures is lagging behind.

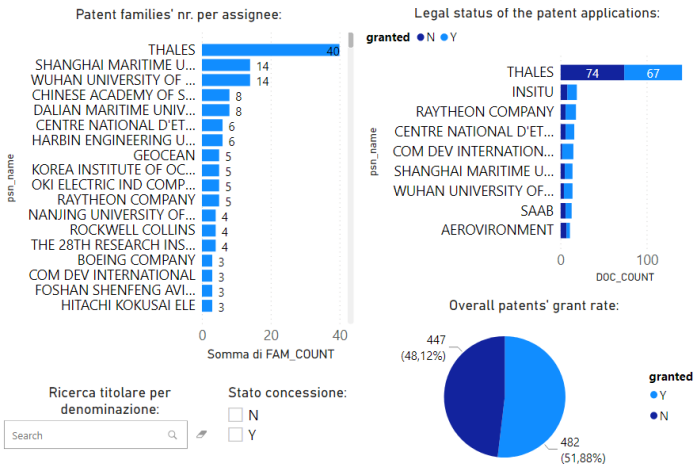
- As will be better ascertained through the analysis dedicated to the legal data, one possible explanation is that in each subsector the technical implementations described in the patent documents are usually innovative, therefore the definition of the territorial coverage is still not complete.
- Although relevant players may be headquartered in the USA or in South Korea, the advice is to include, among the players to be periodically monitored, also some French (especially THALES, as far as the maritime surveillance subsector is concerned) or several Spanish ones.
- As usually observed, the initiatives of the European players can be better appreciated when the assessment is based on the NPL divulgation forms. The UUV subsector may provide an exceptional picture in which a restricted pool of countries results particularly involved in the R&D activities, the role of the eastern countries – excluding China - appearing marginal if compared to the situation of the EU and of the USA.

2.a BLUE SUSTAINABLE DEVELOPMENT: THE LEGAL INFORMATION ARGUABLE FROM THE PATENTS' DATASETS

a1) Monitoring and Observing systems for Marine Environment → Maritime surveillance

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 23. 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 less than 50%.

Figure 23 Maritime surveillance: Ranking of the applicants based on the patent application number and grant rate

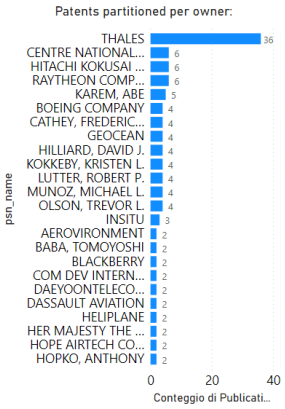


The French player Thales appears as the most prominent applicant and assignee of granted patents. Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail the patent 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 24. There may be other French, Korean and US players worth of consideration and the fraction of patents already expired is quite low (pls. refer to negative values of 'Expiry days' in

the original dashboard), thus suggesting that the technological implementations claimed most patents may be truly innovative.

Figure 24 Maritime surveillance: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
THALES	FR3083633	6460	2
THALES	FR3082666	6444	2
THALES	FR3082007	6426	2
THALES	FR3081053	6403	2
THALES	FR3079296	6355	2
THALES	FR3077452	6306	3
SAFRAN ELECTRONICS & DEFENSE	FR3074342	6242	3
THALES	FR3070768	6153	3
THALES	FR3065297	6013	2
DASSAULT AVIATION	FR3063715	5977	2
DASSAULT AVIATION	FR3063819	5977	2
SAFRAN ELECTRONICS & DEFENSE	FR3059127	5866	4
THALES	FR3051559	5684	4
THALES	FR3050829	5663	3
THALES	FR3050538	5656	3
THALES	FR3050279	5653	3
ATMOSPHERE SYSTEMES ET	FR3049145	5619	3



The results of the assessment of the triadic families are shown in Figure 25.

Figure 25 Maritime surveillance: some of the Triadic families

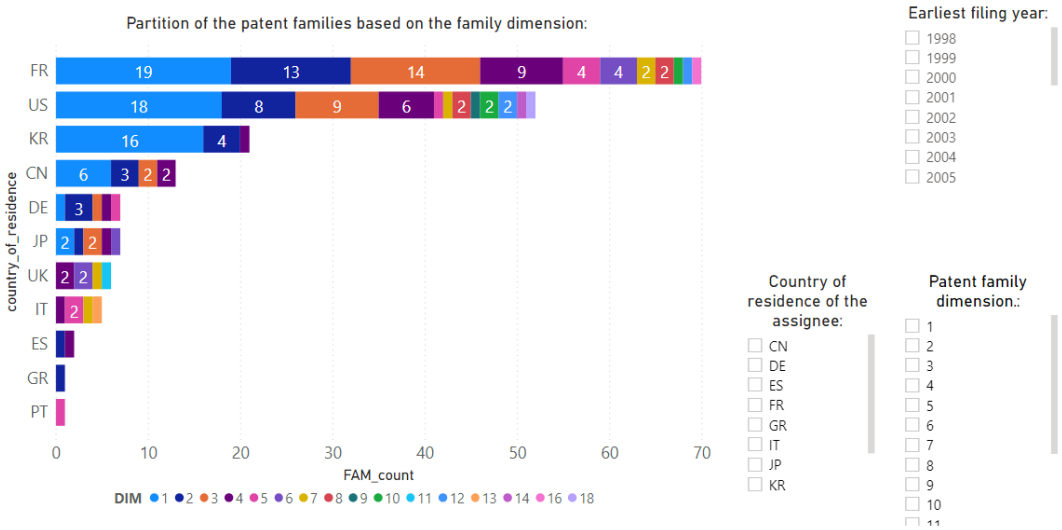
psn_name	person_ctry_code	PUB	Conteggio di nr. famiglie
AEROVIRONMENT	US	EP2513600	1
AIRBUS DEFENCE AND SPACE	FR	EP2517040	1
ARLTON, DAVID, J.	US	EP1761430	1
ARLTON, DAVID, J.	US	EP2799332	1
ARLTON, PAUL, E.	US	EP1761430	1
ARLTON, PAUL, E.	US	EP2799332	1
DORNIER	DE	EP0737321	1
E-ODYN	FR	EP3049762	1
FLIR SYSTEMS	SE	EP1188086	1
LA CALHENE	FR	EP1463614	1
LEFEVRE FRANCOIS	FR	EP0020269	1
LEFEVRE, XAVIER	FR	EP0020269	1
MARINE & REMOTE SENSING SOLUTIONS (MARSS)	MC	EP2070068	1
ORANGE	FR	EP0467818	1
PHILIPS ELECTRONICS	NL	EP0322062	1
QINETIQ	GB	EP1588188	1

There is a not negligible number of applicants corresponding to triadic patent families. These data taken altogether suggest that there is a consistent margin of implementation of technologies/products dedicated to the maritime surveillance.

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 26 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, especially France and USA include several members corresponding to applications filed to a multiplicity of patent authorities.

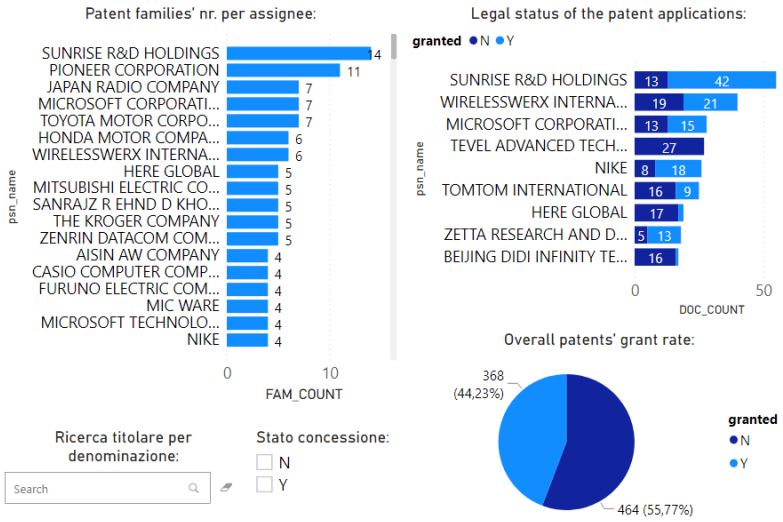
Figure 26 Maritime surveillance: Ranking of the country of residence of the players based on the patent family dimension



a2) Monitoring and Observing systems for Marine Environment → Marine mapping

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 27. 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 about 44%.

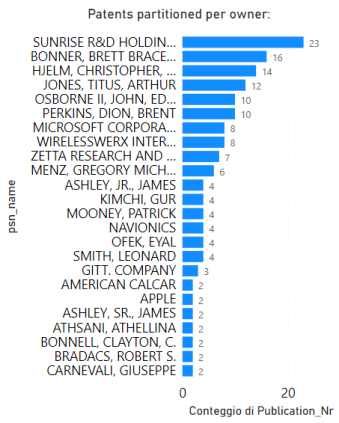
Figure 27 Marine mapping: Ranking of the applicants based on the patent application number and grant rate



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 28. There may be other French, Korean and US players worth of consideration and the fraction of patents already expired is extremely low (pls. refer to negative values of 'Expiry days' in the original dashboard, there are only two listed), thus suggesting that the technological implementations claimed in a large fraction of patents may be truly innovative.

Figure 28 Marine mapping: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal yr.
ONTRACKS	FR3055158	5797	4
EGIS COMPANY	KR101659780	5619	4
THALES	FR3046226	5563	5
ICTWAY COMPANY	KR101592004	5531	5
ICTWAY COMPANY	KR101592006	5531	5
KOREA INSTITUTE OF OCEAN SCIENCE & TECHNOLOGY	KR101642861	5517	4
GITT. COMPANY	KR101565766	5466	5
GITT. COMPANY	KR101590937	5466	5
GITT. COMPANY	KR101576641	5461	5
LEE, JAE JOON	KR101581827	5446	4
KNU-INDUSTRY COOPERATION FOUNDATION	KR101689965	5391	4
SUNYOUNGENG COMPANY	KR101569715	5384	5
HYESUNG COMPANY	KR101550692	5368	5



The results of the assessment of the triadic families are shown in Figure 29.

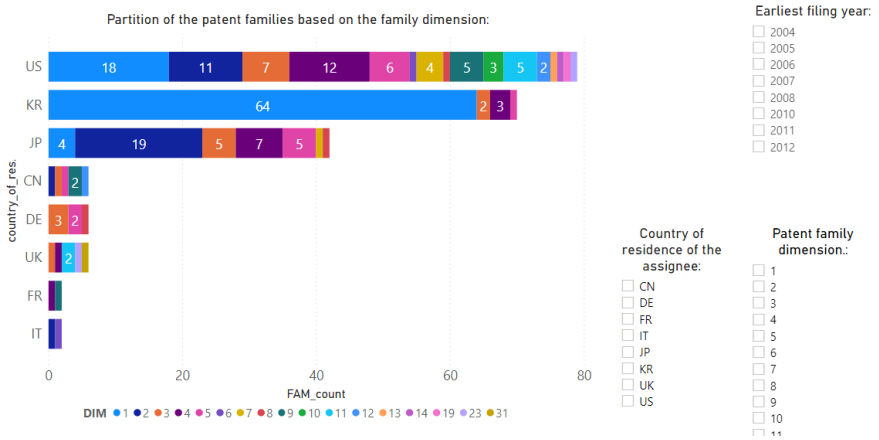
Figure 29 Marine mapping: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di nr. famiglie
ACTIVE MIND TECHNOLOGY R&D	IE	EP2600946	1
AMERICAN CALCAR	US	EP0990119	1
AMERICAN CALCAR	US	EP1630523	1
CLARION COMPANY	JP	EP3287744	1
GARMIN SWITZERLAND	CH	EP3027501	1
HERE GLOBAL	NL	EP3486608	1
HITACHI CONSTRUCTION MACHINERY COMPANY	JP	EP3217380	1
LUTNICK, HOWARD W.	US	EP2079536	1
NIKE	US	EP2603870	1
NIKE INNOVATE	US	EP2787889	1
NISSAN NORTH AMERICA	US	EP3519772	1
OCEAN FLOOR GEOPHYSICS	CA	EP3022589	1
ONTRACKS	FR	EP3500823	1
PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA	US	EP3118705	1
SHANG HAI PAN SHI TOU ZI GUAN LI YOU XIAN GONG SI	CN	EP3287977	1
SUNRISE R&D HOLDINGS	US	EP2593915	1

There is a not negligible number of applicants corresponding to triadic patent families. These data taken altogether suggest that there is a consistent margin of implementation of technologies/products dedicated to the marine mapping.

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 based on the IPRs in a multiplicity of countries. The diagram displayed in Figure 30 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, especially USA, include several members corresponding to applications filed to a multiplicity of patent authorities.

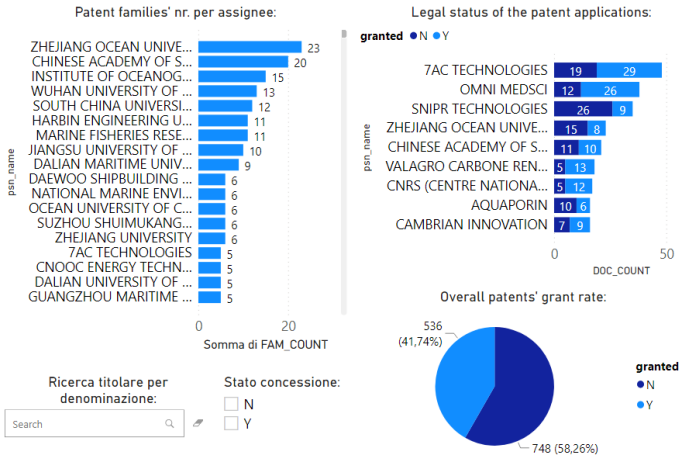
Figure 30 Marine mapping: Ranking of the country of residence of the players based on the patent family dimension



a3) Monitoring and Observing systems for Marine Environment → Seawater sensors

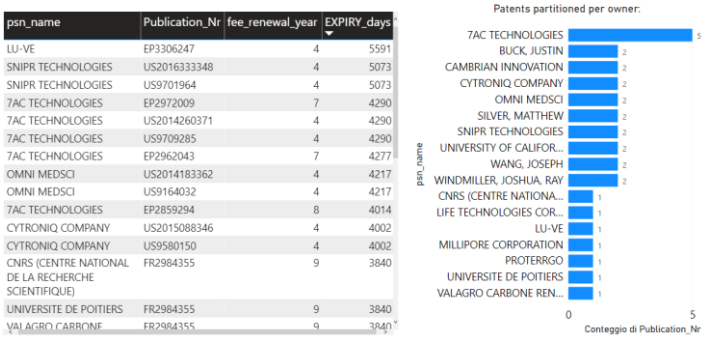
Although the number of the patent owners can be estimated on the order of several hundreds, a selection of the top players is displayed in Figure 31. The top players may be ranked according to the respective amount of patent families owned (as shown in the leftmost bar diagram) or, alternatively, selected 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 less than 42%.

Figure 31 Seawater sensors: Residual validity of granted patents (data from EP Register)



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 32. There may be other French and European applicants worth of consideration and all the patents included in the list may be still valid (there are no negative values of 'Expiry days' in the original dashboard), thus suggesting that the technological implementations claimed in a large fraction of patents may be truly innovative.

Figure 32 Seawater sensors: Residual validity of granted patents (data from EP Register)



psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
LU-VE	EP3306247	4	5591
SNIPR TECHNOLOGIES	US2016333348	4	5073
SNIPR TECHNOLOGIES	US9701964	4	5073
7AC TECHNOLOGIES	EP2972009	7	4290
7AC TECHNOLOGIES	US2014260371	4	4290
7AC TECHNOLOGIES	US9709285	4	4290
7AC TECHNOLOGIES	EP2962043	7	4277
OMNI MEDSCI	US2014183362	4	4217
OMNI MEDSCI	US9164032	4	4217
7AC TECHNOLOGIES	EP2859294	8	4014
CYTRONIQ COMPANY	US2015088346	4	4002
CYTRONIQ COMPANY	US9580150	4	4002
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR2984355	9	3840
UNIVERSITE DE POITIERS	FR2984355	9	3840
VALAGRO CARBONE	FR2984355	9	3840

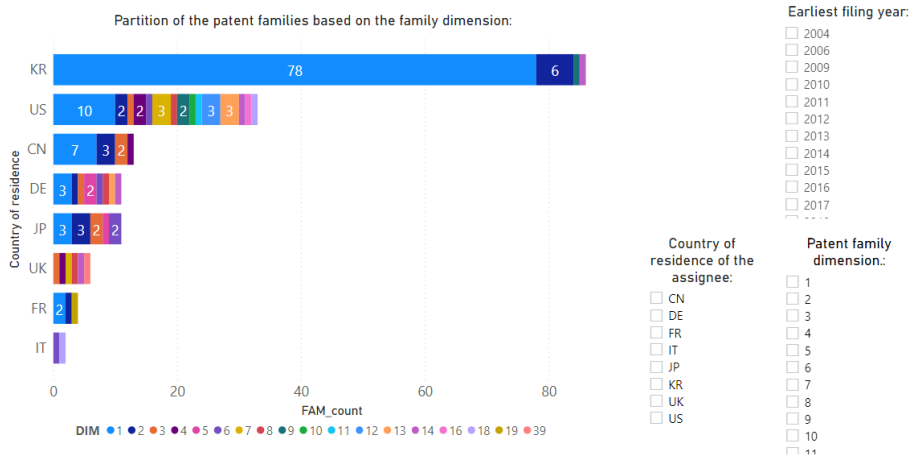
The results of the assessment of the triadic families are shown in Figure 33.

Figure 33 Seawater sensors: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di Famiglie
7AC TECHNOLOGIES	US	EP2962043	1
7AC TECHNOLOGIES	US	EP2971984	1
7AC TECHNOLOGIES	US	EP2972009	1
7AC TECHNOLOGIES	US	EP3120083	1
7AC TECHNOLOGIES	US	EP3428549	1
7AC TECHNOLOGIES	US	EP3614072	1
AQUAPORIN	DK	EP2958662	1
AQUAPORIN	DK	EP3524338	1
CAMBRIAN INNOVATION	US	EP2443070	1
CAMBRIAN INNOVATION	US	EP2510345	1
CAMBRIAN INNOVATION	US	EP3284829	1
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP2794730	1
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP3351585	1
CYTRONIQ COMPANY	KR	EP2860489	1
CYTRONIQ COMPANY	KR	EP3722744	1
DER GRUENE PUNKT - DUALES SYSTEM	DE	EP3509811	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 based on the IPRs in a multiplicity of countries. The diagram displayed in Figure 34 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, especially USA, include several members corresponding to applications filed to a multiplicity of patent authorities.

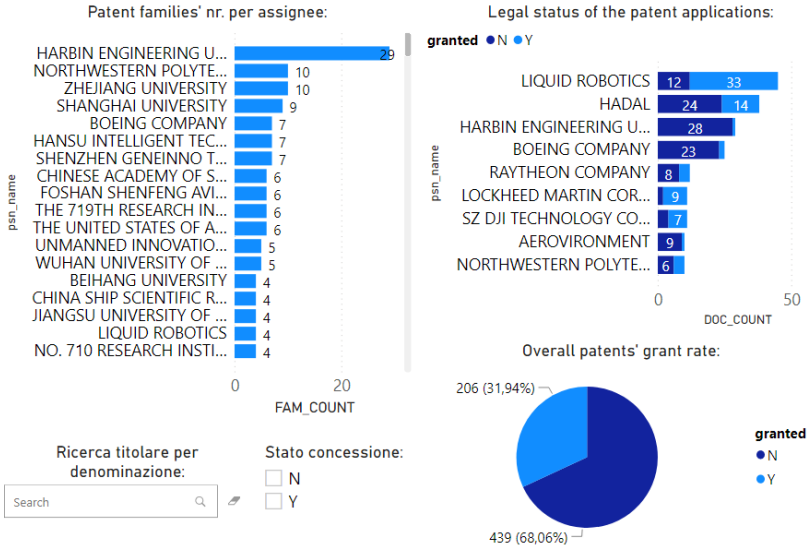
Figure 34 Seawater sensors: Ranking of the country of residence of the players based on the patent family dimension



a4) Monitoring and Observing systems for Marine Environment → Unmanned underwater vehicles (UUV)

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 35. 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 32%.

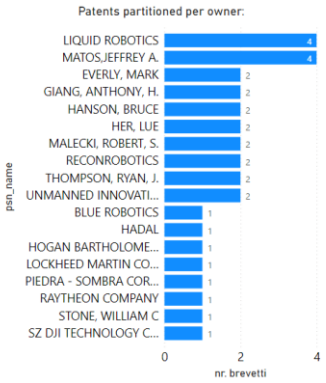
Figure 35 UUV: Ranking of the applicants based on the patent application number and grant rate



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 36. There may be applicants, headquartered especially in the USA, worth of consideration and all the patents included in the list may be still valid (there are no negative values of 'Expiry days' in the original dashboard), thus suggesting that the technological implementations claimed in a large fraction of patents may be truly innovative.

Figure 36 UUV: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
RAYTHEON COMPANY	EP3227629	5175	5
SZ DJI TECHNOLOGY COMPANY	EP2976687	4990	6
BLUE ROBOTICS	EP3137375	4961	5
HADAL	EP2969736	4549	6
LOCKHEED MARTIN CORPORATION	EP2825446	4183	7
EVERLY, MARK	US2012290164	3876	4
EVERLY, MARK	US9096106	3876	4
HANSON, BRUCE	US2012290164	3876	4
HANSON, BRUCE	US9096106	3876	4
UNMANNED INNOVATIONS	US2012290164	3876	4
UNMANNED INNOVATIONS	US9096106	3876	4
LIQUID ROBOTICS	EP2686543	3820	8
HOGAN BARTHOLOMEW P.	US9090315	3706	4
PIEDRA - SOMBRA CORPORATION	US9090315	3706	4



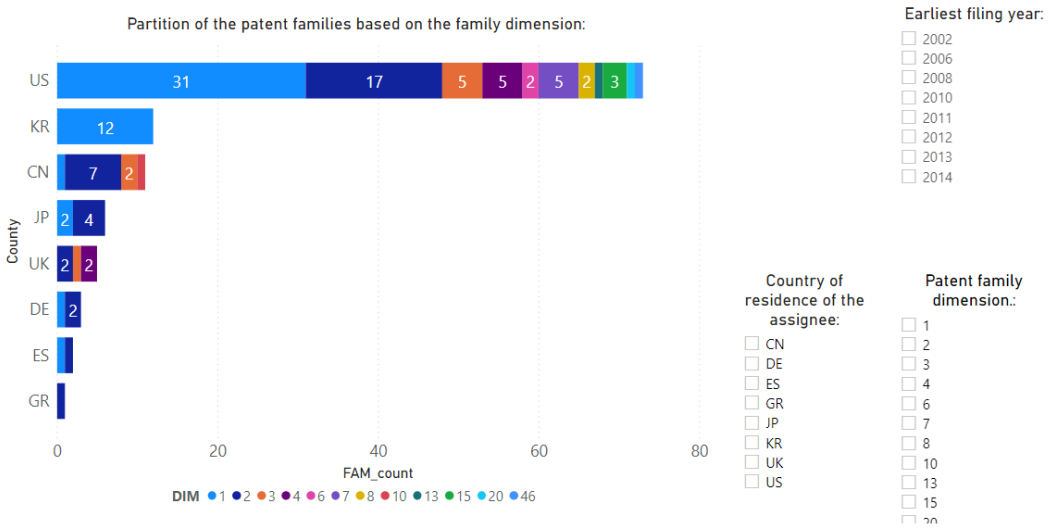
The results of the assessment of the triadic families are shown in Figure 37.

Figure 37 UUV: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di conteggio_famiglie
BOEING COMPANY	US	EP3299277	1
BOEING COMPANY	US	EP3468142	1
HADAL	US	EP2969734	1
HADAL	US	EP2969735	1
HADAL	US	EP2969736	1
HADAL	US	EP2969737	1
HADAL	US	EP2969738	1
HADAL	US	EP2969739	1
HADAL	US	EP3326902	1
HADAL	US	EP3501967	1
Hadal, Inc.	US	EP3572315	1
LIQUID ROBOTICS	US	EP1973775	1
RAYTHEON COMPANY	US	EP3440320	1
SZ DJI TECHNOLOGY COMPANY	CN	EP2976687	1
SZ DJI TECHNOLOGY COMPANY	CN	EP3246776	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 based on the IPRs in a multiplicity of countries. The diagram displayed in Figure 38 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, especially USA, include several members corresponding to applications filed to a multiplicity of patent authorities.

Figure 38 UUV: Ranking of the country of residence of the players based on the patent family dimension



2.a KEYPOINTS

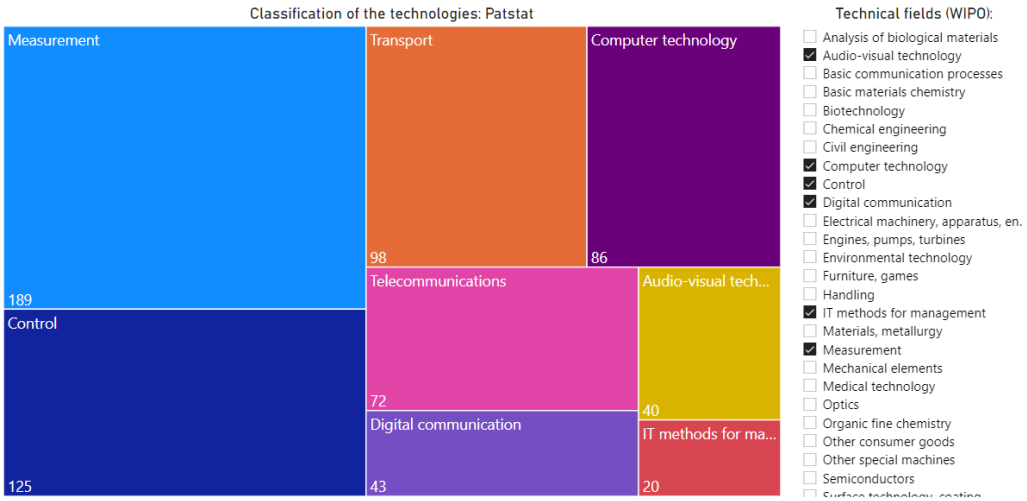
- As arguable from the market data, the increment of the patent filing events is quite impressive when analyzing the trends regarding the most recent years, no matter what subsector dealing with Monitoring and Observing systems is examined.
- As far as the average patents' grant rate is concerned, the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

3.a BLUE SUSTAINABLE DEVELOPMENT: THE TECHNICAL INFORMATION

a1) Monitoring and Observing systems for Marine Environment → Maritime surveillance

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 39.

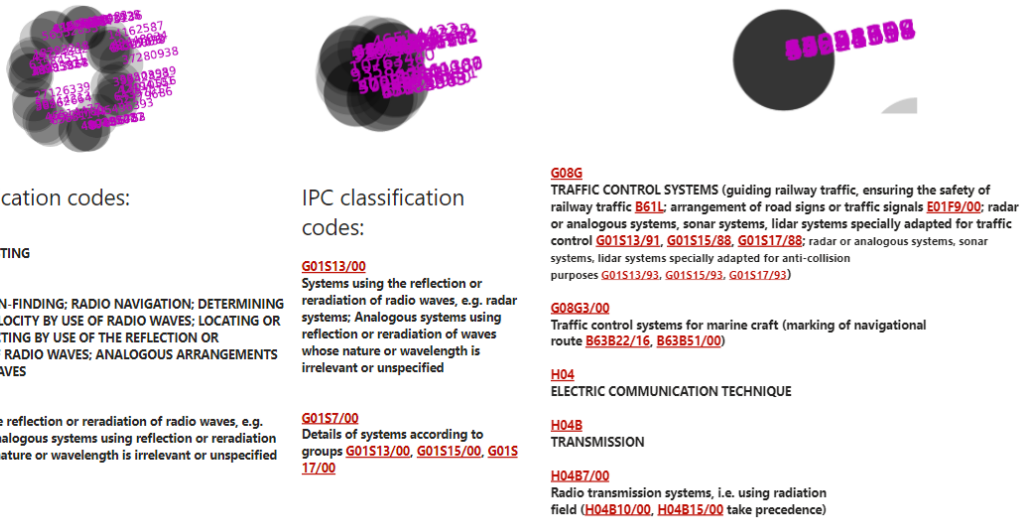
Figure 39 Maritime surveillance: Map of the technology fields defined by WIPO



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 the 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 figure Figure 40 refers specifically to the IPC classification codes:

Figure 40 Maritime surveillance: 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):

G01S7/00, referring to **RADIO DIRECTION-FINDING; RADIO NAVIGATION; DETERMINING DISTANCE OR VELOCITY BY USE OF RADIO WAVES; LOCATING OR PRESENCE-DETECTING BY USE OF THE REFLECTION OR RERADIATION OF RADIO WAVES; ANALOGOUS ARRANGEMENTS USING OTHER WAVES → Details of systems according to groups G01S13/00, G01S15/00, G01S17/00.**
G01S13/00, referring to **Systems using the reflection or reradiation of radio waves, e.g. radar systems; Analogous systems using reflection or reradiation of waves whose nature or wavelength is irrelevant or unspecified.**
G08G3/00, referring to **Traffic control systems for marine craft (marking of navigational route B63B22/16, B63B51/00).**
H04B7/00, referring to **Radio transmission systems, i.e. using radiation field (H04B10/00, H04B15/00 take precedence).**

The co-occurrence of two IPC or CPC classification codes identifying single patents families is not much frequent, despite the dataset includes 470 non duplicated patent families. Codes such as **G08G3/02** (Radio transmission systems, i.e. using radiation field (H04B10/00, H04B15/00 take precedence) → **Anti-collision systems**), may better specify the functionality of the traffic control systems for marine craft, however several other codes, not included in the list above may refer to control systems customized to the needs of aerial vehicles (Figure 41).

Figure 41 Maritime surveillance: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

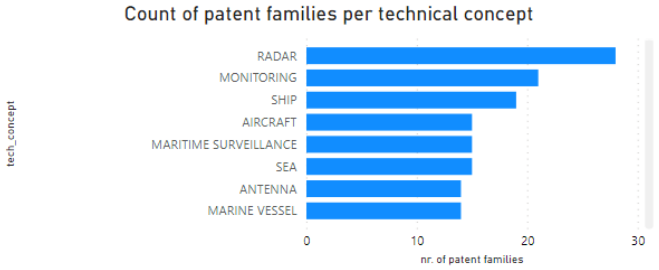
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
8	G08G 3/02	G08G 3/00
6	G06K 9/62	G06K 9/00
6	H04N 7/18	H04N 5/232
4	B64F 3/02	B64C 39/02
4	G01S 13/90	G01S 13/87
4	G01S 13/93	G01S 13/91
4	G05D 1/00	B64C 39/02
4	G06K 9/32	G06K 9/00
4	G06T 7/136	G06T 7/00

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
7	B64C 39/024	B64C2201/027
7	B64C 39/024	B64C2201/205
6	B64C 39/024	B64C2201/127
6	B64C 39/024	B64C2201/146
6	B64C2201/027	B64C2201/205
5	B64C 39/024	B64C2201/042
5	B64C 39/024	B64C2201/108
5	B64C2201/027	B64C2201/042
5	B64C2201/027	B64C2201/108

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 42.

Figure 42 Maritime surveillance: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
6526220	Mil Mi-8 navy tanker helicopter for use in the Navy
7704074	CONTROL OF WARNING AND INFORMATION SYSTEMS
8574569	Rallonge de reproduction pour appareil photographique à visée reflex à
8857241	Remote control for aerial reconnaissance drone has section mounted in computer and mobile telephone connection
9278543	BALISE DE DETRESSE POUR NAUFRAGE
9289763	DISPOSITIF DE SURVEILLANCE INFRAROUGE.
9293386	INFRARED THERMAL IMAGING SYSTEM WITH IMPROVED SENSITIVITY
9331554	ANTENNE RADAR A FAIBLE ENCOMBREMENT.
9358238	PULSE COMPRESSION RADAR
9399121	ELEMENT DE TRANSITION ENTRE GUIDES D'ONDES ELECTROMAGNETIC

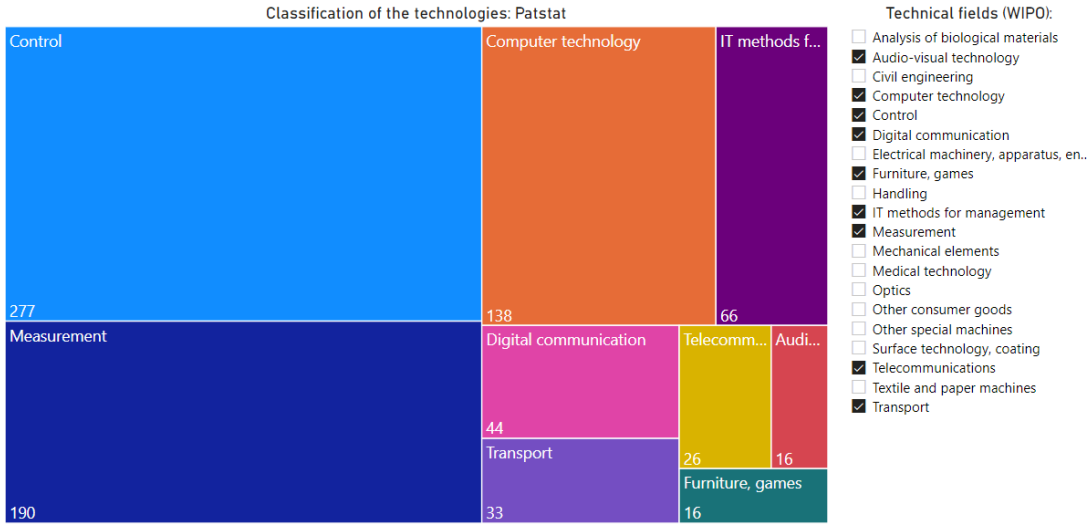


docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
6526220	MARINE TANK	HELICOPTER MIL MI	STEALTH HIGH SPEED BOAT	ENEMY MARITIME SURVEILLANCE	FAST STEALTH MINELAYING	WAR MARINE CORPS	MARINE TANK HELICOPTER	NAVAL COMBAT INSERT	CAMOUFLAGE CRITICAL HELICC
6531792	SEAWATER TRAFFIC	POTENTIAL SHIPPING COLLISION	SEA VESSEL	TRAFFIC	SATELLITE	ICEBERG	SEA	VESSEL COLLISION THREAT	ICEBERG DETECTION
7704074	CONTROL	WARNING MESSAGE SUBJECTIVE RELEVANCE	WARNING INITIALIZATION	WARNING REGULATION	TECHNICAL APPLIANCE RELATED COMPETENCE	DANGEROUS SITUATION	RECENTLY ESTIMATED COMPETENCE	REACTION SUITABILITY	COMPETENCE VALUE
8574569	REFLEX SIGHT	REPRODUCTION CAMERA EXTENSION	DIF FERENT SHOT	SIGHTING JECTIVE	CAMERA OPTICS	LIGHT SCREEN OSCILLOGRAPH	SEMI TRANSPARENT MIRROR	CAMERA LENS	ADJUSTABLE BRIGHTNESS
8857241	OPERATOR	SHIP	UNMANNED	REMOTE	UNMANNED	REALTIME	SECURE LINK	SUBMARINE	AIRBORNE VEHICLE

a2) Monitoring and Observing systems for Marine Environment → Marine mapping

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 43.

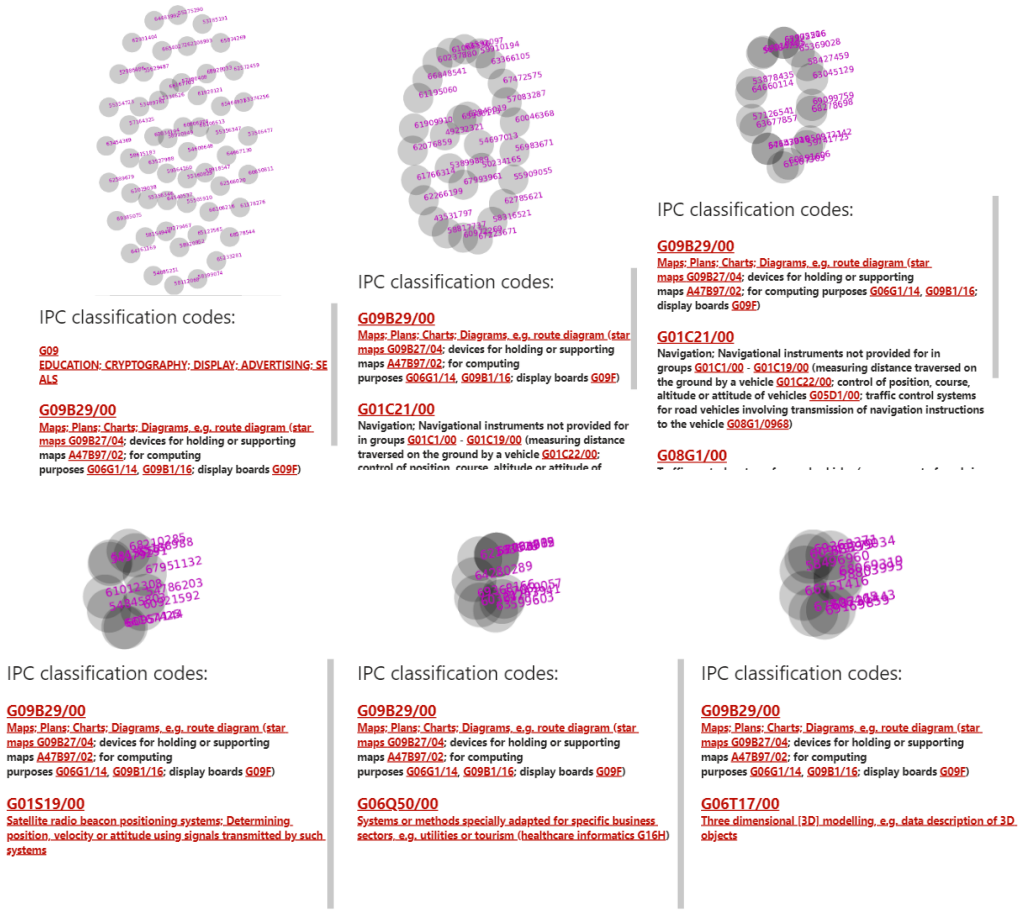
Figure 43 Marine mapping: Map of the technology fields defined by WIPO



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 the technologies specifically dealing with the sub-sector is possible. However, it can be noticed that the granularity based on the technical fields does not enable a clear differentiation

between the sub-sectors (e.g., the maritime surveillance and the marine mapping have several technical fields in common), thus clustering of the documents based on the classification codes, either IPC or CPC, can cast light on possible differences between the datasets. The following figure (Figure 44) refers specifically to the IPC classification codes:

Figure 44 Marine mapping: 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):

G08G1/00, referring to **Traffic control systems for road vehicles (arrangement of road signs or traffic signals E01F9/00; automatic vehicle control B62D)**
G01C21/00, referring to **Navigation; Navigational instruments not provided for in groups G01C1/00 - G01C19/00 (measuring distance traversed on the ground by a vehicle G01C22/00; control of position, course, altitude or attitude of vehicles G05D1/00; traffic control systems for road vehicles involving transmission of navigation instructions to the vehicle G08G1/0968)**
G09B29/00, referring to **Maps; Plans; Charts; Diagrams, e.g. route diagram (star maps G09B27/04; devices for holding or supporting maps A47B97/02; for computing purposes G06G1/14, G09B1/16; display boards G09F)**
G01S19/00, referring to **Satellite radio beacon positioning systems; Determining position, velocity or attitude using signals transmitted by such systems.**

G06Q50/00, referring to **Systems or methods specially adapted for specific business sectors, e.g. utilities or tourism (healthcare informatics G16H).**
G06T17/00, **referring to Three dimensional [3D] modelling, e.g. data description of 3D objects**

The co-occurrence of two IPC or CPC classification codes identifying single patents families may be frequently referring to the presence of an IPC such as G09B29/10 (Map spot or coordinate position indicators; Map reading aids (optical projection apparatus per se G03B)), while the frequency of co-assignments of codes is relatively low as far as the CPC classification codes are concerned (Figure 45).

Figure 45 Marine mapping: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

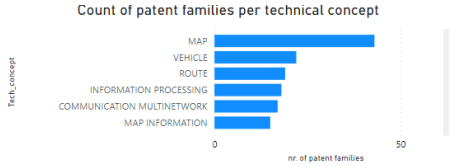
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
68	G09B 29/10	G09B 29/00
41	G09B 29/00	G01C 21/26
32	G09B 29/10	G01C 21/26
30	G09B 29/00	G06T 17/05
22	G09B 29/00	G06F 17/30
17	G09B 29/00	G01C 21/34
16	G09B 29/00	G01S 19/14
15	G09B 29/10	G01C 21/34

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
14	G09B 29/007	G06F 16/29
8	H04W 4/029	H04L 67/18
7	H04L 67/12	G06Q 30/0601
6	G09B 29/003	G06T 17/05
6	G09B 29/007	G01C 21/20
6	G09B 29/106	G01C 21/367
6	G09B 29/106	G06F 16/29
6	H04W 4/029	H04L 67/12

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 46.

Figure 46 Marine mapping: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
25375231	MAP DOWNLOADING SYSTEM WITH GPS AND TRANSCEIVER
35784715	METHOD AND SYSTEM TO MONITOR AND CONTROL DEVICES UTILIZING WIRELE
36118045	Method and system to monitor persons utilizing wireless media
36954007	Method and system for identifying and defining geofences
37108462	Method and System for Initiating and Handling an Emergency Call
37215348	VIRTUAL EARTH
37440585	ANORDNUNG UND VERWENDUNG GEOGRAPHISCHER GEBIETE ZUM ÜBERWACH VON BEWEGLICHEN EINHEITEN
38478394	DYNAMIC RENDERING OF MAP INFORMATION
39023488	METHOD AND SYSTEM TO CONFIGURE AND UTILIZE GEOGRAPHICAL ZONES

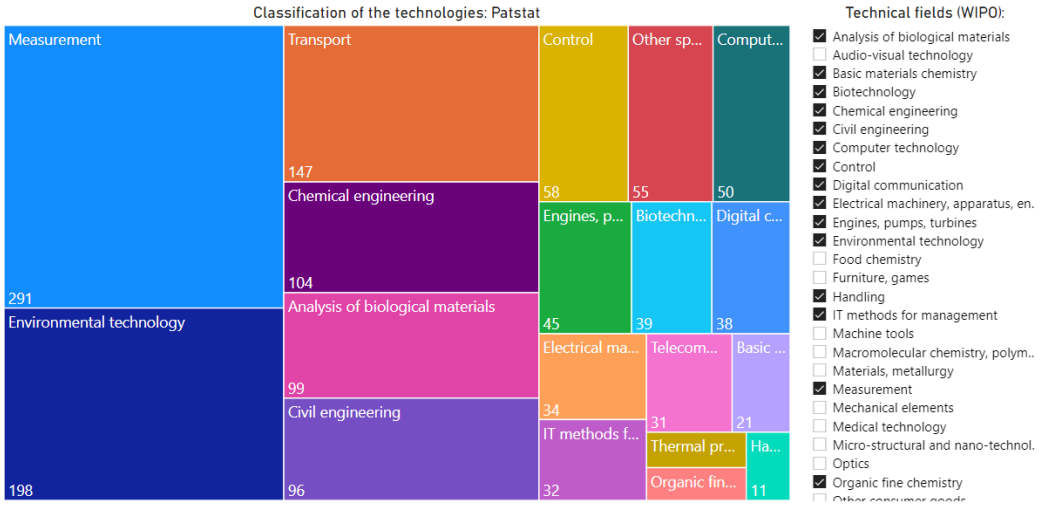


docdb_family_id	Tech_concept #1	Tech_concept #2	Tech_concept #3	Tech_concept #4	Tech_concept #5	Tech_concept #6	Tech_concept #7	Tech_concept #8	Tech_concept #9
25375231	TRANSCEIVER	DOWNLOAD	PERSONAL COMMUNICATION SYSTEM	VOICE DATA	DIGITAL PROCESSOR	MAP INFORMATION	MODEM	PERSONAL DIGITAL COMMUNICATOR	COMMUNICATOR LO
35784715	GEOGRAPHIC AL ZONE	USER PATH	ZONE DATA	PHYSICAL ARRANGEMENT	WIFI RADIO	TRANSPONDER	TRANSPONDER INTEGRITY	RADIO CONNECTIVITY	GEOGRAPHICAL COO
36118045	GEOGRAPHIC AL ZONE	USER PATH	ZONE DATA	PHYSICAL ARRANGEMENT	WIFI RADIO	TRANSPONDER	TRANSPONDER INTEGRITY	RADIO CONNECTIVITY	GEOGRAPHICAL COO
36954007	GEO FENCE	WIRELESS	GEO FENCE EVENT	VIRTUAL SPATIAL BOUNDARY	GEOGRAPHICAL BOUNDARY	PHYSICAL WIRELESS	GRAPHICAL MAP	GEO FENCE DATA	TELEPHONY FUNCTIC
37108462	GEOGRAPHIC AL ZONE	USER PATH	ZONE DATA	PHYSICAL ARRANGEMENT	WIFI RADIO	TRANSPONDER	TRANSPONDER INTEGRITY	RADIO CONNECTIVITY	GEOGRAPHICAL COO
37215348	MAP	RECORDING	VIRTUAL GROUND	TIMESTAMP	VISUAL	DATA VISUAL	INPUT DATA VISUAL	PREDICTED FUTURE	PARTICIPATING INSUF

a3) Monitoring and Observing systems for Marine Environment → Seawater sensors

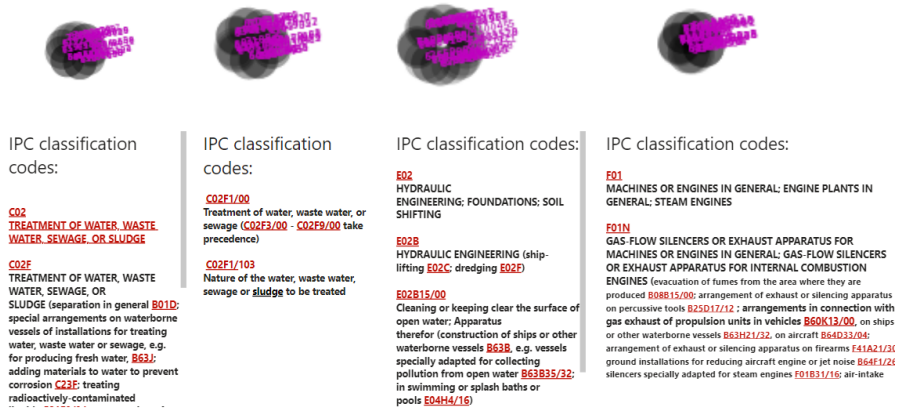
The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 47.

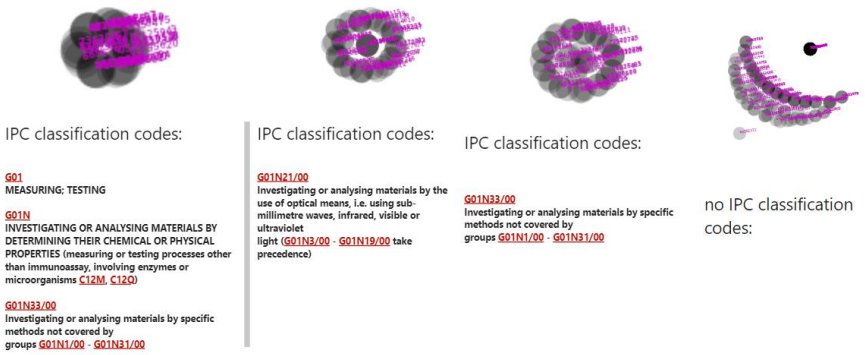
Figure 47 Seawater sensors: Map of the technology fields defined by WIPO



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 the technologies specifically dealing with the sub-sector is possible. A quite relevant number of technical fields is associated to the patent families, thus suggesting that the applicability of sensors is widespread. Clustering the documents of the same dataset may be based on the classification codes, either IPC or CPC. The following figure (Figure 48) refers specifically to the IPC classification codes:

Figure 48 Seawater sensors: 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):

C02F1/00, referring to **Treatment of water, waste water, or sewage (C02F3/00 - C02F9/00 take precedence).**
C02F1/103, referring to **Nature of the water, waste water, sewage or sludge to be treated.**
E02B15/00, referring to **Cleaning or keeping clear the surface of open water; Apparatus therefor (construction of ships or other waterborne vessels B63B, e.g. vessels specially adapted for collecting pollution from open water B63B35/32; in swimming or splash baths or pools E04H4/16).**
F01N3/00, referring to **Exhaust or silencing apparatus having means for purifying, rendering innocuous, or otherwise treating exhaust (electric control F01N9/00; monitoring or diagnostic devices for exhaust-gas treatment apparatus F01N11/00; collecting or removing exhaust gases of vehicle engines in workshops B08B15/00, on highways E01C1/005).**
G01N21/00, referring to **Investigating or analysing materials by the use of optical means, i.e. using sub-millimetre waves, infrared, visible or ultraviolet light (G01N3/00 - G01N19/00 take precedence).**
G01N33/00, referring to **Investigating or analysing materials by specific methods not covered by groups G01N1/00 - G01N31/00.**
G06T17/00, **referring to Three dimensional [3D] modelling, e.g. data description of 3D objects**
One cluster characterized by the co-assignment of the CPC classification codes G01N33/00 and G01D21/00 (Measuring or testing not otherwise provided for) can be detected.

The co-occurrence of two IPC or CPC classification codes identifying single patents families may be not much frequent, considering that the dataset consists of 897 non duplicated patent families. However, relevant IPC classification codes may be referring to the presence of an IPC/CPC such as E02B15/10 (Cleaning or keeping clear the surface of open water; Apparatus therefor (construction of ships or other waterborne vessels B63B, e.g. vessels specially adapted for collecting pollution from open water B63B35/32; in swimming or splash baths or pools E04H4/16) → Devices for removing the material from the surface (E02B15/041, E02B15/042, E02B15/06 take precedence)) or IPC/CPC B63B35/32 (Vessels or similar floating structures specially adapted for specific purposes and not otherwise provided for → for collecting pollution from open water) while the frequency of co-assignments of codes is relatively low as far as the CPC classification codes are concerned (Figure 49).

Figure 49 Seawater sensors: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

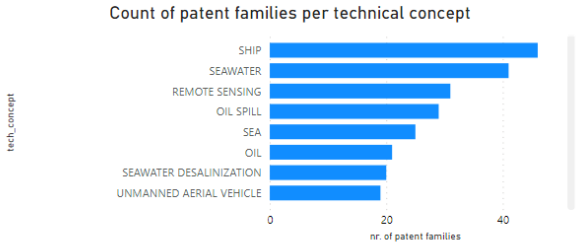
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
23	E02B 15/10	B63B 35/32
11	C02F 103/08	C02F 1/44
9	C02F 103/08	C02F 101/16
9	G01N 30/06	G01N 30/02
8	A01K 63/04	A01K 63/00
8	G01N 30/72	G01N 30/02
8	G01N 30/72	G01N 30/06
8	G06K 9/62	G06K 9/00
8	G06Q 50/26	G06Q 10/06
7	C02F 1/44	B01D 65/02

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
14	E02B 15/10	B63B 35/32
13	C02F 9/00	C02F 1/001
11	B63B2022/006	B63B 22/00
9	G01N 30/06	G01N 30/02
8	C02F 9/00	C02F 1/283
8	C02F2103/08	C02F 9/00
8	G01N 30/72	G01N 30/02
8	G01N 30/72	G01N 30/06
8	G01N2030/062	G01N 30/02
8	G01N2030/062	G01N 30/06

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 50.

Figure 50 Seawater sensors: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
35320956	Antagonistic Properties of Reef Fish Microflora
39536938	Fluorogenic pH sensitive dyes and their method of use
43356675	SYSTEMS AND DEVICES FOR TREATING AND MONITORING WATER, WA OTHER BIODEGRADABLE MATTER
43410393	'aparelho e processo para tratar água residual.'
44146168	MICROBIALLY-BASED SENSORS FOR ENVIRONMENTAL MONITORING
45098582	TEXTILE-BASED PRINTABLE ELECTRODES FOR ELECTROCHEMICAL SENSI
46298500	/ Method for Preparing a Polymer/Biological Entities Blend
47439052	Depth Filters For Disposable Biotechnological Processes
49758855	METHODS AND SYSTEMS FOR TURBULENT CORROSION RESISTANT HE
50272815	SYSTEM FOR WATER EXTRACTION

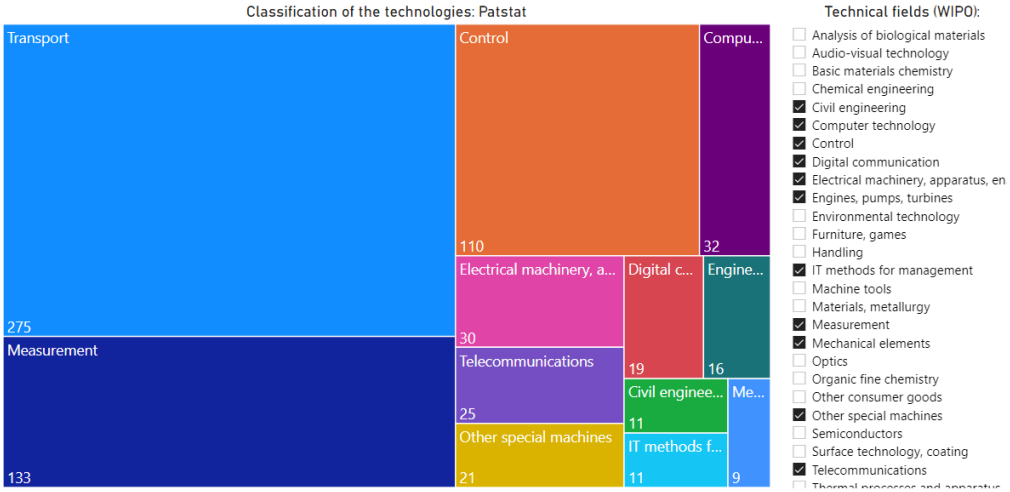


docdb_family_id	tech_concept #1	tech_concept #2	tech_concept #3	tech_concept #4	tech_concept #5	tech_concept #6	tech_concept #7	tech_concept #8	tech_concept #9
35320956	MICROORGANISM	BIOFILM INHIBITING FORMATION	INHIBITING FORMATION	INHIBITING GROWTH	REEF FISH MICROFLORA	INFLAMED MUCOPERIOSTEAL LINING	BACTERIA	CANDIDA ALBICANS	PROSTATE GLAND BACTERIAL INF
39536938	SUBSTITUTED HETEROCYCLYL	FORMULA COMPOUND	PH SENSITIVE DYE	FORMULA III	FLUOROGENIC PH SENSITIVE DYE	FORMULA III COMPOUND	SUBSTITUTED HETEROARYL	ALKYL SUBSTITUTION	ARYL SUBSTITUTION
43356675	WASTEWATER	BIODEGRADANT	AEROBIC DEGRADATION	BIODEGRADABLE SUBSTANCE	METHANOLOGENIC MICROORGANISM	ELECTRICAL POLE	ANAEROBIC DEGRADATION	INTERLAYER	ELECTRON ACCEPTOR
43410393	WASTEWATER	WASTEWATER TREATMENT	ELECTROCHEMICAL TREATMENT	WASTEWATER ELECTROCHEMICAL TREATMENT	ELECTROCOAGULATING CONTAMINANT	ELECTROOXIDIZING CONTAMINANT	ELECTROCOAGULATION	INFLUENT FLOWRATE	WASTEWATER OXIDIZATION
44146168	WASTEWATER	BIODEGRADANT	AEROBIC	BIODEGRADABLE	METHANOLOGEN	ELECTRICAL	ANAEROBIC	INTERLAYER	ELECTRON ACCEPTOR

a4) Monitoring and Observing systems for Marine Environment → Unmanned underwater vehicles (UUV)

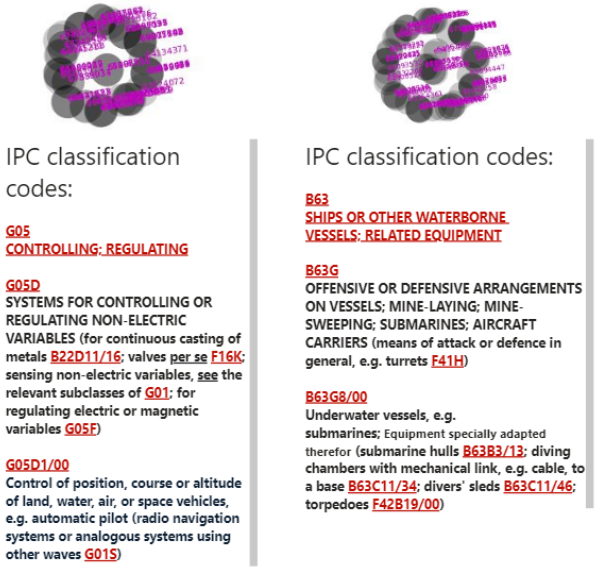
The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 51.

Figure 51 UUV: 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 the 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 figure (Figure 52) refers specifically to the IPC classification codes:

Figure 52 UUV: 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:

G05D1/00, referring to **Control of position, course or altitude of land, water, air, or space vehicles, e.g. automatic pilot (radio navigation systems or analogous systems using other waves G01S).**

B63G8/00, referring to **Underwater vessels, e.g. submarines; Equipment specially adapted therefor (submarine hulls B63B3/13; diving chambers with mechanical link, e.g. cable, to a base B63C11/34; divers' sleds B63C11/46; torpedoes F42B19/00).**

As observed in the case of the "Maritime surveillance" and "Seawater sensors", the co-occurrence of two IPC or CPC classification codes identifying single patents families may be not much frequent, considering that the dataset consists of 504 non duplicated patent families. However, relevant IPC classification codes (Figure 53) may be referring to the presence of an IPC/CPC such as B64C39/02 (Aircraft not otherwise provided for).

Figure 53 UUV: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

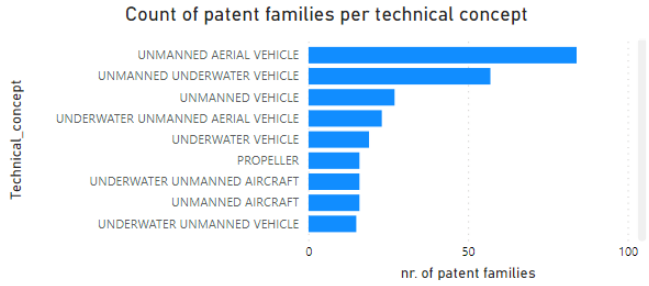
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
14	B63G 8/00	B64C 39/02
12	B64C 39/02	G05D 1/00
11	B63G 8/00	B63G 8/08
10	B63B 35/00	B63G 8/00
10	B63G 8/00	B63G 8/22
9	B63C 11/52	B63G 8/00

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
21	B63G 8/001	B63G2008/002
11	B63G 8/001	B63G2008/004
11	B63G 8/001	B63G2008/005
11	B64C 39/024	B64C2201/146
10	B63B 35/00	B63B2035/006
10	B64C 39/024	B64C2201/141

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 54.

Figure 54 UUV: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
39854486	Systems and methods for detecting and managing the unauthorized use aircraft
40538741	Wave power
41830231	SYSTEM AND METHOD FOR AUTONOMOUS VEHICLE CONTROL
42103318	Efficient transactional messaging between loosely coupled client and ser intermittent networks with policy based routing
45494260	Systems and methods for detecting and managing the unauthorized use aircraft
46045585	BØLGEENERGI
46614579	Assembly, float, wave-actuated component, wave-powered device, fin sy obtaining information, controlling method and wave-powered water veh



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
39854486	POLICE AUTHORITY	UNMANNED AIRCRAFT	PILOT IDENTIFICATION	REMOTELY CONTROLLED VEHICLE	REGISTERED UV PILOT	VISIBLE BIOLOGIC IDENTIFIER	UV POLICE AUTHORITY	POLICING UNMANNED AIRCRAFT	REQUESTED PI
40538741	SWIMMER	VEHICLE	WAVE	STEERING ACTUATOR	FLOAT	SUBMERGED SWIMMER	TETHER	HORIZONTAL SENSOR	UNMANNED WA
41830231	UNMANNED AERIAL VEHICLE	DIRECTIONAL CONTROL COMPONENT	LANDING AREA	AUTONOMOUS VEHICLE CONTROL	AERIAL CRAFT	AERIAL REFUELING CRAFT	TARGET LANDING AREA	AUTONOMOUS FEEDBACK	CAMERA
42103318	WEARABLE DEVICE	MOBILE	CALLING	MESSAGING	HAPTIC CONTROL	TOUCH	PURCHASE	ONE SCAN PAYMENT	ONE TOUCH BUT
45494260	POLICE AUTHORITY	UNMANNED AIRCRAFT	PILOT IDENTIFICATION	REMOTELY CONTROLLED	REGISTERED UV PILOT	VISIBLE BIOLOGIC IDENTIFIER	UV POLICE AUTHORITY	POLICING UNMANNED	REQUESTED PI

3.a KEYPOINTS

- The information arguable from the analysis merely based on the technical fields defined by WIPO is consistent for each of the four sub-sectors, however, the scarce granularity suggests that the evaluation of the frequency of assignment of IPC/CPC classification codes may be the most appropriate approach.

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

4.a BLUE SUSTAINABLE DEVELOPMENT: THE NPL DIVULGATION FOCUSING ON THE COUNTRIES LOCATED ALONG THE MEDITERRANEAN SEA

a1) Monitoring and Observing systems for Marine Environment → Maritime surveillance

The number of patent applications filed by the European residents appears significant, and as already underscored several patent applications are filed by companies headquartered in France. 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 55 to Figure 57, 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 55 Maritime surveillance: data showing the national and trans-national collaborations (NPL research focusing on Italy)

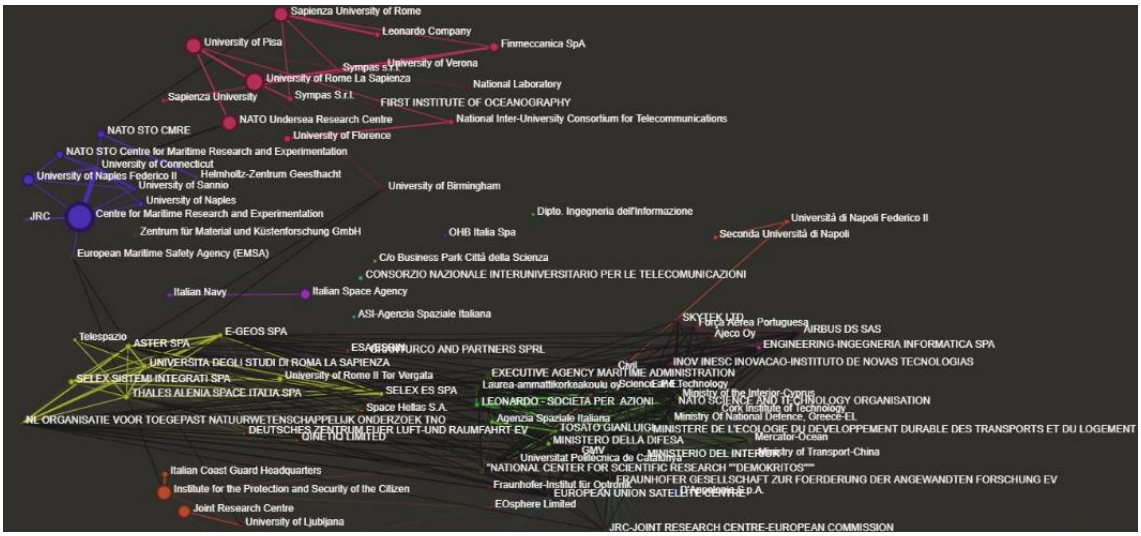


Figure 56 Maritime surveillance: data showing the national and trans-national collaborations (NPL research focusing on France)

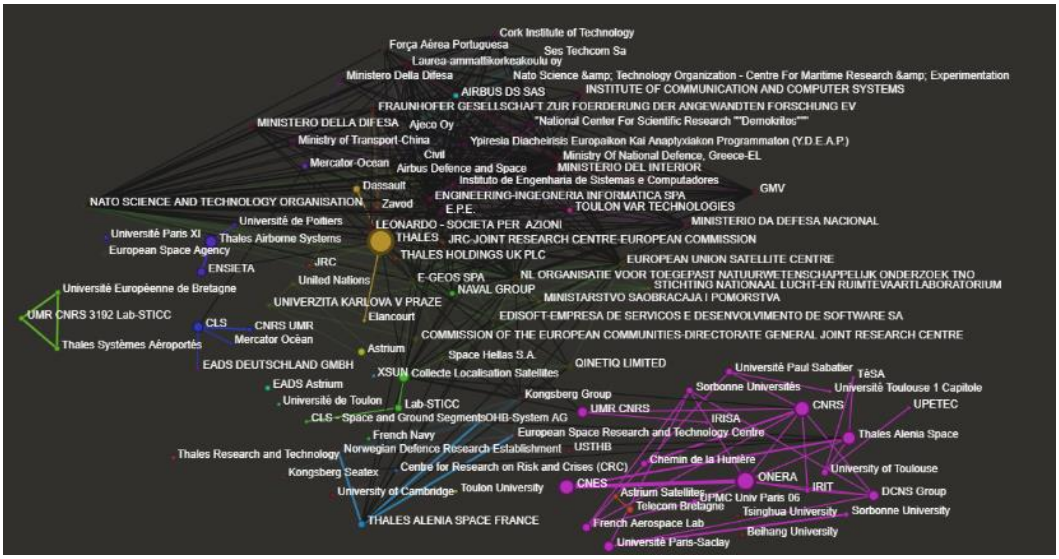
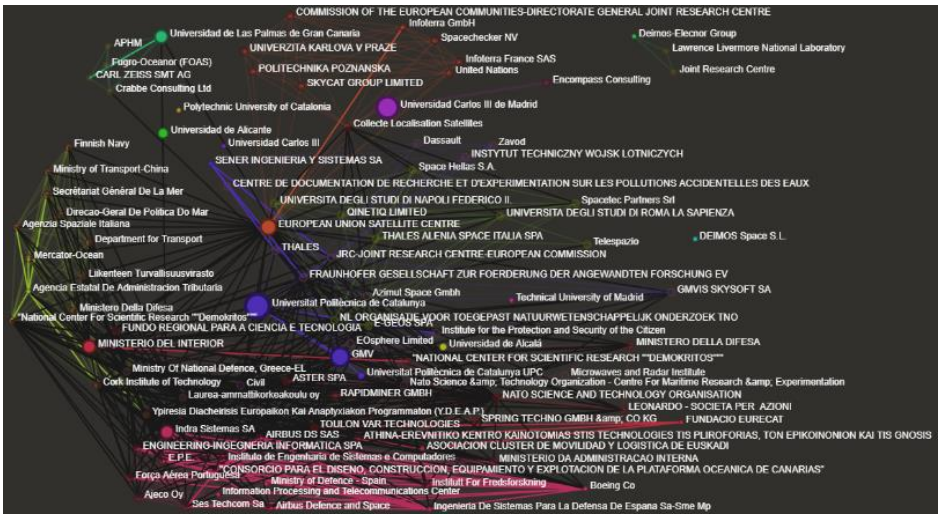


Figure 57 Maritime surveillance: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Greece, Slovenia, Turkey, Israel and Egypt. Consistently with the observation that THALES is the most prominent player emerging from the patent assessment, it results that this player is usually involved in collaborations as arguable from the examination of the NPL data.

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 58 to Figure 60 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the maritime surveillance may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 58 Maritime surveillance: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

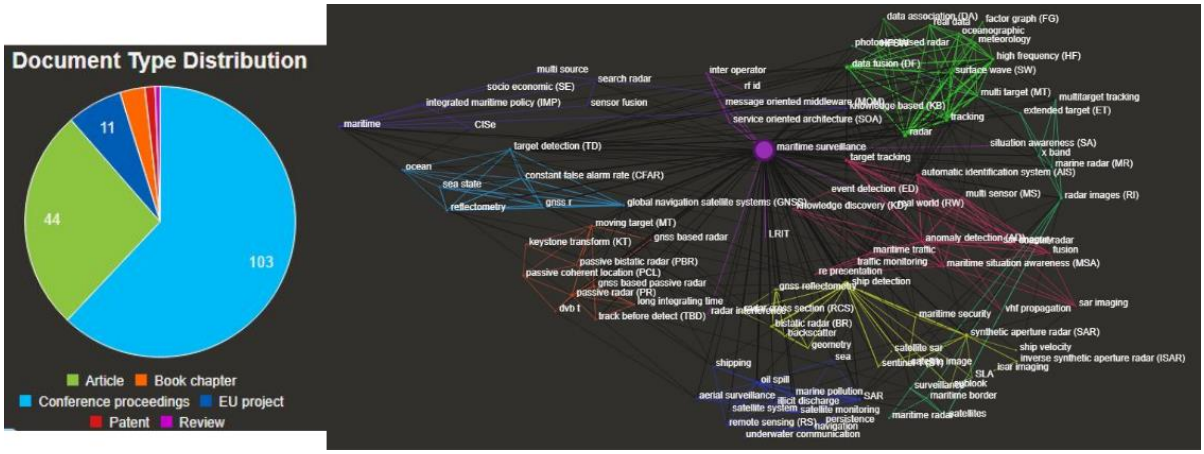


Figure 59 Maritime surveillance: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

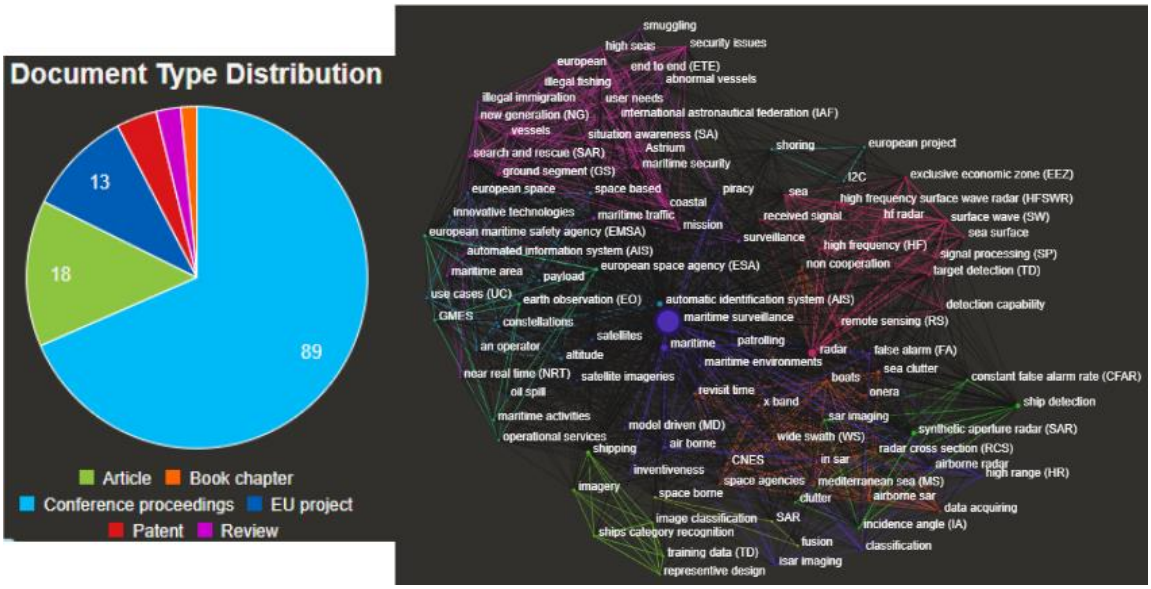
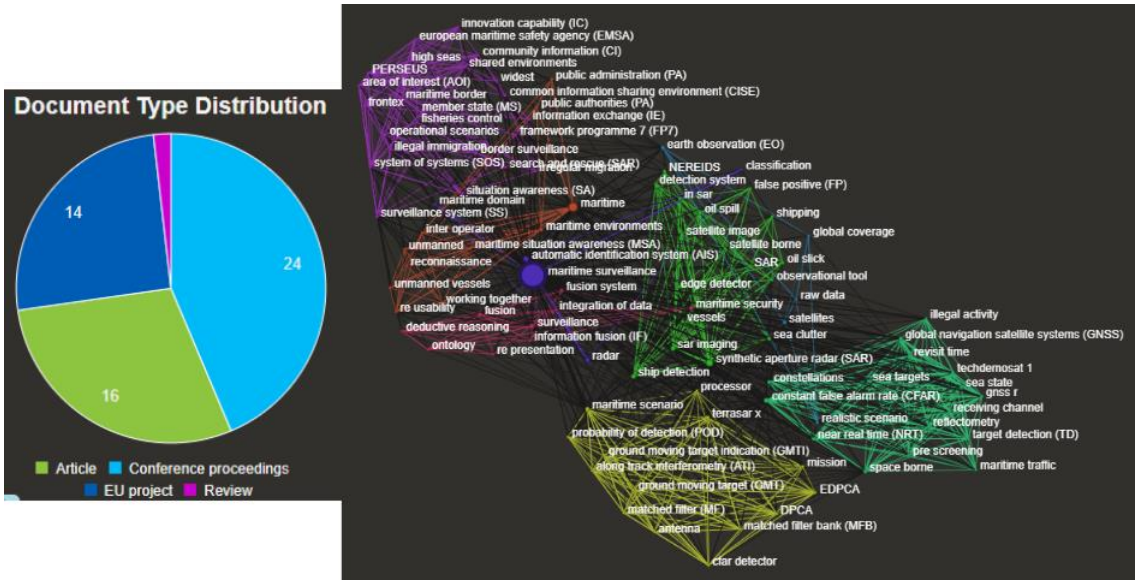


Figure 60 Maritime surveillance: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



a2) Monitoring and Observing systems for Marine Environment → Marine mapping

The number of patent applications filed by the European residents appears quite small, although not negligible, 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 61 to Figure 63, 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 61 Marine mapping: data showing the national and trans-national collaborations (NPL research focusing on Italy)

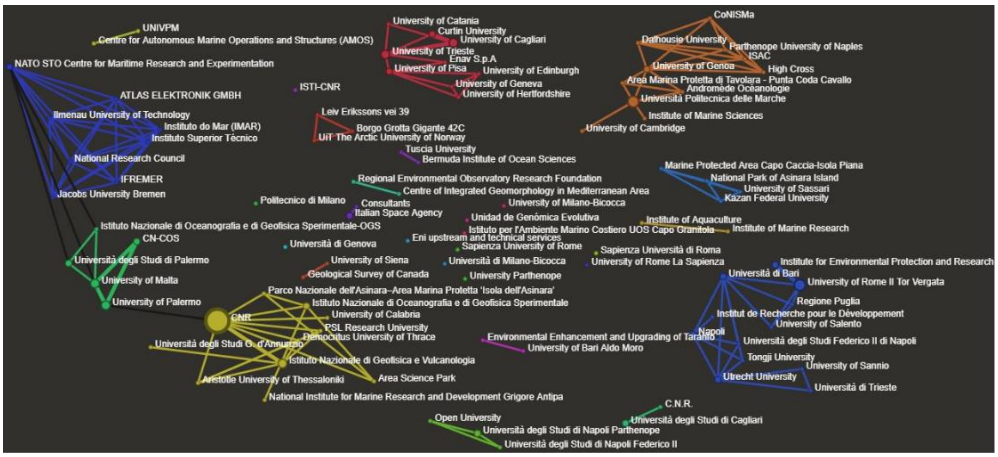


Figure 62 Marine mapping: data showing the national and trans-national collaborations (NPL research focusing on France)

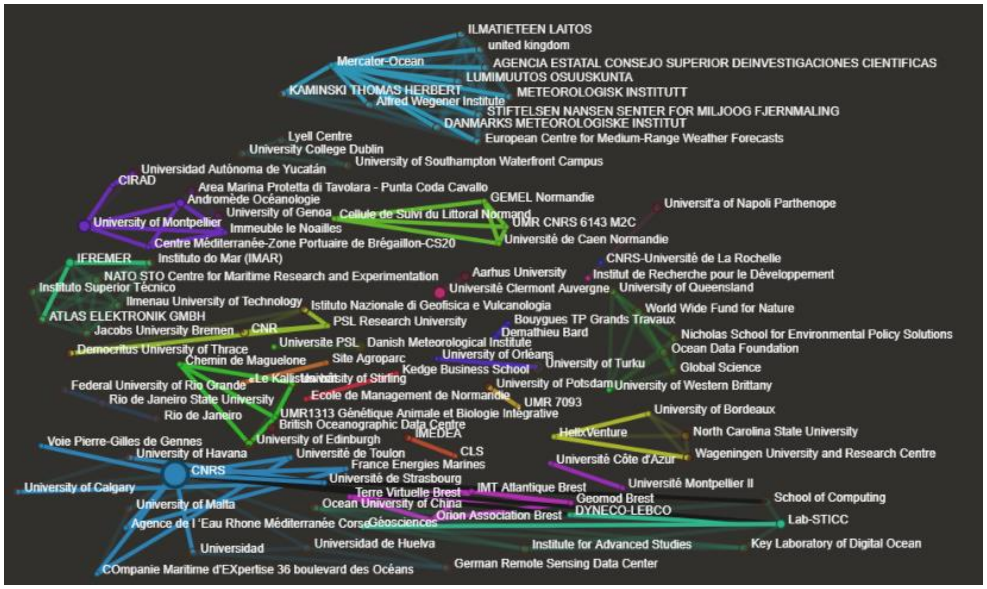
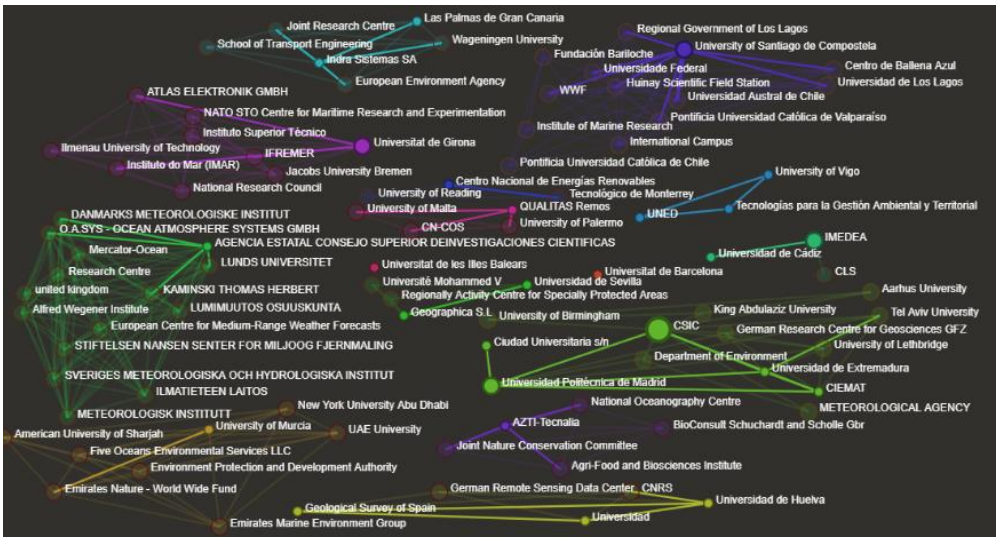


Figure 63 Marine mapping: data showing the national and trans-national collaborations (NPL research focusing on Spain)



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

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 Figures Figure 64, Figure 65 and Figure 66 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the marine mapping may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 64 Marine mapping: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

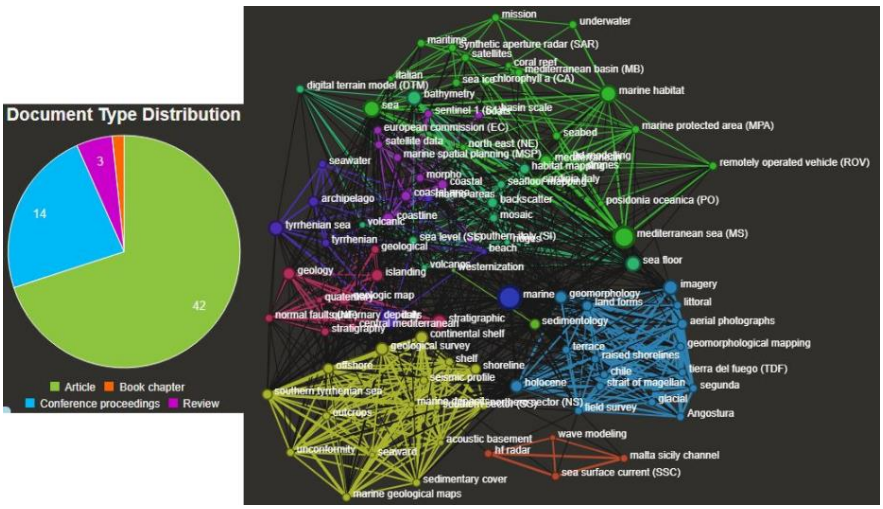


Figure 65 Marine mapping: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

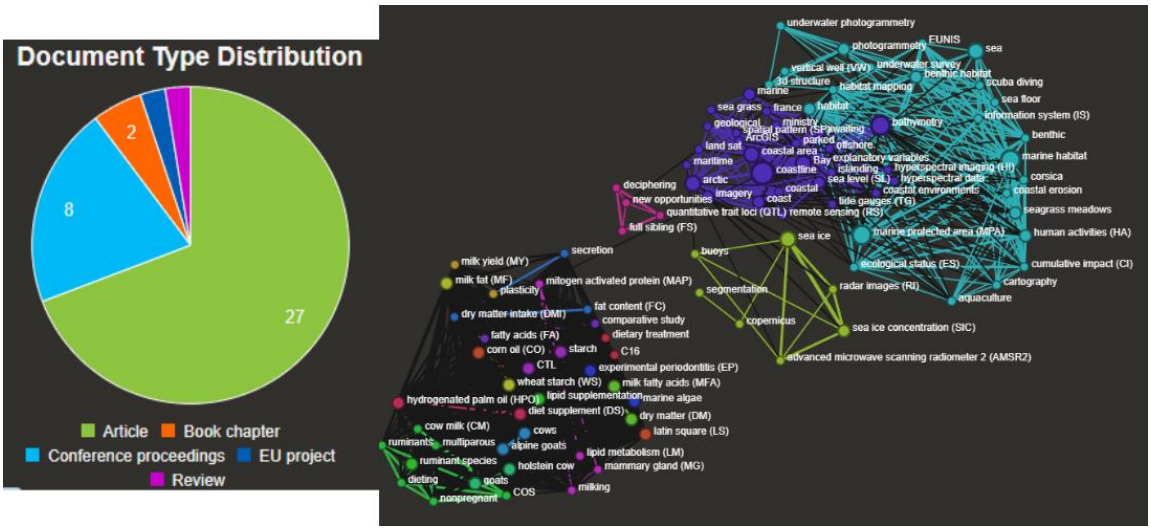
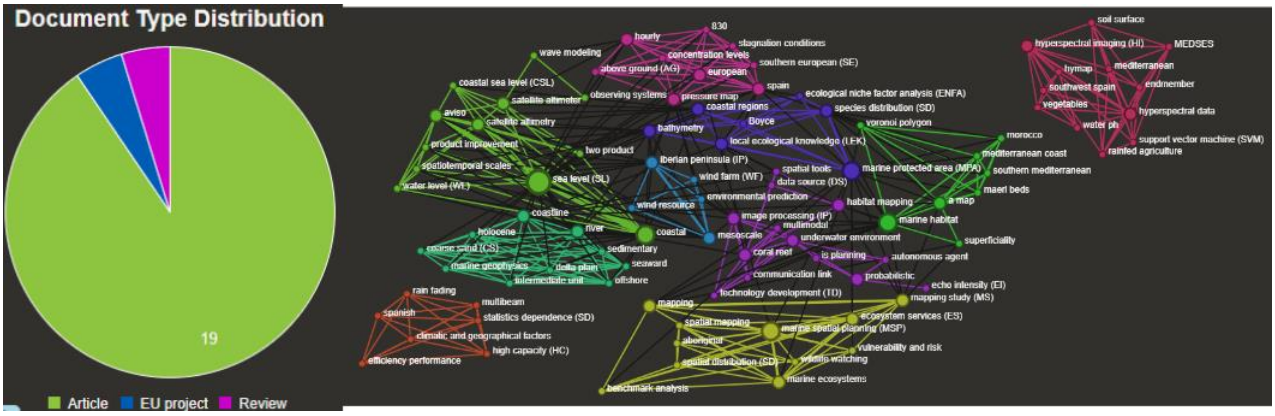


Figure 66 Marine mapping: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



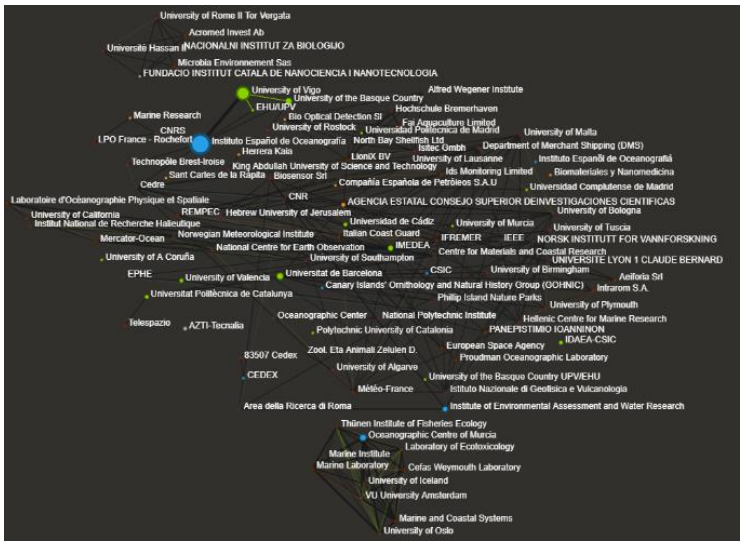
a3) Monitoring and Observing systems for Marine Environment → Seawater sensors

The number of patent applications filed by the European residents appears significant, and as already underscored several patent applications are filed by companies headquartered in France and a couple of Italian players. 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 67 to Figure 69, 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 67 Seawater sensors: data showing the national and trans-national collaborations (NPL research focusing on Italy)

Figure 68 Seawater sensors: data showing the national and trans-national collaborations (NPL research focusing on France)

Figure 69 Seawater sensors: 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 Croatia, Slovenia and Greece.

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 70 to Figure 72provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the seawater sensors may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 70 Seawater sensors: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

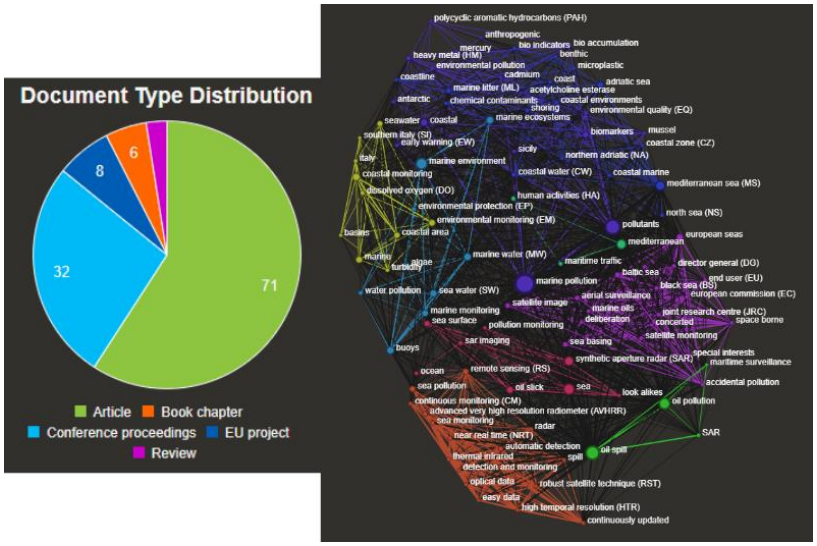


Figure 71 Seawater sensors: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

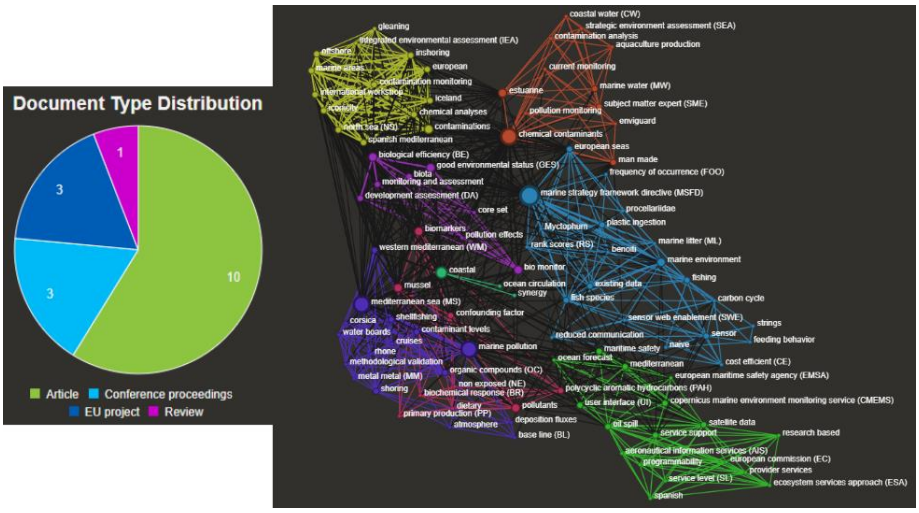
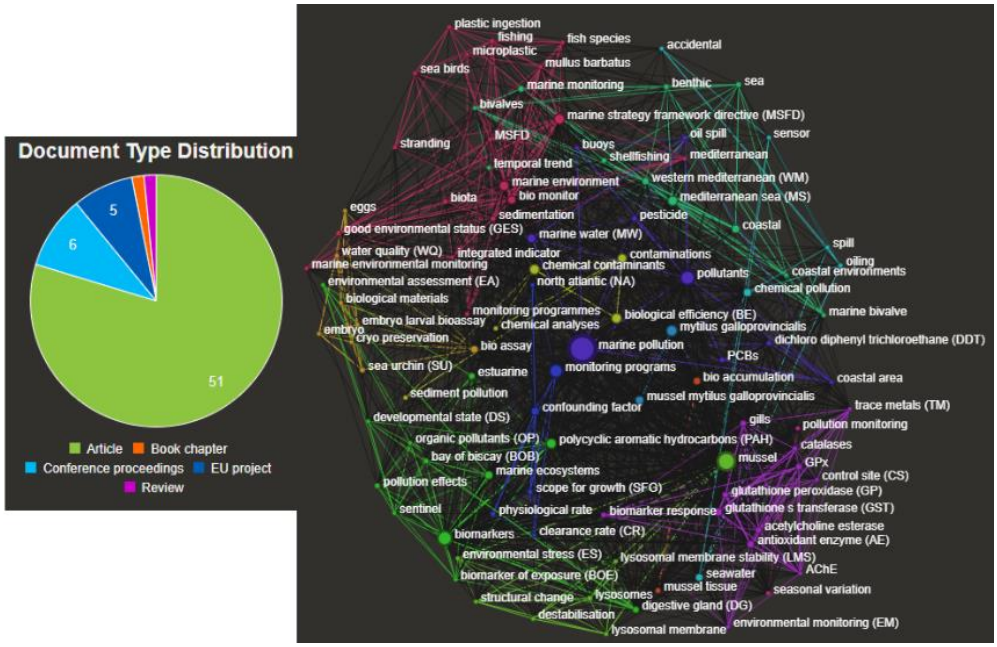


Figure 72 Seawater sensors: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



As far as the technical priorities are concerned, from the diagram specifically mapping the keywords of the French players the quotation of the Marine Strategy Framework Directive[4] (MSFD) can be detected due to the relevant number of documents in which such initiative is mentioned. Article 20 of the MSFD claims that while the EU's framework for marine

[4] Law - EU Coastal and Marine Policy - Environment - European Commission (europa.eu)

environmental protection is one of the most comprehensive and ambitious worldwide, it needs to be beefed up to be able to tackle predominant pressures such as overfishing and unsustainable fishing practices, plastic litter, excess nutrients, underwater noise and other types of pollution.

a4) Monitoring and Observing systems for Marine Environment → Unmanned underwater vehicles (UUV)

The number of patent applications filed by the European residents is small, 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 73 to Figure 75, 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 73 UUV: data showing the national and trans-national collaborations (NPL research focusing on Italy)

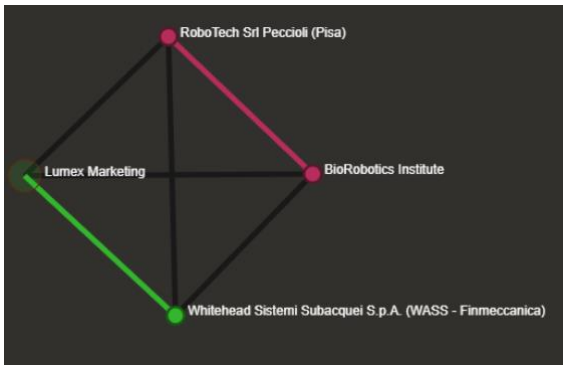
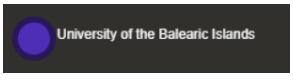


Figure 74 UUV: data showing the national and trans-national collaborations (NPL research focusing on France)

Figure 75 UUV: data showing the national and trans-national collaborations (NPL research focusing on Spain)



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 76 to Figure 78 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the seawater sensors may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 76 UUV: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

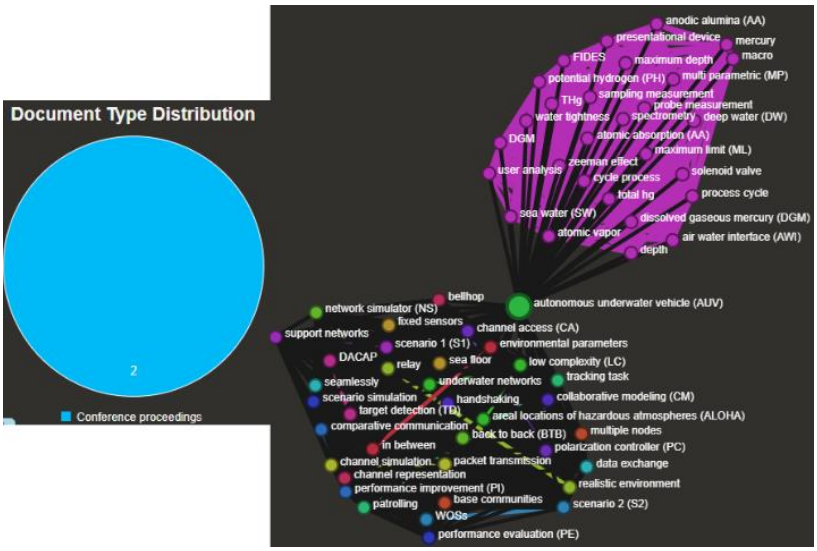


Figure 77 UUV: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

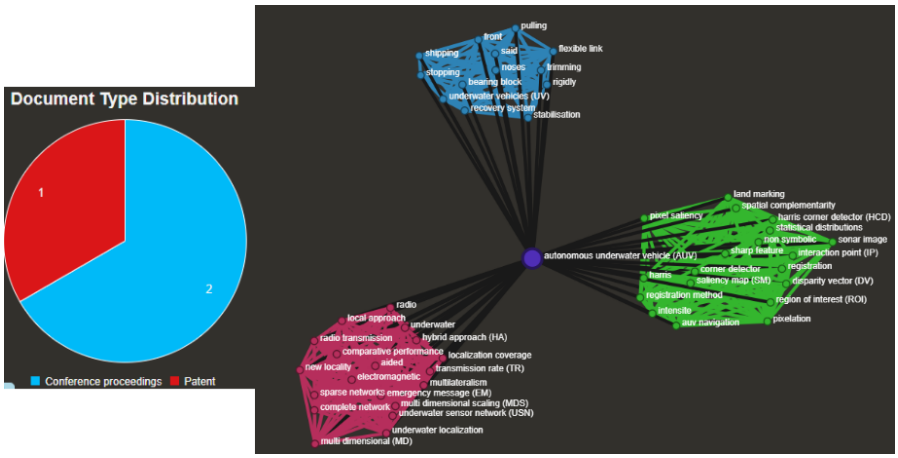
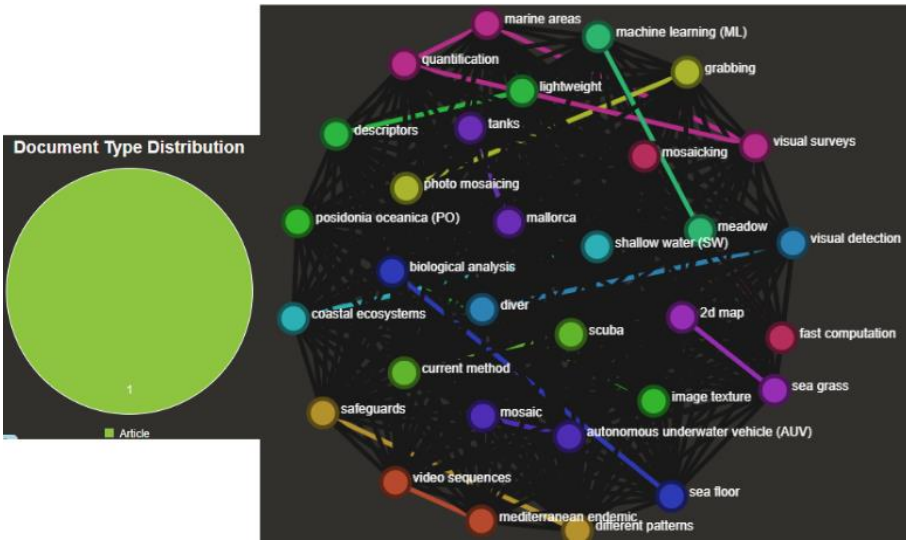


Figure 78 UUV: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.a KEYPOINTS

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

5.a PLAYERS TO BE MONITORED AND EU FUNDED PROJECTS

- **RAYTHEON TECHNOLOGIES** (https://www.rtx.com/)
- **INSITU** (https://www.insitu.com/)
- **AEROVIRONMENT** (https://www.avinc.com/)
- **PRYSMIAN** (https://it.prysmiangroup.com/)
- **SELEX** (http://selex-es.com/)
- **THALES ALENIA SPACE** (located in Italy, https://www.thalesgroup.com/it/italia/global-presence-europe/italia)
- **W-SENSE** (https://wsense.it/)
- **SCIO SOFT SL** (https://www.scioit.es/inicio-eng/)
- **THALES** (Thales - Building a future we can all trust (thalesgroup.com))
- **GEOCEAN** (https://www.entrepose.com/fr/geocean/)

- **SAFRAN** (https://www.safran-group.com/)
- **ETME PEPPAS KAI SYNERGATES EE** (https://etme.gr/)
- **WIRELESSWERX Corp.** (https://www.crowdvision.com/)
- **TEVEL ADVANCED TECHNOLOGIES** (https://www.tevel-tech.com/technology/)
- **TOMTOM** International (https://developer.tomtom.com/products/tracking-api)
- **MICROSOFT CORP.** (https://www.microsoft.com/it-it/) see: https://www.microsoft.com/en-us/maps
- **NAVIONICS** (https://www.navionics.com/ita/)
- **BLUE DNA COMPANION** (BlueDNAcompanion - Rapid Microbiology - Oncology Diagnostics)
- **SUEZ EAU FRANCE** (SUEZ Eau France SAS - Company Profile and News - Bloomberg Markets)
- **INDUSTRIE DE NORA** (Home | De Nora - Electrode and Water Technologies that work!)
- **CAMBRIAN INNOVATION** (Wastewater treatment systems and services | Cambrian (cambrianinnovation.com))
- **AAT BIOQUEST** (Home | AAT Bioquest)
- **LIQUID ROBOTICS** (https://www.liquid-robotics.com/markets/environmental-assessment/)
- **RECONROBOTICS** (https://reconrobotics.com/)
- **BLUEROBOTICS** (https://bluerobotics.com/about/)
- **HADAL Inc.** (https://www.dnb.com/business-directory/company-profiles.hadal.dab25e9bd7adfc9b3f89a3dd2d46899b.html#company-info)
- **MARINE INSTRUMENTS Co.** (https://www.marineinstruments.es/)
- **SEYS MEDIOAMBIENTE SL** (http://www.seysmedioambiente.com/apartado/1677/innovacion)

SECTOR RELATED EU FUNDED PROJECTS:

Maritime surveillance

1) **Maritime Integrated Surveillance Awareness (MARISA).** Combating irregular migration, human smuggling, terrorism at sea, piracy, as well as arms and drug trafficking has become a high priority on Europe's security agenda. Securing the sea requires a day-to-day collaboration activities among European actors of maritime surveillance, Member States' administrations and European agencies principally, and a significant number of initiatives are being taken at EU level to address this challenge.
Grant agreement ID: 740698
https://cordis.europa.eu/project/id/740698

2) **RAdars for loNG distance maritime surveillancE and SaR opeRations (RANGER).** RANGER aims at re-enforcing EU by combining innovative Radar technologies with novel technological solutions for early warning, in view of delivering a surveillance platform offering detection, recognition, identification and tracking of suspicious vessels, capabilities exceeding current radar systems.
Grant agreement ID: 700478
https://cordis.europa.eu/project/id/700478

3) **GALILEO-BASED PASSIVE RADAR SYSTEM FOR MARITIME SURVEILLANCE (spyGLASS).** This proposal brings forward a passive bistatic radar (PBR) based on Galileo transmissions for maritime surveillance. The exploitation of existing transmissions for PBR applications is becoming increasingly attractive due to their low costs, covert operation, and reduced environmental pollution.
Grant agreement ID: 641486
https://cordis.europa.eu/project/id/641486

Marine mapping

1) "**BOTTOM TRAWLING AS A DRIVER OF DEEP SEASCAPE TRANSFORMATION (TrawledSeas)**. The EU-funded project TrawledSeas provides a thorough reading of the impact of bottom trawling in terms of extent, rates, and volume change on the morphology of different geological and climatic deep (>200 m) seafloor settings. Their interdisciplinary approach combines quantitative analysis of high-resolution multibeam data with geophysical and sedimentological information, in situ observations and satellite-based vessel tracks.
Grant agreement ID: 867471
https://cordis.europa.eu/project/id/867471

2) "**The Politics of Marine Biodiversity Data: Global and National Policies and Practices of Monitoring the Oceans (MARIPOLDATA)**. Marine biodiversity data will play a central role: Firstly, in supporting intergovernmental efforts to identify, protect and monitor marine biodiversity. Secondly, in informing governments interested in particular aspects of marine biodiversity, including its economic use and its contribution to biosecurity. In examining how this data are represented and used, this project will create a novel understanding of the materiality of science-policy interrelations and identify new forms of power in global environmental politics as well as develop the methodologies to do so. This is crucial, because the capacities to develop and use data infrastructures are unequally distributed among countries and global initiatives for data sharing are significantly challenged by conflicting perceptions of who benefits from marine biodiversity research. Despite broad recognition of these challenges within natural science communities the political aspects of marine biodiversity data remain understudied.
Grant agreement ID: 804599
https://cordis.europa.eu/project/id/804599

Seawater sensors

1) **Micro AIS Shore Station (MASS)**. Automatic Identification System (AIS) is a VHF based system which is designated to enhance the safety of life and goods at sea by also assuring navigational and environmental improvements. The coverage of national AIS networks is limited because of many reasons (geography, weather conditions, insufficient number of stations etc.) and due to these limitations relevant authorities have difficulties to track and manage the marine traffic properly; causing safety and security weaknesses at sea which also means increased threats of accidents, illegal fishing, immigration & smuggling and water pollution.
Grant agreement ID: 775636
https://cordis.europa.eu/project/id/775636

1.b BLUE SUSTAINABLE DEVELOPMENT → Marine environmental technologies: MARKET SCENARIO

Marine environmental technologies: Precision aquaculture

The **marine environmental technologies** included in the Blue Sustainable Development sector are referring to the technologies used for the safe exploitation of the marine environment. Among the new technologies targeting the marine resources, the **Precision Aquaculture** (PA) is significantly appealing. Specifically, PA is based on the application of control-engineering principles to fish production, thereby improving the farmer's ability to monitor, control and document biological procedures in fish farms using smart electronic devices and computing capabilities. These technological

innovations are improving the overall production and efficiency of the aquaculture industry which, as anticipated, shows a steeply rising market trend. The most important factors driving the growth of PA market include:

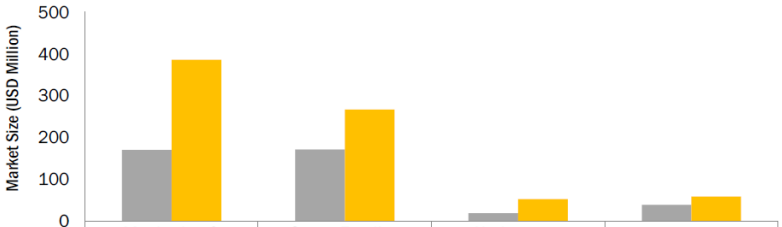
- Surging adoption of advanced technologies such as Internet of Things (IoT), remotely operated vehicles (RoVs), and artificial intelligence (A.I.) in aquaculture farms;
- Growing investments in aquaculture technology and R&D projects aimed at the adoption of innovative devices;
- Rising income levels and demand for protein-rich fish feed;
- Increasing worldwide the governments' support developing infrastructure tailored to the aquaculture needs.

The number of aquaculture farms and fish farmers has doubled since 1970 across the world. The **aquaculture industry** is expected to grow at a healthy growth rate of ~5% by 2020. Currently, more than 50% of global fish production is done through aquaculture harvesting and a share of wild capture production is declining substantially. Since 1990, aquaculture has been the fastest-growing segment of food production by volume, with compound annual growth rate of 8.3%. Increasing number of aquaculture farms across the world provides an exciting opportunity to the equipment and technology providers.

The **global PA market** is projected to reach a value of USD 763.7 million in 2024, being 14% the predicted CAGR in the period 2019 – 2024. The precision aquaculture market is experiencing gradual adoption of integrated monitoring systems that gather the information from hardware components such as sensors and smart cameras and then analyze this data with the help of AI-based advanced tools. Different types of monitoring, inspection, control, and feeding systems are available in the market to improve efficiency in aquaculture farms. The advent of underwater Remotely Operated Vehicles (ROVs) has opened a new wave of opportunity for aquaculture equipment manufacturers across the world. Overall, the main systems provided by the PA market include the smart feeding systems, the monitoring systems, the control systems and the underwater ROVs.

Smart feeding systems segment comprises the devices designed to help aquaculture farmers to save a significant number of hours of labour each day and to substantially lower the feeding and the operation coast. This market segment is forecasted at USD 267 million in 2024, at a CAGR of 9%. **Monitoring and Control systems** segment mainly implicates the use of water sensors and of machine learning technologies for the assessment of the well-functioning of the aquaculture farms. This segment is projected to reach a value of USD 386 million in 2024, showing a remarkable CAGR of 18%. The market for **underwater remotely operated vehicles** (ROVs) is expected to grow at the highest rate in the years, being the value of USD 52 million expected by 2024, and a CAGR of 23% between the period 2019 - 2024. The adoption trend of underwater ROVs in Western Europe and North America has gained good traction in recent years. Currently, countries such as the US, Canada, Norway, and Chile account for more than 60% of the installed base of underwater ROVs.

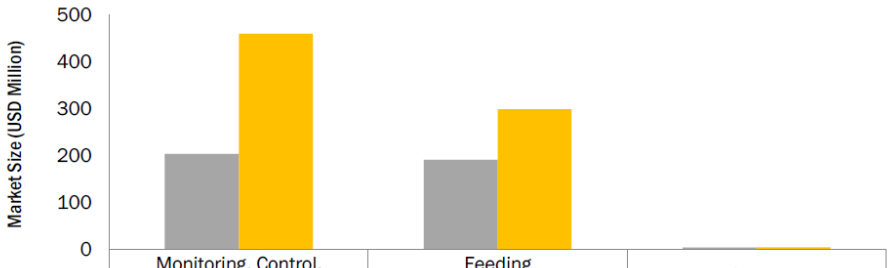
Figure 79 Global Precision Aquaculture Market by System Type, in the Period 2019-2024 valued in United States Dollar (USD) Million. "Others" includes underwater lighting systems, net inspection and cleaning systems, lice counting systems, and aeration systems



	Monitoring & Control Systems	Smart Feeding Systems	Underwater ROVs	Others
2019	170	171	18	38
2024	386	267	52	58
CAGR (2019–2024)	18%	9%	23%	9%

Based on **application**, the precision aquaculture market could be segmented into: feeding management; monitoring, control, and surveillance and other applications (yield analysis, biomass estimation, fish size estimation, net inspection, lice counting, and fish appetite detection applications).

Figure 80 Monitoring, Control and Surveillance Application to Lead Precision Aquaculture Market During 2019–2024



	Monitoring, Control, and Surveillance	Feeding Management	Others
2019	203.7	190.6	3.7
2024	460.3	298.7	4.7
CAGR (2019–2024)	18%	9%	5%

The **monitoring, control and surveillance application** is expected to command the precision aquaculture market from 2019 to 2025. Factors contributing toward the predominance of this application over others are increasing installation of automated aquaculture farm monitoring devices such as IoT-based monitoring devices, underwater ROVs, and smart camera systems and the growing focus of aquaculture farmers on effective management of fisheries to ensure improved farm productivity and efficiency.

Feeding management includes feed waste management, feed dose, and feed optimization. A critical part of feeding management is to accurately formulate diets and manage the feeding so that nutrients in the feed consistently match with the nutrient requirements of each group of species in the aquaculture farm. Distinctly different diet plans are required for different groups of aquatic species, leading to differences in the volume and nutrient composition of the feed. In this regard, maintaining diet plans can be efficiently achieved using hardware devices and software solutions. Through this approach, diets can be formulated and updated regularly to avoid overfeeding.

The **monitoring, control, and surveillance application** includes fish behaviour monitoring; health monitoring; fish position tracking; and net inspection, identification, and tracking. IoT-based monitoring of aquaculture farms has gained tremendous popularity in recent years owing to the increasing focus on increasing farm productivity, early detection of diseases among aquatic species, and improving the water quality in aquaculture farms.

Globally, the American region is expected to be the fastest-growing market in the coming years, whereas the Asia Pacific region is likely to continue to account for the largest size of the precision aquaculture market. The **European market** for PA is expected to reach the value of USD 141.6 million in 2024, with a CAGR of 11%. This growth is related to the presence of various commercial aquaculture farms and favourable government policies. The aquaculture industry of Europe is renowned for its high quality, sustainability, and consumer protection standards. In Europe, aquaculture accounts for about 20% of fish production and directly employs around 85,000 people. The aquaculture industry in Europe is mainly composed of small and medium-size enterprises, and micro enterprises in coastal and rural areas. The European Commission is responsible for simplifying administrative procedures, implementing spatial planning, and promoting sustainable aquaculture in Europe.

In the **Mediterranean area** the leading countries in the sector include France, Italy and Spain. **Spain** is one of the biggest producers of aquaculture products in Europe. More than 70% of aquaculture production in Spain comes from sea fishing, a quarter from aquaculture, and less than 1% from inland fishing. Specifically, the aquaculture industry of Spain is widely diversified in terms of species and farming technologies. The aquaculture industry in **France** is well-established and the most developed among all countries in the European Union. The country produced aquaculture products worth USD 682 million in 2018. France primarily comprises small and medium-size farms with an annual production of around 150–180 tons per year. Overall, the marine aquaculture industry in France is still fragmented with approximately 40 companies occupying 46 production units. However, the French market for underwater ROVs is expected to grow at the highest CAGR during the forecast period as the country is witnessing an increase in the demand for remotely operated vehicles every year.

Italy is identified as the fastest-growing country of the EU in the period 2020 - 2024. The **Italian** aquaculture industry has indeed registered a sharp increase in the production of marine species according to a structural policy, based on 4 large pillars: management of fishery resources, structural policy, common organization of markets and international agreements. The fishery policy is implemented through the Directorate General for Fisheries and Aquaculture of the Italian Ministry of Agriculture, Food and Forestry Policies (MIPAAF) and by the Directorate for Fisheries of the regional administrations, with the support of services provided by decentralized offices (Marine Coastal Guard) [1].

Figure 81 Global Precision Aquaculture Market by Region in the Period 2019-2024. The numbers inside the boxes denote the CAGR of individual countries (2019–2024)

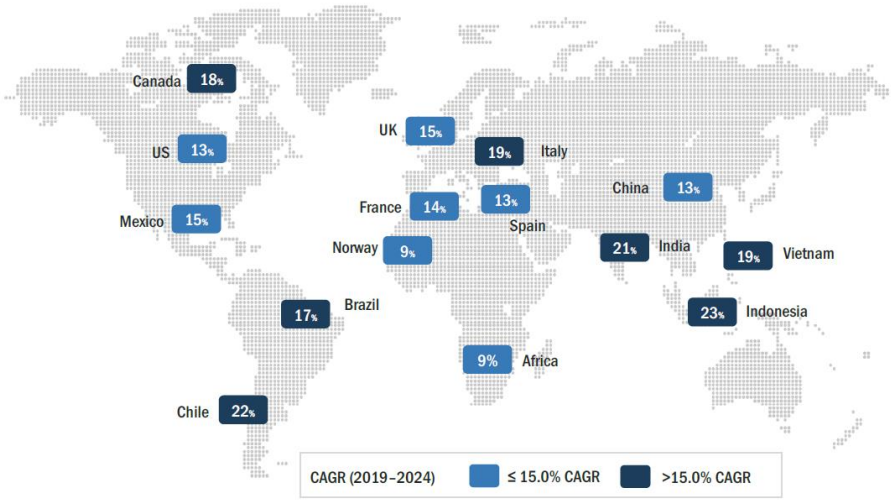
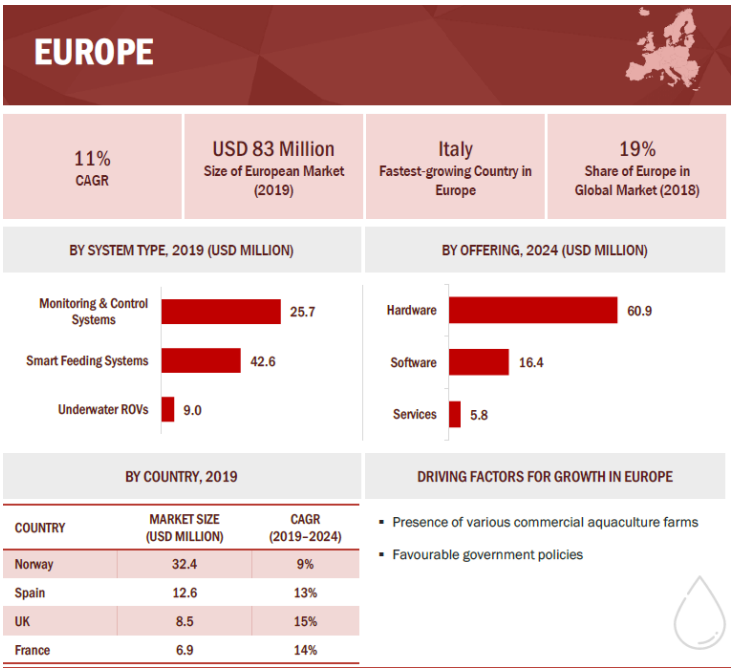
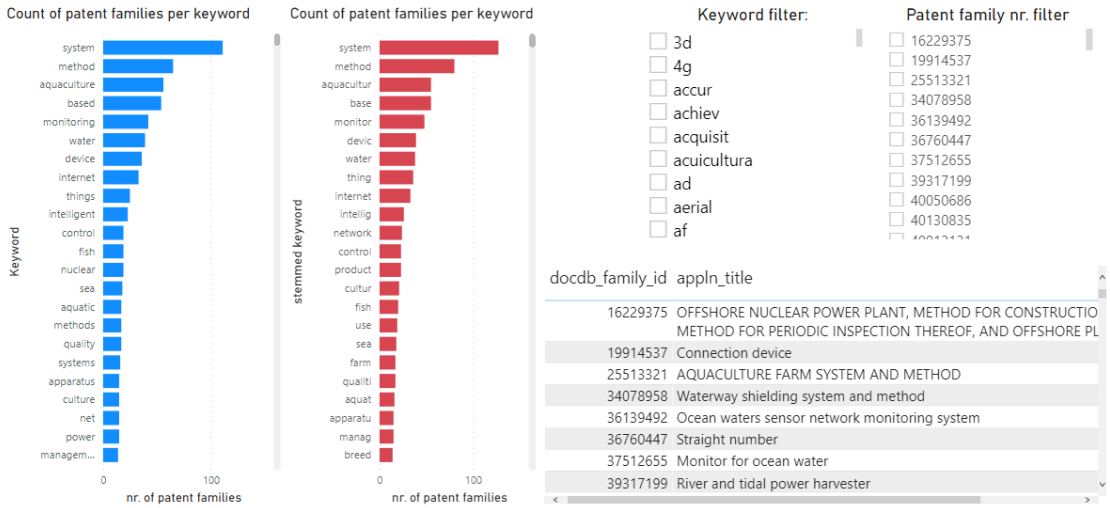


Figure 82 Precision Aquaculture Market Snapshot in Europe



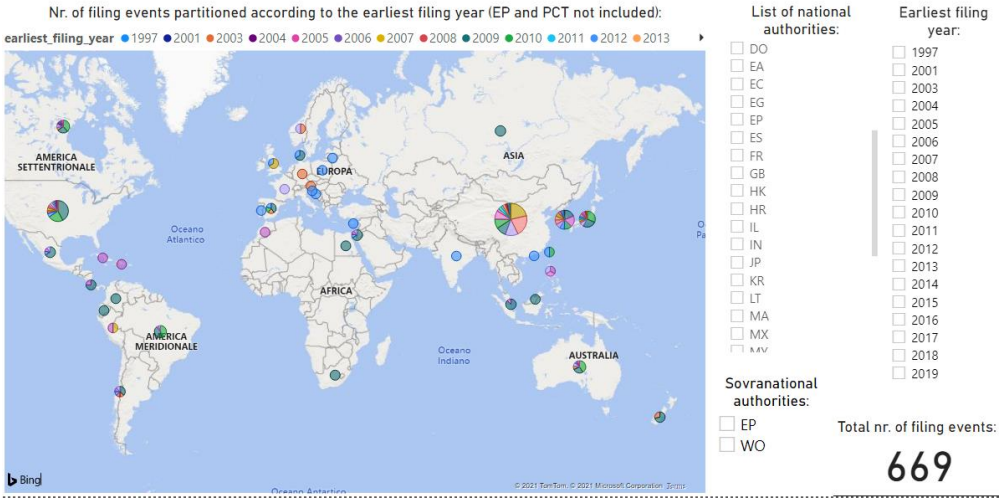
As far as the specific subsector of the seawater decontamination is concerned, a dataset consisting of **269 non-duplicated patent families** corresponding to **669 patent applications** has been analyzed. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 83.

Figure 83 Precision aquaculture: keywords' frequency



The number of patent applications filed to the CNIPA/SIPO is remarkable (178), whereas considering the Mediterranean region, a small number of patent applications have been filed to the Spanish and French patent authorities, respectively and an almost negligible number of patent applications has been filed to the national patent authorities hosted in the other countries located along the Mediterranean coast. Relatively consistent numbers of patent applications have been filed to the EPO (43) or to the WIPO (62) authorities. Such information may be argued upon a deeper analysis of the data of Figure 84.

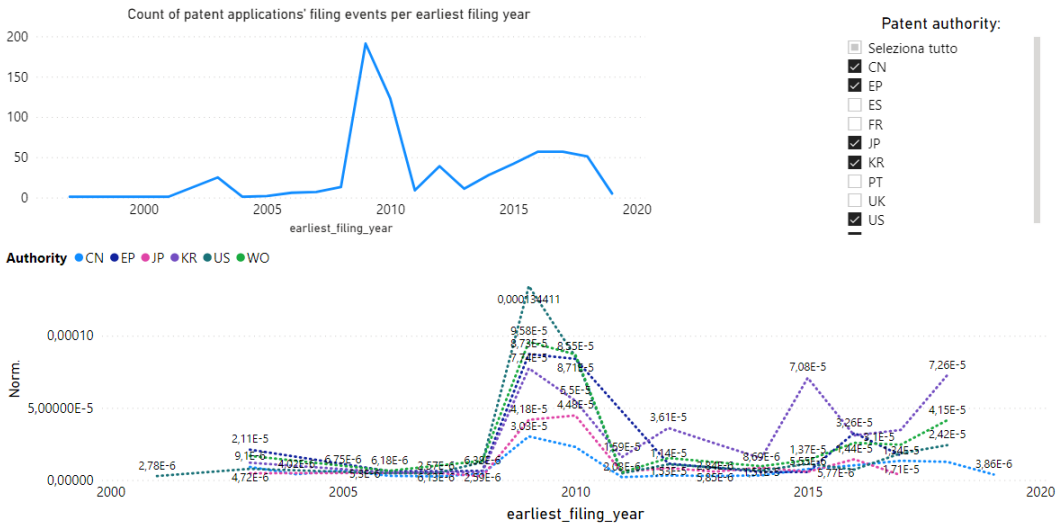
Figure 84 Precision aquaculture: Map of national/supranational patent authorities



Upon analysing the data of Figure 85 a consistent increase of the number of patent applications occurred around years 2009 and 2010. Moreover, from the normalized data it appears that the proportion of patent applications filed in recent year is relevant especially in South Korea. It is also evident how an increase in the proportion of filed applications correspond to the peak observed around year 2009 and 2010 as far as the total number of applications is

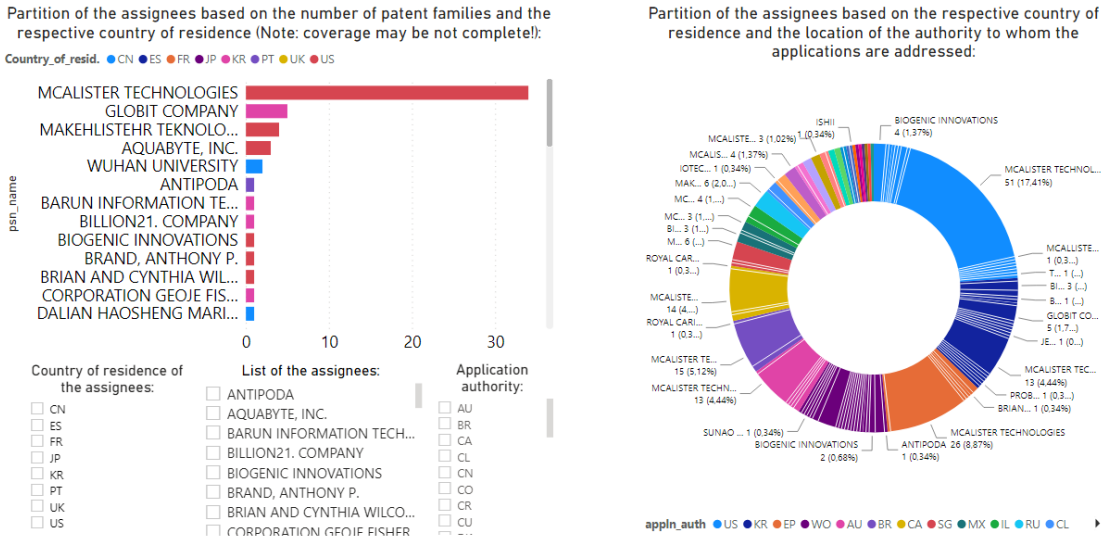
concerned. This is the case of applications filed to the USPTO and to the KIPO national authorities but is as well the case of the applications filed through harmonized procedures, namely the applications directly filed to the EPO and to the WIPO, respectively.

Figure 85 Precision aquaculture: 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, one player is headquartered in France (GENOCEAN) and one (UNIVERSITY OF CADIZ) in Spain. A quite high number of US residents may be identified. 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 86.

Figure 86 Precision aquaculture: Legal protection strategy



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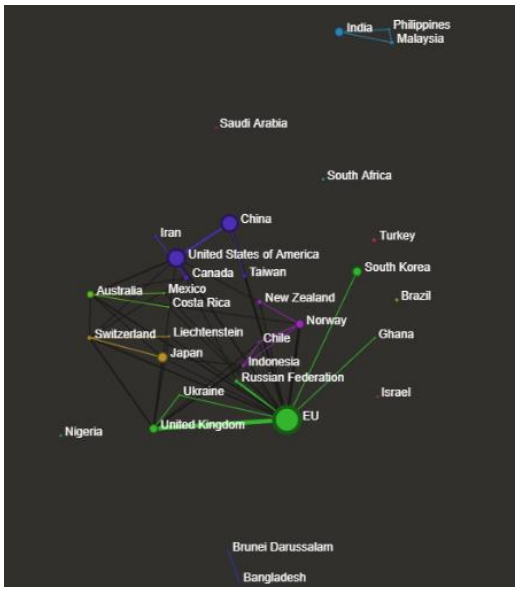
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the Asian countries such as China, Japan and South Korea (Figure 84) may be argued, basic research activities, monitored by analyzing 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 and US institutions relevant, as evident from Figure 87.

Figure 87 Precision aquaculture: NPL data worldwide



1.b KEYPOINTS

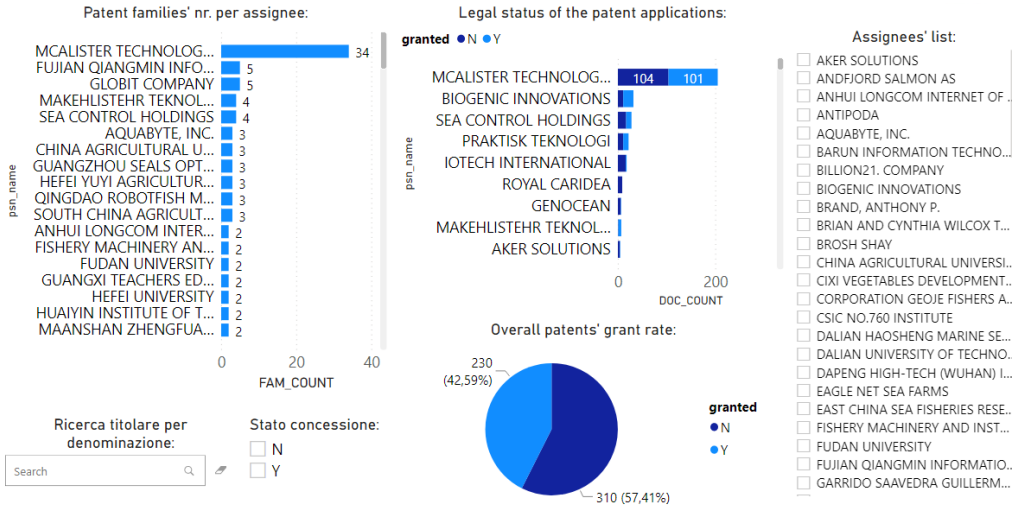
- Considering the number of non-duplicated families (269), the dataset concerning the Precision Aquaculture is one of the smallest along with the Sea organisms' genetics and the Microplastics sectors. Patent applications concern a niche sector since referring to technical implementations tailored to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

2.b BLUE SUSTAINABLE DEVELOPMENT → Marine environmental technologies: THE LEGAL INFORMATION ARGUABLE FROM THE PATENTS' DATASETS

Marine environmental technologies: Precision aquaculture

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 88. 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 less than 43%.

Figure 88 Precision aquaculture: Ranking of the applicants based on the patent application number and grant rate

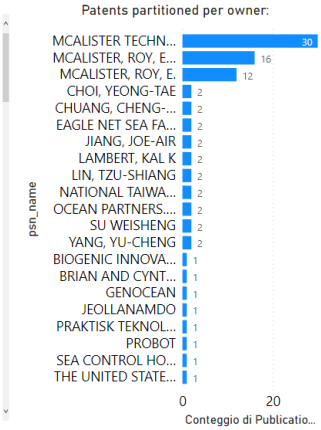


The US company McAlister Technologies appears as the most prominent applicant and assignee of granted patents. Irrespectively from the ranking, there may be other players worth of consideration, being the expected lifespan of the respective patents considerably long. The possibility of analyzing in detail 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 89. Quite often there are US players worth of consideration and no patents already expired can be detected (pls. refer to negative values of 'Expiry days' in the original dashboard), thus suggesting that the technological implementations claimed in most patents may be truly innovative.

Figure 89 Precision aquaculture: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
GENOCEAN	FR3054409	5762	3
OCEAN PARTNERS. COMPANY	KR101658224	4922	4
OCEAN PARTNERS. COMPANY	KR20150117868	4922	4
SEA CONTROL HOLDINGS	EP2846630	4219	7
JEOLLANAMDO	KR101127694	4004	8
CHOI, YEONG-TAE	KR101314316	3962	7
CHOI, YEONG-TAE	KR20130022557	3962	7
MCALISTER TECHNOLOGIES	US2014224210	3660	4
MCALISTER TECHNOLOGIES	US9175654	3660	4
CHUANG, CHENG-LONG	US2011305115	3525	4
CHUANG, CHENG-LONG	US8576665	3525	4
JIANG, JOE-AIR	US2011305115	3525	4
JIANG, JOE-AIR	US8576665	3525	4
LIN, TZU-SHIANG	US2011305115	3525	4
LIN, TZU-SHIANG	US8576665	3525	4
NATIONAL TAIWAN UNIVERSITY	US2011305115	3525	4



The results of the assessment of the triadic families are shown in Figure 90.

Figure 90 Precision aquaculture: some of the Triadic families

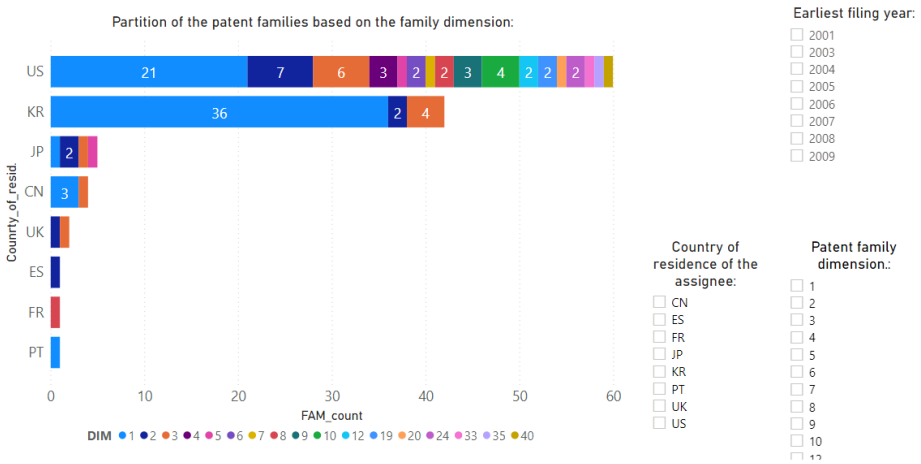
psn_name	person_ctry_code	PUB	Conteggio di nr_famiglie
BIOGENIC INNOVATIONS	US	EP2493464	1
BIOGENIC INNOVATIONS	US	EP2494059	1
BRIAN AND CYNTHIA WILCOX TRUST	US	EP2244934	1
IOTECH INTERNATIONAL	US	EP3125952	1
MCALISTER TECHNOLOGIES	US	EP2398937	1
MCALISTER TECHNOLOGIES	US	EP2398938	1
MCALISTER TECHNOLOGIES	US	EP2399316	1
MCALISTER TECHNOLOGIES	US	EP2533889	1
MCALISTER TECHNOLOGIES	US	EP2533891	1
MCALISTER TECHNOLOGIES	US	EP2534094	1
MCALISTER TECHNOLOGIES	US	EP2534095	1
MCALISTER TECHNOLOGIES	US	EP2534096	1
MCALISTER TECHNOLOGIES	US	EP2534097	1
PRAKTISK TEKNOLOGI	NO	EP1596653	1
PRAKTISK TEKNOLOGI	NO	EP1599389	1
PRAKTISK TEKNOLOGI	NO	EP1736416	1

The number of applicants owning patents corresponding to triadic patent families is quite modest. These data taken altogether suggest that there is a consistent margin of implementation of technologies/products dedicated to the precision aquaculture.

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 91 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, especially USA, include several members corresponding to applications filed to a multiplicity of patent authorities.

Figure 91 Precision aquaculture: Ranking of the country of residence of the players based on the patent family dimension



2.b KEYPOINTS

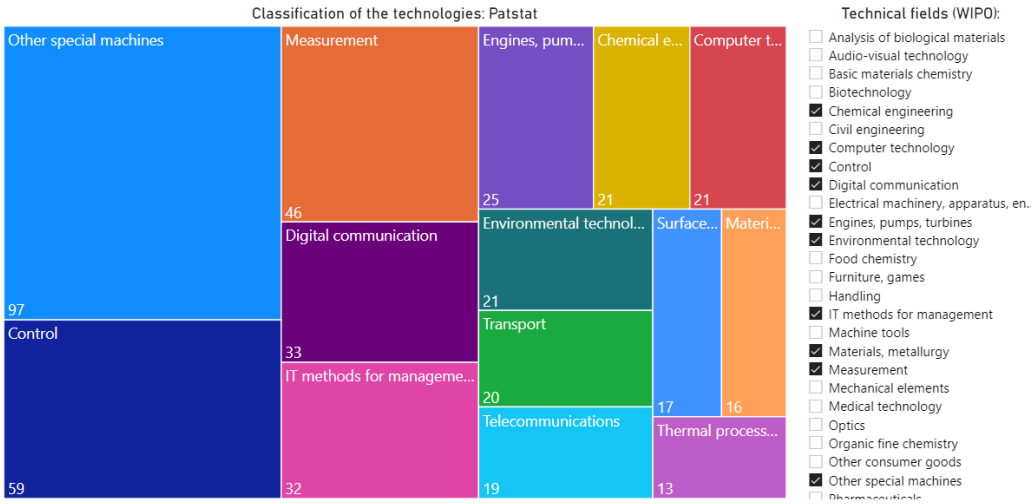
- As already pointed out in the sector concerning the "Monitoring and observing systems for the marine environment", also in the case of the subsector specifically referring to the "Precision Aquaculture" the residual validity of the granted patents is noticeable, thus indicating that there is a remarkable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

3.b BLUE SUSTAINABLE DEVELOPMENT → Marine environmental technologies: THE TECHNICAL INFORMATION

Marine environmental technologies: Precision aquaculture

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 92.

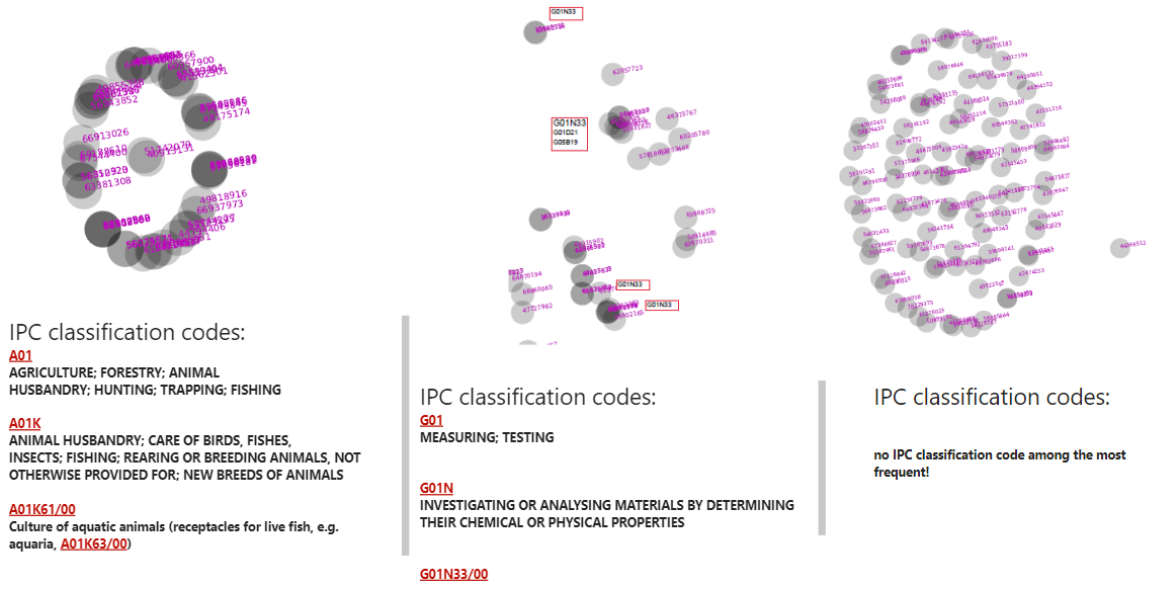
Figure 92 Precision aquaculture: Map of the technology fields defined by WIPO



The clustering of the patent documents according to patterns defined by one or more technical fields suggest that a large panel of technologies may lead to the implementation of applications pertaining to the Precision Aquaculture subsector. Clustering the documents of the same dataset may be based on the classification codes, either IPC or CPC.

The following figure (Figure 93) refers specifically to the IPC classification codes:

Figure 93 Precision aquaculture: 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 one pattern characterized by the following main group:

A01K61/00, referring to **Culture of aquatic animals (receptacles for live fish, e.g. aquaria, A01K63/00)**.

Smaller clusters share the main group **G01N33/00**, referring to **Investigating or analysing materials by specific methods not covered by groups G01N1/00 - G01N31/00**.

The co-occurrence of two IPC or CPC classification codes identifying single patents families is not much frequent, despite the dataset includes 269 non duplicated patent families (Figure 94). IPC codes such as **A01K63** (Receptacles for live fish, e.g. aquaria (keepnets or other containers for keeping captured fish A01K97/20); Terraria) may either refer to **Arrangements for treating water specially adapted to receptacles for live fish** (**A01K63/04**) or to **Arrangements for heating or lighting in, or attached to, receptacles for live fish** (**A01K63/06**)), while CPC codes such as **F24S20/20** (**Solar heat collectors specially adapted for particular uses or environments**).

Figure 94 Precision aquaculture: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

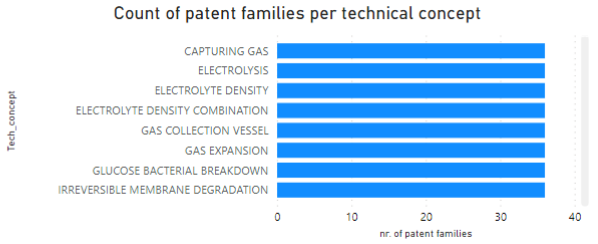
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
9	A01K 63/04	A01K 63/00
7	A01K 63/06	A01K 63/04
7	G06Q 50/10	G06Q 50/02
7	G08C 17/02	G01D 21/02
7	H04L 29/08	G06Q 50/02
6	A01K 63/04	A01K 61/80
6	G08C 17/02	G01N 33/18
5	A01K 61/65	A01K 61/60

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
15	Y02E 10/41	F24S 20/20
12	C01B2203/0266	C01B 3/24
11	C25B 13/02	C25B 11/03
10	C01B 3/24	B01J 19/127
10	C01B2203/0266	B01J 19/127
10	C01B2203/0811	B01J 19/127
10	C01B2203/0811	C01B 3/24
10	C01B2203/0811	C01B2203/0266

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 95.

Figure 95 Precision aquaculture: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
16229375	OFFSHORE NUCLEAR POWER PLANT, METHOD FOR CONSTRUCTION TH FOR PERIODIC INSPECTION THEREOF, AND OFFSHORE PLANT
19914537	Connection device
25513321	AQUACULTURE FARM SYSTEM AND METHOD
34078958	Waterway shielding system and method
36139492	Ocean waters sensor network monitoring system
36760447	Straight number
37512655	Monitor for ocean water
39317199	River and tidal power harvester
40050686	METHOD FOR PRODUCING ETHANOL AND DEVICE FOR THE SAME
40130835	Integral submarine maintenance system



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
16229375	SEA	PLATFORM	OFFSHORE NUCLEAR POWER	REACTOR BUILDING	TURBINE	FLOATATION	SEAWATER	TURBINE BUILDING	NUCLEAR POWER PI
19914537	CONTAINER	STACK	AQUATIC ENVIRONMENT	CULTURE	BENTHO	STORAGE	DEPOSIT UPPER PORTION	ELEVATING	LOW DEPOSITION P
25513321	HABITAT	MOLLUSC	SEA	PREDATOR	PROTECTION	TETHER	AQUACULTURE	MOLLUSC CULTIVATION	SEA FLOOR
34078958	UNDERWATER NODE	WATERWAY SURVEILLANCE	WATERWAY SHIELDING	GATEWAY UNDERWATER NODE	WATERWAY	DIGITAL DATA	ACOUSTIC ATTRIBUTE DATA	ENTITY ACOUSTIC PHYSICAL ATTRIBUTE	ACOUSTIC PHYSICA
36139492	MARINE	MONITORING	SENSOR NETWORK MONITORING	OCEAN WATER SENSOR	ONLINE MONITORING NODE	WIRELESS TRANSCEIVER INTERFACE INTERCONNECTIO	REALTIME EMERGENCY SITUATION	REALTIME MONITORING ENVIRONMENTAL PARAMETER	ROUTE DISCOVERY

3.b KEYPOINTS

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

4.b BLUE SUSTAINABLE DEVELOPMENT → Marine environmental technologies: THE NPL DIVULGATION FOCUSING ON THE COUNTRIES LOCATED ALONG THE MEDITERRANEAN SEA

Marine environmental technologies: Precision aquaculture

The number of patent applications filed by the European residents appears scarce 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 not negligible for Italy, France and Spain, as revealed by Figure 96 to Figure 98, being there evidence of the national and also the trans-national collaborations especially involving several academic institutions located in each of the countries mentioned above.

Figure 96 Precision aquaculture: data showing the national and trans-national collaborations (NPL research focusing on Italy)

Figure 97 Precision aquaculture: data showing the national and trans-national collaborations (NPL research focusing on France)

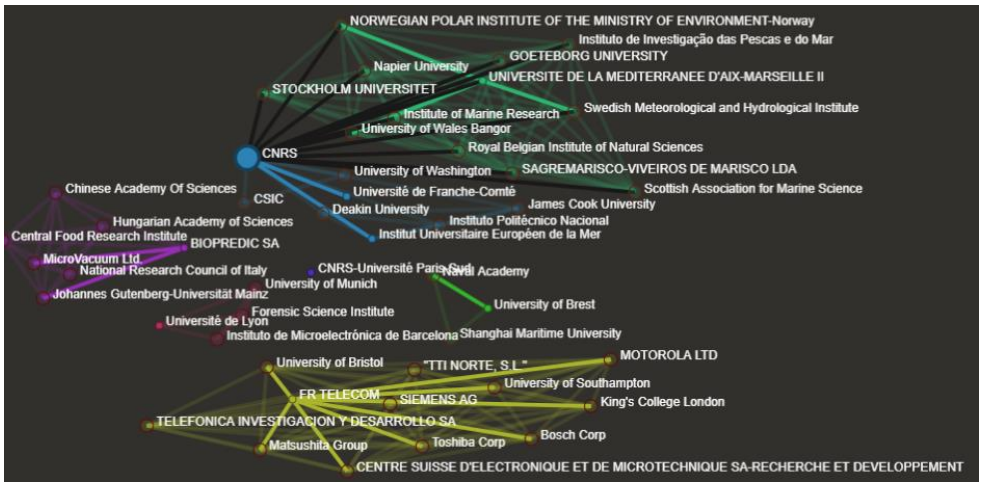
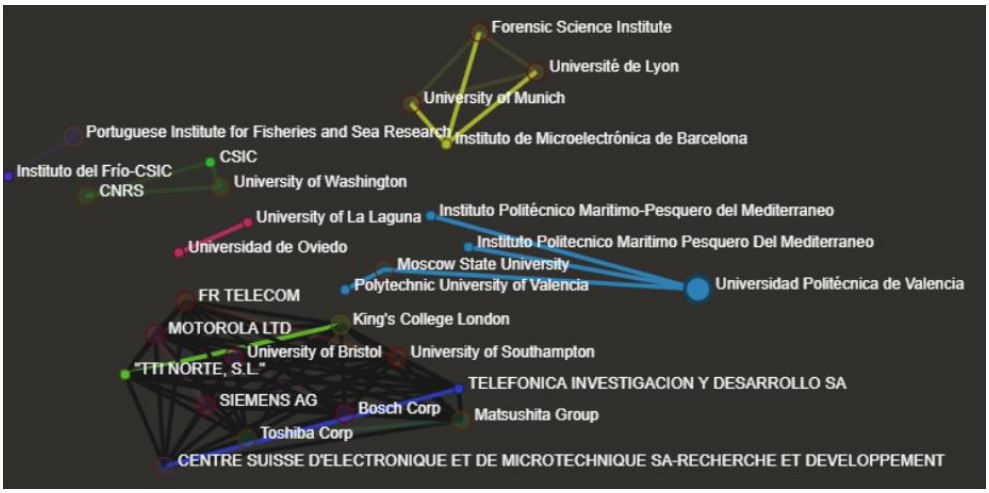


Figure 98 Precision aquaculture: data showing the national and trans-national collaborations (NPL research focusing on Spain)



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

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 99 to Figure 101 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the precision aquaculture may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 99 Precision aquaculture: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

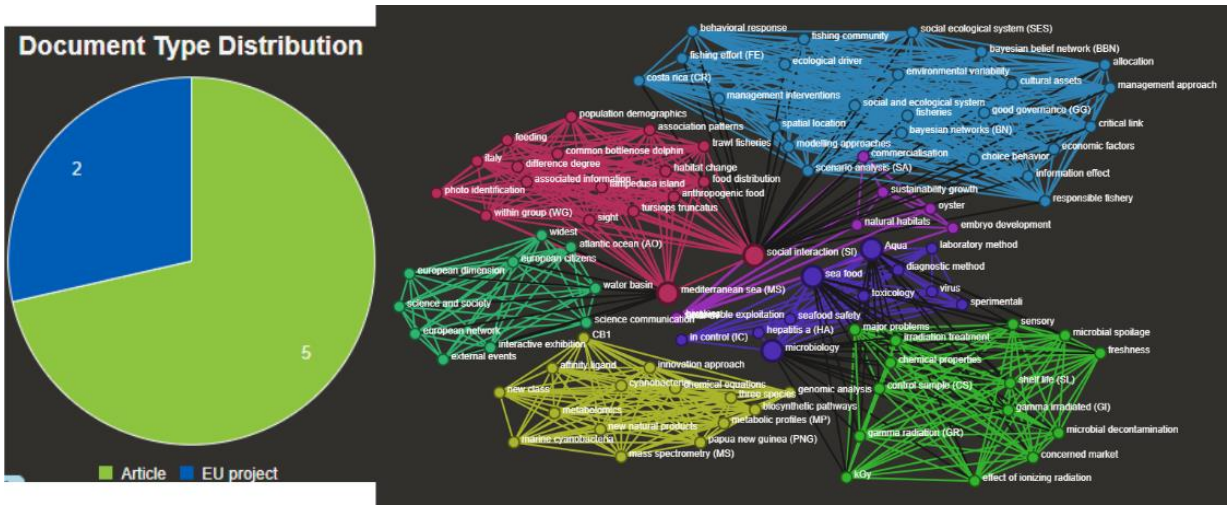


Figure 100 Precision aquaculture: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

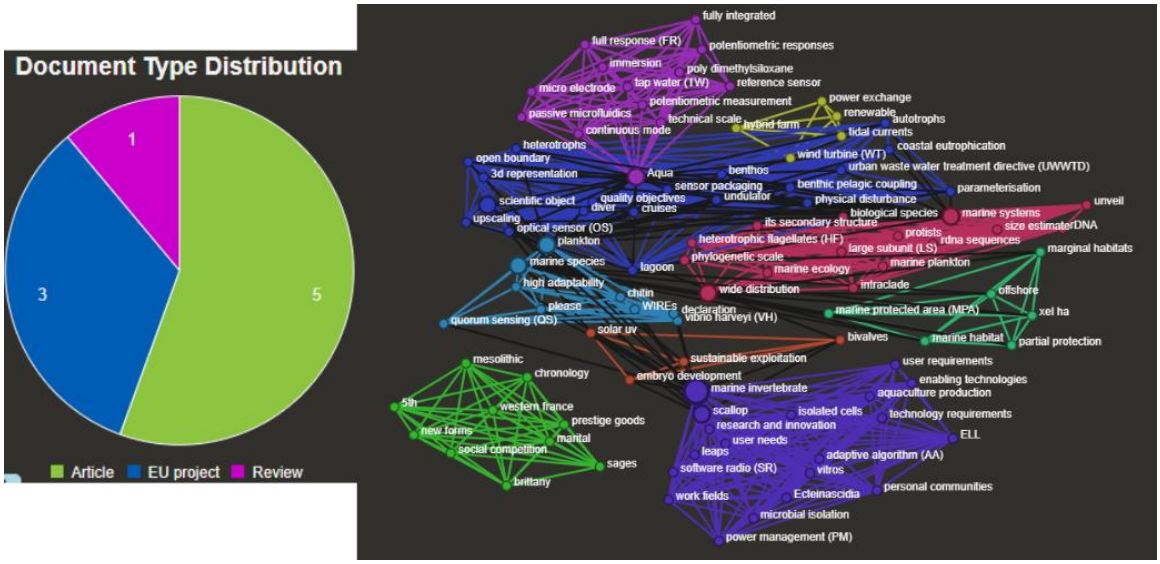
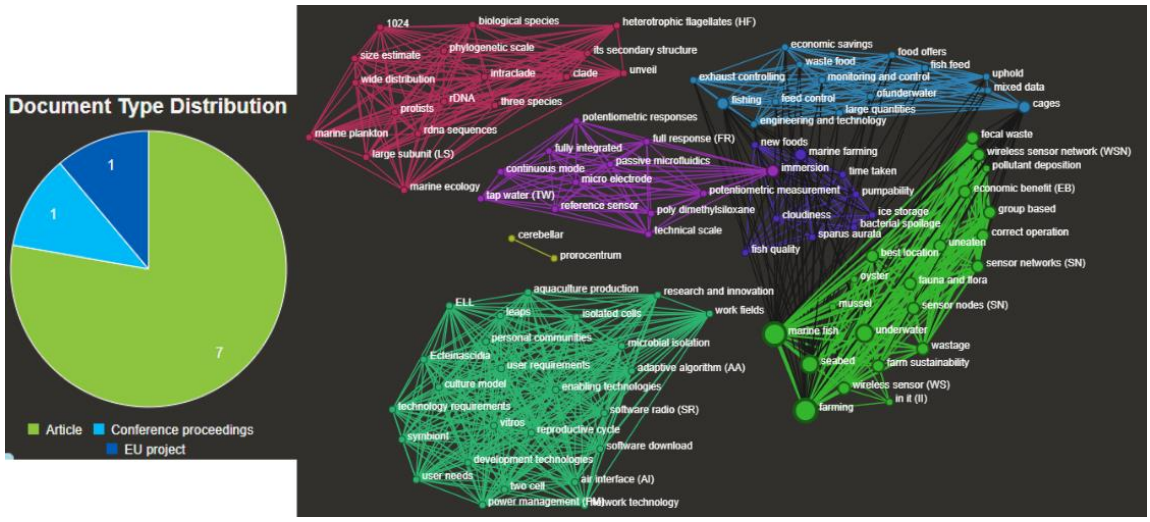


Figure 101 Precision aquaculture: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.b KEYPOINTS

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

5.b PLAYERS TO BE MONITORED AND EU FUNDED PROJECTS

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

SECTOR RELATED EU FUNDED PROJECTS:

1) **Development and field validation of biosensor methods for the assessment of the effects of pollution and solar uv radiation on commercially and ecologically important marine invertebrates (UVTOX)**
The main goal of this research project is to introduce novel cellular biosensor (marine invertebrate cell culture) and molecular biosensor techniques for the estimate of the health state of ecologically and/or commercially important marine invertebrates at their natural habitats (sponges and sea urchins) or held in aquaculture (bivalves).
Three molecular biosensors will be developed:
a) immunosensor,
b) DNA affinity biosensor, and
c) DNA damage biosensor. These biosensors will be used to determine and to quantify the impact of cosmic (UV-B radiation) and ecosystem (xenobiotics) factors, and their combinations on marine invertebrates (laboratory experiments and field studies). This project will contribute to a sustainable exploitation of the sea. Commercialisable products (biosensor chips for environmental monitoring) will be developed and distributed throughout the world.
Grant agreement ID: EVK3-CT-1999-00005

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

1.c BLUE SUSTAINABLE DEVELOPMENT → Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure: MARKET SCENARIO

c1) Microplastics

The **Blue Sustainable Development** sector includes a topic focused on the methods and tools for the preservation and management of marine ecosystems and for the reduction of the anthropogenic pressure to achieve an adequate level of environmental protection. One of the main side effects of sea-based human and industrial activities is **pollution**, which is threatening the commercial and the recreation activities depending on the marine resources. Moreover, the sea pollution is also one of the main causes of the loss of biodiversity and of the degradation of the marine environment.

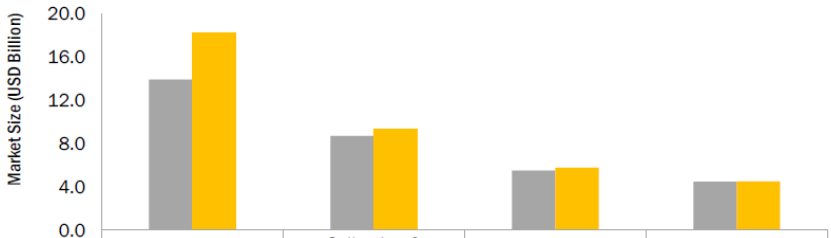
Marine pollutants concern a wide range of different contaminants such as chemical and toxic substances, nutrients, litter and underwater noise [1] most of whom coming from land sources which are washed or blown into the ocean. Among them, **plastic litter** is identified as the fastest-growing pollutant in aquatic systems especially when considering the smaller debris ranging from below 5 mm to 100 nm and identified as "**microplastics**" and "nanoplastics", respectively [2;9].

Over the past 50 years, the role of plastics in the economy has consistently grown, determining an increasing consumption of such material which has reached 359 million tonnes globally in 2018 [3]. However, while the production is very high, the recovery rate of such material very often does not ensure immediate profits or recycling opportunities. The global rate of recycling of plastic materials is low. In **Europe**, by far one of the most careful set of countries with respect to recycling, this activity accounts for less than 30% of the total production of plastic currently undergoing to recycling procedures. Moreover, it has been estimated that 95% of the plastic packaging material is discarded after a very short first-use cycle. Hence, very large quantities of mismanaged plastic wastes leak into the environment contaminating either the land or the sea. Globally, 5 to 13 million tonnes of plastics (4% of the overall plastics production) end up in the oceans every year and it is estimated that plastics account for over 80% of the marine litter [4].

Nevertheless, the **global market for plastic waste management** is increasing in recent years thanks to governmental legislation and regulation that advocate the proper handling and disposal of plastic waste and are aimed at increasing the awareness of the consumers by means of specific programs addressing the sustainable management, as well as the need to remove and recycle the plastics' waste from the sea.

The global market for **plastic recycling** is projected to reach USD 18.2 billion in 2024, with a CAGR of 5.51% predicted during the timeframe 2019 - 2024. Although in the recent years more controls in the wastes reduced the inputs at sea, the long-lasting life of the plastic material and their inevitable disaggregation into microparticles, result in an increasing trend of plastic concentration worldwide.

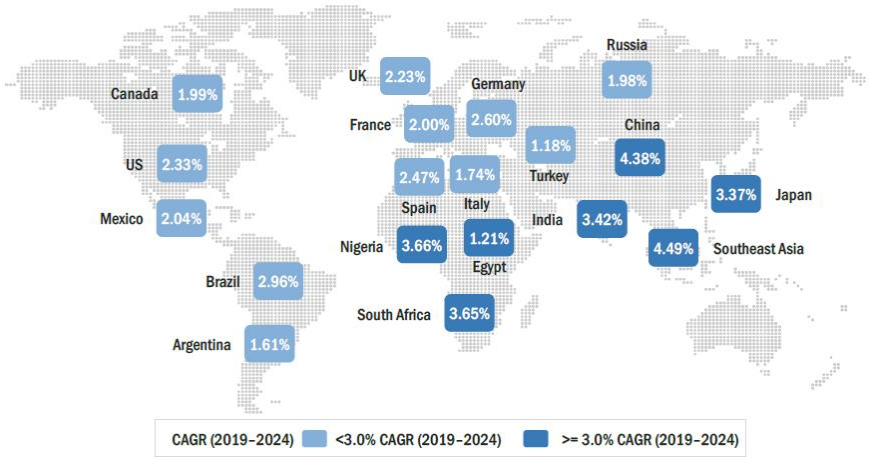
Figure 102 Plastic Waste Management Market by service in the period 2019 – 2024 valued in United States Dollar (USD) Billion. e-Estimated; p-Projected; Compound Annual Growth Rate (CAGR)



	Recycling	Collection & transportation	Incineration	Landfills
2019-e	13.9	8.7	5.5	4.5
2024-p	18.2	9.4	5.8	4.5
CAGR (2019-2024)	5.51%	1.54%	0.89%	0.27%

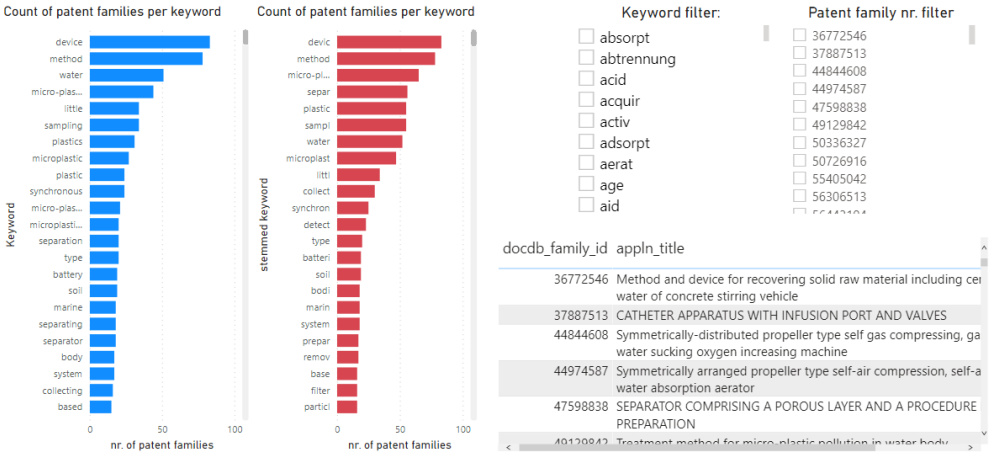
Upon a deeper analysis based on the identification of the **plastic polymer types**, the polypropylene (PP) dominated the plastic waste management market, followed by low-density polyethylene (LDPE) and high-density polyethylene (HDPE).
Recycled plastics offers various benefits including the reduction of water pollution (through lesser landfill waste or disposal of waste in oceans) and reduction air pollution (caused by the landfills). Moreover, it creates opportunities for a lesser dependence on fresh raw materials (fossil fuels) for manufacturing new plastics, thus facilitating the onset of a sustainable development, consistent with the circular economy concept [5].
Looking at the European region, in 2018, 29.1 million tonnes of plastic waste were collected and treated with an overall reduction of plastic waste export by 39% outside the EU from 2016 to 2018. Since 2006 the amount of recycled plastic waste has double. However, 25% of plastic post-consumer waste was still sent to landfill sites in 2018.
In 2018, 3.6 million tonnes of plastic post-consumer waste were collected in Italy. From 2006 to 2018, the volumes of recycled polymers increased by 68% and the landfill disposal decreased by 48% [9].
In **Europe**, the plastic waste management market is forecasted to reach USD 7.52 billion in 2024 at a CAGR of 2.5% between 2019 and 2024. In the **Mediterranean area** France, Spain and Italy account for the largest share in the European plastic waste management market, thanks to the strong influence of environmental and governmental regulations and the concomitant increase of the prices of feedstocks. As consequence, the use of recycled plastic polymers is encouraged with the aim of producing new packaging or building materials, and to innovate especially for the clothing and the automotive sectors [5].

Figure 103 Plastic Waste Management by Region in the period between 2019-2024. The numbers inside the boxes denote the CAGR of individual countries



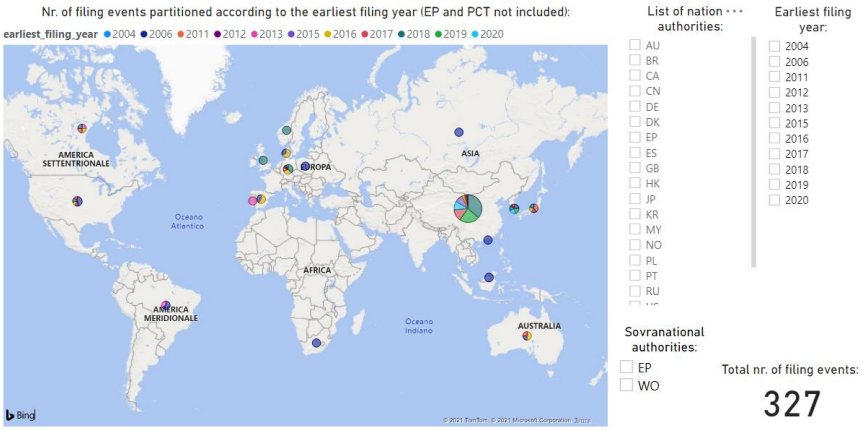
From the perspective of the patent analysis, a dataset consisting of 241 non-duplicated patent families corresponding to 327 patent applications has been analyzed. No limitation is assumed concerning the applications' filing timeframe. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 104.

Figure 104 Microplastics: Keywords' frequency



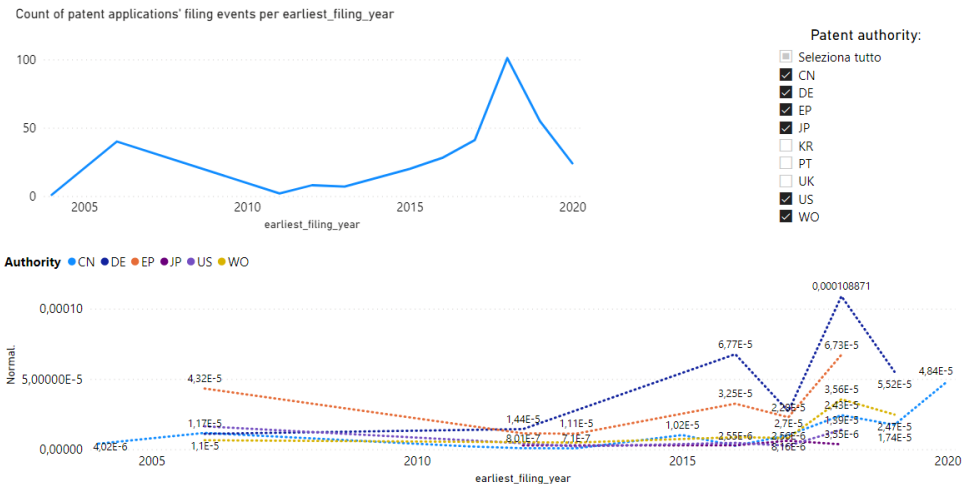
The number of patent applications filed to the CNIPA/SIPO is remarkable (212), whereas considering the Mediterranean region, only five patent applications have been filed to the Spanish patent authority and no patent application has been filed to the French patent authority, unless considering the possibility of filing events subsequent to patent applications initially filed to the EPO (being the total number of patent applications 15) or to the WIPO (being the total number of patent applications 17). Only 15 patent applications have been filed to the USPTO. Such information may be argued upon a deeper analysis of the data of Figure 105.

Figure 105 Microplastics: Map of national/supranational patent authorities



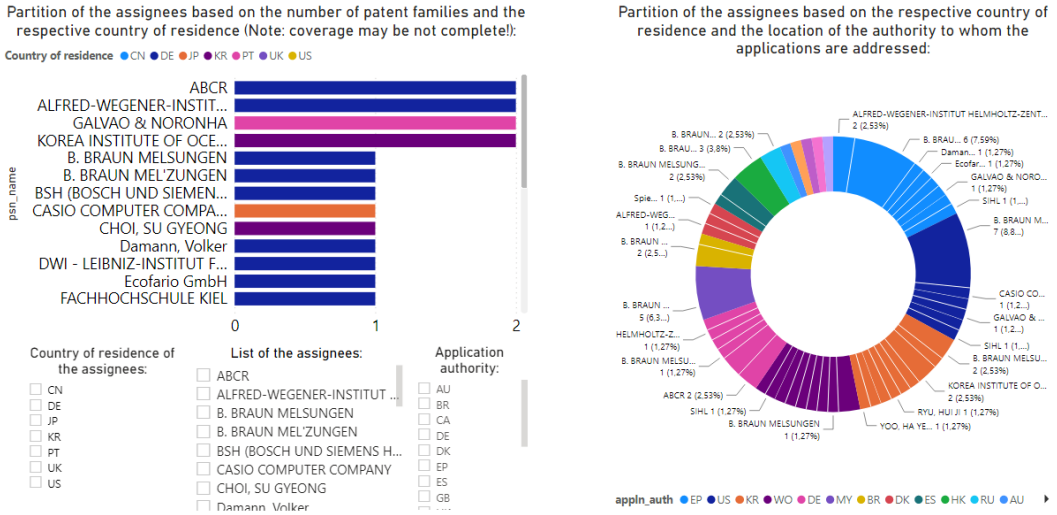
Upon analysing the data of Figure 106 a consistent increase of the number of patent applications occurred between years 2017 and 2019. Moreover, from the normalized data it appears that the proportion of patent applications filed only in the latest years is relevant especially in South Korea. Excluding the data concerning the applications filed to KIPO, it is evident that especially the proportion of applications filed to the German patent office is relevant, being consistently higher than the proportion of the applications filed to the EPO and to the WIPO, respectively.

Figure 106 Microplastics: Normalization of patent applications



As far as the European applicants are concerned, especially those headquartered in one of the countries bordering the Mediterranean Sea are concerned, no one could be identified, although several applicants headquartered in Germany 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 107.

Figure 107 Microplastics: Legal protection strategy



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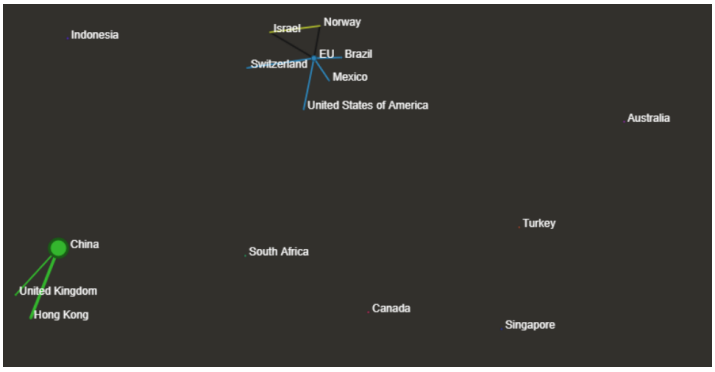
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the Asian countries, especially China, (Figure 105) may be argued, basic research activities, monitored by analyzing other divulgation 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 China, while western countries, such as USA and the whole EU territory, host institutions playing a very marginal role, as evident from Figure 108.

Figure 108 Microplastics: NPL data worldwide



c2) Bioplastics

Bioplastics derived from marine organisms are new materials with an emerging applicability in the blue bioeconomy sector. In recent years, the increasing evidence of the environmental impacts of petroleum-based plastic products has increased the demand of new safer plastic materials such as the **bio-based plastics** [6]. The term bioplastics refers to either the bio-based origin of the plastics or to the biodegradable features of the plastics.

Overall, **biodegradable bioplastics** are made from renewable resources and can be naturally recycled by biological processes by-passing the exploitation of limited resources and reducing the greenhouse gas emissions [7]. Several sources can be used to produce bioplastics such as plant-based materials, natural polymers (i.e., carbohydrates, proteins, etc.) and other small molecules (sugar, disaccharides, and fatty acids). Nowadays, bioplastics are mainly obtained from terrestrial crops such as corn and potatoes which are, on the other hand, valuable food supplies yet require large quantity of land and water to be cultured at large scale. **Microalgae** represent potentially a more suitable biomass source for the bioplastic production since their use is not in competition with the food production, they can be easily farmed, and permit high lipid accumulation, a key characteristic to produce bio-based plastics [6].

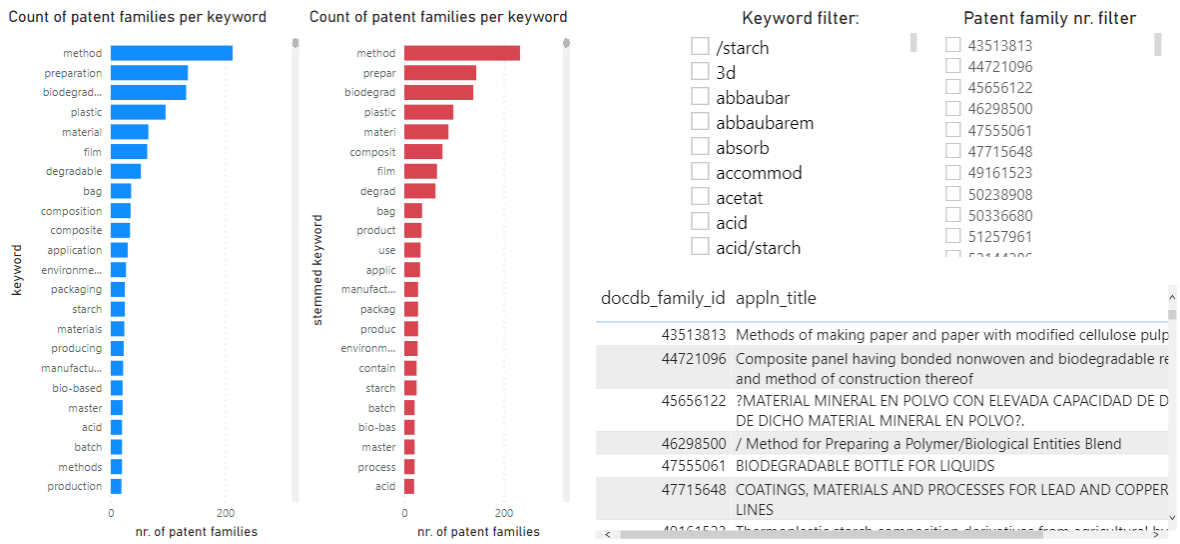
The **global market for biodegradable bioplastics** is projected to reach a value of USD 11,468.9 million in 2025 at a CAGR of 19.0% in the timeframe 2020 - 2025. This significant growth is due to several drivers such as:

- The shift in consumer preference toward eco-friendly products;
- The increasing use of bioplastics in the packaging industry;
- The improvement of waste management regulations in Europe;
- The push towards green procurement policies and regulations induced by the governmental institutions.

Europe is gradually conforming to the strict government norms regarding the use of plastics in the region. The market for bioplastics in Europe is expected to reach the value of USD 8,800 million in 2025, at a CAGR of 18.1% in the forecasted period 2018 – 2025. Italy, France, and Spain are the main producers of bioplastics in Europe due to heavily investments in innovative packaging technologies improved to suit the customers' demand in these countries [8].

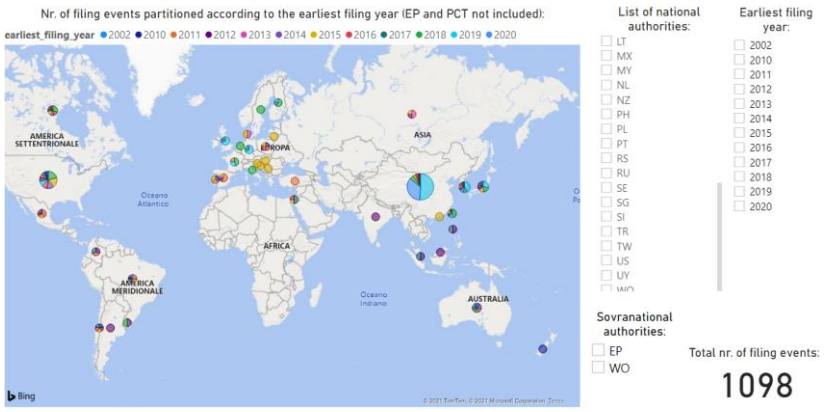
From the perspective of the patent analysis, a dataset consisting of **600 non-duplicated patent families** corresponding to **1098 patent applications** has been analyzed. The applications' filing timeframe corresponds to the priority years from 2019 to Jun 2021. The main topic regarding this sector may be argued considering the frequency of citations of specific keywords present in the patent titles' as shown in Figure 109.

Figure 109 Bioplastics: Keywords' frequency



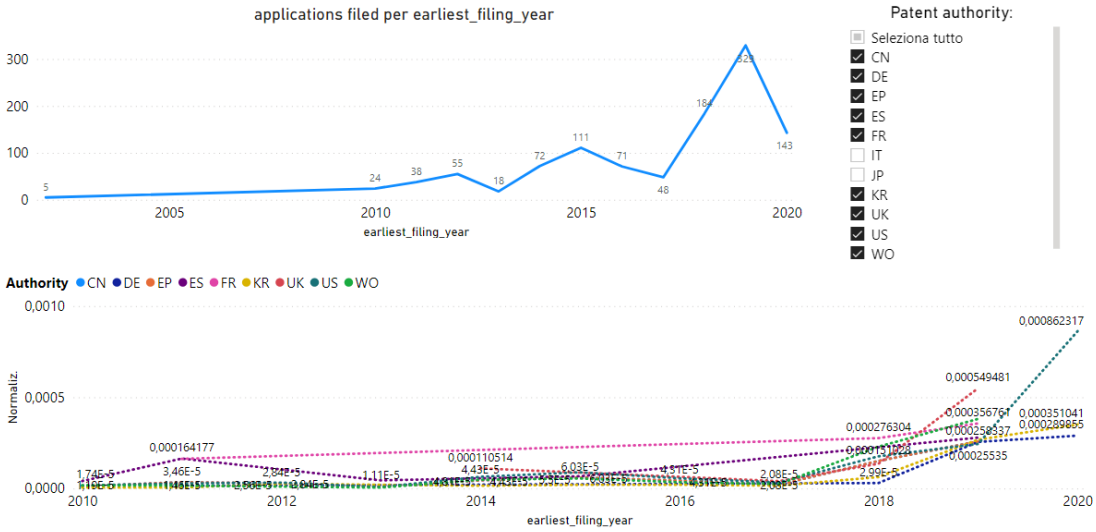
The number of patent applications filed to the CNIPA/SIPO is remarkable (365), whereas considering the Mediterranean region, only 7 patent applications have been filed to the Spanish patent authority and 9 patent applications have been filed to the French patent authority, unless considering the possibility of filing events subsequent to patent applications initially filed to the EPO (being the total number of patent applications 60) or to the WIPO (being the total number of patent applications 153). A quite consistent number of patent applications have been filed to the USPTO (188). Such information may be argued upon a deeper analysis of the data of Figure 110.

Figure 110 Bioplastics: Map of national/supranational patent authorities



Despite the timeframe analysed is restricted to recent priority years, upon analysing the data of Figure 111 a consistent amount of patent applications filed in the timeframe 2018 – 2020 can be detected. Moreover, from the normalized data it appears that the proportion of patent applications filed in the latest years is relevant when considering several patent authorities, either national or international ones.

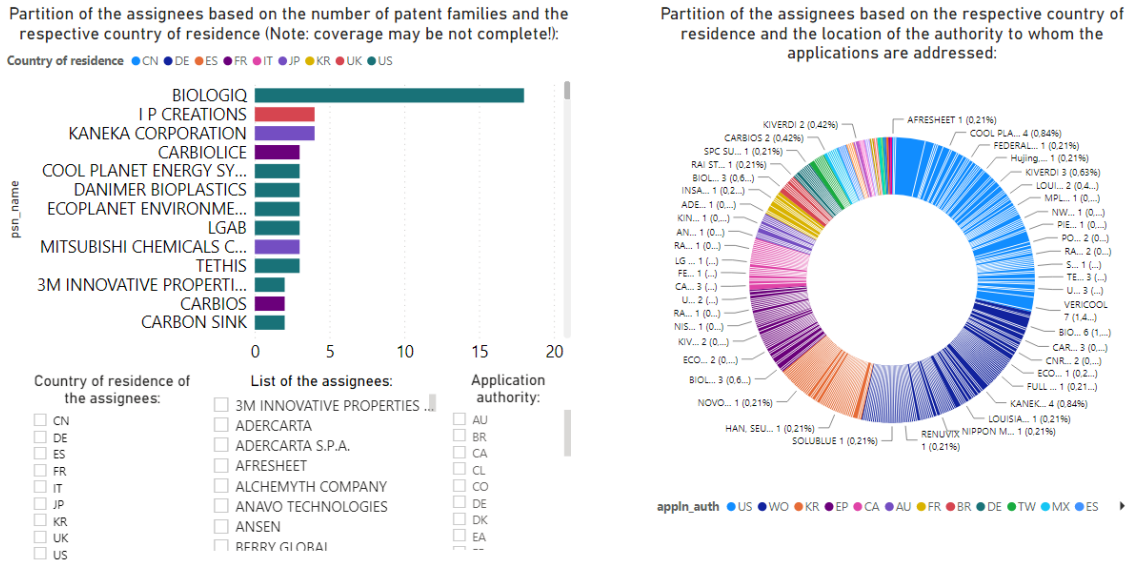
Figure 111 Bioplastics: Normalization of patent applications



As far as the European applicants are concerned, especially those headquartered in one of the countries bordering the Mediterranean Sea are concerned, several players headquartered in France can be identified

along with few players who are resident of Spain and Italy, respectively. 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 112.

Figure 112 Bioplastics: Legal protection strategy



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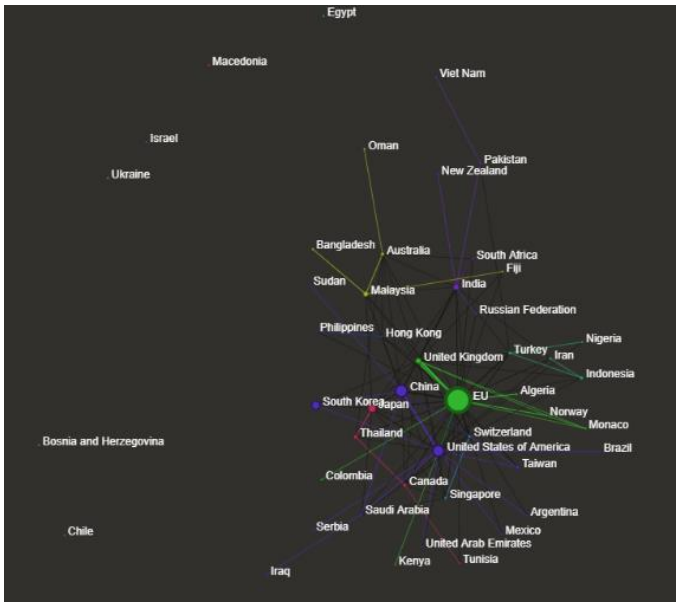
Despite from the analysis of the patent data a relevant impact on the commercialization of innovative technical solutions worldwide and especially in territories such as the Asian countries, especially China, (Figure 110) may be argued, basic research activities, monitored by analyzing other divulgation 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 territory, while other leading countries, such as USA and China appear significantly involved although at a lower extent, as evident from Figure 113.

Figure 113 Bioplastics: NPL data worldwide



1.c KEYPOINTS

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

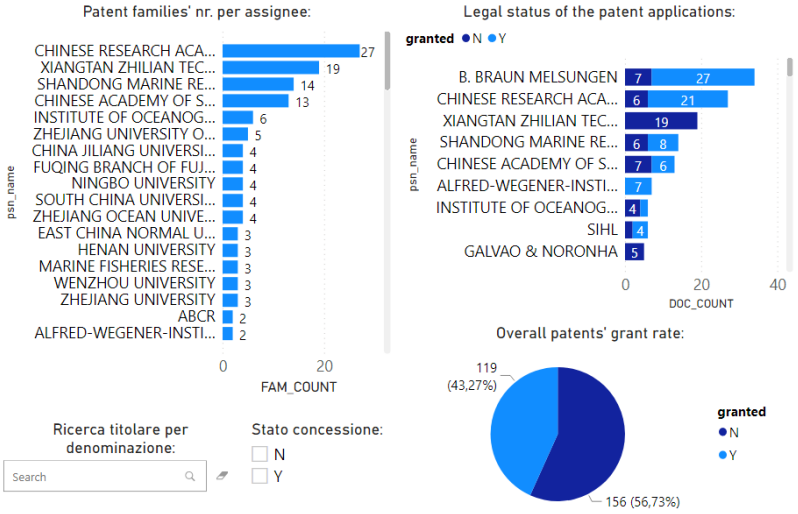
2.c BLUE SUSTAINABLE DEVELOPMENT → Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure: THE LEGAL INFORMATION ARGUABLE FROM THE PATENTS' DATASETS

c1) Microplastics

Although the number of the patent owners is slightly less than one hundred, a selection of the top players is displayed in Figure 104. 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%.

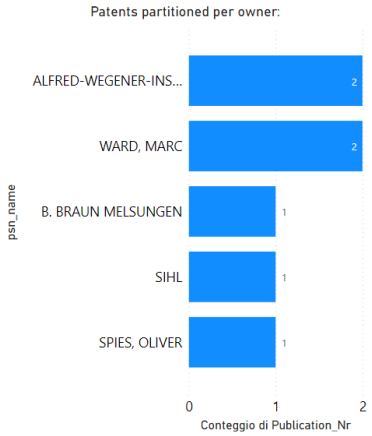
Figure 114 Microplastics: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be several 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 115. There are only few players worth of consideration who own patents with a relevant number of residual days before patent validity expiry.

Figure 115 Microplastics: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FUR POLAR- UND MEERESFORSCHUNG	EP3272421	5726	4
ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FUR POLAR- UND MEERESFORSCHUNG	EP3329994	5858	3
B. BRAUN MELSUNGEN	EP2083898	2176	13
SIHL	EP2805366	4079	8
SPIES, OLIVER	EP3402921	5534	4
WARD, MARC	US2014138288	4386	4
WARD, MARC	US8944253	4386	4



Only one triadic family could be detected (Figure 116).

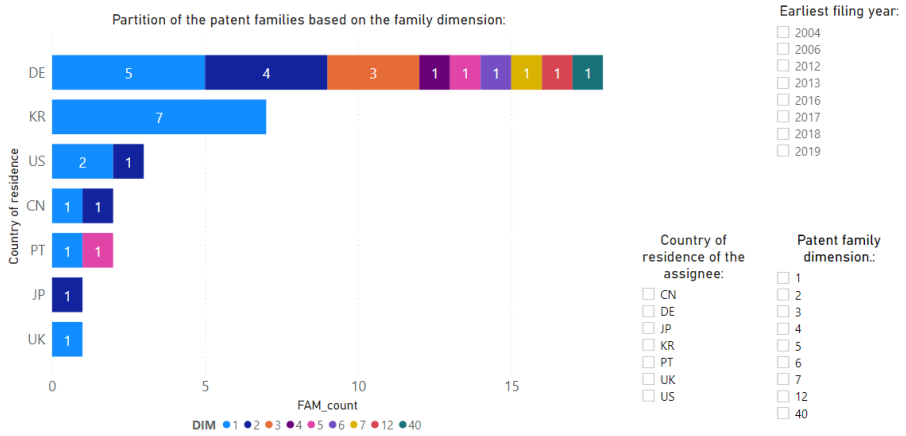
Figure 116 Microplastics: the unique Triadic family detected

psn_name	person_ctry_code	PUB	Conteggio di conteggio_famiglie
SIHL	DE	EP2805366	1

These data taken altogether suggest that despite the query used to select the patent documents is focusing on purification of the microplastics, at least in Europe there is still little attention paid to this relevant environmental threat.

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 117 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, especially Germany, include several members corresponding to applications filed to a multiplicity of patent authorities.

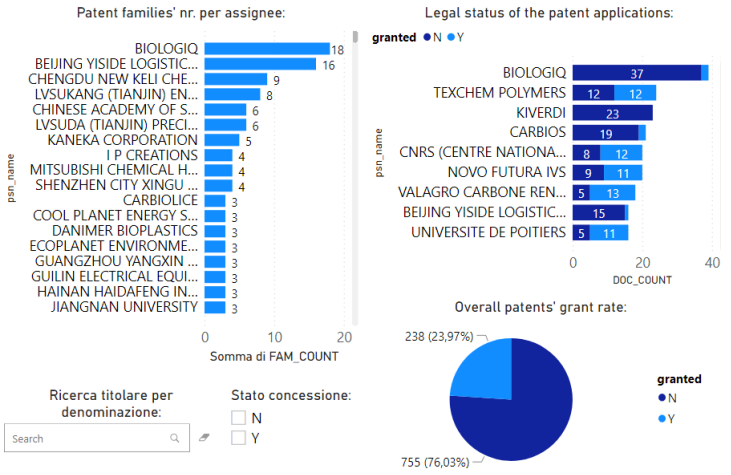
Figure 117 Microplastics: Ranking of the country of residence of the players based on the patent family dimension



c1) Bioplastics

Although the number of the patent owners is slightly less than one hundred, a selection of the top players is displayed in Figure 118. 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 24%. The value may seem low if compared to the grant rates of other sectors, however it is worth reminding that the patent documents included in the dataset have been filed recently, therefore in most cases the patent applications may be still undergoing examination.

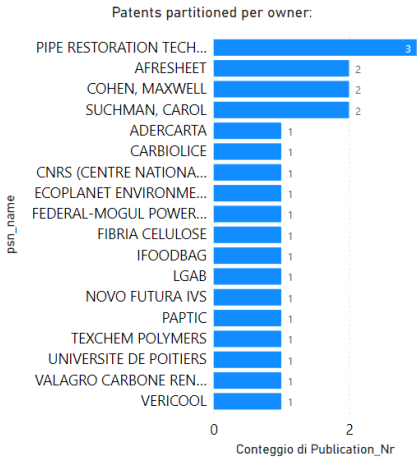
Figure 118 Bioplastics: Ranking of the applicants based on the patent application number and grant rate



Irrespectively from the ranking, there may be several 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 119. There are several European players worth of consideration each characterized by a relevant number of residual days before patent validity expiry.

Figure 119 Bioplastics: Residual validity of granted patents (data from EP Register)

psn_name	Publication_Nr	fee_renewal_year	EXPIRY_days
CARBIOLICE	FR3083544	3	6232
ADERCARTA	FR3077561	3	6070
VERICOOL	US9550618	4	5406
NOVO FUTURA IVS	EP3288431	6	5068
PAPTIC	EP3224411	5	4912
IFOODBAG	EP3140223	6	4712
ECOPLANET ENVIRONMENTAL	EP3017054	7	4402
AFRESHEET	US2014215715	4	4153
AFRESHEET	US9565955	4	4153
COHEN, MAXWELL	US2014215715	4	4153
COHEN, MAXWELL	US9565955	4	4153
SUCHMAN, CAROL	US2014215715	4	4153
SUCHMAN, CAROL	US9565955	4	4153
TEXCHEM POLYMERS	EP2756034	8	3926
CNRS (CENTRE NATIONAL DE LA RECHERCHE	FR2984355	9	3842



Only one triadic family could be detected (Figure 120).

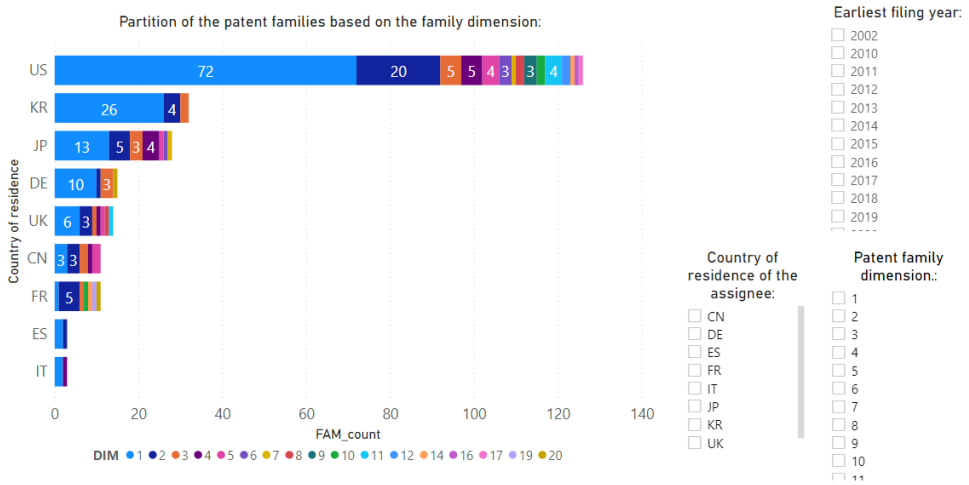
Figure 120 Bioplastics: some of the Triadic families

psn_name	person_ctry_code	PUB	Conteggio di Famiglie
BIOLOGIQ	US	EP3317459	1
CARBIOS	FR	EP3307811	1
CARBIOS	FR	EP3307812	1
CARBIOS	FR	EP3555281	1
CARBON SINK	US	EP3349563	1
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP2794730	1
CNRS (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE)	FR	EP3351585	1
EVERYONE'S EARTH	US	EP3324910	1
KANEKA CORPORATION	JP	EP3369713	1
MC10	US	EP3114911	1
NOVO FUTURA IVS	DK	EP3288431	1
OMYA DEVELOPMENT	CH	EP2628775	1
OMYA INTERNATIONAL	CH	EP2814888	1
ORLA PROTEIN TECHNOLOGIES	GB	EP3094655	1
PAPTIC	FI	EP3224411	1
RAI STRATEGIC HOLDINGS	US	EP3684207	1

These data taken altogether suggest while the sensitization toward the microplastics' threat may be currently quite low in Europe, on the other hand in the same territory the production of bioplastic, and especially of the bio-degradable plastics, is considered of utmost importance.

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 121 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, especially USA, include several members corresponding to applications filed to a multiplicity of patent authorities.

Figure 121 Bioplastics: Ranking of the country of residence of the players based on the patent family dimension



2.c KEYPOINTS

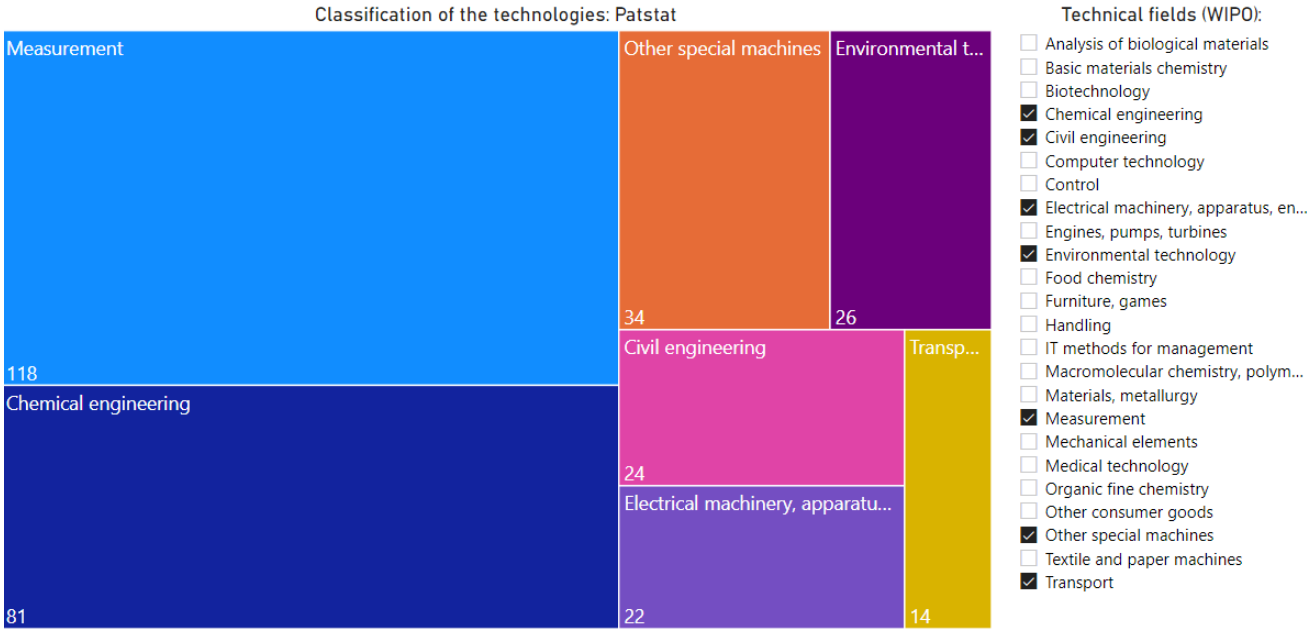
- The legal information regarding the patent documents concerning the prevention of environmental issues caused by microplastics confirms that in western countries the sensitization toward this important threat needs a substantial improvement, having retrieved mainly German applicants active in this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

3.c BLUE SUSTAINABLE DEVELOPMENT → Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure: THE TECHNICAL INFORMATION

c1) Microplastics

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 122.

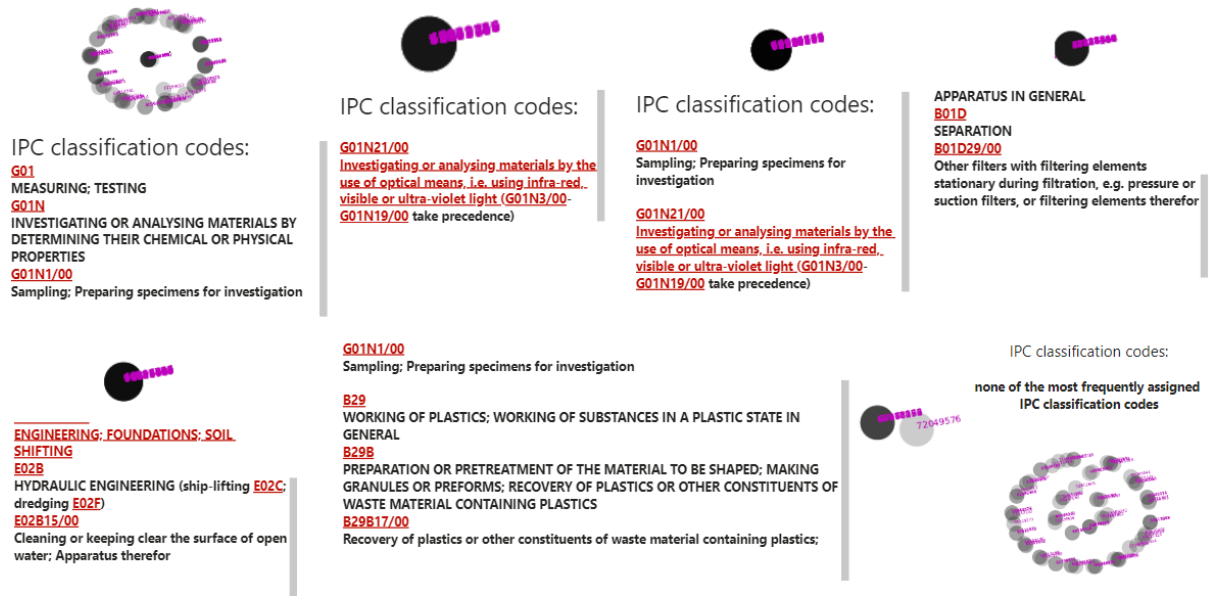
Figure 122 Microplastics: Map of the technology fields defined by WIPO



The clustering of the patent documents according to patterns defined by one or more technical fields highlights the relevant contribution of technical fields such as chemical engineering and technologies dealing with measurement. Clustering the documents of the same dataset may provide more specific information, especially if based on the classification codes, either IPC or CPC.

The following figure (Figure 123) refers specifically to the IPC classification codes:

Figure 123 Microplastics: 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 dealing with analysis of materials and cleaning of the surface of water as well as recovery of plastics, the clusters being characterized by the following IPC main groups:

G01N1/00, referring to **Sampling; Preparing specimens for investigation**.
G01N21/00, referring to **Investigating or analysing materials by the use of optical means, i.e. using sub-millimetre waves, infrared, visible or ultraviolet light.**
B01D29/00, referring to **Other filters with filtering elements stationary during filtration, e.g. pressure or suction filters, or filtering elements therefor**.
E02B15/00, referring to **Cleaning or keeping clear the surface of open water; Apparatus therefor**.
B29B17/00, referring to **Recovery of plastics or other constituents of waste material containing plastics**.

The co-occurrence of two IPC or CPC classification codes identifying single patents families is not much frequent, despite the dataset includes 241 non duplicated patent families. IPC codes such as **G01N1/10** (**Sampling; Preparing specimens for investigation → Devices for withdrawing samples → in the liquid or fluent state (burettes, pipettes B01L3/02; sampling of ground water E02D1/06; metering by volume of fluids or fluent solid material G01F11/00, G01F13/00)**) as well as **G01N1/34** (**Purifying; Cleaning**) might appear co-assigned to a small number of patent families, while the CPC **Y02W30/62 specifically refers to Plastics recycling** and **Rubber recycling**, being **co-assigned along with B29B17/02** (**Separating plastics from other materials**).

Figure 124 Microplastics: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

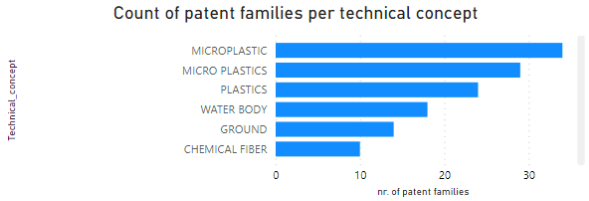
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
10	G01N 1/34	G01N 1/10
9	E02B 15/10	B63B 35/32
9	G01N 1/34	G01N 1/28
8	B29B 17/02	B29B 17/00
7	G01N 1/40	G01N 1/34
6	B01D 29/58	B01D 29/01
6	G01N 1/10	B01D 35/02

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
11	Y02W 30/62	B29B 17/02
11	Y02W 30/62	Y02W 30/52
7	Y02E 60/10	H01M 4/16
7	Y02E 60/10	H01M2220/20
6	G01N 1/34	G01N 1/28
6	Y02E 60/10	H01M 4/57
6	Y02W 30/52	B29B 17/02

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 125.

Figure 125 Microplastics: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
36772546	Method and device for recovering solid raw material including cement fi of concrete stirring vehicle
37887513	CATHETER APPARATUS WITH INFUSION PORT AND VALVES
44844608	Symmetrically-distributed propeller type self gas compressing, gas sucki sucking oxygen increasing machine
44974587	Symmetrically arranged propeller type self-air compression, self-air sucti absorption aerator
47598838	SEPARATOR COMPRISING A POROUS LAYER AND A PROCEDURE FOR IT
49129842	Treatment method for micro-plastic pollution in water body
50336327	BREAKING SYSTEM APPLIED IN CAPSULES FOR ESPRESSO MACHINES, T SOLUBLES, MADE OF THERMOPLASTIC MATERIAL, ALUMINIUM OR ITS I

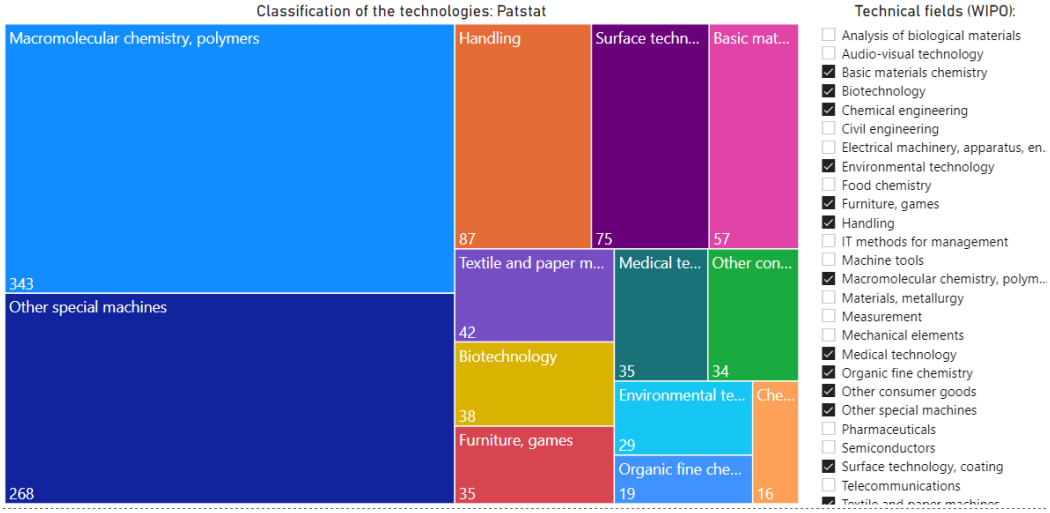


docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
35463332	ADENOSINE	PURINE DERIVATIVE	RECEPTOR AGONIST	CNB	PURINE DERIVATIVE	ANIMAL	MONOCYCLIC CYCLOALKYL	HALO	METABOLISM ANIM
36772546	WATER	CEMENT	WASH TUBE	SOLID FEEDSTOCK	MIXING VEHICLE	RECYCLING CONCRETE MIXING VEHICLE	SOLID	RECOVERED SOLID RAW	CEMENT WASH TU
37887513	CATHETER HUB	CATHETER ASSEMBLY	VALVE OPENER	TIP PROTECTOR	NEEDLE WITHDRAWAL	CATHETER TUBE	NEEDLE HUB	NEEDLE TIP	SUCCESSFUL CATH
38698030	ADENOSINE	PURINE DERIVATIVE	RECEPTOR AGONIST	CNB	PURINE DERIVATIVE	ANIMAL	MONOCYCLIC CYCLOALKYL	HALO	METABOLISM ANIM
43416265	ADENOSINE	PURINE DERIVATIVE	RECEPTOR AGONIST	CNB	PURINE DERIVATIVE	ANIMAL	MONOCYCLIC CYCLOALKYL	HALO	METABOLISM ANIM
44844608	COMPRESSOR	SUCTION	ABSORPTIVE INCREASE	OXYGEN MACHINE	SYMMETRICAL ARRANGEMENT	GETTER	PROPELLER SYMMETRICAL	HELICAL BLADE CONICAL	WATER ABSORBING

c1) Bioplastics

The simplest scheme allowing to visualize the distribution of the technical fields among the patent families is shown in Figure 126.

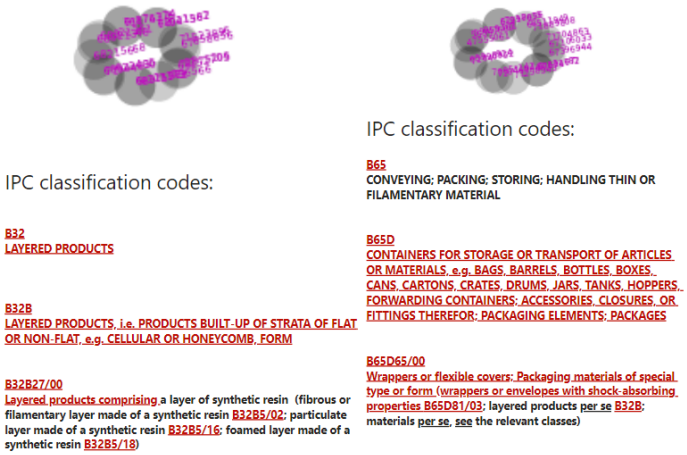
Figure 126 Bioplastics: Map of the technology fields defined by WIPO



The clustering of the patent documents according to patterns defined by one or more technical fields highlights the relevant contribution of technical fields such as the Macromolecular chemistry, however clustering of the documents may provide more specific information, especially if based on the classification codes, either IPC or CPC.

The following figure (Figure 127) refers specifically to the IPC classification codes:

Figure 127 Bioplastics: clustering of the patent families based on the identification of patterns of CPC classification codes



Excluding the documents not identifiable by means of IPC classification codes, a relevant number may be included in patterns each being characterized by one IPC main groups, namely the following two:

B32B27/00, referring to **Layered products comprising a layer of synthetic resin (fibrous or filamentary layer made of a synthetic resin B32B5/02; particulate layer made of a synthetic resin B32B5/16; foamed layer made of a synthetic resin B32B5/18)**.

B65D65/00, referring to **Wrappers or flexible covers; Packaging materials of special type or form (wrappers or envelopes with shock-absorbing properties B65D81/03; layered products per se B32B; materials per se, see the relevant classes).**

The co-occurrence of two IPC or CPC classification codes identifying single patents families quite consistent. IPC codes such as **C08L67/02** (**Compositions of polyesters obtained by reactions forming a carboxylic ester link in the main chain (of polyester-amides C08L77/12; of polyester-imides C08L79/08); Compositions of derivatives of such polymers**) and the **C08L67/04** (**Polyesters derived from hydroxycarboxylic acids, e.g. lactones (C08L67/06 takes precedence)**) might appear co-assigned quite frequently. Among the CPC classification codes, the **C08L2201/06 refers to biodegradable matter**, being co-assigned to the patent families along with the CPC **C08L67/04**.

Figure 128 Bioplastics: Co-occurrence of IPC classification codes (leftmost table) and CPC classification codes (rightmost table)

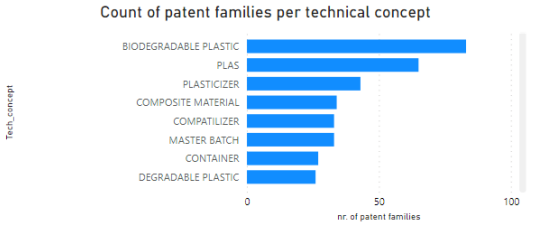
NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
83	C08L 67/04	C08L 67/02
58	C08L 67/04	C08J 5/18
45	C08L 3/02	C08J 5/18
44	C08L 67/02	C08J 5/18
41	C08L 67/04	C08L 3/02
40	C08L 23/06	C08L 3/02
40	C08L 67/04	C08K 3/34
39	C08L 3/02	C08K 5/053
34	C08L 67/02	C08L 3/02
33	C08L 67/02	C08K 3/34
32	C08K 5/053	C08J 5/18
32	C08L 23/06	C08J 5/18

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
32	C08L2201/06	C08L 67/04
31	C08L2205/035	C08L2201/06
29	C08J2403/02	C08J 5/18
26	C08L2201/06	C08L 3/02
24	C08L2201/06	C08L 67/02
23	C08J2467/04	C08J 5/18
23	C08K 5/053	C08J 5/18
21	B32B2307/7163	B32B 27/36
21	C08J2367/02	C08J 5/18
21	C08J2367/04	C08J 5/18
21	C08L2205/03	C08L2201/06
19	C08K 5/053	C08J2403/02

A meaningful piece of information about the technical concepts characterizing single patents families may be argued from the following Figure 129.

Figure 129 Bioplastics: List of technical concepts associated to each patent family of the dataset and ranking

docdb_family_id	appln_title
43513813	Methods of making paper and paper with modified cellulose pulps
44721096	Composite panel having bonded nonwoven and biodegradable resinous method of construction thereof
45656122	?MATERIAL MINERAL EN POLVO CON ELEVADA CAPACIDAD DE DISPERS DICHO MATERIAL MINERAL EN POLVO?.
46298500	/ Method for Preparing a Polymer/Biological Entities Blend
47555061	BIODEGRADABLE BOTTLE FOR LIQUIDS
47715648	COATINGS, MATERIALS AND PROCESSES FOR LEAD AND COPPER WATE
49161523	Thermoplastic starch composition derivatives from agricultural byprodu
50238908	Protein coated polymeric substrate
50336680	LUBRICANT COMPOSITIONS



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
43513813	CELLULOSE	MAKING PAPER	MODIFIED CELLULOSE PULP	PULP RENDERING	BIOPOLYMER	BLEACHING SEQUENCE	CELLULOSE PULP	DIFFERENTIATED PULP	AROMATIC HYDROPHOBIC GROUP
44721096	COMPOSITE PANEL	NONWOVEN MAT	COMPOSITE MEMBER	CONSTRUCTION	BIODEGRADABLE RESINOUS FIBER LAYER	BONDED NONWOVEN	BONDABLE TEXTILE FIBER	COMMINUTING CARDBOARD	ANNACARDIUM OCCIDENTALE GUM
45656122	MINERAL MATERIAL	DISPERSING AGENT	DISPERSING AGENT ABSENCE	GROUND MINERAL	HYDROPHOBIC TREATMENT	DISPERSION ABILITY	MINERAL MATERIAL POWDER	WET GRINDING MINERAL	ACRYLIC ADDITIVE
46298500	POLYMER BIOLOGICAL ENTITY	POLYMER BIOLOGICAL ENTITY ALLOY	POLYTETRAMETHYLENE BUTANEDIOATE	PETROCHEMICAL ORIGIN PLASTIC	BUTYLENE BUTANEDIOATE	TWIN SCREW EXTRUDER	PETROCHEMICAL ORIGIN	ENZYME	COROTATING EXTRUDER
47555061	BIOPLASTIC NECK	LIQUID	BOTTLE BIODEGRADATION	CONTAINER	PULP SHOULDER	PULP SHOULDER OVERHANGING LIP	STRENGTHENING CREASE	OVERHANGING LIP	PULP

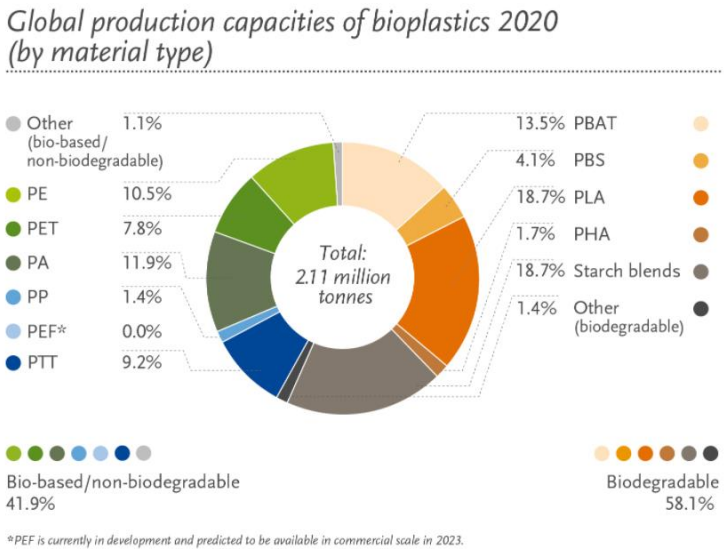
3.c KEYPOINTS

- Although from the analysis of the patent applications it may appear that the awareness of the environmental issues caused by the microplastics is still scarce, the ranking of the technical concepts confirms that a relevant fraction of the patent documents selected deals with such relevant issue, the accuracy of the search criteria

being confirmed by the assignment of specific classification codes, either IPC or CPC, identifying the technologies aimed at the recovery/recycling of plastics (such as B29B17 or Y02W30/62). As far as the bioplastics' sector is concerned, specific IPC or CPC classification codes may be detected, especially the CPC C08L2201/06 that refers to biodegradable matter.

- Considering the small rate of legal protection, either in Europe or USA, of technical solutions regarding purifications methodologies aimed at reduction/removal of microplastics, it might be argued that the implementations seem not appealing for the commercial exploitation, maybe because the TRL is still low or maybe because the performance needs to be further improved. To the contrary, as far as the bioplastics sector is concerned, there are many patent families clearly assigned to the Macromolecular chemistry technology field, being the exploitation of materials such as PLA, PHA and other natural compounds (starch, cellulose) relevant (see, for example, Bioplastics – European Bioplastics e.V. (european-bioplastics.org)), as arguable from Figure 130.

Figure 130 (source: **Bioplastics – European Bioplastics e.V. (european-bioplastics.org)**)



4.c BLUE SUSTAINABLE DEVELOPMENT → Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure: THE NPL DIVULGATION FOCUSING ON THE COUNTRIES LOCATED ALONG THE MEDITERRANEAN SEA

c1) Microplastics

The number of patent applications filed by the European residents appears scarce 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 not negligible for Italy, France and Spain, as revealed by Figure 131 to Figure 133, being there evidence of the national and also the trans-national

collaborations especially involving several academic institutions located in each of the countries mentioned above.

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

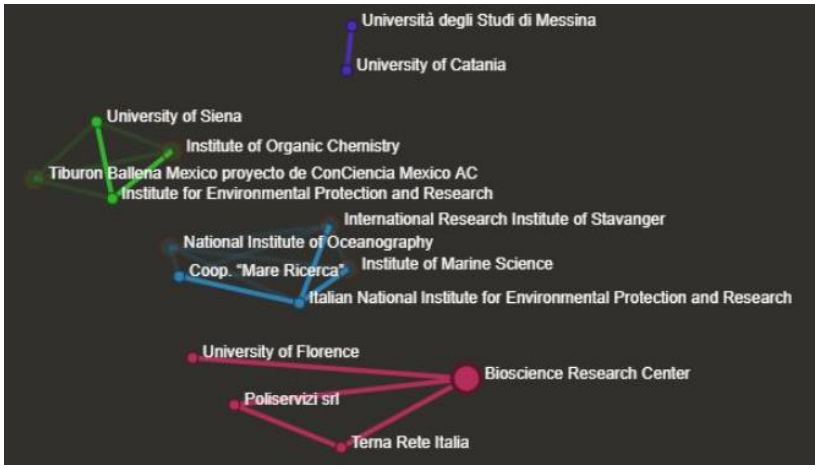


Figure 132 Microplastics: data showing the national and trans-national collaborations (NPL research focusing on France)

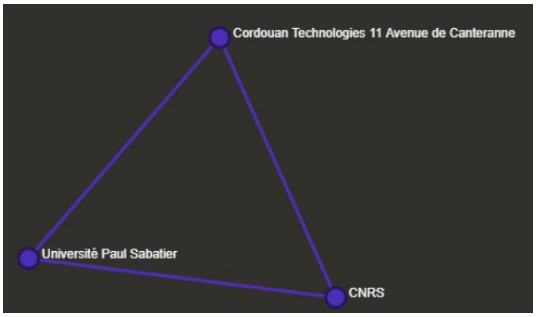
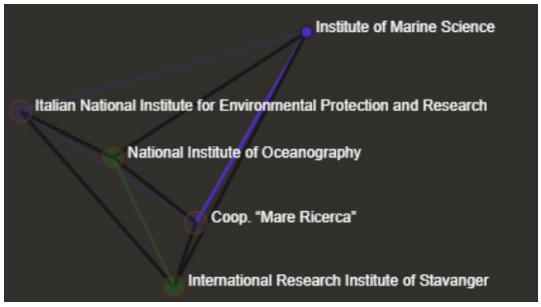


Figure 133 Microplastics: data showing the national and trans-national collaborations (NPL research focusing on Spain)



Similar diagrams are available as far as other countries located along the Mediterranean Sea are concerned, namely Greece, 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, although the number of publications is very little. Figure

134 to Figure 136 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the microplastics may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 134 Microplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

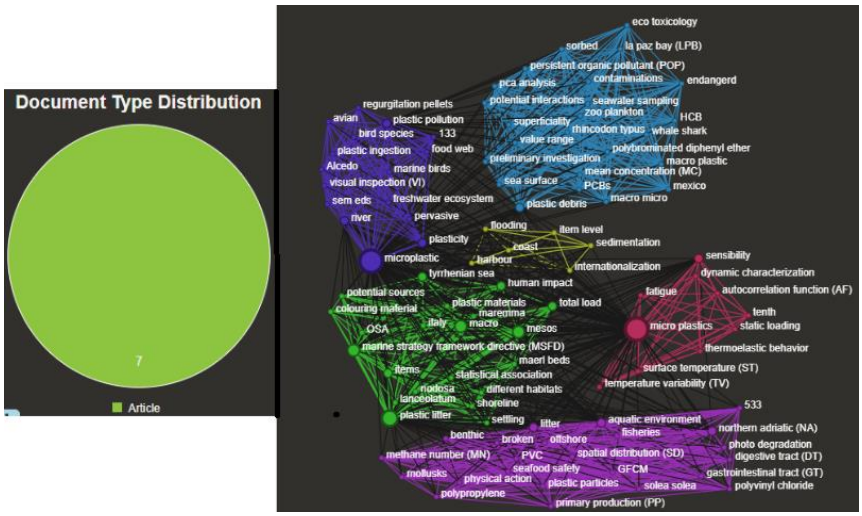


Figure 135 Microplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

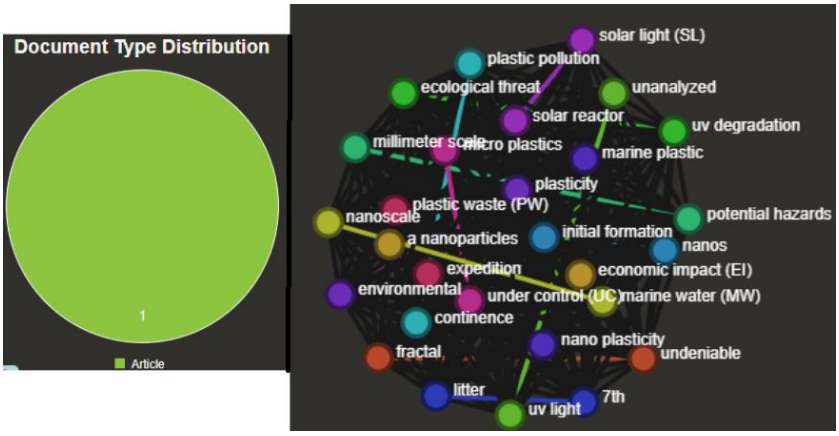
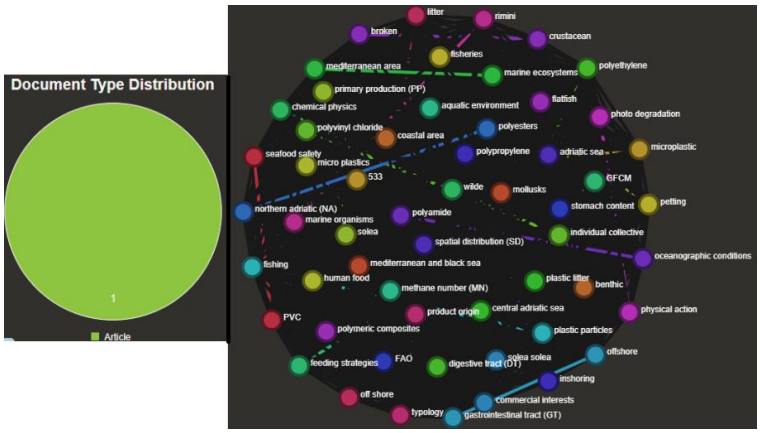


Figure 136 Microplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



c1) Bioplastics

The number of patent applications filed by the European residents appears meaningful, in addition, 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 not negligible for Italy, France and Spain, as revealed by Figure 137 to Figure 139 being there evidence of the national and also the trans-national collaborations especially involving several academic institutions located in each of the countries mentioned above.

Figure 137 Bioplastics: data showing the national and trans-national collaborations (NPL research focusing on Italy)

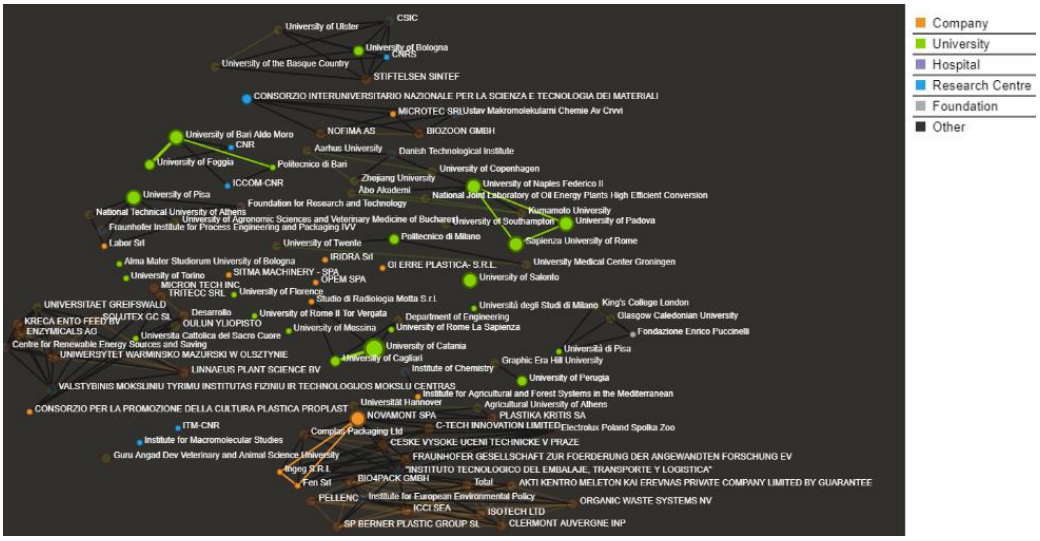


Figure 138 Bioplastics: data showing the national and trans-national collaborations (NPL research focusing on France)

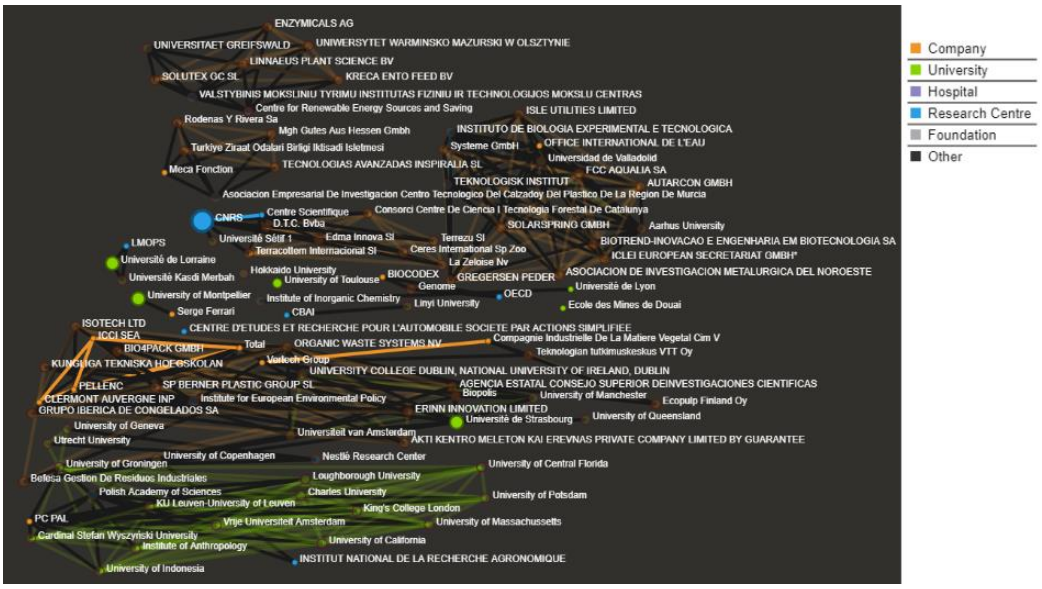
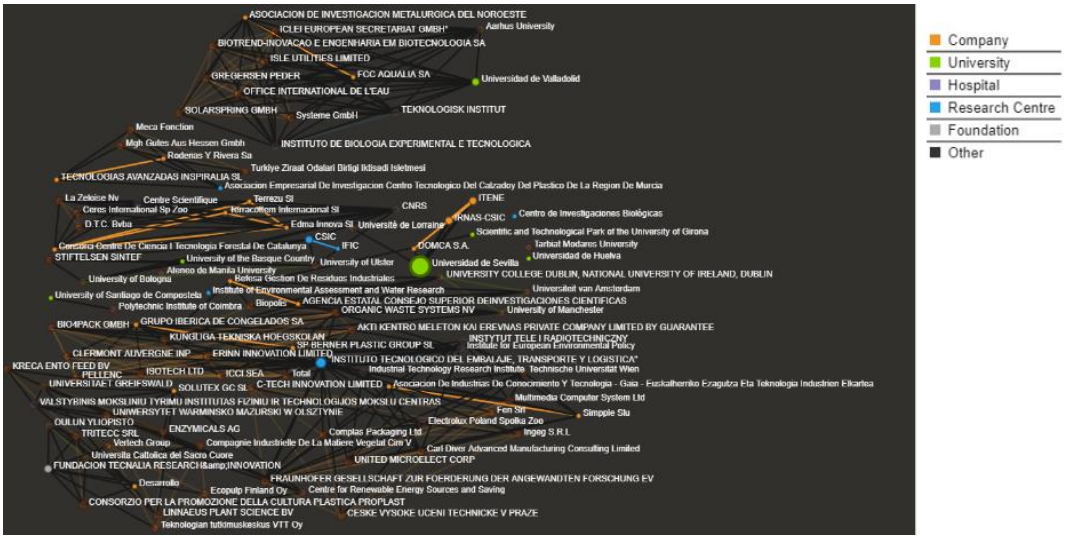


Figure 139 Bioplastics: data showing the national and trans-national collaborations (NPL research focusing on Spain)



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

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 140 to Figure 142 provide such evidence and highlight the technical elements addressed by the publications. The main topics regarding the issues dealing with the bioplastics may be included in clusters listing the technical concepts, each cluster being evidenced by a different color on each map.

Figure 140 Bioplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Italy)

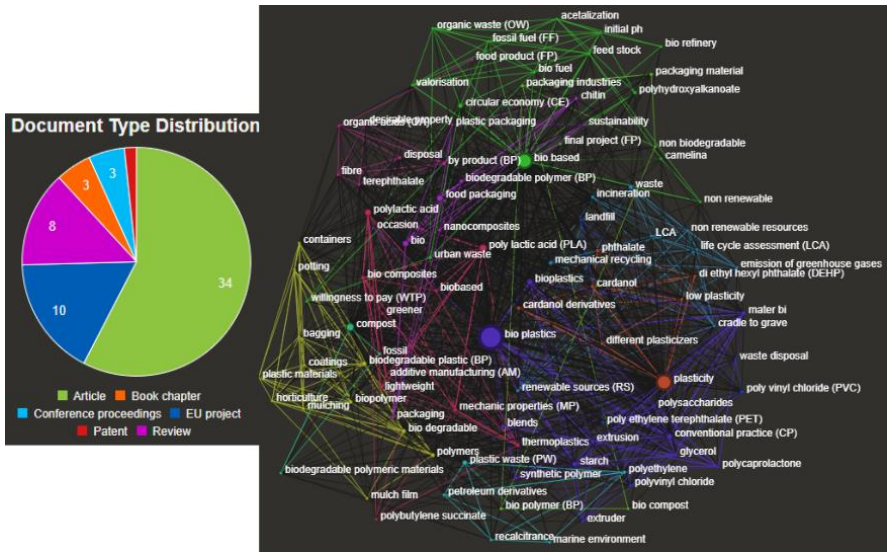


Figure 141 Bioplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on France)

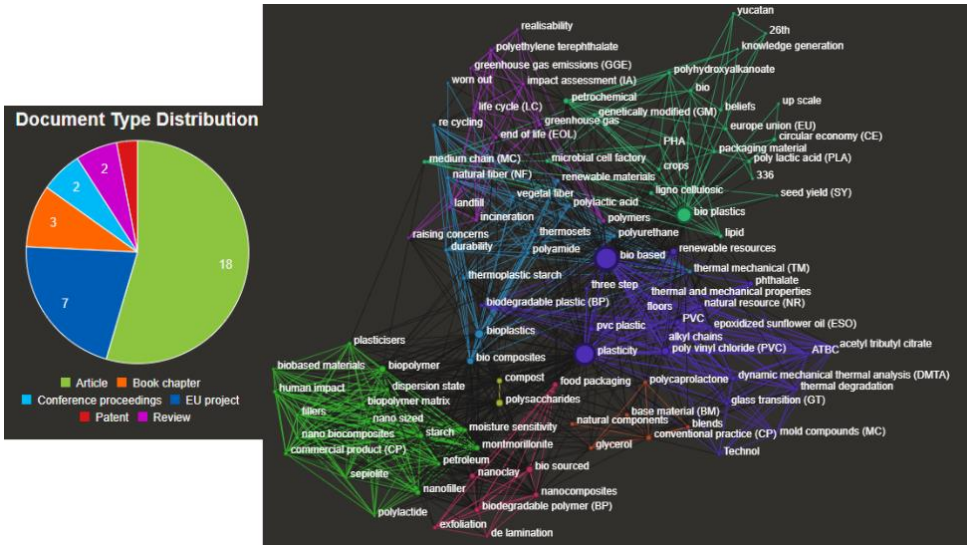
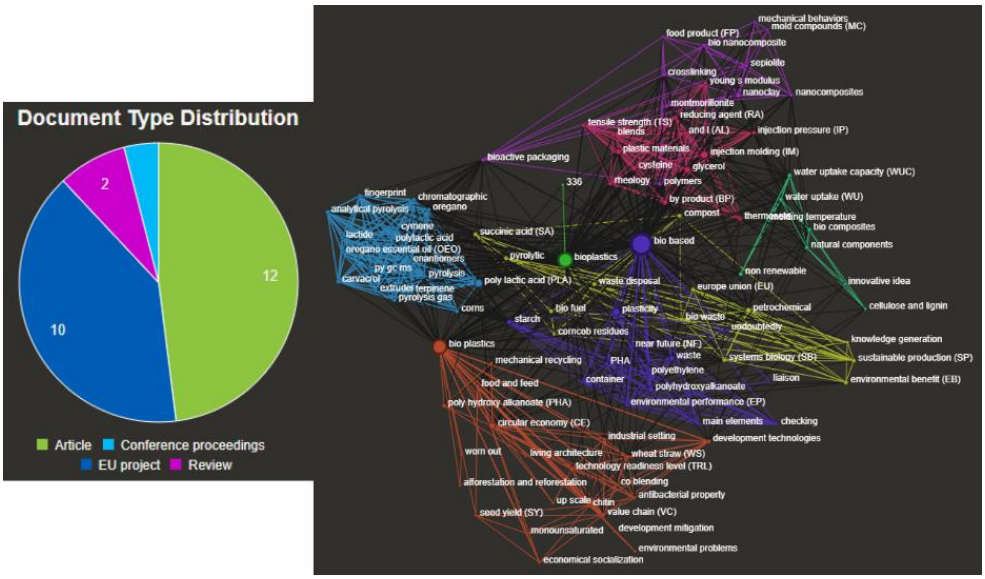


Figure 142 Bioplastics: data showing the partition of the publication kind (left) and the relationships between the automatic keywords (NPL research focusing on Spain)



4.c KEYPOINTS

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

5.c PLAYERS TO BE MONITORED AND EU FUNDED PROJECTS

- **CARBIOS** (Carbios - Innovating for a true circular economy in plastics)
- **CARBIOLICE** (Carbiolice ≡ Compostable plastic solutions)
- **CABAMIX** (CABAMIX, producer of CARBOMAX and CARBOMAX BIO, calcium carbonate base additive)
- **VALAGRO CARBONE RENOUVELABLE POITOU** (Home - Valagro Research and Development (valagro-rd.com))
- **PATENT SHOES S.L.** (Patent Shoes – Science for design (patent-shoes.com))
- **ADERCARTA SpA** (Carte e sacchetti alimentari | Adercarta)
- **MIXCYCLING Srl** (Mixcycling srl - Brand di design Italy | Fuorisalone.it)
- **BIOLOGIQ** (BioLogiQ)
- **DANIMER BIOPLASTICS** (Home - Danimer Scientific)
- **TETHIS** (Home (tethis.com))
- **HOPE TREE INTERNATIONAL GmbH** (Hope Tree International GmbH - Umwelteinrichtung Für Erneuerbare Natürliche Ressourcen in Holzkirchen (business.site))
- **SPC SUNFLOWER PLASTIC COMPOUND** (SPC-Biopolymere)
- **PORVAIR SCIENCES** (Porvair Sciences Limited)

- **SOLUBLUE** (SoluBlue - The Clear Alternative to Plastic Packaging)
- **DOIL ECOTEC** (Doil Ecotec Co., Ltd.)
- **ALCHEMYTH** (Alkermis (alchemyth.com))
- **OMYA** (Welcome to Omya)
- **PAPTIC** (Sustainable Alternative to Plastic Materials in Packaging - Paptic)

SECTOR RELATED EU FUNDED PROJECTS:

Microplastics

1) **Baseman- Defining the baselines and standards for microplastics analyses in European**.
The project, which brings together 24 research partners from 11 European countries, is intended to produce uniform standards for measuring and assessing microplastic. For one thing, group experiments are planned, in which the different partners will all analyse the same microparticle sample.
http://jpi-oceans.eu/sites/jpi-oceans.eu/files/public/Press%20release/Short%20description%20BASEMAN.pdf

Bioplastics

1) **Developing and Implementing Sustainability-Based Solutions for Bio-Based Plastic Production and Use to Preserve Land and Sea Environmental Quality in Europe (BIO-PLASTICS EUROPE)**.The project BIO-PLASTICS EUROPE addresses the topic „Sustainable solutions for bio-based plastics on land and sea“ (Topic identifier: CE-BG-06-2019), within the focus area „Connecting economic and environmental gains - the Circular Economy (CE)“ and will focus on sustainability strategies and solutions for bio-based products to support the Plastics Strategy. This shall include innovative product design and business models facilitating efficient reuse and recycling strategies and solutions, including ensuring the safety of recycled materials when used for toys or packaging food stuffs. In line with the EU strategy on international cooperation in research and innovation and in order to encourage the further replication, the European consortium is complemented by a partner in Malaysia, providing an added value and helping them to address the many problems they face.
Grant agreement ID: 860407
https://cordis.europa.eu/project/id/860407

2) **Strategies of circular Economy and Advanced bio-based solutions to keep our Lands and seas allVE 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

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

machinery to paper packaging. Its target market is the global packaging industry. The end goal is to contribute to a cleaner environment and increase profits by promoting an eco-friendly model of business.
Grant agreement ID: 882661
https://cordis.europa.eu/project/id/882661

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 sustainable development	**Maritime surveillance**	(MARIT+ 2W (SURVEILLANCE OR MONITOR+))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW	470	1050
	Marine mapping	(G09B-029)/IPC/CPC (MARITIM+ OR COAST+ OR SEA OR MARINE)/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 2 AND 1 PRD=2015-01-01:2020-10-03 3 AND 4	309	886
	Seawater sensors	((MARINE OR MARITIM+ OR SEA_WATER) 5D (POLLUT+ OR CONTAMINAT OR WASTE_WATER OR SLUDGE))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW (SENSOR+ OR MONITOR+)/TI/AB/CLMS/OBJ/ICLM/KEYW 1 AND 2 PRD=2017-01-01:2021-05-29 3 AND 4	897	1329
	UUV	(UNMANNED 2W VEHIC+)/TI/AB/CLMS/ICLM (UNDERWATER OR SUBMARINE OR SUB-MARINE)/TI/AB/CLMS/ICLM 1 AND 2 PRD=2018-01-01:2020-09-18 3 AND 4	504	724
	Precision aquaculture	((AQUACULTURE) AND (SEA OR MARIT+ OR MARIN+))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW (COMPUTER 2W VISION)/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 1 AND 2 ((INTERNET 2D THINGS) OR (IOT))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 1 AND 4 (SENSOR+ 2W NETWORK)/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 1 AND 6 ((ACOUST+ OR ECHO+) 5W (DATA 2W ACQUI+))/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 1 AND 8 ((AQUACULTURE) AND (SEA OR MARIT+))/TI/CLMS/ICLM (ROBOT+)/TI/AB/CLMS/OBJ/ADB/ICLM/KEYW 10 AND 11 3 OR 5 OR 7 OR 9 OR 12	269	669
	Microplastics	(((MICROPLASTIC+ OR (MICRO 1W PLASTIC)) 2D (COLLECT+ OR FILTER+ OR FILTR+ OR CLEANUP OR (CLEAN+ 1W UP) OR INTERCEPT+ OR SEPARAT+)) AND (SEA OR MARIN+ OR MARITI+))/TI/AB/CLMS/DESC/ODES/OBJ/ICLM/KEYW	241	327
	Bioplastics	(((POLY_LACTIC 1W ACID) OR (POLY_HYDROXY 1W ALKANOATE+) OR STARCH OR CELLULOS+ OR NANO_CELLULOS+) AND (BIO_PLASTIC OR (BIO_DEGRAD+ 2D PLASTIC)))/TI/AB/CLMS/OBJ/ICLM/KEYW PRD=2019-01-01:2021-05-28 1 AND 2	600	1098
			3290	**6083**

7 Online visualizations

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

Blue Sustainable Development	BIOPLASTICS	https://app.powerbi.com/view?r=eyJrIjoiNTMwNDc1YmEtZTdjMC00MGVmLThjMzMtNjlkYTkyN2IxNjNiIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MARINE MAPPING	https://app.powerbi.com/view?r=eyJrIjoiOTI0MDljYjAtYTM0Ny00OTIyLWIyN2ItMGVmNDcxYTA1NGRiIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MARITIME SURVEILLANCE	https://app.powerbi.com/view?r=eyJrIjoiMzg5ZDg3MGItNjgzMy00MjBmLTk0YzQtZWVlZDBhNjUxNDBjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MICROPLASTICS	https://app.powerbi.com/view?r=eyJrIjoiYzhmMGM3ZTktNWE1ZC00OTEzLTgzMjctOTZlMjVkZDk2ODQ2IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	PRECISION AQUACULTURE	https://app.powerbi.com/view?r=eyJrIjoiMGY5MGU4NDItNGI0Mi00ODU5LWEwYWUtYjA1N2NkM2Q1Y2Q2IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SEAWATER SENSORS	https://app.powerbi.com/view?r=eyJrIjoiNjQzMGYwMTItYTBhYS00MTZhLWE1ZjQtZjlhYTc3OGMyNGIzIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	UUV	https://app.powerbi.com/view?r=eyJrIjoiZjAwZWQ2OWItMzM3OC00YTY4LTk3MjgtZjNlZDg1ZmEyODZkIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9

8 References

Technology and Market Landscape bibliography:

a) Monitoring and Observing system for Marine Environment

[1] Markets&Markets Knowledge Store (https://www.mnmks.com/)[5] report "Environmental Monitoring Market – Global Forecast to 2025", June 2020;

[2] Markets&Markets Knowledge Store (https://www.mnmks.com/) report "Autonomous Underwater Vehicle (AUV) Market – Global Forecast to 2025", April 2020;

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[3] Markets&Markets Knowledge Store (https://www.mnmks.com/) report "Unmanned Surface Vehicle Market – Global Forecast to 2023", November 2018;

b) Marine Environmental Technologies

[1] Markets&Markets Knowledge Store (https://www.mnmks.com/) report "Precision Aquaculture Market - Global Forecast to 2024", December 2019.

c) Methods and Tools for the Preservation and Management of Marine Ecosystem and the Reduction of Anthropogenic Pressure

[1] European Commission (2020). The EU Blue Economy Report. 2020. Publications Office of the European Union. Luxembourg.
[2] ECHA European Chemical Agency. (n.d.). Microplastics - ECHA. Retrieved March 1, 2021, from https://echa.europa.eu/hot-topics/microplastics
[3] PlasticsEurope Market Research Group (PEMRG) and Conversion Market & Strategy GmbH.
[4] European Commission, 2018. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A European Strategy for Plastics in a Circular Economy. COM (2018) 28 Final SWD(2018), 1–18.
[5] Markets&Markets Knowledge Store (https://www.mnmks.com/) report "Plastic Waste Management Market - Global Forecast to 2024", September 2019.
[6] Onen Cinar, S., Chong, Z. K., Kucuker, M. A., Wieczorek, N., Cengiz, U., & Kuchta, K. (2020). Bioplastic production from microalgae: a review. International journal of environmental research and public health, 17(11), 3842.
[7] Pilla, S. (Ed.). (2011). Handbook of bioplastics and biocomposites engineering applications (Vol. 81). John Wiley & Sons.
[8] MarketsandMarkets Knowledge Store (https://www.mnmks.com/) report "Bioplastics & Biopolymers Market by Type - Global Forecast to 2025", April 2020.
[9] PlasticsEurope. (2020). Plastic - the Facts 2020. An analysis of European plastics production, demand and waste data. https://www.plasticseurope.org/en/resources/publications/4312-plastics-facts-2020

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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