European Commission

Portfolio Analysis

EU Mission “Restore our Ocean and Waters by 2030”

Analysis of a portfolio of projects financed by sixteen EU programmes contributing to the objectives of the Mission Ocean and Waters

Independent Expert Report

Research and Innovation

Portfolio Analysis EU Mission "Restore our Ocean and Waters by 2030"

European Commission
Directorate-General for Research and Innovation
Directorate B — Healthy Planet
Unit B.4 — Healthy Oceans and Seas
Contact Elisabetta BALZI
Maria FERNANDEZ GUTIERREZ
Nicolas SEGEBARTH

Email Elisabetta.Balzi@ec.europa.eu
Maria.FERNANDEZ_GUTIERREZ@*ec.europa.eu*
Nicolas.SEGEBARTH@*ec.europa.eu*

RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Portfolio Analysis EU Mission "Restore our Ocean and Waters by 2030"

Analysis of a portfolio of projects financed by sixteen EU programmes contributing to the objectives and enablers of the Mission Ocean and Waters

Report written by

Giovanna CHIMINI, Pierre FAILLER, Luisa GALGANI, Markus LEHNE, Stefania LEONI,

Patrizio MARIANI, Magda MATCZAK, Katerina MOUTOU, Teresa ROCHA SANTOS,

Isabel SOUSA PINTO, Oliver THUM and Philippe VALLETTE

Guided and reviewed by European Commision policy officers

Eduardo CARQUEIJEIRO, Edoardo CASAROTTO, Maria FERNANDEZ GUTTIEREZ,

Kristi KIITSAK, Claudia PECORARO

Nicolas SEGEBARTH, Ana Maria STAN,

Nikos ZAMPOUKAS

2023 Directorate-General for Research and Innovation

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1. Executive Summary. *By Oliver Thum*

This report presents the results of the analysis of a portfolio of 841 EU projects - completed or ongoing – which contribute to the objectives of the EU Mission "Restore our Oceans and Waters by 2030" (from now on the Mission). These projects have been funded by the following sixteen EU programmes: CEF, CEF2027, COSME, DIGITAL, EMFAF, EMFF, EPLUS2020, ERASMUS2027, ESTAT, H2020, HORIZON, I3, Interreg, LIFE, LIFE2027 and SMP (see Appendix 1. Glossary). Their starting date spans between October 2014 and April 2023. The twenty projects already launched by the Mission by January 2023 are included in the portfolio.

The objective of the analysis has been twofold: to help assessing the R&I's baseline underpinning the activities of the Mission Ocean & Waters to accomplish its ambitions goals and to contributing to prospective analysis on content and future needs for the implementation of the Mission.

The analysis has been performed by twelve independent experts in various objectives and enabblers of the Mission Ocean. This report provides the following results of the analysis:

- A structured overview of the project portfolio in terms of their contribution to the objectives of the Mission, Green Deal targets, thematic areas of intervention, geographical areas, levers of change
- An overview of tangible results delivered by the projects' portfolio including good practises and innovative solutions (technological, social, business and governance)
- Recommendations for the implementation of this Mission, including gaps and approaches to scale-up and roll-out solutions that would require further support at European level, as well as synergies between programmes, stakeholders and initiatives

The methodology for the selection of this portfolio of 841 projects is described in detail in the section 2. It followed two main steps: firstly, a search using the Commission's text mining tool CORTEX, which covers information from more than 60 directly managed programmes, on the bases of 200 keywords and secondly, an expert assessment of a sample of projects selected from the overall pull retrieved by CORTEX, specifically those with the highest relevance score.

This portfolio includes a large, yet not exhaustive list of all the projects relevant to the Mission financed by the mentioned EU programmes in the said period. There are two main reasons for this: on one hand, the search by CORTEX in the available data corpus (see appendix 2) may have overlooked some relevant projects; and on the other hand, due to time constrains, experts focused the analysis on a sample of the potentially relevant projects (those with the highest relevance score) from the overall pool retrieved by CORTEX. In brief, all projects included in the portfolio are relevant to the Mission, but not all relevant projects are in.

It should be mentioned that for all recent ongoing projects, especially for those under the frame of Horizon Europe, only limited information has been available to the experts as at early project phase no intermediate or final results have been published yet.

While the experts confirm the relevance of all the projects of the present portfolio, they have been able to come up with the identification of gaps in the respective field as well

as with recommendations for the future implementation of the Mission and the design of further programmes. Recommendations on the level of the individual objectives and enabling categories can be found in sections 4 to 13 which include the detailed dedicated reports per objective/enabler. Overarching observations and recommendations can be summarized as follows:

- The design of the Mission with its three objectives and two enablers is well aligned to the efforts that have been dedicated by the EU funding programmes prior and in parallel to the running Mission. The analysis showed generally a good and balanced coverage of them except for what relates to freshwater ecosystems (see next point).
- A large number of projects is based on marine and coastal habitats while less of projects are focussing of freshwater habitats. This trend applies not only to objective 1 (protect and restore biodiversity and ecosystems) but across the objectives/enablers of the Mission. Other rivers beside the Danube river can be reasonable targets as they also bear environmental challenges. Other freshwater ecosystems, such as lakes and ponds are significantly underrepresented in the current set of activities. Defining additional lighthouse areas based on rivers, midland freshwater ecosystems systems would allow contribution to habitats yet not in focus but also of importance.
- Improved alignment between different funding programmes, schemes and calls will improve the overall outcome of running and planned activities. While on the level of individual calls the definition of the expected deliverables and unmet needs is well done, redundancies can be observed due to improper alignment between funding programmes and types of action. This could be overcome for example by joint programming on high EC level as well as by setting up cross-programme fundings or cross sectoral umbrella projects, thereby also reducing the risks of fragmentation of efforts and of geographic concentration of activities. Furthermore, increased collaboration with other important stakeholders from political, cultural, economic, and social origin should be encouraged to maximize the deployment of results.
- The analysis shows a very strong support of research and innovation programmes, resulting in the delivery of the expected novel technical/social solutions. This result is in line with the fact that the framework programmes for R&I (Horizon Europe and Horizon 2020) contribute with 85% of the funding. However, insufficient focus is set by programmes addressing knowledge transfer towards deployment, financing and commercialization. Shifting the balance between RIA and IA activities more towards the latter one (231 vs. 111 projects) would strengthen the funding of demonstration units and of projects aiming for reaching high level technology or societal readiness levels (TRL or SRL) and full-scale deployment of solutions.
- Building on these high TRL or SRL levels, aligning regulatory approaches will reduce techno-socio-economical risks and thus increase the likelihood of uptake of novel solutions by the private sector, including industry and SMEs, local/regional/national authorities, communities of actors, etc. Identifying complete systems or value chains and enforcing more prominent representation and contribution of representatives of all major parts of them will also strengthen the outcome of projects in terms of tangible results on reasonable scale. Setup

of proper funding options, such as Interreg, LIFE, etc. would help to bring more projects towards realization.

- The analysis shows synergies between projects financed by R&I and other EU programmes. This includes the financing by Interreg of solutions aimed at preventing and removing pollution, ocean digitalisation or the blue economy. LIFE and LIFE2027 have been supporting the protection and restauration of marine and freshwater biodiversity and ecosystems. EMFF and EMFAF have broadly covered all the objectives and enablers of the Mission. The same can be said about ERASMUS which is very relevant to raising awareness and mobilisation. It is recommended to increase the support and alignment of these programmes to the Mission Ocean and to further foster synergies between them and R&I Framework Programmes.

- The high emphasis of the Mission towards communication need to be maintained and ramped up. Important societal groups outside those typically targeted by projects are yet insufficiently addressed in the portfolio under analysis. First of all, better communication in a language targeted to the general public and using proper communication channels will increase their awareness and commitment to participate and contribute to the challenges ahead. Utilization of interested people as citizen scientists, incorporating the requirements of local communities into the Mission's goals, as well as understanding the needs of end users both direct (e.g. users of marine/freshwater space) or indirect (e. g. farmers for solutions on nutrients and pesticides), consumers and citizens in general will increase the acceptance of proposed actions and thereby ensure successful implementation of necessary measures to reach ambitious goals.

- Novel ways of dissemination are necessary to increase the reach of the Mission as well as of the obtained results. Broader implementation of the Mission goals and environmental needs into educational systems will better engage youth, In addition, addressing specifically tourists to support conservation of endangered regions or habitats or contribution of arts, literature, or related disciplines will further raise awareness.

Considering the above, a more holistic approach is recommended to successfully reach the ambitious goals of the EU: Better alignment between the different funding schemes and Types of Action, broader involvement of target groups others than scientists and increasing awareness of the society by improved involvement of the public.

These recommendations fully align and endorse the approach taken by the Mission Ocean to (i) pooling resources of funding programmes and combining actions ranging from R&I to deployment, investment, and regulation, and (ii) support new forms of communication and mobilisation of public and private actors, such as member states, regional and local authorities, businesses, financial actors, philanthropists, NGOs, etc and engagement to citizens to play an active role.

An interactive report (Dashboard) is being published in connection to this report. For further information on the projects of this portfolio, please visit the dashboard in the following link.
https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters/portfolio-analysis-dashboard_en

2. Strategic context and methodology of this portfolio analysis

The Mission has been designed to deliver on the EU's 2030 targets for protecting and restoring ecosystems and biodiversity, for zero pollution, and for decarbonisation towards climate-neutrality, within the EU's ocean, seas and waters.

It will deliver impact by pooling the necessary resources in terms of funding programmes and by combining actions ranging from research and innovation to deployment, investment and regulation. The Mission promotes new forms of mobilisation of public and private actors, such as EU Member States, regional and local authorities, businesses, etc and of engagement with citizens to play an active role.

The Mission has a strong regional dimension. It has a focus on "*lighthouses*" as sites for the development and deployment of transformative innovations (which can be technological, social, business, governance) in 4 main basins: Baltic and North Sea basin; Mediterranean Sea basin; Atlantic & Arctic coast and Danube river basin.

Prior and in parallel to the running of the Mission (launched in September 2021), European Programmes have financed a substantial number of projects relevant to its objectives. The current analysis takes stock of these projects to ensure that the Mission builds on their outcome and mobilises their actors towards the accomplishment of its ambitious goal.

This report aims to contribute to the assessment of the R&I's baseline on which the activities of the Mission Ocean & Waters builds upon to reach its ambitions goals and to contributing to prospective analysis on content and future needs for the implementation of the Mission.

The analysis has been carried out by twelve independent experts who whose work has resulted in the following sections of this report:

- (iii) one expert undertook the analysis of the overall portfolio of relevant projects and the main conclusions of the analysis (Executive summary and section 3)
- (i) ten experts analysed projects dedicated to the ten sub-objectives/enablers of the Mission (sections 4 to 13).
- (ii) one expert assessed the synergies between programmes, activities, and stakeholders (section 14)

Methodology of this portfolio analysis

Identification of projects potentially relevant to the Mission

This analysis has been structured around the three objectives and two enablers of the Mission. They were broken further down into ten specific sub-objectives/enablers (see table 2.1). For instance, objective 1 of the Mission on protecting and restoring marine and freshwater ecosystems and biodiversity was broken down in two sub-objectives: one dedicated to marine and coastal and another one on freshwater biodiversity and ecosystems.

The programme Core TextMining (CORTEX) has been used to search for projects potentially relevant to the Mission on the bases of 200 keywords corresponding to the 10 defined sub-objectives/enablers. The scope of the search included twenty EU funding

programmes[1] from a data corpus of ca. 63902 projects (see appendix 2 with the details for each programme). The starting date of the projects spans between October 2014 and April 2023. The search retrieved a large portfolio of projects (ca. 17000) potentially relevant to the Mission.

Table 2.1: Sub-objectives/enablers in which this analysis has been structured. Number of projects assessed by experts and flagged as relevant.

Mission Objectives/Enablers	Sub-objectives/enablers in which this analysis has been structured	No projects analysed	No projects relevant
Objective 1: Protect and restore marine and freshwater ecosystems and biodiversity	Sub-objective 1a: Focus on marine and coastal ecosystems and biodiversity.	300	151
	Sub-objective 1b: Focus on freshwater ecosystems and biodiversity.	300	86
Objective 2: Prevent and eliminate pollution of our ocean, seas and waters	Sub-objective 2a: Focus on marine litter and microplastics.	300	154
	Sub-objective 2b: Focus on nutrients, chemical pesticides and other pollutants	300	200
Objective 3: Make the sustainable blue economy carbon-neutral and circular	Sub-objective 3a: Focus on multiuse of water space (Maritime Spatial Planning (MSP), multi-use platforms)	102	46
	Sub-objective 3b: Focus on circular blue economy & zero-carbon and low-impact fisheries and aquaculture	165	62
	Sub-objective 3c: Focus on decarbonisation and ecosystem perspectives in maritime industries (marine & offshore energy, ports & shipping including fishing vessels)	184	111
Enabler 1: Digital ocean and water knowledge system.	Sub-enabler 1: Development of the EU Digital Twin of the Ocean (data -platforms, interoperability, standards, communications, models, digital interfaces, artificial intelligence and big data).	402	187

[1] CEF, CEF2027, CIF, COSME, DIGITAL, EEPR, EMFAF, EMFF, EPLUS2020, ERASMUS2027, ESF, ESTAT, H2020, HORIZON, I3, INNOFUND, Interreg, LIFE, LIFE2027 and SMP.

Mission Objectives/Enablers	Sub-objectives/enablers in which this analysis has been structured	No projects analysed	No projects relevant
Enabler 2: Public mobilisation and engagement	Sub-enabler 2.a: focus on mobilisation of citizens and young generations in restoring Ocean, seas and rivers.	153	96
	Sub-enabler 2.b: focus on raising awareness on the need to protect our ocean and waters.	150	77
	Total with duplicates	**2356**	**1170**
	Total	**1430**	**841**

From the large portfolio of potentially relevant projects, ten experts (one per sub-objective/enabler) analyse a short total list of 1430 projects with the highest relevance (between 150 and 400 projects each expert). Some projects were analysed by more than one expert as they contribute to more than one objective/enabler (2356 analysis). See table 2.1 with the distribution of projects across sub-objectives/enablers.

The reason to focus the analysis only on the projects with the highest relevance score is the intention to use the resources in the most effective manner. One of the consequences is that the resulting portfolio of relevant projects cannot be exhaustive as the sample of non-analysed projects may also comprise some relevant ones. In addition, the search by CORTEX is limited to the given data corpus (appendix 2) and has also uncertainties (e.g. definition of keywords, algorithm for the scoring relevance, etc).

Experts flagged 841 projects as relevant to the Mission's sub-objectives/enablers. It should be noticed that some of these projects contribute to more than one sub-objective/enablers, therefore are counted in several sub-objective/enabler. Counting multiple times the projects which contribute to each and every of the ten sub-objectives/enablers it results in a figure of 1170 projects.

<u>Methodology for the analysis of the ten portfolios of projects addressing each of the sub-objective/enabler</u>

The analysis included the following three main elements:

A. Structured overview of the EU funded projects relevant to each of the Mission's sub-objectives/enablers. Experts assessed the following items based on the abstracts and possibly the Cordis factsheets of the projects.
    a. Relevance to the specific sub-objective/enabler of the Mission
    b. Contribution to the following Green Deal targets referred in the Mission Implementation Plan: (i) Protect at least 30% EU's sea areas; (ii) Strictly protect at least 10% EU's sea areas; (iii) Restore 25.000 km free flowing rivers; (iv) Reduce by at least 50% plastic litter; (v) Reduce by at least

30% microplastics; (vi) Reduce by at least 50% nutrient losses; (vii) Reduce by at least 50% chemical pesticides; (viii) Multi-use of maritime space; (ix) Zero carbon aquaculture; (x) circular aquaculture; (xi) toxin-free aquaculture; (xii) Net zero maritime emissions; (xiii) Enabler digital transition.

c. Thematic areas of intervention. Projects were categorised and grouped according to relevant thematic areas of intervention defined by the experts.

d. Geographical areas. Projects were assessed towards their possible connection with a specific Sea/River basin targeted by the Mission. This would be the case, for instance, if the solution targeted by the project is to be develop, demonstrate or deploy in a specific basin. The projects whose concept (i) that are not intended for any specific sea-basin or (ii) that can be applied to any basin were referred as cross-basin.

e. Levers of change: Projects were assessed by the matter in focus or the tool they used to drive (or leverage) change towards their goal. Levers of change included governance, financing and economy, research and innovation, new knowledge and data, deployment, citizens engagement as well as education and training.

For the above items, projects can have multiple contributions, for instance, for item b. projects can contribute to more than one green deal target. The same is applied for the rest of the items.

B. Overview of tangible results. Experts identified tangible results, good practises and innovative solutions (technological, social, business and governance). This assessment was done for a group of about twenty projects selected for an in-depth analysis in each of the sub-objectives/enablers. The selection of these projects for in-depth analysis was made taking into consideration the following criteria: relevance, balance coverage of programmes, geographical coverage and mixed of maturity. In total, this study includes 226 in depth analysis of projects.

C. Recommendations for the implementation of this Mission. Experts identified gaps and approaches (to scale-up and roll-out) that would require further support at European level; Identify synergies with stakeholders and initiatives.

3. Description of the overall portfolio. *By Oliver Thum*

The current section presents an overview of the distribution of the 841 projects of the portfolio according to EU funding programmes, types of action, objectives/enablers of the Mission, Green Deal targets, levers of change, type of participants, and thematic areas. Possible slight discrepancies[2] between the EU financial contribution featured in this section 3 vs. sections 4 to 13 is due to the fact that this section has been edited last and displays the values of the dashboard (see below) with most up to date figures.

An interactive report (Dashboard) is being published in connection to this report. It allows the user to navigate the visuals filtering according to your specific interests. Readers of this report are invited to visit the Dashboard in the following link.

https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters/portfolio-analysis-dashboard_en

Distribution of projects across EU funding programmes

Projects flagged as relevant to the Mission Objectives have been funded by a panoply of sixteen EU programmes. Figure 3.1 and Table 3.1 show the distribution of number of projects and budget per programme. As can be seen, R&I framework programmes Horizon 2020 (H2020) and Horizon Europe (HORIZON) account for the highest contribution in terms of number of projects (~ 66%) and funding (~ 85%). They are followed by Interreg (territorial cooperation programme), funded by European Regional Development Fund (EDRF), in terms of number of projects and LIFE2027 (Programme for the Environment and Climate Action) in terms of EU contribution. Other programmes with a substantial contribution include EMFF (European Maritime and Fisheries Fund), ERASMUS2027 (The European Union Programme for education, training, youth and

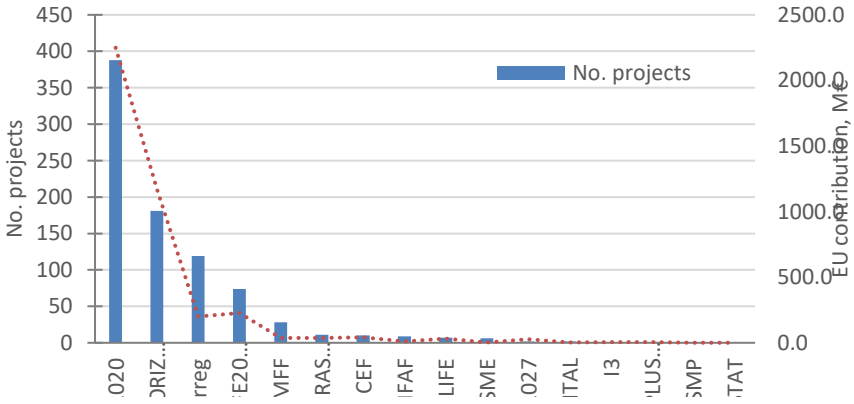


Figure 3.1: Distribution of projects across per EU funding programmes, in number of projects and EU contribution (see appendix 1. Glossary)

[2] Possible slight discrepancies between the EU financial contribution featured in the Mission Ocean Portfolio Dashboard and the Report Mission Ocean Portfolio Analysis are due to the fact that the report presents an snapshot of the data available at the cut-off date.

sport 2027), CEF (Connecting Europe Facility), LIFE and CEF 2027.This shows a complementary coverage of actions from various complementary angles. The contribution of some of the programmes (COSME, DIGITAL, I3, EPLUS2020, SMP and ESTAT) is rather minor, especially in terms of overall financial contribution.

Table 3.1 shows that the lion share of the efforts have focused on R&I while the resources dedicated to the implementation of approaches and solutions to restore the ocean and waters has been made mainly by the programme LIFE and LIFE2027, Interreg, EMFAF (and its early EMFF). The contribution of the current editions of the programmes LIFE2027 and ERASMUS2027 is significantly larger than the previous ones (LIFE and EPLUS2020) which indicates that their strategic programming is getting further aligned to the objectives of the Mission Ocean. For the case of EMFAF, owing its launching in 2021, it is expected that it will continue contributing to the objectives of the Mission at least to the level done by the former EMFF. On the other hand, although the current contribution of the Horizon Europe programme is still smaller than that of it predecessor (HORIZON 2020), additional projects are to be expected in the next years, in particular owing the additional emphasis given by the Mission Ocean and Waters.

Table 3.1: Distribution of projects per programme (see appendix 1. Glossary)

Framework Programme	Number of projects	EU contribution (M€)[3]
H2020	388	2249,6
HORIZON	181	1174,8
Interreg (ERDF)	119	199,9
LIFE2027	74	226,4
EMFF	28	37,9
ERASMUS2027	11	38,0
CEF	10	40,5
EMFAF	9	9,3
LIFE	7	32,3
COSME	6	3,8
CEF2027	2	27,7
DIGITAL	2	2,8
I3	1	5,1
EPLUS2020	1	5,0
SMP	1	1,4
ESTAT	1	0,2
Total	**841**	**4055**

Distribution of projects across types of action

As expected from the distribution according to the funding programmes, Research and Innovation actions, which are intended to fund early-stage development of novel solutions, are the most used types of actions in both in Horizon Europe and Horizon

[3] The EU financial contribution is reported on the best effort basis and it not available for all portfolio projects.

2020 (see Figure 3.2). They are followed by Innovation Actions which are dedicated to later stage demonstration activities. Worth to mention the 4 HORIZON-COFUND actions contributing to the objectives of the Mission Ocean for a combined EU funding of about 300 M€. These are partnerships involving EU countries, with research funders and other public authorities at the core of the consortium. They are important to align and structure the research and innovation strategies of the member states. They are SBEP: A climate neutral, sustainable and productive blue economy Partnership; Water4All – Water Security for the Planet; PARC: Partnership for the Assessment of Risks from Chemicals and Biodiversa-plus: The European Biodiversity Partnership.

The ERDF actions (via the Interreg programme) contribute with a significant number of projects, but a relatively low amount of funding compared to the innovation-driven activities. LIFE-PJG are less in number than Interreg but receive higher budget.

In terms of R&I, there are a substantial number of actions dedicated to coordination and support (CSA), ERC, SME, etc.. Although their budget is smaller than that of RIAs and IAs, they are complementary by assisting in the coordination of stakeholders, advance knowledge, involve private sector, etc.

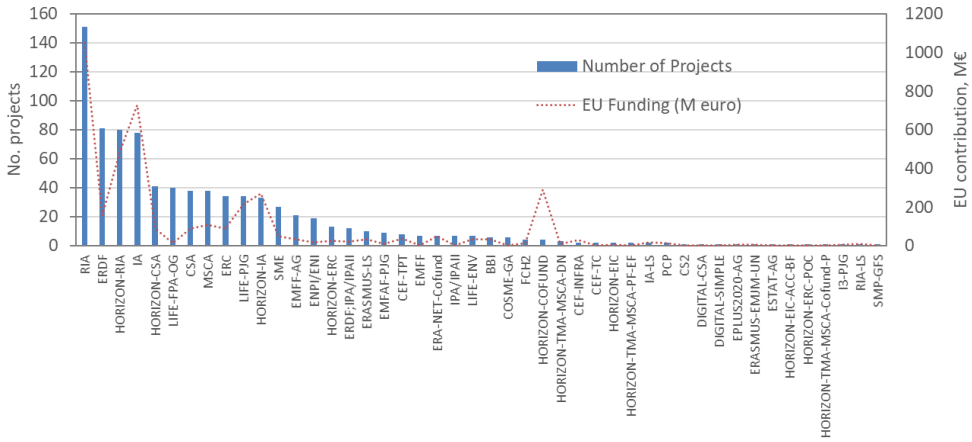


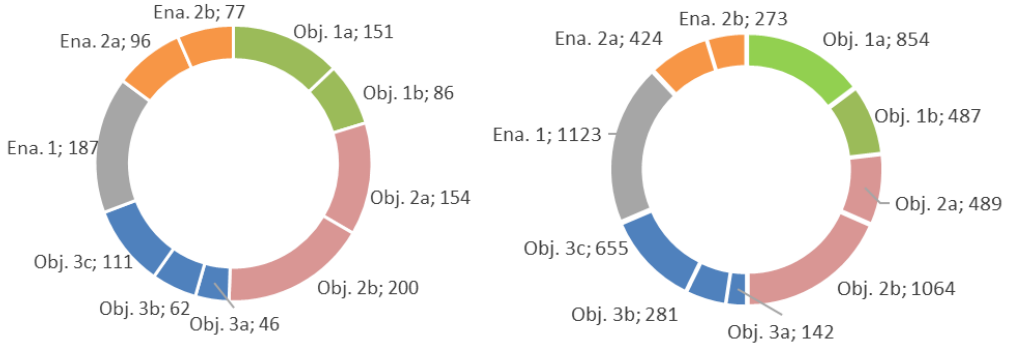
Figure 3.2: Distribution of projects per EU Types of Action, in number of projects and EU contribution (see appendix 1. Glossary)

Distribution of projects across Mission objectives

The sum of projects which contribute to each of the objectives as showed in Figure 3.3 (1170) is larger than the total number of projects (841, see Table 2.1). The same happens for the EU funding (5,8 b€ in Figure .3 right vs. 4,05b€ in Table 2.1). The reason is that some projects (214) contribute to more than one sub-objective/enabler. For these cases, the current analysis has not attempted to allocate a share of the project per sub-objective/enabler, but rather it has counted as the complete project to each sub-objectives/enablers, therefore resulting in multiple counting. The case of enabler 2 is very illustrate for this multiple counting. The large majority of the projects contributing to sub-enabler 2a: mobilisation and engagement, also contribute also to 2b: raising awareness. In addition, very often, these projects relate to one particular objective of the Mission Ocean and dedicate some efforts to mobilisation, engagement of stakeholders

and awareness raising. It is also frequent that projects dedicated to a given objective contribute also to enabler 1: Ocean digital knowledge system.

Having acknowledged the above, Figure 3.3 shows a substantial coverage of all the sub-objectives/enablers of the Mission Ocean. With regards to objective 1: Protecting and restoring biodiversity and ecosystems, the projects dedicated to marine and coastal ecosystems (obj. 1a) almost doubles those dedicated to freshwater ones. Objective 2: Preventing and eliminating pollution is the objective which has received the largest financial effort, with projects dedicated to both marine and plastic litter as well as other pollutants like nutrients, pesticides, and chemicals. Projects flagged as relevant to objective 3 have a focus on greening the blue economy through three main approaches: multiuse of water space, make fisheries and aquaculture carbon neutral and circular as well as fostering decarbonisation and ecosystem perspectives of maritime industries. Therefore, projects dealing with the development of maritime industries which do not focus on the three mentioned approaches have not been considered in this study. It is important to highlight that both enablers “digital ocean” and “engagement and awareness raising” are well covered by EU funded projects.



Obj. 1a	*Protect&Restore Marine and coastal ecosystems and biodiversity*	*Obj. 1b*	*Protect&Restore Freshwater ecosystems and biodiversity*
Obj. 2a	*Zero pollution - litter and microplastics*	*Obj. 2b*	*Zero pollution – nutrients, chemicals, pesticides*
Obj. 3a	*Blue econ. - multiuse of water space*	*Obj. 3b*	*Blue econ. - C neutral and circular fisheries and aquaculture*
Ena. 1	*Ocean digital knowledge system*	*Obj. 3c*	*Blue econ. - Decarb. & ecosystem in maritime industries*
Ena. 2a	*Mobilisation and engagement*	*Ena. 2b*	*Raising awareness*

Figure 3.3: Projects per mission objective, in number of projects (left) and in EU funding (M€, right)

Distribution of projects across EU green deal targets

An underlying rational of current EU funding activities is to support the achievement of the EU Green Deal targets. Figure 3.4 shows the distribution of the analysed projects according to their contribution to the individual EU green deal targets. As seen above, the total number of projects contributing to any of the indicated Green deal targets is

slightly higher than the total number of flagged as relevant (845 projects contributing to green deal targets vs. 841 total projects flagged as relevant; 4.3 vs. 4.1 B€ EU contribution). A more detailed analysis shows that 537 projects out of the 841 projects are contributing to one or more of the targets, while the remaining ones either do not or at least do not specifically elaborate on potential contributions (especially those projects initiated in the early phase of the observed timeframe).

Figure 3.4 also shows that the largest share of the budget is dedicated to the digital transition and the several "individual reduction" targets, representing 26% and 42% of the EU contribution, respectively. The contribution to the targets of the "protect" categories is significantly lower, with "protection of the sea areas" having the biggest share among them (13%). Projects river restoration so far see only a marginal share of available funding.

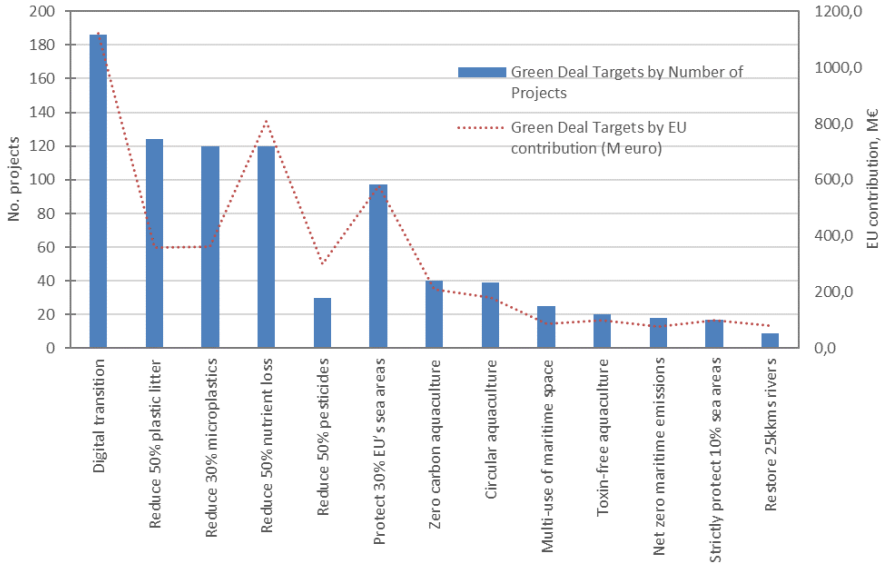


Figure 3.4: Distribution of projects per EU Green Deal targets, in number of projects and EU contribution (M€)

Distribution of projects across different basins

Several basins had been selected based on urgency and potential impact of changes to be implanted. An analysis of the projects according to the basins their work is dedicated to (see Figure 3.5) shows a relatively equal distribution together with a large cluster of projects that don't target a specific basin or that can be applied to any kind of basin. About ~100 projects target more than one of the lighthouse basins, thus explaining the slightly inflated overall number. However, a clear focus on marine/coastal activities can be identified with the only pure river basin (Danube) attracting less than 100 projects.

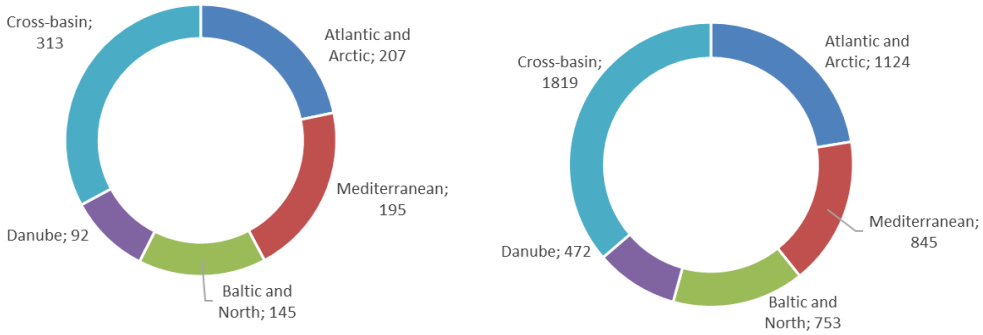
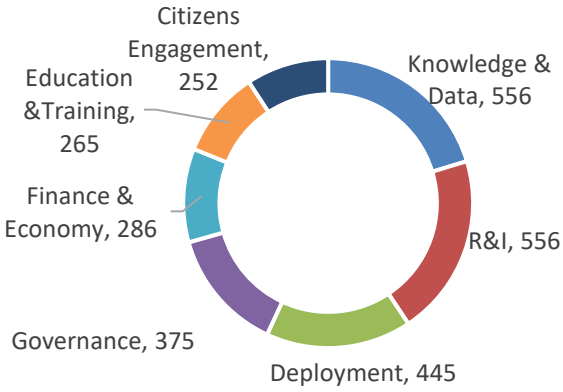


Figure 3.5 Distribution of projects per sea/river basins. Left: number of projects; Right: budget (M€)

Distribution of projects across Levers of Change

The high amount of RIA/IA based types of action is also mirrored in the distribution of the projects according to their Levers of Change. Figure 3.6 shows levers typically associated with these actions, such as generation of know-how and data, Research & Innovation and deployment are the most occurring ones compared to governance, financial & economic or education and training ones. However, as the projects on average contribute to more than three of the analysed categories (2735 projects counted vs. 841 overall projects) it is very difficult to draw any deeper analysis or conclusion in addition to the ones drawn in the analysis of the individual sub-objectives and enablers (sections 4 to 13). In any case, it is clear that more efforts are needed towards education and training and to finding new business models or economic/financial mechanisms to support the objectives of the Mission. Deployment and governance need also additional attention.

Figure 3.6: Distribution of projects per Levers of change (number of projects)



The participants of the 841 projects of this portfolio are distributed across the five main categories showed in Figure 3.7. Anyhow, fitting to the domination of RIA/IA based actions it can be observed that more than 50% of the contributors are from the group of Higher Education (Universities, etc.) or Research Centers. Only ~25% are from the group of profit organisations, representing industrial partners as well as financial

advisors or other non-technological commercial participants. This can also be expected taking into consideration that significant more RIA than IA based actions are funded and that RIA actions are typically focusing on lower technology readiness levels (TRL) compared to the IA ones and thus need less contribution from industry or other non-academic institutions.

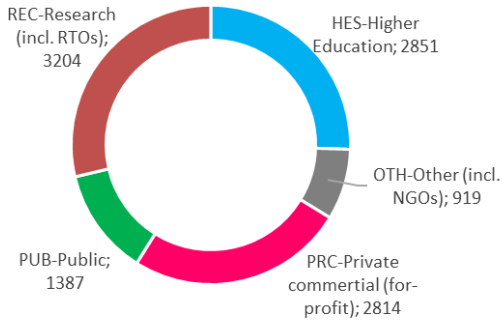


Figure 3.7: Distribution across type of participants

Distribution of projects across Thematic Areas

The projects could be attributed to a total of 64 Thematic Areas (T.A.) with a contribution between 4 and 114 projects per T. A. Figure 3.8 shows the large panoply of thematic areas that have been addressed by the projects. The visualisation of these thematic areas in a dashboard is helpful to identify projects that address specific R&I issues. On average each project contributed to more than 3 T. A. which again makes it difficult to draw conclusions. However, the T.A. with the highest number of projects are well in line with expectations based on the distribution of projects by Mission objectives and enablers. The objectives and enablers which present the highest number of relevant projects (enabler 1 and objective 2b are associated to the technology areas more intensively covered “Source Reduction” and “Application and Services” and “models”.

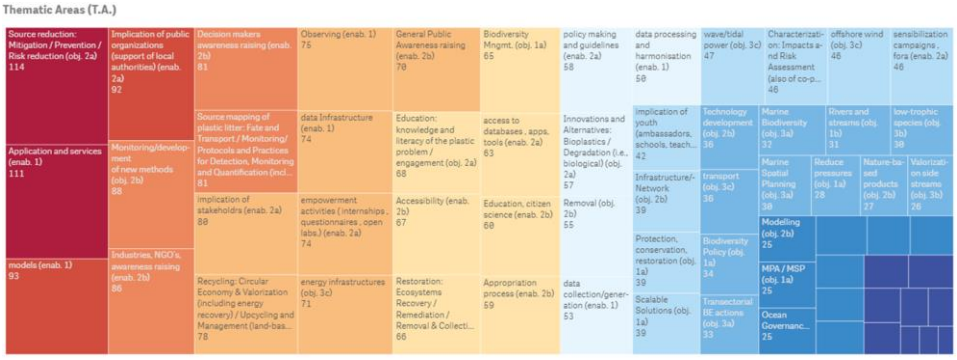


Figure 3.8: Treemap showing the distribution of the projects across the Thematic Areas (T.A.)

4. Protect and restore marine and coastal ecosystems and biodiversity. *By Patrizio Mariani*

4.1. Main findings of the analysis

This report analyzes a total of 151 projects dedicated to marine and coastal biodiversity. These projects represent a significant EU investment of 865M € and are primarily focused on the conservation, preservation, and restoration of marine life (see list of projects in section 4.5). They are related to different programs and actions, including among the others Horizon Europe (HORIZON), Horizon 2020 (H2020), LIFE, Interreg, ERC, and MSCA instruments (see Appendix 1. Glossary). The projects are wide-ranging, encompassing research and innovation actions, as well as coordination and infrastructure funds. Most of these projects are ongoing (2022-), while others have been recently concluded. Activities within the projects are scored against different items, such as the Mission Goals on protecting biodiversity and ecosystems and Green Deal targets on the protection of 30% of the sea and strictly protect 10%. They are also scored against specific thematic areas, including: (i) protection, conservation and restoration, (ii) marine protected areas and maritime spatial plan (MPA/MSP), (iii) reduce pressures, (iv) scalable solutions, (v) biodiversity management, and (vi) biodiversity policy. The impacts of these activities are considered in terms of governance, finance and economy, R&I, knowledge and data, deployment, citizen engagement, education, and training.

The research questions addressed in the projects can be grouped around six themes, all of which aim to enhance our understanding of marine biodiversity and ecosystems. They are: (1) restoring and protecting coastal habitats, forests, wetlands, and other ecosystems; (2) leveraging emerging technologies and models to predict and map ecosystem changes; (3) mitigating and adapting to the impacts of climate change; (4) planning and managing marine spatial use and conservation; (5) promoting sustainable economic activities in the blue economy; and (6) improving ocean governance and coordination.

Addressing these questions will significantly advance our understanding of marine biodiversity, including processes and drivers, at various locations in Europe, with a focus on local scales. However, these research questions are still relevant to shape future research programs when a more global and regional approach is taken. Scaling up best practices from local to regional and global oceans is essential to improve our understanding of marine and coastal biodiversity dynamics.

Based on the gap analyses, future research priorities have been identified. These include advancing our understanding of the impacts of climate change on biodiversity, developing new tools and techniques for effective monitoring, and assessing marine and coastal biodiversity (and including a network of European marine biodiversity observatories) developing new approaches to marine conservation and management, identifying and addressing the major drivers of biodiversity loss in coastal and marine ecosystems, improving the effectiveness of marine protected areas (MPAs), and understanding changes in marine megafauna ecology and assessing the services they provide.

These priorities should align with the objectives of the Kunming-Montreal Global Biodiversity Framework to facilitate coordinated actions between ocean and land, and to engage with business and financial institutions. Alignment between funding tools is strongly encouraged to address biodiversity research with a system approach covering the development of fundamental knowledge, innovation in observation technology, and capacity building to improve biodiversity management.

Finally, it should be noted that several of the projects analyzed have overlapping research questions and will run during a similar timeframe. To avoid fragmentation and to promote a coordinated approach, it is strongly recommended that a dedicated support action be established at the end of the program to assess research results and commonly identify best practices and future directions to harmonize biodiversity monitoring and management in EU waters and seas.

4.2. Description of the portfolio

Out of 300 projects assessed, a total of 151 projects have been found as relevant for the analyses of marine and costal biodiversity and the list includes various challenges related to marine conservation and management, such as improving transdisciplinary science for effective ecosystem-based maritime spatial planning and conservation, the preservation of oceans, marine protected areas, marine biodiversity assessment, and prediction. Other challenges include the restoration of marine and coastal ecosystems, sustainable fishing practices, climate change and future marine ecosystem services, and reducing climate-based health risks in blue environments. Additionally, the list of beneficiaties of these projects includes various organizations and initiatives, such as Coalition Clean Baltic, Seas At Risk, Surfrider Foundation Europe, WWF European Policy Office, and Renewables Grid Initiative, among others. The research questions addressed by these titles are diverse and cover different aspects of biodiversity conservation, management, and governance, including the development of sustainable marine activities, the creation of efficient and resilient networks of marine protected areas, and the reduction of cumulative impacts on European marine biodiversity and ecosystem functions.

In particular, the research questions addressed in the analyzed projects can be grouped around:

- How can we restore and protect coastal habitats, forests, wetlands, and other ecosystems to enhance biodiversity and ecosystem services?
- How can we leverage emerging technologies and models to enhance our understanding of marine ecosystems, predict ecosystem changes, and map and monitor ecosystems more effectively?
- How can we mitigate and adapt to the impacts of climate change on marine ecosystems, biodiversity, and human health?
- How can we effectively plan and manage marine spatial use and conservation in a transdisciplinary manner that incorporates ecosystem-based approaches?
- How can we promote sustainable economic activities in the blue economy (e.g., renewables, tourism, eco-responsible actions) while protecting marine ecosystems and biodiversity?
- How can we improve ocean governance and coordination across different regions and stakeholders to achieve sustainability goals

When addressed those questions will largely advance our understanding on marine biodiversity, including processes and drivers, at several locations in Europe and with a focus on local scales.

Of the 151 projects the vast majority (n=128) are from Research and Innovation (H2020 and HORIZON) and LIFE2027 programmes (Figure 4.1).

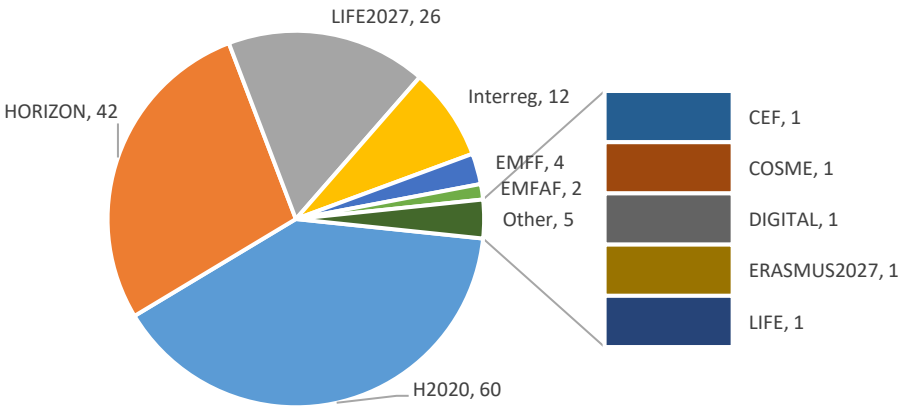


Figure 4.1. Number of projects per EU funding programme. Total number of projects: 151.

This group of projects will also represent the largest fraction of funds with 795M € (Figure 4.2). Interreg projects are also significant and represent 39.5M € allocated to 12 projects. Other programmes include LIFE (1 project, 13.4M €), EMFF (4 project, 7.1M €), EMFAF (2 projects, 3.1M €), and other individual projects from LIFE, CEF, COSME, DIGITAL, ERASMUS for a total of circa 21M €.

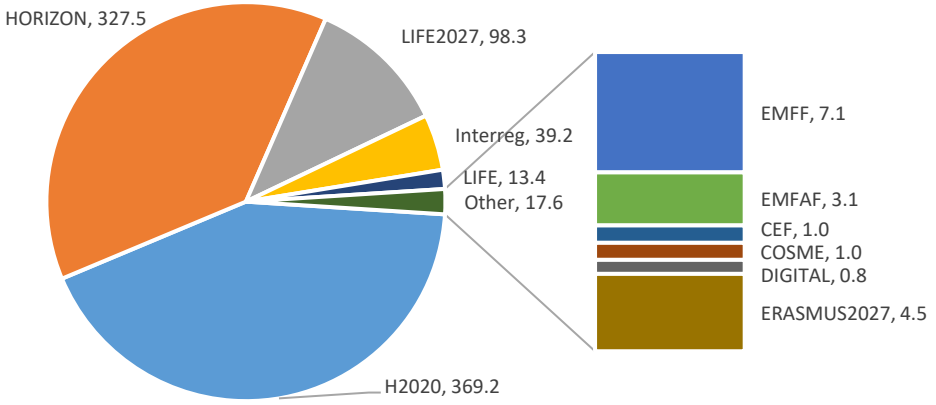


Figure 4.2. EU contribution (M€) per funding programme. Total EU contribution: 865,1M€.

The type of actions in the list of projects (Figure 4.3) range across several types such as Research and Innovation Actions (n=51), Coordination and Support Actions (n=19) and a significant fraction of Innovation Actions (n=17) and also LIFE FPA (n=17) and LIFE PJG (n=9). Interestingly the number of ERC is relatively low (n=8) considering the fundamental knowledge and theoretical frameworks that still need to be developed on understanding biodiversity patterns, organisation, mode and tempo across a range of different ecosystems.

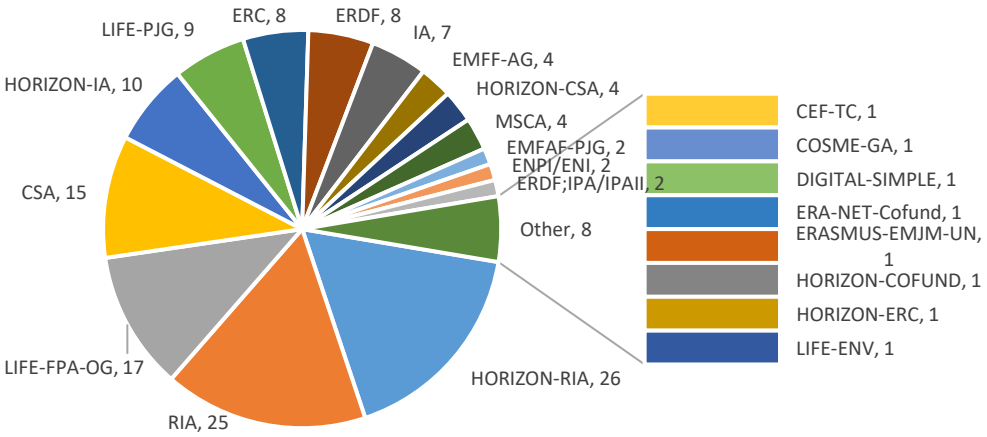


Figure 4.3. Number of projects per type of action. Total number of projects: 151.

In terms of EU funding across the different types of action, Figure 4.4 shows that research and innovation actions (RIA), dealing with medium to long term research, received close to half of the EU contribution, while the contribution to Innovation Actions (closer to implementation) is more modest. Other types of actions with subtantial EU funding include coordination and support actions and LIFE actions.

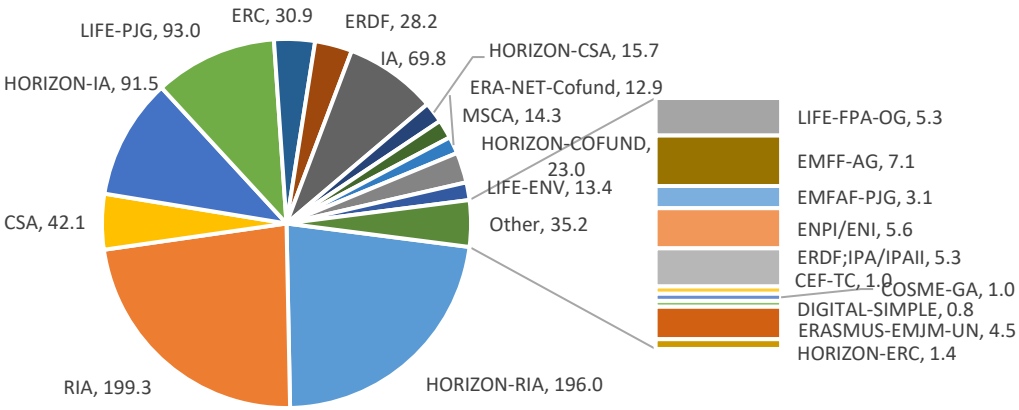


Figure 4.4. EU contribution (M€) per type of action. Total EU contribution: 865,1M€.

The relevance of the topics against the MISSION OCEAN's objectives and Green Deal's targets can be summarised noting that a total of 39 projects perform research contributing to advancing towards the 30% protection of the sea by 2030. Among these a total of 17 projects are clearly directly contributing to the design and management of conservation measures and the strict protection of at least 10% of European seas. Those projects are sometimes cross-basin (30%) and are based on large scale consortia within the different Horizon frameworks. Several projects include identification and management of biodiversity pressures and among these prevent and eliminate pollution are often considered as research targets. There are

relative few projects linking biodiversity research to the sustainable blue economy carbon-neutral and circular (total 3).

Selected Thematic Areas have been identified to analyse the relevance of the projects to specific targets. Those are:

Protection, conservation and restoration – these objectives refer to projects addressing interactions between pressures and single species or community level, and/or habitats or ecosystem level.

MPA / MSP – these refer to projects aiming at improving the establishment and management of marine protected areas or more generally contributing to the definition of marine spatial plans in certain areas,

Reduce pressures – projects scored against this category have a specific focus on management and analyses of pressures on different ecosystem components. This may include climate and anthropogenic pressures including pollution.

Scalable solutions – projects in this category provide tangible methods, tools, processes, etc. that are developed and applied in specific areas, but can potentially be used in other regions.

Biodiversity Management – projects in this category provide significant impacts to advance marine and coastal biodiversity management.

Biodiversity Policy - projects in this category provide significant impacts to support and inform policy on marine and coastal biodiversity.

Those thematic areas are substantially covered by the different projects (Figure 4.5) with several projects that address more than one area and many contributing to advance our understanding of management of marine and coastal biodiversity. Areas like marine spatial planning and MPA, management of pressures, protection, conservation and restoration, may deserve further effort to better advance towards the Mission Ocean and Green Deal Goals. Additionally, as the UN Ocean Decade calls for solutions to the global challenges, further effort should be considered to advance research in this direction.

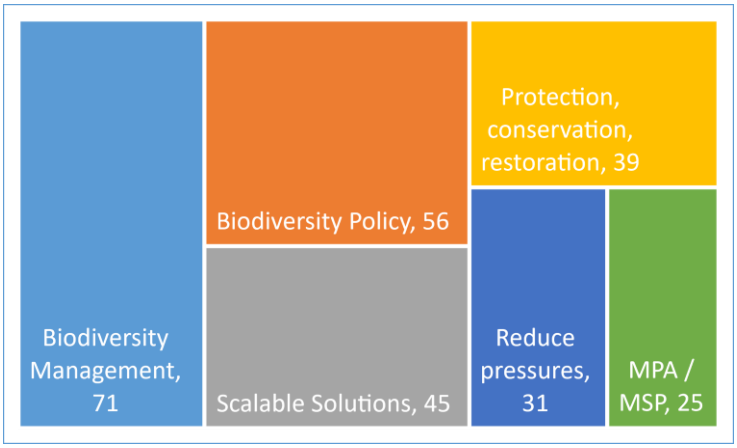


Figure 4.5. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 267. Total number of projects: 151.

Table 4.1 shows the crossing the activities under the different thematic areas and the main type of tool targeted by the project to drive (or leverage) change in the desired direction. A prevalent uniform overlap exists for specific themes and tools used. However, for some categories a lack of effort is identified. Finance and economy are generally under-represented in projects, indicating a lack of focus to translate research and innovation ideas into business opportunities around marine and coastal biodiversity. Similarly significant effort in building capacity around those themes appears to be lacking. This might also include a mismatch between the development of new technologies for better observations of marine and coastal biodiversity and limited efforts to provide training and education opportunities to practitioners around those new methods and technologies. Generally, although several projects are enlarging the solutions for better management of biodiversity, several of those have limited applications in real-world scenarios given the low score on the Deployment impact.

Table 4.1. Main type of matter addressed by the projects dealing with the different thematic areas.

Thematic	Governance	Finance & Economy	R&I	Knowledge & Data	Deploym.	Citizen Engament	Educ. & Training
Protection, conservation, restoration	22	8	22	17	14	20	6
MPA / MSP	17	0	7	11	3	8	4
Reduce pressures	17	4	19	16	9	13	7
Scalable Solutions	20	10	25	30	18	19	7
Biodiversity Policy	36	8	20	23	8	31	13
Biodiversity Management	45	10	37	36	16	27	13
Total	157	40	130	133	68	118	50

4.3. Main outcomes and fostering the uptake of solutions

4.3.1. Main outcomes

A selection of 23 projects (out of the 151 projects identified as relevant) was made to carry out an in-depth analysis. These projects are highlighted in blue and bold in section 4.5 list of projects. The projects analysed have results with a substantial contribution to conservation, protection and restoration of marine biodiversity (see the Table 4.2). They aim to achieve these goals through a variety of approaches such as implementing sustainable fishing practices, promoting awareness among local communities, developing innovative monitoring tools, and creating protected marine areas. The projects are spread across different regions and countries and involve collaborations between various organizations such as research institutes, NGOs, and local governments. Nine out of 23 projects are scored as cross basin with analyses spanning several EU and international regions.

The approach considered in those projects does often include analyses of single and/or multiple pressures, with contribution in same cases to specific management tools like design of Marine Protected Areas and the support to Marine Spatial Planning. Several projects offer specific solutions to, e.g., contribute to management, identification of ecosystem indicators, toolbox to support ecosystem-based management approaches. Some projects are specifically focused on addressing the impacts of climate change on marine ecosystems and developing strategies to mitigate these effects. But the combined effects of restoration and protection measurements under future climate and socio-economic scenarios is not always addressed. Others aim to promote the sustainable use of marine resources and encourage economic development in a way that is environmentally responsible. But large-scale actions of societal transformation towards equitable and sustainable use of marine resources is lacking.

The projects advance knowledge on several fundamental processes regulating marine biodiversity. Specific areas are however not well covered like the importance of active behaviour in regulating vertical fluxes, trait distributions and functional biodiversity, robustness and resilience indicators under future global changes. In general, all projects seek to improve our understanding of the complex relationships between different marine species, their habitats and ecosystems, and to find conditions to support protection, conservation and in some cases restoration of different groups. They recognize the importance of preserving marine biodiversity not only for its intrinsic value but also for its vital role in supporting human well-being and livelihoods. The projects also emphasize the need for cross-border collaborations and knowledge-sharing to address the global nature of the challenges facing our oceans.

Tabe 4.2. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
A-AAgora	Demonstration of large scale restoration with effective nature-based solutions including blue reforestation	Coastal restoration	https://a-aagora.eu/
ACTNOW	Solutions to halt biodiversity loss, to restore habitats and ecosystem processes, and to safeguard ecosystem goods and services	Ecosystem based management	https://www.actnow-project.eu/
ANERIS	A digital framework to integrate different types of marine life-sensing technologies	Biodiversity monitoring and management	https://www.aneris.eu/
BESTLIFE2030	Establish financing mechanisms for projects demonstrating EU Overseas committment towards biodiversity and sustainable development strategies	Support mechanism	website
BIOcean5D	Methods and technologies to advance knowledge on holistic biodiversity approaches across scales	Ecosystem based management	https://www.biocean5d.org/
BRIDGE-BS	Tools and methods to support ecosystem based management and sustainable blue economy in the Black Sea	Ecosystem based managment	http://bridgeblacksea.org/
CLIMAREST	Develop a modular toolbox designed to establish guidelines for ecosystem restoration and to enhance climate resilience in coastal communities	Coastal restoration	https://climarest.eu/
FutureMARES	Socially and economically viable nature-based solutions for climate change adaptation and mitigation and marine biodiversity protection	Ecosystem based management	https://www.futuremares.eu/

Project acronym	Description of result	Application	Link to the result
GES4SEAS	Toolbox for adaptive ecosystem based managment of pressures and impacts to support marine governance	Marine governance	https://www.ges4seas.eu/
GIREPAM	A common strategy for the integrated management of protected marine coastal environments in the Mediterranean	MPA management	https://interreg-maritime.eu/web/girepam
iAtlantic	Maps and data of deep sea biodiversity in the Atlantic Ocean	Marine spatial planning	https://www.iatlantic.eu/
LIFE21-IPN-BE-B4B LIFE	Implementation of regional Prioritised Action Frameworks and the Belgian Marine Strategy - Natura 2000 objectives	Biodiversity management	Yes, Protect and restore marine biodiversity
LIFE21-NAT-IT-LIFE DREAM	Active and passive intervantions for mitigating the anthropic pressure on deep sensitive habitats	Spatial planning and restoration	website
MARBEFES	A set of ecological, economic and socio-cultural valuation tools for marine biodiversity status	Ecosystem based management	https://marbefes.eu/
MarinePlan	Develop Decision Support System (DSS) for ecosystem-based maritime spatial planning (EB-MSP)	Spatial planning	https://www.marineplan.eu
Marine SABRES	Socio ecological systems to support ecosystem based managment in three case studies	Ecosystem based management	https://www.marinesabres.eu/
MarPAMM	Models to support MPA management plans	MPA management	https://www.mpa-management.eu/
MERCES	Assessment of restoration practises for degraded marine habitats	Habitat restoration	http://www.merces-project.eu/

Project acronym	Description of result	Application	Link to the result
MISSION ATLANTIC	Implementation of integrated ecosystem assessments across Atlantic regions	Ecosystem based managment	https://missionatlantic.eu/
NECCTON	Enable the European Copernicus Marine Service to deliver products that inform marine biodiversity and food resources management	Ecosystem based management	https://neccton.eu/
OBAMA-NEXT	Integrating technologies for marine biodiversity monitoring	MPA design and management	https://obama-next.eu/
OCEAN CITIZEN	Ecoengineering interventions for marine habitat restorations across scales	Marine spatial planning	Yes, Protect and restore
SMARTLAGOON	Digital twin of the socio-environmental system of a coastal lagoon in Spain	Ecosystem based management	https://www.smartlagoon.eu/

4.3.2. Fostering the uptake of solutions

All projects are concerned with advancing knowledge on different ecological processes and biodiversity characteristics and have a significant level of interactions with policy makers, ecosystem managers, industry, citizens, and local stakeholders. Specific good practices and innovative solutions (technological, social, business, governance) have been identified that could be scaled and transferred across EU seas and beyond.

Decision support systems and tools are delivered for e.g. ecosystem-based maritime spatial planning (MarinePlan), restoring and monitoring multiple coastal habitats (CLIMAREST), minimizing human pressures (GES4SEAS), managing ecosystem services and societal benefits (ACTNOW), performing vulnerability assessments and tradeoffs of Nature-Based Solutions (FutureMARES), scaling-up solutions for the implementation of Ecosystem Based Management (Marine SABRES) at regional scale (BRIDGE-BS) and the whole Atlantic Ocean (MISSION ATLANTIC, iAtlantic). Specifically, MISSION ATLANTIC aims to identify the most important risk factors influencing sustainable development in the Atlantic Ocean by developing and systematically applying Integrated Ecosystem Assessments (IEAs) at basin and regional scales, an approach clearly scalable in all EU seas and beyond. Of particular interest is the approach followed in MARBEFES which aims to develop a set of ecological, economic and socio-cultural valuation tools to enhance policy and governance. The tools are used to value different natural capital resources and inform planning from financial allocations to management and with monetary and non-monetary benefits.

Demonstrations of large-scale restoration projects are performed targeting different species, habitats and regions, e.g., Marine Deep Reefs (LIFE DREAM), degraded marine habitats (MERCES), marine forest organisms (OCEAN CITIZEN), coastal communities vulnerable to sea level rise (A-AAgora). The solutions provided are generally scalable across different EU regions and beyond. In particular, OCEAN CITIZEN delivers an approach to marine restoration that combines conservation and restoration with local citizen involvement and socio-economic benefits. The project targets the restoration of the most neglected marine biome, encompassing different types of Marine Forest (MF) organisms, including sponges, corals, and seaweeds and also introduces the definition of a new profession of "gardeners of the sea" as a novel approach to carbon sequestration.

Technology advances include a suite of technologies, protocols, and models investigated in the projects. They are aimed at exploring and understanding the richness and functioning of marine life across multiple spatial and temporal scales, from pre-industrial to present day (BIOcean5D), but also to enable monitoring of marine ecosystem, using remote sensing, eDNA, and citizen science (OBAMA-NEXT), and digital models of lagoon systems (SMARTLAGOONS), as well as models and tools to enable the European Copernicus Marine Service to provide new products that inform marine biodiversity conservation and food resources management (NECTON). Interestingly, the project ANERIS aims to develop new scientific instrumentation tools and methods for sensing marine life using genomics, imaging-biooptics, and participatory sciences. The project proposes the concept of Operational Marine Biology, a biodiversity information system for routine measurements of ocean and coastal life.

Of the different nature-based solutions investigated in several projects it is of interest the methods for the design, implementation and management of Marine Protected Areas. The Marine Protected Areas Management and Monitoring project (MarPAMM) aims to develop and implement six management plans for Marine Protected Areas (MPAs), using four models designed to support conservation of habitats and species. The models include mobile species models (seabirds and seals), a seabed-dwelling species and habitats model, and a coastal processes model. GIREPAM aims to develop a shared cross-border strategy for the

integrated management of coastal marine areas by regions and managers of bordering protected areas. It seeks to improve governance and management, stop loss of biodiversity and degradation of ecosystem services, and adhere to a green and blue EU economic development perspective.

Of significant interest for scalability are the approaches followed in the BESTLIFE2030 project that is a financing facility coordinated by IUCN that aims to support applicants and grantees in implementing projects that ensure impact on the ground and demonstrate the commitment of the EU Overseas towards regional and international biodiversity and sustainable development strategies. The project aims to contribute to the achievement of the post-2020 Global Biodiversity Framework to be adopted at the CBD COP 15. While the B4B project aims to protect and restore biodiversity in Belgium by implementing regional Prioritised Action Frameworks and the Belgian Marine Strategy. The project will be carried out by all authorities in charge of Natura 2000 policy in Belgium to enable biodiversity restoration and a transformative Change with many stakeholders involved and thus the support of several horizontal measures (capacity building, communicating towards stakeholders, branding, etc.).

4.4. Policy recomendations

Based on the challenges outlined in the summary and the current trends, future research in marine and coastal biodiversity conservation should prioritise several areas.

Advance understanding of the impacts of global changes on biodiversity.

Climate and other social and economic changes have severe direct and indirect implications for marine biodiversity, including impacts on the functioning of marine ecosystems and the critical goods and services they provided, changes in community structures, contraction and expansion of habitat ranges, alteration of the mode, tempo and behaviour of several taxonomic groups, increasing rates of biodiversity loss. Research should focus on understanding these impacts by developing new theories integrating social, economic and ecological dimensions and including practically applications to ensure effective mitigation, adaptation and restoration strategies. Models and methods should include impacts under a multiple stressors framework, developing smart mitigation strategies, and identifying areas and ecosystem components that are particularly vulnerable to climate induced changes with priority given to marine biodiversity hotspots, high sea and vulnerable marine ecosystems. Potential barriers are represented by increased fragmentation and the lack of cooperative policy and international governance schemes to work across meaningful ocean regions (e.g., Black Sea, Mediterranean, North Sea, Atlantic, Arctic).

Develop tools and techniques for the effective monitoring and assessment of marine and coastal biodiversity, including a network of European marine biodiversity observatories

This includes developing new technologies and methods leveraging on remote sensing and in situ automation and robotics, as well as broadband acoustic, optical imaging and genetic techniques to properly identify species and track populations both in coastal regions and in the high seas. Solutions should be cost effective and scalable to enable distribute monitoring on a global scale including developing countries. A network of sustained marine biodiversity observatories to understand our changing oceans and to implement management strategies able to adpat to evolving scenarios. Data collected should be delivered following agreed standards to ensure FAIR principles. New AI technologies to facilitate digital transformation should be exploited including observation

based Digital Ocean Twin. The observing systems should help identify areas of high biodiversity, monitor changes over time, including migrations, and identify threats to marine ecosystems. Specific gaps exist on methods to properly assess large scale horizontal and vertical movements of the species and their effects in the transfer of energy and biomass across different ocean regions. For example, to quantify the role of the mesopelagic community in carbon sequestration. Possible barriers are the access to technology components given the present market conditions, we well as the lack of clear legislative schemes for unmanned operations which are required to boost automation and robotics in the marine environment.

Develop new approaches to marine conservation and management that incorporate the needs and perspectives of local communities.

This includes using co-management approaches that involve local communities in decision-making and management, and recognizing the importance of cultural values and practices in marine conservation. Research should focus on promoting inclusive approaches like Integrated Ecosystem Assessment methods to increase the transparency of the scientific process and promote acceptance of the stakeholders. The methods should contribute to the ocean transformation around sustainable solutions and bring together social scientists, policy makers, marine and biodiversity researchers to promote global sustainable models for the protection and restoration of the ocean commons. Possible barriers are the difficulty in the ethical engagment with local communities and decision makers given the lack of long-term fora to support the needed dialogue at local scales.

Identify and address the major drivers of biodiversity loss in coastal and marine ecosystems, including unmanaged fishing, habitat destruction, pollution, introduction of alien species, and extreme events.

Research should provide a more detailed understanding of these drivers and their impacts across the entire ecosystem from local to global scales. The approach should include the development of effective policies and strategies for the sustainable management of fisheries and other extractive industries, protecting critical habitats, reducing pollution from land-based sources and mitigating the effects of alien species and extreme events in coastal regions. The goal should be to maximize ecosystem service provision for the future generations. Possible barrier is the lack of culture in certain sectors for long term goals given the general preference for short term profits.

Improve the effectiveness of marine protected areas (MPAs).

While MPAs are an important tool for conserving marine biodiversity, they can be ineffective if they are poorly designed or managed. Future research should focus on identifying the key factors that make MPAs effective, including size, location, and management practices, and developing best practices for MPA design and management for example leveraging on digital ocean representations (e.g., Digital Ocean Twin). Those tools should be demonstrated in all EU seas and beyond with focus on hot spots of marine biodiversity. The methods should directly include the connectivity of the MPA to other regions given organisms transport and migrations. Possible barriers are the difficult interactions between science-based versus opportunistic protection strategies given the natural, economic and societal tradeoffs influencing design and implementaion of MPAs. Additional significat technolgoy barriers could be face for high sea MPAs.

Understand the changes in marine megafauna ecology and assess the services provided to our societies.

Research should be performed to increase our understanding of how megafauna biodiversity is affected by climate change and how food webs and biogeochemical cycles are controlled at different scales by their biomass and migratory behaviour. Protecting the role of charismatic species in our oceans will not only accommodate public expectations but also benefit our societies, preserving our cultural heritage, reducing risks oof pathogen spreading and creating opportunities for more jobs to improve the connections between humans and nature. Possible barriers is the lack of accurate data and the limited access of several players in access to suitable tracking technology.

As already described in detail under section 4.3 (and the Table 4.2 therein), several projects have contributed to specific elements within the priorities mentioned above.

The theoretical models developed in BioOcean5D, the socio ecological toolboxes used in MARBEFES, FutureMARES and CLIMAREST, the decision support systems in Marine Sabres and MarinePlan could be combined with the demonstrations of restoration procedures as in OCEAN CITIZEN, A-AAgora and MERCES to advance on priority 1. The technology, sensors and tools developed and demonstrated in OBAMA-NEXT, NECCTON, ANERIS, ACTNOW, and partially in BRIDGE-BS and MISSION ATLANTIC, could provide a best practises to advance on new ocean monitoring systems under priority 2. The integrated Ecosystem Assessment methods used in some projects (i.e., ACTNOW, MISSION ATLANTIC, GES4SEAS, and partially in iATLANTIC) should be used to advance on priority 3 ensuring the engagement of local communities. The approach developed in MISSION ATLANTIC, GES4SEAS and ACTNOW will ensure that no pressures or ecosystem components are excluded from the integrated analyses, hence could also contribute to advance on priority 4 once scaled up to regional and global scales and including diverse ecosystem goods and services. The tools and methods used in MarPAMM, GIREPAM, SMATLAGOON and LIFE DREAM could be expanded to include indicators and models such as those developed in MarinePlan, BRIDGE-BS, and ACTNOW to improve the management of MPAs as for priority 5. Few projects have contributed so far to address priority 6 altough some results under ACTNOW and BioOCEAN5D will address marine species at the top of the food chains (e.g. tuna, swordfish, etc.).

Strategies and synergies

The research priorities above should be aligned with objectives of the Kunming-Montreal Global Biodiversity Framework to identify coordinated actions between ocean and land, and to facilitate engagement with business and financial institutions, with focus on Specific, Measurable, Ambitious, Realistic and Timebound (SMART) targets. This should include: (i) access to data to provide baselines, develop targets and monitor progress; (ii) accurate monitoring of the impacts across the land-ocean interface; (iii) facilitate responsible consumption of marine and land resources; (iv) promote and facilitate compliance by mitigating technology, legislative and governance barriers.

New technologies for underwater biodiversity observations are needed as a major enabler for reaching biodiversity goals and priorities. Observations should come from cost-effective solutions to guarantee scalability across global ocean regions. A European network of sustained marine observatories is strongly recommended for all European regional seas to boost innovation across different dimensions including science, society and economy. Indeed, the critical biodiversity data is needed not only for research but to

enable informed decision-making in areas such as fishery and fisheries management, marine conservation, coastal development, aquaculture, marine renewable energy and transport. Additionally, the development of such technologies can stimulate innovation and entrepreneurship, creating new opportunities for economic growth in the blue economy, improving the competitiveness of the European industry in the global market. By investing in research and development of underwater biodiversity observation technology, we can drive sustainable growth and innovation while also safeguarding our oceans for future generations. Linking R&D, and R&I with regional research and innovation funding instruments (e.g., the partnerships, Interreg, I3, COSME) and a better alignment with ESA research programs could stimulate research synergies and achieve the critical funding needed to set ambitious projects on ocean observation technologies.

Similarly, a strategic alignment between specific actions such as ERC, MSCA and RIA would be needed to develop the capacity to develop and use new ocean technologies across the entire data value chain of collecting, storing, processing, analyzing, and ultimately using data. In this regard important enablers are both the digital ocean infrastructure and a large scale societal engagement initiaitve. While the former has a clear pathway for development (Digital Ocean Twin, EMODNET, COPERNICUS) the latter is still not clearly defined within the Mission Ocean framework. New ideas and renewed initiatives (such as the All Atlantic Research and Innovation Alliance), can clearly contribute to fill this gap. Additionally, initiatives promoting the transfer of data into ecosystem assessments and decision support tools for biodiversity management are numerous but fragmented. Exploiting synergies between different funding instruments could harmonize the biodiversity data value chain delivering knowledge and information to derive value for organizations, individuals and for the collective benefit.

Finally, it is noted that several of the project analysed have overlapping research questions (see section 4.3 above) and will run during a similar timeframe. It is advised that projects identify synergies to avoid duplications. It is also strongly reccomended that at the end of the period a dedicated support action is established to assess research results and commonly identify best practises and future directions to harmonize biodiversity monitoring and management in EU waters and seas.

4.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
2019-EU-IA-0115	-	CEF	CEF-TC
813360	4D_REEF	H2020	MSCA
101004221	4S	H2020	IA
101093956	**A-AAgora**	**HORIZON**	**HORIZON-IA**
818395	AANChOR	H2020	CSA
101060072	**ACTNOW**	**HORIZON**	**HORIZON-RIA**
101056844	ALFAwetlands	HORIZON	HORIZON-RIA
19791	ANDIKAT	Interreg	ERDF
101094924	**ANERIS**	**HORIZON**	**HORIZON-RIA**

652677	AORAC-SA	H2020	CSA
642197	AQUAINVAD-ED	H2020	MSCA
678760	ATLAS	H2020	RIA
817574	BANOS CSA	H2020	CSA
101096887	**BESTLIFE2030**	**LIFE2027**	**LIFE-PJG**
101059492	BGE	HORIZON	HORIZON-RIA
101059915	**BIOcean5D**	**HORIZON**	**HORIZON-RIA**
642420	BiodivERsA3	H2020	ERA-NET-Cofund
101082008	BIOTRAILS	HORIZON	HORIZON-RIA
860055	Black Sea CONNECT	H2020	CSA
101094014	BLUE4ALL	HORIZON	HORIZON-IA
101057764	BlueAdapt	HORIZON	HORIZON-RIA
666773	BlueHealth	H2020	RIA
727453	BLUEMED	H2020	CSA
101093962	BlueMissionAA	HORIZON	HORIZON-CSA
101082304	BlueRemediomics	HORIZON	HORIZON-RIA
101079995	BoSS	HORIZON	HORIZON-CSA
101000240	**BRIDGE-BS**	**H2020**	**RIA**
101059823	B-USEFUL	HORIZON	HORIZON-RIA
678193	CERES	H2020	RIA
101093865	**CLIMAREST**	**HORIZON**	**HORIZON-IA**
677039	ClimeFish	H2020	RIA
679812	CLOCK	H2020	ERC
101050331	COASTHazar	ERASMUS2027	ERASMUS-EMJM-UN
22840	Co-Evolve4BG	Interreg	ENPI/ENI
820989	COMFORT	H2020	RIA
20739	COMPASS	Interreg	ERDF
948476	CoralStem	H2020	ERC
101060958	CrossGov	HORIZON	HORIZON-RIA
863529	CTP	EMFF	EMFF-AG
101093985	DANUBE4all	HORIZON	HORIZON-IA
739562	DANUBIUS-PP	H2020	CSA
101016958	DeeperSense	H2020	RIA

633680	DiscardLess	H2020	RIA
101000518	DOORS	H2020	RIA
101093908	EcoDaLLi	HORIZON	HORIZON-CSA
641762	ECOPOTENTIAL	H2020	RIA
101000302	EcoScope	H2020	RIA
869383	ECOTIP	H2020	RIA
101101473	EDITO-Infra	HORIZON	HORIZON-IA
101093293	EDITO-Model Lab	HORIZON	HORIZON-IA
871126	eLTER PPP	H2020	CSA
731036	EMSO-Link	H2020	CSA
101035797	eMSP NBSR	EMFF	EMFF-AG
765515	ENSYSTRA	H2020	MSCA
{"text":"951088"}	ETGG2030	COSME	COSME-GA
862626	EuroSea	H2020	IA
869154	FACE-IT	H2020	RIA
101060879	Fish-X	HORIZON	HORIZON-IA
870465	FORCOAST	H2020	IA
869300	**FutureMARES**	**H2020**	**RIA**
101059877	**GES4SEAS**	**HORIZON**	**HORIZON-RIA**
17693	**GIREPAM**	**Interreg**	**ERDF**
101039532	GLOBCOADEV	HORIZON	HORIZON-ERC
101056921	GreenFeedBack	HORIZON	HORIZON-RIA
818123	**iAtlantic**	**H2020**	**RIA**
101058625	iMagine	HORIZON	HORIZON-RIA
17670	IMPACT	Interreg	ERDF
101061083	Invest4Nature	HORIZON	HORIZON-RIA
101058960	LIFE21 FPA/AT/WWF-CEE	LIFE2027	LIFE-FPA-OG
101058121	LIFE21 FPA/BE/SAR	LIFE2027	LIFE-FPA-OG
101058920	LIFE21 FPA/BE/WWF EPO	LIFE2027	LIFE-FPA-OG
101058918	LIFE21 FPA/DE/RGI	LIFE2027	LIFE-FPA-OG
101056522	LIFE21 FPA/FR/MedPAN	LIFE2027	LIFE-FPA-OG
101058916	LIFE21 FPA/FR/SFE	LIFE2027	LIFE-FPA-OG
101057743	LIFE21 FPA/SE/CCB	LIFE2027	LIFE-FPA-OG
101058915	LIFE21 NGO/BE/WWF EPO	LIFE2027	LIFE-FPA-OG

101059073	LIFE21 NGO/DE/RGI	LIFE2027	LIFE-FPA-OG
101058993	LIFE21 NGO/FR/MedPAN	LIFE2027	LIFE-FPA-OG
101058839	LIFE21 NGO/NL/SBE	LIFE2027	LIFE-FPA-OG
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101069566	LIFE21-IPC-EE-LIFE-SIP AdaptEst	LIFE2027	LIFE-PJG
101069526	**LIFE21-IPN-BE-B4B LIFE**	**LIFE2027**	**LIFE-PJG**
101074422	LIFE21-NAT-DK-COASTal LIFE	LIFE2027	LIFE-PJG
101074453	LIFE21-NAT-EE-urbanLIFEcircles	LIFE2027	LIFE-PJG
101070722	LIFE21-NAT-FR-LIFE-SEADETECT	LIFE2027	LIFE-PJG
101074547	**LIFE21-NAT-IT-LIFE DREAM**	**LIFE2027**	**LIFE-PJG**
101074584	LIFE21-NAT-IT-LIFE TURTLENEST	LIFE2027	LIFE-PJG
101074309	LIFE21-NAT-IT-REEForest	LIFE2027	LIFE-PJG
101111969	LIFE22 NGO/BE/SAR	LIFE2027	LIFE-FPA-OG
101112025	LIFE22 NGO-BE-WWF EPO	LIFE2027	LIFE-FPA-OG
101104287	LIFE22 NGO-FR-MedPAN	LIFE2027	LIFE-FPA-OG
101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
101112150	LIFE22-NGO-DE-RGI	LIFE2027	LIFE-FPA-OG
LIFE15 IPE/ES/000012	LIFE-IP INTEMARES	LIFE	LIFE-ENV
970972	Living Ports	H2020	IA
869710	MaCoBioS	H2020	RIA
101060937	**MARBEFES**	**HORIZON**	**HORIZON-RIA**
101082021	MARCO-BOLO	HORIZON	HORIZON-RIA
101100771	MAREGRAPH	DIGITAL	DIGITAL-SIMPLE
710708	Marine Mammals	H2020	CSA
101058956	**Marine SABRES**	**HORIZON**	**HORIZON-IA**
101059407	**MarinePlan**	**HORIZON**	**HORIZON-RIA**
804599	MARIPOLDATA	H2020	ERC
854088	MARIX	H2020	ERC
675997	MARmaED	H2020	MSCA
20750	**MarPAMM**	**Interreg**	**ERDF**
22871	MED4EBM	Interreg	ENPI/ENI
689518	**MERCES**	**H2020**	**RIA**
101002721	MERMAID	H2020	ERC

862428	**MISSION ATLANTIC**	**H2020**	**RIA**
101059988	MPA Europe	HORIZON	HORIZON-RIA
19133	MPA-ADAPT	Interreg	ERDF
101060707	MSP4BIO	HORIZON	HORIZON-RIA
101081314	MSP-GREEN	EMFAF	EMFAF-PJG
887390	MSPMED	EMFF	EMFF-AG
101035822	MSP-OR	EMFF	EMFF-AG
101081273	**NECCTON**	**HORIZON**	**HORIZON-RIA**
101081642	**OBAMA-NEXT**	**HORIZON**	**HORIZON-RIA**
101093910	**OCEAN CITIZEN**	**HORIZON**	**HORIZON-IA**
883583	OCEAN DEOXYFISH	H2020	ERC
869357	OceanNETs	H2020	RIA
727277	ODYSSEA	H2020	RIA
21402	PlasticBusters MPAs	Interreg	ERDF;IPA/IPAII
101056957	PREP4BLUE	HORIZON	HORIZON-CSA
18988	RECONNECT	Interreg	ERDF;IPA/IPAII
101081219	REGINA-MSP	EMFAF	EMFAF-PJG
809988	RENATURE	H2020	CSA
101093968	RESIST	HORIZON	HORIZON-IA
652643	Respon-SEA-ble	H2020	CSA
101037097	REST-COAST	H2020	IA
101056782	RESTORE4Cs	HORIZON	HORIZON-RIA
21692	SARCC	Interreg	ERDF
101006443	SATURN	H2020	RIA
101086379	SBEP	HORIZON	HORIZON-COFUND
101082311	SDGs-EYES	HORIZON	HORIZON-RIA
856488	SEACHANGE	H2020	ERC
730960	SeaDataCloud	H2020	RIA
101060415	SELINA	HORIZON	HORIZON-RIA
101017861	**SMARTLAGOON**	**H2020**	**RIA**
774567	SOPHIE	H2020	CSA
679849	SponGES	H2020	RIA
101094649	STRAITS	HORIZON	HORIZON-RIA

826469	SUST-BLACK	H2020	CSA
730338	ThinkNature	H2020	CSA
817911	TRADITION	H2020	ERC
24029	TRETAMARA	Interreg	ERDF
817578	TRIATLAS	H2020	RIA
101091959	TRIDENT	HORIZON	HORIZON-RIA
862915	UNITED	H2020	IA
101004186	Water-ForCE	H2020	CSA
101036484	WaterLANDS	H2020	IA

5. Protect and restore marine and freshwater ecosystems and biodiversity. *By Isabel Sousa Pinto*

5.1. Main findings of the analysis

Number of initial projects included in the analysis: 300, from these 86 projects selected as relevant for freshwater biodiversity and ecosystems (see list of relevant projects in section 5.5); final number of relevant projects selected for further analysis: 24 (projects highlighted in blue and bold in section 5.5).

Total budget of the 86 selected projects: € 421,1 million; EC contribution: € 218,3 million.

Thematic areas covered: Rivers and streams, Lakes and ponds, Wetlands and peatlands, Urban freshwaters, Freshwater ecosystem (not specified), and Others (not specified).

Levers of Change: Governance, Finance & Economy, R&I, Knowledge & Data Deployment, Citizen Engagement, Education & Training

Main outcomes (mostly expected):

- Tested management tools for dams to account for ecosystem and biodiversity protection and energy production (and other water uses)

- Restoration and protection of freshwater ecosystems across Europe: a) Wetlands, b) Rivers, c) Lakes & ponds

- Enlarged and/or improved protected areas that include freshwater ecosystems and biodiversity across Europe

- Implementation of Digital portals or platforms to centralize information and make available relevant environmental information for many different purposes but mainly for better management of water and of freshwater ecosystems.

- Production of free and open scientific dissemination materials

- Campaigns and actions to raise awareness of the public regarding the importance of freshwater biodiversity and ecosystems and needed conservation and management measures: a) as a part of a specific project, b) advocacy by established organisations

- Collaboration in funding between EC and Member states for biodiversity and ecosystem services, including freshwater.

Policy recommendations:

- Working and collaborating closely with stakeholders to establish alliances and cooperation. Development of methods, platforms and good practices to explore different political, social, cultural and economic contexts, national experiences and organisation of society in different countries.

- Co-creation of research and solutions with all the relevant stakeholders. Raise awareness and incentivize non-scientists to invest time in these exercises of co-designing the

questions and the research to address them, as soon as possible (e.g. during the writing of the proposals). Devise strategies to counteract stakeholder fatigue.

- Dissemination of results and best practices to the different sectors of society to create awareness, influence behaviour, increase support for the existing policies and legislation and increase their implementation.

- Provide messages in an adequate and “attractive” language (e.g. posters, infographics, social media communications, tv-interviews, and school interventions) to engage the different sectors of society. Develop initiatives for education and training in environmental issues, policies and existing legislation relevant to freshwater ecosystems and options for their implementation.

- Increase attention to the freshwater part of biodiversity and ecosystems in the funded and new coordination actions of the Mission Ocean and waters, which often focus mainly in the marine part.

- Reinforce the investment in projects and initiatives that focus on freshwater biodiversity and ecosystems including their link to the marine environment to reinforce the research on the continuum of freshwater-coastal-marine ecosystems. And in the Nexus (intensive) agriculture – urbanization - energy production - biodiversity and climate change to support adequate freshwater management, adaptation and increasingly difficult decision making.

- Increase the importance of coordination and cooperation between projects and initiatives, having umbrella programs and online tools to support this cooperation, and value joint work over the metrics of individual project accomplishments to really promote cooperation.

5.2. Description of the portfolio

5.2.1. Description of the portfolio of projects flagged as relevant

- Projects relevant to the Mission’s objectives and Green Deal targets

The "Restore our Ocean and Waters" EU Mission aims to safeguard and rehabilitate the health of the ocean and waters through research and innovation, blue investments, and citizen involvement. It intends to take a new approach that treats the ocean and waters as a continuous entity. One of the Mission's primary goals is to help conserve and restore aquatic biodiversity and ecosystems, with several targets for the year 2030 in line with the EU Biodiversity Strategy 2030. The initiative promotes regional cooperation and engagement through "lighthouses" situated in significant sea and river basins, namely the Atlantic-Arctic, Mediterranean Sea, Baltic-North Sea, and Danube-Black Sea. These lighthouses serve as test sites to showcase, develop, and implement the Mission's activities across the EU's river basins and seas.

Keeping in mind these specific objectives of the Mission, a total number of 300 projects previously selected were reviewed within our portfolio, and only 86 were deemed relevant to be included under the scope of this freshwater biodiversity analysis, even if many didn’t focused only on freshwater biodiversity.

The most common reason for excluding projects from the initial 300 was that they were focused on other ecosystems than freshwater. Falling in this category, the great majority were linked to the study of marine and coastal ecosystems only. But other were only terrestrial

or focusing on agriculture or other activity without an acknowledged link to freshwater biodiversity.

Sometimes, it was difficult to draw a line to separate which projects were relevant for this analysis, and which were not. Particularly, when the project addressed the thematic area (T.A.) “Urban freshwater and “Nature-Based Solutions (NBS) & (Urban) Restoration”, since even if they didn’t refer to biodiversity or ecosystems the actions foreseen would certainly be relevant for their health. But unless this link was explicitly made in the project it was not considered for this analysis. For instance, when a project’s main objective was to implement a hydraulic dam or hydraulic energy power station along the course of a river, it was only included as relevant within the freshwater biodiversity and ecosystem’s scope when the actions and reasoning available on the project’s descriptions indicated explicitly that: a) the protection of local/regional biodiversity was going to be taken into account in the implementation of the project, e.g. by including a fish passage or ladder in the hydroelectric dam system; or b) take the ecosystem’s needs in consideration for water/energy production management; or c) determine the impact of the actions of the proposed actions in the freshwater biodiversity or ecosystems).

- Distribution of projects according to programmes

The 86 projects flagged as relevant fell into five different types of funds: Horizon2020 (31 projects), Life2027 (26 projects), HorizonEU (21 projects), Interreg (7 projects), and Eurostat (1 project) (Figure 5.1a).

The total EC contribution for the entire group of projects was € 488.2 million, distributed in this way according to the different funding programmes: Horizon2020 (€ 229.9 million), Horizon EU (€ 131.5 million), Life2027 (€ 121.8 million), Interreg (€ 4.9 million), Eurostat (€ 0.2 million) (Figure 5.1b).

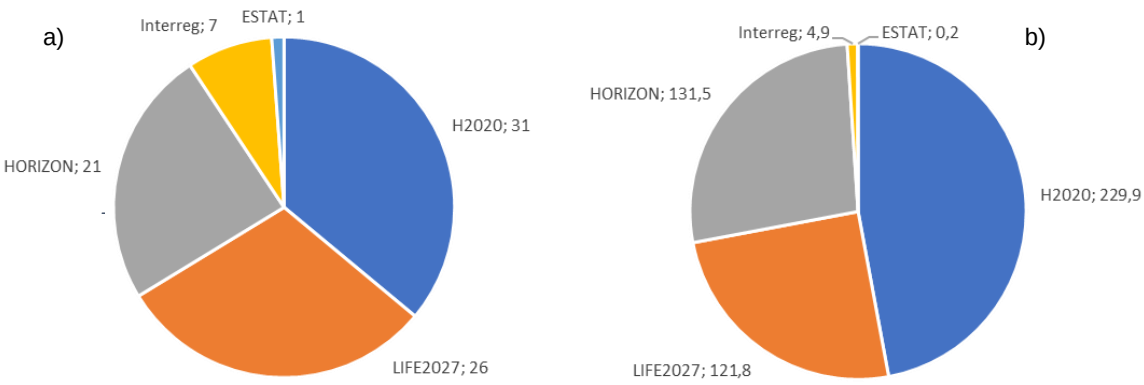


Figure 5.1. a) number of projects per EU funding programme (total number of projects: 86) and b) EC contribution (M€) per funding programme (total EC contribution: 488,2 M€)

- Distribution of projects according to type of action

Analysing the portfolio according to the type of action funded, it can be observed that the two LIFE programs, the Operating Grant Framework Partnership Agreements (Life-FPA OG) and Life Project Grants (Life-PJG) supported the largest number of projects (13 each). Research and Innovation Actions in Horizon 2020 (RIA) and Horizon EU (Horizon-RIA) followed with 12 and 11 projects, respectively (Figure 5.2a).

In terms of funding, Life-PJG was the action that received the highest contribution from the EC (€ 118 million), followed by Horizon2020-RIA (€ 90.9 million), Horizon2020-Innovation Action (IA; € 75.7 million), and Horizon EU-RIA (€ 60.6 million) (Figure 5.2b).

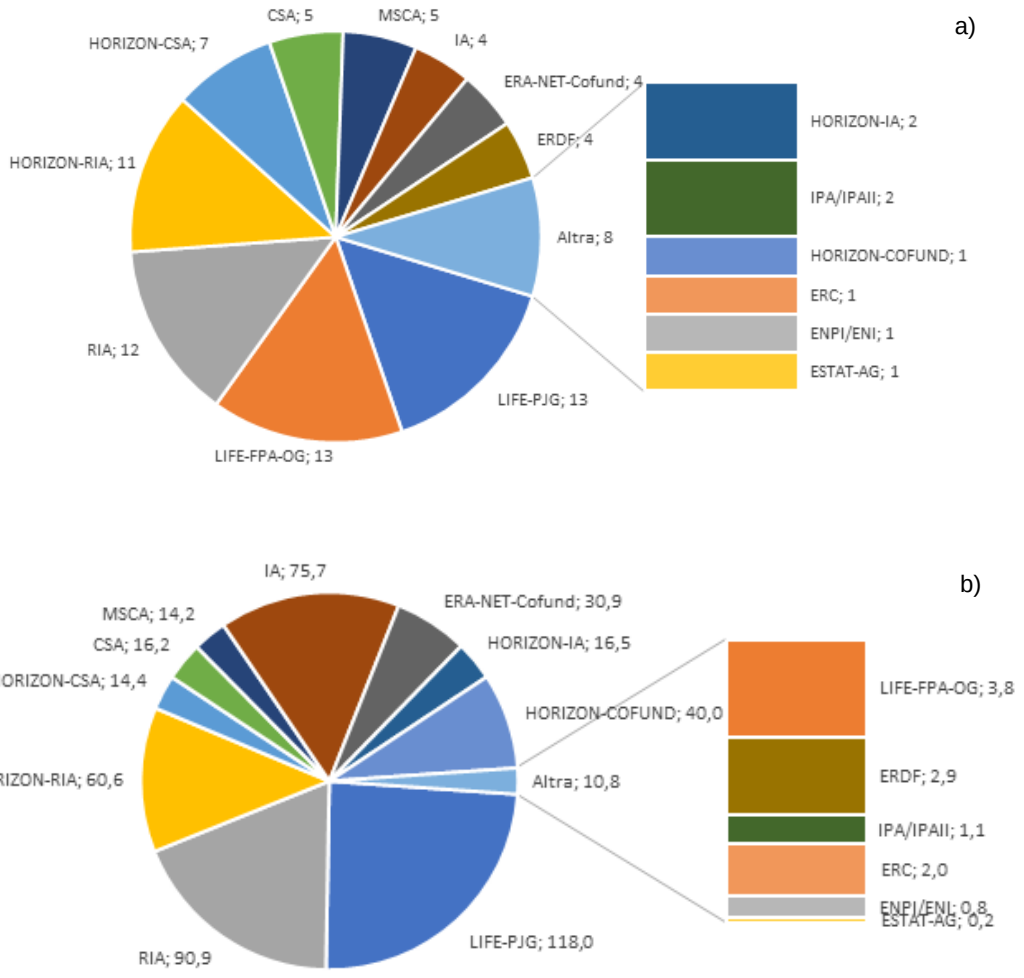


Figure 5.2. a) Number of projects per type of action (total number of projects: 86) and b) EC contribution (M€) per type of action (total EC contribution: 488.2 M€)

- Distribution of projects according to main thematic areas

Six main thematic areas (T.A.) were defined for the analysis, mainly classified by the ecosystem the projects focused on: a) “Rivers and streams”, b) “Lakes and ponds”, c) “Wetlands and peatlands”, 4) “Urban freshwater”, when the ecosystems were in urban areas “Several freshwater ecosystems (not specified)” when several ecosystems were mentioned in the project and there was no clear focus in any of the previous TAs, and “Others (not specified)” when no specific ecosystems where mentioned.

From the analysis of the 86 projects present in the portfolio, the six thematic areas were addressed 131 times, either as the main target or as part of their scope (some projects address more than one thematic area). “Several freshwater ecosystems (not specified)” was the area with the most references (35), followed by “Rivers and streams” (32). Only 7 references were made to the thematic area “Lake and ponds” (Figure 5.3). This shows that many of the projects didn’t focus on a specific ecosystem and at least in the information we were able to find, they focused on freshwater biodiversity in general or focused in landscapes that included freshwater ecosystems, like the cases of many protected areas.

The relatively stronger focus on rivers (more than lakes and ponds or wetlands) can also reflect the wider importance of the rivers in the European context, their importance for water management and energy production, which is now more pressing with climate change that is decreasing water availability in many European areas. So, the need for adequate tools to manage water use for agriculture, industry, urban, energy production and ecosystem health and the knowledge to make the best choices is becoming increasingly more pressing, especially in rivers. Also, the focus of the mission that has a lighthouse in the Danube Basin, as well as the EU Biodiversity Strategy 2030 target of restoring at least 25000km of free-flowing rivers puts more attention on these ecosystems.

“Wetlands and peatlands”, globally recognized as important carbon sequestrating ecosystems, were fairly represented as well, maybe due to a growing interest of the scientific community and general public in these essential ecosystems that have an important role in buffering the effects of climate change.

Regarding the “Lakes and Ponds” T.A., there were fewer projects focusing on these ecosystems compared to the other Thematic Areas. We considered two possible explanations: a) Firstly, the provided portfolio to be reviewed only included a few projects that explicitly indicated covering these specific ecosystems. But these ecosystems may be present in projects that didn’t specify in the available information what ecosystems they were addressing (e.g. TA “Other - Not specified” and “Several Freshwater Ecosystems - Not specified”). In that case, there might not be a real gap in lake ecosystem research at the EU scale, but rather a lack of freshwater projects focusing specifically on lakes and pond ecosystems. b) Another possibility is that there is indeed a real lack of representativity of the “Lake and ponds” T.A. overall in the portfolio of projects. In this case, this could mean that here is a reduced involvement of the EU in the study of these ecosystems and that this could represent a research gap.

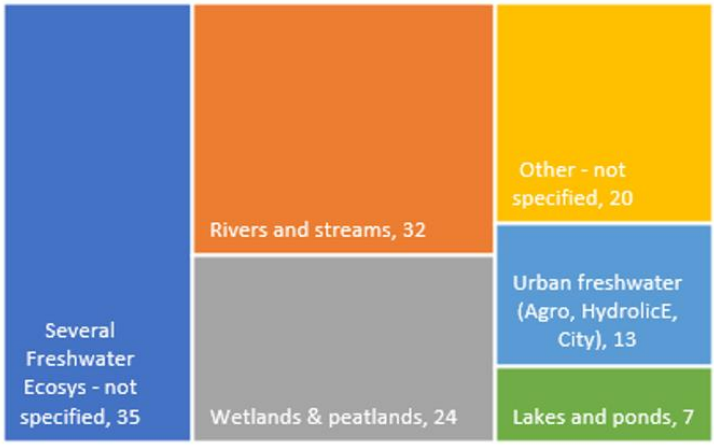


Figure 5.3. Thematic areas and the number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 131. Total number of projects: 86.

- Main focus of the project in terms of Levers of Change

By “Lever of Change (LoC)” is understood as the type of tool targeted by the project to drive (or leverage) change in the desired direction. The different LoCs were plotted against the selected thematic areas (T.A.) in Table 5.1.

The most common Lever of Change identified through the reviewed projects was the Governance aspect, indicating that there is a particularly important focus on projects that aim to improve or implement governance and management tools for/relevant to freshwater systems. This is also explained by the focus of many projects on restoration that involves practical work in the field that involves many institutions and requires sometimes innovative governance structures. During the past decades, several European policies (i.e. EU Green Deal; Water Framework Directive, Biodiversity Strategy, Habitats Directive - Natura 2000) have been adopted with the goal of protecting and improving the quality of Europe's environment and water resources, including rivers, lakes, groundwater, and coastal waters, as well as all biodiversity associated to these ecosystems. Hence, the implementation of enforcement structures and management guidelines is imperative to ensure that the existing EU legislation and environmental requirements and recommendations are duly met.

Other LoCs commonly encountered were the “R&I” (76), “Knowledge & Data” (77) and “Deployment” (76). In particular, the “Knowledge & Data” LoC was often represented within the projects by the intention to create online open-source standardized metadata and information platforms to provide unified European databases and digital tools and platforms (e.g. the ones provided by the scientific partnerships “Water-ForCE”, “BiodivERsA” and the project “NetworkNature”, to name a few). This is a tendency that should continue to be supported: the generation of knowledge and data to support decision-making at all levels: from individual decision-making to all levels of governance. Support should also continue for the development and testing of technical solutions that can be up-scaled in other regions or in other ecosystems. This is the case for many Nature-Based solutions that are being developed and tested.

Another interesting result was that the “Urban freshwater” T.A. was mostly associated with the “Governance and Deployment” LoC which highlighted a significant focus on the

development of technical and applied solutions for the benefit of water use in cities and urban areas while maintaining other uses of freshwater, including functioning ecosystems.

Table 5.1: Lever of Change (LoC) vs. thematic areas (T.A.). Total number of project: 86.

LoC T.A.	Governance	Finance & Economy	R&I	Knowledge & Data	Deployment	Citizen Engagement	Education & Training
Rivers and streams	29	13	19	18	17	0	4
Lakes and ponds	6	2	6	5	3	0	1
Wetlands & peatlands	23	3	7	12	20	2	3
Several Freshwater Ecosys - not specified	28	10	18	21	16	8	4
Urban freshwater	13	8	8	7	10	3	2
Other - not specified	15	9	18	14	10	3	7
Total	114	45	76	77	76	16	21

5.2.2. Description of the portfolio of projects selected for in-depth analysis

- Distribution of the selected projects according to programmes and actions

Throughout the revision process, 24 projects relevant to the Mission's objectives and Green Deal targets related with freshwater biodiversity and ecosystems have been selected for further analysis. The criteria for selection were mainly the interest of the project to the main theme and that the whole group included projects from different sub-themes and different funding programs, although not all themes and funding programs were present in the final selection. Most of the projects examined were from the Horizon EU and Life 2027 programmes (8 projects each), while just two projects were from Interreg programmes (Figure 5.4a). The total budget funded by the European Commission was € 218,3 million, whilst the projects' total funding reached a total amount of € 421,1 million since several received co-funding from national, regional or private funds. The programme that received the highest contribution from the European Commission was Horizon EU (€ 85.6 million), followed by Life2027 (€ 78.3 million), Horizon 2020 (€ 52.2 million) and Interreg (€ 2.2 million) (Figure 5.4b).

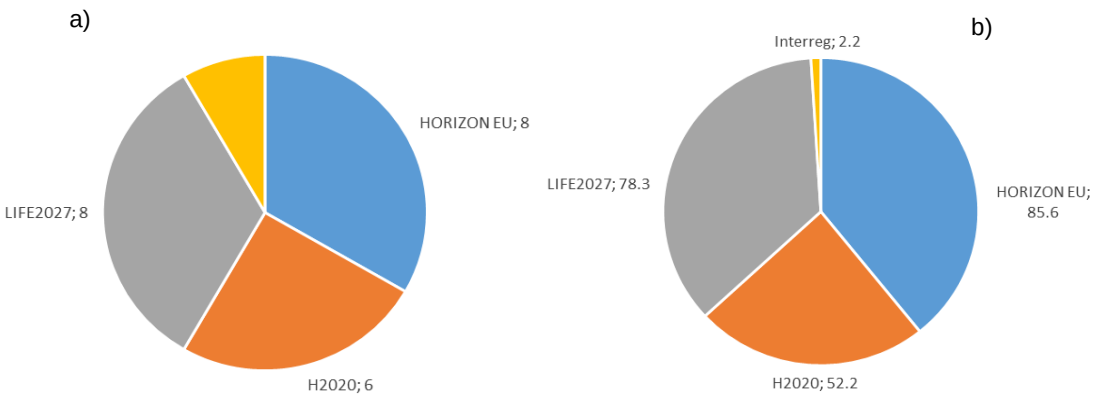


Figure 5.4. a) Number of projects per EU funding programme (total number of projects: 24) and b) EU contribution (M€) per funding programme (total EU contribution: 218.3 M€)

Observing the number of currently active projects per year, a peak can be observed in 2023. During this year, a total of 21 projects will be active. Among them, 9 projects started/will start in 2023, mainly referred to the Horizon EU and Life 2027 funding programmes (Figure 5.5). This indicates a substantial activity of funding in this area in this year that may be (or not) continued in the future. The number of projects in future years will be increased by the funding of new projects but the high number of active projects in 2023 is also the result of many of the selected projects starting this year and the results should be coming out just in the next years.

This made the analysis of outcomes more difficult since the projects are just starting.

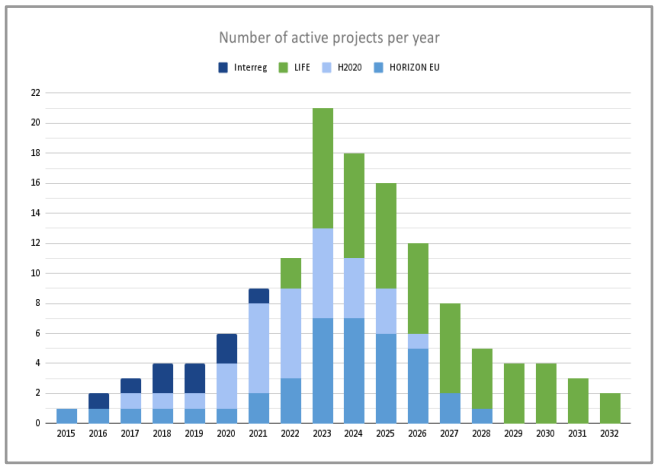


Figure 5.5. Number of active projects per year (2015-2032)

Analysing the final project selection according to the type of action funded, it can be observed that the Life-PJG supported the largest number of projects (6), followed by ERA-NET-Cofund (Horizon2020, 3) (Figure 5.6a). Life-PJG was the action that received the highest contribution from the EC (€ 77.7 million), followed by Horizon-EU COFUND (€ 40 million, Biodiversa+ Partnership), and ERA-NET-Cofund (€ 24.9 million) (Figure 5.6b).

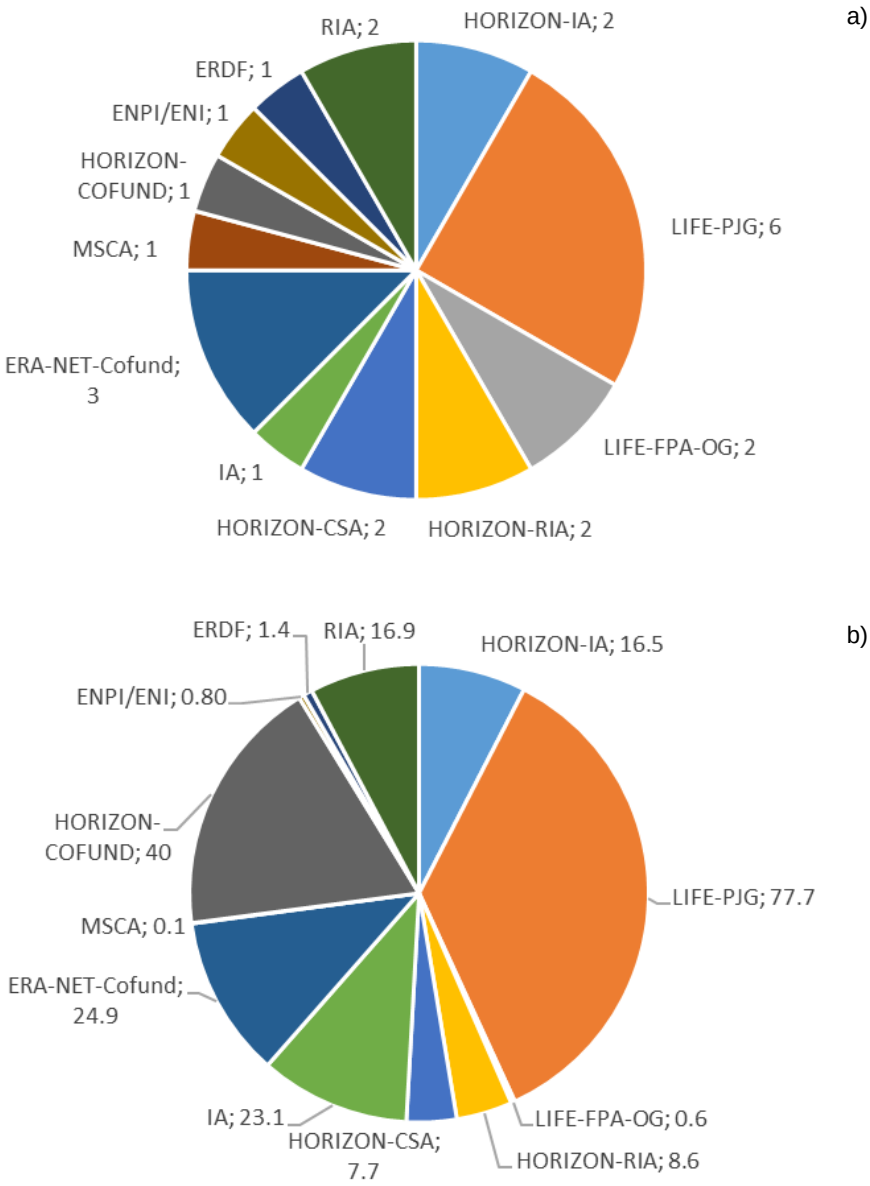


Figure 5.6. a) Number of projects per type of action (total number of projects: 24) and b) EC contribution (M€) per type of action (total EC contribution: 218.3 M€)

- Distribution of projects according to main thematic areas

Among the 24 selected projects, the majority of them referred mainly to the “Rivers and streams” area (10 projects) and the “Freshwater ecosystem – not specified” (9 projects). The thematic area to which the lowest number of projects referred was the “Urban freshwater” (2 projects) (Figure 5.7).

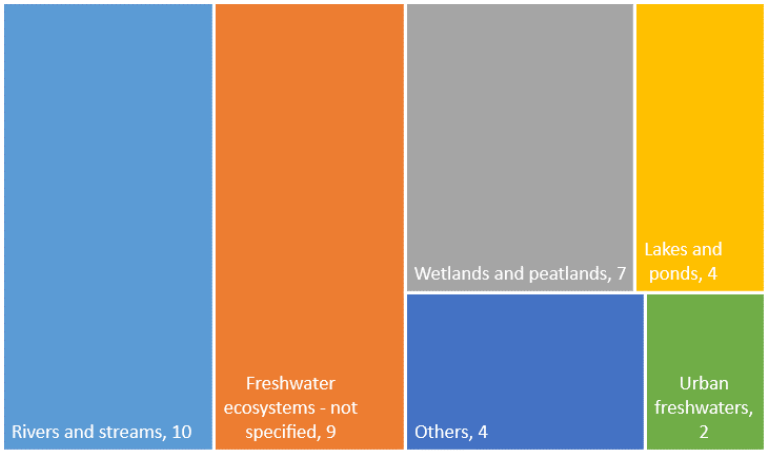


Figure 5.7. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 36. Total number of projects: 24.

Examining the Levers of Change, it was observed that the projects mainly focused on Management & Governance (22 projects) and Deployment (16), only 3 focused on Education & Training and 2 on Citizen Engagement (Table 5.2).

Among the 24 reviewed projects, several aimed at contributing to the objective of the mission to restore 25,000 km of free-flowing rivers being this the goal that many projects mentioned in their objectives. Related to this goal, there is a significant focus on the development of solutions to remove barriers from rivers or to improve water management to decrease its impact on biodiversity. The problem of water management in dams, enhanced by decreasing water flow due to e.g. climate change, leads to hydropower providers having to reduce or even stop energy production, to provide the required residual amount of water in the natural river bed. This decrease in water leads to a loss in energy generation and revenues and additional pressures on the river ecosystem and biodiversity, requiring balanced solutions that are presented and tested in several projects.

A set of projects are working on restoration measures for freshwater ecosystems and will have as major outcomes restored ecosystems, including free-floating rivers (target restoration of 25,000 km of free-flowing rivers until 2030), and test of best practices on engagement with stakeholders and technical solutions that will be then replicated in selected areas and the aim often to scale up their application more widely.

Another relevant set of expected outcomes is platforms to coordinate the activities of protecting and restoring biodiversity at the national or basin scale, bringing together the main stakeholders and the scientific community. This is in line with the design of the Mission that has launched a number of CSAs to coordinate its activities from the overall Mission level to

the lighthouse level. These projects integrate all the objectives of the Mission, although it was found that when specific case studies exist, they usually don't target freshwater ecosystems but only marine and or coastal ones (those projects were not included in the final 24).

Table 5.2. Lever of Change (LoC) vs. thematic areas (T.A.). Total number of project: 24.

LoC/ T.A.	Governance	Finance & Economy	R&I	Knowledge & Data	Deployment	Citizen Engagement	Education & Training
Rivers and streams	10	3	5	7	8	0	1
Lakes and ponds	4	1	3	3	1	0	1
Wetlands & peatlands	7	0	2	4	7	0	1
Several Freshwater Ecosys - not specified	7	3	4	5	5	2	2
Urban freshwater (Agro, HydrolicE, City)	2	1	2	2	2	0	0
Other - not specified	4	3	4	2	2	0	1
Total	34	11	20	23	25	2	6

- Geographical area

Only part (11) of the selected projects were focused on specific river basins. The geographical distribution of these projects was represented in the map below (Figure 5.8). The Danube region was well represented, with four projects referring exclusively to the Danube basin and one more to the Danube-Dnieper basin (3 projects belonging to the Horizon EU and 2 to the Life2027 programmes). The Danube river basin is of extreme international relevance as it is the longest river within the European Union, traversing or touching 10 countries and affecting 9 more through its drainage basin before emptying into the Black sea (2,860km). Is also one of the Lighthouses from the Mission Ocean and Waters and so it to expect calls and projects that focus on this river basin.

The Rhine-Meuse and the Dnieper basins were also well represented, with 2 projects each (2 Life2027 and 2 Interreg projects).

In the remaining 13 selected projects, the geographical area could not be traced back to any specific basin, as they take action in different sites across the European continent. In the case of the Era-NETS and Biodiversa+ several different freshwater biodiversity projects were funded in different parts of Europe but those were not considered in this analysis (only as an outcome of these co-fund activities).

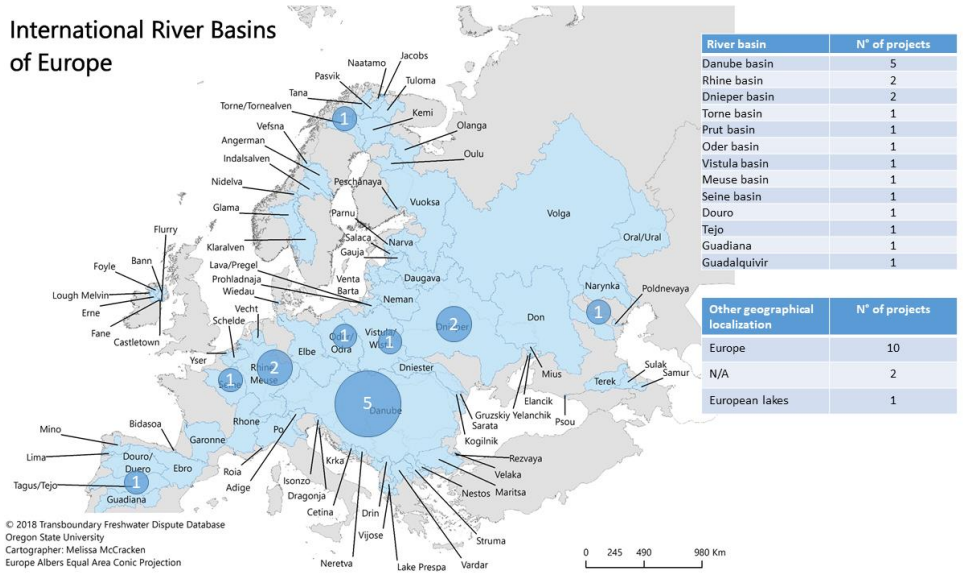


Figure 5.8. Geographical distribution of the selected projects (total number of projects: 24). Some of the projects have a cross-basin approach, taking into consideration more than one basin.

5.3. Main outcomes and fostering the uptake of solutions

5.2.1. Main outcomes

From the 24 projects selected for in-depth analysis, to cover the different themes, project types and funding programs, only three (HydroEcoNex, Grenspark Groot Saeftinghe and BiodivERsA3) are actually concluded and have reported their results. Most of the other projects are just starting and the information available is extremely scarce, thus it was not possible to find details about their work. This made the analysis of main outcomes very challenging, however, here we present the analysis of the intended outcomes for most of the projects, as they appear in the information that is accessible online. Table 5.3 shows a summary of tangible results delivered by these 24 projects.

Classes of outcomes:

1. Restoration, protection and management of freshwater ecosystems:

- Wetlands:

  - Best-practice models for scalable, resilient large-scale restoration of wetland sites across Europe including engagement with local communities and stakeholders to ensure that wetland restoration results in tangible community gains, alongside environmental rehabilitation (e.g WaterLANDS, LIFE21-NAT-SE-TRIWA LIFE).

- Rivers:

  - Tested methods and best practices for the removal of hydromorphological pressures in rivers, such as dams and barriers, in line with the European objective of the 25,000 km target for free-flowing rivers. Also in ways to reduce flood and drought risk and increase sediment and biota continuity, improved protection of local communities and ecosystems from extreme events and pollution threats (e.g. HydroEcoNex).

  - Improved methods to increase the natural reproduction of native fish species (e.g. CRYO-FISH).

  - Development of comprehensive Restoration Action Plans for the Danube river basin to adapt to climate change as well as to improve its endangered biodiversity and ecosystems (e.g. DANUBE4All).

  - Improve the conservation status for species and habitats of the Habitats Directive and reach good ecological status according to the WFD of riverine ecosystems.

- Lakes and ponds:

  - Increase the presently low understanding of the role of ponds in providing contributions to people/ecosystem services and develop improved methods for maximising the use of ponds and pondscapes (e.g., creation of artificial ponds) to mitigate and adapt to climate change, protect biodiversity and the delivery of ecosystem services (PONDERFUL project).

  - Tested methods and strategies to stop the spreading and introductions of invasive species, such as European catfish (Silurus glanis) in southern European lakes, implementing new techniques to detect, capture and use this species (LIFE21-NAT-IT-PREDATOR).

2. Implementation of digital portals or platforms to centralize information and make available relevant environmental information

  - Develop a virtual environment equipped with FAIR multi-disciplinary data and services to support marine and freshwater scientists and stakeholders restoring healthy oceans, seas, coastal and inland waters (e.g. project AquaINFRA).

3. Production of free and open scientific dissemination materials

  - Produced and published videos to guide TA users on the submission of metadata on the Mesocosm Metadata Catalogue. Developed the material and layout for a dedicated industry-oriented page in the aquacosm.eu webpage, as well as related brochures targeting industry (e.g., AQUACOSM-plus)

4. Campaigns and actions to sensitise the public to conservation measures

- As a part of a specific project: Awareness-raising campaigns targeting specific stakeholders, such as anglers (e.g. LIFE21-NAT-IT-PREDATOR) but also the general public.

- New approaches to co-creating insights to support future policies for ocean and waters with young people (e.g. FLOW) to study their expectations, engagements, and human-nature relationship with the seas and waters, and by bringing together policy-makers, researchers and other relevant stakeholders with the youth and engaging them in co-creation of stewardship assemblages.

- Advocacy by established organisations: Funding the work of NGOs that promote the conservation of biodiversity, using a wide range of methods and tools from putting pressure to the competent authorities, raising awareness of the public to also support with knowledge, proposing solutions and participating in their implementation.

5. Collaboration in funding and biodiversity monitoring between EC and Member states for biodiversity and ecosystem services

- Implementation of a strategic research agenda and shared vision on biodiversity research needs and priority actions across European countries.

- Mobilization of local, national and EU resources for implementing transnational and global biodiversity calls (with partnerships e.g with Belmont Forum in the context of the project BiodivErsA) and specific for freshwater biodiversity with Water JPI, has been achieved.

- Projects and joint calls on biodiversity, ecosystem services and nature-based solutions, from which several in freshwater biodiversity were funded (e.g. three in the 2015 call where around 3 million euros were invested and five with about 7 million euros by the COFUND initiative BiodivScen).

Table 5.3. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Link to the result
AQUACOSM-plus	● Material and layout for a dedicated industry-oriented page in the aquacosm.eu webpage, as well as related brochures targeting industry ● Finalised and made public the first versions of a Wiki Book ● Produced and published videos to guide TA users on the submission of metadata on the Mesocosm Metadata Catalogue ● Development of a primary mesocosm data collection portal ● Organised workshops on Science Communication, Video filming for science communication, and on Breeching barriers to Open Mesocosm Science ● Developed and built the first version of a light-weight, portable mesocosm raft system ● Developed and tested a prototype of a Chlorophyll-a sensor ● Constructed a low-cost, self-flushing system for automated measurement of greenhouse gas fluxes ● Opened its facilities for 17 TA projects with the provision of 829 person-days in 2021, ● Published 6 scientific articles in peer-reviewed journals	link
AquaINFRA	● Develop a virtual environment equipped with FAIR multi-disciplinary data and services to support marine and freshwater scientists and stakeholders ● European Open Science Cloud as an overarching research infrastructure enabling collaboration across the domains of marine and freshwater scientists and stakeholders	Expected results: link
BiodivScen	● Coordinate the research agendas of major European and international research funders to agree on shared research priorities related to scenarios of biodiversity & ESS ● Design and implement a joint call for research proposals focused on the development of scenarios of biodiversity & ESS ● Promote and support research collaboration across national borders and across disciplinary boundaries, to build capacity, overcome fragmentation and have an effect on the international research community and landscape ● Encourage and support dialogue and collaboration between academia and research stakeholders to increase the impact of research on policy and practices	Expected results

Project acronym	Description of result	Link to the result
	● Rapid and efficient uptake of funded research results by the IPBES for its future assessments, and by other relevant initiatives ● Reinforce open access to data and data sharing ● Prepare a longer term collaboration between all BiodivScen partners in close relation to BiodivERsA and the Belmont	
BiodivERsA3	● Enhance the capacity of the network to coordinate research programmes on biodiversity and ecosystem services in Europe and to increase the international dimension of BiodivERsA activities ● Develop a strategic, multi-annual vision of the network's priorities, based on ambitious mapping and foresight activities developed in collaboration with key initiatives in the field ● Design and implement a co-funded call and other joint calls to better integrate research on biodiversity and ecosystem services across Europe ● Develop a range of other joint activities (e.g., alignment of national research programmes for biodiversity and ecosystem services), and activities for promoting mobility and equal opportunities for researchers and reinforcing data sharing ● Promote effective science-policy and science-society (including science-business) dialogue during the whole research process	Cordis
Biodiversa-plus	● Setting up a pan-European network of monitoring schemes, building on existing national/regional monitoring schemes, creating capacity for setting up new schemes, and feeding into the EC Knowledge Center for Biodiversity ● Coordinating research programmes between the EU and its Member States and associated countries ● Contributing science-based methodologies to account for and possibly value ecosystem services and the natural capital, and to assess the dependency and impact of businesses on biodiversity ● Better linking of R&I programmes to the policy arena, providing input to policy making and improving the assessment of policy efficiency	Expected results
BiodivRestore	● Studying the biological and biophysical processes at stake for conservation/restoration, and their interactions	Expected results; Joint call

Project acronym	Description of result	Link to the result
	• Assessing trade-offs and synergies between targets, benefits and policies for conservation and restoration • Knowledge for improving the effectiveness and upscaling of conservation and restoration actions	
CRYO-FISH	• Progress on basic knowledge of the reproductive biology of endemic freshwater ichthyofauna • Assessing for the first-time gamete quality throughout the breeding season • New techniques for gamete assay and protocols for cryopreservation will the purpose of creating a genetic resource bank for biodiversity preservation.	Results, link
DANUBE4all	• Production of a comprehensive scientific knowledge base ready for application to identify, evaluate, prioritize, implement and upscale effective and profitable Win2 NBS restoration measures to enhance the free-flowing status of the river ecosystem. • Implementation of demonstration activities and business cases at 3 sites in 3 countries, providing tools for upscaling innovative Win2 NBS restoration activities to 10 Danube Synergy Sites and to the whole Danube basin. • Mobilization of citizens for river stewardship and stimulation of economic benefits by business cases. • Transferring the outcomes, knowledge and tools gained in the Danube basin to 5 Associated Regions	Expected results: link 1 , link 2
DALIA	• Execution of innovative actions across a variety of geographies, their scaling and the multiplication of outcomes with a wider network of ecosystems and related EU Missions and project actions throughout framework	Expected results
EcoDaLLi	• Centralise Danube governance structures in terms of innovative solutions for improved ecological restoration • Protection and preservation of the Danube basin and its Delta by fostering a stronger innovation ecosystem within a well-connected Practices Living Lab System, supported by a digital Portal, completely linked to the Mission Implementation Platform	Expected results: link

Project acronym	Description of result	Link to the result
FLOW	• Enable co-ownership, co-responsibility and co-implementation of the young generation to co-create target-group oriented and actionable blueprints for stewardship assemblages featuring social interaction and engagement with sea and waters • Direct cooperation with young people via 1) the FLOW Youth advisory board, 2) the European network of youth-focused NGOs, 3) futures workshops with young people from seven regions across Europe and 4) Youth-stakeholder co-creation.	Expected results: link
Grenspark Groot Saeftinghe	• Investing in biodiversity (e.g., restoration of bird biodiversity, optimisation of estuarine nature and eco-hydrological restoration of the inner dike areas). • Building together at the border park: the partners in the project were also working on a long-term narrative, a so-called 'cooperation entity' to manage the border park in the future.	link
HydroEcoNex	• Implement a common methodology for monitoring of impacts of hydropower on trans-boundary river ecosystems • Implement a strategy for bilateral water cooperation on joint monitoring of trans-boundary rivers affected by hydro-power • Holding one Youth Summer School to raise awareness on monitoring methods, impact of hydro-power on river ecosystems, integrated river basin management concept and EU water legislation • Holding one International Conference on hydro-power impact on ecosystem functioning • Develop a digital platform that will contribute to the dissemination of knowledge and good practices for the sustainable management of aquatic resources of rivers of cross-border importance affected by hydro-power and climate change	HydroEcoNex; project ; report here
LIFE21-IPN-BE-B4B LIFE	• Enlarging and connecting protected areas, installing an appropriate management and compliance promotion • Improving the conservation status of species and habitat by putting in place a dedicated large scale restoration agenda • Reducing the impact of environmental stressors. Several pilots will be initiated and will be up-scaled using complementary funding.	Expected results: link 1 ; link 2

Project acronym	Description of result	Link to the result
	• Implementation of several horizontal measure to involve stakeholders, including capacity building	
LIFE21 FPA/AT/WWF-CEE	• Implementation of relevant policies under the EU Green Deal, EU Nature and Water Framework Directives to ensure the sustainable management of forests and river basins • Engage national authorities to make ambitious pledges on meeting the 30% protected areas and 10% strict protection target of the Biodiversity Strategy • Climate change mitigation and adaptation efforts are focused on national policy-making and biodiversity safeguards for renewable hydropower and biomass • Advocate for integrating biodiversity and climate targets into sectoral decision-making under the Operational Programmes, the Common Agricultural Policy and National Recovery and Resilience Plans	Expected results: link
LIFE21-NAT-SE-TRIWA LIFE	• Restore 103 hectares of 3210 and 3260 river habitats historically channelized for floating timber to a natural-like status • Remove 399 anthropogenic migration barriers along more than 3366 km of tributary river creating a blue infrastructure of significant scale • Improve water quality and hydrological regime through catchment restoration work in 2521 hectares of wetland and from plugging 262 leaking ditches • Develop a Greener Best Practice for restoration projects, by reducing GHG emissions	Expected results: link
LIFE21-IPE-SK-LIFE Living Rivers	• Transpose the identified solutions of the new Water Policy Conception through an integrated cooperation of public bodies and stakeholders and to connect the interests within the use of ecosystem services towards an integrated river basin management in the pilot sub-basins • Proposed actions comprise an expertise in several scientific disciplines (e.g., hydrology, hydraulics, morphology, biology, water quality and engineering)	Expected results
LIFE22 NGO-NL-WI-EA	• Support management of migratory waterbirds with international flyway-scale monitoring and expanding the new Trans-European Swimways • Network to advocate for the protection of migratory fish and catalyse reaching the 25,000 km target for free-flowing rivers	Expected results

Project acronym	Description of result	Link to the result
	• Work with stakeholders to strengthen the implementation and enforcement of freshwater-related Directives and scale-up solutions such as barrier removals. • Protect and improve high-carbon soils by pioneering climate-friendly alternatives to drainage-based agriculture on peatlands • Deploy and upscale “natural sponges” as innovative nature-based solutions to address increasingly frequent European floods and droughts • Ensure that the Green Deal transition is sustainable by ensuring Fit for 55 related legislation contributes to solving both the climate and nature crises together.	
LIFE21-CCA-DE-CONTEMPO	• Control temperature and oxygen in rivers with diversion hydropower plants • Dynamic management approach to balance power generation and environmental protection • Develop an approach to react dynamically to local circumstances	link
LIFE21-NAT-IT-PREDATOR	• Contrasting the spread and introductions of the invasive European catfish *Silurus glanis* in southern European lakes • Testing an early detection system based on environmental DNA in 50 lakes and integrated with citizen science records • Test and select the best capture method to reduce the catfish biomass in small and isolated Natura 2000 lakes, in large lakes and reservoirs, involving commercial fishermen and anglers • Massive awareness-raising campaigns organized targeting specifically anglers but also the general public • Protocols and best practices transferred to at least 15 management authorities to be integrated into their management plans • Developing solution to make the catfish more palatable to increase the fishing pressure on catfish and create an economic activity	link
LIFE21-IPN-PL-WETLANDS GREEN LIFE	• Create opportunities for the implementation of the Prioritised Action Framework for the Natura 2000 network in Poland in the areas of marshes, peatlands and wetlands in Natura 2000 and Green Infrastructure areas • Define active protection tasks and their implementation together with designation of buffer zones for 100% of habitats	Expected results: link

Project acronym	Description of result	Link to the result
	• In the areas of Green Infrastructure affecting Natura 2000 areas, protective measures will be proposed, preceded by mapping, determination of the state and designation of buffer zones	
PREP4BLUE	• Facilitate a successful first phase (2022-2025) of the Mission, by developing the co-creation and co-implementation R&I modalities required to achieve the Mission objectives and preparing the ground for inspiring and engaging citizens and stakeholders • Deliver a series of tools, guidelines, methodologies and recommendations tested through pilots, which will interlink, leverage and optimise activities among the projects funded under the Mission • Cohesion and connectivity between knowledge and technology, funding, regulation, education and skills, social structures and co-creation with R&I actors, citizens and stakeholders	Expected results: link 1; link 2
WaterLANDS	• Demonstration of large-scale wetland restoration • Overcome barriers to restoration and develop integrated solutions for upscaling. • Cross-sectoral and interdisciplinary collaboration to co-create wetland restoration • Maintained wetland carbon storage and enhanced natural carbon sequestration services • A community-led paradigm in the co-design of restoration, empowering, engaging and reconnecting with nature • Tailored financial solutions and resources for restoration of wetlands	Policy Briefing: Higher Ambition for Peatlands in the EU Nature Restoration Law Proposal , project; link
PONDERFUL	• Develop a multidimensional framework to support the implementation of pondscape NBS for CC mitigation and adaptation, biodiversity conservation and ES/NCP delivery • Understand how biodiversity, ecosystem state and processes, and ES/NCP co-vary and interact in pondscapes across a climatic gradient • Use empirical data, incorporating direct and indirect interactions and feedbacks between CC, biodiversity, ES and connectivity, to develop a modelling framework predicting the impact of CC on biodiversity and ES of ponds for various land use and pondscape scenarios • Develop NBS for CC adaptation and mitigation through pondscape management	Results: link, project, link

5.2.2. Fostering the uptake of solutions

Although most of the projects analyzed are still starting, some new technologies and good practices that could be rolled up across the EU after being developed and tested were identified.

Greener Best Practice for restoration projects, including removing barriers in rivers, with significantly reduced GHG emissions. Since there is an important European target to restore 25 000 Km of free flowing rivers until 2030, it is very important to optimize the methods and technologies, reducing costs and the impacts that these works can have in the environment, as well as in human communities. Additionally, management of dams to account for ecosystem and biodiversity protection, across both transboundary and local rivers will be implemented. Evaluating the state of aquatic ecosystems as part of the sustainably operated hydropower facilities, with the development of relevant policy instrument is also contemplated

Finally, the sharing of experiences of major de facto restoration projects that are in progress and what was found to be best practices will increase the likelihood of success of these projects, as well as their sustainability and will encourage similar projects in other parts of Europe.

The strategy and a range of methods to decrease the introduction and spread of species that have a high potential for invading aquatic ecosystems are being tested around Europe. An Early detection system for extremely invasive species (European catfish) based on environmental DNA will be tested and developed in 50 lakes and integrated with citizen science records (e.g. LIFE21-NAT-IT-PREDATOR). Capture methods are also being tested. The strategy of improving the palatability of the invasive species (catfish) to increase fisheries could be used for other places and potentially with other invasive fish species.

Deploy and upscale “natural sponges” as innovative nature-based solutions to address increasingly frequent European floods and droughts are also being tested and could be used in many European settings.

Methods to help the restoration of endangered species populations are also being tested. A new fish embryo cryopreservation will be tested, based on a laser gold nanotechnology, and it will be applied for the first time in freshwater endangered species for preserving biodiversity (e.g. Cryo-Fish). If successful, this method could be tested for cryopreservation of other fish embryos.

To conclude, collaboration in funding and biodiversity monitoring will be an essential tool. A pan-European network of harmonized monitoring schemes, built on existing national/regional monitoring schemes, will create the capacity for setting up new schemes, and feed into the EC Knowledge Center for Biodiversity.

5.4. Policy recommendations

- Description of identified gaps

The analysis of the gaps is also done taking into consideration the scarce information about the (intended) results from the projects analysed, and also that these projects are a limited sample of the research that is being done in Europe regarding the protection and restoration of freshwater biodiversity and ecosystems. Regarding the studied ecosystems, there seems to be clear attention on the rivers, especially from the Danube basin and much less attention focused on other ecosystems as lakes and ponds. One possible explanation for this can be

that existing “lake and pond” biodiversity projects are nested within other broader projects, where localised actions on lakes and ponds are not explicitly mentioned, therefore maybe even falling into the category that we identified as “Several freshwater ecosystems”. It could be also that these may be included in terrestrial ecosystem research (especially the ponds), and not included in the list of projects that were analysed. Anyway, there was no identification of relevant projects focusing on lake ecosystems that were not considered in this portfolio analysis. So is possible that there is a research gap regarding these ecosystems and specific funds and research efforts could reduce the apparent difference between studied lakes and ponds, and other thematic areas such as rivers and streams or even wetlands and peatlands.

Although major freshwater basins, such as the Danube, are usually explicitly mentioned in the projects’ abstracts or points of action, for most of the studies it was difficult to determine the actual study sites. And even in the case of these main freshwater basins, some of them are so large and widespread that was difficult to locate where is the actual site of action taking place for a given study, particularly when the studied basins traverse as many countries as it is the case for the Danube river. This may hide some bias regarding the geographic location of the study sites and existing gaps. But looking at the geographic distributions of studies, and taking out the obvious concentration of projects in the Danube River Basin, there seems to be a fair distribution of projects, excluding southern Europe, where only one project focusing on a particular species was found (Cryofish).

There is a lack of consistency in the information provided by the projects from the different programs and sometimes even within the same programs. This made it hard to analyse the portfolio but also highlights a gap in the way that data is stored and classified more generally in the biodiversity field. Other recent biodiversity reports have similarly suggested that there is a need for some “metadata standards” and “Consistency across data aggregation frameworks” (MarBioMe).

Specially after the review of the initial 300 projects it is apparent the need to reinforce the freshwater biodiversity component in future Mission related calls, as more focus has been put in the marine ecosystems in the first calls. Also reinforce the investment in projects and initiatives that focus on their link to the marine environment to reinforce the research on the continuum freshwater - coastal - marine ecosystems.

Some of the important freshwater habitats and ecosystems as lakes and ponds seem to be less studied so far.

Finally the increasing freshwater scarcity problem in many European regions should lead to a strong focus on the research and test of solutions along the nexus (intensive) agriculture-urbanization-energy production-biodiversity and climate change to support adequate water management, adaptation and increasingly difficult decision making.

- Description of identified synergies and recommendations on how to boost them

Synergies between projects that address particular ecosystems and the different problems faced by them should be brought together to make possible a more integrated analysis of the advances in terms of knowledge and also the solutions tested. It is clear that there are several parallel processes that were proposed by different projects, e.g. from technical solutions to decrease the impact of artificial barriers in rivers to mechanisms and strategies to involve citizens that are being tested and if successful could be used in other regions. Even if some projects have already planned to have test sites and then “Associated test sites”, it is not

clear that inter-project collaboration with similar ongoing projects is going to be done (except if they are from the same program and clustering activities are mandatory by the funder).

Integrated analysis of the results should be done, especially during the life of the project and before the main results are publicized, e.g. by peer-review publications or other dissemination activities. Even if collaborations between projects are challenging in terms of logistics and staff time, this is the way to progress faster and increase the impact of solution testing and increase the speed of wider implementation.

Good examples of collaboration are shown by initiatives such as BiodivRestore which links BiodivERsA and the WATER JPI, to enhance their collaboration for funding issues at the crossroad of water resources, aquatic ecosystems and biodiversity sustainable management. Also, collaboration between EC and national and regional funding is mentioned in several projects, leading to an up-scale of actions and an increase in impact. Collaborations between research infrastructures were put in place by AQUACOSM-plus (LTER, ICOS, DANUBIUS, JERICO) at all project activity levels (i.e., NA, JRA, TA).

In Biodiversa, potentials for collaboration with global platforms as IPBES (Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services) were explored through meetings with this platform's Technical Support Unit on Scenarios and Models as well as the Secretariat in April and May 2018. These discussions resulted in a draft cooperation framework designed around the main functions of the IPBES (BiodivScen).

In general, what could be done to facilitate the collaboration between projects is: creating an umbrella theme or program that has the main page and branding and avoid the creation of multiple short-lived pages and brandings for each short-term project. The present obligation of reporting metrics of individual success for each project, that also has to promote its brand, as logo and social media, creates competition between projects for the attention of stakeholders and public and does not encourage cooperation. These "clusters of projects" could share important resources such as e.g. databases of stakeholder contacts, promotion of educational activities and materials, news, mapping of activities from the different projects (e.g., fieldwork) and so on, and could have dedicated funding.

The best way to ensure that projects contribute to the Mission lighthouses is to make them widely known and to encourage the projects to show, from the proposal phase, how they will connect and actively contribute to the Mission, e.g. using the new Mission Implementation Platform

- General policy recommendations:

Working and collaborating closely with stakeholders in order to establish long-lasting trustworthy alliances and cooperation are already a major activities identified in many projects, but this is a complex process and the development of methods, platforms and good practices should continue, to also explore different political, social, cultural and economic contexts, national experiences and organisation of society in different countries. The language barrier still exists, and local activities with stakeholders should continue to be in the local language. But with modern translation technologies this can be overcome in websites and with web-based tools and the translation of website materials in different languages should be made available as a norm in websites produced by EC funded projects.

Co-creation of research and solutions with all the relevant stakeholders is also mentioned in many projects but this still needs a lot of development, as well as awareness of non-scientists for the need to invest time in these exercises, as soon as possible (e.g. during the writing of

the proposals). A number of ongoing initiatives to address challenges as stakeholder fatigue and difficulties to attract some stakeholders to the co-creation activities and the promotion of sharing of experiences is also very needed in this social sciences field.

Dissemination of results and best practices (which also include what does not work) is an essential part of research to make an impact beyond the community participating in the project – even if this is already a wide community, including the general public. This is important to create knowledge and awareness, to influence behaviour and encourage respect for the existing policies and legislation (e.g. environmental protection and freshwater biodiversity) and support its implementation. It is essential that the messages are provided in the appropriate "language" for each sector of society (e.g. posters, infographics, social media communications, TV interviews, and school interventions - to name a few). A message is not really delivered until it is fully understood. Thus, initiatives specifically for education and training in environmental issues, policies and existing legislation, in a non -scientific kind of approach could be encouraged and funded, also beyond the NGO system. This applies also to information in local parks and protected ecosystems that is often lacking, and can be responsible or deleterious actions by well-meaning citizens that just do not know that what they do is not allowed and why.

5.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
831232	2018-FI-ECOSYSTEMS	ESTAT	ESTAT-AG
101056844	ALFAwetlands	HORIZON	HORIZON-RIA
18249	ALFFA	Interreg	ERDF
689682	AMBER	H2020	RIA
731065	AQUACOSM	H2020	RIA
871081	**AQUACOSM-plus**	**H2020**	**RIA**
101094434	**AquaINFRA**	**HORIZON**	**HORIZON-RIA**
642197	AQUAINVAD-ED	H2020	MSCA
869178	AquaticPollutants	H2020	ERA-NET-Cofund
642420	**BiodivERsA3**	**H2020**	**ERA-NET-Cofund**
101052342	**Biodiversa-plus**	**HORIZON**	**HORIZON-COFUND**
101003777	**BiodivRestore**	**H2020**	**ERA-NET-Cofund**
776617	**BiodivScen**	**H2020**	**ERA-NET-Cofund**
101059662	BIONEXT	HORIZON	HORIZON-RIA
678193	CERES	H2020	RIA
101038049	**CRYO-FISH**	**H2020**	**MSCA**
19930	D168	Interreg	ERDF
101094070	**DALIA**	**HORIZON**	**HORIZON-IA**
101093985	**DANUBE4all**	**HORIZON**	**HORIZON-IA**

101079778	DANUBIUS IP	HORIZON	HORIZON-CSA
739562	DANUBIUS-PP	H2020	CSA
869226	DRYvER	H2020	RIA
101060497	EcoAdvance	HORIZON	HORIZON-CSA
101093908	**EcoDaLLi**	**HORIZON**	**HORIZON-CSA**
641762	ECOPOTENTIAL	H2020	RIA
19245	EcoWET	Interreg	IPA/IPAII
654359	eLTER	H2020	RIA
871128	eLTER PLUS	H2020	RIA
871126	eLTER PPP	H2020	CSA
765553	EUROFLOW	H2020	MSCA
101003553	EuropaBON	H2020	CSA
727830	FIThydro	H2020	RIA
101093928	**FLOW**	**HORIZON**	**HORIZON-RIA**
726176	FRAGCLIM	H2020	ERC
101056921	GreenFeedBack	HORIZON	HORIZON-RIA
18064	**Grenspark Groot Saeftinghe**	**Interreg**	**ERDF**
22492	**HydroEcoNex**	**Interreg**	**ENPI/ENI**
101058625	iMagine	HORIZON	HORIZON-RIA
956623	inventWater	H2020	MSCA
101058960	**LIFE21 FPA/AT/WWF-CEE**	**LIFE2027**	**LIFE-FPA-OG**
101059001	LIFE21 FPA/NL/Eurosite	LIFE2027	LIFE-FPA-OG
101058990	LIFE21 FPA/NL/WI-EA	LIFE2027	LIFE-FPA-OG
101057743	LIFE21 FPA/SE/CCB	LIFE2027	LIFE-FPA-OG
101058986	LIFE21 NGO/AT/WWF-CEE	LIFE2027	LIFE-FPA-OG
101059024	LIFE21 NGO/NL/Eurosite	LIFE2027	LIFE-FPA-OG
101058839	LIFE21 NGO/NL/SBE	LIFE2027	LIFE-FPA-OG
101058992	LIFE21 NGO/NL/WI-EA	LIFE2027	LIFE-FPA-OG
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101073824	**LIFE21-CCA-DE-CONTEMPO**	**LIFE2027**	**LIFE-PJG**
101074396	LIFE21-CCM-LV-LIFE PeatCarbon	LIFE2027	LIFE-PJG
101069566	LIFE21-IPC-EE-LIFE-SIP AdaptEst	LIFE2027	LIFE-PJG

101069928	LIFE21-IPC-IT-LIFE CLIMAX PO	LIFE2027	LIFE-PJG
101069837	**LIFE21-IPE-SK-LIFE Living Rivers**	**LIFE2027**	**LIFE-PJG**
101069526	**LIFE21-IPN-BE-B4B LIFE**	**LIFE2027**	**LIFE-PJG**
101069640	**LIFE21-IPN-PL-WETLANDS GREEN LIFE**	**LIFE2027**	**LIFE-PJG**
101074146	LIFE21-NAT-AT-LIFE Boat 4 Sturgeon	LIFE2027	LIFE-PJG
101074368	LIFE21-NAT-EE-LIFE Baltic Sturgeon	LIFE2027	LIFE-PJG
101074458	**LIFE21-NAT-IT-PREDATOR**	**LIFE2027**	**LIFE-PJG**
101074711	LIFE21-NAT-LT-LIFEfarms for birds	LIFE2027	LIFE-PJG
101074158	**LIFE21-NAT-SE-TRIWA LIFE**	**LIFE2027**	**LIFE-PJG**
101074480	LIFE21-NAT-SK-LIFE 4 STEPPE BIRDS	LIFE2027	LIFE-PJG
101112255	LIFE22 NGO/AT/WWF CEE	LIFE2027	LIFE-FPA-OG
101112025	LIFE22 NGO-BE-WWF EPO	LIFE2027	LIFE-FPA-OG
101112263	**LIFE22 NGO-NL-WI-EA**	**LIFE2027**	**LIFE-FPA-OG**
101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
101036337	MERLIN	H2020	IA
730497	NAIAD	H2020	RIA
101060418	NAPSEA	HORIZON	HORIZON-CSA
887396	NetworkNature	H2020	CSA
101003881	NEXOGENESIS	H2020	RIA
101060020	NORDBALT-ECOSAFE	HORIZON	HORIZON-CSA
101086521	OneAquaHealth	HORIZON	HORIZON-RIA
19070	Open landscape	Interreg	ERDF
101094041	OTTERS	HORIZON	HORIZON-CSA
869296	**PONDERFUL**	**H2020**	**RIA**
101056957	**PREP4BLUE**	**HORIZON**	**HORIZON-CSA**
776866	RECONECT	H2020	IA
101037097	REST-COAST	H2020	IA
101056782	RESTORE4Cs	HORIZON	HORIZON-RIA
101056804	REWET	HORIZON	HORIZON-RIA
860800	RIBES	H2020	MSCA
101059264	SOS-WATER	HORIZON	HORIZON-RIA

101004186	Water-ForCE	H2020	CSA
101036484	**WaterLANDS**	**H2020**	**IA**
101056848	WET HORIZONS	HORIZON	HORIZON-RIA
23512	WetlandRestore	Interreg	IPA/IPAII

6. Prevent and eliminate pollution - litter and microplastics. *By Luisa Galgani*

6.1. Main findings of the analysis

The analysis comprised 300 projects funded under different European programmes, both complete and ongoing. These projects were selected by DG RTD as plausible to address the objectives of the Mission "Restore Our Ocean and Waters by 2030" (from now on the 'Mission') and the European Green Deal targets relevant to the sub-objective 2a "Zero Pollution: Marine Litter and Microplastics". The selection included the projects with the highest relevance following the search using CORTEX (CORe TEXt mining) based on a number of keywords. CORTEX allows to find projects proposals under different framework programmes and evaluate their relevance to a specific mission by using keywords and further clustering the identified projects under the different Mission's objectives.

Out of the 300 projects that were identified by CORTEX and selected, **154** projects assessed as relevant to the Mission sub-objective 2a and to the European Green Deal (EGD) targets, and considered as most promising to deliver tangible results (see the list of projects in section 6.5). The portfolio of 154 projects has a total cost of 551.5 M€, of which 490.3 M€ are contributed by the EU. These 154 projects are either completed, ongoing/signed or under preparation. Projects have started between 2015 and 2023 (beginning) and have an end comprised between 2019 and 2029. 37 projects were ended before the Mission launch in 2021, while 6 projects have been funded by the Mission directly and recently started (early 2023), for a total requested budget of 36.5 M€.

The European Green Deal targets specifically addressed in this sub-objective are the reduction by at least 50% of plastic litter at sea and the reduction by at least 30% of leakage of microplastics into the environment. 114 projects in the portfolio address both GD targets, for a total requested European contribution of 334.3 M€; 24 projects address the Mission objective "Zero Pollution: Marine Litter and Microplastics" in general, in conformity with the EU adoption of the Zero Pollution Action Plan[4], with a minority of projects addressing either one or the other GD target.

The 154 projects in the portfolio have been clustered by:

- **Seven Thematic Areas of intervention (TAs)** that include reduction of litter (TA1), source tracking and monitoring (TA2), recyling and valorization (TA3), remediation (TA4), education and literacy (TA5), risk assessment and characterization (TA6) and last but not least innovation technologies (TA7). These areas of intervention fit into the Zero Pollution Hierarchy[1] and each TA can address one or more of the three categories: prevent (TAs 1, 2, 5, 7), minimise & control (TAs 2, 5, 6, 7), eliminate & remediate (TAs 3, 4);
- **Seven Levers of Change (LoC)** across governance, economy, R&I, data gathering, practical solutions, citizen engagement, and training;
- **Geographically across the four Mission lighthouses** (Mediterranean Sea Basin, Atlantic and Arctic coasts, Baltic and North Sea Basin, Danube Basin and cross-basin), and *Other* that covers projects across all EU countries with no specific indication on the

[4] Communication - EU Action Plan: "Towards Zero Pollution for Air, Water and Soil", https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

lighthouse, or that are focused either internationally, or on laboratory or industrial developments.

The following section 6.2 comprises several graphical representations to better visualize the portfolio, the budget, the number of projects per funding programme and action, and the distribution of projects across Thematic Areas (TAs) and Levers of Change (LoC), also meant to understand possible knowledge gaps and gaps in intervention actions across geographical areas, LoC and TAs.

Source-reduction of marine litter is the major TA across projects addressed by the vast majority of the portfolio, followed by source mapping, thereby highlighting the need of understanding sources and fluxes through harmonized monitoring approaches. Recycling and waste management adds up to the most addressed TAs by the sub-portfolio, indicating the urgency of tackling marine litter and plastic on land, **before it reaches the ocean, seas and waters**. Projects focused on the educational, literacy and engagement TA are also a relevant number of the whole portfolio, as a proper waste management starts from concerned communities and this is perceived by many projects.

By analyzing the different TAs per LoC it is clear that technological innovations are mostly driving changes through R&I and possibly develop a market (i.e., bio-based, biodegradable and compostable new materials), highlighting a gap in European governance to properly regulate the immission of these new materials into the environment, underlined also by the lack of studies and knowledge on the possible effects on the long run (i.e., Figure 6.6 and section 6.4).

In terms of LoC, these are not equally represented across the Mission basins with the overall need of intervention in terms of governance and economy in the Baltic/North Sea and Atlantic/Arctic lighthouses, and the scarcity of solutions and R&I in the Danube area (Figure 6.7).

An in-depth analysis was conducted on a subset of **21 projects to individuate tangible results and foster the uptake of solutions** (section 6.3). Of these 21, twelve projects have ended between 2019 and 2022 and nine are still ongoing. Three projecst of the portfolio have been financed by the Mission “Restore Our Ocean and Waters by 2030” and one has later adhered to the Mission Charter. These 21 projects have been funded under different programmes and actions, and are meant to be as much as possible representative of the four Mission lighthouses.

Tangible results (included in section 6.3.1) of the subset of 21 projects have been divided by **five categories**, and include systems to prevent macrolitter to enter seas and oceans, installed in estuaries and river mouths; wastewater treatment plants filtration technologies; automated removal systems; approaches for monitoring and modeling sources and fluxes, including standard operating procedures (SOPs) to be harmonized at a European level; the creation or strengthening of citizen observatories and digital platforms; the valorization of plastic waste through recycling, energy recovery and circular economy models; citizen and stakeholders engagement and training to prevent, reduce and mitigate marine litter; and policy interventions, namely to develop guidelines for marine litter reduction and processing in different decision-making contexts, taking into account technical, environmental, socio-economic, and political aspects, as well as to identify policy framework for waste regulation and improvement across national borders. Some of the tangible results are **considered innovative solutions and practices that could be scaled and replicatedacross the EU**, and include technical, social, business cases applications that represent novel and scalable approaches worth being implemented (section 6.3.2). Examples comprise the development of biopolymers as substitutes in a variety of applications, like in the food packaging industry; harmonisation protocols for the quantification of marine litter and microplastics; physical barriers to prevent the leakage of marine litter into oceans and seas; and circular economy solutions to valorize plastic waste among these.

Based on the portfolio analysis of 154 projects relevant to the Mission sub-objective "Zero Pollution: Marine Litter and Microplastics", the GD targets as well as on the in-depth analysis of the subset of 21 projects, a non-ehausitive list of **policy recommendations** is drawn (section 6.4). Policy recommendations are made to individuate and address of synergies 1) among projects pertinent to the Mission "Zero Pollution: Marine Litter and Microplastics" objective with similar outcomes and results, 2) among Mission sub-objectives in key areas of need of protection, pollution reduction and circular economy – blue economy (such as the Mediterranean Lighthouse), and 3) between the Mission and UN instruments, namely the UN High Seas Treaty (2023) and the negotiation on a legally binding instrument to prevent plastic pollution (United Nations Environment Assembly – UNEA – Resolution 5/14). As already mentioned, policy interventions are strongly recommended towards the regulation of new materials introduced in the European and international market, along with the creation of European standards of good practices, standard reference materials for risk assessemnt studies, eco-labels and certifications, and the harmonisation of waste management practices across member states which are highly necessary. It is of uttermost importance to regulate nanomaterials (like nanoplastics), an area where research aimed at understanding the effects on ecosystems' health and functioning, along with possible impacts on humans should be fostered. And lastly, it is suggested to leverage environmental curricula across European primary and secondary schools to improve literacy with respect to plastic pollution issues as well as unifying citizen efforts, protocols and approaches across member states and Mission lighthouses.

The full list of projects of the sub-portfolio is available in section 6.5.

6.2. Description of the portfolio

The portfolio consists of 300 projects funded under different European programmes and actions. The information on each project in the portfolio is collected from CORDIS and, where available, the project websites. The relevance of every project to the Mission's objectives and the Green Deal (GD) targets that stem from the Guidelines and the Mission is assessed based on information on projects' objectives and activities. The relevant GD targets for the "Sub-objective 2a. Zero Pollution: Marine litter and Microplastics" are:

1. Reduce by at least 50% plastic litter at sea.
2. Reduce by at least 30% microplastics released into the environment.

The methodology to assess these projects followed these steps:

- projects relevant to the Mission objective Zero Pollution have been marked;
- a subset including all projects addressing marine plastics has been delineated;
- all projects that are relevant to GD target nr. 1 are considered relevant to GD target nr. 2 unless it is clearly specified by the project objectives and the available information, that the target is either macro-litter or micro-litter only. This choice is based on the consideration that plastics breaks down into smaller pieces and exists in a continuum of sizes, reason for which it is difficult to distinguish between micro and macro when tackling the amount of plastic waste. Reducing the amount of macro-plastics automatically reduces the amount of microplastics that will be generated by the breakdown of larger items. Preventing microplastics to reach the ocean and waters reduces the total amount of all plastic present in the aquatic environments by number (not by volume or weight).

Out of 300 projects analyzed, **154** (**51.3%**) are relevant to the Mission's objectives, with a **total requested contribution from the European Union of 490.3 M €** and total costs of 551.5 M €. Of this sub-portfolio of 154 projects:

- 114 projects (74%) address both GD targets 1 and 2 (with a total requested budget of 334.3 M € and overall costs of 388.1 M €);
- 24 projects (15.6%) are in line with the Mission objective Zero Pollution: Marine Litter and Microplastics but do not specifically address either of the GD targets.
- A limited number of projects addresses only target 1 (10 projects, 6.5%, with a total requested budget of 27.4 M € and total costs of 40.2 M €) or 2 (6 projects, 3.9% with a total requested budget of 26.1 M € and total costs of 25.7 M €) separately.

The 154 projects relevant to the Mission's objective Zero Pollution are distributed in the following programmes: Horizon2020 (44%), Interreg (19%), Horizon (14%), LIFE2027 (12%), EMFF (6%), ERASMUS2027 (3%), and the remaining 4% shared equally between COSME, LIFE, EMFAF and EPLUS2020 (Figure 6.1).

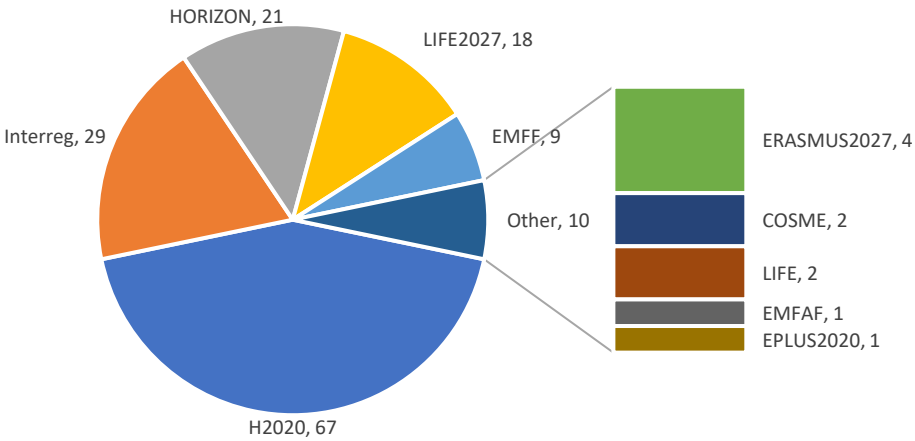


Figure 6.1. Number of projects per EU funding programme. Total number of projects: 154

The total EU contribution of 490.3 M€ is distributed for the vast majority among Horizon2020 (318.7 M€), Horizon (85.9 M€), Interreg (38.3 M€) and LIFE2027 (29.6. M€). Other programmes share the remaining 17.9 M€ (in order of decreasing contribution): EMFF, EPLUS 2020, ERASMUS2027, COSME, LIFE and EMFAF (Figure 6.2).

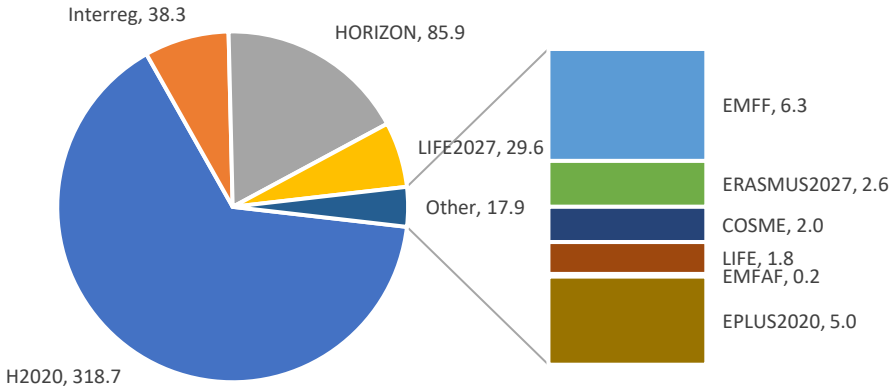


Figure 6.2. EU contribution (M€) per funding programme. Total EU contribution: 490.3 M€

Within the 114 projects that address both GD targets 1 and 2, 50 projects are funded by Horizon2020 programme (44%), 25 projects (22%) are funded by Interreg, 11 projects (10%) are funded by Horizon, 10 projects (9%) are funded by LIFE2027, 8 projects(7%) are funded by EMFF, 4 projects (4%) are funded by ERASMUS2027, 2 projects (2%) are funded by LIFE, and the remaining is funded by EMFAF (1%) and EPLUS2020 (1%).

The 154 projects relevant to the Mission's objective Zero Pollution are funded by 29 different types of actions across the EU programmes mentioned above. The highest number of projects are:

- Research and Innovation Actions (RIA, Horizon2020),
- Interreg projects (under European Cross Border Cooperation European Neighbourhood Instrument ENI and European Neighbourhood and Partnership Instrument – ENPI),
- Innovation Actions (IA, Horizon2020), and
- LIFE-FPA-OG LIFE Operating Grants Framework Partnerships (2021-2024) (Figure 6.3).

The total requested EU contribution per action is described in Figure 6.4. In relation to their relevance to the Mission, there is not always a direct relationship between the number of projects funded per action and the budget granted. Projects funded under Horizon2020 RIA actions had the highest contribution with 152.9 M€, followed by Horizon2020 IA (82.9 M€), Horizon-IA (44.3 M€), LIFE-PJG (Project Grants, 25.3 M€) and MSCA actions (Marie-Curie Actions, including ITN, 25.0 M€).

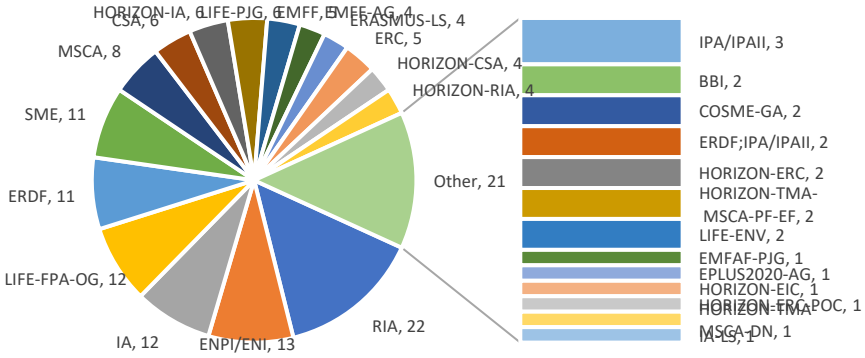


Figure 6.3. Number of projects per type of action. Total number of projects: 154

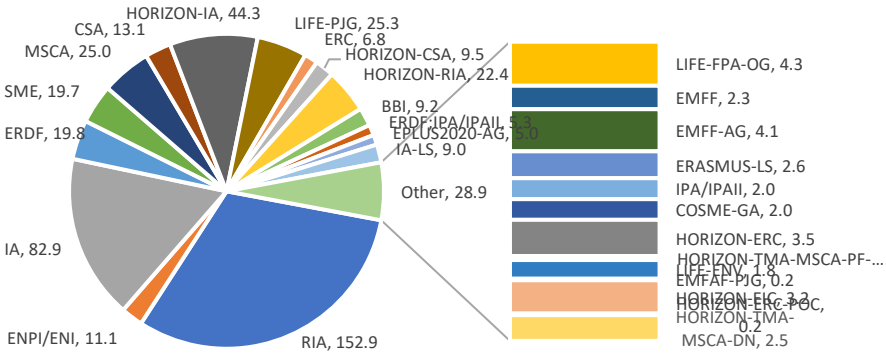


Figure 6.4. EU contribution (M€) per type of action. Total EU contribution: 490.3M€.

Thematic Areas of Intervention

- The 154 projects that are relevant to the Mission objective and the GD targets mentioned above have been clu stered under **seven *thematic areas of intervention (TA)* that tackle the "Zero Pollution:** Marine Litter and Microplastics**" goal** from different but complementary perspectives. The clustering was based on the information available: projects can address one or more areas of intervention as can be inferred from the project description and websites. The portfolio of projects relevant to the Mission's objectives address a total count of 510 thematic areas, meaning that **the vast majority of projects develop their activities across multiple actions** and **TAs** towards the Zero Pollution goal. These areas of intervention fit into the Zero Pollution Hierarchy (ZPH) (Prevent, Minimise & Control, Eliminate & Remediate) of the Zero Pollution Action Plan[1] and each TA can address one or more of the three categories: prevent (TAs 1, 2, 5, 7), minimise & control (TAs 2, 5, 6, 7), eliminate & remediate (TAs 3, 4);

The thematic areas are the following (Figure 6.5):

- **1. Source reduction:** Mitigation / Prevention / Risk reduction. This area includes all actions aimed at reducing marine and aquatic litter at the source, and therefore aimed at preventing and mitigating plastic pollution and its related risk. 114 projects address this TA. ZPH "prevent".
- **2. Source mapping of plastic litter:** Fate and Transport / Monitoring/ Protocols and Practices for Detection, Monitoring and Quantification (including Lab protocols) / Indicators and Sentinels. This area includes all actions that are undertaken within the analyzed projects to understand plastic litter sources, transport and distribution by field observations (including citizen observatories), modeling approaches as well as efforts aimed at harmonizing techniques for detection and quantification within Europe and beyond, including field and laboratory protocols. Within this area, it was also considered important to include indicators and sentinels for plastic pollution as well as actions aimed at uniformizing plastic materials standards for laboratory studies on a variety of plastics and microplastics effects. 81 projects address this TA. ZPH "prevent" and "minimise & control".
- **3. Recycling:** Circular Economy & Valorization (including energy recovery) / Upcycling and Management (land-based waste management). This area includes all actions aimed at managing plastic waste through valorization, recycling, upcycling and circular economy. Some projects included in this thematic areas directly address local stakeholders and engage local communities. 78 projects address this TA. ZPH "eliminate & remediate".
- **4. Restoration:** Ecosystem Recovery / Remediation / Removal & Collection. This area includes all actions where technological advancements are put in place for mechanical cleanup (i.e., autonomous seabed cleanup from marine litter), as well as ecosystem recovery and remediation by removal of plastic litter (e.g. abandoned, lost or discarded fishing gears). 66 projects address this TA, which links to another Mission's objective: Biodiversity and Ecosystems (both freshwater and marine). ZPH "eliminate & remediate".
- **5. Education:** Knowledge and Literacy of the plastic problem / Engagement. This TA includes projects with an education, training and communication wider dimension, where outreach, engagement and behavioral change are prominent within the projects' activities and whose actions are meant to educate and engage communities to tackle the plastic problem at the source. 68 projects address this TA. ZPH "prevent" and "minimise & control".
- **6. Characterization:** Impacts and Risk Assessment (also of co-pollutants) / Early Warnings. This TA includes projects that address the characterization of plastics and

microplastics in terms of impacts on the ecosystems, risk assessment, and the study of associated pollutants. It is considered an important area of intervention that addresses a major knowledge gap in the field, since plastic is thought to be inert but in the environment it comes with a plethora of co-pollutants as well as pathogens and harmful species that can be later be transported to the most remote and sensitive regions, also in terms of biodiversity, linking sub-objective 2 “Zero Pollution” to sub-objective 1 “Biodiversity and Ecosystems”. 46 projects address this TA. ZPH “minimise & control”.

- **7. Innovations and Alternatives:** Bioplastics / Degradation (i.e., biological, chemical). This TA includes projects that propose technical solutions in terms of alternative materials (bio-based, biodegradable and compostable polymers) and degradation processes (i.e., industrial processes or directly applied in wastewater treatment plants), including biologically-mediated plastic degradation. 57 projects address this TA. ZPH “prevent” and “minimise & control”.

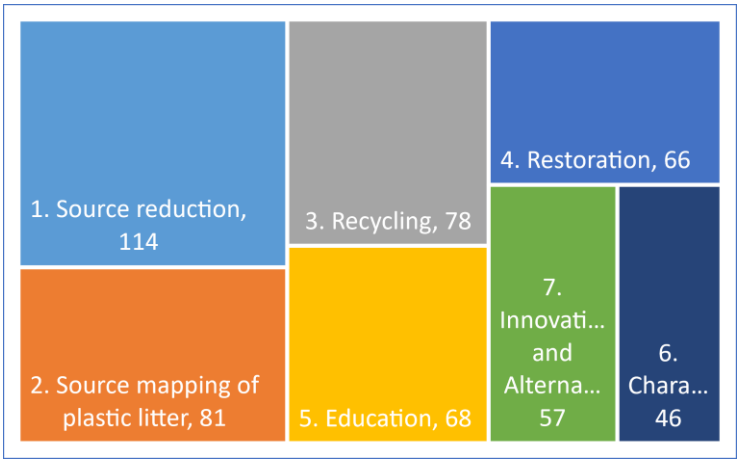


Figure 6.5. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 510. Total number of projects: 154.

Levers of Change

After being clustered according to thematic areas of intervention, projects have been classified according to seven ***Levers of Change*** **(LoC)**. Each LoC is the different type of instrument that can be applied to drive or leverage change (Table 6.1):

- **Governance** (e.g. identifying regulatory hurdles or defining new regulations). ;
- **Finance&Economy** (e.g. developing new business models and markets, value-chains);
- **R&I** (Research and Innovation, developing solutions for complex problems, with different technology readiness levels - TRLs);
- **Knowledge and Data** (the acquisition of data and information to address knowledge gaps);
- **Deployment** (deploy solutions at real scale);
- **Citizen engagement** (e.g., citizen science and participative projects);
- **Education and training** (that include schools and university level programmes and workshops. Generally MSCA-ITN and ERASMUS projects are classified under this LoC).

Table 6.1. Lever of Change (LoC) vs. thematic areas (T.A.). For LoC it is understood the type of tool targeted by the project to drive (or leverage) change in the desired direction.

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engament	Education& Training
Source reduction	74	74	65	78	81	65	70
Source mapping of plastic litter	63	31	46	75	41	50	56
Recycling, upcycling and Management	50	59	49	53	60	44	45
Ecosystems Restoration	48	38	39	52	48	40	41
Education & engagement	59	35	26	52	40	60	64
Characterization, impacts and Risk Asses.	35	18	33	44	23	19	24
Innovations and Alternatives	22	52	52	34	46	12	17
Median LoC per T.A.	50	38	46	52	46	44	45

To retrieve information on how Thematic Areas of intervention are clustered to address different Levers of Change with the aim to individuate possible intervention gaps or under-represented LoC in the sub-portfolio of the 154 projects relevant to the Mission's objective, the median of each Lever of Change (LoC) is calculated (last row in Table 6.1). This value is then substracted by each number of LoC/TA as the distance from the median, and represents how far or how close each TA is from each LoC (Figure 6.6). By this graph, it is evident that TA Source Reduction addresses most LoC while other TAs show possible ranges for upscaling to cover intervention gaps addressing other LoC.

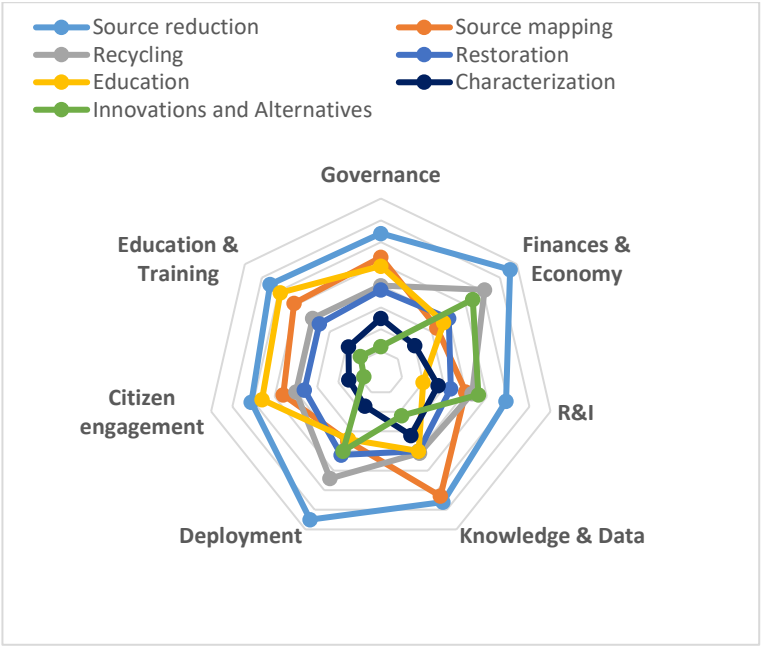


Figure 6.6. This graph shows the distance from the median of each Thematic Area of intervention (TA), represented by the colored lines, per Lever of Change (LoC). This gives information on how Thematic Areas of intervention are distributed across Levers

Geographical coverage

In the EU Mission "Restore Our Ocean & Waters by 2030", four lighthouses as sites to pilot, demonstrate, develop and deploy the Mission activities across EU seas and river basins have been individuated: Mediterranean Sea basin, Atlantic and Arctic coasts, Baltic and North Sea basin, and Danube basin (that includes the Black Sea). Projects relevant to the Mission's objective and the GD targets have been classified based on the geographical location of the projects' activities when the information was available from CORDIS and/or the project's website. Some projects act across multiple basins (i.e., do not exclusively focus their actions on one lighthouse), and therefore they have been marked as "cross—basin" projects (Table 6.2).

Table 6.2. Number of projects per lighthouse and percentage over the total number of projects relevant to the Mission and GD objectives (n = 154). Per each basin, projects only focused on that lighthouse have been counted. Projects addressing multiple basins are 19 and distributed among the four lighthouses.

Basin	Projects per single basin	% over the total amount (154)
Mediterranean	20	13
Atlantic and Arctic	9	6
Baltic and North Sea	6	4

Danube	18	12
Cross-Basin	19	12
Other	82	53

82 projects are classified under the category “Other” and represent 53% of the sub-portfolio. For some of these projects it was not possible to retrieve information on the specific geographical focus/lighthouse from the available information online, but this category also includes projects that have either an international focus, a modeling approach distributed across all EU countries, or that deal with industrial innovations and technologies, laboratory studies and development of new products, as well as projects that target groundwaters and soil plastic pollution. These projects were considered relevant to the Mission as it is known that most plastic and microplastics pollution in our ocean and waters has a land-based source. Of the remaining 72 projects, 13% (20 projects) has as sole geographical area the Mediterranean Sea basin, 12% (18 projects) is focused on the Danube Basin with most of the projects in the Black Sea, 6% (9 projects) is solely focused on the Atlantic and Arctic areas, 4% (6 projects) on the Baltic and North Sea basins, and 12% (19 projects) is focused on multiple basins, so distributed: the Mediterranean basin is included in 14 cross-basin projects out of 19; the Atlantic and Arctic basin and the Baltic and North Sea basin are included in 12 cross-basin projects out of 19, the Danube basin is included in 4 cross-basin projects of the 19 individuated. These 72 projects can be clustered under different LoC to individuate major actions promoting a change per geographical basin (Figure 6.7).

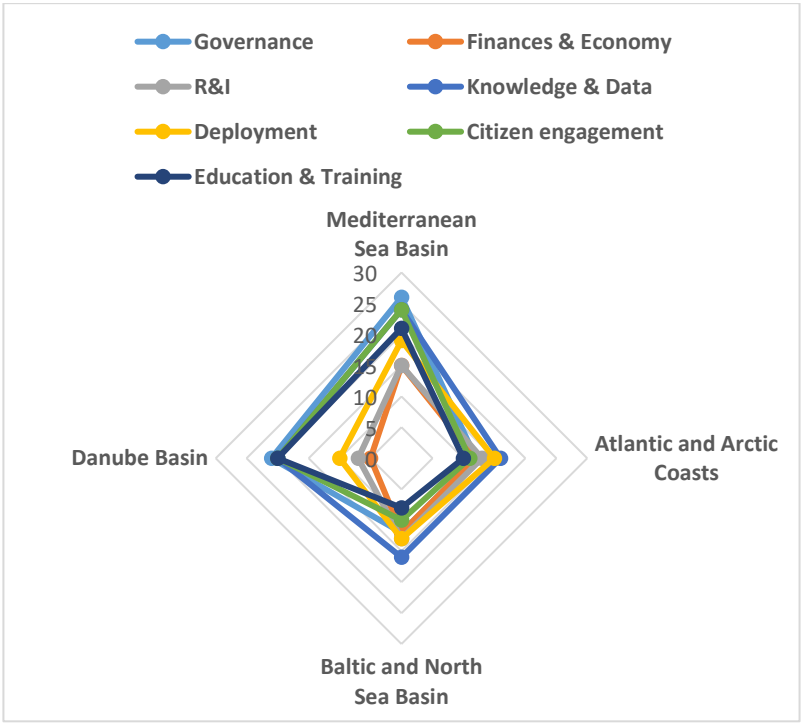


Figure 6.7. Geographical distributions across lighthouses for Levers of Change. Total number of projects analyzed for which it was possible to retrieve information on their geographical areas of action: 72. Total count of LoC addressed: 420.

6.3. Main outcomes and fostering the uptake of solutions

6.3.1. Main outcomes

The analysis of a sub-portfolio for objective 2a – plastic pollution was focused on 21 projects out of the 154 projects assessed as relevant, on different stages of implementation. This projects are highlighted in blue and bold in section 6.5. list of projects. Of these, twelve projects have ended between 2019 and 2022 and nine are still ongoing. Three projecst of the portfolio have been financed by the Mission “Restore Our Ocean and Waters by 2030” (REMEDIES, SeaClear2.0 and PlasticPiratesEU). Additionally, a project that recently started but that was funded under Horizon2020 has adhered to the Mission Charter as well (LABPLAS). One project (SeaClear2.0) is the direct upgrade of a previously funded project under Horizon2020 (SeaClear) and applies the technologies previously developed on a larger scale.

The 21 projects analyzed in depth are funded by the following schemes:

- Horizon: 3 projects (2 IA, 1 CSA);
- Horizon2020: 10 projects (that include 4 IA, 2 RIA, 2 CSA, 1 MSCA, 1 SME);
- European Maritime and Fisheries Fund (EMFF): 3 projects;
- Interreg Programmes: 5 projects across different areas of intervention (Interreg Europe, Balkan-Mediterranean, Bulgaria-Turkey, Black Sea, Northern Periphery and Arctic Programme).

The vast majority of projects address more than one thematic area of intervention, where citizen engagement, outreach and education are almost always present when they are not the direct objectives of the analyzed subset of projects. In the field of marine litter and plastic pollution of aquatic environments communication and citizen engagement actions are commonly seen, because the threat is tangibly perceived by stakeholders at various level. Literacy is the first step to reduce the load of plastic and microplastics in our oceans and waters by 50% and 30% respectively, as aimed by the Mission and the Green Deal targets. Therefore, when discussing mitigation and prevention actions there should be a distinction between “behavioral” and “mechanical” mitigation/prevention. Where clearly the first action includes local capacity development and is targeted to the wider community to promote sustainable practices, the second intervention relates to R&I advancements and practical solutions that remove litter from aquatic systems either before their entrance and dispersion to wider areas (i.e., at the river mouth), as well as already present in a marine compartment (mainly on the seabed) thereby improving the state of the aquatic environment.

Tangible results are defined as products/outcomes/results that can be measured or put into exploitation by end-users (i.e. prototype technology, ready-to-work sensing-tool technology, etc. but also policy papers, guidelines and methodologies). Tangible results have been identified for all 21 projects (See Table 6.3) and are grouped into 5 categories that build upon the Levers of Change but regroup them. In particular, LoC “Deployment” is addressed by all categories of tangible results, while LoC “Citizen Engagement” and “Education and Training” have been regrouped under one tangible result category, as follows (relevant LoC is indicated):

- R&I advances on innovative products, materials, processes and solutions to tackle plastic pollution, mitigate, and reduce, including mechanical removal and prevention*; LoC R&I;*
- Knowledge generated on the sources and transport pathways of plastics in aquatic environments (oceans and waters) through improved monitoring platforms, protocols and models, as well as risk assessment of plastic and co-pollutants at various stages of plastic degradation; *LoC Knowledge & Data;*
- Circular Economy applications and valorization of the plastic waste, including waste management and cleanups (beach-cleanup and citizen engagement); *LoC Finance & Economy;*
- Citizen engagement and training; *LoC Citizen Engagement and Education and Training;*
- Policy interventions, guidelines, and coordination and support actions; *LoC Governance.*

R&I advances. In this category are included systems to prevent macrolitter to enter seas and oceans and are installed in estuaries and river mouths (CLEANTRASH system from the CLAIM project, "Bubble Barrier" developed by MAELSTROM in the Ave River, Portugal); microplastics filtration techniques to trap particles in wastewater treatment plants (a photocatalytic reactor that facilitates plastic degradation upon exposure to sunlight by CLAIM project, and a novel technology seeking potential investors that uses the mucus harvested by jellyfishes to create filters for microplastics developed by the GoJelly project); biopolymers for a high mechanical strength for a variety of applications (B4PNOW) and food packaging (BIOCOMPLACK); automated removal systems to remove litter from the seabed (Robotic Seabed Cleaning platform from MAELSTROM project tested in various sites, as well as autonomous vehicles unmanned and remotely operated for mapping, removing and valorizing litter developed by SeaClear and upscaled in the newly funded project SeaClear2.0 under the Mission, that aims at removing a minimum of 57% litter in the areas covered by the robot).

Knowledge on the sources and transport pathways. Many projects address the need of monitoring and modeling plastic and microplastic distributions, as this is a knowledge gap in the field, partially due to a lack of harmonized standard operating procedures (SOPs), including risk assessment of plastic and co-pollutants. Monitoring actions are undertaken by novel research approaches as well as by the engagement of multiple stakeholders and citizens in most cases. Novel approaches include passive filtering systems and monitoring on ships of opportunity (FERRYBOX by CLAIM project); models of plastic dispersion (CLAIM); protocols and SOPs for monitoring, identification, and assessment to be harmonized at least on a European level (EUROqCHARM, LimnoPlast, LABPLAS); risk assessment of plastic and co-pollutants at various stages of plastic degradation and overall life cycle (LimnoPlast, LABPLAS). The engagement of citizen and multiple stakeholders in marine litter and plastic monitoring is undertaken by the creation of regional citizen platforms and observatories to monitor litter (BLUEMED, MELTEMI, PlasticPiratesEU, CAPonLITTER) and in some cases also actions in place (BLUEMED) as well as digital tools and maps of litter concentration also stemming from aquaculture (AQUA-LIT, OCEANETS);

Circular Economy and valorization. In this category are included projects aimed at valorizing plastic litter into new materials to the goal of zero waste. Projects addressing this category are all in line with the Mission and its charter even if they ended before the Mission launch in 2022. Tangible results include the valorization of litter derived from fishing activities either directly to generate other goods (Seas without waste, BLUENET, BCE, OCEANETS) as well as through the generation of new business models of circular economy (CLAIM, BCE); promoting good practices for waste reduction and management, including removal, beach clean-ups, alternatives to disposable plastics in public events (CAPonLITTER, CroCuS).

Citizen and stakeholders engagement and training. Tangible results in this category are identified where engagement and training have provided practical solutions to prevent, reduce and mitigate marine litter. These actions include improving literacy and citizen perception (BLUEMED, CLAIM, MELTEMI, CAPonLITTER), including behavioral change intervention areas (LimnoPlast); training on waste management (CroCuS), gamification approaches (GoJelly) and engagement through competitions and art (Seas without waste, BLUEMED, MAELSTROM); and waste identification, collection and management through digital tracking with the help of stakeholders and citizens (MAELSTROM, CroCuS).

Policy interventions. Results in this category include the development of guidelines to identify new marine litter reduction and processing technologies in different decision-making contexts, taking into account technical, environmental, socio-economic, and political aspects (CLAIM); the identification of policy framework for waste regulation and improvement across national borders (MELTEMI), and market interventions for valorized waste (BCE); and an environmental performance certification related to virtuous actions towards zero waste accredited to companies, tourism industry, and events (CAPonLITTER).

Existing Links with the Mission and lighthouses

Four projects of the sub-portfolio of 21 are part of the Mission's Work programme (REMEDIES, SeaClear2.0, PlasticPiratesEU, LABPLAS), the first one relevant to the Mediterranean lighthouse, the second ones on a larger European level.

Of the projects belonging to past funding schemes (n = 17), 47% are relevant for the Mediterranean lighthouse as test site for the prevention and elimination of pollution, in particular: BLUEMED (closed), CLAIM (closed), MAELSTROM (ongoing), MELTEMI (closed), SeaClear (ongoing), CAPonLITTER (ongoing), AQUA-LIT (closed) and OCEANETS (closed).

Some projects are cross-basin: those of the previously funded projects relevant for the Baltic and North Sea lighthouse are CLAIM (closed), SeaClear (ongoing) and SeaClear2.0 (ongoing), and LABPLAS (ongoing).

Those relevant for the Danube Basin are: PlasticPiratesEU (ongoing), CAPonLITTER (ongoing), MELTEMI (closed), Seas without waste (closed) and CroCuS (closed).

The projects funded in previous schemes that are relevant for the Atlantic and Arctic regions lighthouse are CAPonLITTER (ongoing), OCEANETS (closed), AQUA-LIT (closed), BCE (closed) and BLUENET (closed).

This analysis highlights that despite the Mission has recently been launched and selected the Mediterranean Lighthouse as a test site towards the Zero Pollution target, the majority of the projects funded and/or ended before the Mission launch in September 2021 already identified the Mediterranean Basin as an important test site to prevent and eliminate plastic pollution.

Table 6.3. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
AQUA-LIT	The project aims at preventing marine littering from aquaculture activities by better monitoring schemes in place, and By removing and recycling litter from the aquaculture facilities both before litter enters the sea and for litter already existing at sea.	Prevention/ Monitoring / Removing / Valorization and Circular Economy	https://aqua-lit.eu/about https://aqua-lit.eu/toolbox/solutions Toolbox that has been developed as result of the project to address the 3 main components of marine littering: prevention & reduction, monitoring & quantification, and removal & recycling https://aqua-lit.eu/assets/content/D4.1_From_prevention_to_recycling_toolbox_final.pdf
	Regional maps on aquaculture litter (Baltic, Mediterranean, North Sea) that includes sea surface and sea bed.	Monitoring	https://aqua-lit.eu/resources/regional-maps-on-aquaculture-litter
	Marine litter inventory (Mediterranean, Baltic and North Sea)	Monitoring	https://aqua-lit.eu/marine-litter-inventory/menu
	Policy recommendation and guidelines to reduce littering from aquaculture and exploitation plan for the results	Governance / Reduction / prevention	https://aqua-lit.eu/assets/content/AQUA-LIT_D5.1_PolicyRecommendations.pdf https://aqua-lit.eu/assets/content/D5.4_Exploitation%20Plan_watermark.pdf
B4PNOW	Biopolymers designed for the highest mechanical strength, outcompeting non-degradable fossil materials such as traditional polymers like polyamides.	Biodegradable polymers Textiles, fishing nets, gear whels, bioclips, shoe sole,	**FortePlastics** (cross-projects: GLAUKOS project https://b4plastics.com/projects/glaukos/ https://glaukos-project.eu, https://cordis.europa.eu/project/id/887711) biodegradable fishing nets and textiles https://b4plastics.com/technologies/forteplastics/ **TriggerPlastics**

Project acronym	Description of result	Application	Link to the result
		forklift tyre, bike handgrips, hoses and cables; straws, cosmetics, 3D printing filaments Circular economy	(cross-projects: ENZYMASE https://b4plastics.com/projects/enzymase/ https://vito.be/en/project-enzymase - Enzymes to build and degrade polymeric backbones and VIPRISCAR https://vipriscar.eu / https://cordis.europa.eu/project/id/790440 - non-isocyanate polyurethanes and non-toxic polycarbonates from biorefineries) https://b4plastics.com/technologies/triggerplastics/ **RubberPlastics** https://b4plastics.com/technologies/rubberplastics/
BCE – Blue Circular Economy	Fishing gear recycling solutions in the Northern Periphery and Arctic region to develop the market also by creating an eco-label for sustainable products.	Recycling, circular economy and valotisation	https://bluecirculareconomy.eu/wp-content/uploads/2022/03/FINAL-V2-BCE-MASTER-CREATING-BUSINESS-OPPORTUNITIES-FROM-WASTE-FISHING-NETS-JULY-2020.pdf Circular Business Models for waste https://bluecirculareconomy.eu/wp-content/uploads/2021/03/HosseinArshad-Supply-chain-optimisation-for-CE-FinalVersion-3_3_2021.pdf develop a circular supply chain network https://www.youtube.com/watch?v=HJsqN5eb09g
	Possible Applications for Waste Fishing nets in Unfired Adobe Bricks of Greenlandic Sediments	Recycling, circular economy and valorization	https://bluecirculareconomy.eu/wp-content/uploads/2021/03/4_Adobe-BCE-Seminar-GL.pdf

Project acronym	Description of result	Application	Link to the result
BIOCOMPLACK	Biobased, biodegradable and compostable food packaging with enhanced barrier properties. BIOCOMPLACK is an alternative to common bio-packaging products that enhances 300% the shelf-life of food.	Alternative (biodegradable) solution to plastic food packaging that improves shelf-life of products creating an oxygen barrier	Deliverable 3.1 Definitive product https://cordis.europa.eu/project/id/720326/results https://natureplast.eu/en/biocomplack-project-in-video/
BLUEMED	National Hubs in the Mediterranean Region – actions to be promoted against plastic (map)	Monitoring plastic pollution / early warning	http://www.bluemed-initiative.eu/pilot-action-on-a-healthy-plastic-free-mediterranean-sea/ https://cordis.europa.eu/project/id/727453/results (final Implementation Plan, 2021)
	Understanding and acting for a healthy plastic free Mediterranean Sea: E-training course	Training / capacity development	http://www.bluemed-initiative.eu/e-training-course/
	Hackaton for best ideas and solutions for a Healthy Plastic Free Mediterranean Sea, to promote sustainable blue growth and circular bioeconomy in the Mediterranean.	Citizen engagement / capacity development / solutions / management / circular economy	http://www.bluemed-initiative.eu/bluemed-hackhaton/ http://www.bluemed-initiative.eu/the-bluemed-hackathon-winner-teams-announced/
BLUENET	Development of long line ropes for mussle aquaculture from abandoned, lost or discarded fihing and aquaculture gears to prevent marine pollution	Recycling and valorization / upcycling	https://www.youtube.com/watch?v=2RK8q7vWgs0 https://maritime-spatial-planning.ec.europa.eu/projects/creating-new-life-discarded-fishing-and-aquaculture-gears-prevent-marine-litter

Project acronym	Description of result	Application	Link to the result
		/ circular economy	https://www.bluenetproject.eu
CAPonLITTER	The project provides multiple solutions to improve policies and practices that can help in preventing marine litter stemming from coastal tourism and recreational activities, with a particular focus on food and drinks plastic packaging. The solutions are presented in 26 “good practices”: https://projects2014-2020.interregeurope.eu/caponlitter/ https://www.interregeurope.eu/policy-solutions/good-practices/projects?keywords=&projects=CAPonLITTER	Certifications of good practices to companies, events, tourism industry	https://www.interregeurope.eu/good-practices/plastic-free-balearics https://es.plasticfreebalearics.org Certification Plastic Free for the Balearic Islands https://www.interregeurope.eu/good-practices/3r6-certification-waste-management 3R6 Certification - Waste Management https://www.interregeurope.eu/good-practices/clean-business https://www.cleanbusiness.org certification given to companies committed to reducing their plastic footprint and making sustainability part of their menu.
		Monitoring	https://www.interregeurope.eu/good-practices/fuerteventura-marine-litter-observatory https://www.interregeurope.eu/good-practices/creando-con-ciencia-0 https://www.interregeurope.eu/good-practices/sos-oceans-project-beach-cleaning-marine-litter-monitoring-action
		Cleaning, preventing and reducing	Several “good practices” are implemented for beach cleaning and litter monitoring (e.g. https://www.interregeurope.eu/good-practices/creando-con-ciencia-0), litter prevention (https://www.interregeurope.eu/good-practices/zero-cigarette-butts-on-the-floor), reusable alternatives also during public events (https://www.interregeurope.eu/good-practices/sustainability-and-waste-management-in-public-events), citizen engagement through

Project acronym	Description of result	Application	Link to the result
			the adoption of a spot to be maintained clean (https://www.interregeurope.eu/good-practices/adopt1-spot), and addressing retailers towards zero single-use plastics (https://www.interregeurope.eu/good-practices/engaged-retailers-for-zero-waste)
		Literacy, awareness and training	https://www.interregeurope.eu/good-practices/plastic-in-sight https://www.interregeurope.eu/good-practices/educar-social-and-environmental-responsibility https://www.interregeurope.eu/good-practices/green-habits-for-a-sustainable-labin-area https://www.interregeurope.eu/good-practices/projeto-lixo-marinho-marine-litter-project https://www.interregeurope.eu/good-practices/training-actions-for-operational-assistants-responsibles-for-beach-cleaning
		Recycling and waste management	https://www.interregeurope.eu/good-practices/plastic-in-sight
CLAIM	Monitoring on ships of opportunity: Ferrybox, through-flow system, continuous measuring of physical, chemical and biological parameters; modeling.	Monitoring	https://eurogoos.eu/ferrybox-task-team/ https://www.ferrybox.org (network) https://www.claim-h2020project.eu/technologies/
	Identify marine plastic waste hotspots by modelling tools that take into account marine currents, waves and wind to simulate the	Monitoring (modeling Mediterranean and Baltic Sea)	https://www.frontiersin.org/articles/10.3389/fmars.2021.743117/full https://www.frontiersin.org/articles/10.3389/fmars.2022.886295/full https://www.frontiersin.org/articles/10.3389/fmars.2022.784937/full

Project acronym	Description of result	Application	Link to the result
	pathways of plastics from land-based sources into the sea.		
	Passive filtering system to provide information on marine litter distribution in the Mediterranean and Baltic Seas, used on board, on vessels equipped with FerryBox systems or other flow-through seawater pumping systems.	Monitoring	https://tos.org/oceanography/article/developing-realistic-models-for-assessing-marine-plastic-pollution-in-semi-enclosed-seas https://www.claim-h2020project.eu/technologies/
	Engaging with society to understand the public perception of marine litter	Citizen engagement/ ocean literacy of the plastic problem	https://www.claim-h2020project.eu/claim-research-topic-claim-researchers-conduct-a-survey-on-the-public-perceptions-of-marine-plastic-litter/ https://www.frontiersin.org/articles/10.3389/fmars.2021.784829/full
	Prevention of macrolitter in river estuaries to avoid it entering the seas	Prevention / mitigation / removal	https://www.frontiersin.org/articles/10.3389/fmars.2021.738876/full (CLEAN TRASH)
	Valorization of litter derived from fisheries and fishing activity	Valorization, circular economy	https://www.frontiersin.org/articles/10.3389/fmars.2022.722815/full
	Guidelines for assessing new marine litter reduction and processing technologies.	Governance / implementation	https://www.frontiersin.org/articles/10.3389/fmars.2022.886581/full
	Filtration technique to trap all the microplastics in wastewater treatment plants and to further degrade them using sunlight. The technology uses an automated filtering device and a photocatalytic reactor that facilitates plastic degradation upon exposure to light.	Removal and remediation / Innovation technology	https://www.claim-h2020project.eu/technologies/ https://link.springer.com/article/10.1007/s10311-019-00859-z

Project acronym	Description of result	Application	Link to the result
CroCuS Cleaner Rivers, Cleaner Seas	App to report waste issue in participants' locality, find recycling centers and services in the neighborhood, resources and news on waste management and clean-up days.	Waste management and citizen engagement: produce innovative tools for rapid assessment of river litter and waste recycling potential	https://play.google.com/store/apps/details?id=com.webmaster.trashalert&pli=1 https://blacksea-cbc.net/communication/stories/stories-2022/crocus-bsb784-tamapp
	Training on the main sources of river plastic pollution and best solutions to reduce riverine plastics, including waste management	Training / preventing / reducing / waste management	https://www.earthforever.org/pics/p22/Training%20Pack%20BSB%20784.pdf https://www.earthforever.org/pics/p22/leaflet%20crocus%20a4.pdf
EUROqCHARM	Analyze and evaluate existing methodologies for plastic pollution assessment, and harmonize them on a European level though an inter-comparison laboratory study.	Mapping/ monitoring / harmonization of protocol and intercomparison to assess impacts	https://zenodo.org/communities/eqctest/search?page=1&size=20 https://zenodo.org/record/7520724#.Y_i_Fy-B2qQ harmonizaed analysis https://www.euroqcharm.eu/en/news/analysis-of-microplastics-in-environmental-matrices-results-of-the-interlaboratory-comparison-study Laboratory intercomparison study results https://zenodo.org/record/7568365#.Y_i_ES-B2qQ microplastics reference matewrials
	Workshop on the analysis of microplastics	training	https://www.euroqcharm.eu/en/calendar/workshop-on-the-analyses-of-microplastics
		Prevention / removal /	https://www.frontiersin.org/articles/10.3389/fmars.2021.690749/full

Project acronym	Description of result	Application	Link to the result
	Harvest the mucus produced by medusae to create filters removing plastic particles from wastewater before it reaches the ocean.	innovation technique	
		Mitigation, Recycling and valorization by microorganisms	https://www.frontiersin.org/articles/10.3389/fmars.2020.567126/full
GoJelly	Strategy online game that demonstrates the complexity of a marine system with jellyfish in it, under changing environmental conditions, giving solution approaches for a sustainable management. It is focused on the human elements of the socio-ecological system as both impacted by and in turn causing changes in the marine environment. Plastics in the oceans is but one of the problems to solve in the GoJelly game.	Education and engagement	https://www.go-jelly.com
Joint cross-border initiatives for reduction of marine litter in Aegean and Black Sea (Seas without waste)	Cleaning campaign in the area of Lake Vaya, flowing in Black Sea and elimination of the landfill in the area of channel. Separate waste management containers were installed in Enez, which contributed to reducing urban pollution in the wetlands. Project partners organized wetland cleaning campaigns at the cross-border region of both countries.	Cleaning/ removal of marine litter / recycling / valorization	https://redmarlitter.eu/en/via-pontica-foundation-is-actively-involved-in-the-campaign-to-clean-the-wetlands-around-burgas/

Project acronym	Description of result	Application	Link to the result
	Public awareness on the prevention of marine litter: A children's competition "What do you know about waste?" And an art exhibition with objects made by the children during the trainings; A pilot system for separate waste collection in Enez was introduced and promoted.	Public engagement / literacy	http://www.ipacbc-bgtr.eu/projects-funded/joint-cross-border-initiatives-reduction-marine-litter-aegean-and-black-sea-seas
LABPLAS	SOP for a comparative Life Cycle Assessment (LCA) between conventional fossil-based vs bio-based plastics (both non-degradable and degradable) based on the Plastics LCA methodology developed by the Joint Research Centre (JRC).	Risk assessemnt / monitoring / circular economy / valorization	https://labplas.eu/wp-content/uploads/2022/09/LABPLAS_WP5_D5.6_LCA-methodology_Final.pdf
	Guidelines on methods for extraction, pre-concentration and purification of small micro and nanoplastics, as well as the determination of microplastics in atmospheric samples.	Monitoring / protocol harmonization	https://labplas.eu/wp-content/uploads/2022/06/LABPLAS_WP4_D4.1_Guideline-for-methods-for-extraction-pre-concentration-and-purification-of-SMNP_v2.pdf https://labplas.eu/wp-content/uploads/2022/12/LABPLAS_WP3_D3.2_Guideline-Methods-for-MP-Determination-in-Atmospheric-Samples.pdf https://labplas.eu/wp-content/uploads/2021/12/LABPLAS_WP2_D2.1-Harmonisation-of-sampling-methods_final.pdf https://labplas.eu/wp-content/uploads/2022/06/LABPLAS_WP2_D2.2-First-sampling-campaigns-and-sample-preparation_v3_Final.pdf

Project acronym	Description of result	Application	Link to the result
	Understand the effects of chemicals added to plastic objects to enhance their physical properties, and assess their potential effect to metabolism.	Risk assessment of plastic and co-contaminants	https://www.sciencedirect.com/science/article/abs/pii/S0048969722061101 https://www.sciencedirect.com/science/article/pii/S0025326X22003551?via%3Dihub https://www.mdpi.com/2073-4360/13/21/3742 https://www.sciencedirect.com/science/article/pii/S0269749122001506?via%3Dihub
LimnoPlast	SOP to assess polymer degradation	Plastic degradation characterization / monitoring	https://zenodo.org/record/6779469#.Y_ty0C-B2gQ
	SOP for microplastics sampling and analysis	Monitoring	https://zenodo.org/record/6779408#.Y_t1JC-B2gQ
	Analysis of people's risk perceptions and mental models of microplasticsfor risk communication strategies and behavioral change interventions	Characterization/ Risk assessment / public engagement	https://zenodo.org/record/6779485#.Y_t1WC-B2gQ
MAELSTROM	Design, manufacture and integrate scalable, replicable and automated technologies, co-powered with renewable energy and second-generation to identify, remove, sort and recycle all types of collected marine litter into valuable raw materials.	Cleaning / Removal / Prevention	Robotic Seabed Cleaning Platform in the Venice coastal area, to remove litter directly from the seabed Seabed cleaning platform tested in Venice https://www.youtube.com/watch?v=QGbCNkvaSL0 https://cordis.europa.eu/project/id/101000832/results https://www.maelstrom-h2020.eu/maelstrom-outputs/#technologies

Project acronym	Description of result	Application	Link to the result
	Bubble Barrier in the Ave River (Portugal) to prevent the litter to reach the ocean	Cleaning / Removal / Prevention	https://www.maelstrom-h2020.eu/maelstrom-outputs/#technologies https://cordis.europa.eu/project/id/101000832/results D5.3, system being developed
	App designed for practitioners and aims to facilitate marine litter management cycle through three main sections: identification, collection (clean-up) and transfer to the final destination for recycling (tracking).	Source mapping / monitoring and tracking plastic	https://www.maelstrom-h2020.eu/maelstrom-outputs/ App being developed for practitioners
	Educational workshops, info-days, and beach clean ups. MAELSTROM's team has designed a set of three real size sperm whale calves, made of recycled polyethylene which are presented at key events and used as engagement tolls during educational workshops for young generations in the pilot countries – Italy and Portugal.	Citizen engagement	https://www.maelstrom-h2020.eu/about/#whatsinforme and social media channels for events (including the forum)
OCEANETS	ICT Tool: advanced geolocation technologies are used to monitor and quantify the current marine litter status	Monitoring	https://oceanets.appslopers.com/
	Prevention, recover, re-use and recycle of fishing gears to obtain added-value products in the textile industry	Recycling, removal, circular economy and valorization	https://www.euronews.com/green/2021/04/27/alternatives-to-plastic-help-lower-pollution-in-the-oceans http://oceanets.eu/wp-content/uploads/2021/09/OceaNets-D2.4-Textile-product-obtained.pdf development of textiles from recovered fishing gears

Project acronym	Description of result	Application	Link to the result
			http://oceanets.eu/wp-content/uploads/2021/09/OceaNets-D3.3.-Summary-of-the-environmental-impact-and-the-Cost-Benefit-Analysis.pdf environmental impact and cost-benefoits analysis
PlasticPirates EU	The project will raise awareness throughout Europe of the importance of rivers, the protection of natural resources, and the significance of international research collaborationby upscaling the 'Plastic Pirates – Go Europe!' project. This will increase the capacity to collect, organise and verify data on plastic waste pollution stemming from and in European rivers, coastlines, and seas. The project will test, replicate and refine best practice models to achieve Mission Ocean's objective.	Training, monitoring and source mapping	https://www.plastic-pirates.eu/sites/default/files/document/2022-09/Plastic_Pirates_Lehrmaterialien_Web_0.pdf Teaching materials https://www.plastic-pirates.eu/sites/default/files/document/2020-08/PPEU_Bauanleitung_Plastiksieb_A4_EN_CPS_barrRZ.pdf how to build a sand sieve https://www.plastic-pirates.eu/en/results/map results map https://www.plastic-pirates.eu/en/results/analysis results on collected items 2016-2020
REMEDIES	Started in December 2022, it aims at monitoring and prevention of micro and macroplastics and engage citizens in plastic waste valorization (over 422 tons) through entrepeneurship towards zero-waste target.	Plastic waste valorization / recovery and prevention Citizen engagement	Envisaged results: https://cordis.europa.eu/project/id/101093964 https://etmi-al.org/portfolio/remedies-co-creating-strong-uptake-of-remedies-for-the-future-of-our-oceans-through-deploying-plastic-litter-valorization-and-prevention-pathways/ https://athens.impacthub.net/news/remedies-for-the-future-of-our-oceans-through-deploying-plastic-litter-valorisation-and-prevention-pathways/?lang=en
SeaClear and SeaClear2.0	SeaClear deploys a state-of-the-art autonomous surface vehicle (ASV), capable of launching simultaneously two remotely operated	Remediation / Seabed cleaning / Source	https://seaclear-project.eu/about-main/about-seaclear videos about the functioning of the autonomous device

Project acronym	Description of result	Application	Link to the result
	vehicles (ROV) and serving as a landing platform for an unmanned aerial vehicle (UAV). The UAV and one ROV are responsible for mapping the litter on the seabed, while the second ROV collects the waste and transfer it to a collection basket, which in turn, is launched from the ASV and lowered to the seabed.	reduction / monitoring	https://seaclear-project.eu/images/deliverables/SeaClear_D_5_3.pdf Technical End User Guide https://cordis.europa.eu/article/id/436481-building-the-first-robots-to-clean-up-ocean-floor-litter Test in the Port of Hamburg, May 2022. https://seaclear-project.eu/news/news/104-3rd-trials-of-seaclear-system-in-marseille Third trial of the SeaClear system (Marseille, Sept. 2022) https://seaclear-project.eu/news/videos SeaClear system operating videos https://seaclear-project.eu/news/news/110-litter-classification-algorithm Improved algorithm for the observation ROV to map the surrounding environment on the seabed
	SeaClear2.0 is the upgrade of SeaClear. It aims at direct collection of at least 57% of existing litter in the areas covered by the robot teams, with options for valorization	Effective monitoring and collection of marine seafloor and surface litter / valorization of the collected waste / circular economy	https://cordis.europa.eu/article/id/442770-cleaning-up-our-oceans-with-smart-robots https://youtu.be/vz9V3-VUBFI collection basket for valorization (from SeaClear)

6.3.2. Fostering the uptake of solutions

Of the tangible results identified in the previous section, the following ones are innovative solutions and practices that could be scaled and transferred across the EU, divided according to the five categories previously described. These solutions include technical, social, business cases applications that represent novel and scalable approaches worth being implemented.

- R&I advances

- BIOCOMPLACK project developed a bio-based, biodegradable and compostable food packaging that improves shelf-life by creating a barrier for oxygen and food deterioration. According to PlasticsEurope[5], bio-based plastics have increased from 3.5% (2018) to 5.9% (2021) of the global plastic production. 44% of global plastic production in 2021 (390.7 Mt) is used for packaging, of which, food packaging represents the vast majority. Such alternative food packaging should be promoted and implemented on a European level and in non-EU countries in the lighthouses of the Mission.

- B4PNOW developed biopolymers outcompeting non-degradable and fossil-fuel based plastics for biodegradable fishing nets and textiles, gear wheels and bioclips (FortePlastics®); bioplastics with tunable properties, wide range of application and strongly controlled biodegradability thanks to “triggers” (enzymes, or salts, or solvents) to trigger their degradation, and used in cosmetics, 3D printing filaments, straws, (TriggerPlastics®), and bio-based elastomers for shoesoles, hoses and cables among its major applications (RubberPlastics®).

- CLAIM and MAELSTROM have deployed barriers at the river mouths and estuaries, that are installed and prevent litter from entering the seas and oceans (CLEANTRASH and Bubble Barrier).

- CLAIM and GoJelly have developed filtration techniques for wastewater treatment plants where the majority of the microplastics, deriving from fibers originating in household waste, end up and from there, potentially reach rivers, seas and oceans. CLAIM uses a photocatalytic reactor to trigger the uv degradation of the retained microplastics, while GoJelly uses the mucus produced by harvesting jellyfishes to produce biodegradable filters for microplastic waste, addressing two contamination problems at once (plastic and jellyfishes overpopulation).

- Knowledge on the sources and transport pathways

- EUROqCHARM analyze and evaluates existing methodologies to assess plastic pollution impacts and risk assessment by an inter-comparison laboratory study (by assessing microplastics reference materials for test studies, harmonized analysis protocols, laboratory intercomparison analysis and training on microplastics analysis) on a European level, with the objective to develop a globally scalable method (e.g. used in SCOR – Scientific Committee on Oceanic Research guidelines).

- Circular Economy and valorization

- BCE, OCEANETS, AQUA-LIT and BLUENET are focused on the recovery of fishing and aquaculture gears from abandoned, lost or discarded materials and valorize the recycled materials into the development of long line ropes for mussel aquaculture (BLUENET), textiles (OCEANETS), building materials (BCE). BCE also aims at stimulate market

[5] © 2022 PlasticsEurope AISBL – Plastics - the Facts 2022 (October 2022).

demand for waste fishing nets in the NPA region (Northern Periphery and Arctic) helping small medium enterprises in creating an eco-label and contributing to the commercialization of second-life plastic.

- REMEDIES, started in January 2023, is also focused on zero-waste approach for the valorization of over 442 tons of plastics by promoting and sustaining citizens entrepreneurship.

- Citizen and stakeholders engagement and training

- PlasticPiratesEU supports the scale and rollout of the Plastic Pirates – Go Europe! initiative launched by the Trio-Presidency of Germany, Portugal and Slovenia into a pan-European citizen science initiative (2020). It was implemented as a joint campaign by the Ministries of Education, Science and Research in Germany, Portugal and Slovenia in the period from 2020 to 2021. This latter is in turn the upscaling of Plastic Pirates, a successful citizen science campaign which contributed to research on the distribution of macro- and microplastics along German rivers, as part of the Science Year 2016*17 - Seas and Oceans and of the research focus “Plastics in the Environment” of the German Federal Ministry of Education and Research (BMBF). It was carried out by the Ecologic Institute in cooperation with ozean:labor at Kieler Forschungswerkstatt, 2016 – 2020. In the campaign and its upscaling, school classes and youth groups collect plastic samples from streams and rivers and document their findings. The collected data is then analysed by scientists and researchers, making an important contribution to researching the state of European rivers and the extent of pollution caused by plastic waste.

- **Policy interventions**

- CAPonLITTER is an Interreg project that provides multiple solutions to improve policies and practices resulting from coastal tourism and recreational activities. A particular attention is given to food and drinks packaging, as previously mentioned, 44% of worldwide plastic production end use. Three sub-projects under the programme have implemented innovative actions that could be upscaled and rolled out to every member state in Europe and beyond. The first initiative is a Certification of Plastic Free for the Balearic Islands targeting the hospitality industry, with high potential for scalability and impact through the HAPI (honest alternatives to plastic INDEX), an indicator which scores the degree of environmental impact of single-use plastic products and their alternatives through 5 criteria: waste prevention, compliance with the law, reusability, optimization of the material and material (availability, renewability, impact on production and end of life). The second initiative is 3R6 Certification for waste management through six steps—auditing, consultation, training, measurement, activation, and visibility—it aims to encourage proper waste management in different settings, including public events. The third good practice is the Clean Business initiative, a certification given to companies committed to reducing their plastic footprint. The certification is designed to communicate and create transparency between business and customer with a QR code certificate. By showcasing the commitments of each individual business, consumers become more aware of the eco-social impacts on the businesses they choose to support.

6.4. Policy recommendations

A number of policy recommendations can be drawn from the analysis of the portfolio and of the sub-portfolio of 21 projects in particular: these recommendations are based on identified knowledge gaps and potential barriers to the implementation and upscaling of certain innovations, along with the suggestion of the type of support that such technological/social/governance advancement would need at a European level to reach the Mission objectives.

1. In March 2022, the United Nations Environment Assembly (UNEA) adopted Resolution 5/14[6] to end plastic pollution through an international legally binding instrument. The binding instrument, foreseen to be completed by 2024 through an interngovernmental negotiating committee, shall promote sustainable production and consumption of plastics through, among other things, product design and environmentally sound waste management, including through resource efficiency and circular economy approaches. Moreover, the instrument shall be used to promote national and international cooperative measures to reduce plastic pollution in the marine environment, including existing plastic pollution. In light of these ongoing negotiations, the European Union could build up on UNEP specific objectives by, for example, fostering Interreg programmes in areas where member states work together with non-EU member states towards the development of national framework in preparation to the internationally binding instrument. An example is the Mediterranean Basin, already identified as lighthouse by the Mission and one of the focus regions of the UNEP "Regional Seas Programmes"[7] through the Mediterranean Action Plan (MAP)[8]. Similarly to the Mediterranean Basin, other lighthouses of the Mission could be sites to test such innovations and policies.

2. Following up on the recommendation to prepare the background in EU member states for international ongoing negotiations, it is worth mentioning that technical solutions to prevent plastics entering waterways, seas and oceans, are not equally shared among different European countries because of differences in resources availability and waste management practices. Therefore, it is recommended that common waste management policies and practices are shared among the EU member states, to which countries must adhere. It is recommended the creation of a European standard for waste management and good practices in the collection, recycling and valorization of plastic polymers, are harmonized on a European scale, with the aim to create a common EU market for second-life materials as it is envisaged for the NPA region by the BCE project and that can represent an important model for upscale on a European level. Synergies are identified between BCE, OCEANETS, AQUA-LIT, BLUENET and the Mission project REMEDIES and these synergies should be explored and exploited.

3. In terms of synergies, besides similar targets and outcomes across projects and programmes within the same Zero Pollution: Marine Litter and Microplastics objective (i.e., similar tangible results or activities), it is recommended that synergies are addressed within the Mission sub-objectives and enablers in future funding schemes and calls. In particular, conventional plastic production is fossil-fuel based; however, projects exploring novel bio-based polymers production methods as well as plastic waste valorization actions also address the Blue Economy – Carbon Neutral and Circular Mission objective. Moreover, the recent UN resolution "High Seas Treaty" from early March 2023 to protect at least 30% of world's oceans by 2030 creates an unprecedented opportunity for the EU Mission and in particular for the objective "Protect and Restore Marine and Freshwaters Ecosystems and Biodiversity" to individuate technologies and innovations to restore European protected areas from plastic and other anthropogenic types of pollution. This is particularly true for the Mediterranean Seaa Basin as lighthouse of the Mission to prevent and eliminate pollution, where only 9.68% is currently designated as Marine Protected Area[9], of which only 1.27%

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[6] UNEP/EA.5/Res.14, End plastic pollution: towards an international legally binding instrument (March 2022).

[7] UNEP Regional Seas Action Plan

[8] UNEP Mediterranean Action Plan (MAP)

[9] WWF's report "30 by 30: Scenarios to recover biodiversity and recover fish stocks in the Mediterranean", 2021.

has an implemented management plan, is among the most plastic-polluted sea in the world[10] and where plastic an microplastics may seriously compromise habitat species and reduce biodiversity.

4. Overall, there are important advancements in the production of bio-based and biodegradable plastics as substitute to fossil-fuel derived plastic in a variety of applications, and among these, food and drinks packaging. Barriers to the implementation on a European scale of these new materials might be constituted by the higher production costs and patents, reflected in higher process for the consumers. However, while a number of companies invest into the design of bio-based, biodegradable and compostable materials, independent studies that assess the realistic degradation time of these bio-plastics in the marine/aquatic environment, as well as their potential impacts are lacking. It is recommended:

- that a proper legally-binding policy distinction is made on a European level between the different types of polymers: bio-based, biodegradable and compostable;
- that European policy interventions on conventional plastics in commercial applications, like food packaging (substituted by bio-degradable/bio-based and compostable materials) go parallel to independent research assessing the impacts of these new materials into the environment following the principle of precaution.

These two recommendations are needed before upscaling policy intervention and market solutions on a European level, as it is necessary that a number of conditions are met to ensure that the production and use of these plastics result in overall positive environmental sustainability and do not add upon problems of plastic pollution, climate change and biodiversity loss. In fact, the recently adopted EU policy framework on bio-based, bio-degradable and compostable plastics brings clarification on the types of polymers but is not legally binding[11]. Additionally, there is no EU law in place for those materials (unlike the Directive on single-use plastics and on plastic bags). While there is a EN standard for industrially compostable packaging, there is no standard for marine degradation.

5. It is recommended the creation of a EN standard internationally agreed upon for the harmonization of analysis protocols for the i) quantification and qualification, ii) risk assessment, and iii) creation of reference materials for the extraction and analysis of microplastics in a variety of matrices (water, air, soil, food, organisms, biological matrices). In this respect, synergies are identified between EUROqCHARM and LABPLAS projects that could be harmonized. It is also important to establish the maximum threshold of micro-and nanoplastics found in aquatic environments and establish an indicator to assess the water quality level as in the Water Framework Directive[12] for nutrients.

6. It is equally important to foster research on nanoplastics in aquatic environments whose challenges at present mostly rely on technological barriers for the quantification, and the effects are mostly studied in the field of medical and health sciences. Synergies should be identified with the Mission projects and objectives towards the concept of “one health” approach.

7. The creation of a certification for sustainable coastal tourism towards zero-pollution, as it is being done for the Balearic Islands in the CAPonLITTER project, should be promoted to a

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10 Baudena et al., *Nature Communications* volume 13, Article number: 2981 (2022), https://doi.org/10.1038/s41467-022-30572-5

11 Communication – EU policy framework on biobased, biodegradable and compostable plastics, 30 November 2022, https://environment.ec.europa.eu/publications/communication-eu-policy-framework-biobased-biodegradable-and-compostable-plastics_en

12 https://environment.ec.europa.eu/topics/water/water-framework-directive_en

European scale. In the Mediterranean lighthouse, this certification, or label of good practice, has the great potential to be upscaled to the whole basin including EU and non-EU countries and engage multiple stakeholders, possibly creating a new market and tackle one of the major sources of plastic pollution in one of the most plastic-polluted seas.

8. Three projects are focused on autonomous technologies for the clean-up of marine litter from the seabed: MAELSTROM, SeaClear and SeaClear2.0. These three projects could identify synergies and share technical advancements, as well as test their respective methodologies in specific sites to identify common challenges/solutions, overlaps and strengths/upscaling possibilities of each on a wider European level.

9. Last but not least, it is suggested the adoption of environmental curricula in European schools that fosters a unified level of literacy with respect to plastic pollution issues and impacts, from reducing, re-using, recycling, waste management and valorization. Likewise, citizen science and engagement initiatives towards reduction, monitoring, mitigation and management should follow harmonized protocols across EU member states and Mission lighthouses, for the creation of a unique citizen-based monitoring platform and shared approaches.

6.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
21174	ADRINET	Interreg	IPA/IPAII
959016	Aerones	EMFF	EMFF-AG
22475	ANEMONE	Interreg	ENPI/ENI
24593	APRA	Interreg	ENPI/ENI
789391	**AQUA-LIT**	**EMFF**	**EMFF**
813680	AQUASENSE	H2020	MSCA
818173	AquaVitae	H2020	RIA
863034	ASTRAL	H2020	RIA
862923	AtlantECO	H2020	RIA
850717	ATLANTIS	H2020	ERC
101010454	**B4PNOW**	**H2020**	**SME**
20083	**BCE**	**Interreg**	**ERDF**
101092863	Be2aty	ERASMUS2027	ERASMUS-LS
24608	BeECO	Interreg	ENPI/ENI
720326	**BIOCOMPLACK**	**H2020**	**IA**
863708	BIOGEARS	EMFF	EMFF-AG
23151	BioLearn	Interreg	ENPI/ENI
860407	BIO-PLASTICS EUROPE	H2020	IA
860055	Black Sea CONNECT	H2020	CSA

727453	**BLUEMED**	**H2020**	**CSA**
101094073	BlueMissionMed	HORIZON	HORIZON-CSA
788894	**BLUENET**	**EMFF**	**EMFF**
101099528	BMRex	HORIZON	HORIZON-EIC
101000240	BRIDGE-BS	H2020	RIA
101059923	BUDDIE-PACK	HORIZON	HORIZON-IA
869673	CAPARDUS	H2020	CSA
21481	**CAPonLITTER**	**Interreg**	**ERDF**
951076	CEnTOUR	COSME	COSME-GA
101003806	CIRCULAR FoodPack	H2020	RIA
22116	CircularSeas	Interreg	ERDF
101055916	CIRCVET	ERASMUS2027	ERASMUS-LS
774586	**CLAIM**	**H2020**	**IA**
19342	CleanAtlantic	Interreg	ERDF
22820	COMMON	Interreg	ENPI/ENI
820477	CREAToR	H2020	RIA
765198	CRESTING	H2020	MSCA
24611	**CRoCuS**	**Interreg**	**ENPI/ENI**
863529	CTP	EMFF	EMFF-AG
101094070	DALIA	HORIZON	HORIZON-IA
101000518	DOORS	H2020	RIA
101036428	EcoeFISHent	H2020	IA
101010323	EcoFLEXY	H2020	SME
813124	ECORISK2050	H2020	MSCA
783681	eco-soft	H2020	SME
101093293	EDITO-Model Lab	HORIZON	HORIZON-IA
20089	EMERGREEN	Interreg	ERDF
849456	EnviroCaps	H2020	SME
101089548	ET GYM4SD	ERASMUS2027	ERASMUS-LS
951043	EU ECO-TANDEM	COSME	COSME-GA
101004049	EURECA-PRO	EPLUS2020	EPLUS2020-AG
101003805	**EUROqCHARM**	**H2020**	**CSA**
101010566	Fibrestop	H2020	SME
863697	FISH4FISH	EMFF	EMFF-AG

727892	GENIALG	H2020	IA
887711	Glaukos	H2020	BBI
774499	**GoJelly**	**H2020**	**IA**
101079267	GREENLand	HORIZON	HORIZON-CSA
101000632	HEREWEAR	H2020	IA
101090291	IMPACTAS	HORIZON	HORIZON-TMA-MSCA-PF-EF
965173	Imptox	H2020	RIA
101000612	In-No-Plastic	H2020	IA
23807	**Joint cross-border initiatives for reduction of marine litter in Aegean and Black Sea (Seas without waste)**	**Interreg**	**IPA/IPAII**
101003954	**LABPLAS**	**H2020**	**RIA**
955387	LEON-T	H2020	RIA
LIFE15 ENV/ES/000252	LIFE LEMA	LIFE	LIFE-ENV
LIFE20 GIE/FR/000114	LIFE SEABIL	LIFE	LIFE-ENV
101058121	LIFE21 FPA/BE/SAR	LIFE2027	LIFE-FPA-OG
101058653	LIFE21 FPA/ES/Oceana in Europe	LIFE2027	LIFE-FPA-OG
101058916	LIFE21 FPA/FR/SFE	LIFE2027	LIFE-FPA-OG
101057743	LIFE21 FPA/SE/CCB	LIFE2027	LIFE-FPA-OG
101058217	LIFE21 NGO/BE/SAR	LIFE2027	LIFE-FPA-OG
101058826	LIFE21 NGO/ES/OCEANA in EUROPE	LIFE2027	LIFE-FPA-OG
101058944	LIFE21 NGO/FR/SFE	LIFE2027	LIFE-FPA-OG
101058820	LIFE21 NGO/NL/ZWE	LIFE2027	LIFE-FPA-OG
101074191	LIFE21-ENV-ES-BIODAPH2O	LIFE2027	LIFE-PJG
101074258	LIFE21-ENV-IE-PLASTIC2WAXLIFE	LIFE2027	LIFE-PJG
101074314	LIFE21-ENV-IT-LIFE RESTART	LIFE2027	LIFE-PJG
101069513	LIFE21-IPE-FI-PlastLIFE	LIFE2027	LIFE-PJG
101070722	LIFE21-NAT-FR-LIFE-SEADETECT	LIFE2027	LIFE-PJG
101074547	LIFE21-NAT-IT-LIFE DREAM	LIFE2027	LIFE-PJG
101111969	LIFE22 NGO/BE/SAR	LIFE2027	LIFE-FPA-OG

101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
101112067	LIFE22-NGO-ES-Oceana in Europe	LIFE2027	LIFE-FPA-OG
101111878	LIFE22-NGO-FR-SFE	LIFE2027	LIFE-FPA-OG
860720	**LimnoPlast**	**H2020**	**MSCA**
24607	LitOUTer	Interreg	ENPI/ENI
101000832	**MAELSTROM**	**H2020**	**IA**
21616	MARELITT Baltic	Interreg	ERDF
789314	MarGnet	EMFF	EMFF
22474	MARLENA	Interreg	ENPI/ENI
24582	MARLESS	Interreg	ERDF
22445	MARLITER	Interreg	ENPI/ENI
21325	MEDSEALITTER	Interreg	ERDF
19021	**MELTEMI**	**Interreg**	**ERDF;IPA/IPAII**
101075944	MiCoS	HORIZON	HORIZON-ERC
101010214	MIMBOX	H2020	SME
101008724	MINKE	H2020	RIA
870294	MIX-UP	H2020	RIA
23073	ML-REPAIR	Interreg	ERDF
860775	MONPLAS	H2020	MSCA
22470	MWM-GMR	Interreg	ENPI/ENI
101074766	NAFO NEREIDA 2022	EMFAF	EMFAF-PJG
646002	NanoFASE	H2020	RIA
101101022	NanoPlastBall	HORIZON	HORIZON-ERC-POC
948666	NaPuE	H2020	ERC
101000825	NAUTILOS	H2020	IA-LS
101081273	NECCTON	HORIZON	HORIZON-RIA
887474	NENU2PHAR	H2020	BBI
101036127	NET	H2020	CSA
789121	NetTag	EMFF	EMFF
101081865	NINFA	HORIZON	HORIZON-RIA
789390	**OCEANETS**	**EMFF**	**EMFF**
19309	OceanWise	Interreg	ERDF
101043711	OCN	HORIZON	HORIZON-ERC

101086521	OneAquaHealth	HORIZON	HORIZON-RIA
101090795	OSES	ERASMUS2027	ERASMUS-LS
101000210	PAPILLONS	H2020	RIA
101086297	PERMAGOV	HORIZON	HORIZON-RIA
873312	PlanticsInside	H2020	SME
21402	PlasticBusters MPAs	Interreg	ERDF;IPA/IPAII
20505	PlasticFreeDanube	Interreg	ERDF
965196	PLASTICHEAL	H2020	RIA
101088822	**PlasticPiratesEU**	**HORIZON**	**HORIZON-CSA**
965367	PlasticsFatE	H2020	RIA
101072777	PlasticUnderground	HORIZON	HORIZON-TMA-MSCA-DN
964766	POLYRISK	H2020	RIA
952983	PRESERVE	H2020	RIA
761112	PRESTIGE	H2020	IA
825803	ProtCap	H2020	ERC
780121	PTwist	H2020	IA
101060806	R3PACK	HORIZON	HORIZON-IA
22460	RedMarLitter	Interreg	ENPI/ENI
101093964	**REMEDIES**	**HORIZON**	**HORIZON-IA**
860221	REPOL	H2020	MSCA
652643	Respon-SEA-ble	H2020	CSA
814100	SAMCAPS	H2020	MSCA
871295	**SeaClear**	**H2020**	**RIA**
101093822	**SeaClear2.0**	**HORIZON**	**HORIZON-IA**
862910	SEALIVE	H2020	IA
101036640	SHARED GREEN DEAL	H2020	RIA
955334	SOPLAS	H2020	MSCA
101060213	SOS-ZEROPOL2030	HORIZON	HORIZON-CSA
101009793	SUNFISH	H2020	SME
101090336	Sus-Bio-plastics	HORIZON	HORIZON-TMA-MSCA-PF-EF
830150	TAPP X	H2020	SME
715386	TOPIOS	H2020	ERC
953073	UPLIFT	H2020	RIA

772923	VORTEX	H2020	ERC
101008984	WasteShark	H2020	SME
21198	Welcome	Interreg	IPA/IPAII
968384	YANGI	H2020	SME
101036756	ZeroPM	H2020	RIA
24610	ZeroWasteBSB	Interreg	ENPI/ENI
22448	ZEWSGES	Interreg	ENPI/ENI

7. Prevent and eliminate pollution – nutrients, chemicals, pesticides. *By Teresa Rocha Santos*

7.1. Main findings of the analysis

This report provides an analysis of a portfolio of 200 projects selected as relevant to the Mission "Restore our Ocean and Waters" (from now on the Mission) specifically to its objective 2b (prevent and eliminate pollution of our ocean, seas and waters in particular nutrients, chemical pesticides and other pollutants such as pharmaceuticals, heavy metals or underwater noise). This objective is in line with the EU action plan towards zero pollution for air, water and soil for which there are targets to reduce by at least 50% nutrient losses, and the use and risk of chemical pesticides. The projects contribute to the Mission's objectives and the European Green Deal targets of eliminating pollution by providing nature-based or synthetic-based solutions, monitoring or generating knowledge, modelling, and data management, developing methods or technology for monitoring, protecting, and conserving the ecosystem, and net zero maritime sector's emissions. The 200 projects are also related to nutrients, pesticides, other pollutants (*e.g.,* per- and poly-fluoroalkyl substances (PFAS), pharmaceuticals and personal care products (PPCPs), toxins, heavy metals, and hydrocarbons), and underwater noise. The list of projects is included in section 7.5.

The 200 projects receive a contribution of 1076,1M€ from EU funding programmes. The main funding programme was Horizon 2020 (H2020) contributing 53.6%. Horizon Europe (HORIZON) follows by contributing 37.8%. H2020 and HORIZON were also the main contributors in terms of the number of projects funded. A total of 48.5% of the 200 projects were funded by H2020 while a total of 23% was funded by HORIZON.

The projects are classified into nine thematic areas: monitoring/development of new methods, removal, Infrastructure and network, technology development, nature-based products, synthetic products, modelling, protection, conservation and prevention, and restoration. Some projects address more than one area, and the count of thematic areas is 302. Monitoring/development of new methods and removal are the main thematic areas addressed by the projects. As regards the tools used to drive (or leverage) the wanted change, research and innovation is the one most targeted by the projects (48.8%). Knowledge generation and deployment of solutions are also targeted by a substantial number of projects. Only a limited number of projects deal with the definition and implementation of new governance structures or effective financial and economic models. It is also worth noting that the focus on citizen's engagement or training and education is also scarce, in particular owing to its importance in pollution prevention.

A total of 20 projects were selected for further analysis (they are highlighted in blue and bold in section 7.5 - list of projects) of the results according to their relevance and distribution by funding programmes. From the 20 selected projects (of the 200) 8 are closed and 12 are ongoing. Most of the projects cover more than one thematic area or target more than one pollutant and some are focused on providing new technology or methods or harmonized technologies for monitoring contaminants while others are providing new treatments or new materials. The projects mainly produced or will produce technology validated in relevant environments (13 projects) or technology developed ready for commercial exploitation and other ready-to-use results such as guidelines, and web tools (10 projects). Some projects will produce more than one type of result.

Of the 12 ongoing projects, only NAUTILOS shows, in the publicly available information, a direct link with the Mission's Mediterranean Lighthouse through an action of citizen

engagement. Although not found in publicly available information (project website, Mission action website) at least 5 other projects may contribute to the achievement of Missions objectives in the Atlantic and Artic, Mediterranean, Baltic and North Sea lighthouses.

Several options are used by the projects to foster the uptake of solutions. The most used are dissemination events with the participation of relevant stakeholders to promote research and market solutions (*e.g.,* NOMAD). NOMAD developed a movable digestate technology for nutrient recovery and antibiotics removal that has the potential for application and replication in small farms (and others) across rural, peri-urban and urban areas. This project also facilitates the uptake by producing technology with a payback of 2.5 years which is considered a short period. One different option was used by one of the projects (FLORA) by building a multi-stakeholder value chain to leverage innovation and decrease the risk of commercialisation of a multi-sensing self-energising ocean station for oceanographic data collection. Other projects such as JAMOSPANS produced/proposed to OSPAR Intersessional Correspondence Group, ICG Noise a joint monitoring programme for application in the North Sea. NORDBALT-ECOSAFE project communicates the project solutions to sister projects (HORIZON funded) such as NAPSEA and to an IST-funded project ECOSAT.

Overall, there is a need to invest in technology for the monitoring of pollutants capable of stand-alone for long-time monitoring in harsh conditions. There is also a need for further developing or improving methods for pollutant removal. It is also necessary to understand the market related to the commercialization of the solutions for farmers and factories/industries to control the release of nutrients, pesticides, and other pollutants. It is necessary to understand the barriers and propose, in future project proposals, the enablers for the successful uptake and implementation of project results. It is also necessary to develop more guidelines for monitoring, management and modelling solutions and allow their availability on online networking platforms. These platforms should be able to work in the long term beyond the project duration and preferably with the option to add more data.

7.2. Description of the portfolio

This portfolio comprises an analysis of 200 projects considered as relevant to the Mission 'Restore our Ocean and Waters' mainly to its objective 2b (prevent and eliminate pollution of our ocean, seas and waters in specific nutrients, pesticides, and other pollutants *e.g.*, heavy metals, pharmaceuticals and underwater noise). Mission objective 2b is in line with the EU action plan towards zero pollution for air, water and soil concerning the targets of reducing by at least 50% nutrient losses, the use and risk of chemical pesticides. The projects are related to nutrients, pesticides, other pollutants (*e.g.,* per- and poly-fluoroalkyl substances (PFAS), pharmaceuticals and personal care products (PPCPs), toxins, heavy metals, and hydrocarbons), and underwater noise. Generally, the projects in the portfolio contribute to eliminating pollution, monitoring pollution, protecting, and conserving the ecosystem, and net zero maritime emissions, therefore, contributing to the Mission's objectives, and also to the European Green Deal targets. Most of the projects (60%; 120 of 200 projects) contribute to the Green Deal target of reducing by at least 50% nutrient losses while a minority (15%; 30 of 200 projects) contribute to the Green Deal target of reducing by at least 50% the use and risk of chemical pesticides.

The majority of the 200 projects in the portfolio, that is 71.5%, are funded either by H2020 (48.5%) or by HORIZON (23%). 28.5% of the projects were funded by other programmes such as European Territorial Co-operation (INTERREG, 13%), by Programme for the Environment and Climate Action 2027 (LIFE2027, 10%), by European Maritime and Fisheries Fund (EMFF, 2%), by Programme for the Environment and Climate Action (LIFE, 1.5%), by

European Maritime, Fisheries and Aquaculture Fund (EMFAF, 1%), by Digital Europe Programme (DIGITAL, 0.5%) and by Erasmus+2027 (ERASMUS2027, 0.5%) (Figure 7.1).

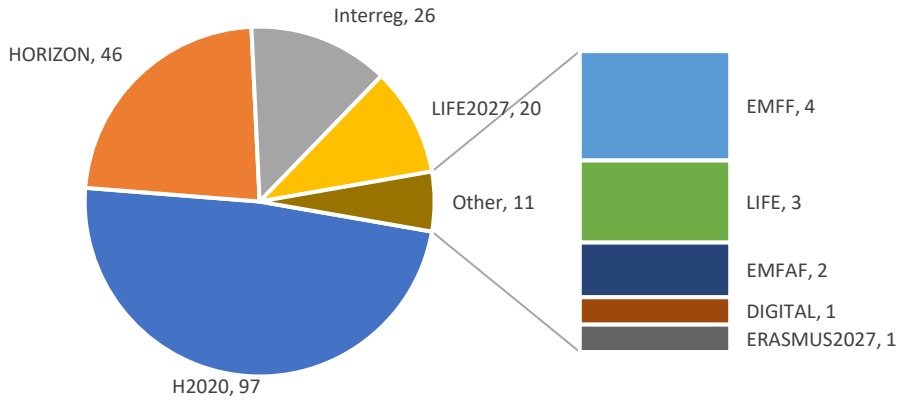

Figure 7.1. Number of projects per EU funding programme. Total number of projects: 200.

These projects resulted in a total contribution from European programmes of 1076,1 M€ whereas H2020 and HORIZON are the major funding programmes contributing 576,8 M€ and 406,6 M€, respectively. INTERREG contributed 58,1 M€ while other funding programmes contributed 30 M€ (LIFE2027; 19,0 M€), EMFF (4,4 M€), LIFE (5,4 M€), EMFAF (3,4 M€), DIGITAL (2,0 M€) and ERASMUS 2027 (0,4 M€) (Figure 7.2).

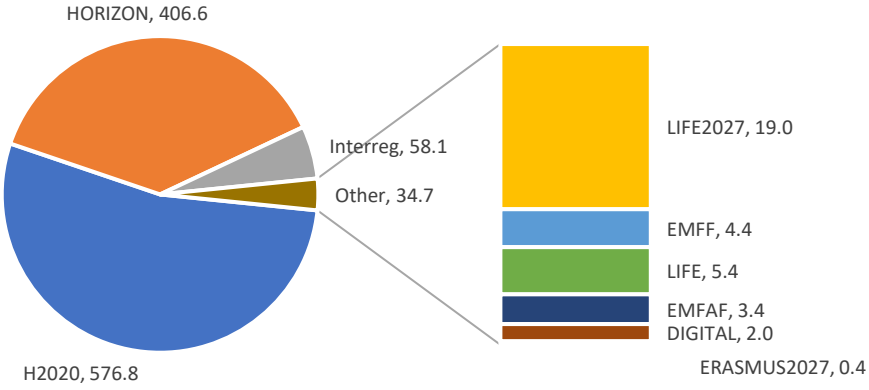

Figure 7.2. EU contribution (M€) per funding programme. Total EU contribution: 1076,1M€

In terms of the type of action most projects, 44, are research and innovation action (RIA) followed by HORIZON research and innovation action (HORIZON-RIA), 23, by European regional development fund (ERDF), 22, and by Innovation action (IA), 20, Marie Sklodowska-Curie Action (MSCA), 12, and *LIFE* Operating Grant Framework Partnership Agreements (LIFE-FPA-OG), 11 (Figure 7.3).

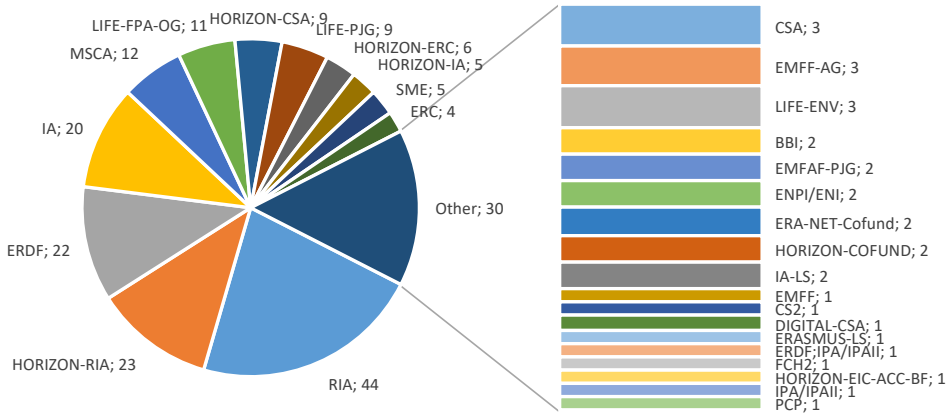

Figure 7.3. Number of projects per type of action. Total number of projects: 200.

A number of projects between 9 and 4 are Horizon - Coordination and support action (*CSA*), 9, LIFE-PJG, 9, Horizon Europe – European Research Council (HORIZON-ERC), 6, HORIZON innovation action (HORIZON-IA), 5, Small or Medium-Sized Enterprise Instrument (SME), 5, European Research Council (ERC), 4. Equal or less than 3 projects are other actions such as Coordination and Support Actions (CSA), 3, EMFF Action grant (EMFF-AG), 3, LIFE-Environment (LIFE-ENV), 3, among others.

Concerning the budget RIA (306,4 M€, 28.5 %), Horizon Europe Co-fund Action, HORIZON-COFUND, (226,0 M€, 21.0%), IA (149,7 M€, 13.9%) and Horizon Europe Research and Innovation Action, HORIZON-RIA, (113,6 M€, 10.6%) have the highest shares in the total budget. The share of projects supported by European Regional Development Fund (ERDF), HORIZON-IA and Marie Skłodowska-Curie Actions (MSCA) is 5.1%, 3.6%, 3.0%, respectively. The other 23 different actions have a small budget in the portfolio and together contribute to a total share of 14.3 % of the budget (Figure 7.4).

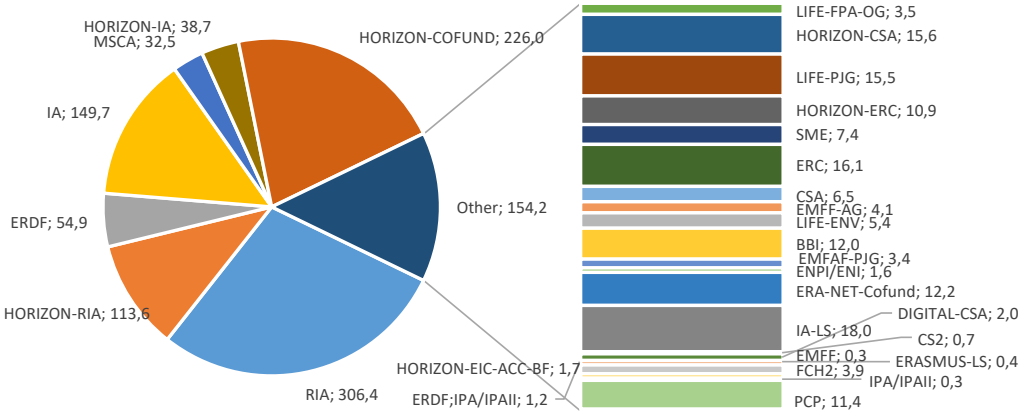

Figure 7.4. EU contribution (M€) per type of action. Total EU contribution: 1076,1 M€.

Of the 200 portfolio projects 120 projects address nutrient issues while 136 projects are related to other pollutants (*e.g.,* PFAS, PPCPs, toxins, heavy metals, hydrocarbons, and underwater noise) and 30 projects are related to pesticide pollution (Figure 7.5). The total number of projects addressing any of these types of pollutants is 286 which is higher than the total number of projects in the portfolio since several projects deal with more than one main type of pollutant. There are projects that address nutrient pollution directly by for example monitoring nutrients, studying eutrophication, and removing nutrients or there are projects that contribute indirectly to reducing nutrients by for example reducing energy consumption and carbon emissions.

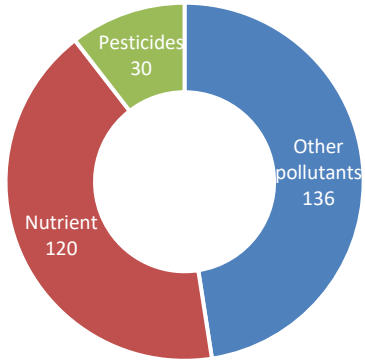

Figure 7.5. Main type of pollutant addressed by the projects. Some projects address more than one type of pollutant. Total count of projects addressing any of these types of pollutants: 289. Total number of projects: 200.

The relevance of the projects to nine main thematic areas is assessed based on the abstract, of each project, as a part of their scope. The thematic areas are as follows:

- Monitoring/developing new methods: environmental monitoring of water quality, discharges, and emissions; use of life-cycle approaches to assess environmental impact in water; use of analytical tools or sensors for the monitoring of a certain pollutant, development of new sensors or improvement in existent analytical methodologies towards the monitoring of a certain pollutant or group of pollutants.

- Removal: reducing the use of nutrients and other pollutants; applying management practices to mitigate pollutants' impacts; use of technology or processes (e.g., photochemical, electrochemical) for removal of pollutants from matrices such as water and wastewater.

- Infrastructure and Network (Infrastructure/Network): Institutions/partners join to make infrastructure available (*e.g.,* access to certain equipment or data) for the scientific community; constitute a network to transfer knowledge to the scientific community, public and stakeholders.

- Technology development: development of underwater vehicles equipped with sensors for monitoring pollutants, platforms for sea observation with self-energy, new ships, and turbines.

- Nature-based products: development of new products nature-based (*e.g.,* products from the biological origin such as marine organisms or food wastes) for the removal of pollutants (*e.g.*, from waters and wastewater).

- Synthetic products (Synt. Products): development of new products non-nature-based for the removal of pollutants (*e.g.,* from waters and wastewater).

- Modelling: use of representative data from monitoring or observation schemes for predicting contamination scenarios and mitigating impacts; mapping and assessment of the influence or impact of certain pollutants.

- Protection, conservation, and prevention (protect/conserve./prevent.): provide indicators towards biodiversity conservation and protection; use of preventive measures towards biodiversity protection.

- Restoration: development or use of measures towards environmental restoration.

The total count of thematic areas is 302 for the 200 projects (Figure 7.6). There are several projects contributing to more than one thematic area, according to the available information. Most of the projects deal with the monitoring /development of new methods (29.1%), followed by removal (18.2%), Infrastructure and Network (12.9%), technology development (11.9%), nature-based products (8.9%), and modelling (8.3%). The thematic areas of protection, conservation, prevention, synthetic products, and restoration are the less addressed, by the projects, counting 5.3%, 4.0% and 1.3%, respectively.

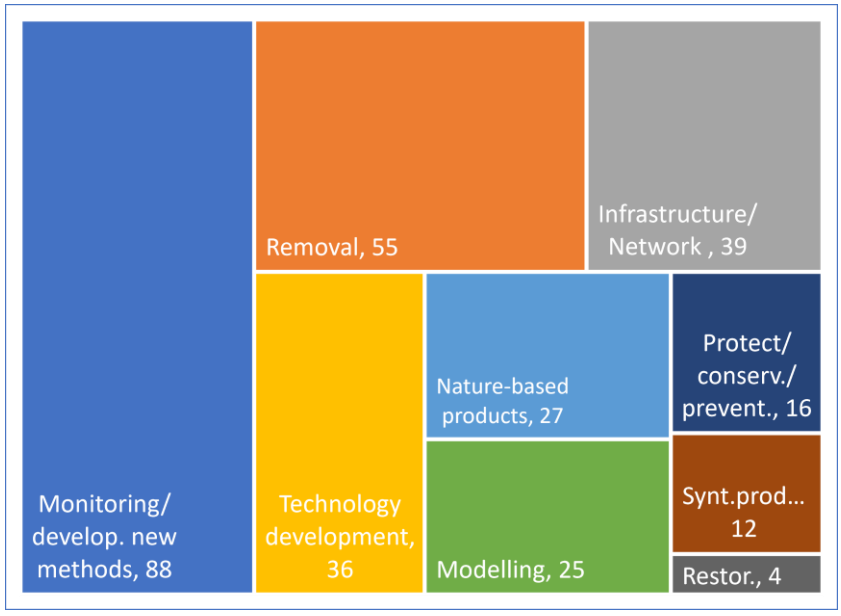

Figure 7.6. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 302. Total number of projects: 200.

Levers of change (LoC) relate to the main type of tool used or activity undertaken by the projects to drive (or leverage) change towards_preventing and eliminating pollution of our ocean, seas and waters. Table 7.1 shows the focus of the projects in terms of LoC across thematic areas. Some projects focus on more than one LoC. Research and Innovation (R&I, 48.8%), Knowledge & Data, 14,7%, and Deployment (13.6%) are the most targeted by the projects while Education & Training, Governance, Citizen Engagement and Finance & Economy are the less targeted accounting 9.8%, 9.2%, 3.3%, 0.6%, respectively. It can be observed that for the thematic areas of monitoring/developing new methods and modelling thematic areas there is a decrease from the most targeted R&I to Knowledge & Data, followed by Deployment. In the case of project thematic area Removal, Deployment follows the most targeted R&I.

Table 7.1. Lever of Change (LoC) vs. thematic areas (T.A.). For LoC it is understood the type of tool targeted by the project to drive (or leverage) change in the desired direction.

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engament	Education& Training
Monitoring/develop. new methods	12	1	71	23	17	4	12
Removal	6	0	43	10	14	4	5
Infrastructure/ Network	2	0	0	1	0	0	2
Technology development	2	0	0	1	0	0	2
Nature-based products	2	0	23	1	9	1	1
Modelling	3	0	17	9	5	0	3
Protect/conserv./prevent.	3	0	4	5	0	2	7
Synt. Products	0	1	11	0	2	0	0
Restoration	2	0	0	1	0	0	2
Total	32	2	169	51	47	11	34

Concerning the geographical coverage, at least 7 projects are developed for the Mediterranean basin, 17 in the Atlantic/Artic basin, and 17 Baltic/North basin.

From the 200 portfolio projects, a total of 20 (highlighted in blue and bold in section 7.5) were selected for in-depth analysis of the main outcomes and for fostering the uptake of solutions. These projects are mainly funded by H2020 (9 projects) where 2 are SME and 1 is MSCA actions. HORIZON funded 4 of the 20 projects whereas 1 of those is ERC action. Programmes such as INTERREG, LIFE2027, LIFE and EMFAF funded 3, 2,1 and 1 projects, respectively.

Of the 20 projects 12 projects (EMERGE, DAML, PONTOS, PRISTINE, NORDBALT-ECOSAFE, IBAIA, Saraswati 2.0, NOMAD, OC-TEC, NAUTILOS, BRIDGES, NAPSEA) contribute directly or indirectly to the Green Deal target of reducing by at least 50% nutrient losses while 5 projects (KNOWPEC, LIFE21-ENV-ES-LIFE, EiCLaR NextFUMIGREEN, PRISTINE, CGM,) contribute to the Green Deal target of reducing by at least 50% the use and risk of chemical pesticides. Other projects such as POSEIDON, LIFE PortSounds, JOMOPANS contribute mainly for reducing underwater noise. One project may contribute to more than one Green Deal target.

7.3. Main outcomes and fostering the uptake of solutions

7.3.1. Main outcomes

Taking into consideration the fact that at the time of writing this report, 12 of the 20 analysed projects are still ongoing (Table 7.2), the available information about tangible results is rather limited. The information, in this case, is collected based on the predicted results and was gathered mainly using both the CORDIS and the project website.

The information was also collected using mainly the CORDIS and the project website regarding projects already finished. The information publicly available such as documents and reports, peer-review articles, videos, open data, and conference proceedings were also assessed. Very limited information is available online regarding the LIFE, LIFE2027 and ERC funded projects.

Most of the projects include more than one application for nutrients, other chemicals, or underwater noise. Some projects are focused on providing new technology, methods, or harmonized methodologies for monitoring the contaminants in the environmental compartments or emissions and sources of these contaminants, while others are advancing in remediation strategies by providing new treatments or new materials.

Table 7.2 shows tangible results that were found for the 20 projects analysed in depth.

Table 7.2. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
BRIDGES	Project developed gliders able to operate in extreme pressure environments, hybrid buoyancy and propeller propulsion navigation. The sensing systems were miniaturized, and capable of in-situ analysis of nutrients, acoustic characterization of the sea-bed, and small particle.	The developed technology and sensors can be applied to the detection of nitrate, phosphate, ammonia, oil, and gas in underwater for sea-bead and ocean column exploration.	https://cordis.europa.eu/project/id/635359/results
CGM	The project developed a solution to unsustainable water usage through targeted capture of micropollutants from industrial wastewater.	The project solution can capture micropollutants concentrations to parts per trillion (ppt) levels.	https://cordis.europa.eu/project/id/805997/reporting
DAML	The project developed a tool to assess seasonal exceedances of nutrients loads and for the selection of temporarily efficient catchment scale measures to reduce the riverine load of nutrient to the Gulf of Riga and the Baltic Sea.	Decrease nutrient load to the Gulf of Riga and the Baltic Sea.	https://envir.ee/en/media/6384/download https://keep.eu/projects/24926
EiCLaR	The project expect to develop and exploit (electro)- nanobioremediation, bioaugmentation, bioelectrochemical remediation, enhanced phytoremediation tools.	The techniques will be applied in industrial processes for the treatment of environmental pollutants such as chlorinated solvents, heavy metals, hydrocarbons.	https://cordis.europa.eu/project/id/965945/results

Project acronym	Description of result	Application	Link to the result
EMERGE	The project submitted a few reports including the available abatement methods for SO_x, NO_x and particulate matter (PM), together with data on emissions, waste streams, costs and applicability; the measurements of dissolved and particulate contaminants in case study regions; the scrubber water whole effluent toxicity testing at different geographical regions and shipping emission data set for air quality models.	These results will be used in the modelling of shipping emissions and in the evaluation of their cost-effectiveness. The project will provide control measures for reducing of SO_x, NO_x and PM from marine vessels.	https://emerge-h2020.eu/results/ https://cordis.europa.eu/project/id/874990/results
FLORA	The project will develop a prototype of a self-energising, multi-sensing ocean station capable of an annual energy production of 25 MWh to power its oceanographic data services.	The project technology will provide a solution for monitoring the underwater environment and contribute to marine spatial planning.	https://wedgeglobal.com/flora-floatingradar/
IBAIA	The project will develop a prototype of a modular device integrating photonic and electrochemical sensors.	The modular device is for real-time monitoring of multiple potential organic chemicals, nutrients and heavy metals in water bodies including rivers, lakes, and oceans.	https://cordis.europa.eu/project/id/101092723 https://rd-technologiques.ifremer.fr/en/Projects/IBAIA-Innovative-environmental-multi-sensing-for-waterbody-quality-monitoring-and-remediation-assessment
JOMOPANS	The project developed standard procedures for ocean noise monitoring. The project has obtained underwater sound data by	The standard procedures can be used for noise monitoring in seas and oceans.	https://northsearegion.eu/jomopans

Project acronym	Description of result	Application	Link to the result
	hydrophone measurements at selected stations within the area of the North Sea. The project has developed a Good Environmental Status tool (GES tool). JOMOPANS has developed a framework for a fully operational joint monitoring programme for ambient noise in the North Sea.		https://keep.eu/projects/19154/Joint-Monitoring-Programme--EN/ https://northsearegion.eu/media/17501/interreg_jomopans_10-years-of-north-sea-soundscape-monitoring_final.pdf
KNOWPEC	The project developed and validated analytical methods for monitoring pesticides in waters. The project applied solar remediation technologies for pesticides removal and demonstrated its potential both in laboratory and in pilot plant. Biobeds and wetlands were also applied to remediate pesticide contaminated water under both European and Latin America climatological conditions.	The project monitored pesticides in natural waters, evaluated toxicity and provided remediation tools thus contributing the water protection in Latin America and Europe.	https://cordis.europa.eu/project/id/690618/reporting
LIFE PortSounds	The project will provide a management tool for near real-time and continuous monitoring of underwater noise, and data used to generate predictive scenarios associated with different traffic intensities.	The project expects to apply the tool in another 3-5 Port Authorities, and replication of underwater noise mitigation measures by at least one Port Authority.	https://webgate.ec.europa.eu/life/publicWebsite/project/details/5592

Project acronym	Description of result	Application	Link to the result
	It is also expected that the project will contribute to the reduction of 5 and 10 dB of sound pressure level of 105.3 tons of CO_2 (8.8% change), of 8.8% in SO_x (1.38 tons) and NO_x emission.		
LIFE21-ENV-ES-LIFE NextFUMIGREEN	The project will test the effectiveness of a new type of nature-based pesticide in the protection of greenhouse crops.	It is expected the biopesticide will be effective against pests and diseases specific to pepper and tomato crops (greenhouse crops) and that it can be used for other pathosystems.	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/43252405/101074143/LIFE2027
NAPSEA	The project addresses the linkages between land, water, delta, estuary, coast, nearshore and ocean ecosystems thereby supporting a holistic view of socioeconomic development and environmental management.	The geographical scope of the project covers the catchment of the Wadden Sea, with case studies for the Rhine, Elbe and Hunze catchments and the Wadden Sea itself.	https://napsea.eu https://www.hereon.de/about_us/eu_projects/horizon_europe/earth/107166/index.php.en https://cordis.europa.eu/project/id/101060418
NAUTILOS	The project developed instruments such as dissolved oxygen and fluorometric sensors, downward-looking hyperspectral and laser-induced fluorescence imagers, passive acoustic sensors, active multi-frequency bio-acoustic water column profiling sensors, and phytoplankton and other suspended matter samplers. The project also developed the Citizen Science dedicated App for the	The instruments can be used for marine biological observations and pollutants monitoring.	https://cordis.europa.eu/project/id/101000825/reporting https://www.nautilos-h2020.eu

Project acronym	Description of result	Application	Link to the result
	uploading and analysing data gathered during Citizen Science campaigns.		
NOMAD	The project developed a mobile digestate technology. The technology was arranged onto two transportable trailers: Trailer 1 including the heat recovery and digestate separation while Trailer 2 performs the nutrient recovery and the antibiotics removal.	The mobile approach enables digestate management and nutrient recovery from decentralised anaerobic digestion plants, producing digestate-derived fertilizers and soil amenders tailored to farmers' soil and crop requirements and pharmaceutical free water.	https://cordis.europa.eu/project/id/863000 https://www.projectnomad.eu
NORDBALT-ECOSAFE	The project will develop a method to set harmonised reference values for nutrients for different types of waterbodies in the Nordic-Baltic region. The project will develop a tool/portfolio of nature-based solutions and mitigation measures to reduce nutrient losses from agriculture and forestry.	The nature-based solutions and mitigations measures can be applied to the reduction of nutrients from agriculture and forestry thus contributing to safer water bodies.	https://projects.au.dk/nordbalt-ecosafe https://cordis.europa.eu/project/id/101060020
OC-TEC	The project developed a catamaran-vessel comprised by different cleaning systems to collect and manage various floating wastes within water bodies.	The OC-TEC demonstrated that can collect any surface waste, including: - Hydrocarbons and oils - Microplastics - Microalgae bloom - Floating marine litter	http://www.oceansplasticleanup.com/Projects_Plastics_Oceans_Cleaning/OC-Tech_Ocean_Cleaner_H2020_Horizon_Catamaran_Aluminium_Commission_European.htm
POSEIDON	The project will develop anti-auxetic underwater metamaterials and topologically	The new materials will contribute to underwater wave control.	https://cordis.europa.eu/project/id/101039576

Project acronym	Description of result	Application	Link to the result
	protected and impedance adapted underwater metamaterials.		
PONTOS	The project developed a platform that offer free-of-charge online services for various specialists, including those who do not have the technical expertise to write codes or algorithms to process data.	The project makes information about Black Sea environment accessible to users such as scientists, policymakers, citizens through a platform called PONTOS.	https://ace.aua.am/pontos/ https://pontos-eu.aua.am/wp-content/uploads/2022/12/PONTOS-PUBLIC-REPORT-FINAL-Eng_compressed.pdf
PRISTINE	The project will provide a solution based on the integration of encapsulated adsorbent technology, hollow-fibre nanofiltration membrane, and AOP processes for removal of contaminants of emerging concern.	Removal of PFAS, pesticides, PPCPs, toxins, antibiotic resistance genes and microplastics as target contaminants.	https://eurecat.org/portfolio-items/life-pristine/
Saraswati 2.0	The project developed and applied several technologies for wastewater treatment.	The technologies were applied in 10 pilot sites in India to the treatment of decentralised municipal wastewater, black-water, sludge treatment and post-treatment of conventionally treated effluent.	https://cordis.europa.eu/project/id/821427/reporting https://projectsaraswati2.com/project-deliverables/

Considering the information in the abstract the 20 projects are classified in thematic areas according to: monitoring/developing new methods (FLORA, EMERGE, KNOWPEC, PONTOS, JOMOPANS, NORDBALT-ECOSAFE, IBAIA, NAUTILOS, BRIDGES and NAPSEA), removal (EMERGE, KNOWPEC, LIFE PortSounds, PRISTINE, EiCLaR, Saraswati 2.0, NAPSEA), infrastructure and network (KNOWPEC), technology development (FLORA, POSEIDON, OC-TECH, NOMAD), nature-based products (CGM, NOMAD, LIFE21-ENV-ES-LIFE NextFUMIGREE, modelling (JOMOPANS, NAPSEA, NAUTILOS, EMERGE). Some projects are classified in more than one thematic area.

It can be observed in the description of the results (Table 7.2) that several projects mainly produced or will produce:

- technology validated in relevant environment (TRL 5-7), or technology developed and ready for commercial exploitation (TRL 8-9)

- other ready-to-use results such as policy papers, guidelines, and web tools that are relevant to citizens, stakeholders, and policymakers.

In most cases of the 20 projects, the TRLs are not explicitly stated in publicly available sources or documents. Of the 20 projects, 13 will produce technology validated in relevant environments from which some will produce technology developed and ready for commercial exploitation, while 10 projects will produce ready-to-use results. Each project may produce more than one type of result and may produce more than one technology at different TRL. As an example, the EiClar project, classified in the thematic area removal, will develop techniques applicable in industrial processes for the treatment of pollutants such as heavy metals and hydrocarbons and expect to produce more than one technology and achieve a TRL 6 to 9, depending on the developed product.

As another example, the FLORA project classified in the thematic areas monitoring/developing new methods, and technology development. FLORA will develop an industrial-scale prototype of a multi-sensing ocean station capable of producing energy to power its oceanographic data services and expects to achieve a TRL 7.

As an example of another ready-to-use results project, the JOMOPANS project classified in the thematic areas monitoring/developing new methods, and modelling. JOMOPANS developed a Good Environmental Status tool (GES tool) and proposed a framework for a fully operational joint monitoring programme for ambient noise in the North Sea.

Another example of other ready-to-use results projects is the PONTOS project, classified in the thematic area monitoring/developing new methods. This project makes information about Black Sea environment from the EU Copernicus Earth Observation accessible to users such as scientists, policymakers, and citizens through a platform called PONTOS. The platform offers the following services:

- The PONTOS Data Cube can be used to produce maps from satellite data.

- The PONTOS Web Application manages the in-situ data created within the project.

- The PONTOS WebGIS allows the visualisation of chlorophyll concentration, land use, salinity, temperature, hydrology, weather, and topography. Besides this it allows the visualisation of the data produced in PONTOS pilots regarding eutrophication, floating vegetation and forest changes, coastal erosion, water balance and uses.

From the 12 ongoing projects (Table 7.2) only for NAUTILOS was found a link with the Mission (https://webgate.ec.europa.eu/maritimeforum/en/mission-ocean-actions?page=4) through the action of citizen engagement, ocean science and water literacy, awareness raising and participatory approaches. NAUTILOS is a Horizon 2020 Innovation Action project, classified in the thematic areas monitoring/developing new methods, and modelling, that aims to develop cost-effective sensors and samplers and integrate them within observing platforms and deployment in large-scale demonstrations in the Mediterranean basin. The project is linked with the Mediterranean lighthouse and this action will contribute to the following objectives: the protection and restore marine and freshwater ecosystems and biodiversity, the prevention and elimination of pollution from ocean, seas, and waters, the ocean and waters knowledge system and the public mobilisation and engagement.

For the other 11 ongoing projects, no links to Mission were found in publicly available information (e.g., project website, Mission action website), nonetheless, one project (FLORA; classified in the thematic areas monitoring/developing new methods, and technology development) funded by EMFAF will provide technology for ocean observation (pilot tests in the Atlantic Ocean and potential to replication and upscale) and may contribute to the achievement of Mission Objectives in the Atlantic and Artic Lighthouse Area. Two HORIZON projects, NAPSEA, and NORDBALT-ECOSAFE classified in the thematic areas removal and monitoring/developing new methods, respectively, may contribute to the Missions objectives for the Lighthouse in the Baltic and North Sea area. The LIFE 2027 LIFE PortSounds project (thematic area monitoring/developing new methods) may contribute to the Missions objectives for the Mediterranean Lighthouse, while the H2020 project EMERGE (thematic area removal) may contribute to the Missions objectives for both the Atlantic and Artic lighthouse and the Mediterranean lighthouse.

7.3.2. Fostering the uptake of solutions

Many of the projects of the 20 selected did not finish yet, therefore the following uptake solutions are based on the finished projects or in the planned in the case of ongoing projects.

Several options are used by the projects to foster the uptake of the developed solutions. Some projects (*e.g.,* FLORA) use the connection to relevant stakeholders by building a multi-stakeholder value chain to leverage innovation. Other projects (*e.g.,* PONTOS, LifePortSounds) develop platforms allowing interaction and communication with stakeholders by providing access to relevant results (such as in-situ collected data, satellite maps, among others), surveys and pilots demonstrations, project results demonstration, feasibility studies for further application in other locations and market studies and allowing the identification of relevant partnerships for each solution. These user-friendly easy-to-use platforms showing projects' exploitable results and applicability may contribute to increasing cooperation between experts from different disciplines and stakeholders towards roll-out across the EU.

The dissemination events with the participation of stakeholders such as conferences (*e.g.,* project NOMAD) and awareness-raising events are also used and important to facilitate and promote research, uptake and market solutions.

Some projects (*e.g.,* NORDBALT-ECOSAFE, JAMOPANS) presented their outcomes in committees where international organizations, public bodies, national authorities, and international authorities are members. This may represent an important source of information for politicians allowing them to know available new market solutions or new research solutions that may influence the course of future policies and may roll-up across the EU.

Some projects (*e.g.,* NORDBALT-ECOSAFE) ensure the communication of results to other EU projects having similar objectives such as projects funded under the same programme or funded by different programmes, which may contribute to the exchange of expertise and sharing results with different stakeholders in order to enable the uptake of the project solutions.

Partnership with companies in projects, and participation of companies or Environmental Institutions in steering committees is also a way towards the uptake of relevant results.

Other enabler for the uptake of solutions is the use of economic instruments and incentives such as cost-effective technology. As an example, the technology developed in NOMAD has a payback period of 2.5 years, which is considered a short time.

Some examples of the identified innovative solutions and/or good practices, mentioned above, that could be scaled and transferred are described in more detail:

- FLORA consortium composed of SMEs from the Atlantic Maritime Strategy Member States represents a case study of cross-border collaboration in the Atlantic basin. This project is initiating a multi-stakeholder value chain to leverage innovation thus reducing the risk of following project commercialization prospects. Besides the production of a multi-sensing self-energising ocean station for oceanographic data services, this project also expects a blue job generation (at least 32 full-time employees by 2028) as a product of project exploitation.

- KNOWPEC project transferred good practices between Europe and Latin America. As an example, instead of spraying pesticides on crops fungicides can be topically applied inside special bags, thus avoiding diffuse pollution.

- LifePortSounds will produce a management tool for underwater noise monitoring that provides near real-time continuous data through fixed hydrophones and data used to generate predictive scenarios associated with different traffic intensities. The project will elaborate a feasibility study for a broader application of the tool, applied to the Port of Cartagena, in another 3-5 Port Authorities and replication of underwater noise mitigation measures by at least one Port Authority.

- NORDBALT-ECOSAFE will Integrate a River Basin Management Support System in the Online Networking Platform for involving stakeholders in the selection and placement of Nature-Based Solutions and mitigation measures in agriculture and forestry. The Project will also demonstrate SWAT+ model results and modelling strategies from the six project river basins to HELCOM/OSPAR. This HORIZON funded project also communicates the project outputs to other projects such as other HORIZON-funded projects NAPSEA and NEW-HARMONICA and IST funded project ECOSTAT working with comparing nutrients targets and boundaries. Projects NEW-HARMONICA and ECOSTAT are not part of the 20 selected projects.

- JOMOPANS produced a joint monitoring programme for ambient noise plan and advised OSPAR regarding the outlines of the programme. The project participated in meetings of the Intersessional Correspondence Group, ICG Noise, to present the project results.

- NOMAD developed a mobile digestate technology arranged onto two transportable trailers: Trailer 1 includes the heat recovery and digestate separation while Trailer 2 performs the nutrient recovery and the removal of antibiotics. The pilots are in Greece, Italy, Malta and United Kingdom to treat animal residue, crop waste, municipal wastewater

and food waste, respectively. The project technology has high potential to be widely replicated across rural, peri-urban, and urban areas, therefore a final conference considered of particular interest for those interested in digestate management practices is organized.

7.4. Policy recommendations

The analysis of the available information (*e.g.*, peer-review papers, project reports) regarding knowledge, research, and innovation gaps for the 8 closed projects (of the 20 selected from the portfolio) allows the following specific considerations regarding specifically nutrients and pesticides:

- It is evident that there is a need to define a more specific list of measures to reduce the transport of nutrients and achieve a good environmental status of the rivers and the coastal sea, thus requiring additional catchment and field scale studies.
- Related to the above, efficient measures to reduce the diffuse load of agricultural nutrients need to be applied at the farm and field scale.
- There is a need for proposing safe ecological boundaries for nutrients to local, regional, and national river basin managers.
- There is a need for identifying the occurrence and fate of pesticides and newly developed (bio)pesticides in natural waters, thus evaluating their toxicity, and proposing guidelines for national prioritization.

The following considerations regarding other pollutants such as contaminants of emerging concern can be made:

- There is a need for integrated solutions for monitoring and removing contaminants of emerging concern from water streams.
- There is a need for new solutions for removing emerging contaminants from the environment and from sources by developing and applying new materials and biobased solutions.

Considering other pollutants more specifically underwater noise, the following considerations can be made:

- There is still low knowledge of the contributing sources of underwater noise, therefore there is a need for the evaluation of other potential sources of underwater noise besides ships.
- It is necessary to gain knowledge of the characteristics, intensity and spatial distribution of underwater noise and its impacts on marine wildlife by monitoring and understanding the distribution and sensitivity of marine animals.
- There is a need to create more governance mechanisms (for example technical working groups) to agree on and assess the mitigation measures needed to prevent the impact of underwater noise in marine ecosystems.

- There is a need for the creation of joint monitoring programmes for underwater noise.

Taking into consideration that identified projects represent different funding programmes and types of actions focusing on monitoring (*e.g.,* assessment of indicators), the development of methodologies or technology for monitoring or observation schemes, the generation of knowledge, modelling and data management, and the solutions to remove pollutants, the overall considerations can be made:

- It is important to make a reliable diagnosis of the abundance of a certain pollutant in the environment by adequately identifying the occurrence, fate, and behaviour in the environment and this applies to nutrients, pesticides, and other pollutants.

- There is a need for the development of more guidelines and factsheets for monitoring, management, and modelling solutions and making them available on online networking platforms. There is also a need for enhanced interdisciplinary research and training researchers to apply tools and methods used in different fields.

- There is a need to invest in technology for in-situ monitoring of pollutants (nutrients, pesticides, compounds of emerging concern and underwater noise) capable of operating continuously for a long time in harsh conditions (such as seawater, and underwater, among others) to provide a better understanding of the environmental status.

For the uptake of project solutions, it can be made the following overall considerations:

- It is important to have the participation of the private sector/companies in technology development projects thus contributing to the potential commercialization of the project resulting products.

- There is a need to build a multi-stakeholder value chain to leverage innovations and increase the uptake and potential commercialization of project products.

- There is a need for understanding the market related to the commercialization of solutions for farmers to control the release of nutrients and pesticides, and for the industry the removal of contaminants of emerging concern.

- Identifying the barriers to the uptake and implementation of project solutions is necessary. Moreover, research proposals should explore the development of best practices to overcome the identified barriers.

- It is necessary to further identify, in future research proposals, the enablers for successful uptake and implementation of project results.

A final remark is that maintaining research in the long term beyond the project duration is difficult and this is also valid for the protection and conservation efforts. It is also difficult to find operational websites and platforms of the projects both in the short and long term beyond the project duration.

7.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
19356	@BluePortS	Interreg	ERDF
680777	ADREM	H2020	RIA
101056835	Ammonia2-4	HORIZON	HORIZON-IA
18622	APP4SEA	Interreg	ERDF
765860	AQUAlity	H2020	MSCA
689450	AquaNES	H2020	IA
731465	AQUARIUS	H2020	RIA
869178	AquaticPollutants	H2020	ERA-NET-Cofund
818173	AquaVitae	H2020	RIA
101004372	ARCOS	H2020	RIA
101003472	Arctic PASSION	H2020	RIA
862923	AtlantECO	H2020	RIA
101091464	BIO-SUSHY	HORIZON	HORIZON-RIA
101060211	BIOSYSMO	HORIZON	HORIZON-RIA
22126	Blue-GIFT	Interreg	ERDF
666773	BlueHealth	H2020	RIA
767667	BMX-11	H2020	SME
101000240	BRIDGE-BS	H2020	RIA
635359	**BRIDGES**	**H2020**	**RIA**
871260	BugWright2	H2020	IA
101060546	CALIMERO	HORIZON	HORIZON-RIA
101084443	CARBIOW	HORIZON	HORIZON-RIA
805997	**CGM**	**H2020**	**SME**
715173	CHEMO-RISK	H2020	ERC
956009	CHRONIC	H2020	MSCA
818290	CIRCLES	H2020	IA
101092633	CISE- ALERT	EMFAF	EMFAF-PJG
700200	COMPASS	H2020	FCH2
971209	CRIMSON	H2020	IA
23786	Cross border Maritime Environment Protection - (CbMEP)	Interreg	IPA/IPAII

101060638	D4RUNOFF	HORIZON	HORIZON-RIA
101094070	DALIA	HORIZON	HORIZON-IA
24926	**DAML**	**Interreg**	**ERDF**
837998	DEEP PURPLE	H2020	BBI
101000518	DOORS	H2020	RIA
641762	ECOPOTENTIAL	H2020	RIA
101101473	EDITO-Infra	HORIZON	HORIZON-IA
965945	**EiCLaR**	**H2020**	**RIA**
815180	ELEMENT	H2020	RIA
101054300	Embodied Ecologies	HORIZON	HORIZON-ERC
874990	**EMERGE**	**H2020**	**RIA**
101039270	ERA-ARE	HORIZON	HORIZON-ERC
821301	ERICE	H2020	CS2
691495	eSHaRk	H2020	IA
731103	EUMarineRobots	H2020	RIA
824131	Euro-Argo RISE	H2020	RIA
883751	EuropeWave	H2020	PCP
101036457	EU-SCORES	H2020	IA
101049678	EUWAY	ERASMUS2027	ERASMUS-LS
723360	FIBRESHIP	H2020	IA
24578	FIRESPILL	Interreg	ERDF
101077554	**FLORA**	**EMFAF**	**EMFAF-PJG**
101093928	FLOW	HORIZON	HORIZON-RIA
18197	FORESEA	Interreg	ERDF
101094716	GEORGE	HORIZON	HORIZON-RIA
654497	GeoWell	H2020	RIA
101039532	GLOBCOADEV	HORIZON	HORIZON-ERC
825489	GOLIATH	H2020	RIA
20237	GoToS3 - DURATEX	Interreg	ERDF
101039118	GPP	H2020	CSA
679266	GRACE	H2020	RIA
101083927	GREAT	DIGITAL	DIGITAL-CSA
101005541	GreenOffshoreTech	H2020	IA
17773	HAZARD	Interreg	ERDF

101084097	HE-FARM	HORIZON	HORIZON-RIA
800926	HyPhOE	H2020	RIA
769417	HySeas III	H2020	IA
101017928	HYSOLCHEM	H2020	RIA
101092723	**IBAIA**	**HORIZON**	**HORIZON-RIA**
774109	IMPAQT	H2020	RIA
821922	IMPRESSIVE	H2020	IA
871120	INTERACT	H2020	RIA
734522	INTERWASTE	H2020	MSCA
101058245	IRISS	HORIZON	HORIZON-CSA
19129	I-STORMS	Interreg	ERDF;IPA/IPAII
756288	IV-BWTS	H2020	SME
654410	JERICO-NEXT	H2020	RIA
19154	**Jomopans**	**Interreg**	**ERDF**
22132	JONAS	Interreg	ERDF
690618	**KNOWPEC**	**H2020**	**MSCA**
820735	LIBERATE	H2020	IA
LIFE20 ENV/ES/000387	**LIFE PortSounds**	**LIFE**	**LIFE-ENV**
LIFE20 ENV/ES/000880	LIFE SOuRCE	LIFE	LIFE-ENV
101059006	LIFE21 FPA/BE/EEB	LIFE2027	LIFE-FPA-OG
101058901	LIFE21 FPA/BE/HEAL	LIFE2027	LIFE-FPA-OG
101058857	LIFE21 FPA/BE/SAFE	LIFE2027	LIFE-FPA-OG
101058916	LIFE21 FPA/FR/SFE	LIFE2027	LIFE-FPA-OG
101057743	LIFE21 FPA/SE/CCB	LIFE2027	LIFE-FPA-OG
101058876	LIFE21 NGO/BE/FoEE	LIFE2027	LIFE-FPA-OG
101059035	LIFE21 NGO/BE/HEAL	LIFE2027	LIFE-FPA-OG
101058820	LIFE21 NGO/NL/ZWE	LIFE2027	LIFE-FPA-OG
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101074264	LIFE21-ENV-BE-LIFE CAPTURE	LIFE2027	LIFE-PJG
101074503	LIFE21-ENV-DE-LIFE OCEAN	LIFE2027	LIFE-PJG
101074191	LIFE21-ENV-ES-BIODAPH2O	LIFE2027	LIFE-PJG
101074143	**LIFE21-ENV-ES-LIFE NextFUMIGREEN**	**LIFE2027**	**LIFE-PJG**

101074430	**LIFE21-ENV-ES-PRISTINE**	**LIFE2027**	**LIFE-PJG**
101074321	LIFE21-ENV-IT-LIFE FOUNTAIN	LIFE2027	LIFE-PJG
101074245	LIFE21-GIE-DE-LIFEChemBee	LIFE2027	LIFE-PJG
101074412	LIFE21-GIE-PL-LIFE MERCURY-FREE	LIFE2027	LIFE-PJG
101074309	LIFE21-NAT-IT-REEForest	LIFE2027	LIFE-PJG
101112309	LIFE22 NGO-BE-EEB	LIFE2027	LIFE-FPA-OG
101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
LIFE18 ENV/FR/000308	LIFE-PIAQUO	LIFE	LIFE-ENV
851885	LiftWEC	H2020	RIA
970972	Living Ports	H2020	IA
101061343	MADRIDNIGHT	HORIZON	HORIZON-CSA
101082048	MAR2PROTECT	HORIZON	HORIZON-RIA
731084	MARINET2	H2020	RIA
20750	MarPAMM	Interreg	ERDF
863584	MER-CLUB	EMFF	EMFF-AG
675219	METAL-AID	H2020	MSCA
101075581	MICROSURF	HORIZON	HORIZON-ERC
101038095	MIDFun	H2020	MSCA
862428	MISSION ATLANTIC	H2020	RIA
766327	MixITiN	H2020	MSCA
101060395	MONUSEN	HORIZON	HORIZON-CSA
101058450	MOZART	HORIZON	HORIZON-RIA
101003527	MULTISOURCE	H2020	RIA
101060418	NAPSEA	HORIZON	HORIZON-CSA
101000825	**NAUTILOS**	**H2020**	**IA-LS**
861647	Nautilus	H2020	RIA
101081273	NECCTON	HORIZON	HORIZON-RIA
815278	NEMMO	H2020	RIA
101096324	NEMOSHIP	HORIZON	HORIZON-IA
887474	NENU2PHAR	H2020	BBI
766251	NEUROSOME	H2020	MSCA
101079156	NEXUS-MONARC	HORIZON	HORIZON-CSA
863000	**NOMAD**	**H2020**	**IA**

101060020	**NORDBALT-ECOSAFE**	**HORIZON**	**HORIZON-CSA**
101000554	NOVATERRA	H2020	IA
773421	Nunataryuk	H2020	RIA
19847	NWE MEA	Interreg	ERDF
883583	OCEAN DEOXYFISH	H2020	ERC
783773	**OC-TECH**	**H2020**	**SME**
21605	OIL SPILL	Interreg	ERDF
820633	OILBLOCK	H2020	IA
101057014	PARC	HORIZON	HORIZON-COFUND
860665	PERFORCE3	H2020	MSCA
101059534	PFAStwin	HORIZON	HORIZON-CSA
17738	PHOTOPUR	Interreg	ERDF
101006912	Phy2Climate	H2020	RIA
24612	**PONTOS**	**Interreg**	**ENPI/ENI**
810139	PORTWIMS	H2020	CSA
101039576	**POSEIDON**	**HORIZON**	**HORIZON-ERC**
959001	PowerFLEX	EMFF	EMFF-AG
949252	ProblemShifting	H2020	ERC
776816	Project O	H2020	IA
101036449	PROMISCES	H2020	RIA
101091842	PROPLANET	HORIZON	HORIZON-RIA
859891	PRORISK	H2020	MSCA
722634	PROTECTED	H2020	MSCA
19282	Puur natuur: 100% biobased	Interreg	ERDF
727689	RealTide	H2020	RIA
22106	RECUPA	Interreg	ERDF
101017857	RESET	H2020	RIA
190193416	RHINO	HORIZON	HORIZON-EIC-ACC-BF
19415	S-3 EUROHAB	Interreg	ERDF
18044	SAFE SEA	Interreg	ERDF
821427	**Saraswati 2.0**	**H2020**	**RIA**
101006443	SATURN	H2020	RIA
17834	SB OIL	Interreg	ERDF

101037509	SCENARIOS	H2020	RIA
101003906	SCIRT	H2020	IA
773400	SEAFOODTOMORROW	H2020	IA
773903	SHui	H2020	RIA
863737	SIMBIOSE	EMFF	EMFF-AG
24410	SIMREC	Interreg	ENPI/ENI
20241	SMARTBIOCONTROL - BioScreen	Interreg	ERDF
101000371	SOILGUARD	H2020	RIA
23122	SOUNDSCAPE	Interreg	ERDF
848834	SpilLess	EMFF	EMFF
856408	STUOD	H2020	ERC
101060361	SYMBIOREM	HORIZON	HORIZON-RIA
678396	TAPAS	H2020	RIA
101000858	TechOceanS	H2020	IA-LS
101095253	THETIDA	HORIZON	HORIZON-RIA
101082035	ToDrinQ	HORIZON	HORIZON-RIA
101091944	TORNADO	HORIZON	HORIZON-RIA
101091959	TRIDENT	HORIZON	HORIZON-RIA
101094818	TRIQUETRA	HORIZON	HORIZON-RIA
101059867	TwiNSol-CECs	HORIZON	HORIZON-CSA
101093888	ULTFARMS	HORIZON	HORIZON-IA
101081807	UPWATER	HORIZON	HORIZON-RIA
101086340	UWIN-LABUST	HORIZON	HORIZON-CSA
805055	VegeaTextile	H2020	SME
101053543	VIBES	HORIZON	HORIZON-ERC
101058328	VITAL	HORIZON	HORIZON-RIA
24096	Wasserqualität - Waterkwaliteit	Interreg	ERDF
101060874	Water4All	HORIZON	HORIZON-COFUND
734409	Water4Cities	H2020	MSCA
101004186	Water-ForCE	H2020	CSA
727450	WATERPROTECT	H2020	RIA
731778	WaterSpy	H2020	RIA
101060922	WATERUN	HORIZON	HORIZON-RIA

776692	WaterWorks2017	H2020	ERA-NET-Cofund
958730	ZABIO	H2020	IA
730390	ZERO BRINE	H2020	IA
101092164	ZeroF	HORIZON	HORIZON-RIA
101036756	ZeroPM	H2020	RIA

8. Blue economy - multiuse of water space. *By Pierre Failler*

8.1. Main findings of the analysis

A set of 98 projects on multiuse of water space have been analysed for this report, 46 of them have been considered relevant with 20 of them selected to provide a deeper analysis. The total amount of the whole set of projects is about 490 million euros with an EC contribution of 70% (340 million euros). Projects have been developed under different funding programs such as LIFE, INTEREG, IMFF, and for most of them under the Horizon Programs (H2020 and Horizon Europe). The list of the 46 relevant projects is showed in section 8.5, where the 20 projects selected for in-depth analysis are highlighted in blue and bold.

Projects address mainly the Objective 1 and 3 of the Mission Restore our Ocean and Waters by 2030 (Mission Ocean)[13]. For the Objective 1 "Protect and restore marine and freshwater ecosystems and biodiversity, in line with the EU Biodiversity Strategy 2030", MPA and MSP orientated projects aims to contribute mainly to the sub-objective 1.a "Protect a minimum of 30% of the EU's sea area and integrate ecological corridors, as part of a true Trans-European Nature Network" and to some extend to the sub-objective 1.b "Strictly protect at least 10% of the EU's sea area". A few projects have restoration activities planned (deep-reef restoration for instance) and as such participle to the efforts specific to sub-objectives 1.c and 1.d respectively dedicated to "Restore at least 25,000 km of free-flowing rivers" and "Contribute to relevant upcoming marine nature restoration targets including degraded seabed habitats and coastal ecosystems".

For the objective 3 "Make the sustainable blue economy carbon-neutral and circular"[14], projects are mainly addressing the sub-objective 3.b "Develop zero-carbon and low-impact aquaculture, and promote circular, low-carbon multi-purpose use of marine and water space" with activities on the development of Offshore Low-trophic Aquaculture for example. Other projects are devoted to the Energy transition, using offshore wind energy (often with protection activities and fishery regulated activities around the turbines) or wave energy to value the energy of the ocean without ocean degradation. A small number of projects are concentrating on shipping transitions to zero carbon emissions and zero pollution. A few of them are contribution to the sub-objective 3 a. "Eliminate greenhouse gas emissions from maritime economic activities in the EU and sequester those emissions that cannot be avoided (net zero maritime emissions)". They are essentially talking the decarbonisation of the fishing and transportation fleets. Only 4 relevant projects are qualified GD target low C multipurpose.

Despite not being too numerous, some of the projects address the Objective 2 of the Mission Ocean, namely "Prevent and eliminate pollution of our ocean, seas and waters, in line with the EU Action Plan Towards Zero Pollution for Air, Water and Soil", with activities on public awareness, the understanding of the plastic pollution effects on marine ecosystem and on citizen actions on cleaning and plastic pollution prevention.

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[13] With sub-objectives: a. Reduce by at least 50% plastic litter at sea; b. Reduce by at least 30% microplastics released into the environment; c. Reduce by at least 50% nutrient losses, the use and risk of chemical pesticides).

[14] In line with the proposed European Climate Law and the holistic vision enshrined in the Sustainable Blue Economy Strategy.

Overall, projects match the objective of the Mission Ocean. They covered a very large range of intervention areas, from MPA and MSP to Blue Energy. Usually with a similar approach, they intend to develop a specific method for addressing the identified issue, using stakeholders for the problem definition, the solution findings, and the potential pathway for implementation (in a co-construction perspective). They are usually very optimistic on the readiness of their tools/methods and other findings for policy implementation. They often reach the stage of the pilot projects but not the one of the real-life policy formulations.

The multiuse dimension is not very often put forward as only 16 projects are designed around it. These projects are mainly devoted to blue energy and intend to use floating or offshore structures for additional purposes such as aquaculture, fish conservation areas or artificial reef implementation to boost the biodiversity and the fish production. The level of integration is thus basic as the purpose is mainly to add value added with an additional activity to an existing platform and sometimes, like in the case of the offshore wind turbines, to ensure the acceptation of the project by fishermen organisations as they are built very often on fishing rounds. As such, these projects are not design with the intention of developing a highly integrated multiuse of space and resources like past projects did such as the MARIBE[15] (Marine Investment for the Blue Economy) project that looked at the multiuse aspect from a business perspective.

8.2. Description of the portfolio

Out of a set of 98 projects on multiuse of water space have been analysed for this report, 46 have been considered relevant with 20 used to provide a deeper analysis. Twelve of them are already closed and 33 are on-going.

The criteria to judge the relevance of the projects were: the inclusion of the Green Deal target regarding low carbon multipurpose; the trans-sectorial nature of Blue Economy (BE) actions; the Ocean Governance dimension; the Marine Protected Area (MPA) activities; the Marine Spatial Planning (MSP) development; the Marine Biodiversity dimension and the Multipurpose platform conception and elaboration. The criteria used to select the restrictive number were mainly their contribution to the 3 objectives of Mission Ocean as presented in the section above.

Distribution of portfolio across programs and actions

The 46 relevant projects have been mainly funded under the Interreg programme (45% of them), the HORIZON (24%), the H2020 (11%) and the LIFE27 (9%) (see Figure 8.1). They represent a budget of 251 million euros with a contribution of the EU of 146 million euros. The HORIZON programme is the main source of funding of projects with more than 50% of the EU contribution, followed by the H2020 (17%) (see Figure 8.2). Comparing the number of projects per programme and the financial contribution of each of them, the average EU contribution for an Interreg project is about 1.8 million euros compared to 5.1 million euros for a H2020 and 6.7 million euros for a HORIZON one (Figure 8.2).

[15] Horizon 2020 research and innovation programme under grant agreement No 652629.

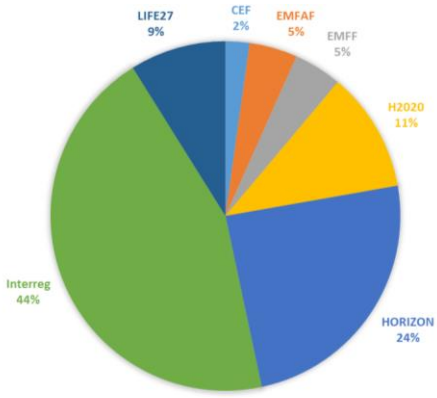
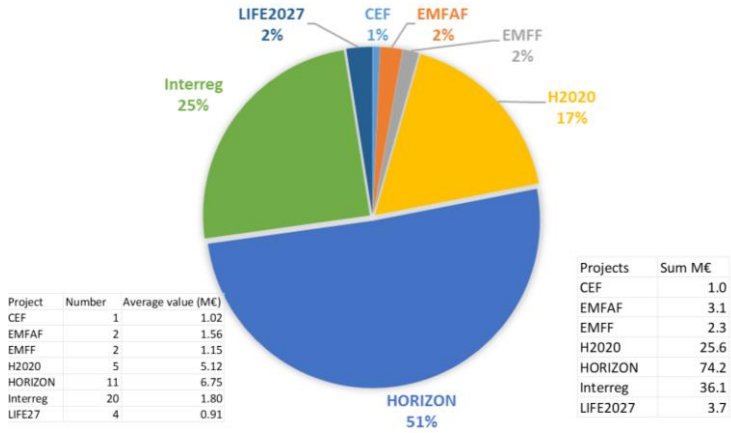


Figure 8.1. Repartition of the forty-six relevant projects per EU funding Programme



Project	Number	Average value (M€)
CEF	1	1.02
EMFAF	2	1.56
EMFF	2	1.15
H2020	5	5.12
HORIZON	11	6.75
Interreg	20	1.80
LIFE27	4	0.91

Projects	Sum M€
CEF	1.0
EMFAF	3.1
EMFF	2.3
H2020	25.6
HORIZON	74.2
Interreg	36.1
LIFE2027	3.7

Figure 8.2. Percentage of the EC contribution of the forty-six relevant projects per EU funding Programme

Geographical distribution

The geographical distribution of relevant projects is limited to Europe. Mediterranean Sea concentrates the largest number of projects (15 or 40% of them), followed by the Baltic (10 or 27%), the Atlantic/Artic area (10 or 27% with 2 specifically located in the Artic). Only one project is implemented in the EU outermost region (“other basin” on the Figure 8.3 below) and one in the Danube basin. No cross-basin projects have been identified in the list of 46 relevant projects while about half of the projects have a multi-basins base, especially the H2020 and HORIZON ones. Thanks to Interreg projects, the Mediterranean and the Baltic basins are overrepresented compared to the Atlantic. Interreg and Life projects tend to be geographically stamped (MSP for instance in the Mediterranean and Baltic, Blue Energy in the Baltic, etc.) which limits the spreading of the collaboration over two basins or more.

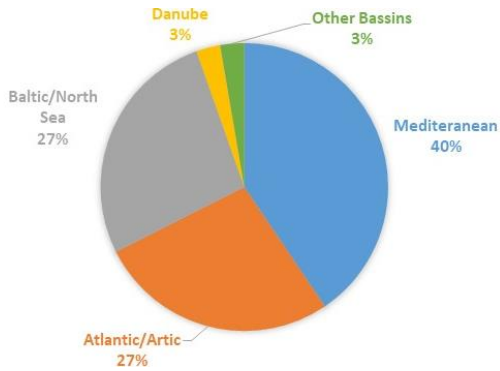


Figure 8.3. Geographical distribution of the forty-six relevant projects

Assessment by thematic areas

Seven descriptors have been used for the classification of the projects: the Green Deal (DG) low carbon multipurpose; the transectorial Blue Economy (BE) actions; the Ocean Governance dimension; the Marine Protected Area (MPA) activities; the Marine Spatial Planning (MSP) development; the Marine Biodiversity dimension and the Multipurpose platform conception and elaboration. The Figure 8.4 below shows, from the left to the right lower corner the importance of the MSP over the Ocean Governance and the Marine Biodiversity areas. These two broad areas are often associated with MSP and MPA. As mentioned earlier, the low carbon and the multiplatform dimensions are not too numerous while Transectorial BE actions, mainly fishery with blue energy mobilise projects, in the Baltic essentially.

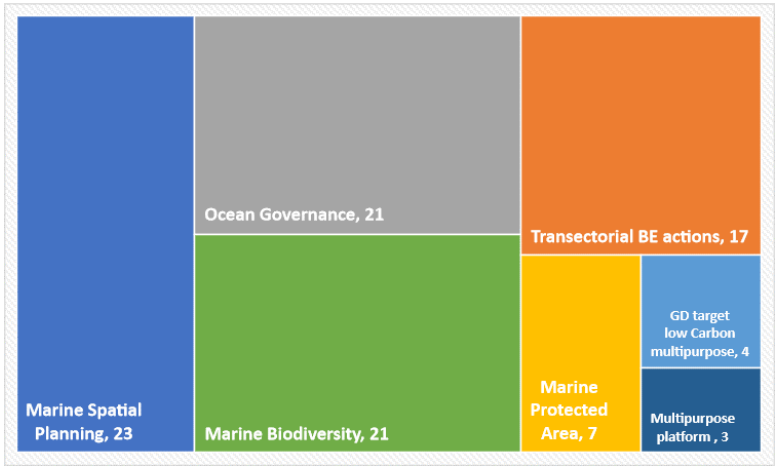


Figure 8.4. Thematic areas and number of projects addressing them exclusively or as part of their scope. (Note: some projects address more than one thematic area. Total count of thematic areas addressed: 96 for 46 relevant projects.)

The use of the “lever of change” indicators (Governance; Finance & Economy; Research and Innovation (R&I); Knowledge & Data; Deployment; Citizen engagement; Education &Training) to characterise the relevant projects provides another view of the coverage of the projects from the governance to the education. The Figure 8.5 below shows the focus/elements of attention of the projects.

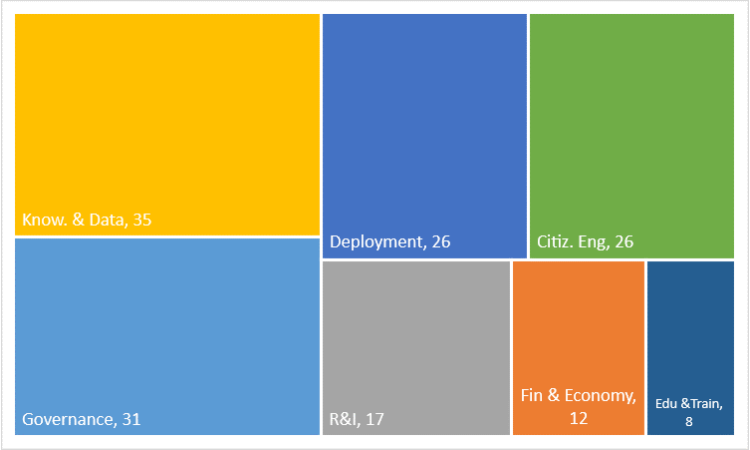


Figure 8.5. Lever of change and number of projects addressing them exclusively or as part of their scope. (Note: some projects address more than one lever of change; Total count of lever of change addressed: 155 for 46 relevant projects.)

Having a mix of projects from pure research ones (H2020 and HORIZON) to problem solving and policy ones (MPS, etc.) within the Interreg and Life programmes, leads to a coverage of most of the dimensions of the project from development to solutions proposal. As such, knowledge & data acquisition as well as governance implementation as considered as key lever of changes. Being mainly research and innovation driven projects, education and training is not considered as key lever of change. The low level of association with private sector conduces to a medium consideration of the Finance and Economy as lever of change.

8.3. Main outcomes and fostering the uptake of solutions

8.3.1. Main outcomes

The 20 projects selected for in-depth analysis tackle the challenges of the Mission Ocean. They contribute to delivering on the EU's quantified and measurable targets for protecting and restoring ecosystems and biodiversity, preventing and eliminating pollution. They are also participating into the sustainable blue economy climate-neutral and circular initiatives and therefore supporting the goals of the European Green Deal (see Table 8.1).

Table 8.1. Main results and achievements of the narrow portfolio of 20 selected projects

Project Acronym	Description of the results	Application	Link to the results
LIFE21 FPA/BE/SAR LIFE21 NGO/BE/SAR Sea At Risk	Planned results covered all areas of the Mission Ocean. They included: Ocean economy & governance focusing on well-being of planet and people; Rewilding the ocean to make it climate-resilient and restoration of ocean ecosystems by 2030; Seafood production in balance with nature; Clean energy transition (Shipping transitions to zero carbon emissions and zero pollution, Renewable energy at sea develops without ocean degradation; Zero pollution & circular economy (Marine litter is tackled at the source and Deep-sea mining is stopped).	Ocean Governance Blue Economy & Circular Economy Climate neutral Sustainable seafood production	www.seas-at-risk.org/
MARIPOLDATA	Results consist of the development and implementation a new multiscale methodology for the analysis of science–policy interrelations with research.	Ocean Governance	www.maripoldata.eu
Respon-SEA-ble	Main results are the raising of awareness of individual and collective responsibility towards maintaining healthy oceans through better targeted communication.	Ocean Governance	cordis.europa.eu/project/id/652643
MSP-OR	Results in 2024 will mainly comprise the development of an innovative approach, based on Ocean Governance principles applied to MSP in ORs. It will consist of a common Ocean Governance Platform which provides all partners with a virtual arena to compile and exchange information, participate and build capacity.	MSP Ocean Governance	msp-or.eu

Project Acronym	Description of the results	Application	Link to the results
LIFE21 FPA/FR/SFE	The main results to be achieved by the end of 2023 are the contribution to the reduction of consumption and production of single-use plastics to prevent pollution; the involvement and mobilisation of citizens in the fight against marine litter as well as the awareness raising of citizens in Europe about the impact of climate change on coastlines and the related.	Preventing and eliminating pollution Climate change Ocean Governance	surfrider.eu/en
UfMEASME	The main results are the reinforcement of the regional dialogue (among the 46 countries of the Union for the Mediterranean) on Blue economy/integrated maritime policy; the reinforcement of the Blue Economy regional agenda, portfolio and data sharing that contributes to the set-up of the EU Med lighthouse.	Blue Economy Ocean Governance	ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/31098847/881619/EMFF
iAtlantic	The work of the project spans the full scale of the Atlantic basin using a strong international collaboration for the realisation of an integrated assessment of Atlantic marine ecosystems in space and time	Climate change Biodiversity	www.iatlantic.eu
PHAROS4MPAs	The project capitalized existing results delivered by previous EU-funded projects (H2020 and FP ones) and other initiatives concerning MPAs and their interactions with economic sectors. The main outcomes were the delivering of common capitalization baselines, the recommendations and policy tools adapted to appropriation by the MedPAN network, and others.	MPA	www.wwf.fr/projets/pharos4mpas-referentiel
MSP LSI	The project provided a significant contribution the EU MSP ESPON initiative by developing digitalisation and visualisation tools of the land-sea interactions.	MSP	www.espon.eu/MSP-LSI

Project Acronym	Description of the results	Application	Link to the results
AMAre	The key results were numerous: the increased awareness about the role of non-native citizens in city resilience; the Improved capacity of European cities to protect their citizens, in particular the most vulnerable, from the consequences of natural disasters and to contribute to a higher quality of life; the Improved dialogue, cooperation and understanding between cities (institutions) and their citizens; the Improvement, integration and adaptation of existing material on risk awareness, risk management, citizens involvement which will be made available at an international level; the strengthened prevention and disaster risk management approaches; the promotion of active citizenship, volunteering and solidarity; the protection of the most vulnerable categories and; the promotion and enhancement of inclusive, dynamic and risk aware European cities.	MPA Climate change	www.amareproject.eu
JONAS	This Interreg Atlantic project produced results on the ocean noise in the Atlantic Seas and recommendations to reduce it and to limit its impacts on marine life.	Preventing and eliminating pollution	www.jonasproject.eu/research
MOSES	The project will produce a series of results by the end of June 2023 that mainly consist of innovative solutions to improve the short-sea transport such as the development of some autonomous Tugboats control stations, recharging stations design, AutoDock system, Innovative Feeder Vessel, etc. that will lead to the reduction fo 10% of the green gas emission of this sector. As such, it contributes to the Connecting Europe Facility (CEF) Marco Polo I and II frameworks.	Preventing and eliminating pollution Blue Economy	http://martrans.org/
ADRIENNE	The main results of the projects have been the capacity increasing of the environmental protection to maintain biodiversity and ecosystem performance in the Gulf of Finland under multiple human uses and climate change pressure	Biodiversity	https://tesim-enicbc.eu/wp-content/uploads/2021/02/ADRIENNE.pdf

Project Acronym	Description of the results	Application	Link to the results
SEAPLANSPACE	The project developed marine spatial planning instruments for sustainable marine governance such as SeaPlanSpace manuals for the organisation of knowledge, a portal on MSP and a network for the Baltic Sea.	MSP	https://seaplanspace.ug.edu.pl
MAREA	Projects results will consist, at the end of 2023, of the mutualization of coastal observation and development of real time monitoring systems at high frequency and resolution; the development of local tools for modelling very locally the effects of storms to warn flood waves and erosion process to help decisions-making; the analysis of sedimentary stocks dynamics and risk erosion to define recommendation about coastal and sedimentary management and the introduction of reflections about risk culture in the public policies.	Climate change Biodiversity MSP Ocean governance	http://marea.balticseaportal.net/
COMMON	The main achievement of the project was the development of a coastal management and monitoring network for tackling marine litter in Mediterranean Sea notably through the establishment of an ICT platform for sharing methodologies and data on marine litter.	Preventing and eliminating pollution	keep.eu/projects/22820/COastal-Management-and-MOni-EN/
Land-Sea-Act	The project guided national, regional and local authorities, as well as stakeholders of various sectors to improve transnational cooperation and facilitate knowledge exchange to foster Blue Growth; to raise awareness, knowledge and skills to enhance Blue Growth initiatives and integrated development in coastal areas and; to balance development of new sea uses with coastal community interests by improving coastal governance.	Blue Economy	https://land-sea.eu/
HERMES	The project developed an harmonized framework to mitigate coastal erosion promoting an Integrated Coastal Zone Management (ICZM) protocol implementation	Biodiversity Climate change	www.h2020-hermes.eu/
Coast4us	The project resulted in 8 sustainable development plans for pilot regions around the Baltic coast. It mainly consisted of producing a mapping and	Climate change	http://centralbaltic.eu/

Project Acronym	Description of the results	Application	Link to the results
	assessment of values (e.g. ecological, cultural and social) as well as mapping of the present use of resources and local demands for economic; planning tools (e.g. GIS, planning IT tool, LEA and Smart City Planning) to facilitate the planning process; and the establishment of meeting points, both physical and web-based.		
CO-EVOLVE	The project produced results that contribute to the promotion of the co-evolution of human activities and natural systems for the development of sustainable coastal and maritime tourism, based on the principles of ICZM/MSP.	MSP Blue Economy	www.coevolve.eu

The MSP projects such as MSP-OR, MSP-LSI, SEAPLANSPACE, MAREA and CO-EVOLVE contribute to the enhancement of the EU member States capacity to manage coasts. Only one project, MSP-LSI, addresses the critical issue of the land sea interaction while it is essential for the restoration component of the Mission Ocean: there is no value of restoring habitats (including with nature-based solutions) if their vulnerability towards threats and pressures from the land and sea are not addressed properly. Development and implementation of MSP tools will lead to the application of the 2014 EU MSP Directive[16] to foster the capacities of Member State's authorities to analyse and organise human activities in marine areas to achieve ecological, economic, and social objectives. In that regard, projects contribute to the establishment of plans, permits and other administrative decisions that decide on the spatial and temporal distribution of relevant existing and future activities and uses in the marine waters. As such they participate to the reduction of conflicts between sectors and creation of synergies between different activities, the encouragement of investments by creating predictability, transparency and clearer rules and the protection and preservation of the environment through early identification of impact and opportunities for multiple use of space (including MPAs).

Blue Economy projects are mainly focusing on technical solutions to tackle pollution (MOSES, COMMON, SURFRIDER, JONAS, and carbon emission reduction from the maritime sector (MOSES, Sea At Risk). Some projects like the Sea At Risk one and the Land-Sea-Act have developed an integrative method to co-develop solutions and to outreach users and civil society. Other projects like UfMEASME are focusing on the reinforcement of regional dialogue that is needed to support BE development without having externalities impacting neighbouring countries. In the same vein, the Co-EVOLVE project has delivered solutions for the avoidance of externalities generated by the coastal tourism industry. Without leding to the development of BE mutli-use platforms, these projects contributed to the elaboration of corporate and policy solutions to the smooth implementation of BE in Europe.

Ocean Governance is addressed in projects like Sea At Risk, MARIPOLDATA, Respon-SEA-ble, MSP-OR, UfMEASME, MAREA both from a technical point of view with the development of specific tools (MSP, MPA, etc.) and from a broader perspective, considering Ocean Governance as an umbrella paradigm that provides a sound support for the discussion of marine issues around the implementation of the BE (UfMEASME for instance). A such, projects are not specifically dedicated to the transformation of the ocean governance through changes in the institutions, processes and policies. They are rather devoted to improve the current situation using Ocean Governance as a pathway to mobilise resources.

8.3.2. Fostering the uptake of solutions

Past and current projects are fully contributing to the implementation of the piloting phase of the Mission Ocean (2021-2025). They provide tangible results and development pathways for the establishment of the lighthouses such as the new Baltic and the Mediterranean ones that will constitute hubs in major European sea and river basins. These lighthouses will act as hubs for the development, demonstration, and deployment of solutions on the ground and as a framework for cooperation at a basin level. Current projects will also feed the Mission Ocean deployment and upscaling phase (2026-2030) with both innovative solutions for the BE development, pollution reduction, biodiversity enhancement and more globally with transformative solutions for ocean governance. Thus, they will provide a robust support for the development, replication and scaling-up of the specific solutions piloted in the first phase

[16] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning.

of Mission Ocean. This should enable a broad implementation and participation in the Mission Ocean across the EU and its bordering basins.

In that regard, fostering the uptake of solutions, developed within projects, would consist of:

- Developing the engagement with the civil society on one side and with the policy decision on the other. Analysed projects have all in common a wish to associate both parties in a co-development way while in fact the association is limited to their consultation. Having projects more embedded into the society and policy will lead to a better anchorage of projects and provide a more robust support for the use of results (NGOs are efficient to ensure civil society integration and outreach of research results). Thus, HORIZON research projects should be followed by Interreg or LIFE projects to impulse and complement the transfer of knowledge, solutions, technologies, etc.

- Having the private sector much more engaged will lead to the production of ready-to-use solutions. Very few projects are developed with the industry even though they addressed industry issues (pollution, carbon emission reduction, etc.). The international maritime transport company CMA-CGM is currently investing 1.5 billion USD into research and innovation for the decarbonisation of its fleet. This should lead to multiple joint research activities with EU research centres. More broadly, the inclusion of the industry from the elaboration of the terms of reference of the call to the co-development of solution should be promoted and encouraged.

- Ocean Governance should be addressed in a specific way not as an umbrella concept, a situation that is found in almost all projects assessed. Ocean governance study requires policy, institutional, lawyers, transformative change, etc. expertise that is currently not visible in the projects mentioned in the Table 8.1. In short words, we all know today what to do to fight climate change effects, biodiversity degradation, overexploitation of resources, etc. but we don't know how to translate this knowledge into ocean governance action. Therefore, fostering the uptake of solutions requires fully dedicated projects on transformative ocean governance.

8.4. Policy recommendations

Following the analysis of the set of 20 project mentioned above and the overview of another set of 26 projects completed, on-going and recently started (considered as relevant for the selection out of 100 listed), the set of policy recommendations can be made:

A better integration of the policy needs and considerations into project design, implementation, and solution finding & testing. Despite announcements of policy solution co-design, co-development, stakeholder engagement, etc, projects are mainly research-driven with the aim of developing new tools, methods, approach etc. for policy. They require associating policy makers upfront of the project formulation for a real co-development and thorough the live of the project for ensuring tangible impacts on the use of space/resources. Thus, projects should have a significant period dedicated (18 to 24 months) to test policy solutions. And as such should reduce their development phase to increase the one of the application of solutions and measurement of impacts. This is possible as most of the approaches/tools used to address the multi-use challenges of space/resources are common and don't need specific research/development.

A focus on the policy process should be made to enable change in both the way to formulate the multi-use questioning and the way to develop and apply solutions. The current approach in projects is very mechanistic and doesn't take into consideration all the institutional and society constraints that will inhibit the adoption and the implementation of solutions elaborated. As such,

projects should go beyond the solution delivery stage and provide support for the real implementation phase with researchers in social sciences (from sociology to psychology) deeply involved for inducing a transformative change into the policy execution. They should also be less focused on the development of variant of MSP and ICZM and other tools that have overall a low value added and that are rarely used by administrations because of the need to change their whole system, which is another reason to concentrate efforts on the process (to avoid such mistake for instances).

A more economic approach should be made to the multi-use of space to include externalities. MSP, as well as ICZM, are seen as geographical tools rather than economic ones that allow both policy and industry to better plan over space and time. Industry not directly associated with the development of MSP while it needs to secure its investment on a long-term basis. MSP are developed without considering externalities from an economic point of view and as such the associated cost that one use can have on another one or a set of uses. For instance, impacts of marine pollution generated by cruise ship industry, fisheries, maritime transport etc. should be integrated into any MSP and other spatial tools. The same consideration should be made for the CO_2 emissions of these sectors and their effect on Ocean used by all. Therefore, spatial tools should go beyond the spatialisation of activities and include a more robust approach of the economic externalities. The deep implication of the various industrial sectors should contribute to this. The economic approach should also de deployed for the establishment of strong links between the users such as fishery, coastal tourism for instance and the environment, through Payments for ecosystem services or other economic mechanisms that ensure sustainable financing mechanisms for conservation uses.

An integration of a land-sea interface into MSP and other coast and marine multi-use spatial tools should be done to provide robustness for implementation of policies. Many MSP and ICZM are dedicated to the establishment of conservation areas and management of uses. With the current EU Nature Restoration objective, some emphasis is put into the identification of restoration areas while little is done to establish a vulnerability mapping that will contribute to a better identification of external threats and pressures that need to be considered for any restoration actions. As most of the vulnerabilities originate from land, the development of land-sea integrated policy is seeking, accompanied by the development of proper tools.

An insertion of trans-sectorial approaches into BE policies will provide better guidance for the development of key European initiatives regarding coast and seas. BE development relies on the capacity of public and private actors to set-up new bridges between sectors and components of the BE that are required to tackle challenges such as plastic pollution and decarbonisation of coastal and marine activities. None of the projects evaluated tackle this issue as they remain sectorial focused. The current use of spatial tools tends to reduce BE uses to a geographical information that leads the debate to spatial arrangements instead of providing inspiration to address trans-cutting challenges.

A better consideration of climate change adaptation and mitigation needs into the spatialisation of the uses and the BE policies. Climate change is not fully embedded yet into MSP and other tools. As such, multi-use tools should be improved by using a more proactive approach to integrate climate change effects and required responses.

A need to have large BE umbrella programmes. Large programmes provided spaces for developing innovative approaches and new collaborations. One large BE project evaluated offers this possibility but as it wished to address too many issues it tends to dilute this mobilisation capacity. Furthermore, synergies between projects is overall poor and don't farthest than 2 or 3 other projects. So, there is a need to run large umbrella projects with the aim of gathering initiatives and creating new areas of co-design and implementation solutions and as such provoke changes.

8.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
2019-EU-IA-0115	FLOWS	CEF	CEF-TC
22425	**ADRIENNE**	**Interreg**	**ENPI/ENI**
21352	**AMAre**	**Interreg**	**ERDF**
101094014	BLUE4ALL	HORIZON	HORIZON-IA
101000240	BRIDGE-BS	H2020	RIA
101059823	B-USEFUL	HORIZON	HORIZON-RIA
24580	CASCADE	Interreg	ERDF
19369	**Coast4us**	**Interreg**	**ERDF**
21338	**CO-EVOLVE**	**Interreg**	**ERDF**
22840	Co-Evolve4BG	Interreg	ENPI/ENI
22820	**COMMON**	**Interreg**	**ENPI/ENI**
101060958	CrossGov	HORIZON	HORIZON-RIA
952012	DiHECO	H2020	CSA
17782	DiveSmart Baltic	Interreg	ERDF
101101473	EDITO-Infra	HORIZON	HORIZON-IA
101060693	GUARDEN	HORIZON	HORIZON-RIA
18985	**HERMES**	**Interreg**	**ERDF;IPA/IPAII**
101094621	HiAOOS	HORIZON	HORIZON-RIA
818123	**iAtlantic**	**H2020**	**RIA**
101073911	I-SEAMORE	HORIZON	HORIZON-IA
22132	**JONAS**	**Interreg**	**ERDF**
21580	**Land-Sea-Act**	**Interreg**	**ERDF**
101058121	**LIFE21 FPA/BE/SAR**	**LIFE2027**	**LIFE-FPA-OG**
101058916	**LIFE21 FPA/FR/SFE**	**LIFE2027**	**LIFE-FPA-OG**
101058217	**LIFE21 NGO/BE/SAR**	**LIFE2027**	**LIFE-FPA-OG**
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101074547	LIFE21-NAT-IT-LIFE DREAM	LIFE2027	LIFE-PJG
24701	**MAREA**	**Interreg**	**ERDF**
101059407	MarinePlan	HORIZON	HORIZON-RIA
804599	**MARIPOLDATA**	**H2020**	**ERC**

19314	**MOSES**	**Interreg**	**ERDF**
22528	**MSP LSI**	**Interreg**	**ERDF**
101060707	MSP4BIO	HORIZON	HORIZON-RIA
101081314	MSP-GREEN	EMFAF	EMFAF-PJG
101035822	**MSP-OR**	**EMFF**	**EMFF-AG**
21378	**PHAROS4MPAs**	**Interreg**	**ERDF;IPA/IPAII**
18734	Plan4Blue	Interreg	ERDF
101056957	PREP4BLUE	HORIZON	HORIZON-CSA
101081219	REGINA-MSP	EMFAF	EMFAF-PJG
652643	**Respon-SEA-ble**	**H2020**	**CSA**
19415	S-3 EUROHAB	Interreg	ERDF
101086379	SBEP	HORIZON	HORIZON-COFUND
19313	**SEAPLANSPACE**	**Interreg**	**ERDF**
19839	THAL-XOR 2	Interreg	ERDF
881619	**UfMEASME**	**EMFF**	**EMFF-AG**
21198	Welcome	Interreg	IPA/IPAII

9. Blue economy - carbon-neutral and circular fisheries and aquaculture. *By Katerina Moutou*

9.1. Main findings of the analysis

The pressure on aquaculture to provide healthy food, bioactive compounds and biomaterials at low ecological footprint is higher than ever, and the current policy framework calls for urgent action to restore our oceans and seas without compromising their production potential. The launch of the Mission "Restore our Ocean and Waters by 2030" in September 2021 crystalised the goal of achieving zero-carbon, toxin-free, fully circular aquaculture/algae production compatible with vulnerable ecosystems by 2030. EU-funded research has been supporting the increase of knowledge and innovation towards a sustainable and competitive aquaculture mainly through the successive framework programmes for research and innovation but also through other funding streams. From an initial set of 165 projects selected by a text mining tool, the current analysis identified sixty-two (62) projects that have addressed the challenges set by the Mission. These projects have been funded since 2014 across different funding programmes with the total EC contribution amounting to 281.1 million Euros. The list of the 62 projects identified as relevant is included in section 9.5.

The funded projects fall within six thematic areas building knowledge and innovation relevant to the Mission goal. Shifting the focus to low-trophic and/or extractive species (thematic area A) for production of biomass alone or in combination with finfish and other species in Integrated Multi-Trophic Aquaculture (IMTA) schemes can accelerate the pace towards **zero-carbon aquaculture/algae production**. Supporting IMTA (thematic area B) development with appropriate species combination and digital applications for continuous monitoring of the IMTA components can define the production outcome. Low-trophic species and microbiome hold big potential as sources of alternative ingredients for fish feeds (thematic area C), as do nutrients extracted from waste and side-streams. The valorisation of waste and side-streams (thematic area D) is the cornerstone of **fully circular aquaculture/algae production**, where wastewater treatment and re-use, and efficient retention of biomass is powered by novel enzymes and green processing methods and technologies to deliver new products and value chains, making full use of nutrient input in a production system and the side streams. Low-footprint resources (thematic area E) go beyond alternative feed ingredients to include plastic-free construction and packaging materials, green energy and water recirculation systems, extension of shelf-life and decrease of biomass loss and they have a significant contribution to the overall target of zero-carbon aquaculture. Reducing chemical use (thematic area F) while minimizing losses and securing the sustainable operation of the production sites is key to achieving **toxin-free aquaculture** and relies on the discovery and validation of bioactive substances with anti-biofouling, antimicrobial and immunostimulant properties and the development of efficient vaccines.

All three aquaculture-related Mission targets have been pursued by the funded projects. 40 projects have contributed to the target of zero-carbon aquaculture, 39 to fully circular aquaculture, and 20 to toxin-free aquaculture. Projects have delivered or are expected to deliver outcomes falling into more than one Thematic areas. The biology and farming of low-trophic/extractive species and the valorisation of waste and side-streams have received the most of attention. Projects funded after the launch of the Mission in 2021 are clearly more Mission-oriented. By 2020, three programmes (H2020, Interreg and EMFF[17]) had financed 40 projects of 219 million euros total cost. Programmes currently under implementation

[17] European Maritime and Fisheries Fund

(HORIZON Europe, EMFAF, Life 2027, I3[18] and Erasmus 2027) have already added another 22 projects to the list, of 204 million euros total cost. A spectrum of funding tools and actions have shaped the portfolio of Mission-relevant projects since 2014, representative of the research and education, innovation, cooperation, policy and regional development pathways leading to the Mission targets. The appreciation of the multiple dimensions of the Mission targets is also evident in the Levers of Change[19] (research and innovation, deployment, value chains, and business aspects, new governance schemes, regulation and policy development, capacity building and citizen engagement) mobilised in the Mission-relevant projects. The majority (39/62) of the Mission relevant projects address challenges common to all basins and with wide application potential. Marine aquaculture/algae production has dominated the Mission relevant project portfolio. The solutions generated by the Mission-relevant projects are grouped into:

- Pilot demonstrations of IMTA production systems based on combinations of different species, some of them new to IMTA, and equipped with sensors and digital platforms for advanced monitoring as a decision-making tool in daily production;
- Pilots of combined uses of marine space that include aquaculture;
- Pilots of microalgae production based on wastewater and side streams;
- New enzymes and green processing technologies;
- Pilots of biorefineries processing microalgae, seaweed and fish waste;
- New bioactive compounds for downstream uses and applications;
- New commercial products.

In the first development and piloting phase of its implementation (2021-2025), the Mission has established “lighthouses” (BlueMissionMed, EcoDALLi, BlueMissionBANOS, BlueMission AA) in the Mediterranean, the Danube, the Baltic and the North Seas, the Atlantic and the Arctic Oceans. As hubs and deployment platforms, the lighthouses can be the vehicles to connect the Mission to the Digital Europe programme by liaising with European Digital Innovation Hubs and actively promoting the digital solutions deployed in the field by funded projects, to monitor and manage offshore operations, to achieve multiple use of marine space and to optimise biomass production in IMTA and RAS. R&I governance appeared instrumental in contributing to the objectives of the Mission. An ERA-Net COFUND alone managed to effectively steer decisions to fund 25 projects in support of the Mission objectives and highly focused projects funded by the EMFF/EMFAF or the SME instrument have been successful in delivering tangible outputs of high TRL in the project lifetime.

The implementation of the Mission to achieve its ambitious goals cannot afford fragmentation in governance and policy development. Organisational innovation to ensure the prolific crosstalk between all aquaculture support mechanisms and stakeholders in the frame of the

[18] Interregional innovation investments instrument

[19] A lever of change can be understood as an area of work that has the potential to deliver wide-ranging positive change beyond its immediate focus.

EU (AAC[20], SCAR Fish[21], STECF[22]) and their alignment to the Mission is key in maximizing their contribution to the Mission goals. To the same direction, feasibility studies and foresight exercises of high credibility are needed to convince of the need for change and the realistic solutions available, to predict the timeline to achieve the change, and to allow for planning founded on extensive buy-in by the sector that jeopardise neither environmental nor economic sustainability.

The development and validation of sustainable value chains that are quickly integrated in production systems, distribution channels and market segments, and they deliver products highly acceptable by the consumers are integral to the Mission implementation plan. The market entry of promising biomaterials for manufacturing, bioactive compounds and novel food/feedstuffs from low-trophic species and circular processes is usually hampered by answered questions about their durability, cost of production, availability, fate in the natural environment, mode of action, dose effects, nutritional value, health benefits and easiness to use. The European Innovation Council can have a dedicated role in tracking how a given novel compound/product advances towards the end of the innovation path, in raising awareness among the innovation actors regarding the support instruments available to accelerate market entry, in promoting accreditation of these novel compounds/products according to established standards relevant to their future use, to facilitate positioning new compounds/products and to secure consumer acceptance. Mapping the consumer response to the new face of aquaculture and building recognition of the overall benefits of the novel produce are horizontal objectives to be pursued.

Human capital is fundamental in capitalising on solutions, methods, processes, products and knowledge generated. Actions to make the blue component of primary production an attractive career are recommended in order to attract the critical mass for achieving the Mission goals.

9.2. Description of the portfolio

According to the FAO[23], global aquaculture production should expand sustainably from 35% to 40% by 2030, according to national and regional contexts, to satisfy the growing demand for aquatic foods in the next ten years. The pressure on aquaculture to provide healthy food and novel biomaterials at low ecological footprint is high also in the EU that has aligned the efforts with the FAO to achieve the Blue Transformation[24].

Modern aquaculture has been growing fast driven by intensive generation of knowledge. EU-funded research has been supporting the increase of knowledge and innovation in modern aquaculture -mainly through successive framework programmes for research and innovation but also through structural and other funding streams- with the ultimate aim to support the financial and environmental sustainability of the sector. The objective of a zero-carbon, toxin-free, fully circular aquaculture/algae production compatible with vulnerable ecosystems, as described in the implementation plan of the Mission “Restore our Ocean and Waters by

[20] Aquaculture Advisory Council

[21] Standing Committee for Agricultural Research – Strategic working group on Fisheries and Aquaculture

[22] Scientific, Technical and Economic Committee for Fisheries)

[23] https://www.fao.org/state-of-fisheries-aquaculture

[24] https://www.fao.org/documents/card/en/c/cc0458en/

2030", has been conceptualised and served by several projects before the Mission was launched. The current analysis focuses on 62 projects across different funding programmes, that addressed or have been addressing the challenges set by the Mission and they have been funded since 2014, with the total EC contribution amounting to 281.1 million Euros.

Achieving **zero-carbon aquaculture/algae production** asks for neutralising the environmental impact of aquaculture to the extent that aquaculture operations are compatible with vulnerable ecosystems. Currently, the carbon footprint of aquaculture is largely attributed to the formulation and production of feeds based on ingredients that exert high pressure on fish stocks, land and water, compete with human food for resources, and often have a significant transportation footprint. Inefficient feeding strategies and digestive physiology determine the release of uneaten feed and nutrient-rich excretions in the water. The choice of farmed finfish species dictates the use of feeds, and the feed and feeding technology determine the use of ingredients and release of nutrients in the water. Shifting the focus to low-trophic and/or extractive species (thematic area A) for production of biomass alone or in combination with finfish and other species in integrated multi-trophic aquaculture (IMTA) schemes (thematic area B) can accelerate the pace towards zero-carbon aquaculture. Making IMTA production viable has been a long-standing challenge, and key to adoption and expansion of IMTA practices. The appropriate species combination and digital applications for continuous monitoring of the IMTA components can define the production outcome. Low-trophic species and microbiome hold big potential as sources of alternative ingredients for fish feeds (thematic area C), as do nutrients extracted from waste and side-streams.

The valorisation of waste and side-streams (thematic area D) is the cornerstone of **fully circular aquaculture,** where wastewater treatment and re-use, and efficient retention of biomass is powered by novel enzymes and green processing methods and technologies to deliver new products and value chains, making full use of nutrient input in a production system and the side streams. IMTA systems, coupled with green energy production and high yield biorefineries are major to the deployment of circular solutions. Low-footprint resources (thematic area E) are not limited to alternative feed ingredients; plastic-free construction and packaging materials, green energy and water recirculation systems, extension of shelf-life and decrease of biomass loss have a significant contribution to the overall target of zero-carbon aquaculture.

The production in aquatic ecosystems is continuously vulnerable to biofouling, pathogens and parasites with important ramifications for the health and welfare of the farmed organisms and the overall productivity. **Toxin-free aquaculture** relies on the discovery and validation of bioactive substances with anti-biofouling, antimicrobial and immunostimulant properties and the development of efficient vaccines to reduce chemical use (thematic area F) while minimizing losses and securing the sustainable operation of the production sites.

All three aquaculture-related Mission targets have been pursued by the funded projects. 40 projects have contributed to the target of zero-carbon aquaculture, 26 of which have also developed outputs to enhance circularity in aquaculture and another 14 have pursued toxin-free solutions. The complete portfolio of projects looking for circular and toxin-free solutions contain 39 and 20 projects, respectively.

All thematic areas have been supported by the funded projects relevant to the Mission (Table 9.1, Figure 9.1). All projects have delivered or are expected to deliver outcomes falling into more than one Thematic area. The biology and farming of low-trophic/extractive species and the valorisation of waste and side-streams have received the most of attention. Projects funded after the launch of the Mission in 2021 are clearly more Mission-oriented as the number of projects per Thematic Area in the last two years is comparable to the overall number of projects funded between 2014-2020 (Table 9.1).

Table 9.1. Number of projects funded before and after 2020 contributing to each of the thematic areas considered instrumental in achieving the relevant Mission targets

Thematic Area	Title	Number of projects (2014-2020)	Number of projects (2021-present)
A	Biology and farming of low-trophic or/and extractive species	13	17
B	Supporting Integrated Multi-Trophic Aquaculture (IMTA)	5	5
C	Alternative feed ingredients with low carbon footprint	9	10
D	Valorisation of waste and side-streams	14	12
E	Low-footprint resources for aquaculture	8	7
F	Reduction of chemical use	9	7

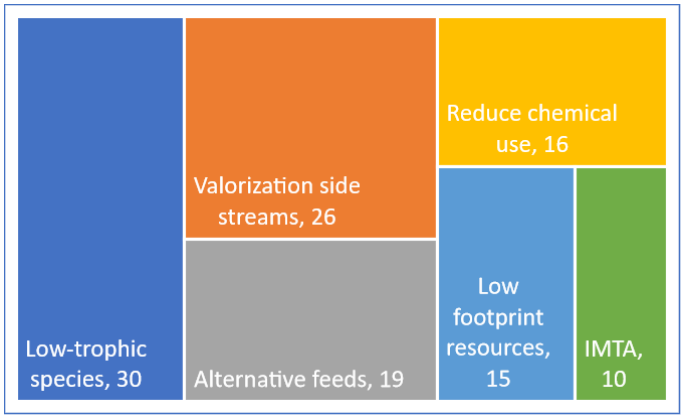


Figure 9.1. Number of projects contributing to each of the thematic areas considered instrumental in achieving the Mission targets

By 2020, three programmes (H2020, Interreg and EMFF) had contributed 40 projects with relevance to the Mission (Figure 9.2). Framework programmes currently under implementation (HORIZON Europe, EMFAF, Life 2027, I3 and Erasmus 2027) have already added another 22 projects in the list (Figure 9.2). The complementary scope of the different framework programmes indicates the need to approach the challenges set by the Mission from different angles and the recognition that the transformation of the aquaculture requires

effective governance and policy frameworks, new knowledge, technological innovations, capacity building, investment opportunities and value chain developments.

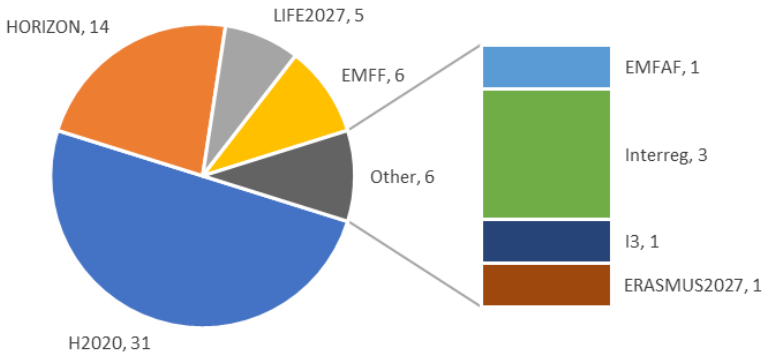


Figure 9.2. Number of projects relevant to the Mission funded under different programmes

By 2020, the cost of implementation of projects with relevance to the Mission had been a total of 219 million euros with the EC contributing 80.8% of this cost (177 million euros; Figure 9.3). The relevant projects that secured funding after 2020 come with a total cost of 204 million euros in which EC contribution accounts for 51% with 104 million euros (Figure 9.3).

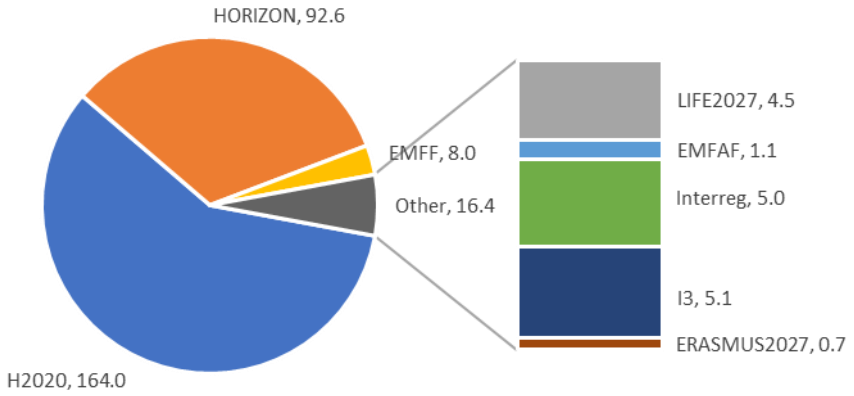


Figure 9.3. Distribution of EC contribution across different programmes to projects relevant to the Mission

An array of funding tools and actions have shaped the portfolio of Mission-relevant projects since 2014 (Figure 9.4). Besides the Research and Innovation Actions (RIA) and Innovation Actions (IA) that form the bulk of portfolio and have absorbed 65.6% of the EC contribution (Figure 9.5), Coordination and Support Actions (CSA) and COFUND schemes were funded to support governance tools, spread good practices, align programmes at pan-European level, pool research and innovation investments while leveraging other funding and finance

streams. Innovation in action was also present in the Mission-relevant portfolio with projects funded in support of the SMEs and to promote the Bio-Based Industries (BBI), and more recently under the vision of the European Innovation Council (EIC) and though the Interregional Innovation Investment (I3) Instrument. European Regional Development Fund has contributed with three Interreg V projects to promote cross-border cooperation in the Mediterranean and transnational cooperation to develop and validate the technological processes to obtain biodiesel from cultivating microalgae. Structural funds for the implementation of the Common Fisheries Policy (EMFF, EMFAF) have supported Mission-relevant projects with 9.1 million Euros, while another 4 million Euros were directed to support partnership for transformation in higher education (ERASMUS) and a doctoral network (MSCA). The spectrum of actions in the portfolio of Mission relevant projects is representative of the research and education, innovation, cooperation, policy and regional development pathways leading to the Mission targets.

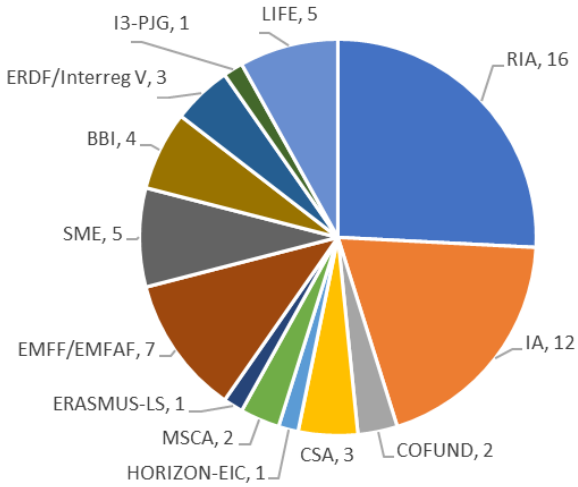


Figure 9.4. Types of Actions across different programmes supporting projects relevant to the Mission

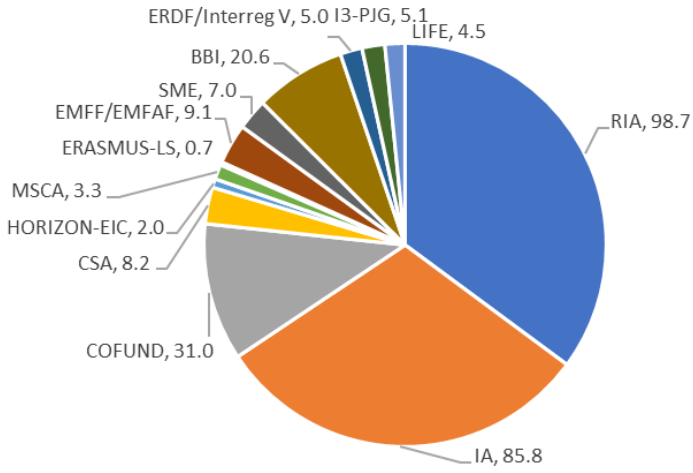


Figure 9.5. Distribution of EC contribution across the different types of actions supporting projects relevant to the Mission

The appreciation of the multiple dimensions of the Mission targets is also evident in the Levers of Change (LoC) mobilised in the Mission-relevant projects. Research and innovation was the dominant LoC in 77% of the projects (48/62), followed by deployment (29/62), value chains, and business aspects (24/62). Fifteen projects combined all three LoC pushing the development of targeted solutions to higher TRLs and exploring market segments. New governance schemes, regulation and policy development have been used as LoC in 16 projects, yet they were combined with citizen engagement only in projects funded after 2021, setting in motion a force with amplifying impacts. Capacity building through education and training was a component in 17 projects, mostly as a way to transfer the results of research and innovation (15/17).

Ten projects from different framework programmes and using various funding schemes, have set to contribute to all three targets of the Mission; three projects funded under LIFE were directed to the support of the 2022-2024 workplan of the NGO **Seas at Risk** with the goal to ensure that the roll out of the Green Deal has a strong 'blue' component, improve EU and international marine policies, integrate climate and biodiversity objectives in maritime policies, and a more effective implementation of EU regulations.

The COFUND **SBEP** "*A climate neutral, sustainable and productive blue economy Partnership*" is an ambitious endeavour of 59 partners from 25 Member and Associated States to implement impactful R&I governance to steer and support an inclusive blue transformation based on extensive digitalisation and ocean monitoring, promotion of ocean value chains and support of coastal communities, and policy development at regional, national and European level. Considering the success of the COFUND **BlueBio** in promoting the vision of the Mission, SBEP holds big potential as a R&I steering tool.

The Coordination and Support Actions (CSA) **UfMEASME** and **BlueMed** have supported governance schemes in the Mediterranean to ensure inclusivity, networking of the stakeholders from the Blue economy sectors, effective shaping of the regional R&I priorities and promotion of initiatives. CSA **BlueMissionBanos** focuses on the Baltic and North Seas with the ambition to act as an efficient facilitator and knowledge broker as to inspire, engage, and support stakeholders from politics, industry, science and the public to channel resources effectively towards the Mission Ocean objectives.

AQUAEXCEL2020 provided transnational access to 39 aquaculture research infrastructures, following open calls and selection procedures, and 112 projects were successfully completed addressing challenges highly relevant to the Mission. **NewTechAqua** on the other hand is an Innovation Action funded in the context of Blue Growth call that has approached aquaculture sustainability from a variety of angles to promote solutions in the areas of feeds, genetics, production methods, new products, digitalisation and technology for established fish species, emerging fish, extractive species and microalgae. NewTechAqua and BlueBio fall within the cluster of projects delivering promising and tangible results most relevant to the Mission targets.

The majority (39/62) of the Mission relevant projects address challenges common to all basins and with wide application potential. Nine projects focused to the development of cooperations across the Atlantic to research problems and develop solutions with the Atlantic as primary application area. Ten projects shifted their focus on the Mediterranean basin and three of them also pursued objectives relevant to the Atlantic and the Baltic Sea. Marine aquaculture/algae production has dominated the Mission relevant project portfolio.

A sub-set of 20 projects (out of the 62 projects flagged as relevant) were selected to be analysed in depth. They are highlighted in blue and bold in the list of projects (section 9.5).

9.3. Main outcomes and fostering the uptake of solutions

9.3.1. Main outcomes

Achieving zero-carbon, toxin-free, fully circular aquaculture by 2030 requires a series of disruptive approaches, a fresh mindset, highly skilled human resources to implement the changes needed and inclusive governance schemes that efficiently engage stakeholders from a wide spectrum of industries, all policy levels, advocate groups, scientists and citizens. This realisation is reflected in the EU funded research portfolio years before the EU Mission "Restore our Ocean and Waters" was launched and has paved the way to a new generation of projects set to serve the Mission. A series of solutions have been pursued to meet the Mission targets and outputs of differentiating TRL have been generated. Table 9.2 presents tangible results that have been generated by the 20 projects analysed in depth (marked in blue and blue in section 9.5 list of projects).

Zero-carbon aquaculture/algae production: the shift of focus to low-trophic species and an intensification of efforts to introduce new such extractive species in organised production and in IMTA schemes is particularly prominent. **IMPAQT** focused exclusively on IMTA production plans and deployed sensors and digital tools to monitor and optimise the production of six pilot sites in five countries that represented inland, coastal and offshore IMTA operations. Each pilot hosted a unique combination of organisms and the monitoring technology and strategy used was tailored to the needs of each pilot. The monitoring strategy and technology, results, experience and key messages are presented in a compelling open-access handbook that underlines the importance of high-resolution environmental monitoring for successful IMTA operations. IMTA systems development is further supported with new farming structures (**BIOGEARS, ULTFARMS**), integrated digital monitoring and management solutions, the introduction of new species and the development of new value chains (**AquaVitae, ASTRAL**). BIOGEARS has delivered prototypes of bio-based ropes for mussel and seaweed farming with comparable properties to the conventional ropes, and ULTFARMS is set to pilot new cultivation structures and integrated monitoring platforms for making seaweed and bivalve farming compatible to wind-energy production for efficient multi-use of marine space.

Although certain projects come with focused geographical concept, their outputs are transferrable to wider geographical coverage. **ClimeFish** covered a wide range of European aquatic production systems through case studies that allowed the development of guidelines for Climate Adaptation Plans and decision support software under changing climate. A variety of farmed species were studied for their adaptive capacity to climate change and resilience to adverse weather, including the mussels. Biological modelling was an important attribute in the prediction model.

In addition, the use of low-trophic species and microbiome to source alternative ingredients for fish feeds that lift the pressure from fishstocks, land and water use is widely explored in an attempt to secure a sustainable future for the established EU finfish production. **SAFE** is expected to deliver low footprint feeds and nutritional programming schemes for established freshwater species, while **NewTechAqua** has been testing novel feed ingredients from low-trophic organisms and side-streams for established and emerging fish species. Circularity has emerged as the sustainable approach to source for novel ingredients and biomaterials of varying properties and uses.

Fully circular aquaculture: new products and value chains have been designed and demonstrated to make full use of nutrient input in a production system and the side streams. IMTA systems are often coupled with green energy production (**OLAMUR, ULTFARMS**), and

high yield biorefineries (**REALM**) towards higher efficiency of circularity. The efficient multi-use of the marine space will also be promoted in the **AquaWind** pilot, where wind-energy production will be combined with fish production.

Connecting wastewater treatment with algae production is another circular approach yielding results. **ALGAENAUTS** will set up and pilot the complete pipeline from algae strain selection for optimizing biopesticide production and processing, to the production of algae using wastewater as nutrient source and the extraction of algae compounds with biopesticide activity. **REALM** is developing two pilots of innovative protocols to use nutrient-rich water discharged from soilless production of vegetables to grow microalgae that will undergo processing for the extraction of compounds for the agrochemical sector. To the same direction, **SAFE** is developing low-cost methods to use the nutrients captured in the sludge of carp ponds. **BlueBiochain** and **SIDESTREAM**, funded within the context of BlueBio ERA-Net, use wastewater to grow microalgae for fishfeeds, cosmetics and food additives and side streams to produce polychaetes and crustaceans for the production of omega-3 lipids.

New enzymes and green processing methods and technologies for valorising biomass and side-streams have been generated by several projects to support circularity in aquaculture. In **NewTechAqua**, new yeast strains have been validated for their enzymatic capacity to release peptides and flavor-aroma compounds from fish waste. **AquaBioProfit** has intensively worked to develop protocols of green technologies for extracting protein, carbohydrates, pigments and antioxidants from microalgae and fish side-streams, and to run trials that demonstrate their cryoprotective, anti-inflammatory and skin repairing capacity. **MULTISTR3AM** has also developed a protocol for the chlorophyll-free extraction of a protein fraction from *Nannochloropsis* microalgae for application in biorefineries. **REFISH** focuses on the valorisation of landed fish discards through the first biorefinery demonstration using fish raw material to retrieve value-added products (protein hydrolysates, fish and squid oils, mineral fraction, collagen hydrolysates, gelatines, fish mince, chitin and chitosan). Several projects funded within the context of BlueBio ERA-Net (**SuMaFood, Aquaheal3D, BlueCC, SureMetS, IMPRESSIVE, MIVERNA, MARIKAT**) have also been working to enhance circularity in aquaculture through the development of green processing methods and the discovery of novel enzymes to retain valuable nutrients or bioactive compounds for downstream use in health applications, food and feed. **SEAFOOD ALGERNATIVE** has pushed the processing innovation to the highest TRL levels with the production of algae-based food commercial products, alternatives to fish-based food products.

Green processing of seaweed to maximise recovery of valuable substances, seaweed cultivation and pilot processing are also the subjects upon which the doctoral network **SEACHEM** has been built to train a new generation of scientists in the dynamic seaweed sector.

Toxin-free aquaculture: in recognition of the daily need to fight biofouling, pathogens and parasites in a sustainable way in aquaculture, screening for bioactive substances with antimicrobial and immunostimulating properties complements the biosourcing objectives of several projects. **ELOXIRAS** and **NetWave** have delivered commercial products and commercial prototype, respectively, for chemical-free water treatment for RAS and net antifouling. Two strategies for biological treatment of water in freshwater RAS are under development in the project **RASbiome** funded in the context of BlueBio ERA-Net. **PlastiSea**, also funded in the context of BlueBio ERA-Net is contributing to the elimination of plastic with the development of bioplastic materials from brown algae.

BlueBio has been a very successful ERA-Net COFUND in selecting projects relevant to the Mission, with 25 out of 30 projects selected focusing on new, underutilised and invasive species as sources of enzymes, blue biomaterials to support blue biotechnology and

revolutionarise feed formulation towards zero-carbon aquaculture; re-use and valorise aquatic waste-streams, design, validate and introduce innovative biorefinery processes of algae, and further advance with circular production design with innovations in water treatment and digitalisation of Recirculating Aquaculture Systems (RAS).

Table 9.2 Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
ALGAENAUTS	Pre-commercial **pilot line** for the optimised production of selected algae strains with enhanced biopesticide activity, using wastewater. Protocols for strain selection, optimised production and processing	Algae culture; Agriculture Wastewater management	Website
AQUABIOPRO-FIT	**Protocols** of green technologies to successfully increase the yield of proteins from fish side-streams and extract protein, carbohydrate, pigment and antioxidants from microalgae and fish side-streams. Health benefits of fish-derived bioactive compounds demonstrated.	Valorisation of fish side-streams; Production of bioactive compounds and nutraceuticals	Results
AquaVitae	Introduction of **new species** for IMTA and new **value chains**; Guidelines for performing health-risk benefit assessment of low trophic species products; New sensors and **IoT platform** for IMTA data integration and analysis; Network of knowledge generation and exchange across the Atlantic	Cross- Atlantic IMTA; Smart Aquaculture	Results
AquaWind	**Pilot** of wind energy and fish production; digital **applications** in aquaculture production; **Engaging process** for all relevant stakeholders	Fish production; Green Energy; multi-use of marine space	website
ASTRAL	New **digital tools** and sensors for IMTA; Validated cost-effective IMTA **processes**; Identification of **new species** for IMTA; Network of knowledge generation and exhange across the Atlantic	Cross- Atlantic IMTA; Smart Aquaculture	Objectives Results
BIOGEARS	**Prototypes** of bio-based ropes for mussel and seaweed culture of similar design to the conventional petrol-based ropes	Mussel and seaweed culture; aquaculture	Prototype Report
BlueBio	25 out of 30 projects selected relevant to Mission; new, underutilised and invasive species as sources of enzymes, blue biomaterials and low-impact feeds; re-use and valorisation of waste-streams; innovative biorefinery processes of algae; water-treatment and digitalisation of RAS	Low-trophic production; pharma-, nutra- cosmeceuticals; fish farming; water treatment; bioremediation	Selection of projects

Project acronym	Description of result	Application	Link to the result
ClimeFish	**Guidelines** to create Climate Adaptation Plans for fisheries and aquaculture supported by a decision support framework (DSF) including data, forecasting models, visualisations and the Decision Support Software (DSS) validated in different aquaculture practices and climate zones.	Pond Aquaculture; Atlantic and Mediterranean marine fish and bivalve farming;	Guidelines for Climate Adaptation Plans
ELOXIRAS	An innovative chemical-free system to treat marine or brackish water in recirculating aquaculture systems (RAS). Eliminates the need for biological treatment and disposable filters. Enhanced pathogen control and reduced water use. Available **commercial models**!	All scales of RAS operations; Fish transportation and quarantine	Presentation of commercial products
IMPAQT	**Validated digital solutions** deploying tailored combination of sensors and cameras for high resolution real-time monitoring of hydrodynamic and biogeochemical processes, behaviour and welfare for sustainable Integrated Multi-Trophic Aquaculture (IMTA).	Inland, coastal, off-shore IMTA; optimisation of site selection and design; environmental monitoring and sustainability	Handbook
MULTI-STR3AM	**Protocol** to extract soluble proteins, free from the insoluble protein fraction, with a low lipid content and eliminating the colored chlorophyll-a for food applications; maximise the potential of a *Nannochloropsis* sp. biorefinery process	Algae biorefiniries; food industry;	Publication
NetWave	Commercial **prototype** of chemical-free antifouling system for aquaculture based on ultrasound	Clean Aquaculture Nets	Demonstration
NewTechAqua	Validation of **new yeast strains** to produce antioxidant hydrolysates containing peptides and flavor/aroma compounds from fish waste for feed or food formulations	Valorisation of fish side-streams; Food industry	Results
OLAMUR	Pilot **demonstrations** (3) of mutli-purpose use of marine space; off-shore wind farms and low-trophic species; **governance/ policy recommendations** for low-impact multi-use of marine space.	IMTA; Green Energy; Location identification for multi-use	Available information

Project acronym	Description of result	Application	Link to the result
REALM	**Pilot** (2) of innovative protocol to grow algae in nutrient-rich drain water of soiless greenhouse cultivation; Microalgae **biorefinary products** for use in agriculture	Microalgae culture; Soiless production; agrochemical industry	website
LIFE21-ENV-ES-LIFE REFISH	**Demonstration** of a biorefinary that implements interconneted chemical processes to obtain **valuable substances from fish discards**	Fisheries; valorisation of fish side-streams	website
SAFE	**Low footprint feeds** for established European freshwater farmed fish; nutritional programming for reduced footprint feeding; low-tech, low-cost **technology** for pond sludge valorisation; innovative **method** for the co-culture of carp and crayfish	Freshwater finfish farming Fishfeeds; waste valorisation; IMTA	website
SEAFOOD ALGERNATIVE	Algae-based alternatives to canned tuna, smoked salmon, tarama. **Commercial products** by ALGAMA Foods	Algae processing; food industry	Product presentation and promotion
SEACHEM	Ten highly-skilled **young scientists** with expertise in seaweed cultivation and valorisation; Properties and maintainance of open ocean seaweed structures in multi-use farms; Green chemistry **methods** for maximised recovery of valuable substances; Pilot seaweed biorefinery	R&I; seaweed cultivation and biorefinery; multi-use of open marine space	website
ULTFARMS	Pilot **demonstrations** (6) of low-trophic (seaweed, bivalves) aquaculture in offshore wind farms; New **cultivation structures** and grow-out systems; Integrated monitoring and management **platforms** using existing forecasting systems	IMTA; Green Energy; multi-use of marine space	Available information

9.3.2. Fostering the uptake of solutions

Some promising solutions generated by the Mission-relevant projects are:

- Pilot demonstrations of IMTA production systems based on combinations of different species, some of them new to IMTA, and equipped with sensors and digital platforms for advanced monitoring as a decision-making tool in daily production;
- Pilots of combined uses of marine space that include aquaculture;
- Pilots of microalgae production based on wastewater and side streams;
- New enzymes and green processing technologies;
- Pilots of biorefineries processing microalgae, seaweed and fish waste;
- New bioactive compounds for downstream uses and applications;
- New commercial products.

Digitalisation appears instrumental in monitoring and managing offshore operations and in achieving multiple use of space as well as in optimizing biomass production in IMTA and RAS. European Digital Innovation Hubs (EDIHs) are dedicated to accelerating digital transformation in European and they can make an efficient mechanism to promote the adoption of **digital innovation in aquaculture** and make precision farming a standard practice. The European Aquaculture Technology and Innovation Platform (EATiP) is strongly advocating the potential of digitalisation and it is important that it acts as the facilitator between the producers and digital technology and data analytics providers to ensure that the needs are identified, and solutions are provided in a tailored manner. The projects funded have managed to deploy digital solutions in the field with existing sensors and technology, which indicates that the adoption of project results can proceed quickly with the help of EDIHs.

The prototypes of biobased and biodegradable ropes for mussel and seaweed culture developed by **BIOGEARS** is a highly promising result and the project has already completed the validation of the performance in mussel culture in the sea. A workshop was organised to inform and discuss with potential users as well as to explore the value chain of biopolymer ropes. Biogears were proven to support higher mussel production in the sea compared with the conventional ropes. However, a series of concerns hamper their adoption in practice: durability in comparison to conventional ropes, unexplored fate in the water when they disintegrate, availability and high cost of biopolymers for their production, ways to recycle them, and unwillingness of producers to shift to their use. The technical issues call for further research. EMFAF grants remain an appropriate funding tool for such focused application development. The established negative perception and intention of the farmers call for actions to raise awareness among their community and to offer financial motivation towards the use of biogears. Introducing new policy that makes the use of the biogears mandatory could also be transformative, yet it should take into consideration the economic dimension and availability of the biogears.

Seaweed and microalgae are to provide the bulk of aquatic biomass to extract compounds and formulate biomaterials for an array of sectors. Farming practices based on wastewater or nutrient-rich discharges are particularly good practices that should be continuously supported. European Innovation Council (EIC) grants could be used to push the TRLs to

commercial levels. Bioactive compounds deriving from algae and side streams deserve also support to find their position in the manufacturing industries. **AQUAHEAL3D** funded in the context of BlueBio ERA-Net takes patented skin regenerating HTX extracted from salmon roe to the next level of production as it focuses on the development of a wound healing patch composed of 3D printed alginate and cellulose from seaweed and tunicates and the bioactive HTX. The consortium holds experience in industrial research and application that could be transferred to develop industrial applications from other promising bioactive compounds and biomaterials. Identifying the winning points of a success story is key to transferring it to other fields along with the organisation of mentoring events between successful projects and projects with promising results under the support of the EIC.

The transformation of aquaculture practice under way leads to the production of big volumes of fresh and highly perishable biomass. **QualiSea** funded in the context of BlueBio ERA-Net strives to establish standardised conditions for transfer and storage of fresh seaweed biomass to lift limitations in the development of the new value chains and avoid biomass loss. The results are important in the drafting of guidelines and regulations to guide the development of suitable logistics for seaweed. The involvement of the European Algae Biomass Association could ensure the participation of all stakeholders in the drafting of the guidelines.

The European Algae Biomass Association operates working groups in all areas of biology and applications of algae and can act as an aggregator and communicator of the knowledge rapidly accumulating. Securing free flow of ideas and solutions between relevant actors within and outside the EU is essential to expand the dimensions of solution application and propagate the ideas. The support of a platform for knowledge sharing in all aspects of algae biology, farming, processing and applications through the Coordination and Support Action funding tool can provide an attractive framework for effective networking between the stakeholders of the algae sector, for identifying gaps in algae research and innovation and continuously updating the EU research agenda, and for developing the narrative and communication strategy for different audiences.

Algae as well as side stream biomass is valorised with the help of green chemistry for processing and extraction of nutrients and added-value compounds. **AQUABIOPROFIT** has delivered a number of green approaches for the valorisation of aquatic biomass, and it advanced with studies that substantiate the properties of certain extracts making them attractive to downstream users. This practice highlights the merit of a complete and use-oriented approach in projects, designed to deliver materials and compounds, which could be promoted as a good practice in future calls. To capitalise on the results delivered, separate pathways for outputs transfer and uptake should be pursued and financially supported by the EIC or the European Institute of Innovation and Technology (EIT-Food).

SEAFOOD ALGERNATIVE has already positioned its products in the market, a series of algae-based food products that come to create a new niche and pave the way for other such products to come. The impact of the project relies heavily on the consumer acceptance and the promotion of the products, in a way that their significance in transforming aquaculture and the food system is highlighted to address the sustainability concerns of the consumers and advocate for responsible consumption. Such actions fall within the remit of EIT-Food that recognises the role of public engagement in the transformation of food systems. Sustainable aquaculture is one of the focus areas that EIT-Food directs funding to. EIT-Food has endorsed the EC Communication "*Towards a Strong and Sustainable EU Algae Sector*" by recognising that "*micro- and macroalgae could provide a solution to sustainably feed our growing global population and simultaneously contribute to the decarbonisation of the food system*". Through the operation of the Citizen Participation Forum, EIT-Food has identified the need to fight the lack of consumer awareness about the benefits of the algae and the

consumer scepticism when it comes to consuming algae-based foods. The FoodUnfolded® platform funded by the EIT-Food can serve as a vehicle for promoting all algae-based food and foodstuffs developed by the EU R&I frameworks.

9.4. Policy recommendations

The European Green Deal was launched in 2019 to call for a transformation of our economy to become a modern, resource-efficient and competitive economy, where net emissions of greenhouse gases are phased out by 2050. The Farm-to-Fork Strategy (2020) and the Sustainable Blue Economy Strategy (2021) detail the European Green Deal ethos and the approach towards its implementation. In recognition of the role of aquaculture in Food Security and Blue Economy, the Strategic Guidelines for a more Sustainable and Competitive EU Aquaculture (2021-2030) were also published in May 2021 setting four major objectives and suggesting actions to ensure the successful green transition of the sector. The launch of the Mission in September 2021 added clear goals to the existing framework for aquaculture/algae production and called for urgent action to restore our oceans and seas without compromising their production potential.

The implementation of the Mission is to connect, integrate and upscale solutions of various EU programmes and initiatives to achieve its ambitious goals and it cannot afford fragmentation in governance and policy development. Alignment of efforts is crucial in achieving so much in such a short time. The Aquaculture Advisory Council, the SCAR Fish, and the Scientific, Technical and Economic Committee for Fisheries (STECF) offer recommendations and advice to the EC for policy development and implementation, identify R&I priorities, engage the Member States and the relevant stakeholders. All such support mechanisms are valuable in rolling out the implementation plan of the Mission in a realistic manner. Organisational innovation to ensure the prolific crosstalk between all of them and their alignment to the Mission is key in preventing fragmentation of efforts and maximising their contribution to the Mission goals.

Long-standing producer organisations and stakeholders' platforms like the Federation of the European Aquaculture Producers (FEAP) and the European Feed Manufacturers' Association (FEFAC), the European Aquaculture Technology and Innovation Platform (EATiP) and the European Algae Biomass Association are instrumental in implementing the greening of the aquaculture and the sustainable development of algae production. Feasibility studies and foresight exercises of high credibility are needed to convince of the need for change and the realistic solutions available, to predict the timeline to achieve the change and to allow for planning founded on extensive buy-in by the sector that jeopardise neither environmental nor economic sustainability.

The Mission implementation plan recognises that Research and Innovation are instrumental in pushing forward and accelerating the pace of change. In the first development and piloting phase of implementation (2021-2025), the Mission has established "lighthouses" (BlueMissionMed, EcoDALLi, BlueMissionBANOS, BlueMission AA) as hubs for the development, demonstration and deployment of all forms of transformative innovations in the Mediterranean, the Danube, the Baltic and the North Seas, the Atlantic and the Arctic Oceans. The lighthouses are CSAs that started between November 2022 and January 2023 with only one lighthouse (BlueMissionBANOS) focusing on the carbon-neutral and circular Blue economy. The lighthouses are expected to provide a dynamic drive of change and it is highly recommended that appropriate steps are taken to include aquaculture/algae production in their action plan. As hubs and deployment platforms, the lighthouses could connect the Mission to the Digital Europe programme by liaising with European Digital Innovation Hubs and actively promoting the digitalisation in aquaculture/algae farming. This

is a highly pertinent topic for European R&I as smart applications hold big promise in reducing the environmental impact of aquaculture operations while maximising their production.

R&I governance appeared instrumental in contributing to the objectives of the Mission. An ERA-Net COFUND alone managed to effectively steer decisions to select and fund 25 projects in support of the Mission objectives. COFUND schemes appear an appropriate tool for streamlining R&I serving the Mission. Projects with specific focus funded by the EMFF/EMFAF or the SME instrument have been successful in delivering tangible outputs of high TRL in the project lifetime. These funding instruments appear attractive to companies that want to pursue one clear and mature objective, and getting involved in bigger consortia would not provide extra benefits to them. More generic and open calls that allow bottom-up development of proposals and a higher funding allocation could enhance the attractiveness of these tools and produce several focused solutions with relevance to the Mission.

Streamlining R&I planning, implementation, and assessment across the different programs and tools is a *sine qua non* for supporting the Mission goals. The Mission Implementation Plan partly addresses this need with the establishment of the lighthouses as the hubs and platforms for the development, demonstration and deployment of solutions to support the implementation of the Mission specific objectives. Each lighthouse is set to serve a specific objective within defined basins/seas. Currently, no lighthouse focuses on aquaculture or objective 3 at large, despite the size of value of the blue economy and the volume of R&I funded by the EC. A mechanism integrated in the Mission Implementation Plan that oversees the efficient planning and funding allocation across different programs, tools and initiatives and evaluates the outcome based on Mission-specific indicators appears appropriate to coordinate efforts from different angles towards the identified targets.

The success of the Mission relies on the development and validation of sustainable value chains that can be quickly integrated in production systems, distribution channels and market segments, and deliver products highly acceptable by the consumers. Biomaterials for manufacturing, bioactive compounds and novel food/feedstuffs from low-trophic species and circular processes are being delivered, often with insufficient information about their durability, cost of production, availability, fate in the natural environment, mode of action, dose effects, nutritional value, health benefits and easiness to use. Persistent gaps in this kind of information lead to the removal of novel biomaterials, bioactive compounds and food/feedstuffs from the ready-to-transfer list and the path to innovation is disrupted. R&I strategy reinforced with a tool to watch and track how a given novel compound/product advances towards the end of the innovation path could rescue novel compounds/products from early perish and capitalise the maximum on the R&I investments. Accreditation of these novel compounds/products according to established standards relevant to their future use is also recommended as a strategy to introduce them to markets, manufacturers and consumers. Raising awareness among the innovation actors regarding the support instruments available to reduce such information asymmetries for accelerating market entry and proactively promoting their use would maximise the return on R&I investments.

Nurturing sustainability takes extensive public awareness and consumer acceptance. A combination of actions to reach out to consumers and underline their role, to increase their awareness, and to position the new products in established and emerging markets is a prerequisite for shaping a sustainable future for aquaculture/algae production. Mapping the consumer response to the new face of aquaculture, establishing a transparent communication between production and consumption choice and building recognition of the overall benefits of the novel produce are horizontal objectives to be pursued.

Human capital is fundamental in capitalizing on solutions, methods, processes, products and knowledge generated. Scientists, highly skilled technical personnel, policymakers of all levels

and entrepreneurs are the moving force behind the change sought. Innovating education, training and capacity building programmes beyond the framework and lifetime of the projects to instil the Mission principles and to provide the necessary background is key for sufficient and competent human capital to use the knowledge generated and scale up solutions developed. Actions to make the blue component of primary production an attractive choice in career paths are recommended to attract the critical mass for achieving the Mission goals.

9.5. List of projects

Project id	Project Acronym	EU Programme (FP)	Type of Action (ToA)
101082557	AFISHE	ERASMUS2027	ERASMUS-LS
101038250	**ALGAENAUTS**	**EMFF**	**EMFF-AG**
790956	**AQUABIOPROFIT**	**H2020**	**BBI**
652831	AQUAEXCEL2020	H2020	RIA
817923	AQUA-FAANG	H2020	RIA
101038541	AquaPekilo	EMFF	EMFF-AG
818173	**AquaVitae**	**H2020**	**RIA**
101077600	**AquaWind**	**EMFAF**	**EMFAF-PJG**
101099476	ASTEASIER	HORIZON	HORIZON-EIC
863034	**ASTRAL**	**H2020**	**RIA**
101083785	Baltic MUPPETS	I3	I3-PJG
863708	**BIOGEARS**	**EMFF**	**EMFF-AG**
817992	**BlueBio**	**H2020**	**ERA-NET-Cofund**
23491	BLUEfasma	Interreg	ERDF;IPA/IPAII
727453	BLUEMED	H2020	CSA
101093845	BlueMissionBANOS	HORIZON	HORIZON-CSA
101060537	BlueRev	HORIZON	HORIZON-CSA
678193	CERES	H2020	RIA
101060607	CIRCALGAE	HORIZON	HORIZON-IA
677039	**ClimeFish**	**H2020**	**RIA**
101084405	CRONUS	HORIZON	HORIZON-RIA
101084204	Cure4Aqua	HORIZON	HORIZON-RIA
20603	CYCLALG	Interreg	ERDF
101036428	EcoeFISHent	H2020	IA
651167	**ELOXIRAS**	**H2020**	**SME**
775922	ENTOMICSBLUEGROWTH	H2020	SME

823943	FISHSkin	H2020	MSCA
870465	FORCOAST	H2020	IA
817737	FutureEUAqua	H2020	IA
773330	GAIN	H2020	RIA
101006618	HIGFLY	H2020	RIA
818036	iFishIENCi	H2020	IA
101084651	IGNITION	HORIZON	HORIZON-RIA
774109	**IMPAQT**	**H2020**	**RIA**
101038311	KELP-EU	EMFF	EMFF-AG
101058121	LIFE21 FPA/BE/SAR	LIFE2027	LIFE-FPA-OG
101058217	LIFE21 NGO/BE/SAR	LIFE2027	LIFE-FPA-OG
101074517	LIFE21-ENV-DE-LIFE LEMNERGY	LIFE2027	LIFE-PJG
101074323	**LIFE21-ENV-ES-LIFE REFISH**	**LIFE2027**	**LIFE-PJG**
101111969	LIFE22 NGO/BE/SAR	LIFE2027	LIFE-FPA-OG
727315	MedAID	H2020	RIA
887227	**MULTI-STR3AM**	**H2020**	**BBI**
887474	NENU2PHAR	H2020	BBI
778453	NEPTUN	H2020	SME
958776	**NetWave**	**H2020**	**IA**
862658	**NewTechAqua**	**H2020**	**IA**
101084180	NOVAFOODIES	HORIZON	HORIZON-IA
101094065	**OLAMUR**	**HORIZON**	**HORIZON-IA**
22569	P.Ri.S.Ma. MED	Interreg	ERDF
634429	ParaFishControl	H2020	RIA
727610	PerformFISH	H2020	RIA
101010113	Proton	H2020	SME
101060991	**REALM**	**HORIZON**	**HORIZON-IA**
101023567	REDWine	H2020	BBI
101084549	**SAFE**	**HORIZON**	**HORIZON-RIA**
101086379	SBEP	HORIZON	HORIZON-COFUND
101000402	SEA2LAND	H2020	IA
101073471	**SEACHEM**	**HORIZON**	**HORIZON-TMA-MSCA-DN**
101038453	**SEAFOOD ALGTERNATIVE**	**EMFF**	**EMFF-AG**

881619	UfMEASME	EMFF	EMFF-AG
101093888	**ULTFARMS**	**HORIZON**	**HORIZON-IA**
101009401	UVERA	H2020	SME

10. Blue economy - Decarbonisation and ecosystem perspectives in maritime industries. *By Markus Lehne*

10.1. Main findings of the analysis

The purpose of this analysis is to assess the current landscape of EU-funded research, innovation and deployment projects in relation to the overall transition of maritime transport and its land-based infrastructures, and to the environmental perspective of offshore renewable energy projects and deployments. The vast stakeholders landscape, the urgency to harness the potential of offshore energy for the EU climate neutrality goals, and the complexity of maritime transport decarbonisation (a sector included in the “hard-to-abate” ones) make the portfolio of EU-funded projects diverse and complex.

The analysis finds that the portfolio brings fundamental added value for reaching the objectives of the European Green Deal and Mission Restore our Ocean and Waters by 2030. In maritime transport, it includes new fuels and propulsion technologies, as well as the centrality of ports to support, through infrastructure development and logistic support, the transition of shipping. On offshore energy, the portfolio includes optimisation, multi-uses and increased efficiency of offshore energy installations (wind, tidal, wave). Only recently, the studied programmes have started to fund a more focused environmental perspective for offshore renewable developments, for example through the Mission Restore our Ocean and Water dedicated Work Programme in Horizon Europe.

While the analysis finds that funding allocation generally meets the needs to support the transition, some gaps persist. In particular, a stronger and more structured synergy between different projects and funding instruments would be beneficial for all actors and stakeholders involved. Moreover, the analysis stresses the importance of communicate externally projects’ results in a continuous and more focused way, to improve the recognition of technology maturity and marketability for newly developed solutions.

The development of new offshore energy technologies, which will see an exponential increase in the next decades, poses relevant question of its environmental consequences on the marine environment, in particular in large-scale developments. In some case, projects’ focus is solely on advancing the efficiency of the technology without looking into the possible environmental and social implications, which should become inherent elements for consideration for future calls. Such inclusion would facilitate a wider buy-in from communities, while allowing to adapt technologies in consideration of their related impacts. Additionally, to be successful and ensure market uptake, financial viability of new, green technologies is fundamental. The study highlights the importance of a level playing field between different technologies, with market-based-measures and internalisation of negative externalities for carbon-based existing technologies, through an expansion of schemes such as the EU ETS or other carbon taxes.

As shipping and ports are lifeline of global trade, and offshore renewables are set to become more and more central in the future European energy mix, the portfolio of EU-funded instruments demonstrates to be up to speed with most of the recent needs of the sectors. Nevertheless, a more synergetic approach and the inclusion of environmental and social perspectives in new technology developments would definitely bring additional value, and strengthen the EU competitiveness in sectors that will see a renewed global relevance.

10.2. Description of the portfolio

The portfolio consists of 112 relevant reprojects for a total EU contribution of 702 M€. The list of projects of projects is included in section 10.5.

As can be seen in Figure 10.1, one third of the projects are supported by R&I Framework Programmes. Interreg follows with 19 projects (15%). Other programmes include CEF, EMFF.

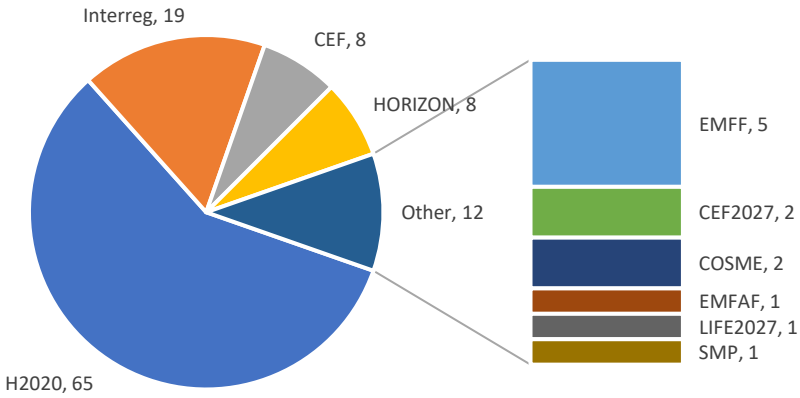


Figure 10.1. Number of projects per EU funding programme. Total number of projects: 112

In terms of EU funding, the lion's share (~80%) is provided by R&I Framework Programmes. The rest of the contributors follow similar order as above. This shows the need to increase the support of the deployment of solutions following up research and innovation (Figure 10.2).

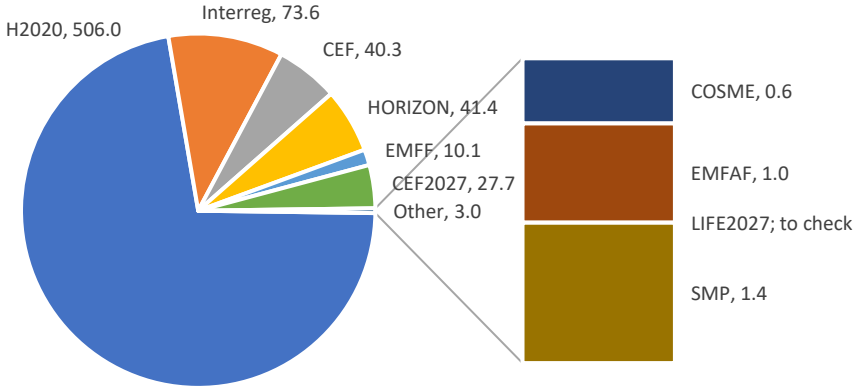


Figure 10.2. EU contribution (M€) per funding programme. Total EU contribution: 702,1M€.

Projects take a panoply of different instruments or types of action (Figure 10.3). As regards R&I there is a good split between Research and Innovation Actions and Innovation Actions. This means that all: long, medium and short term priorities are considered by the projects.

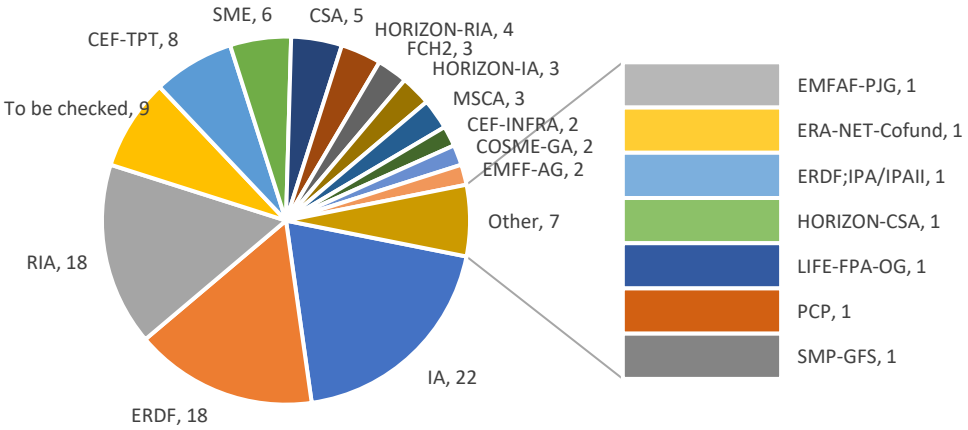


Figure 10.3. Number of projects per type of action. Total number of projects: 112

In terms of funding (see Figure 10.4), it calls attention that Horizon Europe Innovation Actions receive more than 3 times as much as Research and Innovation Actions. Meaning that demonstration projects demand high funding (around 13M€ each).

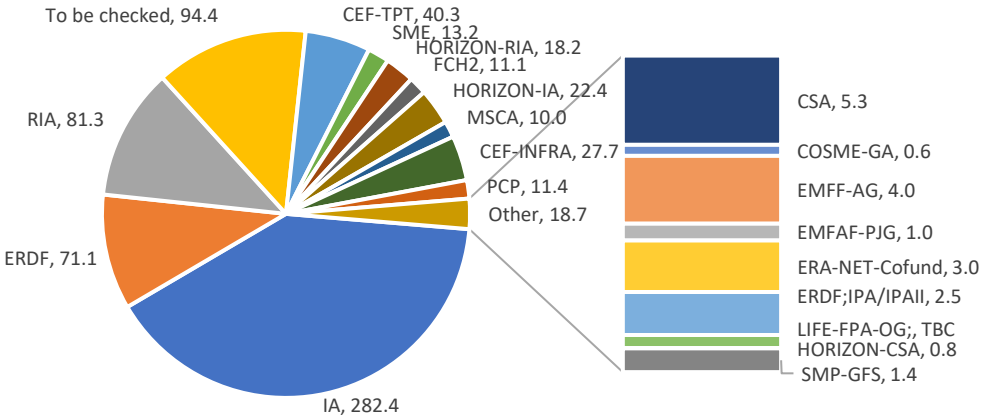


Figure 10.4. EU contribution (M€) per type of action. Total EU contribution: 702,1M€.

Projects have been categorised and grouped according to 5 thematic areas. Some of the projects contribute to more than one thematic area. See tree chart below (Figure 10.5) which shows that energy infrastructure receives the highest attention, following by Wave/tidal power, Offshore wind and Transport.

Energy infrastructures includes projects related to the infrastructures associated with energy system, from cradle to grave, such as the electrical grid, pipelines, port bunkering infrastructures.

Offshore wind includes projects focusing on the development, upscale and deployment of wind farms at sea

Tidal/Wave includes projects focusing on technologies aimed at harnessing the power generated by tidal movements, currents, and waves.

Transport includes projects focusing on maritime transport and its transition to net-zero through the uptake of alternative and zero-carbon fuels, including their supply chains, and energy efficiency measures

Fisheries/Aquafarming includes projects focusing on the environmental sustainability of industries and business models linked to fisheries and aquaculture,

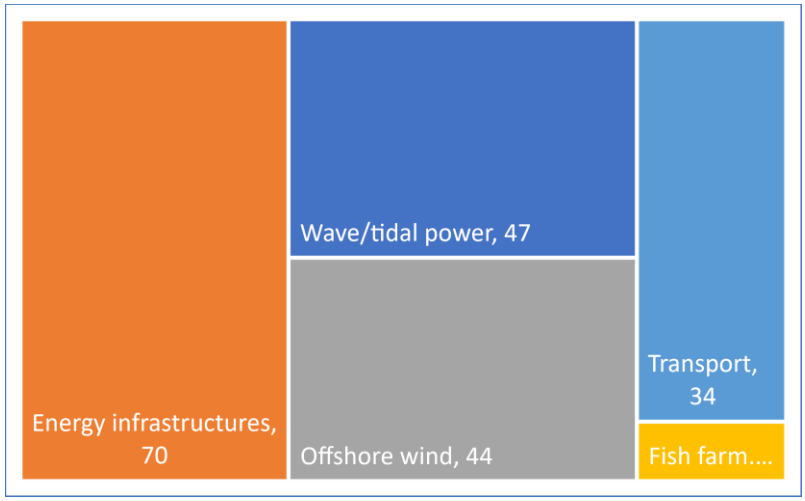


Figure 10.5. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 200. Total number of projects: 112.

In order to drive (or leverage) change towards their goal, projects have focused or applied different kind of levers. The so-called levers of change considered have been governance, financing and economy, research and innovation, new knowledge and data, deployment, citizen's engagement and education and training. The analysis included an assessment of the levers of change by thematic area of intervention.

As showed in Table 10.1, projects have followed mostly in governance, knowledge and data and deployment issues. Citizen engagement and education and training have been considered the least.

Table 10.1. Levers of change in function of thematic areas of intervention.

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engament	Education& Training
Wave/tidal power	28	13	11	40	28	10	8
Energy infrastructures	45	29	21	62	47	10	10
Offshore wind	28	17	15	37	24	7	8
Fisheries/aqua farming	4	1	1	4	1	3	2
Transport	18	10	15	33	21	5	5
Total	123	70	63	176	121	35	33

10.3. Main outcomes and fostering the uptake of solutions

The following table focus is on projects addressing protecting and restoring the health of our ocean and waters through research and innovation, citizen engagement and blue investments - and in particular : "Eliminate greenhouse gas emissions from maritime economic activities in the EU and sequester those emissions that cannot be avoided (net zero maritime emissions).

10.3.1. Main outcomes

Out of the 112 projects of this portfolio, a sub-set of 20 projects was selected for in-depth analysis. The projects are highlighted in blue and bold in section 10.5. A summary of the results identified from these selected projects in included in Table 10.2.

Table 10.2. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
@BluePortS	The “Blue Ports” Network of 270 members implemented a series of pilots: - a mobile port facility for treatment of ballast water, - an innovative oily water treatment process, - digital applications for risk and quality assessment in ports, - baselines of business plans for investors, - a knowledge database and - e-training tools.	Ports (environment)	Atlantic Blueports Website (marinesoutheast.co.uk)
ALL-IN Zero	Developing a multi-fuel system to generate electrical and mechanical power with zero emissions by prototyping a compact Membrane Reactor producing a common intermediate temporary energy vector to be consumed in situ by power generation systems such as internal combustion engines and fuel cells.	Transport	No results yet (start 09/22)
DGIM2	An ingenious new technology turns low-flow tidal currents into a cost-effective source of renewable energy for small islands by using an underwater kite with an impeller to convert low -flow tidal currents into electricity. The lightweight system provides predictable renewable energy at comparatively low operation and maintenance cost. This new type of power plant also offers the competitive advantage of operating completely submerged and out of sight – a key aspect for islands where a large proportion of the economy depends on tourism. Low-flow sites represent at least half of the tidal sites and most of the ocean current sites around the world: the global potential of our technology is substantial. Deep Green technology was successfully tested showing the capability of these power plants to replace diesel generators in microgrids	Offshore energy (Tidal)	Underwater kites bring green energy to islanders | DGIM2 Project | Results in brief | H2020 | CORDIS | European Commission (europa.eu) Media Library - (frontify.com) Minesto 3D Animation Video (frontify.com) Dragon 4 Product Video - Fast and Efficient Operations (frontify.com)

Project acronym	Description of result	Application	Link to the result
			Dragon 4 Product Video - Automatic Installation (frontify.com)
ELICAN	Self erecting/installing 5MW offshore wind turbine for deep water (20 to 50 meters range) prototype. design, build, certify and fully demonstration in operative environment a deep water substructure prototype supporting Adwen's 5MW offshore wind turbine, installed in the Southeast coast of Las Palmas (Canary Islands). It is the first bottom-fixed offshore wind turbine in all of Southern Europe and the first one worldwide to be installed with no need of heavy-lift vessels	Offshore Wind	https://www.esteyco.com/projects/elican/ https://www.youtube.com/watch?v=y1HaokUSulw
E-Ferry	Fully battery-electric ferry ELLEN operated by AEROE-ferries DK **Energy efficiency**: 85 % grid-to-propeller **Energy consumption**, 22 nautical mile (approx. 40 km) roundtrip: 1600 kWh; installed battery with 4,3MWh **Years before higher investment cost of new e-ferry turns into savings by low operational costs**: 4-8 **CO2 emissions saved in comparison to a modern diesel**: 2.520 tonnes/year **Passenger satisfaction:** Very high valid commercial alternative to traditional diesel- and diesel-electric propelled ferries. Fully electric ferries are more economical than traditional diesel ferries	Maritime transport	eFerry_Information_Package.pdf
FLOATECH	Design tools for floating windturbine optimisation, the prediction methods and models to adjust floating wind-turbines to wave motion to increase the efficiency of floating wind-turbines will safeguard the leading role of Europe's Offshore wind industry and will allow to harvest more energy with less material by intelligent control mechanismsand thus reducing the LCOE.	Offshore wind	https://www.floatech-project.com/deliverables

Project acronym	Description of result	Application	Link to the result
FloTEC	Developing and deploying the world's most powerful tidal stream turbine FloTEC project is now in the operation phase with the installation of the O2 2MW. Since June 2021 they are demonstrating an advanced, full-scale device in real conditions with high levels of reliability and survivability, while developing a greater understanding of factors such as installation, operation and decommissioning costs. Nuilding the floating body as wells as its installation has been performred by SMEs.	Offshore energy (tidal)	https://cordis.europa.eu/project/id/691916/reporting https://www.youtube.com/watch?v=Mj_czIIGHQk
FORESEA	The Interreg North West Europe 'FORESEA' project has been helping technology developers (tidal turbines, wind turbine module, anchoring, grid integration, etc.) to access Europe's test centres, and helps get demonstration projects into the water – and these demonstrations are essential to prove technology, generate valuable data, and push down costs. FORSEA (Funding Ocean Renewable Energy through Strategic European Action) provides free access to North-West Europe's world-leading network of test centres.(European Marine Energy Centre (EMEC): Orkney Islands, UK SmartBay: Galway, Ireland SEM-REV: Nantes, France Dutch Marine Energy Centre: Alkmaar, Netherlands) To date the project has seen 11 device deployments – allowing the testing of 55 different pieces of technology. e.g.:cost-effective wave energy device (CorPower Ocean's C4 full scale prototype) a mid-size marine platform that produces its own energy from the swell and the sun (GEPS Techno's WAVEGEM) the first off shore wind turbine installed off the French coast (2018- deol's Floatgen) Contra-Rotating Marine Tidal turbine plus subsystems and components (Nautricity's CoRMaT project) specific software to precisely classify sound sources (NEREIS)	Offshore energy	https://www.nweurope.eu/projects/project-search/funding-ocean-renewable-energy-through-strategic-european-action/ FA Forsea_stories-2.indd (nweurope.eu)

Project acronym	Description of result	Application	Link to the result
GAINN-IT (ITALY)	Development of adequate infrastructure in the two ports of Livorno and Venice that are expected to become the gateways of the Italian LNG network. Livorno LNG multi-modal facility is expected to have a storage capacity of about 9,000m3, while Venice about 32,000m3. Both multi-modal facilities are planned to be duly equipped for the reception of LNG from bunkering ships. Italian Ministry of Economic Development in agreement with the Ministry of Infrastructures and Transport has issued an official authorisation decree for the construction and operation of the first LNG storage in Porto Marghera. The facility will be built on a brownfield site on the South Industrial Canal. The decree was issued in late December 2020 and has been notified on 15 January 2021. Among the requirements for Venice LNG from the authorities are the use of non-polluting materials, the mitigation of dust and noise emissions during the construction phase, an Environmental Monitoring Plan, the implementation of procedures to limit waste production. LNG will be delivered to the terminal by small and medium-sized LNG carriers and will be distributed via tank trucks, ISO-tanks and barges. Decal Spa Group will invest more than €100 million in the facility. The project is promoted and supported by the North Adriatic Sea Port Authority and co-financed by the European Commission under the Connecting Europe Facility (CEF) initiative for a total of €18.5 million.	Infrastructure	https://trimis.ec.europa.eu/project/gainn-south-europe-maritime-lng-roll-out https://www.rivieramm.com/news-content-hub/news-content-hub/venice-lng-import-terminal-gets-green-light-62828 Location - OLT Offshore LNG Toscana
GreenOffshoreTech	GreenOffshoreTech will boost innovation by directly supporting at least 82 SMEs and 82 SMEs innovative projects aiming at developing new innovative products, processes or services (advanced materials, advanced manufacturing, Industry 4.0 and environmental technologies in the	technology incubator	News - GreenOffshoreTech

Project acronym	Description of result	Application	Link to the result
	emerging sectors offshore wind energy and offshore aquaculture, and the established sectors offshore oil & gas and waterborne transport) Direct financial support to SMEs through a competitive Call of Proposal for innovation projects in relevant maritime related topics; A range of dedicated and tailored Business Support Services to the winner SMEs. A list of the first 26 selectd projects can be found here: 1st Call for Proposals - GreenOffshoreTech		Evaluation Phase: the results are out! - GreenOffshoreTech
HyMethShip	Full scale Technology demonstrator -Membrane performance in reformer environment shows lower selectivity than in laboratory environment - High H2 / CO2 selectivity of membranes was demonstrated in laboratory - Full scale engine part load operation with 100 % hydrogen - Combined hydrogen production and hydrogen consumption processes demonstrated. Shows high potential to speed up acceptance of alternative fuels and is a first step to circular fuels.	Maritime transport	Technology demonstration and key technologies (hymethship.com) Integration on a ship: feasibility and impacts (hymethship.com)
H2SHIPS	Two pilot projects will be implemented as part of H2SHIPS: A hydrogen powered port vessel (FC and sodium borohydride storage for H) will be built in Amsterdam and in Belgium In Belgium, infrastructure and equipment will be built to power a H2 refuelling station in the Port of Ostend. Sodium borohydride is a very attractive candidate for Hydrogen storage application for maritime transport as well as for land based applications.	Maritime transport	https://www.nweurope.eu/projects/project-search/h2ships-system-based-solutions-for-h2-fuelled-water-transport-in-north-west-europe/#tab-3 https://www.nweurope.eu/projects/project-search/h2ships-system-

Project acronym	Description of result	Application	Link to the result
			based-solutions-for-h2-fuelled-water-transport-in-north-west-europe/#tab-4 https://www.nweurope.eu/projects/project-search/h2ships-system-based-solutions-for-h2-fuelled-water-transport-in-north-west-europe/news/h2ships-event-at-the-eu-hydrogen-week-flagship-expo/
IMAGINE	Development testing and evaluation (Hard Ware in the Loop) of a Electro-Mechanical Generator (EMG) for use as Power Take Off (PTO) in Wave Energy Converters (WECs) in close cooperation and based on work of the EMERGE project -> TRL5 The Electro-Mechanical Generator (EMG) consists of a recirculating ball screw integrated with a rotational permanent magnet generator and is able to convert reciprocating linear motion, typical of many marine energy devices, into electricity.	Offshore energy (wave)	Innovative Method for Affordable Generation IN ocean Energy | IMAGINE Project | Results | H2020 | CORDIS | European Commission (europa.eu)
LINCOLN	Design tools and designs/simulation/evaluation for low emission vessels, prototype applications to verify simulation .The approach is attractive for small and medium sized shipyards and might help to accelerate the provision of more efficient workboats for Europe's coasts.	Maritime transport	http://www.lincolnproject.eu/results/ http://www.lincolnproject.eu/business-cases/
MAGPIE	Demos: 1: BioLNG production; 2: Smart Energy Systems; 3: Shore power peak shaving; 4: Ammonia bunkering demo; 5: Offshore Charging Buoy; 6: Autonomous E-barge and transhipment; 7: Green container; 8: Hybrid	Ports	

Project acronym	Description of result	Application	Link to the result
	shunting locomotive; 9: Green Connected Trucking; 10: Spreading road traffic		
OCEAN_2G	demonstrated the good behaviour of the full-scale prototype in real environment (grid connected tidal test site in Orkney (Scotland) through EMEC's subsea cables and onshore substation) Test results: • Maximum power obtained: 1.5MW • Average power: 1MW • Energy obtained per tide: 2.5-3MWh/tide • Energy generated: over 100MWh • Hours of operation per day: 16-18 h/day • Current power coefficient >40% • 100% Availability	Offshore energy (tidal)	https://northsearegion.eu/periscope/news/magallanes-reinstall-atir-tidal-turbine-at-emec/ Unlocking energy from tidal power (magallanesrenovables.com) Magallanes Renovables : EMEC: European Marine Energy Centre
PIONEERS	Clean energy production & supply 1: Hydrogen refuelling infrastructure 2: A corridor of modular docking stations for energy containers 3: Battery storage and Smart Management of Green Energy in terminal operations 4: Hydropower Turbine 5: A corridor of modular docking stations for energy containers. Sustainable port design 6: hydrogen heating for buildings 7: Local resource recovery for green, circular concrete 8: Green Straddle Carriers 9: Electric green last mile Modal shift & flows optimization 10: IT Platform for planning multimodal transport	Ports	News | PIONEERS (pioneers-ports.eu)

Project acronym	Description of result	Application	Link to the result
	11: Realizing a modal shift in the commute of port employees 12: Cargo Flow Optimisation 13: Cargo Flow Prediction 14: Multimodal access to port using a MaaS platform Digital transformation 15: Automated container shuttle solutions for port operations 16: Automated vessels 17: Vessel traffic optimization 18: Digital Twin 19: Maritime 5G for intelligent vessel location		
Space at Sea	conceptual design, simulation and model tests of a modular floating multi-purpose island. Potential application cases are combining power generation, storage, and conversion, logistics hub, aqua-culture and housing.	Offshore (multi-purpose)	Frontiers | Conceptual Design of a Modular Floating Multi-Purpose Island (frontiersin.org)
STEERER	provided input to the Waterborne TP regarding the development and update of the Strategic Research and Innovation Agenda of the Co-Programmed Partnership on Zero-Emission Waterborne Transport in the framework of Horizon Europe. - together with an Scientific Committee and the Green Shipping Expert Group the emission targets towards 2050 (including targets for 2025 and 2030) have been described; - Contributing to the update of the Strategic Research and Innovation Agenda of the Co-Programmed Partnership on Zero-Emission Waterborne Transport (cPP ZEWT) in the framework of Horizon Europe,; - Developing an Implementation Plan to reach the targets in due course, while staying competitive and offering a valid business case; - Developing and implementing a communication campaign, aimed at	Governance	https://www.linkedin.com/company/steerer/posts/?feedView=all https://steerer.citizenlab.co/uploads/0b6799f1-6fb3-481f-b6d3-f92a17971a5a/project_file/file/85991472-536f-4291-a2e3-2ae706f9ca1e/The_state-of-play_of_decarbonisation_

Project acronym	Description of result	Application	Link to the result
	broader awareness of the waterborne transport sector and its commitment towards zero-emission transport.		of_waterborne_transport_STEERER.pdf
TrAM	Fully battery-electric fast ferry MEDSTRAUM (>23 knots for one hour) operated by KOLUMBUS (N). - unique modular manufacturing methods - a propulsion efficiency of around 80 percent - a battery with 1,5 MWh capacity - aluminium lightweight design - operating a multi-stop commuter route in Rogaland, Norway substituting a diesel powered ferry	Maritime transport	https://www.linkedin.com/posts/tram-h2020_the-tram-tale-activity-6977949025178128384-rTGK?utm_source=share&utm_medium=member_desktop MS «Medstraum» is Ship of The Year - TrAM (tramproject.eu)

10.3.2. Fostering the uptake of solutions

All projects have delivered remarkable results, which will contribute to the EU Mission Restore our Ocean & Waters. Some of the projects like E-Ferry and TrAM deliver ships in operation to be used as direct proof and showcase for other operators to follow. They have delivered fully integrated systems and their findings range from optimized hydrodynamics to efficient propulsion pushing the limits of technology within the limits of rules and regulations. These limits are often dictated by experience of technology which is at least one generation old. The effect of what is technically possible and what is possible to be commercially operated is hindered by rules and regulation which develop less progressive than technology. A nice approach to overcome this are the testing areas dedicated to deploying latest developments of e.g offshore energy harvesting devices. In these areas prototypes can show their potential although they are not covered by existing regulations and can deliver both experience for approval procedures as well as data for efficiency, environmental impact and financial demand. Good examples for this kind of projects are OCEAN_2G and DGIM2 where the test of the energy harvesting devices included full integration with the energy grid. One important success factor was in these cases an existing application case with the operator and a business case in place.

The Battery Electric prototypes of both ELLEN (E-FERRY) and MEDSTRAUM (TrAM) are best practice examples to showcase both the power of European research as well as the way to deploy the research results and thus to showcase to all stakeholders the potential of the developed solutions. Using battery electric propulsion trains for short distance shipping can now be considered state of the art and best practise for zero emission shipping in case the infrastructure and the required surplus of renewable electricity is given. The integration with the existing infrastructure and the contribution to public transport and local grid stabilisation is definitely worth to be copied to similar settings in Europe where we have thousands of short ferry connections and isolated small communities on islands which are still dependant on diesel generators for electricity supply and diesel ferries for commuting.
One step further away from deployment and evenly important for pushing technology limits are projects like HyMethShip. The HyMethShip system innovatively combines a membrane reactor, a CO_2 capture system, a storage system for CO_2 and methanol as well as a hydrogen-fuelled combustion engine into one system. The proposed solution reforms methanol to hydrogen, which is then burned in a conventional combustion engine that has been upgraded to burn multiple fuel types and is specially optimized for hydrogen use.

To support the development of new technologies dedicated tools and methods are required, Within the portfolio of projects two where explicitly looking into improving the developer's toolbox, LINCOLN for ship design and FLOATECH for wind turbine optimisation. There is a market for these tools and it is up to the tool providers to make the tools market ready and to find the customers to buy them. Possibilities of spreading the news in related conferences are vastly available.
The number of projects looking into production aspects were astonishingly small. One of the exceptions is the ELICAN project which developed a self-erecting wind-turbine platform utilising local materials and skills focusing on minimising erection cost. An ideal project to show that local economies can be enabled to survive with new products for a renewable energy infrastructure. One project (Space at Sea) is looking into the problem of potentially rising sea-levels developing a modular floating multi-purpose island. A concept which has also potential to decongest European ports as well as to provide space for less costly energy harvesting.
The maritime transport and energy sector portfolio of stakeholders is quite large and the interface between ocean and shore is usually the port where energy storage plays an important role. Shipyards and suppliers are often located in the port area where also chemical industry and storage capacity needs to be accommodated. Green port concepts or multi fuel

ports are reflecting current trends. All three port projects evaluated are showing significant impact on the potential success of transport and energy transition towards sustainability. Research in this field covers all elements from energy harvesting to storage and conversion. Additional challenges are the interfacing with land transport the concentration, of traffic, and emissions for the port city inhabitants. Ports play a significant role when ship operators decide which alternative fuel they will use in the future and the ports themself have to decide on which terms they will operate their port fleet of tomorrow. Ports are also responsible to provide the infrastructure to fulfil the requirements of FF55, including cold ironing (OPS – onshore power supply from renewable sources). The projects approach this by developing demonstrators in the fields of (i) Clean energy production & supply, (ii) Sustainable port design, (iii) Modal shift & flows optimization and (iv) Digital transformation. One common goal of two of the port projects (MAGPIE and PIONEERS) is to transfer the results to other ports in Europe and thus multiplying their finding becomes part of the research.
For transitioning to new fuels, it is essential to have infrastructure in place and therefor it makes sense to provide funding to support local LNG port infrastructure deployment as in the GAINN-IT project to achieve a European coverage for LNG storage capacity to allow bunkering all along Europe's coastline and thus allowing short sea shipping with LNG fuelled ships. The problems encountered in acceptance by citizens and reaching approval from authorities shows that besides technicalities the information to and integration of citizens in the decision processes is a must. Best practise and experience exchange are vital for this kind of (infrastructure) projects.
One of the projects analysed is a Coordination and Support Action (STEERER) funded under the Horizon Framework Programme, which is working on the interface between citizens and the waterborne sector. With citizen lab campaigns and expert group meetings a lively interaction between stakeholders delivered input to the Strategic Research and Innovation Agenda of the Co-Programmed Partnership on Zero-Emission Waterborne Transport (ZEWT) in the framework of Horizon Europe. The project moderated the setting of the industry's emission targets for 2025, 2030 and 2050. This approach guarantees a good match between industry's need, the academic development power and the political targets and can easily be copied by other stakeholder groups.
Another approach for deploying key enabling technologies the GreenOffshoreTech project targeting to support at least 100 SMEs and 100 SMEs innovation projects dedicated to developing new innovative products, processes or services. It is a cluster-facilitating project, bringing together 9 of Europe's leading clusters and SME intermediaries from 15 regions and 7 countries: Norway, Portugal, Latvia, Poland, Iceland, UK, Germany. This direct support of SME's seems to be a promising approach to speed up deployment of green technologies.

10.4. Policy recommendations

The portfolio of projects shows a good coverage of the technical areas required to further push sustainable energy and transport as well as blue growth. Given the time pressure to transit from fossil-based energies to renewables it is good to see many projects focusing on deploying available technologies and showcasing that first movers can have a market advantage. On the other hand, we see many projects exploring new concepts ranging from energy storage to conversion and circularity for products and fuels. The use of test areas with reduced requirements for deployment is very good and could be extended for transport application in form of corridors/port areas where prototyping of new technologies follows a less restrictive regime of regulations (without jeopardising safety of citizens or environment).
The availability of project results in general is not consistent and can in any case be improved. It can be discussed whether it is good to enlarge the research consortia with public relations partners or if it is better that they are required to expand communication efforts, to cooperate with communication projects which channel the reporting of research results into the public

domain, including policy makers. In any case, the attractiveness of the result presentation has improving potential. Topic related (online) conferences for clusters of projects would help exchanging results between tech developers and, more importantly, with potential users. Broadcasting of results would help to inform the public about tech trends and how Europe is pushing the limits in research and supports their own political targets with respect to climate goals and protection of the environment. Having said that it seems that in some cases the project focus is solely on advancing the efficiency of the technology without looking into the possible implications for citizens or environment. This should be an inherent part of every research project.

We see a variety of technical solutions developed up to prototype level, waiting to be acknowledged as ready for industrial use. These technologies have demonstrated that they have the potential to close the gap for renewable energy. The business case though depends in many cases on strict environmental legislation which is politically announced and yet not established. With certainty in a long-term legislation the investments will come to allow the technology providers to walk the last mile to industrial readiness level. Although still more expensive than established fossil-based approaches, a breakthrough can be envisaged by 2030 given the carbon taxes and trading schemes are coming as promised. Both these points also show the demand for action. First, shipowners, ports and technology providers need to get support to build strategic alliances to make the new approaches a win-win for all involved, mature the technology, and prepare the infrastructure and train for its use. Second, the reliability on the political course of continuously growing market-based measures and ecological taxes (including carbon taxes) must be ensured.

For transport as well as for offshore energy we will see a vast variety of solutions to improve today's situation. Each transport problem has particular demands which favour different energy sources, energy storage and energy conversion approaches. The driving force for commercial shipping companies will always be financial viability and this is the reason that the political decisions and thus binding regulations and environmental taxes are deciding on the speed of innovation. The same holds for energy providers, as long as fossil energy is cheaper than renewable energy the growth of offshore energy will be lacking the required pace to cope with climate change. The moment we reach the financial break even for an innovative solution the decision makers will risk an investment if they have evidence that the innovation has reached a certain level of maturity. Funded research projects which can contribute to this certainty, by operating prototypes and thus providing evidence that the offered solution, has a fair chance to get acceptance by authorities on short terms and stable politics in the long run.

What funded research projects ideally deliver are additional solutions to the existing solutions portfolio which have proven ecologic and economic viability. Analysis of the best technology match for the shipping companies, the energy providers or the communes are than the topic to be supported next. For the funding authorities it seems important to find the best first mover showcases and to communicate the project findings within the respective communities and the wider public to show what have been learned about limitations and potentials both from financial viability to value for money with respect to environmental gains.

10.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
2020-PT-TM-0056-S	port of Leixões	CEF	CEF-TPT

2017-IT-TM-0066-W	**GAINN-IT (ITALY)**	**CEF**	**CEF-TPT**
2019-NL-TM-0196-W	LNG PORTS	CEF	CEF-TPT
2019-EU-TM-0097-S	ELECTRIFYING SSS	CEF	CEF-TPT
2019-DE-TA-0041-W	blue port kiel	CEF	CEF-TPT
2016-IT-TM-0284-S	GAINN4MED	CEF	CEF-TPT
2020-DE-TM-0050-S	HH PORT TRAIN	CEF	CEF-TPT
2014-RO-TMC-0313-W	Port of Giurgiu	CEF	CEF-TPT
19356	**@BluePortS**	**Interreg**	**ERDF**
101079550	21-ES-TG-BilbOPS	CEF2027	CEF-INFRA
101079700	21-RO-TC-E-COLD	CEF2027	CEF-INFRA
21185	AFLOWT	Interreg	ERDF
101069888	**ALL-IN Zero**	**HORIZON**	**HORIZON-RIA**
101009363	ARCHIME3	H2020	SME
958976	ATOMS	EMFF	EMFF-AG
17768	Baltic InteGrid	Interreg	ERDF
23481	BLUE DEAL	Interreg	ERDF;IPA/IPAII
884418	C4U	H2020	IA
655594	CEFOW	H2020	IA
735692	CH2P	H2020	FCH2
23089	COASTENERGY	Interreg	ERDF
815083	COREWIND	H2020	RIA
734032	D2T2	H2020	SME
21430	DecomTools	Interreg	ERDF
691925	DEMOTIDE	H2020	IA
872404	**DGIM2**	**H2020**	**SME**
101056799	DT4GS	HORIZON	HORIZON-RIA
785921	DTOceanPlus	H2020	IA
19105	DUAL Ports	Interreg	ERDF
636027	**E-ferry**	**H2020**	**IA**
945810	EHSTACK	H2020	SME
783389	ELBE	COSME	COSME-GA
101074230	ELBE	SMP	SMP-GFS
951148	EUROCLUSTER ELBE PLUS	COSME	COSME-GA

815180	ELEMENT	H2020	RIA
691919	**ELICAN**	**H2020**	**IA**
745862	EnFAIT	H2020	IA
955413	ENGIMMONIA	H2020	RIA
826033	ETIP OCEAN 2	H2020	CSA
883751	EuropeWave	H2020	PCP
101036457	EU-SCORES	H2020	IA
952966	FIBREGY	H2020	IA
101007142	**FLOATECH**	**H2020**	**RIA**
784040	FloatMastBlue	H2020	SME
860879	FLOAWER	H2020	MSCA
101077554	FLORA	EMFAF	EMFAF-PJG
691916	**FloTEC**	**H2020**	**IA**
18197	**FORESEA**	**Interreg**	**ERDF**
101037125	FORWARD-2030	H2020	IA
21675	Go LNG	Interreg	ERDF
101005541	**GreenOffshoreTech**	**H2020**	**IA**
21841	**H2SHIPS**	**Interreg**	**ERDF**
875091	HIGGS	H2020	FCH2
101006689	HIPERWIND	H2020	RIA
768945	**HyMethShip**	**H2020**	**IA**
818153	i4Offshore	H2020	IA
764066	**IMAGINE**	**H2020**	**RIA**
101007071	IMPACT	H2020	RIA
19145	Inn2POWER	Interreg	ERDF
765585	InnoDC	H2020	MSCA
730799	InToTidal	H2020	IA
19435	ITEG	Interreg	ERDF
101058121	LIFE21 FPA/BE/SAR	LIFE2027	LIFE-FPA-OG
727982	**LINCOLN**	**H2020**	**IA**
685445	LORCENIS	H2020	RIA
21387	MAESTRALE	Interreg	ERDF
101036594	**MAGPIE**	**H2020**	**IA**
763959	MegaRoller	H2020	RIA

19367	MONITOR	Interreg	ERDF
851703	MooringSense	H2020	RIA
861647	Nautilus	H2020	RIA
815278	NEMMO	H2020	RIA
730628	**OCEAN_2G**	**H2020**	**IA**
21211	OceanDEMO	Interreg	ERDF
731200	OCEANERA-NET COFUND	H2020	ERA-NET-Cofund
840651	OceanSET	H2020	CSA
21446	OESA	Interreg	ERDF
21126	OPIN	Interreg	ERDF
101007168	OYSTER	H2020	FCH2
21374	PELAGOS	Interreg	ERDF
101086297	PERMAGOV	HORIZON	HORIZON-RIA
101037564	**PIONEERS**	**H2020**	**IA**
783535	PowerModule	H2020	SME
791875	ReaLCoE	H2020	IA
727689	RealTide	H2020	RIA
101056815	RESHIP	HORIZON	HORIZON-RIA
101096068	RETROFIT55	HORIZON	HORIZON-IA
745625	ROMEO	H2020	IA
101000175	SafeWAVE	EMFF	EMFF-AG
814893	SCIPPER	H2020	RIA
963560	SEABAT	H2020	RIA
763070	SEANSE	EMFF	EMFF
857840	SeaTech	H2020	IA
764014	SEA-TITAN	H2020	RIA
101038256	Seawing4Blue	EMFF	EMFF-AG
101075412	SEETIP Ocean	HORIZON	HORIZON-CSA
23719	Selkie	Interreg	ERDF
842231	SETWIND	H2020	CSA
101056940	sHYpS	HORIZON	HORIZON-IA
774253	**Space at Sea**	**H2020**	**IA**
875285	**STEERER**	**H2020**	**CSA**

860737	STEP4WIND	H2020	MSCA
727465	TAOIDE	H2020	RIA
101038671	TECOW	EMFF	EMFF-AG
727793	TIPA	H2020	RIA
769303	**TrAM**	**H2020**	**IA**
857631	TWIND	H2020	CSA
101006927	VALID	H2020	RIA
727598	WaveBoost	H2020	RIA
101075527	WEDUSEA	HORIZON	HORIZON-IA
101007135	XROTOR	H2020	RIA

11.Ocean digital knowledge system. *By Magdalena Matczak*

11.1.Main findings of the analysis

The current analysis focuses on a portfolio consisting of 187 projects relevant to the broad subject of the ocean digital knowledge system. The list of projects is presented in section 11.5. By enabling the digital transition, all of them contribute to the Green Deal implementation. The analysed projects received 1126.1M€ of requested EU contribution which translates into 1234.1 M€ of the total budgets. Research and innovation Framework Programmes (H2020, Horizon Europe) support almost 90% of projects and representing almost 94% of requested EU contribution.

The main types of actions covered by Enabler 1 portfolio projects are these devoted to research and innovation (HORIZON-RIA, RIA); innovation (HORIZON-IA, IA) and ERC actions. Only two of the portfolio projects received funding from DIGITAL programme.

For the purpose of this portfolio analysis, projects have been structured across five main Thematic Areas. These are:

T.A. OBSERVING – including the development, harmonisation of observing technologies (remote/in situ), designation of and/or harmonisation of monitoring programmes and observing systems, sensing technologies, sensing devices, observing research infrastructures, etc.

T.A. DATA GENERATION/COLLECTION – including the big data generation, data on human activities collection, data on specific topics, data generation, data integration, model outputs, citizen knowledge collected/generated via applications, etc.

T.A. MODELS – including the ecosystem modelling, physical and biogeochemical modelling, climate changes modelling, responses modelling, socio-ecological modelling, impact modelling, assimilation techniques, etc.

T.A. DATA PROCESSING AND HARMONISATION – including the development of products and information, data transformation, data harmonisation, standardisation, data processing, AI etc.

T.A. DATA INFRASTRUCTURES – including data handling (databases, storage etc.), data mining and warehousing, data harmonisation standards, data sharing standards, interoperability, connecting data infrastructures and sources, data preservation, DTO infrastructure, etc.

T.A. APPLICATIONS AND SERVICES – including the Decision Support Systems (DSS), forecasts, scenarios, data-based service systems, applied toolboxes, mobile applications for citizen science, visualisation tools, e-platforms, etc.

This study also analysed the scope of the projects, i.e. whether they addressed one or more of the following domains: climate and physical ocean (physical ocean variables, wind, waves, etc), ecosystem (biodiversity, MPA, etc), pollution (litter, nutrients, chemicals, acidification, etc) and human activities (Blue economy, fisheries, aquaculture, energy, transport, etc.).

The Mission Ocean Enabler 1 portfolio projects contribute to large extend to the generation of knowledge and data with substantial number also addressing research and innovation.

Both aspects are paramount to leverage change towards ocean's digitalisation. In addition, a number of projects consider ocean governance as supporting decision making processes based on adequate tools and expertise.

Many of the projects cover almost all recognised Thematic Areas, starting from *in situ* ocean data collection, harmonising, modelling and finally, visualising and sharing the results through the e-platforms/mobile applications or forecasting applications. Such projects are mostly of regional seas character, focusing greatly on Atlantic Ocean research and recognition. New data is collected, new models are developed/upgraded to describe the ocean system, the changing paths relevant for climate changes' impacts and cumulative impact assessments. New applications, platforms, allowing for visualisations, forecasting and scenario building are being deployed. Most of the collected and processed data's scope is on climate and physical ocean (physical ocean variables, wind, waves, etc), then on ecosystem (biodiversity, MPA, etc), then on human activities (blue economy, fisheries, aquaculture, energy, transport, etc.) and pollution (litter, nutrients, chemicals, acidification, etc). The portfolio of projects ranges from coastal zones to deep ocean ecosystem, focusing on sea basins as well as the whole Atlantic basin up to Southern Ocean.

Many of the portfolio projects focus on the design, development, testing and even deployment of new observing technologies and devices. Other have been looking at the observing system as a whole and deliver solutions to strengthen its infrastructural and R&I capacities.

Many of portfolio projects make ambitious efforts to generate/collect new data series and knowledge, collected in-situ or generated by models. Some of them developed and tested the tools for grasping the citizen science (mainly focused on pollution – litter – recognition). They often focus on specific sea basin/area, but many are not geographically biased and create cross-basins opportunities also contributing to EU programmes.

These initiatives are mostly dedicated to collect the big data on physical, chemical, and biological ocean parameters, but the efforts are made towards observing of pollution or human activities.

Portfolio projects respond also to the urgent need of managing the enormous amounts of ocean data generated by research (as well as private/industrial) initiatives and projects, ocean observatories, national monitoring systems, and modelling. Many of them make ambitious efforts to integrate and connect the wide range of data and models with cloud infrastructures, employ high performance computing, *artificial intelligence, standardise and harmonise data for better sharing possibilities and end-users' accessibility. Here – among others - the* EU Core Digital Twin Ocean *infrastructure* will be built and c*onnections to existing EU instruments and programmes are being made.*

Some of the portfolio projects create connections with business and policies, showing how EU instruments/databases might be useful for marine sectors management and vice versa, how sectors might bring added value by specific data generation.

The Mission Ocean Enabler 1 portfolio brings good practices in harmonisation and data sharing practices, digitalisation, and cloud infrastructure building. The efforts are being made to contribute to existing EU programmes like Copernicus or EMODNET. Some synergies between the projects contributing from different EU funding programmes were identified, although this does not constitute a standard.

It is recommended to continue the EU support in creating the ocean digital knowledge system in all recognized Thematic Areas. The focus might be given to maintain/create the

instruments to increase the collection and use of commercial as well as private and industry sources data, especially in times of increased offshore investments performing in situ research and post-investments monitoring.

Careful and responsible approach to project deliverables is crucial. The maintenance of produced data/results is often out of the projects' range. It needs to be ensured that the speed of increasing the volume of data and the number of tools does not outstrip the ability to maintain the data and tools. The support for databases maintenance is crucial.

The support to the initiatives at regional basins' level aiming at harmonisation and maintenance of regional data should be continued.

The efforts towards cataloguing the portfolio tangible and usable results (like HORIZON Results Platform, but cross-programme "enabler 1 platform") should be supported. The future projects might be encouraged to use tools developed by earlier projects. This could help in synergies and continuation in efforts, contributing to a more effective use of EU funding.

More and more focus on knowledge transfer towards business/sectors/decision-making is desirable.
The business/sectors co-ownership is important. The participation of business and public bodies should be strengthened in EU projects. The discussion with maritime spatial planning institutions/ responsible actors should be strengthen.

The recognition of EU instruments/programmes/observatories should be strengthened among end-users. Campaigns, hackathons, open days should be continued/developed. European Maritime Days should be used. Permanent cooperation with European maritime universities/high schools should be established/maintained. Skills programmes should be developed/continued.

11.2. Description of the portfolio

The Mission Ocean Enabler 1 portfolio consists of 187 projects relevant to the broad subject of the ocean digital knowledge system. By enabling the digital transition, all of them contribute to the Green Deal implementation.

The analysed projects received 1126.1M€ of requested EU contribution which translates into 1234.1 M€ of the total budget.

EU Programmes and actions

Taking into consideration the contributing EU funding programmes of this portfolio, the most important programme – either in value of EU contribution or in the number of projects is the Horizon 2020 (2014-2020). In terms of quantity, it builds almost 60% of the portfolio, when considering the costs – 64%. Second important source of financing of digital ocean actions is its successor - the current HORIZON Europe framework programme (2021-2027) creating around 30% of the portfolio, both in terms of projects' numbers and budgets. The remaining part of actions has been financed by Interreg, EMFF, EMFAF, CEF, DIGITAL, COSME and LIFE 2027 (see Figure 11.1 and Figure 11.2). Only two of the portfolio projects received funding from DIGITAL programme.

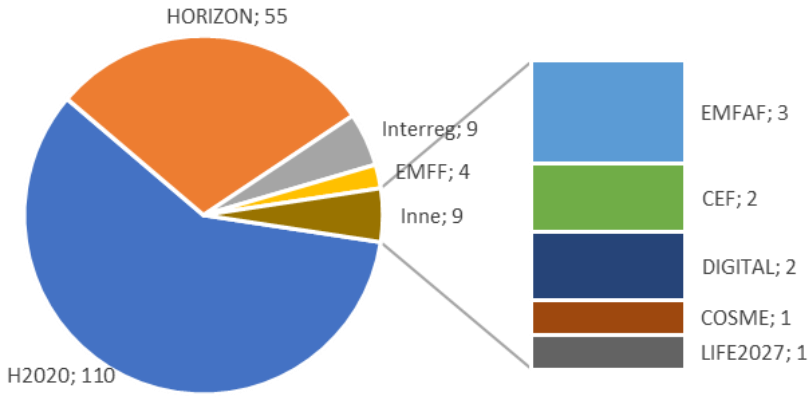


Figure 11.1. Number of projects per EU funding programme. Total number of projects: 187

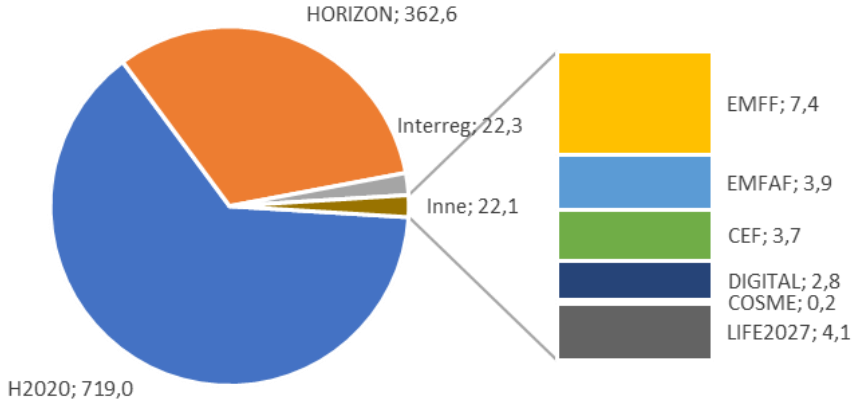


Figure 11.2. EU contribution (M€) per funding programme. Total EU contribution: 1126,1M€

Within the Horizon 2020 and Horizon Europe programmes, the actions operating at lower TRL (ERC grants, Research and Innovation Actions) dominate the portfolio with 115 projects worth 810 M€, followed by Innovation Actions (28 projects, 189M€) and Coordinated and Support Actions (15 projects, 46M€) (see Figure 11.3 and Figure 11.4). That clearly indicate that the Mission Ocean (MO) enabler 1 portfolio is strongly focused on establishing new knowledge, solutions, services, improving technology, smart solutions, testing and demonstrating.

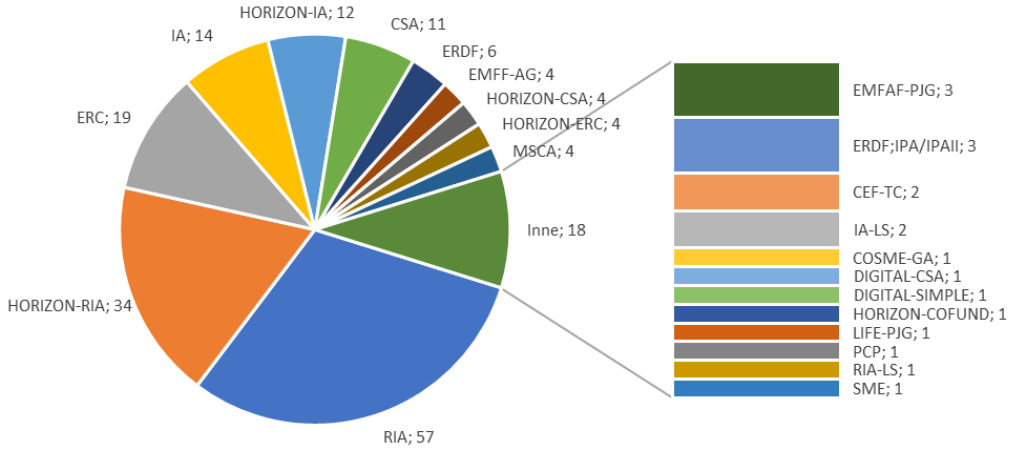


Figure 11.3. Number of projects per type of action. Total number of projects: 187

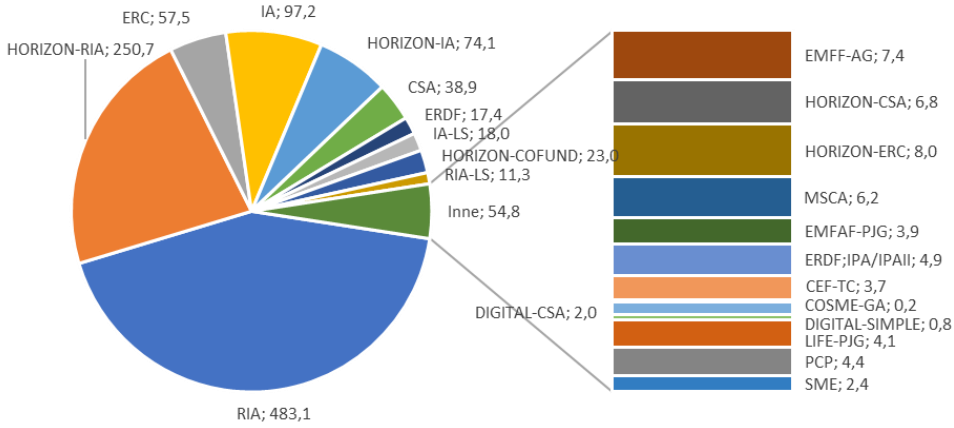


Figure 11.4. EU contribution (M€) per type of action. Total EU contribution: 1126,1M€.

The portfolio timeline covers last five years with first projects starting in 2017 and heads up till 2029 (one Horizon COFUND project – Sustainable Blue Economy Partnership). The average projects duration is 3 years with some longer initiatives of research or coordination nature ranging up to seven. The continuation of specific themes/activities can be recognised in succeeding projects like, e.g., strengthening of the Arctic observing system (in IntarOS and Arctic Passion), developing observing capacities in fisheries (in SMARTFISH and EveryFish), or developing cloud infrastructure (in the SeaDataCloud and Blue-Cloud projects). The newly approved portfolio projects (started 2022/2023) – thanks to the more targeted EU programmes' priorities, are better focused on the data management and repository as well as steered towards the Digital Twin Ocean creation.

Portfolio Thematic Areas

The enabler 1 portfolio delivers added value on two directions – knowledge creation (including observations, data generation, models, forecasting) and data management (including e-infrastructures). The following thematic areas were identified as the main

components of this portfolio, and all the projects categorised accordingly in one or more categories:

T.A. OBSERVING – including the development, harmonisation of observing technologies (remote/in situ), designation of and/or harmonisation of monitoring programmes and observing systems, sensing technologies, sensing devices, observing research infrastructures, etc.

T.A. DATA GENERATION/COLLECTION – including the big data generation, data on human activities collection, data on specific topics, data generation, data integration, model outputs, citizen knowledge collected/generated via applications, etc.

T.A. MODELS – including the ecosystem modelling, physical and biogeochemical modelling, climate changes modelling, responses modelling, socio-ecological modelling, impact modelling, assimilation techniques, etc.

T.A. DATA PROCESSING AND HARMONISATION – including the development of products and information, data transformation, data harmonisation, standardisation, data processing, AI etc.

T.A. DATA INFRASTRUCTURES – including data handling (databases, storage etc.), data mining and warehousing, data harmonisation standards, data sharing standards, interoperability, connecting data infrastructures and sources, data preservation, DTO infrastructure, etc.

T.A. APPLICATIONS AND SERVICES – including the Decision Support Systems (DSS), forecasts, scenarios, data-based service systems, applied toolboxes, mobile applications for citizen science, visualisation tools, e-platforms, etc.

The Figure 11.5 indicates the distribution of projects according to the main thematic areas.

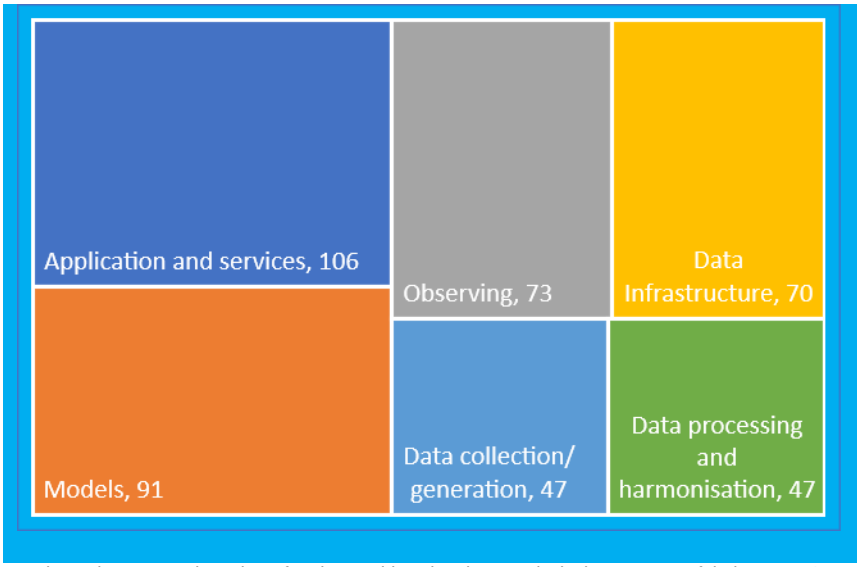


Figure 11.5. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 434. Total number of projects: 187

Many of the projects covers almost all recognised areas, starting from in situ ocean data collection (via new devices or partners' research infrastructures), then modelling and finally harmonising, visualising and sharing the results through the e-platforms/mobile applications or forecasting applications. Such projects are mostly of regional seas character, focusing greatly on Atlantic Ocean research and recognition. No such cross thematic area project has been recognized for the Baltic Sea.

Almost 25% of portfolio projects have been collecting or generating new data. Also, one quarter touched upon data processing and harmonisation aspects. In over ninety projects modelling actions were recognised. Some of the projects develop new models, other upgrade existing or implement them to new sea basins. Most of the collected and processed data's scope is on climate and physical ocean (physical ocean variables, wind, waves, etc), then on ecosystem (biodiversity, MPA, etc), then on human activities (Blue economy, fisheries, aquaculture, energy, transport, etc.) and pollution (litter, nutrients, chemicals, acidification, etc) (Figure 11.6).

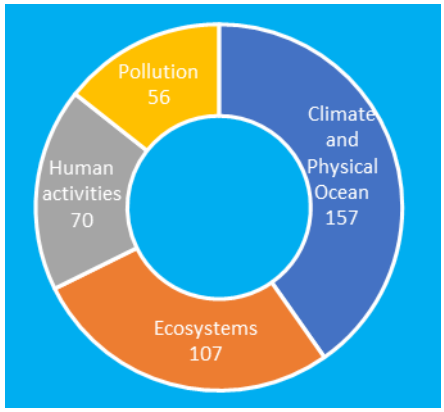


Figure 11.6. Main type of scope of the projects. Some projects address more than one type of scope. Total count of projects addressing any of these scopes: 390. Total number of projects: 187

Many of analysed projects made an effort to create and even deploy new sensors, devices as well as to upgrade/verify existing methods and instruments. Many of them presumably will contribute to EU or global observatories, to Copernicus Marine, to the implementation UN Decade of Ocean Science for Sustainable Development, the Paris Climate Agreement and many more. The range of undertaken efforts is vast – from focused on specific new types of sensors or very specific new algorithms to be used in underwater or drifting observatory devices, to huge cooperative undertakings influencing regional seas or European monitoring systems.

It can be noticed, that over time more and more of the portfolio projects are dedicated to or relate themselves to EU and global data programmes like Copernicus, EOOS, GOOS, EMODnet and others and this is a positive change hopefully resulting in better integration of their results also in DTO. Also – thanks to the EU programmes requirements on data quality and management, the results might be better handled once the projects have been completed.

Levers of Change

Levers of change (LoC) relate to the main type of tool or activity undertaken by the projects to drive (or leverage) change towards the creation of an ocean knowledge system. Important levers of change include the definition and implementation of new governance structures or

effective financial and economy models, research, and innovation to develop and demonstrate new solutions, the generation of new data/knowledge as well as citizen's engagement or training and education.

Table 11.1 shows the main focus of the thematic areas (and their corresponding projects) in terms of contributing to the levers of change. As can be seen, most of the projects target the generation of knowledge and data – which is crucial for creating Ocean Knowledge System (Table 11.1). At the same time, a large majority address research and innovation to develop and demonstrate innovative solutions. It can also be seen that a number of projects involve citizens' engagement alongside education and training. It is worth noticing that a smaller number of projects across thematic areas address the deployment of new solutions or the definition of new governance structures or finance and economy models.

Table 11.1. Lever of Change (LoC) vs. thematic areas (T.A.). For LoC it is understood the type of tool targeted by the project to drive (or leverage) change in the desired direction.

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engagement	Education& Training
Observing	4	4	66	61	27	5	13
Data collect./generation	4	9	27	46	15	11	11
Data processing and harmonisation	7	6	35	45	17	8	10
Data Infrastructure	7	8	57	64	30	8	13
Models	8	5	57	87	23	10	15
Application and services	15	13	76	98	44	18	20
Total	45	45	318	401	156	60	82

Considering the climate, physical ocean and ecosystems, the scope of new knowledge created/being created is vast – from recognizing ocean wide basic processes, climate changes, Arctic/Antarctic ice cover changes, deep bottom ecosystems, carbon cycles towards understanding the environmental responses, cumulative assessments, climate changes responses and adaptations, and many more. Considering human activities – mainly

fisheries and energy production – how we can use the existing, digital knowledge to make human activities more sustainable. In terms of pollution – databased and platforms are built mainly for plastic pollution.

Tools/models/forecasts are being created to understand the processes and responses. A lot of synergies might be recognised between the projects and sometimes continuation of efforts (like Arctic monitoring, etc.).

The portfolio of projects also shows that the digitalisation of knowledge is getting importance.

Partnership

When looking at the partners statistics and distribution, in all 187 projects over 3400 partners were involved (very often the same partner is involved in two or more projects). In terms of total numbers - the strong involvement of France, Italy and Spain is visible (Figure 11.7). In terms of participants per million inhabitants –engagement in marine research is very evident in Norway (Figure 11.8).

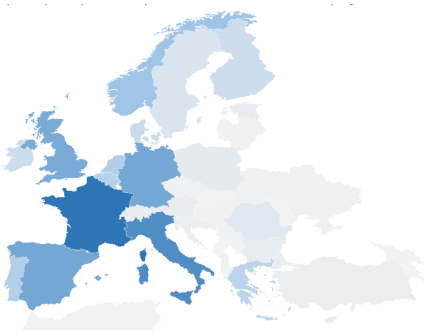


Figure 11.7. Number of participants per country, Europe only. Based on Cordis

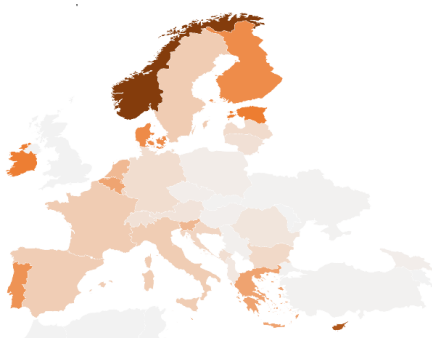


Figure 11.8. Number of participants/million inhabitants per country, Europe only. Based on Cordis

Looking at the types of partners involved, entities from the research and higher education sectors represent a clear majority (creating around 65% of partnership). A quite strong involvement of businesses is visible, as well as a lower participation of public bodies (Figure 11.9).

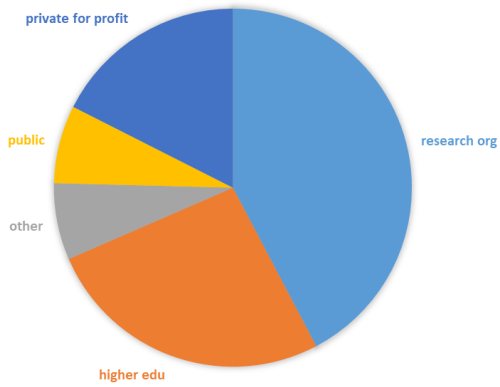


Figure 11.9. Types of participants. Total number of projects: 187

Geographical scope

Portfolio projects create results which are greatly relevant to all sea basins, are of cross-basin nature and might be translated to other seas as creating results applicable widely. These focus mainly on strategies and networking, data managements, building e-infrastructures, models and creating DTO backbone. Figure 11.10 shows the distribution of projects according to sea/river basin.

Some of the projects are explicitly dedicated to sea basins both in terms of partnership composition and the aims and impact area, like BRIDGE-BS, DOORS for Black Sea, BalticDataFlow for the Baltic Sea, ODYSSEA, HarmoNIA, I-STORMS for Med, Mission Altantic, iAtlantic and many others for Atlantic Ocean. They focus mostly on data/knowledge generation and observations. It is worth underlining, that projects devoted to the Atlantic Ocean research gather also non-EU partners from Northern and Southern Americas and Africa. Some of portfolio projects includes demonstrations outside of European basin also at India and Pacific Ocean.

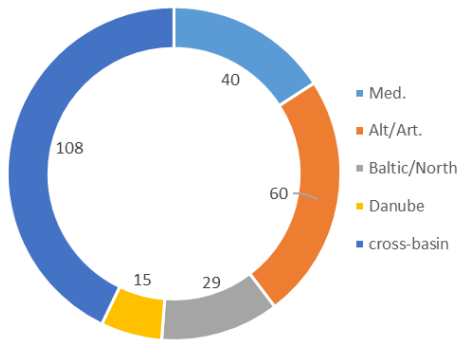


Figure 11.10. Geographical scope of results. Total number of projects: 187

11.3. Main outcomes and fostering the uptake of solutions.

11.3.1. Main outcomes

The analysis of the outcome of the projects has been performed on a sub-set of 26 projects (highlighted in blue and bold in section 11.5) out of the 187 projects of the portfolio. It have shown a cross-section of the important and tangible results relevant for the enabler 1 of the Mission Ocean – which is meant for the development/strengthening of the Digital Ocean and Water knowledge system (with the EU Digital Twin of the Ocean[25] as one of the main deliverables) The most impressive projects' outcomes might be compiled into the following broad categories. A summary of tangible results from the 26 projects seleted for in-depth analysis is included in Table 11.2.

Ocean observing technologies and systems.

Constant and reliable ocean observations, including Arctic ecosystems, are a necessary prerequisite for profound knowledge leading to informed decision-making. There is still a need and room for improvements in the ocean observation's tools or standardisations of methods.

Many of the portfolio projects focus on the design, development, testing and even deployment of new **observing technologies and devices**. Some of them focus on specific, small, one-parameter dedicated sensors which might be integrated in drifting/underwater devices or ferryboxes, some on innovative solutions and software, other develop full scale drifters, underwater observing gliders, etc. Most of them are dedicated to collect the big data on physical, chemical, and biological ocean parameters (like pH levels, primary productivity, marine life, suspended sediments, etc), but the efforts are also made towards observing of pollution (acidification, plastics, noise, etc) or human activities (mostly fishery). As an illustration, the **MELOA project** (2017-2022) tested and deployed the innovative, low-cost, sturdy and multi-purpose surface WAVY drifter's devices. The drifters are a new generation of sustainable platforms, easy to embed in different types of marine observation systems and the assumption is that the data gathered would be made available and linked to GEOSS and Copernicus infrastructures. The very interesting **NAUTILOS project** (2020-2024) has been testing and deploying the set of 13 cost-effective sensors and samplers and other technologies, into existing North Sea, Med and Atlantic observations. The data generated will also serve to verify the satellite data and improve the accuracy of space observations. Complementary to the acquisition of data by sensors, a citizen-science application was created and tested. It is worth to underline that, as many other projects, the NAUTILOS project has signed the Mission Ocean Charter, which is a demonstration of engagement and commitment in the field of *citizen engagement, citizens-science, youth-led initiatives, communities of practice, ocean and water literacy, outreach, awareness raising and participatory approaches*.

Other type of projects – like IntarOS, HiAOOS, AtlantOS, EuroSea, Euro-Argo RISE has been looking at the **observing system** as a whole and deliver solutions to strengthen its infrastructural and R&I capacities. For example, the already finished **INTAROS project** (2016-2022) focused on improving an Arctic ecosystem monitoring programmes. An important Roadmap for a sustainable Arctic Observing System was developed and the

25 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters/european-digital-twin-ocean-european-dto_en

foundations have been laid for potential further sensors' deployments at the research vessels, as ferrybox, moorings, platforms, etc. Its work is continued by Arctic Passion

Other exemplary projects focused on ocean observations: HiAOOS, AtlantOS, EUROSEA, ENDURUNS, FIRE, CarbOcean, Euro-Argo RISE, BRIDGES, TechOceanS, DeeperSense, FleetUSV,

Data infrastructure, data quality, harmonisation

Many research (and commercial, private and industry) initiatives, ocean observatories, national monitoring systems, modelling engines generate enormous amounts of ocean data. The challenge is to manage them as to ensure their durability and reliability. Many of portfolio projects make ambitious efforts to integrate and connect the wide range of data and models (from physics to socioeconomics) with cloud infrastructures, employ high performance computing, *artificial intelligence, standardise and harmonise data for better sharing possibilities and end-users' accessibility. Connections to existing EU instruments and programmes are being made.*

Here – among others - the Core ***infrastructure of the*** EU **Digital Twin Ocean, a main deliverable of the Mission Ocean,** will be built *by the* **EDITO-Infra** project (2022-2024) by upgrading, combining and integrating key service components of the existing EU ocean observing, monitoring and data programmes Copernicus Marine Service and the European Marine Observation and Data Network into a single digital framework. From the EU wide perspective the **Blue Cloud Project** (2019-2022) and its successor Blue-Cloud 2026 are also worth highlighting, that delivered a collaborative virtual environment to **enhance FAIR and Open Science**. A cyber platform was deployed with unprecedented range of multidisciplinary data repositories, offering e-infrastructure services (computing, storage, analytical, SSO, AAI and generic services), federated data (10M+ datasets and products from leading European marine data management infrastructures (COPERNICUS C3S, COPERNICUS CMEMS, ELIXIR-ENA, EMODnet, Euro-Argo, Argo GDAC, EuroBioImaging, EurOBIS, ICOS-Marine and SeaDataNet), and research-intensive virtual labs. AquaINFRA, funded under the same call will bring together the marine and freshwaters domains.

The improvement of the **quality of oceanographic data** has been the core of the **MINKE Project** (2021-2025) aiming at creation of an optimal metrological framework - a new vision in the design of marine monitoring networks, integrating two dimensions of data quality, namely accuracy and completeness, as the driving components of quality in data acquisition.

A good example of handling **datasets at the regional level** might be the **Baltic Data Flows** Project (2020-2023), co-funded under the Connecting Europe Facility Programme, aiming at improvement of the quality and harmonisation of the data from difference sources in the Baltic Sea Region (existing sea monitoring programmes, Helcom monitoring, national processes, projects and research sources) as well as would enhance the data sharing possibilities. An integral part of the Baltic Data Flows project is to ensure that project outputs are FAIR.

The emerging climate changes, especially flooding risks were targeted e.g. by **ECFAS Project** (2021-2022) – a Roadmap for the ECFAS prototype service was prepared towards full integration into the Copernicus suite of emergency services (CEMS). The ECFAS prototype shows real potential for providing the Copernicus Emergency Management Service with an almost ready-to-implement component for coastal flood emergency services.

Other exemplary projects data infrastructure, data quality, harmonisation: A-Aagora, EcoScope, AquaINFRA, iMagine, DT-GEO, FAIR-EASE, BigDataOcean, EO4EU, ENVRI-FAIR,

Research and Innovation infrastructure

Some portfolio projects bring added value by **creating networks and alliances** of partners' research infrastructures improving the access either to vessels or other monitoring infrastructures or to their e-infrastructures and databases. The **EurofleetsPlus Project** (2019-2023) for example, by creating RI network, enabled sharing of information on planned, current and completed research cruises, on the technical details of European research vessels and their equipment. It also enabled and e-access among others to sailing tracks and current position of European research vessels. Another interesting portfolio project - **JERICO-S3** (2020-2024) - responded to the challenge of the EU wide scattered coastal observation platforms and has been developing a network of harmonised and extensive observational capabilities for the European coastal sea to be integrated further within the JERICO-RI.

Other exemplary projects on Research and Innovation infrastructure: ENVRI PLUS, MINKE, EUMarineRobots, DANUBIUS-PP, eLTER PLUS, EMSO-Link, ASSEMBLE Plus, ARICE, EMBRC.

Data and knowledge generation

The main aim of the Digital Ocean and Water knowledge system is to transform data into knowledge for everyone's benefit. Many of portfolio projects make ambitious efforts to generate/collect new data series, including data both on ocean variables, ecosystems, pollution, climate change as well as on human activities, collected in-situ or generated by models. New models are being developed to describe the ocean system, the changing paths relevant for climate changes' impacts and cumulative impact assessments. New applications, platforms, allowing for visualisations, forecasting and scenario building are being deployed. The portfolio projects range from coastal zones to deep ocean ecosystem, focusing on sea basins as well as the whole Atlantic body reaching to Southern Ocean. For example the **AtlantECO Project** (2020-2024) generates new digital knowledge on Atlantic Ocean targeting ecosystem services, their vulnerability and resilience to climate changes; the **BRIDGE-BS Project** (2021-2025) generates new knowledge on Black Sea, developing models on trophic level, ecosystem services, habitat models, algal blooms, aquaculture and many more and the **CoCliCo Project** (2021-2025) – will create Coastal Climate Core Services – a pan European open-source web-based Platform informing and sharing knowledge on climate changes' related present-day & future coastal risks.

Many of portfolio projects are not geographically biased and creates cross-basins opportunities also contributing to EU programmes. For example, a set of numerical ocean models for the next generation of Copernicus Marine Environment Monitoring Service (CMEMS) were developed in the framework of the **IMMERSE Project** (2018-2022) and delivered in the NEMO ocean model. Another portfolio project **SEAMLESS** (2021-2023) provides an open-source, user-friendly assimilative modelling tool, that improves the current capability of European Copernicus Marine Services to simulate and predict the state of marine ecosystems. Another portfolio project - **EcoScope** (2021-2025) will result in delivery of a novel, interdisciplinary, integrative e-tool applicable for fisheries, maritime spatial planning, and other decision-making processes. It will be accompanied by the EcoScope App - a smartphone application which will enable citizens to report on marine hazards, illegal

fishing practices, removal or stranding of protected species, marine litter, pollution and any malpractice and environmental hazard they come across.

One of the DTO dedicated portfolio projects is the **EDITO-Model Lab** (2023-2025), aiming at creation of underlying models for the EU Digital Twin Ocean. Here, a Virtual Ocean Model Lab will be created including the next generation of ocean models, complementary to Copernicus Marine Service.

Other exemplary projects on data and knowledge generation: GES4SEAS, NECCTON, SponGES, Atlas, Geo-INQUIRE, OptimESM, HiSea, MARBEFES, MPA Europe

Knowledge transfer to businesses and policymakers

Some of the portfolio projects aim at creating connections with business and policies, showing how EU instruments/databases might be useful for marine sectors management and vice versa, how sectors might bring added value by specific data generation. Also, maritime spatial planning as an evidence based public process is a good example here. **I-STORMS Project** (2018-2022) increased cooperation on civil protection issues at country level and at Adriatic-Ionian region level, targeting sea storms emergencies responses. Thanks to the project, new data was gathered allowing for more effective forecasting and emergencies response services. An online tool wad deployed allowing for mapping data, forecast systems and current procedures for emergencies responses to sea storm events and to gather available information on coastal disaster caused by sea storm, in order to identify most vulnerable area to focus.

A suite of high-tech systems for the EU fishing sector was delivered by **SMARTFISH Project** (2018-2022) in order to optimize resource efficiency, improve automatic data collection for fish stock assessment, to provide evidence of compliance with fishery regulations and to reduce ecological impact. The work is continued under next project EveryFish. Another example of fishery related portfolio project might be **SUSTUNTECH** (2020-2023) focusing at improving the energy efficiency of tuna fishing vessels by engaging advanced vessel monitoring, Copernicus data and machine learning in more precise fish distribution detection.

The shipping related project **VesselAI** (2021-2023) has been developing a framework that facilitates the modelling and prediction of ships' behaviour. The digital twin technology will be engaged to use shipping big data and to enable modelling as well as the designation and optimisation of ships and fleets under various dynamic conditions. VesselAI will also use the potential of artificial intelligence, cloud computing and high-performance computing, encouraging deeper digitalisation in the shipping industry.

A very interesting perspective is brought by the **MARIPOLDATA Project** (2018-2023), that examine the importance and position of the marine environmental data in high level policy creation and discussion. It wants to create a novel understanding of the science-policy interrelations and identify new forms of power in global environmental politics. It will examine among others, how biodiversity data is represented and used in the ongoing negotiations on a new international legally binding instrument under the United Nation Convention on the Law of the Sea (UNCLOS).

Table 11.2. Main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
Data infrastructure, data quality			
Blue Cloud	collaborative virtual environment to enhance FAIR and Open Science.	Blue-Cloud Data Discovery and Access Service	https://data.blue-cloud.org/
		Blue-Cloud Virtual Research Environment	https://blue-cloud.d4science.org/web/blue-cloudlab
EDITO-Infra	the EU Public **Infrastructure backbone** for the European Digital Twin of the Ocean (DTO)	will create foundation for the further development of the EU DTO initiative,	Not yet available
JERICO-S3	network of harmonised and extensive observational capabilities for the European coastal sea	CORIS Ocean Decade Project, European RIs (EuroARGO, EMSO, AQUACOSM, DANUBIUS, ICOS, EMBRC, LIFEWATCH) and international scientific communities, industry, and other stakeholders, and aligning strategy with COPERNICUS/CMEMS, EMODNET and GEO/GEOSS	https://www.jerico-ri.eu/projects/jerico-s3/coris-ocean-decade-project/
ILIAD	a digital interactive framework including a digital ocean simulator based on a high-resolution numerical model and digital analytic toolboxes to configure the digital ocean	applied as an interoperable, fully integrated, and cost-effective multiplatform network of observing and forecasting systems across European seas, addressing both the open sea and the coastal zone.	https://www.ocean-twin.eu/iliad-project-overview https://www.ocean-twin.eu/digital-twins

Project acronym	Description of result	Application	Link to the result
	simulator and to access what-if scenarios		
ECFAS	Roadmap for the ECFAS proof-of-concept (prototype) service towards full integration into the Copernicus suite of emergency services (CEMS).	contribute to the evolution of the Copernicus Emergency Management Service	https://www.ecfas.eu/outputs/roadmap/ Pilot ECFAS Platform https://www.ecfas.eu/products-and-dataset/the-ecfas-platform/
MINKE	creation an optimal metrological framework - improvement of the quality of oceanographic data.	consolidation of a European network of sparse accurate reference sensors for the accuracy-based metrology approach and the network of dense low-cost instruments for the completeness-based metrology approach;	https://minke.eu/
SEAMLESS	an open-source, user-friendly assimilative modelling tool: the “SEAMLESS prototype	improve the current capability of Copernicus Marine Services to simulate and predict the state of marine ecosystems	https://seamlessproject.org/SEAMLESS_Prototype https://github.com/BoldingBruggeman/eat

Project acronym	Description of result	Application	Link to the result
Baltic Data Flows	Improvement of the quality and harmonisation of the data from difference sources in the Baltic Sea region.	provides the harmonized evidence-base to inform decisions that impact the protection of the Baltic Sea.	https://helcom.fi/baltic-sea-trends/data-maps/
EDITO-Model Lab	Underlying models for the European Digital Twin Ocean	make ocean knowledge available to citizens, entrepreneurs, policymakers, decision-makers, and scientific experts	Not yet available
AtlantECO	Generation of new digital knowledge on Atlantic Ocean ecosystem services	to better understand and manage Atlantic Ocean, forecasting human and climatic pressure impacts. Crucial for research and decision making. Synergies with iAltantic, Blue Cloud, EuroSea, NAUTILOS, AANChOR	https://www.atlanteco.eu/ https://www.atlanteco.eu/publications
BRIDGE-BS	Development of models on trophic level, ecosystem services, habitat models, algal blooms, aquaculture,	to better understand and manage Black Sea, forecasting human and climatic pressure impacts. Crucial for research and decision making	http://database.bridgeblacksea.org/

Project acronym	Description of result	Application	Link to the result
CoCliCo	The Coastal Climate Core Services pan European web-based Platform	to inform end-users about present-day & future coastal risks, support decision-making on coastal risk management and adaptation	https://coclicoservices.eu not yet existing
COMFORT	New knowledge on the state of the art of the ocean tipping points and policy briefs	to better inform end-users, decision makers, EU level, governments, regional, etc. Synergies with TiPACCs and TiPES	
MaCoBioS	New knowledge on natural solutions that counteract the effects of climate changes together with set of indicators to monitor and record the capacity of the ecosystem to cope with CC.	For policy makers to develop ecosystems tailored solutions Will be linked with UN Decade of Ocean Science	https://macobios.eu
IMMERSE	numerical ocean models for the next generation Copernicus Marine Environment Monitoring Service (CMEMS).	delivered in the NEMO ocean model, an established, world-class ocean modelling system that already forms the basis of the majority of the Copernicus Marine Environment Monitoring Service analysis and forecast products	https://www.nemo-ocean.eu/

Project acronym	Description of result	Application	Link to the result
NAUTILOS	Filling the gap in ocean data and knowledge – new sensing devices and technologies combined with Citizen Science to be deployed into existing observations North Sea, Med, Atlantic	to verify the satellite data and improve the accuracy of space observations. to close the knowledge and data gaps Citizen Science dedicated App - to raise awareness and involvement of citizens and gain the new data	https://www.nautilos-h2020.eu/ https://www.nautilos-h2020.eu/results/deliverables/ https://www.nautilos-h2020.eu/data-portal/ https://www.nautilos-h2020.eu/nautilos-cs-app/
ODYSSEA	an interoperable and cost-effective platform that fully integrates networks of observing and forecasting systems across the Mediterranean basin, addressing both the open sea and the coastal zone supplemented with mobile application	Marinomica Platform for the Mediterranean Sea with e.g., services: pollution services, eutrophication indices, wave power, wind resources assessment, coastal erosion, sustainable fisheries, fish distribution dynamics, benthic biodiversity, and remote sensing data	https://www.marinomica.com/
		Marinomica mobile App	https://play.google.com/store/apps/details?id=com.marinomica.app&gl=GB&pli=1

Project acronym	Description of result	Application	Link to the result
iAtlantic	Complex Atlantic Ocean wise and wide knowledge creation, accompanied with a range of tools and technologies to support and advance collection of new information from the deep sea	iAtlantic GeoNode	https://www.geonode.iatlantic.eu/ https://www.iatlantic.eu/our-work/innovation-exploitation/
INTAROS	the iAOS Portal and the INTAROS Data Catalogue, providing access to multidisciplinary data from a wide range of data repositories containing Arctic data	The portal and catalogue will be maintained and used for promotion of data and services in other projects after INTAROS	https://portal-intaros.nersc.no/
			Component of Platform: ARCMAP: Mapping Arctic in situ observing systems https://arcmap.nersc.no
	Roadmap for a sustainable Arctic Observing System		https://drive.google.com/file/d/1Uo2C9F6QZOLH8ePUMgYc50OndEhR-mYk/view
	Testing/deployments of observation/sensing tools and well as software and models	Potential further deployments at the research vessels, or ferryboxe, moorings, platforms, etc. Improvements for arctic ecosystem monitoring programmes	http://intaros.eu/thematic-results/intaros-results-summary/
MELOA	WAVY drifter's devices – new set of multi-purpose surface	Research, ocean observations, the data gathered in the test campaigns and open calls will be made available, and linked to	The geoportal with testing sites and results: https://geoportal.ec-meloa.eu/#/geoportal

Project acronym	Description of result	Application	Link to the result
	drifters supported with a set of software, applications,	GEOSS and Copernicus, via an online catalogue	https://www.ec-meloa.eu/pages/wavy-drifters
		Research, citizens	https://www.ec-meloa.eu/pages/software-ecosystem
business bluer			
EcoScope	a novel, modular, interdisciplinary e-tool integrating met-ocean, biogeochemical, environmental, biological, fisheries, and socio-economic datasets, covering all European Seas accompanied with the EcoScope App	The e-platform will provide both primary data and on-demand derived data services including forecasts, through a single public portal to various end-user groups, stakeholders, and the broader public. Applicable for fisheries, maritime spatial planning, other decision making.	The EcoScope Platform https://ecoscopium.eu/ecoscope-platform
	- a smartphone application which will enable citizens to report on marine hazards, illegal fishing practices, removal or stranding of protected species, marine litter, pollution and any	The report will be transferred online to local management authorities or the relevant port police, with GPS location, pictures and details depending on the incident. This community-based tool will enhance public involvement the cooperation of local communities with authorities and will provide	

Project acronym	Description of result	Application	Link to the result
	malpractice and environmental hazard they come across.	important information (citizen science) for the EcoScope project, fisheries managers and marine policy in general	
SMARTFISH	a suite of high-tech systems for the EU fishing sector	to optimize resource efficiency, to improve automatic data collection for fish stock assessment, to provide evidence of compliance with fishery regulations and to reduce ecological impact Tested at EU wide fisheries, continuation under next project EveryFish	http://smartfishh2020.eu/technologies/
SUSTUNTECH	a compact and cost-effective system to improve the energy efficiency of tuna fishing vessels by at least a 25%.	Fishery industry, This will fill the current need to reduce emissions of all human activities without reducing production as demanded by the Paris Agreement	https://www.sustuntech.eu/
Research infrastructure			
EurofleetsPlus	alliance of European marine research infrastructures - vessels, easier access to research and monitoring infrastructures	researchers	https://www.eurofleets.eu/access/infrastructures/
	Sharing information on planned, current and	European Virtual Infrastructure in Ocean Research (EVIOR)	https://evior.eurofleets.eu/

Project acronym	Description of result	Application	Link to the result
	completed cruises and on details of European research vessels and specialized equipment.		
science to policy – policy to science			
I-Storms	Understanding of the climate changes challenges and increased capacities in storms emergency responses.	Applied in platform, mobile application	Sea Storm Atlas https://iws.seastorms.eu/sea_storm_atlas/map The I-STORMS mobile applications https://istorms.adrioninterreg.eu/news/download-and-install-the-i-storms-application-for-smartphones-and-tablets The I-STORMS Common Data Sharing Web GIS tool
MARIPOLDATA	a novel understanding of the materiality of science-policy interrelations and identification of new forms of power in global environmental politics	Researchers – to better understand what matters, policy makers to better understand what to consider,	
	Marine Biodiversity Country Dashboard -	serves to inform about international marine biodiversity research and politics. By selecting the respective tab, it is possible to access per country information about marine	

Project acronym	Description of result	Application	Link to the result
		biodiversity research and indicators on its position in the BBNJ negotiations	
	BBNJ Governance Literature Database -	a structured, facilitated access to existing scientific publications and therefore serves to inform BBNJ decision-makers, practitioners and incentivizes further academic debates within the BBNJ scientific community	https://erc-maripoldata.shinyapps.io/bbnj_literature_database/

11.3.2. Fostering the uptake of solutions

GOOD PRACTICES ON DATA INFRASTRUCTURE

BalticDataFlow might serve as an example of coordinated and targeted action at the level of the Regional Sea. Its aim is to enhance **harmonisation of regional database** on the marine environment originating from existing sea monitoring programmes, and to move towards **service-based data sharing**. In result, the open datasets on the Baltic Sea marine environment, as well as human activities will be made available to a wider community such as researchers, NGOs, the private sector, maritime spatial planning and other informed evidence-based decision-making processes, as well as to the European open data ecosystem. Additionally, an online database platform sharing Latvian marine monitoring data was developed for more rapid management response for both national and international environmental assessment. More information: https://helcom.fi/baltic-sea-trends/data-maps/ https://latmare.lhei.lv/

Within the Blue-Cloud Project, a **Strategic Roadmap** to 2030 was prepared. It is a policy document providing the basis for the future strategic development of the Blue-Cloud well embedded as a leading system in the wider marine community and as a component of the European Open Science Cloud (EOSC) More information: https://blue-cloud.org/services/blue-cloud-strategic-roadmap-2030

Blue Cloud Hackathon – a innovative way of **demonstrating** to end-users **the Blue Cloud functionalities** and to rise users' capacities. Participants were challenged to develop applications that contribute to improving knowledge of marine ecosystems; support the transition to a greener, blue economy; advance Ocean literacy; and/or enhance international collaboration towards achieving the Sustainable Development Goals (SDGs) of the United Nations Agenda 2030. Teams were grouped into categories and faced different hackathon challenges. More information: https://blue-cloud.org/hackathon

GOOD PRACTICES ON THE TOOLS OF CITIZENS INVOLVEMENT IN DATA ACQUISITION.

The NAUTILOS project recognized several ways to enrich the marine observation with citizen science. Within the project framework the **diving association** are provided with NAUTILOS novel low-cost sensors, measuring and recording different environmental parameters. The Citizen Science **dedicated Application (**https://www.nautilos-h2020.eu/nautilos-cs-app/) has been designed and tested - it allows for the uploading and analysing data gathered during various **Citizen Science campaigns** targeting plastic litters, algal blooms, marine images annotations. Collected data is integrated into the NAUTILOS data infrastructure (https://www.nautilos-h2020.eu/data-portal/)

INNOVATIVE SOLUTIONS – Uptake of Ocean models

Set of **numerical ocean models** for the next generation Copernicus Marine Environment Monitoring Service (CMEMS) are developed within the IMMERSE project**,** that would be delivered in the NEMO ocean model (https://www.nemo-ocean.eu/).The models – benefiting from the new high performance computing technology - contribute to the production of ocean forecasts and analyses that exploit upcoming high resolution satellite datasets and additional process complexity demanded by users and will allow easy interfacing of Copernicus products with detailed local coastal models.

StrathE2E web application is a “big picture” marine ecosystem modelling tool (ecology and fishing fleet), making it possible for anyone to be a marine modeller without the need for expert knowledge. Dedicated to the six areas/sites of the Atlantic Ocean it describes/forecast/simulates the responses (to changing parameters of ecosystems) and up to twelve different fishing fleets. The app allows users to select a geographic region, run a model, explore the results and vary the driving parameters of the model to create their own scenario. According to the authors, the model might be adapted to other regions. The model was developed in 2009 within the framework of the RECLAIM project (FP6), further developed among others thanks to DiscardLess project (H2020), currently used/developed further within the MISSION ATLANTIC (H2020). The model is also available as an R package. More info:

https://outreach.mathstat.strath.ac.uk/apps/StrathE2EApp/

also

https://besjournals.onlinelibrary.wiley.com/doi/10.1111/2041-210X.13510

Within the framework of the EMS2025 project the improvement of representation of ocean processes in the **next generation of Earth System Models** is foreseen. The improvements should be delivered in three fields: better representation of ocean eddies and convection; improved representation of ocean carbon, nitrogen cycling and associated marine emissions of trace gases to better integrate marine biogeochemistry; and the better representation of ocean-ice sheet interactions in standalone ocean or ice-sheet models. More information: https://www.esm2025.eu/icesheets/, https://www.esm2025.eu/about-the-project/project-structure/project-structure-ct1/project-structure-ct1-wp3/

Within the framework of the CRiceS Project, development of **new models at different scales** (process, regional, global) with enhanced descriptions of the Ocean-Ice-Atmosphere system for both poles is foreseen. With the aim to benefit future operational weather forecasting and climate projection systems at all scales. More information: https://www.crices-h2020.eu/about/objectives-and-impacts .

Within the framework of CoCliCo project a web-based platform will be developed –**The Coastal Climate Core Services** with the aim to inform users on present-day & future coastal risks. More information: https://coclicoservices.eu

GOOD PRACTICES ON KNOWLEDGE TRANSFER TO SECTORS AND POLICY

Within the Oddysea project the **Marinomica mobile application** was created – being an extend the web-based Marinomica portal. It offers remote access to the data and services. In addition, citizen science data is included to encourage interaction with the observatories and Marinomica service by the public https://play.google.com/store/apps/details?id=com.marinomica.app&gl=GB&pli=1

FORCOAST offers the e-services, aimed towards users in the **marine sectors of wild fishery, bivalve aquaculture, and oyster ground restoration**. These are novel Copernicus-based downstream information services that will incorporate Copernicus Marine, Land and Climate Services Products, local monitoring data and advanced modelling in the service (https://forcoast.netlify.app/). In the field of wild fishery offered services encompass: Suitable Fishing Areas for Western Black Sea, Frontal Areas Detection (for the Bay of Biscay

and the Northern-Adriatic Sea). In the field of aquaculture: Land Pollution (for the Eforie area in Bulgaria, the Northern-Adriatic Sea and the Galway Bay), Site Prospection (for the Limfjorden in Denmark). More information: https://forcoast.eu/services/

Within the HarmoNIA project a GeoPortal on vulnerability of coastal areas was developed and deployed in order to support a coordinated approach of **pollution management** and assist in creating responses in case of pollution accidents in the Adriatic – Ionian Seas. Together with the Geoportal, a set of transnational Strategies was prepared on methodology for harmonization of Contaminants assessment monitoring programmes as well as on a shared and harmonized evaluation of the risk due to contaminant dispersion from different sources of pollution. More information: https://vrtlac.izor.hr/harmonia/index.html

The SMARTFISH project developed, tested and promoted a suite of **high-tech systems for the EU fishing sector,** in order to optimize resource efficiency, to improve automatic data collection for fish stock assessment, to provide evidence of compliance with fishery regulations and to reduce ecological impact. The concepts developed encompass among others: *FishData* - a hardware and software infrastructure for acquisition, analysis and presentation of data from onboard catch monitoring systems and other relevant data sources; *FishFinder*, a real-time monitoring system for detection of organisms (e.g. nephrops and flatfish) which are undetectable using conventional fish finding techniques (i.e., echo sounders and sonars). Tested at EU wide fisheries, continuation under next project EveryFish. More information: http://smartfishh2020.eu/technologies/

Within the GRACE Project the **EOS (environment & oil spill response) tool** for environmental assessments to support oil spill response planning oil spill analysis was developed. It is a desktop analysis based on oil spill scenarios and published as well as expert knowledge on the environment in an assessment area. It can support decisions of inclusion of mechanical recovery, in situ burning and chemical dispersants in national oil spill contingency plans. In addition, the results obtained through the EOS tool can be used for establishment of cross-border and trans-boundary co-operation and agreements on oil spill response. More information: https://www.grace-oil-project.eu/en-US/Tool_for_environmental_assessments, https://ecos.au.dk/en/researchconsultancy/themes/eos

Recognized synergies between the EU programmes.

The MSP4BIO Horizon project will use and enhance the decision support tool PlanWise4Blue, which was developed by Estonian researchers within the PanBalticScope project (EMFF), ADRIENNE project (Est-Rus cross Border cooperation programme) and MAREA project (INTERREG Central Baltic) and was used in planning processes in Baltic Sea (Estonia). This is the open-source online tool to estimate cumulative effects of various human activities on nature assets. The tool will be used in MSP4BIO for ecosystem modelling and hopefully enriched with socio-economic data/layers, also might be adjusted to the other areas outside the Baltic Sea. The synergy is the result of involvement of the partner that has been developing the PlanWise4Blue tool. The MSP4BIO also prepares review of existing decision support tools useful better consideration of MPA in MSP.

The Tools4MSP community-based, open-source web application was prepared in the framework of DG MARE supported project ADRIPLAN in 2013 and was used by many projects and initiatives supporting the maritime spatial planning in Mediterranean region. In 2023 the updated version was launched in the form of Tools4MSP Geoplatform. The goal is to support marine management strategies, maritime spatial planning, integrated coastal zone

management and other decision-making processes. The Geoplatform is used by several Mediterranean projects of different funding – Interreg, FP7, Horizon 2020, Horizon Europe, including BRIDGE-BS and MSP4BIO as regional knowledge catalogue, sharing of layers, interactive maps, dashboards, geostories and analytical tools collections. The synergy is the result of regional cooperation in maritime spatial planning.

Some portfolio projects on observing technologies are performed outside of HORIZON, these are more targeted to investments, industrial scale:

- iFADO project (INTERREG) - aims to downscale the Copernicus Marine Environment Monitoring Service products and to combine the conventional monitoring programmes with emerging technologies such as gliders, ocean buoys and satellite data, to develop tailor-made and innovative products.

- FLORA (EMFAF) - will develop and demonstrate an industrial-scale prototype of a multi-purpose ocean station with renewable energy generation and operational oceanography capabilities: the FLORA Ocean Station (or FLORA O.S.). location Canary Island. Important for EIA and MSP data driven processes.

- FLEETUSV (EMFF) brings to market the XOCEAN's innovative, high-performing, low-cost Unmanned Surface Vessel (USV) aimed at the commercial ocean data collection sector.

- ESENSE (EMFF) will lead to the development and the qualification of 360 degrees real-time perception BLUESENSE plug-and-play sensors linked to features considered as essentials according to customer feedback.

11.4. Policy recommendations

- It is recommended to continue the EU support in creating the ocean digital knowledge system in all recognized Thematic Areas. The focus might be given to create the instruments to increase the collection and use of industry sources data, especially in view of increased offshore investments performing in situ research and post-investments monitoring.

- In terms of in-situ data availability, there are certainly recognised data gaps on biological parameters, mainly related to bird/fish/sea mammal migrations, which are important especially in the light of rapid maritime investments (i.e., offshore energy) or for the optimisation of the MS maritime spatial plans. To achieve this, the public (or at least public bodies) access to **commercial as well as private and industry data** may be the only solution. It is generally desirable to encourage business to share their data, either related directly to their activity or to the marine environment in which they operate.

  Maintenance and expansion of instruments to increase the collection possibilities and broad dissemination of relevant commercial as well as private or industry (i.e., collected by businesses for e.g., permitting, monitoring etc) is recommended. The European Marine Observation and Data network (EMODnet) is an example of how commercial entities can be encouraged to share data. EMODnet already operates an associated partnership scheme, through which commercial entities can be become stable collaborators, submit their data and receive recognition for their contribution. Additionally, through the EMODnet for Business scheme (E4B), EMODnet engaged annually with specific European Blue Economy sectors (i.e., aquaculture, offshore energy) not only to encourage them to use EMODnet data for their purposes but also encourage them to open up the data they collect.

Examples of collecting/sharing the industry related data, might be the Belgian monitoring of offshore wind investments https://odnature.naturalsciences.be/mumm/en/windfarms/#monitoring where the results of monitoring performed since the 2009 are shared and the digital database of the Princess Elisabeth Zone - https://offshore.digital-database.economie.fgov.be/#/home Connections (data exchange) should be established with such national/industrial monitoring programmes (if not yet established)

- The "project approach" to funding is an issue - any activity with data needs stable funding for data centres. Projects can produce tools and methods, but they do not give stability in the maintenance and availability of results. The more data we have and the more tools/models we can use, the greater the impact of such services on society and the greater the opportunities to monetise these services in commercial activities but the greater the cost of maintaining this infrastructure.

  It needs to be ensured that the speed of increasing the volume of data and the number of tools does not outstrip the **ability to maintain** the data and tools. The support for databases maintenance is crucial.

- It is necessary to continue efforts towards more and more reliable **climate change forecasting** and other decision-making support tools.

- Provide/sustain support to the initiatives at **regional seas' level** aiming at creation/harmonisation/maintenance of regional databases also at implementing regional Strategic Innovation and Research Agendas.

- Challenging is the information complexity we are living in. With the increase of marine and climate issues we experience the increase of funding, projects and information/tools which are being created – it becomes more challenging to be acquainted with all of them and to ensure continuity of their relevance. Many of the projects perform activities "screening the available resources relevant to…", trying to avoid duplication or sort out the existing solutions. Catalogue of reliable the tools, models, software, algorithms, solutions developed by European projects should be maintained by EU. Their usefulness should be **externally validated**. If found important - their further development should be supported beyond the project lifetime, within the DTO environment. Horizon Results Platform should be used and sustained. The Thematic Areas analyses performed for this portfolio should be used as a starting point. The EDITO Model Lab could take it into consideration.

- There is a need to focus more and more on knowledge transfer towards business/sectors/decision-making. The business/sectors co-ownership is important. Their engagement in development makes the tools, solutions, results more applicable in the future. The participation of business and public bodies should be strengthened in EU projects. SMARTFISH with its solutions for fishery sector might be a good example as well as PlanWise4Blue developed for the maritime spatial planning administration. We have to be aware that decision supporting tools are being developed also outside of EU projects – it might be useful to establish links to sectoral knowledge platforms, like e.g. EU MSP Platform:

  https://maritime-spatial-planning.ec.europa.eu/msp-resources/msp-tools-and-guidance or https://maritime-spatial-planning.ec.europa.eu/msp-practice/database?field_term_type_of_practice_tid%5B%5D=63&combine=&sort_bef_combine=title+ASC

- Create the mechanism to transfer, sustain the developed applications for citizen science. If we want to use citizen knowledge as reliable source in data/information – the awareness rising campaigns and stronger eco-education is needed.

- The recognition of EU instruments/programmes/observatories should be strengthened among end-users. Campaigns, hackathons, open days should be continued/developed. European Maritime Days should be used. Permanent cooperation with European maritime universities/high schools should be established/maintained. Skills programmes should be developed/continued.

Constant expansion of EMODNET data sources on human activities (investments). Even after launching One Ocean One EMODnet – some discrepancies/gaps exist, which might influence the evidence-based decision-making process. New national maritime e-services are available and should be made primary sources of information – e.g. for Poland SIPAM https://sipam.gov.pl/english/sipam-en/ (not maritime traffic for offshore oil and gas installations). The data repositories created by European projects might be recognized and connected – e.g.: EMODNET catalogue on cultural heritage might be complemented with the results of BalticRIM research (https://balticrimdataportal.eu/).

11.5. List of projects

Project id	Project Acronym	EU Programme	Type of Action
2019-EU-IA-0115	**Baltic Data Flows**	**CEF**	**CEF-TC**
2018-EU-IA-0089	-	CEF	CEF-TC
101093956	A-AAgora	HORIZON	HORIZON-IA
101081568	ACCIBERG	HORIZON	HORIZON-RIA
101060072	ACTNOW	HORIZON	HORIZON-RIA
101094924	ANERIS	HORIZON	HORIZON-RIA
950212	ANTICS	H2020	ERC
101094434	AquaINFRA	HORIZON	HORIZON-RIA
101003472	Arctic PASSION	H2020	RIA
730965	ARICE	H2020	RIA
730984	ASSEMBLE Plus	H2020	RIA
862923	**AtlantECO**	**H2020**	**RIA**
633211	AtlantOS	H2020	RIA
678760	ATLAS	H2020	RIA
101059592	B3	HORIZON	HORIZON-IA
732310	BigDataOcean	H2020	IA
682602	BIGSEA	H2020	ERC
101059915	BIOcean5D	HORIZON	HORIZON-RIA

101057437	BioDT	HORIZON	HORIZON-RIA
862409	**Blue Cloud**	**H2020**	**IA**
101094227	Blue-Cloud 2026	HORIZON	HORIZON-RIA
101000240	**BRIDGE-BS**	**H2020**	**RIA**
635359	BRIDGES	H2020	RIA
101059823	B-USEFUL	HORIZON	HORIZON-RIA
853516	CarbOcean	H2020	ERC
101092633	CISE- ALERT	EMFAF	EMFAF-PJG
774586	CLAIM	H2020	IA
101093865	CLIMAREST	HORIZON	HORIZON-IA
857586	CMMI – MaRITeC-X	H2020	CSA
872690	CoastCarb	H2020	MSCA
101003598	**CoCliCo**	**H2020**	**RIA**
820989	**COMFORT**	**H2020**	**RIA**
741120	COMPASS	H2020	ERC
101003826	CRiceS	H2020	RIA
739562	DANUBIUS-PP	H2020	CSA
732064	DataBio	H2020	IA
101016958	DeeperSense	H2020	RIA
101000518	DOORS	H2020	RIA
101058129	DT-GEO	HORIZON	HORIZON-RIA
101004211	**ECFAS**	**H2020**	**RIA**
101000302	**EcoScope**	**H2020**	**RIA**
23096	ECOSS	Interreg	ERDF
869383	ECOTIP	H2020	RIA
776136	EDGE	H2020	CSA
101101473	**EDITO-Infra**	**HORIZON**	**HORIZON-IA**
101093293	**EDITO-Model Lab**	**HORIZON**	**HORIZON-IA**
101081383	EERIE	HORIZON	HORIZON-RIA
101017567	EGI-ACE	H2020	RIA
871128	eLTER PLUS	H2020	RIA
676555	EMSODEV	H2020	RIA
731036	EMSO-Link	H2020	CSA
101035797	eMSP NBSR	EMFF	EMFF-AG

101053993	ENDURE	HORIZON	HORIZON-ERC
824348	ENDURUNS	H2020	RIA
654182	ENVRI PLUS	H2020	RIA
824068	ENVRI-FAIR	H2020	RIA
101060784	EO4EU	HORIZON	HORIZON-IA
730066	EOMORES	H2020	IA
101017536	EOSC Future	H2020	RIA
857650	EOSC-Pillar	H2020	RIA
861584	ePIcenter	H2020	RIA
101059547	EPOC	HORIZON	HORIZON-RIA
101038191	ESENSE	EMFF	EMFF-AG
101003536	ESM2025	H2020	RIA-LS
731103	EUMarineRobots	H2020	RIA
101094690	Euro GO-SHIP	HORIZON	HORIZON-RIA
824131	Euro-Argo RISE	H2020	RIA
824077	**EurofleetsPlus**	**H2020**	**RIA**
101003805	EUROqCHARM	H2020	CSA
862626	EuroSea	H2020	IA
101059892	EveryFish	HORIZON	HORIZON-IA
101058785	FAIR-EASE	HORIZON	HORIZON-RIA
869634	FIRE	H2020	CSA
101060879	Fish-X	HORIZON	HORIZON-IA
757239	FLAVE	H2020	ERC
958948	FleetUSV	EMFF	EMFF-AG
101077554	FLORA	EMFAF	EMFAF-PJG
870465	FORCOAST	H2020	IA
101038057	FUTURELARVAE	H2020	MSCA
869300	FutureMARES	H2020	RIA
101058518	Geo-INQUIRE	HORIZON	HORIZON-RIA
101094716	GEORGE	HORIZON	HORIZON-RIA
101059877	GES4SEAS	HORIZON	HORIZON-RIA
724416	GOCART	H2020	ERC
101039118	GPP	H2020	CSA
679266	GRACE	H2020	RIA

101083927	GREAT	DIGITAL	DIGITAL-CSA
101060693	GUARDEN	HORIZON	HORIZON-RIA
19141	HarmoNIA	Interreg	ERDF;IPA/IPAII
101094621	HiAOOS	HORIZON	HORIZON-RIA
101006689	HIPERWIND	H2020	RIA
821934	HiSea	H2020	IA
818123	**iAtlantic**	**H2020**	**RIA**
19332	iFADO	Interreg	ERDF
101037643	**ILIAD**	**H2020**	**IA**
101058625	iMagine	HORIZON	HORIZON-RIA
821926	**IMMERSE**	**H2020**	**RIA**
727890	**INTAROS**	**H2020**	**RIA**
19129	**I-STORMS**	**Interreg**	**ERDF;IPA/IPAII**
951799	JERICO-DS	H2020	RIA
654410	JERICO-NEXT	H2020	RIA
871153	**JERICO-S3**	**H2020**	**RIA**
821984	KEPLER	H2020	CSA
101003954	LABPLAS	H2020	RIA
635568	LAkHsMI	H2020	RIA
101070722	LIFE21-NAT-FR-LIFE-SEADETECT	LIFE2027	LIFE-PJG
869710	**MaCoBioS**	**H2020**	**RIA**
101000832	MAELSTROM	H2020	IA
101060937	MARBEFES	HORIZON	HORIZON-RIA
677898	MARCAN	H2020	ERC
101082021	MARCO-BOLO	HORIZON	HORIZON-RIA
24701	MAREA	Interreg	ERDF
101100771	MAREGRAPH	DIGITAL	DIGITAL-SIMPLE
101058956	Marine SABRES	HORIZON	HORIZON-IA
730098	MARINE-EO	H2020	PCP
101059407	MarinePlan	HORIZON	HORIZON-RIA
731084	MARINET2	H2020	RIA
804599	**MARIPOLDATA**	**H2020**	**ERC**
22568	MATRAC - ACP	Interreg	ERDF

776825	**MELOA**	**H2020**	**RIA**
692173	MESOPP	H2020	CSA
101008724	**MINKE**	**H2020**	**RIA**
862428	MISSION ATLANTIC	H2020	RIA
23484	MPA Engage	Interreg	ERDF;IPA/IPAII
101059988	MPA Europe	HORIZON	HORIZON-RIA
101060707	MSP4BIO	HORIZON	HORIZON-RIA
772584	MYCO-CARB	H2020	ERC
101000825	**NAUTILOS**	**H2020**	**IA-LS**
863448	NEANIAS	H2020	RIA
101081273	NECCTON	HORIZON	HORIZON-RIA
101081642	OBAMA-NEXT	HORIZON	HORIZON-RIA
695094	Ocean artUp	H2020	ERC
101060452	OCEAN ICE	HORIZON	HORIZON-RIA
802835	OceaNice	H2020	ERC
101083922	OceanICU	HORIZON	HORIZON-RIA
101077209	OceanPeak	HORIZON	HORIZON-ERC
727277	**ODYSSEA**	**H2020**	**RIA**
101081193	OptimESM	HORIZON	HORIZON-RIA
101094041	OTTERS	HORIZON	HORIZON-CSA
101073952	PERIVALLON	HORIZON	HORIZON-IA
101086297	PERMAGOV	HORIZON	HORIZON-RIA
101088822	PlasticPiratesEU	HORIZON	HORIZON-CSA
101017808	RAMONES	H2020	RIA
834177	REFINE	H2020	ERC
956200	REMARO	H2020	MSCA
101093964	REMEDIES	HORIZON	HORIZON-IA
101037097	REST-COAST	H2020	IA
690416	ROBUST	H2020	RIA
101077026	SafeNav	HORIZON	HORIZON-IA
101000175	SafeWAVE	EMFF	EMFF-AG
101086379	SBEP	HORIZON	HORIZON-COFUND
101003534	SCORE	H2020	RIA
101082311	SDGs-EYES	HORIZON	HORIZON-RIA

856488	SEACHANGE	H2020	ERC
730960	SeaDataCloud	H2020	RIA
101004032	**SEAMLESS**	**H2020**	**RIA**
22595	SICOMAR plus	Interreg	ERDF
773521	**SMARTFISH**	**H2020**	**IA**
101017861	SMARTLAGOON	H2020	RIA
882340	Smart-TURB	H2020	ERC
821001	SO-CHIC	H2020	RIA
783400	SpaceWave	COSME	COSME-GA
679849	SponGES	H2020	RIA
101071214	SsKi-I	EMFAF	EMFAF-PJG
101094649	STRAITS	HORIZON	HORIZON-RIA
20769	STREAM	Interreg	ERDF
823711	StR-ESFRI2	H2020	CSA
856408	STUOD	H2020	ERC
101009793	SUNFISH	H2020	SME
869342	**SUSTUNTECH**	**H2020**	**IA**
101077477	SYMBIOSIS	HORIZON	HORIZON-CSA
101055096	TAOC	HORIZON	HORIZON-ERC
101000858	TechOceanS	H2020	IA-LS
803140	TERIFIC	H2020	ERC
101095253	THETIDA	HORIZON	HORIZON-RIA
820575	TiPACCs	H2020	RIA
101001451	TITANICA	H2020	ERC
715386	TOPIOS	H2020	ERC
867471	TrawledSeas	H2020	MSCA
817578	TRIATLAS	H2020	RIA
101091959	TRIDENT	HORIZON	HORIZON-RIA
101041743	VERTEXSO	HORIZON	HORIZON-ERC
957237	VesselAI	H2020	RIA
637770	WAPITI	H2020	ERC
101004186	Water-ForCE	H2020	CSA
101058393	WorldFAIR	HORIZON	HORIZON-CSA

12.Mobilization and engagement. *By Giovanna Chimini*

12.1.Main findings of the analysis

The report deals with a portfolio of projects analyzed from the standpoint of public engagement and mobilization and selected by data mining according to predefined keywords across a large spectrum of EC programs.

Successive steps of analysis are performed and reported hereafter. Starting from a first screen for relevance to the objectives and priorities of the mission, the portfolio undergoes an analytical description of project distribution, followed by an in-depth analysis of a narrow selection of projects. In fine a conclusive section is dedicated to policy recommendations.

Section 12.2 describes analytically the distribution the selected 96 projects, identified as relevant for the Mission Restore our Ocean and Waters by 2030 (from now on the Mission) and enabler 2a: mobilisation and engagement of stakeholders, across framework programs, type of granted actions and pertinence for the tools developed to drive change in the foreseen directions.

The portfolio is distributed across eight FPs and drives a total EC contribution of 424 M€.

A high prevalence of Research and Innovation Framework Programmes namely H2020 and Horizon is noted. They represent altogether 63 % of the projects (61 in number) and 77 % of the total budget (327.8M€). LIFE is also well represented whereas somehow surprisingly EMFAF and EMFF account only for a very limited number of projects.

The most represented types of actions are Innovation (IA) and Research and Innovation actions (RIA) accounting across FPs for 29% and 21 %, respectively, of the budget allocated to the portfolio. They are followed by Coordination and Support actions that gather 15.5 % of the total budget.

The challenges embedded in the mission plan and schematized as levers of change are adequately targeted by the portfolio. Indeed, it covers harmoniously the thematic areas as defined to assess the attention paid to the achievement of engagement and mobilization of the public. This is also reflected by a balanced distribution of the efforts and activities engaged to drive the levers of change.

Section 12.3 provides an analysis in depth of the narrow portfolio counting 27 projects, carried out in the aim to highlight tangible results and foster future implementation of solutions.

Satisfactorily all the projects have produced results aligned with their own stated and mission proper objectives; a table of the best ones, limited to a maximum of three per project, is presented.

Few outstanding projects noteworthy for the originality and uniqueness of their initiatives are described.

It is worth stressing the optimal alignment with the Mission's objectives and the strength of ocean-related commitment of two European universities alliances, supported by ERASMUS +, which may represent, in my opinion an asset for the future, long-term success of the mission.

In spite of the last remark, however, the lever of change education and youth seems under targeted, in light of the extreme relevance of efficiently preparing next generations for ocean awareness and literacy.

A similar weakness emerges with respect to engagement of professional stakeholders, whose implication is crucial for transformation and acceptance in economic marketplace.

Again, on the positive side it is important to note that several pilot experiments / process / tools and practice have been already successfully developed and are ready for a pan European spreading and global implementation.

Based on the information available on the project's websites, it appears that only few of the projects have so far endorsed the Mission's charter. This calls possibly for the need of a broader and more capillary diffusion, even in the community, of this message of commitment.

In line with the previous remarks the recommendations presented in section 12.4 mainly propose initiatives related to education and youth's engagement inspired by projects already financed by EC but not yet engaged in ocean related challenges. Notably the need to support a reflection on the best approach to achieve an integrated plan for Ocean-skill is suggested.

From a societal angle, the setup of a recurrent EC driven celebrative event, openly dedicated to the ocean such as the European capital of the seas, could also represent a game changer in the building of local awareness and mobilization.

This may serve on a broader horizon the setup of an articulated strategy from the local level to the European level to mutually enhance dissemination and involve society at large.

A last preoccupation concerns the need to envision as soon as possible a suitable roadmap to speed pan European harmonization while avoiding redundancy and duplication of efforts, the basin-dedicated CSAs are suggested as key actors potentially in charge.

The list of projects in the wide portfolio is included in Section 12.5. The 27 projects selected for in-depth analysis are marked in blue and bold.

12.2. Description of the portfolio

The initial portfolio provided for analysis for enabler 2a consist of 155 projects selected from a wider survey by a text mining tool across all EU-programs.

Out of these, 96 are considered relevant since complying fully with the mission's objectives and targets. The remaining 59 are considered non-relevant since not directly related to the objectives of the mission while, at least frequently, laying in the spectrum of climate and ecology. However, their analysis turns out to be useful since allows to highlight initiatives and practice of interest, inspiring improvements potentially beneficial to the future of the mission.

Out of the 96 projects, 23 (24% of the whole portfolio) are already closed; the remaining 72 will progressively be completed in the forthcoming years with a large group of 61 projects (64%) ending between 2024 and 2026 and only few projects (12 in total = 12.5 %) extending over 5 years and until 2031. It is thus likely that a substantial load of tangible results and achievements will be available for assessment in two years' time.

The geographical coverage of the portfolio appears adequate as schematize in Figure 12.1. Many projects cover more than one European basin with, for instance, multiple prototype pilot locations or whenever dealing with general objectives such as awareness or tools development. It has to be noted, however, a positive skewing towards the Mediterranean with the highest portfolio of dedicated projects and a low coverage of the Danube basin with a single dedicated project.

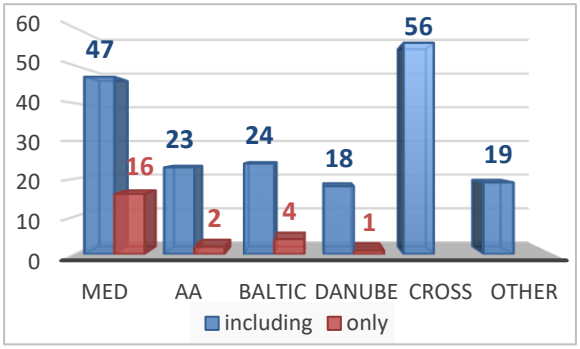


Figure 12.1. Geographical coverage of the 94 projects. Blue bars indicate the number of projects describing actions targeting the basin. Since most projects cover more than one basin the sum of projects over all basins exceeds 94. The orange bars indicate the subgroup of projects dealing exclusively with the indicated basin. Cross Basin projects are frequently dealing with policy making and good practice. 19 projects include basin not identified in the EC objectives

Distribution of portfolio across programs and actions.

The 96 relevant projects represent an overall EU provided budget of 424 M€ over a total cost of 533,5 M€.

All the framework programs are represented in the portfolio, though Horizon, H2020 and LIFE27 are the most largely represented both in terms of budget with 46%, 31 % and 10% respectively and in reference to the number of projects with 40, 21 and 18 supported projects respectively.

The remaining programs are similarly represented but do not exceed 7 projects or 7% or the budget each; namely Interreg with 7 projects, Erasmus + 27 with 4, EMFF with 2, EMFAF with 3 and LIFE with a single project. (Figure 12.2 and 12.3).

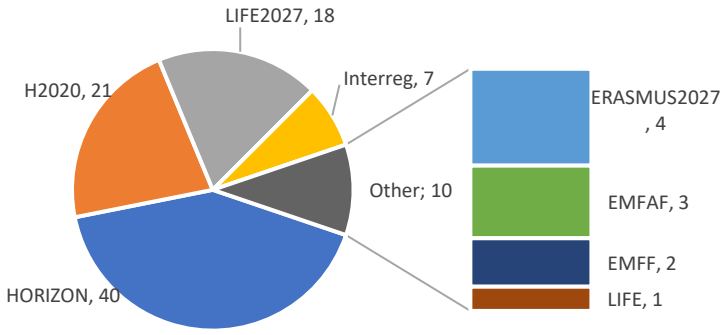


Figure 12.2. Number of projects per EU funding program. Total number of projects: 96.

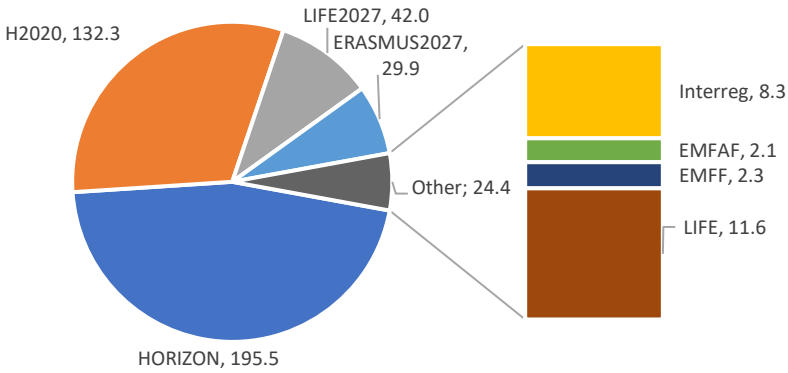


Figure 12.3. EU contribution (M€) per funding program. Total EU contribution: 424 M€

The portfolio of type of actions is also quite diverse and includes 20 types of actions with an extremely variable financial support (see Figure 12.4 and 12.5)

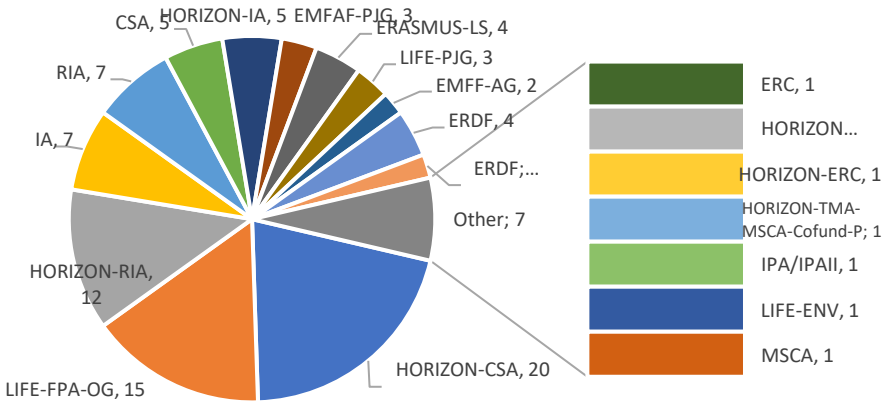


Figure 12.4. Number of projects per type of action. Total number of projects: 96

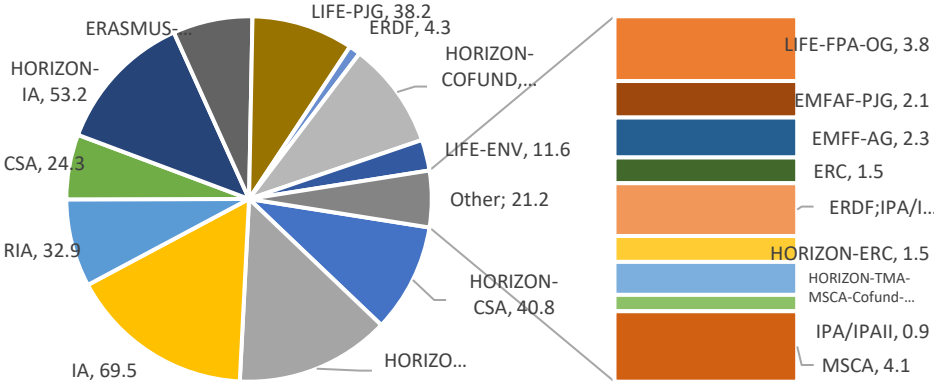


Figure 12.5. EU contribution (M€) per type of action. Total EU contribution: 424 M€.

The most significantly represented group is that of Innovation Action (IA) both under Horizon or H2020 with a global budget of support of 122.7 M€ of which 69.5M€ with 7 projects under H2020 and 53.2 M€ with 5 projects under Horizon. IA is followed budget wise by Research and Innovation actions (RIA) with an overall budget of 91 M€; under H2020, these actions summed to 33 M€ with 7 projects with a manifest increase to 58 M€ and 12 projects under Horizon. The preponderance of these actions highlights their pertinence and alignment with the tight roadmap of the mission. Indeed, these actions while targeting different outcomes in technology readiness levels (from lower to higher from RIA to IA) both aim at establishing transferability of a new knowledge, technology, process or service to the industrial and/or public market.

Coordination and Support actions are funded via a budget of 65 M€ with, in detail, 5 projects and 24 M€ in H2020 and 20 projects and 41 M€ under Horizon. In 7 cases (either past or in progress at this time) the support concerns actions linked to the European researcher's night witnessing the wish, shared across several countries, to take advantage of an European established and well-known event for ocean-oriented citizen science (see below section 12.4 for possible recommendations along this line)

The vast majority of projects under the LIFEs programs (15 out of 19) are Framework Partnership Agreements (FPAs) serving as umbrella for operating grants to non-profit organizations which are involved in the development, implementation and enforcement of EU legislation and policy primarily active in the field of environment or climate action.

A single project LIFE belongs to the type LIFE-ENV; it counts on a substantial budget (11M€) which goes with the ambitious objective to implement the most critical part of the Estonian Prioritized Actions Framework (PAF) for Natura 2000 relating to forests and agricultural land. This includes the task of transforming the image, as for today negative, of nature conservation by introducing more adaptive methods and practices in the Estonian landscape. It serves therefore the aim of adjusting public perception and sensibilization towards nature and ocean related topics.

Out of the remaining projects, two are operational grants dealing with specific threatened econiches in the Mediterranean. The third and last conveys a sizeable financial support (32 M€) to the actions prompted and coordinated by The International Union for Conservation of Nature (IUCN) in their effort to engage competent regional stakeholders in the implementation of activities gravitating around the EU strategies of biodiversity and sustainable development.

An outstanding project funded at approx. 40 M€ under the umbrella of Cofund actions is Biodiversa+ an high-level pan European partnership to coordinate the implementation of actions and research programs between EU, its member states and environmental authorities in focus as part of the EU Biodiversity Strategy 2030. One of its overarching objectives relate to public engagement, mobilization and understanding of the need and urgency of deploying Nature based solutions across Europe.

Only two projects, under the umbrella of Marie Skłodowska-Curie Actions, develop actions to promote, via education, awareness and competence in ocean related disciplines in the novel generation of scientists / citizens. Indeed, though at least two European universities alliances, belonging to the group of 4 projects under ERASMUS +, treat of mission pertinent topics, a very limited project in the portfolio deal with the training of next generations for ocean consciousness and competence.

Of note among the scattered remaining projects in the portfolio is the presence of two ERC starting Grants, the first awarded under the H2020 in 2019 and the second more recently under Horizon in 2022. They are both related to the core of the mission but they deal with very specific and different angles of excellence in research. The older, CALENDAR, from social sciences, is concerned by the symbolism of climate seasons and water handling and how this affects human resilience to climate change while the second, BioGeoMicrobes, issued from geophysical science, aims at blueprinting the molecular mechanisms of algal-bacterial interactions, and their integration into biogeochemical contexts such as the carbon cycling in marine ecosystems. The interdisciplinary approach adopted will allow a better modelling of climate changes and as such provide valuable data for ocean stewardship policy makers.

Assessment by thematic areas

To facilitate the analysis and the assessment of the relevant actions the thematic areas crosscut projects independently of their specific scientific objectives.

They are designed to help diagnosing the level of civic participation and engagement nurtured by each project.

Achieving engagement and mobilization requires as a pivotal initial level the stirring of people's curiosity and the sensibilization to the questions of interest as well as to the urgency for a solution, both leading as a successive step to the acquisition of knowledge and competence. These need for instance the set-up of sensibilization campaigns promoting active participation, the openness of research to general public prompting the understanding of the scientific process and the set-up of empowerment actions or digital user-friendly tools easily accessible to all citizens. Three thematic areas address whether or not the projects take into consideration these points, namely by scoring the presence of Empowerment activities, Access to digital tools, Sensibilization campaigns & fora.

A specific subject requiring assessment in the broad arena of engagement and mobilization is the attention paid to engage youth with appropriate actions and with a sensitive look to education and training for a fulfilled ocean literacy of future generation. The area named Youth's engagement scores these actions.

A further level of maturation in the engagement process leads to its progression towards politics and society and broadly implies the extent and capacity of associating local authorities and professional stakeholder into the program of activities. Their participation is indeed frequently critical to pave the way to tangible results and to positively influence the transfer of processes or guidelines from the scientific world to the work market and societal reality, while respecting collective conscience. Assessment of the awareness to handle these steps is provided by the areas: Stakeholder's engagement and Engagement of public organizations. At last the assessment of a declared intention to influence policy and regulations is analyzed in the area Policy making and guidelines.

The tree map in Figure 12.6 provides a global view of the distribution of actions carried out by the 94 projects of the portfolio across thematic areas. Individual projects never address a single area but on average 4 to 5 areas leading thus to a total number of 450 actions covering areas. On a positive note, it is interesting to remark the balanced distribution of actions across the areas; sensibilization actions and actions destined to youth's engagement lie however in the low range of representation.

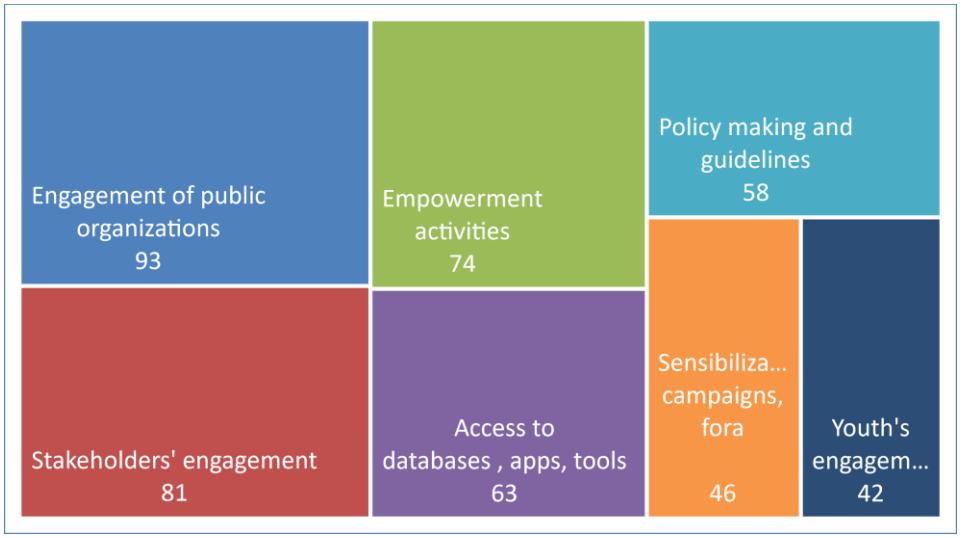


Figure 12.6. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 457. Total number of projects: 96.

Table 12.1 by plotting thematic areas versus levers of changes summarizes the coherence of tools deployed by the portfolio of projects to drive the desired evolution.

Table 12.1 Lever of Change (LoC) vs. thematic areas (T.A.). For LoC it is understood the type of tool targeted by the project to drive (or leverage) change in the desired direction

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deploy.	Citizen Engagement	Education & Training
Sensibilization campaigns	32	27		35	43	45	33
Youth's engagement	23	20	16	29	30	41	36
Empowerment activities	42	37	36	53	58	66	55
Engagement public organizations	57	48	46	66	76	76	58
Policy making and guidelines	52	39	30	47	54	48	30
Access to digital tools	43	35	36	56	57	55	44
Stakeholders' engagement	56	49	44	66	73	67	48
Total	305	255	230	352	391	398	304

12.3. Main outcomes and fostering the uptake of solutions

12.3.1. Main outcomes

Out of the 96 projects retained as pertinent and relevant in the context of the mission this analysis has focused in particular on 27 outstanding projects in perfect alignment with its objectives and notably the enabler civic engagement.

In Table 12.2 the main tangible outputs (with an upper limit to 3 per project) have been arranged by categories of impact. Ten projects out of the 27 only began in the recent months and stem directly from actions driven by the mission itself. As such, though of utmost interest, they cannot provide yet tangible results. They all fully embrace the spirit of the mission, envision precise objectives and engage in producing deliverables on all the levers of changes identified. For the sake of this analysis their perspective outcomes will be considered as successful.

Out of them 5 deal with coordination and support of the Mission set up. The remaining 5 recent projects deal with specific aspects of research and innovation and their interaction with society (i.e. citizen sciences, youth engagement and empowerment, living labs, policy, awareness) and as such they are spread in the Table 12.2 according to the main area. Two projects stand alone in the portfolio for their unique approaches in that they cover ocean awareness via sport – OSES or bridge ocean literacy and awareness to underwater cultural heritage - TETHIDA.

Coordination.
The projects dedicated to lighthouse set up in the different sea basins and its overall coordination (5 projects highlighted with * in the Table 12.2) are quite recent but as expected well aligned and coherent. They pay the necessary attention to wide gathering of knowledge and data, and to granting the access and involvement of the civil society in the building process. No explicit mention is however provided about a crosscutting action enabling a constant dialogue between the lighthouses, smooth and coherent progress and exchange of experiences in problem handling and solving. Attention should be paid to this aspect.

Data & Knowledge and empowerment tools.
A set of results from 12 projects deal with technological developments linked to precise Mission objectives (e.g. biodiversity safeguard, pollution, marine protected areas, off shore marine energy, underwater noise). They all propose technical advances with a precise design for upscaling and transfer from pilot experiences to full application and spreading to the various sea basins. They also consistently provide the setup of publicly available repository of data and the development of empowerment tools to engage dialogue with civil society. For simplicity in the same group are also listed actions and achievements targeting the set-up of tools designed for public empowerment such as applications, toolkits, field expeditions since they found their bases in scientific discovery and methods. Two of the projects listed in this section have endorsed the Mission charter (Aqua wind and Maelstrom in bold in the Table 12.2).

Education and youth
Education and capacity building are extremely important aspects for the perpetuation of mission ideas and adoption by future generations. Several projects deal with the topic though they largely vary in their emphasis. The relevant results are identified.

The action of two European alliances (EU-CONEXUS Plus and SEA-EU 2.0 highlighted as ° in the Table 12.2) deserves particular attention. Among the 44 alliances of European universities existing today, all sharing as general objective the streamlining across nations of the education processes and the engagement of society, these two align perfectly with the Mission since their scientific target is directly linked to ocean and coastal ecosystems. It has to be stressed also that they provide a very interesting cross talk between tools independently set up by European commission and included into different programs (i.e. ERASMUS + supports European alliances). These projects foster a community dedicated to training and engagement of the young generation around the ocean and water by providing the necessary path for marine oriented education of the next generation of citizens. As such they uniquely cover in my opinion a critical ground and structure the tools to acquire the skills and competence for next generations of professionals on a transnational layout.

Initiatives targeting education and ocean literacy of the youngest through actions to schools or even earlier are also present though somehow underrepresented: a single project embraces the question as central aim (Biobeo) and a few others treat the topic yet only peripherally.

Again, as a standalone it is worth noting the AETFOOG project focusing on strengthening contacts across continents (Africa & Europe in this case) on the crucial issues of common policy & governance and fostering joint youth engagement.

Awareness

Large scale sensibilization campaigns with impact on the general public are served very efficiently by the work proposed by NGOs such as SURFRIDERS, SEA at risk, and by IUCN, all renowned for the long-standing experience and outreach. While the activities of the first two is entirely devoted to ocean matters and as such in the full scope of the Mission, it is of note that IUCN, whose interest in nature related actions for sustainability is well known, has developed recently (since the Marseille Manifesto in 2021) a whole branch of awareness activities devoted to ocean and water ecosystems.

Plastic Pirates already included as part of the ERA action “Bring Science closer to Citizens” aims at raising awareness on the impact and benefits that research and innovation can have on daily life, notably on plastic waste. Drawing on six years of successful implementation in Germany, and since 2020 in Portugal and Slovenia, their action is now ready to expand to other EU member states.

Along the same line of thoughts and actions works the project FLOW (due to start in the coming months) fostering engagement of the young generation in the co construction with scientists and stakeholders of new policies via cross nations dialogue and networking.

The project BIOocean5D, in bold in the Table 12.2 since it has endorsed the Mission charter, has a place a part. The project includes in a broader scientific horizon the support of the TARA EUROPA TREC expedition. It is an ambitious collaborative project to study European coastal and marine ecosystems bringing together more than 42 research structures worldwide. The program focuses on the biodiversity and adaptation of living organisms at the land-sea interface along different environmental gradients. Particular attention will be paid to the impact of anthropogenic continental pollution. BiOcean5D will mobilize a variety of technologies and protocols to sample water, aerosols, sediments, and critical marine habitats at 120 selected sites along the European coast from Finland to Crete. The new data, harmonized with those already existing will be openly available to the international research community. Final aim of the project is the obtention of a first of the kind, pan-European census of European coastal ecosystem health. From the public engagement stand point the

originality of the initiative and impact on people frame of thinking linked to previous TARA schooner expeditions grant success and visibility for the mission.

Policy and governance

A tangible evolution of government/ international policies and public perception will certainly be a powerful indicator of the Mission success. This however is very difficult to esteem and can only be achieved in the long term, its prerequisites being the access to exhaustive comparative analysis of difficulties or regulations Europewide and the development of performant tools facilitating decision-making. Many projects are concerned by this goal and they all have produced policy guides and protocol of best practice in various model systems (from biodiversity to ecological monitoring or marine protected areas preservation). These are the building blocks on which it will be possible to open a constructive dialogue on key, ocean-related issues between governmental agencies.

Economy

Finally, at least 8 projects are concerned with the economic impact and have implemented actions to address interaction with and sensibilization of the industrial world and professional stakeholders. In the vast majority, each project deals with specific issues of concern. Out of these actions, the launch by the European university SEA-EU 2.0 of an Observatory for Sustainable Blue Growth is in my opinion of particular interest since providing the basis of an ocean- responsible ecosystem bridging the education of young generations to the needs of stakeholders. Another tantalizing effort developed by IMPRECO deserves mentioning. It consists in the mapping of Socio Economic-System of the relevant stakeholders and analysis of their relationships with local ecosystems.

Geographical coverage

Most of the projects selected as highly pertinent propose actions on a cross basin perspective and deal with general approaches targeting methodology or tools for public engagement. Those dealing with technological developments target pilot sites, with the perspective of a further cross basin distribution. It is worth noting, however, an under coverage of the Danube river basin while the Mediterranean is the best represented.

Table 12.2. Main results and achievements of the narrow portfolio (projects selected for in-depth analysis). Number of projects 27

Project acronym	Description of result	Field of application	Link to the result
BlueMissionAA*	Artic/Atlantic lighthouse coordination	Coordination	https://bluemissionaa.eu/wps/
BlueMissionBANOS*	analysis of priorities for Baltic	Coordination	priorities
BlueMissionBANOS*	Baltic lighthouse coordination	Coordination	
BlueMissionMed*	med lighthouse coordination	Coordination	https://bluemissionmed.eu/
DANUBE4all	Danube lighthouse IA	Coordination	project datasheet
PREP4BLUE *	project show case	Coordination	showcase
PREP4BLUE *	mission coordination & support	Coordination	
A-AAgora	Nature based solutions at dedicated	Data & Knowledge	project
A-AAgora	living labs and citizen enpowerment	Data & Knowledge	project
AMAre	Spatial Geoportal for data on	Data & Knowledge	geoportal
AquaWind	MU test trials joining marine energy	Data & Knowledge	https://aquawind.eu/project/
AquaWind	civic empowering events	Data & Knowledge	aquawind engagement
BIOcean5D	tara Europa trec expedition	Data & Knowledge	TARATREC
CLAIM	Litter map	Data & Knowledge	litter map
CLAIM	Developed technologies	Data & Knowledge	technologies
MAELSTROM	litter related technologies - Italy,	Data & Knowledge	technologies
MAELSTROM	open science data sharing	Data & Knowledge	data management
OSES	Field intervention / showcases	Data & Knowledge	oses project
OTTERS	consolidation and collection of	Data & Knowledge	OTTERS goals
OTTERS	toolkits and digital applications	Data & Knowledge	OTTERS goals
REMEDIES	technology / detect, remove, reuse	Data & Knowledge	tech
REMEDIES	communication to society	Data & Knowledge	society
REMEDIES	Digital education space	Data & Knowledge	education
Respon-SEA-ble	Knowledge - state, pressures and	Data & Knowledge	Knowledge
Respon-SEA-ble	knowledge transfer	Data & Knowledge	Transfer
SafeWAVE	Environmental Research	Data & Knowledge	monitoring
THETIDA	cutting edge interdisciplinary	Data & Knowledge	factsheet
THETIDA	Tools and instruments for citizen	Data & Knowledge	factsheet
FLOW	empowering actions and tools	education & youth	FLOW factsheet
FLOW	co construction of needs and	education & youth	Flow fact sheet

BioBeo	trans association connection	education & youth	biobeo roll out
BioBeo	education tools ocean and water	education & youth	https://www.biobeo.eu/themes/
BioBeo	interconnection state of mind	education & youth	https://www.biobeo.eu/themes/
EU-CONEXUS Plus °	ERASMUS MUNDUS in Marine	education & youth	EMJMD
EU-CONEXUS Plus °	actions for scholars and pupils	education & youth	Actions for schools
SEA-EU 2.0 °	observatory for migrations	education & youth	data on migration
SEA-EU 2.0 °	dedicated training hubs HEI alliance	education & youth	training options
CLAIM	Engagement with society schools ,	education & youth	deliverable community
OSES	education, awareness of youth	education & youth	oses project
AETFOOG	youth engagement ambassadors	education & youth	AFRICA EU
BIOcean5D**	tara Europa trec expedition	education & youth	TARATREC2
LIFE21 FPA/BE/SAR/ sea at risk **	multi-faceted active actions	Awareness	SARactions
LIFE21 FPA/BE/SAR/ sea at risk **	sensibilization campaigns	Awareness	https://www.voiceofthefish.org/
LIFE21 FPA/BE/SAR/ sea at risk **	blue manifesto	Awareness	BLUE manifesto
LIFE21 FPA/FR/SFE/ surfrider**	video games	Awareness	video games
LIFE21 FPA/FR/SFE/ surfrider**	green marine Europe label	Awareness	Marine Europe
LIFE21 FPA/FR/SFE/ surfrider**	sensibilization campaign and	Awareness	
PlasticPiratesEU	upscaling	Awareness	rollout
PlasticPiratesEU	tool kit and guidelines	Awareness	guidelines
PlasticPiratesEU	large recruitment & active	Awareness	results/analysis
BIOcean5D	tara trec expedition	Awareness	TARA TREC
MAELSTROM	social awareness - whales in plastic ,	Awareness	awareness
BESTLIFE2030	ocean and water thematic work	Awareness	IUCN OCEAN
A-AAgora	deliberative democracy	Policy & Governance	project
AETFOOG	plan for ocean governance EU &	Policy & Governance	AFRICA EU
AMAre	best practices / management of uses	Policy & Governance	toolkit
AMAre	protocols for ecological monitoring;	Policy & Governance	deliverables
FLOW	policy making for next generation /	Policy & Governance	FLOW fact sheet
IMPRECO	Best practice action planes for	Policy & Governance	action plans
IMPRECO	Biodiversity joint protocol	Policy & Governance	biodiversity protocol
OTTERS	science policy and new standard	Policy & Governance	OTTERS goals
SafeWAVE	Public Education and Engagement	Policy & Governance	safewave-project.
THETIDA	underwater cultural heritage /	Economy	factsheet

A-AAgora	SME industry & stakeholders	Economy	project
AquaWind	business model & social acceptance	Economy	https://aquawind.eu/project/
EU-CONEXUS Plus °	foster innovation and contact with	Economy	society and Industry
IMPRECO	map of stakeholders and relevance	Economy	stakeholders
Respon-SEA-ble	marine value chains" & economy	Economy	dta on economy
SafeWAVE	Consenting and Planning Strategy	Economy	consenting-processes
SEA-EU 2.0 °	observatory for sustainable blue	Economy	data for blue economy

12.3.2. Fostering the uptake of solutions

In the various categories several actions are sufficiently advanced to allow their upscaling or dissemination. These derived mostly from projects already well in track, the most recently granted being excluded. In general terms, most if not all the mapping devices developed to monitor phenomena and the benchmarks of practice and rules deserve broader dissemination.

An example is the mapping tool for Litter developed by **CLAIM** and the marine litter tracking app developed by **MAELSTROM.** They concern as for now the Mediterranean and, for CLAIM also the Baltic basin, but could easily disseminate further. They provide not only a precious source of information for policy makers but also prompt public engagement and awareness towards the needs of a cleaner coastal ecosystem.

Plastic pollution is also the concern of **REMEDIES**, the innovation action for Mediterranean just implemented by the Mission whose ambitious workplan seems extremely promising. REMEDIES specifically focus on technology development. They will first validate innovative prototypes in the operational environment at nine demonstration sites in eight Mediterranean countries. Once validated, REMEDIES propose a dissemination plan that includes extension to 33 new sites to be implemented throughout the Mediterranean region.

Concerning the Marine protected areas, the Interreg project **AMARE** developed an extremely interesting geoportal analyzing these sites for the Mediterranean basin. The Mission objective could well benefit of a larger cross-basins feeding of the same portal. Similarly, **IMPRECO** has produced an action plan for protected areas that may, possibly with adaptation to specific environmental constraints, be extended and adopted in other sea basins.

On the topic of offshore and renewable marine energy and their effects both Aqua wind and Safe Wave have produced interesting results spanning from test trials of innovative devices joining energy production to aquaculture to a data base of consenting regulations for marine renewable energy exploitation. Again, in my opinion their broader adoption may be beneficial.

It may be of interest to endow to the blue mission coordination projects the task of mapping, assessing timeliness and implementing the suggested actions in their respective territories, with the aim of prompting a continuous process of pan basins harmonization.

Initiatives of extreme interest that would need further dissemination are those related to Education and Training in general and preschool education by innovative pedagogy in particular. Along this frame of thoughts, an extensive mapping of the existing offer in marine related training (both at secondary, professional and higher education level) could provide an initial baseline for future optimization in line with societal needs and as such pave the way for an open dialogue with professional and industrial stakeholders. Preschool education actions such that developed by **BioBeo** or the European university **EU-CONEXUS** Plus are at the time extremely scarce but are a major future need to achieve a satisfactory ocean literacy in this decade and beyond. Similarly, few actors propose research and activities developed by and for stakeholders or professional strata, another not negligible aspect of Ocean literacy.

Unfortunately, the difficulties of effective action set up and their impact assessment and the challenging road map has hampered for the time being tangible advancements in ocean literacy.

The actions of sensitization and awareness held by the NGOs like **Surfriders, IUCN, Sea at risk or Plastic pirates** are powerful and already have a pan European dimension. It is

nevertheless difficult to assess to what extent they actually shape mass opinion and public behavior, nor their ability to influence the governmental policy-making process.

Though not in the restricted panel, several projects in the portfolio propose a *bluefication* of researcher's nights, a well-known event for the dissemination of science and sensibilization of the general public. A more generalized approach stemming directly from the commission and calling for a simultaneous pan European public event for the Ocean may be of impact and beneficial for the visibility of the Mission.

12.4. Policy recommendations

In the initial portfolio at least 5 initiatives were outstanding, in my opinion, in quality and performance though not, as for now, pertinent to the Mission objectives. They nonetheless cover areas of mission's actions that would benefit from consolidation. These will be summarized hereby since it may be worth considering whether and how it would be possible to implement these innovative tools and proposed practices or their adapted variants in ocean related topics.

In addition, these initiatives deal with subjects notoriously difficult to handle and propose insights which are as yet not covered by other projects in the portfolio.

Two ERASMUS + funded projects, **YOU Play** and **RYTA** concern the engagement of youth. They propose and implement actions promoting the development of youngsters by improving their citizenship skills and fostering them to engage in democratic participation.

YOUplay (https://www.tdm2000international.org/members/) supports a network counting over 30 organizations of youth from 23 different countries. It coordinates implement and disseminates activities and projects mainly in the fields of Capacity Building, International Cooperation and Intercultural Learning. An implication of theses NGOs, already organized in network and working together, along with the Mission objectives may be an action to pursue, especially considering that the pan European coordination of actions is likely to be a challenging task for the future of the mission.

RYtTA's originality lies in the design and implementation of non-formal training and mobility activities to encourage youth engagement in rural areas in the Mediterranean basin. An easy step forward could be the broadening of their actual scope with the introduction of ocean / water related goals.

Two other projects are supported by H2020 Swafs and propose methods and practice to strengthen citizen participation and engagement in scientific actions, they are called: **EU-Citizen. Science** (https://eu-citizen.science/) and **INCENTIVE** (https://incentive-project.eu/).

They both prompt practices and tools to optimize methodology to raise citizen and stakeholder participation to research and science and have successfully produced concrete actions to bring citizens to closer contact to science. (citizen Science Hubs, digital toolkit). Building on their knowledge and example, or simply proposing to these preexisting consortia to broaden their scopes to ocean issues may be greatly beneficial to reinforce the ocean awareness in society.

Along the same line of thoughts and in the promotion of awareness it may be worth thinking about the possibility to implement a pan European network of museums, aquariums or similar public spaces devoted to the ocean and water topic. They could be given among others, the task to launch in conjunction with Universities and research agencies a yearly **European**

ocean celebration moment, a collection of simultaneous public events dedicated to the ocean under a label similar to that of the World Science celebration.

Ultimately instate a program for the designation of a **European capital of the Seas** in a process similar to that in place of the Capital of Culture may provide a groundbreaking effect. It is definitely possible that the designation, as capital of the seas, provokes a catalytic effect on ocean awareness and literacy similar to the development of culture triggered on the selected cities.

A last initiative is proposed by **C Urge** : a Doctoral Network funded by Horizon Marie Sklodowska-Curie Actions (some information can be found at https://www.dsps.unict.it/en/courses/lm-62/news/doctoral-fellows-cultural-anthropology-horizon-marie-sklodowska-curie-actions)

They propose to strengthen the contribution of social science to the understanding and engagement with the URGENCY of climate change. The training experiences that is proposed goes beyond academia and strict disciplinary visions. Their ambition is to generate new critical anthropological knowledge about global climate urgency, that is academic, practical and policy-oriented with combined insights from the fields of human and economic geography, media studies, literature studies, digital humanities, international relations, environmental sciences (human geography, hydrology), STS (science, technology & society), and political sciences. Such multifaceted model for doctoral education can easily be inspiring for an adaptation to ocean challenges. In my opinion such a program may provide a leap forward in the roadmap of achievement of ocean literacy.

As mentioned in the previous section Education is a topic scarcely covered as for now. It is certainly not easy to handle it efficiently avoiding whenever possible redundancy of efforts. It may be worth considering the feasibility to structure a **pan European map of the existing training offer** (life long and initial education) related to the Mission Ocean objectives (spanning broadly from nautical engineering to naval carpenters or maritime law).

Though tantalizing, this effort should provide in the end and extremely powerful tool for assessment of opportunities and elaboration of adjustment and evolution in agreement with the need of policy makers, stakeholders or labor market. It could be included in the road map of the 4 lighthouses to grant a harmonious set up all over the continent. Last but not least such a repository may provide an easy to consult portfolio for neighboring countries and promote capacity building initiatives in the field.

This may also represent the first step to serve the broader need of feeding the training programs (both initial and continuing education) with latest available research results to address the challenges of the blue economy and maritime sector and eventually set the framework for an integrated European approach for Ocean- skills.

Aside the proposed specific suggestions and from a broader standpoint, the major challenge of the mission is to fully exploit the potential of joint programming and boost synergies to effectively tackle the ocean related societal challenge. The underlying difficulties concern the need of strong political commitment and smooth alignment (strategic, operational and financial) between EU and member states to build coherent and synergistic plans for implementation, follow up and sharing of results. Indeed, while many European countries develop strategies for the ocean, the panoply of concurrent projects may hamper visibility and possibly delays achievement of goals from duplicated and overlapping efforts.

As far at this analysis goes, synergies are definitely detectable both on the pursued scientific advancements (e.g. treatment of litter, marine protected areas, renewable energies) which engage with public opinion at several levels and methodologies or proposed practices. However, it is not explicit how these can be further optimized and boosted.

While the appointment of the mission clearly responds to the perceived need of an increased transversality for efficient tackling, a further empowerment of its action may be needed. This could be achieved by a high-level joint programming mobilizing both the EC, member states and regional authorities to design aligned roadmaps. At the sole level of EC, the setup of a cross-programmes funding action would certainly be beneficial. Indeed, while projects relevant to the mission are found in a large spectrum of FPs, they are still scarce outside H2020 or Horizon and seem to arise spontaneously, independently from a mission inspired action.

A trans program fund dedicated to the mission objectives could create the opportunity to support and encourage the development of open and European-wide collaborations, pooling expertise and capable of developing integrated approaches in several fields, in particular research and innovation, higher education, initial and lifelong learning, infrastructure, cutting-edge technologies, sharing and use of marine data.

12.5. List of projects

Project id	Project Acronym	EU Programme (FP)	Type of Action (ToA)
21368	4helix+	Interreg	ERDF;IPA/IPAII
101093956	**A-AAgora**	**HORIZON**	**HORIZON-IA**
21384	ACT4LITTER	Interreg	ERDF
101084931	**AETFOOG**	**EMFAF**	**EMFAF-PJG**
21352	**AMAre**	**Interreg**	**ERDF**
27350	AMAre PLUS	Interreg	ERDF
101077600	**AquaWind**	**EMFAF**	**EMFAF-PJG**
101087146	BCThubs	HORIZON	HORIZON-CSA
101096887	**BESTLIFE2030**	**LIFE2027**	**LIFE-PJG**
101059900	**BioBeo**	**HORIZON**	**HORIZON-CSA**
101059915	**BIOcean5D**	**HORIZON**	**HORIZON-RIA**
101052342	Biodiversa-plus	HORIZON	HORIZON-COFUND
101075514	BioGeoMicrobes	HORIZON	HORIZON-ERC
21190	BLUE LAND	Interreg	IPA/IPAII
101061595	Blue-connect	HORIZON	HORIZON-CSA
101093962	**BlueMissionAA**	**HORIZON**	**HORIZON-CSA**
101093845	**BlueMissionBANOS**	**HORIZON**	**HORIZON-CSA**

101094073	**BlueMissionMed**	**HORIZON**	**HORIZON-CSA**
101061605	BlueNIGHTs	HORIZON	HORIZON-CSA
871260	BugWright2	H2020	IA
804150	CALENDARS	H2020	ERC
774586	**CLAIM**	**H2020**	**IA**
101094021	CLIMAS	HORIZON	HORIZON-RIA
857586	CMMI – MaRITeC-X	H2020	CSA
101093985	**DANUBE4all**	**HORIZON**	**HORIZON-IA**
871043	DiSSCo Prepare	H2020	CSA
101059957	EmpowerUs	HORIZON	HORIZON-RIA
101081645	ENRICH-TOGETHER	HORIZON	HORIZON-TMA-MSCA-Cofund-P
101089709	**EU-CONEXUS Plus**	**ERASMUS2027**	**ERASMUS-LS**
872841	FEDORA	H2020	RIA
101061464	FF2022_23	HORIZON	HORIZON-CSA
101087224	FLORES	ERASMUS2027	ERASMUS-LS
101093928	**FLOW**	**HORIZON**	**HORIZON-RIA**
101036041	G9NIGHT	H2020	CSA
773330	GAIN	H2020	RIA
820283	GRRIP	H2020	CSA
101060693	GUARDEN	HORIZON	HORIZON-RIA
101037643	ILIAD	H2020	IA
19170	**IMPRECO**	**Interreg**	**ERDF;IPA/IPAII**
101083936	JustWind4All	HORIZON	HORIZON-RIA
101094825	LEVERS	HORIZON	HORIZON-CSA
101058121	**LIFE21 FPA/BE/SAR**	**LIFE2027**	**LIFE-FPA-OG**
101058920	LIFE21 FPA/BE/WWF EPO	LIFE2027	LIFE-FPA-OG
101058918	LIFE21 FPA/DE/RGI	LIFE2027	LIFE-FPA-OG
101058653	LIFE21 FPA/ES/Oceana in Europe	LIFE2027	LIFE-FPA-OG
101056522	LIFE21 FPA/FR/MedPAN	LIFE2027	LIFE-FPA-OG
101058916	**LIFE21 FPA/FR/SFE**	**LIFE2027**	**LIFE-FPA-OG**
101057743	LIFE21 FPA/SE/CCB	LIFE2027	LIFE-FPA-OG
101059082	LIFE21 NGO/DE/EUROPARC	LIFE2027	LIFE-FPA-OG

101059073	LIFE21 NGO/DE/RGI	LIFE2027	LIFE-FPA-OG
101058944	LIFE21 NGO/FR/SFE	LIFE2027	LIFE-FPA-OG
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101074227	LIFE21-GIC-ES-LIFE AdaptCalaMillor	LIFE2027	LIFE-PJG
101074584	LIFE21-NAT-IT-LIFE TURTLENEST	LIFE2027	LIFE-PJG
101103515	LIFE22 NGO-NL-SBE	LIFE2027	LIFE-FPA-OG
101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
101112150	LIFE22-NGO-DE-RGI	LIFE2027	LIFE-FPA-OG
101111878	LIFE22-NGO-FR-SFE	LIFE2027	LIFE-FPA-OG
LIFE18 IPE/EE/000007	LIFE-IP ForEst&FarmLand	LIFE	LIFE-ENV
101036458	LOCALISED	H2020	RIA
101000832	**MAELSTROM**	**H2020**	**IA**
101059407	MarinePlan	HORIZON	HORIZON-RIA
101061190	MEDNIGHT	HORIZON	HORIZON-CSA
101008724	MINKE	H2020	RIA
101100577	MRF2WIO	EMFAF	EMFAF-PJG
862252	MUSICA	H2020	IA
101060464	NATURANCE	HORIZON	HORIZON-CSA
101084348	NATURSEA-PV	HORIZON	HORIZON-RIA
101060525	NBS EduWORLD	HORIZON	HORIZON-CSA
101081865	NINFA	HORIZON	HORIZON-RIA
101061189	NitRecerCat	HORIZON	HORIZON-CSA
101081642	OBAMA-NEXT	HORIZON	HORIZON-RIA
21126	OPIN	Interreg	ERDF
101090795	**OSES**	**ERASMUS2027**	**ERASMUS-LS**
101094041	**OTTERS**	**HORIZON**	**HORIZON-CSA**
770504	PERICLES	H2020	RIA
101088822	**PlasticPiratesEU**	**HORIZON**	**HORIZON-CSA**
101056957	**PREP4BLUE**	**HORIZON**	**HORIZON-CSA**
101037342	PSLifestyle	H2020	IA
101093873	R4C	HORIZON	HORIZON-IA
101037071	REAL_DEAL	H2020	RIA
101093964	**REMEDIES**	**HORIZON**	**HORIZON-IA**

652643	**Respon-SEA-ble**	**H2020**	**CSA**
101037097	REST-COAST	H2020	IA
101000175	**SafeWAVE**	**EMFF**	**EMFF-AG**
101061603	SCIENCE4FUTURE	HORIZON	HORIZON-CSA
101082311	SDGs-EYES	HORIZON	HORIZON-RIA
101089757	**SEA-EU 2.0**	**ERASMUS2027**	**ERASMUS-LS**
101034309	SEAS	H2020	MSCA
101061553	SHARPER	HORIZON	HORIZON-CSA
817806	SUMMER	H2020	RIA
101095253	**THETIDA**	**HORIZON**	**HORIZON-RIA**
101084110	TRANSCEND	HORIZON	HORIZON-IA
101076447	TwInSolar	HORIZON	HORIZON-CSA
881619	UfMEASME	EMFF	EMFF-AG
101086340	UWIN-LABUST	HORIZON	HORIZON-CSA

13.Raising awareness. *By Philippe Vallette*

13.1.Main findings of the analysis

This study provides an assessment of a portfolio of 77 EU projects - which have been financed by a number of EU programmes – that contribute to the objectives of the Mission "Restore our Ocean and Waters by 2030" (from now on Mission Ocean) in particular through the specific angle of its enabler "Awareness raising". Awareness raising is crucial for the success of projects and for the democratic participation of all stakeholders. The list of projects is included in section 13.5.

Description of the portfolio:

This portfolio projects addresses awareness raising approaches tacking all kind of stakeholders, from policy and decision makers to the citizens. Their total EU contribution is 272,5 M euros.

From the overall sample of 77 projects, 25 projects of them have been selected for a more in-depth analysis. Under the specific angle of "awareness raising" they contribute to deliver on the Green Deal objectives to which the Mission Ocean is aligned, i.e. protecting marine and freshwater ecosystems and biodiversity, eliminating pollution and fostering the green transition.

The projects dedicate important financial resources to the development and implementation of digital tools such as digital platforms and innovative communication tools. Research and Innovation Framework Programmes, count for the large share of the EU contribution, specifically though the following types of action: HORIZON CSA (21 projects for 53,5 M Euros), IA (3 projects for 51 M euros) and HORIZON RIA (9 projects for 48 M euros). In term of average funding, IA projects receive the largest funds (17 M euros in average). Programmes LIFE and ERASMUS have also financed substantial amount of projects e.g. LIFE FPA OG (16 projects for 3,8 M euros).

The projects have been categorized across the following thematic areas which have been quite equally covered: General public awareness raising; Decision makers awareness raising; Industries, NGO's awareness raising; Education citizen science; Accessibility; Appropriation process. It is important to notice that all components of the society have been considered to be reached through various tools that have been developed.

Driving the restoration of the ocean requires to pull a number of key policy levers (governance, R&I, education and training, etc). The projects tackle all these levers and they built on a solid basis of science. They are also built on the important involvement of stake holders, including citizens, for whom awareness raising is crucial. The analysis shows that the projects are quite well equally distributed across Europe.

Main outcomes.

Many various results are implemented or planned in the on-going projects across the defined thematic areas. Below there are a number of examples:

- General public awareness raising through a rich panoply of innovative and effective tools (BBC or A-Aagora)

- Decision-makers awareness raising, with a focus on defining policies and governance (for instance REST-COAST)

- Industries, NGOs, awareness raising, with demonstration sites, leading people to take part of the change (REMEDIES is a good example)

- Education, citizen science, with in depth education leading school children or students to learn more on marine science (BioBeo)

- Appropriation process, leading the citizen to participate and organize themselves in acting communities, (PREP4BLUE)

- Accessibility, with the implementation of the 4 lighthouses (one per basin), but also Living Labs, digital tools

All these projects participate to the 3 objectives of the Mission Ocean, namely: (1) Protect and restore marine and freshwater ecosystems and biodiversity, (2) Prevent and eliminate pollution of our oceans, seas, and rivers and (3) Make the Blue Economy carbon-neutral and circular

Fostering the uptake of solutions requires a concerted effort that involves the following considerations:

- European youth should be central because it constitutes the key of our future: the young citizens will lead the Europe of tomorrow. That's the reason why they must be encouraged to commit themselves in co-creation for future policies, including them in governing bodies, marrying restoration and blue economy, in the context of climate change.

- Education and training efforts are in place and should be further generalized.

- Appropriation process: citizens need to feel that they are concerned in their daily life and that they are part of the solution. They must be encouraged to participate. Even if the basis of knowledge must be science, emotion must not be absent to move the public.

- Lasting effect of the projects: In addition to deliver short term solutions, the projects should also consider long term strategies to extend their impact beyond the end of the EU contribution.

- European excellence in marine science: Europeans have sometimes the tendency to consider they lay behind in science as compared to other countries, particularly USA. Partnership between European countries have never been so strong and the European voice is now well received, as we have seen recently with the BBNJ negotiations. This is thanks to the construction step by step of an excellency in marine science and the strength of its industry.

Policy recommendations

- There is potential for the projects go beyond science and tackle sensitive fields that can move citizens: Art, literature, cultural heritage. However, these fields appeared to be less represented in while can be a good channel to encounter the citizens in their daily life. In addition, it is considered that gamification of ocean issues, using social networks, would be a very effective tool for public awareness but it has not been in focus in any of the

projects analysed. Regarding youth, projects should expand from education towards fostering the committing of young people to for instance participating to Ocean parliaments, world ocean day, or forums implementation.

- Calls should be defined including always public awareness raising as a central element. This is to ensure people feels that they are concerned in their daily life.

- Creating specific project on tourism, tourists can be good targets to aware while they are on vacations

- Enhance the use of the existing powerful network of European aquariums. These European facilities welcome 70 million visitors every year and therefore can bring a great added value in reaching a very large number of people. An important and valuable synergy could be done with the European aquarium organization (EUAC).

- Implementing fora of discussion: Including in the calls fora of discussion to be able to benefit from the citizens feed-back (e.g. Blue Society Forum in Nausicaa)

- Facilitating access to the EU calls: More communication about the calls and simplification of the administration linked to the projects. Many organizations hesitate to answer to calls, because of the administrative complexity.

- The needs of human being should be more taken in consideration in addition to nature protection and restauration. It's not in contradiction with conservation.

- Extend the beneficial effect of the projects beyond the end of the EU contributions. In the future calls request proposals to develop an strategy for the follow-up after the end of the project.

- Put in place mechanisms to align the contributions of all these projects (each with its own interest) towards the objectives of the Mission Ocean. Promote strong partnering of projects to form a mosaic of diverse pieces forming a coherent network.

13.2. Description of the portfolio

Projects relevant to the Mission's objectives and Green Deal targets (Number of projects/Budget)

This assessment focuses on the 77 projects that have been assessed as relevant for to enabler 2b. Raising awareness.

As showed in Figures 13.1 and 13.2, projects dedicate important financial resources to the development and implementation of digital tools such as digital platforms and innovative communication tools. Research and Innovation Framework Programmes, count for the large share of the EU contribution: HORIZON CSA (21 projects for 53,5 M Euros) and IA (3 projects for 51 M euros) and HORIZON RIA (9 projects for 48 M euros). In term of average funding, IA projects receive the largest funds (17 M euros in average). Programmes LIFE and ERASMUS have financed substantial amount of projects e.g. LIFE FPA OG (16 projects for 3,8 M euros).

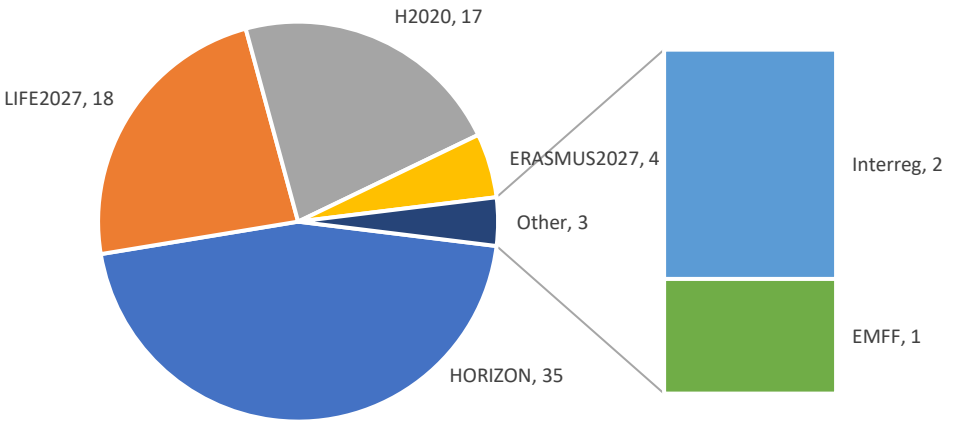


Figure 13.1. number of projects per EU funding programme. total number of projects: 77

In addition to the previously mentioned programmes, the portfolio includes 2 projects Interreg (3%), 1 project EMFF (1%).

This distribution demonstrates Europe's strong will to put itself at the forefront of innovation and research in order to ensure a sustainable development.

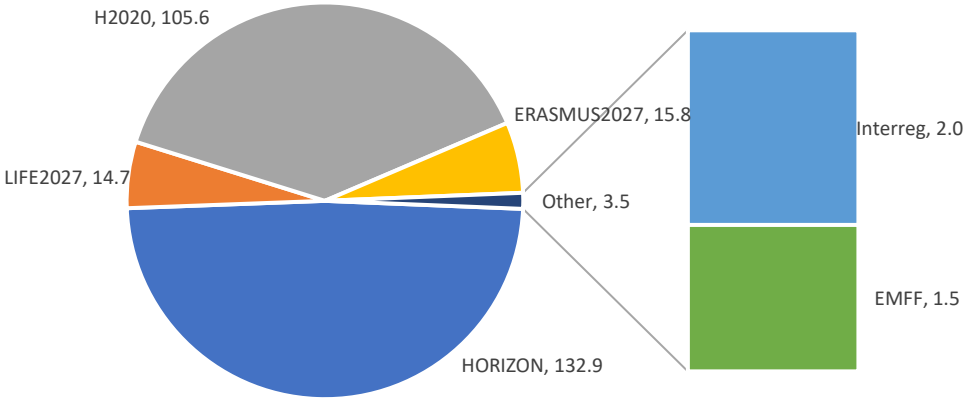


FIGURE 13.2. EU contribution (M Euros) per funding programme. Total contribution 272,5 MEuros

H2020 projects are generally the largest in term of average funding (average of each project 6,2 M euros) then ERASMUS (average 3,9) or HORIZON (average by project 3,8 M euros), then EMFF (1,5 M euros), Interreg (average 1 M euros) or LIFE (average 0,8 M euros)

Distribution of projects according to programmes, actions, type of participants

Figures 13.3 and 13.4 show the distribute of projects by type of action.

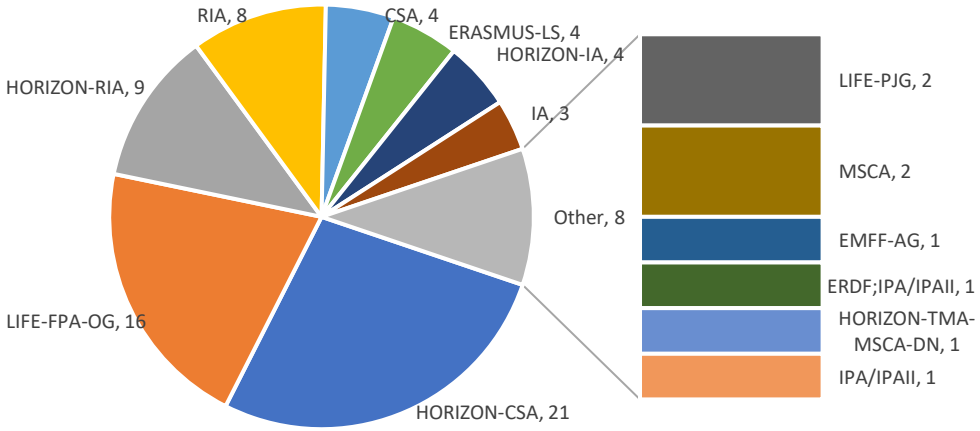


Figure 13.3. Number of projects per type of actions. Total number of projects 77

The majority of the projects are in the form of HORIZON-CSA (21 projects, 27%), LIFE-FPA-OG (16 projects, 21%), HORIZON-RIA (9 projects, 12%), RIA (8 projects, 10%). And then: CSA (4 projects, 5%), ERASMUS-LS (4 projects, 5%), HORIZON-IA (4 projects, 5%), IA (3 projects, 4%), LIFE-PJG (2 projects, 3%), MSCA (2 projects 3%), and then EMFF-AG, ERDF-IPA, HORIZON-TMA-MSCA-DN, IPA/IPAII (1 project each, 1%)

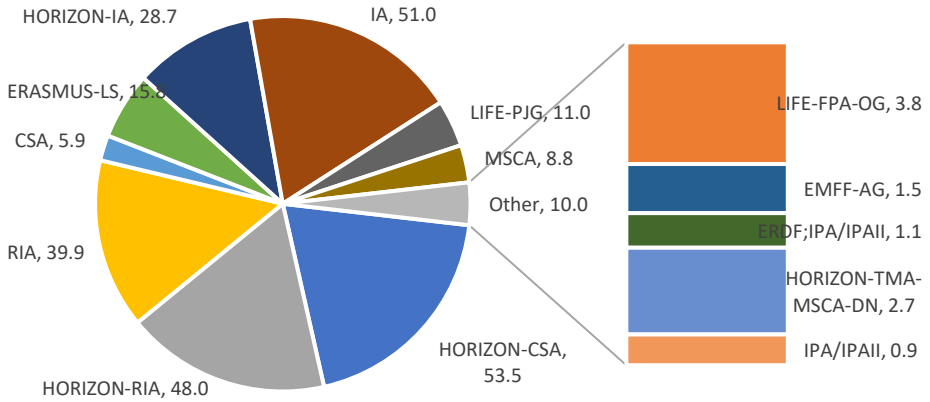


Figure 13.4. EU contribution (MEuros) per type of action. Total EU contribution: 272,5 MEuros

As mentioned above, the largest share of the projects are coordination and support actions which use new platforms of communication such as interactive websites, or social networks: 21 projects (HORIZON-CSA) for 53,5 M euros, 20% of EU contribution (average 2,5 M euros). The projects with largest EU contribution in average are IA: 3 IA projects represent a contribution of 51 M euros, 19% (average 17 M euros). 16 LIFE FPA OG projects represent 3,8 M euros, 1% (average 0,2 M euros), 9 projects HORIZON RIA represent 48 M euros, 18% (average 5,3 M euros), 4 CSA projects represent 5,9 M euros, 2% (average 1,5 M euros), 4 ERASMUS-LS projects represent 15,8 M euros, 6% (average 3,9 M euros), 4 HORIZON-IA projects represent 28,7 M euros, 11% (average 7,2 M euros), 2 LIFE-PJG

projects represent 11 M euros, 11% (average 5,5 M euros), 2 MSCA projects represent 8,8 M euros, 3% (average 4,4 M euros), 1 EMFF-AG represent 1,5 M euros, 1 ERDF; IPA/IPAII represents 1,1 M euros, 1 HORIZON-TMA-MSCA-DN represents 2,7 M euros, 1 IPA/IPAII represents 0,9 M euros. All about 1%.

Distribution of projects according to main thematic areas.

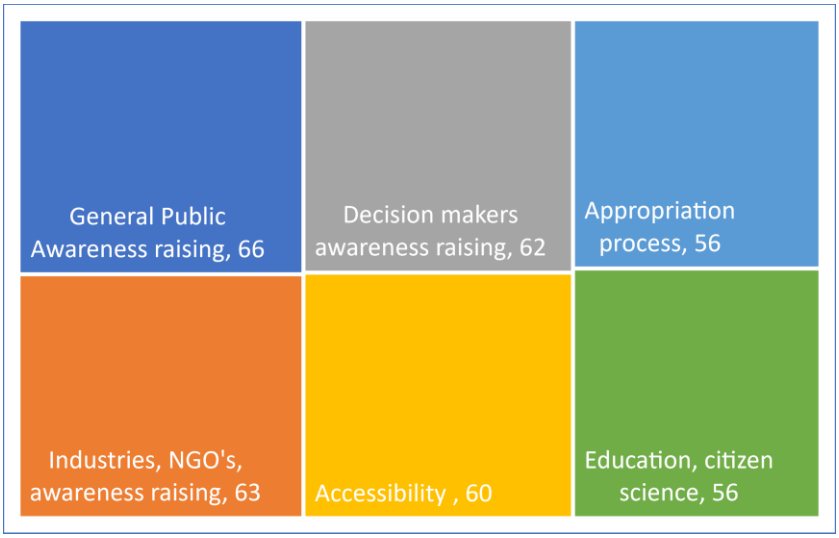


Figure 13.5. Thematic areas and number of projects addressing them exclusively or as part of their scope. Some projects address more than one thematic area. Total count of thematic areas addressed: 363. Total number of projects: 77.

The projects have been categorized across the thematic areas. Projects contribute to one or, often, several of them. As it can be seen in Figure 13.5, thematic areas are quite equally covered by the projects. This means that the different layers of the European society have been considered. Each thematic area allows to pull different levers to drive the change which is looked for. Here are the main proposed thematic areas depending of the communication targets:

General Public awareness raising: this target is the widest, it represents the EU citizens, essential to set in motion to achieve the goals of the Mission. The public understand, act, push decision makers and policymakers. 18,2% of the overall projects. This is the most classical way to inform the citizens. The following tools have been used in the projects:

- Documentations tools
- Awareness raising meetings or actions
- Internet tools
- Species conservation to which the citizens are particularly sensitive.
- Highlight Cultural heritage
- Involving general public

- Involving youth
- Linking sport and ocean

Decision makers awareness raising: This target audience can be reach by the citizens and NGO's. Many projects develop tools to make aware, inform, and push the decision makers to take concrete decision and translate it into policy. 17% of the overall projects. Awareness raising is not only for the public. This kind of awareness is specialised to raise interest to decision and policy makers. It helps develop transformative change in policies and governance. The tools are:

- Advocacy to lead the decision and policy makers to take actions
- Upscaling Protected Areas management
- Several restoration plans, emblematic awareness raising for the decision makers
- Decision making tools to allow the decision makers to aware their audience
- Creation of Living Labs

Industries, NGO's, awareness raising: This is a specific kind of awareness raising to boost the private sector and the NGO's to concretely act, giving them the tools to do so. 17,3% of the overall projects. Regarding the different projects, It can help implementing demonstration sites, Living Labs, or leading local people to become entrepreneurs or change industrial behaviour. This is made with specialised awareness raising tools.

Education, citizen science: Educational awareness raising can be made in the schools, gymnasium or universities. Scientifically based, it gives the scientific keys to the teachers or students to understand the world in which they live. 15,4% of the overall projects. Education can be organized in the context of schools or universities

- Ocean programme in school curriculums
- Implement Excellent Science

About citizen science: Citizen science is becoming an important path to involve the citizen in science. It has to stay simple to implement, but has to be done with a serious scientific framework, in order the results can be indisputable. There are several projects organizing "nights of the researchers" for the general public. We can witness that it's always successful because they are a real encounter between science and public.

Appropriation process: Ocean literacy is often not enough because it is going from the top to the bottom. The appropriation process comes from the bottom, from the citizen, who can feel being part of the solution. We have often found that the public can help finding solutions.15,4% of the overall projects. This is typically the way to involve and to improve (preferably on a long-term basis) public engagement

- Citizen science leading people to become real producers of data

- Setting communities of practice
- Giving long term behaviour for citizens to become actors for marine conservation and work together
- Linking Research and society
- Committing people to conservation processes
- Internet tools
- Linking Science/Industry and citizens: Creating new startups (for instance to re-use plastics)
- Leading citizens to build together a Blue Society

Accessibility : When you don't know that the information is existing you have no reason to look for it, or you don't know how to find it. The information, the knowledge must be accessible in order not to have a two speed society. 16,5% of the overall projects. The projects which develop Living Labs or the 4 Lighthouses allows to combine science, education, economy, decision making. As they are by themselves an attraction for those who are concerned, people know that they are existing. Thus, they are accessible. It is often difficult for projects to be known beyond the partners of the projects themselves. A website is not enough because you have to guess that you can ask to Google (for instance). That the reason why "accessibility" is an important task in raising awareness.

Main focus of the project in terms of Levers of Change

The levers of change (LoC) relate to the main type of tool used or activity undertaken by the projects to drive (or leverage) change towards their goal. They can span from defining and setting up governance structures, new financing and business models, undertaking research and innovation to develop and demonstrate solutions, generate new knowledge and date, deploying solutions as well as citizens engagement and education and training. Table 13.1 shows that the portfolio of projects comprises a rather balanced coverage of levers of change to guarantee an evolution of our European society toward a better sustainable use of the ocean and freshwaters. The majority of the projects are addressing more than one LoC.

Table 13.1. Lever of Change (LoC) vs. thematic areas (T.A.). For LoC it is understood the type of tool targeted by the project to drive (or leverage) change in the desired direction.

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engament	Education& Training
General Public Awareness raising	56	41	33	62	61	63	52
Appropriation process	46	32	26	52	53	55	49

LoC/T.A.	Governance	Finance& Economy	R&I	Knowledge & Data	Deployment	Citizen Engament	Education& Training
Education, citizen science	44	29	31	52	51	52	53
Industries, NGO's, awareness raising	56	45	34	60	59	54	44
Decision makers awareness raising	58	45	33	59	61	53	43
Accessibility	49	36	31	58	57	54	46
Total	309	228	188	343	342	331	287

We can see that knowledge and data, Deployment and Citizen engagement are well addressed by the various thematic areas. Going towards Education is more undertaken by Public awareness raising projects and Education and citizen science projects. As regards governance, it obtains quite a high score, which means that the implementation through governing bodies is well taken into consideration.

13.3. Main outcomes and fostering the uptake of solutions

13.3.1. Main outcomes

Awareness raising is paramount to ensure the success of any project and overall to the achievement of the Mission Ocean objectives. Time is short to 2030, meaning that raising the awaremess and empowering the civil society and decision makers is urgent. This portfolio of projects shows an important diversity of awareness raising tools and methodologies. There is a need, though, to ensure a long term effect of the projects beyond the end of the contacts.

The condition sinequanone for raising awarenes is to make the people to feel they are concerned. To be able to reach its target the Ocean Mission must reach the majority of citizens, and so, awareness raising must be rationally built in accordance with the various targets of the civil society, including decision makers.

25 projects have been selected for an in-depth analysis of their tangible results. These projects are highlighted in blue and bold in section 13.5. Their distribution according to programmes is as follows: LIFE: 3 projects; HORIZON: 15 projects, H2020: 4 projects; Erasmus 2027: 1 project; Interreg: 2 projects.

Table 13.2 shows the geographical areas (sea and river basin) covered in the projects as well as the country where institution coordinating the project is based.

Table13.2. Geographical distribution of the projects analysed in depth.

Acronym	Basin Med	Basin Atl/Arc	Basin Bal/Nor	Basin Danube	Cross Basin	Basin Other	Coordinator Country
CCB		X					Sweden
SFE	X	X	X	X	X	X	France
A-Aagora	X	X	X	X	X		Portugal
REMEDIES	X						Slovenia
OTTERS	X	X	X	X	X		Armenia
OSES	X	X	X	X	X		France
Respon-SEA-ble	X	X	X	X	X	X	France
BlueMissionBANOS	X						Germany
DANUBE4all				X			Austria
REST-COAST	X	X	X	X	X	X	Spain
BlueMissionAA		X					Portugal
EmpowerUs	X	X	X	X	X		Norway
BlueMissionMed	X						Italy
FLOW	X	X	X	X	X	X	Netherlands
PREP4BLUE	X	X	X	X	X	X	France
SDGs-EYES	X	X	X	X	X		Italy
PlasticPiratesEU	X	X	X	X	X	X	Germany
BioBeo		X					Ireland
BlueNIGHTs	X	X	X		X		Italy
PERICLES	X	X	X		X		Denmark
Blue-connect	X						Croatia
SEAS			X				Norway
EUROPARC	X	X	X	X	X		Germany
BLUE LAND	X				X		Albania
IMPRECO	X						Italy

For these 25 relevant projects, we can see with Table 13.2 that all the basins are more or less equally served. In addition, if we consider the origin of the project coordinators in number of projects: (France: 4, Italy and Germany: 3; Norway and Portugal: 2; Sweden, Slovenia, Armenia, Austria, Spain, Norway, Netherlands, Ireland, Denmark, Croatia, Albania: 1)

Here are the results according to thematic areas:

General Public awareness raising:

- **PlasticPiratesEU** collects data on plastic, thanks to citizen science

- **LIFE21 FPA/FR/FSE** it his is the most classical way to inform the citizens. The tools are Documentation (flyers, files, etc.); Internet website ; Meeting of information, lectures; Campaigns for ocean literacy; All these tools are used by most of the projects.

- **EmpowerUs** implements restoration through labs and co creation with the public

- **Blue-Connect** leads the citizens to build a real Blue Society

Decision makers awareness raising

- **CCB**, developed for Baltic, is a very complete project whose methodology could be taken as an example, because it can be used as a model of citizens and stakeholders awareness raising, leading to ocean restoration.

- A project like **DANUBE4all** works on convincing policy and decision makers to restore continuity for the Danube river.

- **REST COAST** Multisite restoration plan helps developing transformative changes in policies and governance, thanks to policy makers awareness raising and public engagement.

- **EUROPARC** builds a network of Protected Areas managers with Protected Areas authorities It upscales the quality and efficiency of the management of the Protected Areas thanks to Stakeholder awareness raising.

- **SDGs-EYES** aims to build scientific based tools to help decisions for stakeholders thanks to stakeholders awareness raising

- **BLUE LAND** develops cross boarder governance strategy for protection. A real example which could be expanded to all the European straits. Stakeholders and public awareness raising.

- **PREP4BLUE** co-creation with stakeholders and citizens, of innovative restoration tools

Industries, NGO's, awareness raising

- **REMEDIES** implements demonstration sites for collected plastic becoming a new resource for new products, thanks to local people becoming new entrepreneurs.

- **A-AAgora**, highlights concrete projects on architecture and sea level rise. This project deserves to be expanded to the whole Europe. Setting Living Labs Awareness raising is an important guaranty of the success.

Education, citizen science: Citizen science becomes an important pathway to involve citizen in science. It has to be done with a serious scientific framework, and has to stay simple to implement, in order the results can be indisputable.

- For instance, the project **OTTERS** values the data collected by citizen science to integrate the results within **EMODnet**.

- **OSES** project brings environmental education to sport organizations, to reach young people in their daily life. It allows science to meet with sport thanks to awareness raising through sport organizations.

- **BlueNIGHTS**, aware citizen and stakeholders that science is built on facts, and that R&I are fundamental disciplines. It's one of the several projects aiming to link citizens and especially young citizens with science for a better science based comprehension of the world around them, and encouraging also to embrace scientific careers.

- **PlasticPiratesEU** is another good example for plastics.

- **BioBeo** develops the encounters between pupils, students and environmental science. It should convince young people to embrace scientific carriers, and gives a chance for youth to invent the bioeconomy of tomorrow in the context of climate change

- Blue-connect invites researchers to teach in schools.

- SEAS invites young researchers in a fellowship programme to reach excellence in science.

- **IMPRECO** enhance the safeguarding of transnational ecosystems thanks to awareness raising and common transnational educational Programme

Appropriation process. This is typically the way to involve and to improve (preferably on a long-term basis) public engagement.

- **LIFE21 FPA/SE/CCB** is doing: Setting communities of practice, Committing people to conservation processes, Internet tools

- **FLOW** empowers youth to manage the ocean issues.

Accessibility. The projects which develop Living Labs (**A-Aagora, EmpowerUs,** and possibly the **4 Lighthouses**) allow to combine science, education, economy, decision making. As they are by themselves an attraction for those who are concerned and that they often launch calls for tender, people know that they are existing. Thus, they are accessible through other means apart from just a website. The latter is not enough because it requires a preliminary knowledge by the user.

Table 13.3. presents an outline of the main results delivered by the selected 25 projects.

Table 13.3. List of main tangible results and achievements of the projects selected for in-depth analysis.

Project acronym	Description of result	Application	Link to the result
LIFE21 FPA/SE/CCB	Setting a community of practice, developing a digital system. Conservation actions to restore populations of porpoise, eel, wild salmon. Long term coalition of partners	Specific project of conservation with citizen participation	https://www.ccb.se
LIFE21 FPA/FR/SFE	Meetings. Internet tools. Citizen science on marine litter	Integrated project with citizen science	https://www.surfrider.eu/
A-Aagora	Setting a community of practice, developing a digital knowledge system; Improve public engagement; Living Lab; Innovative architecture to adapt to sea level rise	Bringing together a community around sea level rise issue	Not yet available
REMEDIES	8 demonstration sites for reusing collected plastic; Lead local people to become entrepreneurs; Set up prevention pathways; Involve public	Concrete project: from collecting plastic to startups creation to transform it	Not yet available
OTTERS	Citizen science, Marine and Freshwater; Campaigns for Ocean literacy; Standards in data; Citizens generate data to EMODnet	Considering citizen science as a real producer of data	Not yet available
OSES	Awareness campaigns and educational tools for sport organizations	A true link between sport and environment	https://www.sportetcitoyennete.com/

Project acronym	Description of result	Application	Link to the result
Respon-SEA-ble	Communication tools; Target groups for mutual learning	Highlighting the role of civil society	Not available
BlueMissionBANOS	Lighthouse project Baltic and North Sea Basin	Multipurpose facility	Not yet available
DANUBE4all	Lighthouse for Danube Basin; Action plan to restore the status and continuity of the Danube river	Multipurpose facility	Not yet available
REST-COAST	Nine pilots; Coastal restoration plan; Develop transformative changes in policies and governance	Replicable project by lighthouses	Not yet available
BlueMissionAA	Lighthouse for Arctic and Atlantic Basin; Mobilizing a wide community of stakeholders and citizens; 6 case studies to represent restoration approaches	Multipurpose facility	Not yet available
EmpowerUs	6 transition coastal labs, including all stakeholders	Working together to restore our sea	Not yet available
BlueMissionMed	Lighthouse for Mediterranean Basin	Multipurpose facility	Not yet available

Project acronym	Description of result	Application	Link to the result
FLOW	Meetings committing young citizens to create future policies	Committing youth	Not yet available
PREP4BLUE	Tools and guidelines; Co-creation of actions about R&I, to commit all the stakeholders and citizens; Pilots	Linking R&I and citizens	Not yet available
SDGs-EYES	Portfolio of a decision making tools to monitor SDGs indicators; 4 pilots with 6 indicators will demonstrate the Copernicus potential	Translation of complex science in easy to understand knowledge	Not yet available
PlasticPiratesEU	Verified data on plastic waste; Raise awareness on best practice mode; especially with youth	Data on plastic for stakeholders and public	Not yet available
BioBeo	Educational programme for pre-school, primary and secondary school levels; Innovative approach in pilot programmes in 35 schools1000 university students, 1800 parents, 100 teachers	Bio-economy in an ambitious educational program	Not yet available
BlueNIGHTs	Connected Blue researcher nights; Interactive and pratical experience; Interactive virtual experience (VR)	Linking research and society	Not yet available
PERICLES	European consortium on maritime culture and history; Practical tools	Maritime historical culture for all	http://www.pericles-heritage.eu/

Project acronym	Description of result	Application	Link to the result
Blue-connect	Awareness actions for general public and stakeholders; Researchers teaching in schools	Implementing a Blue Society	Not available
SEAS	37 researchers in a postdoctoral fellowship programme	Reaching excellent science	Not yet available
LIFE21 NGO/DE/EUROPARC	Building a network of PA managers and PA management authorities	Upscaling PA management	https://www.europarc.org/
BLUE LAND	Building a partnership between stakeholders and citizens from 3 countries concerned by the strait of Otranto, Common plan to restore and preserve biodiversity	Co-managing the South of Adriatica	https://www.italy-albania-montenegro.eu/
IMPRECO	Common programme for educational activities, Transnational monitoring protocol	Global educational programme	http://www.adrioninterreg.eu/

13.3.2. Fostering the uptake of solutions

The real diversity of the selected projects allows to cover awareness raising of many kinds of stakeholders and citizens which are necessary for the success of the Ocean Mission. Fostering the uptake of solutions requires a concerted effort that involves the following considerations:

Youth involvement is of critical importance. Few examples of project are particularly relevant about the role that young citizens can play. Among them we can highlight **FLOW**. Committing young EU citizens in co-creating future policies related to nature-connectedness, preservation and conservation on resource used sustainably and economic prosperity. **FLOW** creates youth advisory board, European network of youth-focused NGOs, experiential futures workshops. This is an excellent example of what projects should do in committing young citizens. This could be expanded in many regions, creating youth assemblies regarding ocean issues, in order to have a real input of youth about solutions and new policies.

Another project particularly relevant is **EU4OCEAN Coalition**, which is composed by EU4Ocean platform, Youth4Ocean Forum and Network of European Blue Schools. It should be interesting to call for such a coalition about sustainable Blue Economy (Blue Society), in the context of climate change, with youth, in co-creation.

Linking sustainability, climate change and economy for youth, **BioBeo** introduces Europe's youth to the benefits and importance of implementing a bio-economy which will reduce the risks posed by climate change **BioBeo** creates an engaging and educational programme encouraging participation and actions. Considering pre-school, primary, and secondary level, this program is a powerful pilot reaching 35 schools, 1000 university students, 1800 parents and 100 teachers in an innovative approach.

About appropriation processes and co-creation: Citizens need to feel that they can be part of the solution. One efficient way to do so is to offer them the possibility to co-create the solution. It is the best way for the leaders of the project to obtain a result which is well adapted to the final users: the citizens.

In that sense we could highlight projects not directly linked with ocean, like **ECF4CLIM** which empowers civil society to act. This project implements an innovative hybrid approach based on participatory action research and citizen science. Encouraging learning-by-doing, several innovative tools are implemented for the citizens. The results really come from a co-design with the citizens. It shows an interesting way to empower civil society that can be replicated to achieve the objectives of the Ocean Mission

Lasting effect of the projects: One of the main benefits of the projects is to create common working habits for all European partners. This is positive and helps for mutual understanding from a culture to another. Another consideration is that many projects need immediate solutions which can be brought by short term projects. Nevertheless, to ensure a lasting effect, the commitment of project participants (and other actors) towards reaching the objectives of the Mission should be maintained beyond the lifetime of the projects. This is particularly important for public awareness projects which are supposed to change behaviour on a long-term basis.

For example, a project like **REMEDIES** is a very interesting project because it cures, it raises public and stakeholders' awareness and it can have a chance to be a long-term project, even after the end of the European budget.

About Excellent Marine Science**:** Ocean is under pressure, although it remains so unknown, and that it obviously contains an important part of the solutions for our future. Considering that the European Exclusive Economic Zone is the largest in the world, the European countries, as a whole, should be the leader in marine science and marine sustainable solutions for our future. The project **SEAS,** implementing a kind of scientists elite, can make a difference, and **BlueConnect,** or **PREP4BLUE** which raise awareness from R&I to citizens, can also make a difference.

13.4. Policy recommendations

Description of the identified gaps or barriers and the support that would be required at European level to overcome them

- Communication materials are often responding to administrative requests (deliverables of contracts) and use a technocratic language. This can act as barrier to attract the interest of the general public. It is recommended that projects build a kind of "instruction for use" that could be appealing for the general public and that go beyond the administrative and technocratic stile. It would help to spread the results, to reach not only the people who have participated to the project. This is an important barrier preventing to allow the results to be used by a maximum of people. Projects such as **BlueMissionAA** can be used as a model, reaching diverse kind of stakeholders including citizens, using various ways to spread information and engage the public.

- Art, cinema, or literature are not covered by the projects analysed and cultural heritage has been very scarcely represented. These are important gaps that should be taken into consideration in the strategic planning of the Mission Ocean.

- Projects analysed do not target enough young citizens. They will be the European leaders in the next future. It is recommended to support projects that implement local or regional assemblies like "Youth parliaments", Blue Schools, World Ocean Day participation (European Ocean Day is today more a day for professionals, administration, decision makers and private sector). Gamification of the ocean issues has not been covered by any of the analysed projects while it could be a good pathway to reach the youth interest

- Tourism opens up important possibilities to link citizens with the ocean in their daily life, in particular during the vacation period where there is more spare time to learn and get involved.

Description of identified synergies and recommendations on how to boost them between the various EU projects and funding programmes

- It is needed to build a real, wide communication explaining complicated concepts in simple words. People must be able to link what is explained with their daily life.

- **Using the existing powerful network of European aquariums:** All the stakeholders, including EC, should be inspired by what is considered in advertising business: to aware people, 30% must be reached with an adapted frequency to be efficient. The European Citizens should be reached at this level to really take action.

- It will be difficult to be concretely in touch with numerous citizens. Even if Local and Regional is important, we should consider to be supported by facilities for which the public and the networks are already existing! The European organization is already existing: which is named EUAC (European Union of Aquarium Curators and directors). To set up an agreement with them could be very efficient. The European facilities welcome each year 70 million of citizens, which means about 15% of the European population.

- Another very important consideration is that the citizens must be “emotionally moved” by what ocean represents, and understand it is important to keep them in good shape to preserve their daily life as it is. This is precisely one of the strengths of the aquariums which act on emotions and education. They implement educational tools and forums to engage the citizens.

- **Implementing fora of discussion**: One important recommendation could be to create forums of discussions, in order to spread information from scientists to the public (ocean literacy, top/down) but it is also very important to ask to the citizens what they know and what they wish. These forums are powerful tools to fit surveys (Down/top). This kind of forum is existing (one is at Nausicaa) and is very efficient, for scientists but also for private companies or local authorities. Because the citizen is too often considered as a spectator and not as an actor of his destiny.

- **Facilitating access to the EU calls:** Many organisations, which would like to apply for the first time, or which are not well structured for the European calls, are not aware of the projects which will be launched or which are currently on-going. It could be interesting for the success of the projects to develop a kind of “project library” to give a chance to new partners to participate. It would be easier for them to navigate through what could be considered as a project maze. It would allow more transparency. This could be a task for the lighthouses, each one operating in its own region.

- **Thinking to Human beings:** Many projects are about protection, conservation of nature, what is good, but they often not take enough in consideration the human social and economic aspects. Because humankind is existing and is part of nature, we should have more projects about sustainable use of the ocean, not only protection. Nevertheless, protecting the potential of the ocean is necessary for a sustainable use of the ocean, it’s not in contradiction.

- **Thinking that public awareness raising is a central issue:** That the reason why awareness raising must not be thought in the programmes as a part which will be implemented at the end, but must really entirely be part of the project. Without the civil society, nothing can be done.

- **Creating specific project on tourism**, tourists can be good targets to aware while they are on vacations

- **More projects** with **Art, cinema, or literature**. It can also be a good channel to encounter the citizens in their daily life.

Some remarkable projects (for Danube River for instance) are about continuity of the rivers. But many projects should be thought at the hydrosphere scale (which is in the spirit of Ocean Mission). Everything, every pollutant will arrive to the sea. This is not obvious for the policy makers, stakeholders and citizens. They often think separately: Ocean, Coastline, Rivers and freshwaters, although everything is linked.

This is to conclude that number and diversity of the projects are a real richness. Private sector, public authorities, Europe, have never planned such heavy projects to succeed in "saving" the Earth hydrosphere.

13.5. List of projects

Project id	Project Acronym	EU Programme (FP)	Type of Action (ToA)
101093956	**A-AAgora**	**HORIZON**	**HORIZON-IA**
101087146	BCThubs	HORIZON	HORIZON-CSA
101059900	**BioBeo**	**HORIZON**	**HORIZON-CSA**
101059915	BIOcean5D	HORIZON	HORIZON-RIA
21190	**BLUE LAND**	**Interreg**	**IPA/IPAII**
101061595	**Blue-connect**	**HORIZON**	**HORIZON-CSA**
101093962	**BlueMissionAA**	**HORIZON**	**HORIZON-CSA**
101093845	**BlueMissionBANOS**	**HORIZON**	**HORIZON-CSA**
101094073	**BlueMissionMed**	**HORIZON**	**HORIZON-CSA**
101061605	**BlueNIGHTs**	**HORIZON**	**HORIZON-CSA**
101086320	CLEVERFOOD	HORIZON	HORIZON-CSA
101094021	CLIMAS	HORIZON	HORIZON-RIA
101073542	C-Urge	HORIZON	HORIZON-TMA-MSCA-DN
101093985	**DANUBE4all**	**HORIZON**	**HORIZON-IA**
101079948	EHHUR	HORIZON	HORIZON-CSA
101059957	**EmpowerUs**	**HORIZON**	**HORIZON-RIA**
101061464	FF2022_23	HORIZON	HORIZON-CSA
101087224	FLORES	ERASMUS2027	ERASMUS-LS
101093928	**FLOW**	**HORIZON**	**HORIZON-RIA**
101037031	FRONTSH1P	H2020	IA
101036041	G9NIGHT	H2020	CSA
773330	GAIN	H2020	RIA
820283	GRRIP	H2020	CSA
101060693	GUARDEN	HORIZON	HORIZON-RIA
101037643	ILIAD	H2020	IA
19170	**IMPRECO**	**Interreg**	**ERDF;IPA/IPAII**
713673	INPhINIT	H2020	MSCA

101094825	LEVERS	HORIZON	HORIZON-CSA
101058121	LIFE21 FPA/BE/SAR	LIFE2027	LIFE-FPA-OG
101058920	LIFE21 FPA/BE/WWF EPO	LIFE2027	LIFE-FPA-OG
101058918	LIFE21 FPA/DE/RGI	LIFE2027	LIFE-FPA-OG
101058653	LIFE21 FPA/ES/Oceana in Europe	LIFE2027	LIFE-FPA-OG
101056522	LIFE21 FPA/FR/MedPAN	LIFE2027	LIFE-FPA-OG
101058916	**LIFE21 FPA/FR/SFE**	**LIFE2027**	**LIFE-FPA-OG**
101058803	LIFE21 FPA/IT/Slow Food	LIFE2027	LIFE-FPA-OG
101057743	**LIFE21 FPA/SE/CCB**	**LIFE2027**	**LIFE-FPA-OG**
101059082	**LIFE21 NGO/DE/EUROPARC**	**LIFE2027**	**LIFE-FPA-OG**
101059073	LIFE21 NGO/DE/RGI	LIFE2027	LIFE-FPA-OG
101058944	LIFE21 NGO/FR/SFE	LIFE2027	LIFE-FPA-OG
101058964	LIFE21 NGO/SE/CCB	LIFE2027	LIFE-FPA-OG
101074453	LIFE21-NAT-EE-urbanLIFEcircles	LIFE2027	LIFE-PJG
101074584	LIFE21-NAT-IT-LIFE TURTLENEST	LIFE2027	LIFE-PJG
101103515	LIFE22 NGO-NL-SBE	LIFE2027	LIFE-FPA-OG
101111990	LIFE22 NGO-SE-CCB	LIFE2027	LIFE-FPA-OG
101112150	LIFE22-NGO-DE-RGI	LIFE2027	LIFE-FPA-OG
101111878	LIFE22-NGO-FR-SFE	LIFE2027	LIFE-FPA-OG
101059407	MarinePlan	HORIZON	HORIZON-RIA
101061190	MEDNIGHT	HORIZON	HORIZON-CSA
101008724	MINKE	H2020	RIA
101006382	MOSAIC	H2020	RIA
101060464	NATURANCE	HORIZON	HORIZON-CSA
101060525	NBS EduWORLD	HORIZON	HORIZON-CSA
101081642	OBAMA-NEXT	HORIZON	HORIZON-RIA
101090795	**OSES**	**ERASMUS2027**	**ERASMUS-LS**
101094041	**OTTERS**	**HORIZON**	**HORIZON-CSA**
770504	**PERICLES**	**H2020**	**RIA**
101088822	**PlasticPiratesEU**	**HORIZON**	**HORIZON-CSA**
101056957	**PREP4BLUE**	**HORIZON**	**HORIZON-CSA**
101037071	REAL_DEAL	H2020	RIA

101093964	**REMEDIES**	**HORIZON**	**HORIZON-IA**
652643	**Respon-SEA-ble**	**H2020**	**CSA**
101037097	**REST-COAST**	**H2020**	**IA**
101036245	RI-URBANS	H2020	RIA
101000175	SafeWAVE	EMFF	EMFF-AG
101061603	SCIENCE4FUTURE	HORIZON	HORIZON-CSA
101082311	**SDGs-EYES**	**HORIZON**	**HORIZON-RIA**
101089757	SEA-EU 2.0	ERASMUS2027	ERASMUS-LS
101034309	**SEAS**	**H2020**	**MSCA**
101061553	SHARPER	HORIZON	HORIZON-CSA
857769	SiS.net 3	H2020	CSA
788217	SISCODE	H2020	RIA
101079251	SMART4ENV	HORIZON	HORIZON-CSA
817806	SUMMER	H2020	RIA
101095253	THETIDA	HORIZON	HORIZON-RIA
101084110	TRANSCEND	HORIZON	HORIZON-IA
101086340	UWIN-LABUST	HORIZON	HORIZON-CSA
101049538	YouPlay	ERASMUS2027	ERASMUS-LS

14. Synergies with other EU territorial cooperation (Interreg) and macro-regional strategies. *By Stefania Leoni*

14.1. Synergies between EU territorial cooperation (Interreg) and the Mission Ocean and Waters

The regional policy of the EU, also referred as EU Cohesion Policy contributes to strengthening economic, social, and territorial cohesion in the European Union. It aims to correct imbalances between countries and regions. It delivers on the Union's political priorities, especially the green and digital transition.

EU addresses specific needs of certain regions ad communities by identifying specific areas of intervention: Europe's outermost regions, urban development, rural development, regions in candidate and potential candidate countries (Enlargement of the EU), mountains, islands and Sparsely Populated Areas and Regions most affected by the transition towards climate neutrality. European Territorial Cooperation is central to the construction of a common European space, and a cornerstone of European integration. It has clear European added value: helping to ensure that borders are not barriers, bringing Europeans closer together, helping to solve common problems, facilitating the sharing of ideas and assets, and encouraging strategic work towards common goals.

Territorial cooperation for the period 2021-2027 is under the framework of the European Union's Cohesion Policy and 'Interreg' is its specific instrument which supports European Territorial Cooperation across regions and countries. Its aim is to jointly tackle common challenges and find shared solutions in fields such as health, environment, research, education, transport, sustainable energy and more.

This section 14 analyses how Interreg programs and directly managed programs especially together with European strategies can integrate and be complementary to the Horizon Europe Mission Oceans and Waters.

The 21-27 Interreg Programmes envisage to finance 100% the costs of the interventions and provide the participation of public and private partners to promote their participation to make the actions more innovative.

These programs aim at improving the governance and capacity building in several sectors by carrying out pilot actions, feasibility studies, innovation solutions, join actions plans, common strategies, experimentation and evaluation, plan for transferability of results.

Interreg Programs can promote useful interfaces with other transnational as well as with cross-border and/or thematic programme projects by the uptake of results of previous projects, the design of complementary activities for ongoing projects, and fostering value chain synergies for future projects - LIFE, HORIZON Europe, Digital Europe.

As regards transnational and cross border cooperation programs faced on the Adriatic, Baltic and Mediterranean Sea, they foresee and finance a wealth of activities aligned with blue economy and Smart specialization strategies. The following description shows the links with the objectives of the Mission Ocean and Waters. Environmental sustainability is central in the planning of all the Interreg programs and both the green and digital transition as well as climate change adaptation measures are foreseen. Another priority is the prevention for risk management for natural disaster and the biodiversity protection.

IPA-ADRION - Transnational cooperation Programme[26]**.** Within the future funding scheme, green policy will play a major role, with 54% of the total allocations targeting environmental topics, including climate change adaptation, biodiversity, and circular economy. The rest of the resources will be covering innovation (29%), sustainable mobility (9%), and the support to the EUSAIR governance (8%). The program has to develop the following objectives: (PO 1) A more competitive and smarter Europe by promoting innovative and smart economic transformation and regional ICT connectivity and (PO 2) A greener, low-carbon transitioning towards a net zero carbon economy and resilient Europe by promoting clean and fair energy transition, green and blue investment, the circular economy, climate change mitigation and adaptation, risk prevention and management, and sustainable urban mobility.

To foster synergies and integration with other EU Programs, ADRION started the capitalization process in 2019 by implementing five Thematic Clusters[27] (TC) identified according to key sectors of development and growth in the Adriatic-Ionian region and following the policy objectives of the new EU Cohesion Policy 2021-27. The topics are transport, mobility, nature conservation, blue and smart growth and sustainable tourism.

The thematic cluster on “blue growth and related smart growth” is composed by the participation of 10 standard projects dealing with Blue innovation technologies.

With a view to coordination between programs and to make cooperation increasingly innovative and directed toward research and capacity building, ADRION Programme opens a new call targeting Universities and research centres, as well as business institutions to raise competences and skills in domains considered of strategic relevance for the Adriatic-Ionian programme area, bridging to the new programming period, and ideally progressing in its path of sustaining marine/maritime, environmental and social innovation topics. The Call focus only on the following topics: Blue Economy, Social Innovation, Renewable Energy and Circular Economy that are that can improve the EUSAIR flagship of the four pillars.

Moreover, it is coherent with the achievement the Mission Ocean’s goals focused on protect and restore marine and freshwater ecosystems and biodiversity, prevent and eliminate pollution and make the sustainable blue economy carbon-neutral and circular.

The cluster activities oriented the improvement of new project proposal to develop flagship actions suggested in blue technologies, fisheries and aquaculture.

The main issues addressed are: (i) Innovation (ii) Sustainability (iii) Digitalization (iv) Reduction of CO_2 emissions and pollution (v) Reduction of production times (vi) Improving security and safety of processes (vii) Identification and channelling of resources towards blue investments.

It will be aimed at developing preparatory measures for the activation of joint Master Programmes to be running in the 2021-2027 programming period. The projects successfully complying with the goals of the present call shall be considered as strategic and granted in the 2021-2027 IPA ADRION Programme.

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[26] https://www.adrioninterreg.eu/index.php/about-program/programme/towards-the-new-adrion-a-view-ahead-on-the-next-programming-period-2021-2027/

[27] https://www.adrioninterreg.eu/wp-content/uploads/2021/02/TC1-Project_ideas_report.pdf

ITALY-CROATIA - Cross border cooperation Programme[28]. The Programme foresees the following priorities that deal with blue economy:

Priority 1 - Sustainable growth in the blue economy - the most relevant challenges identified by the Programme concern strengthening research capacities and promoting technology transfer processes, especially in the Blue Economy sector. At the same time, it is very important to attract and to maintain a higher number of young researchers in the system as well as attracting private and public financial resource for R&D. This priority includes two objectives:

- Specific objective: 1.1 - Developing and enhancing research and innovation capacities and the uptake of advanced technologies and

- Specific objective: 1.4. Developing skills for smart specialisation29, industrial transition, and entrepreneurship. This objective is related to get higher preparedness of businesses for smart specialisation in terms of qualified human capital and appropriate entrepreneurial skills mainly in the blue economy domains.

The operations will be coherent with the Eusair flagships that address the needs for macro-regional coherence in strategic field – Pillar 1 – Blue Growth:

- Fostering quadruple helix ties in the fields of marine technologies and blue biotechnologies for advancing innovation, business development and business adaptation in blue bio-economy.

- Bolstering capacity building and efficient coordination of planning and local development activities for improving marine and maritime governance and blue growth services (with specific regard to actions concerning maritime professional skills).

Italy-Croatia 2021-2027 Programme will favour initiatives point to create synergies and complementarities among projects financed by and those supported by other programmes and initiatives, such as CBC or transnational cooperation programmes (e.g. IPA Adriatic-Ionian), Horizon Europe, ERASMUS+ and other measures envisaged in respective National Recovery and Resilience Plans aimed at increasing the collaboration practices of SMEs and supporting the reinforcement of skills, in particular in the field of the Blue Economy.

The Soundscape project[30] is included in the portfolio of projects flagged as relevant by the experts. Its general objective is to implement concrete and joint interventions that allow to address the phenomenon of noise pollution from different points of view and methods of intervention.

Priority 2 - Green and resilient shared environment.

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[28] https://www.italy-croatia.eu/

[29] Smart Specialization Strategy (S3) has been introduced in the context of the 2014- 2020 programming period, as “ex ante conditionality” within the context of Thematic Objective 1 – research and innovation. It is based on 3 main steps: identify each region’s strengths and comparative assets, prioritise research and innovation investment in competitive areas and define a shared vision for regional innovation.

[30] https://www.italy-croatia.eu/web/soundscape

- Its Specific objective: 2.4. Promoting climate change adaptation and disaster risk prevention, resilience taking into account eco-system based on approaches.

We can mention FIRESPILL[31] strategic project– part of the portfolio - the aim of the project is the capacity of Emergency Service Organizations to increase cross-border effectiveness in tackling natural and man-made disasters, decreasing the exposure of the populations to the impact of hazards and increasing the safety of the Croatian and Italian Adriatic basin by improving emergency prevention and management measures and instruments.

- Specific objective: 2.7. Enhancing protection and preservation of nature, biodiversity, and green infrastructure including in urban areas, and reducing all forms of pollution.

The cooperation area is shaped by the rich but delicate natural biodiversity that also represents an important attractiveness and economic opportunities for the territory. The environmental quality of the Adriatic waters is quite good, even if there are some localized problems of pollution, and the sea hosts an extraordinary habitat where, however, numerous species are rated from declining to critically endangered also because of overfishing. Given the importance of these issues, the main challenge identified by the Programme is to improving the knowledge base and the monitoring system for defining policies of protection of biodiversity and of fight to pollution. Another project analyzed by the Portfolio is ECOSS[32] - ECOlogical observing system in the Adriatic Sea (ECOAdS) will enhance the marine observational capacities for improving the conservation status and the expansion of the marine component of Natura 2000 network. The synergies and feedbacks among the main conservation management questions, ecological variables and key oceanographic processes will be assessed, basing on the connectivity among habitats and species in coastal and offshore waters.

Moreover, sustainable development practices, also in line with lessons learnt from 2014-2020 period and will be implemented by the Programme and encouraged towards funded projects. Circular economy approaches linked to the protection of biodiversity and to fight against pollution will be highly valorised by the Programme. To contribute to EUSAIR macro-regional strategy the listed actions should operate in synergy with the following flagships in the Pillar 3 – Environmental quality: (i) Development and implementation of Adriatic-Ionian Sub/regional Oil spill contingency plan; (ii) Protection and enhancement of natural terrestrial habitats and ecosystems; and (iii) Promotion of sustainable growth of the Adriatic-Ionian region by implementing integrated coastal zone management (ICZM) and marine spatial planning (MSP) also to contribute common regional framework (CRF) on integrated coastal zone management of barcelona convention and the monitoring and management of marine protected area.

- 2.2.3 Specific objective: 4.6. Enhancing the role of culture and sustainable tourism in economic development, social inclusion, and social innovation

Culture and tourism play an important role for the territory's economy and labour market. One of the main challenges for the area is represented by the diversification of touristic flows aimed at ensuring equal access to tourist destinations and cultural heritage (for persons with disability, elderly people and retired, unemployed and low-income population, younger generation). Also, the delocalisation of flows will be pursued to increase the environmental sustainability and to produce a positive impact on the local communities. One of the aims is

[31] https://www.italy-croatia.eu/web/firespill

[32] https://www.italy-croatia.eu/web/ecoss

to get a lowered regional vulnerability to tourism and to guarantee a wider diffusion of sustainable, alternative and special interest tourism. Moreover, it is important to promote new and innovative integrated offers of coastal tourism and to maintain the competitiveness of the sector.

The possible measures envisaged in respective National Recovery and Resilience Plans aiming at improving and modernising the policies for the valorisation of cultural heritage, delocalising tourist flows and promoting new and innovative integrated offers of coastal tourism.

The Programme is eager to uncover the persisting difficulties affecting many aspects of cross-border life and to address them to help border citizens and businesses benefit from the potential of the Programme area. At the same time, the Programme is aware of the need to support both institutional actors and stakeholders in reinforcing capacities to cooperate and actively participate in the Programme to improve the multi-level governance dimension, dialogue among different components of the Programme partnerships, involvement of unexperienced partners and newcomers to better address the needs of the Programme area. At the end of the programming period Italy-Croatia launched a call for financing clusters in the principal fields foresee in the programme area and useful to capitalize results and experiences carried out in the cooperation area.

North West Europe – Trasnational cooperation program[33]. Seven countries (Belgium,France, Germany, Ireland, Luxembourg, The Netherlands and Switzerland) have confirmed their participation in the Interreg North-West Europe Programme. Its purpose is to reduce disparities between the various regions in North-West Europe and and raise the overall level of performance across the whole area. The idea is that cohesion policy should also promote more balanced, more sustainable 'territorial development'. The NWE Programme 2021-2027 focuses on five priorities and nine specific objectives: climate and environment, energy transition, circular economy, innovation and resilience and inclusive society.

Interreg **Baltic Sea Region 2021-27**[34]**.** It brings together cultures, perspectives and expertise to get the best ideas and joint solutions. The program supports, projects drive the transition to a green and resilient region. It helps organisations from countries around the Baltic Sea to cooperate and put their ideas into practice. These ideas need to fit into one of four thematic priorities and help build Innovative societies, Water-smart societies, Climate-neutral societies, or Cooperation governance.

Interreg Atlantic Area 2021-27[35]. The program supports innovative initiatives that contribute to the growth of this area, solving common challenges across border through the implementation of joint actions, exchange of good practices and contribution to new or current policies. The programme supports cooperation in blue innovation and competitiveness, blue and green environment, Blue sustainable tourism and culture, A better governance for cooperation.

[33] https://www.nweurope.eu/

[34] https://interreg-baltic.eu/get-funding/programme-2021-2027/

[35] https://www.atlanticarea.eu/

An example of the project portfolio realized in that area is @BluePorts[36] - Atlantic Blue Port Services - Discharge polluted water in port, not at sea. The aim of the project is to provide a practical support to the European Sustainable Shipping Forum/European Maritime Safety Agency, using the Atlantic Area as a physical platform and its maritime community as a resource to design, prototype, test and demonstrate the “ideal” Port Reception Facility and services for oiled and ballast water (as first concern). The overall goal is to raise awareness and motivation within the maritime community to stop discharge at sea by designing in consensus the "Blue Port Services" for 2020 and beyond.

Interreg North Sea Region 2021-27[37]. It cooperates across borders to stimulate a green and sustainable future and supports enables partnerships to test new ideas and address joint challenges in the North Sea Region. The North Sea Region Programme 2021-2027 centres on four thematic priorities: robust and smart economies, a green transition, a climate resilient and a better governance in the cooperation area. It spotlights some themes that apply across all priorities. They are additional dimensions of special importance in the North Sea Region. There are three spotlight themes: Digitalisation, Rural-urban linkages and Strengths & challenges in the North Sea basin.

EUROMED - Transnational cooperation Programme[38]. The main goal of the Euro-MED is to contribute to the transition towards a climate-neutral and resilient society: fighting against global changes impact on Mediterranean resources, while ensuring a sustainable growth and the well-being of its citizens. The Programme strategic approach has been articulated in 4 operational missions, each of them contributing to the achievement of the main goal: (1) Strengthening an innovative sustainable economy, (2) Protecting, restoring and valorising the natural environment & heritage, (3) Promoting green living areas, (4) Enhancing sustainable tourism.

This program, by financing its projects, brings the development of solutions and implementing systemic changes under research and innovation, cutting across different sectors (for instance agriculture, fisheries and aquaculture, food, manufacturing, tourism, etc). Thus, innovation is rather conceived as an instrument to boost the competitive innovation ecosystem in multiple economy sectors ensuring green transition.

The policy objective 2 – OS 4 - Promoting the transition to circular economy promoting the transition to a circular and resource efficient economy. Reduce the environmental impact of the current linear production system in key sectors - agriculture, food, fisheries and in the tourism sector. Promote prevention, reduction, and economic recovery of waste, including awareness raising and consumers engagement. “Plastic busters MPAs[39]” project included in the portfolio provides a comprehensive, multifaceted and coordinated approach to fight marine litter in Mediterranean coastal and marine protected areas towards healthy marine ecosystems and capitalizes in other program such as Next Med program.

Another example of portfolio project is AMAre[40] - in the Mediterranean Sea, the intensive use of maritime space calls for integrated management to avoid cumulative impacts and user

[36] https://www.atlanticarea.eu/project/53

[37] https://www.interregnorthsea.eu/

[38] https://interreg-euro-med.eu/en/

[39] https://plasticbustersmpas.interreg-med.eu/

[40] https://amare.interreg-med.eu/

conflicts. Maritime Spatial Planning (MSP) - the harmonization of human activities in marine areas - is advocated as a powerful approach to reach these goals.

Interreg NEXT 'Mediterranean Sea Basin[41] - transnational cooperation programme is the result of an extensive collaboration work among the national representatives of 15 countries: Algeria, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Jordan, Malta, Palestine, Portugal, Spain, Tunisia and Turkey. It aims to contribute to smart, sustainable, fair development for all across the Mediterranean basin by supporting balanced, long-lasting, far-reaching cooperation and multilevel governance.

NEXT MED will continue supporting Euro-Mediterranean and supports European Territorial Cooperation across regions and countries. NEXT MED is implemented under strand B Transnational cooperation' of the external dimension of Interreg, allowing for cooperation over larger transnational territories or around sea basins between EU Member States and Southern Neighbourhood partner countries. The programme mission is to finance cooperation projects that address joint socio-economic, environmental and governance challenges at Mediterranean level.

NETX MED thematic strategy is structured around 4 broad objectives, declined into 9 specific objectives. The programme has a lot of common issues with HE – Mission Ocean in fact there are specific objectives regarding the topics present in the Mission oceans: (1) A more competitive and smarter Mediterranean, (2) A greener, low-carbon and resilient Mediterranean, (3) A better cooperation governance for the Mediterranean.

Some best practise of projects in blue growth issues are: MedCoast4BG[42] (included in the portfolio) aims to find common approaches and planning tools to boost sustainable coastal and maritime tourism in the Mediterranean, by promoting the co-development of human activities and natural ecosystems. The project – included in the portfolio analysis - takes into consideration the principles of sustainable development, the effects of climate change, and governance tools such as Integrated Coastal Zone Management (ICZM) and Maritime Spatial Planning (MSP). This project extends the model of the EU-funded Co-Evolve Interreg Med project[43], which focused on EU Mediterranean coasts, to Southern & Eastern Mediterranean countries, taking into account common (at Mediterranean level) and diverse (at the local level) natural, physical and geographic characteristics.

14.2. Synergies with macro-regional strategies and other regional strategic planning tools.

Mission Ocean and waters has a strong regional dimension. It will deploy innovative solutions at basin-scale (sea basin and river basin) for each of its specific objectives. It has identified four lighthouse areas (see below) that could easily refer to the European macro strategies.

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41 https://south.euneighbours.eu/news/european-commission-approves-interreg-next-med-programme/

42 https://ufmsecretariat.org/project/medcoast4bg/

43 https://co-evolve.interreg-med.eu/

EU macroregional strategies[44] are at the top of European programs and address challenges and opportunities specific to certain geographic areas that are too local in scope to affect the EU as a whole and serve as the link between the EU and local policies.

Currently, four EU macroregional strategies have been adopted, each accompanied by a progressive action plan, to be updated regularly considering emerging needs and the changing environment.

These strategies represent more than 340 million people and involve 19 EU MEMBER STATES-Austria, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia, and Sweden-and 8 Non-EU Countries: Albania, Bosnia and Herzegovina, Liechtenstein, Moldova, Montenegro, Serbia, Switzerland, and Ukraine.

Some EU countries, such as Germany and Slovenia, are involved in three strategies, while Croatia, Italy and Austria fall under two strategies. Italy is involved in the EU strategy for the Adriatic and Ionian region and the strategy for the Alpine region.

To be more integrated with mainstreaming programs and Interreg, the European macro strategies have adopted some flagships – adopted by the Commission for every strategy - that consist in priorities issues that must be developed in new future projects. To be more integrated with the national and regional planning (mainstreaming programs, the Commission suggests creating synergies between them, the so called “embedding process”. The suggested themes are coherent with some the priorities given by mainstreaming and Interreg programs. This has direct impacts on the contribution to the strategies at different levels, from the Regional Programmes based on ERDF funds (Article 22(3) Common Provisions Regulation) to the direct management funds such as the LIFE programme which encourages the use of MRS for the implementation of Strategic Integrated Projects at trans-national scale.

Each strategy can refer to the four Mission lighthouses:

- Baltic and North Sea basin: make the blue economy carbon-neutral.
- Danube river basin: protect and restore ecosystems and biodiversity (freshwater)
- Atlantic and Arctic coast: protect and restore ecosystems and biodiversity (marine)
- Mediterranean Sea: prevent and eliminate pollution.

BALTIC SEA REGION STRATEGY (2009)[45] - The EU Strategy for the Baltic Sea Region (EUSBSR) was the first European macrostrategie adopted to join several and different countries with specific condition faced on Baltic and North Sea. It was created to increase the prosperity of neighbouring countries and connect regions in a meaningful way, but also to save the sea. The Baltic Sea is an arm of the Atlantic Ocean in Europe, it is of great importance for both tourism and fishing and, also their influence on climate is very important. Maritime traffic is important, but also dangerous to the natural balance of the sea.

[44] https://ec.europa.eu/regional_policy/policy/cooperation/macro-regional-strategies_en

[45] https://www.balticsea-region.eu

The EUSBSR Policy-action processes, also named Flagships are designed to deliver on the targets and indicators in the EUSBSR Action Plan. Policy-action processes are designed for macro-regional strategies where stakeholders are brought together for developing solutions to complex societal challenges. The four PA EDU Actions in the EUSBSR Action Plan are primarily implemented by so called Flagships, also named policy-action processes. Four such processes are in operation within our policy area. Specially connected to the Mission Oceans and waters are:

- Baltic university programme - largest and oldest university network in the macro region focused on sustainable regional development through cooperation in education, research and applied projects. The flagship welcome universities and other institutions providing higher education and research to join the network.

- Baltic Sea Labor Forum - Largest and oldest university network in the macro region focused on sustainable regional development through cooperation in education, research and applied projects

- Baltic science forum - a policy network gathering relevant transnational, national and regional policy actors. The Network is a springboard for targeted multilateral activities in the frame of research and innovation excellence, mobility of scientists and expanded participation.

DANUBE (2011)[46] - The Danube Region Strategy (EUSDR) addresses a wide range of issues; these are divided among 4 pillars and 12 priority areas: Waterways Mobility, Rail-Road-Air Mobility, Sustainable Energy, Culture & Tourism, Water Quality, Environmental Risks, Biodiversity, Landscapes and Air & Soil Quality, Knowledge Society, Competitiveness of Enterprises, People & Skills, Institutional Capacity & Cooperation, Security. This strategy covers a cross-cutting area from Adriatic Ionian to the Black sea area. Several targets of the strategy topic regard the water and oceans heath status and the environment monitoring and knowledge for conservation, capacity building and governance model for cooperation.

Danube Strategy Flagships are projects or processes that contribute to the implementation of the Strategy for the Danube Region. They are of high importance for the Danube Region's economic, social, and territorial cohesion and for improving the quality of life in the Danube Region.

- Promotion local low-carbon energy actions in the EUSDR
- Adaptation to climate change
- Flagship process on migratory fish
- Emerging substances
- Disaster Management Working Group
- Stakeholder Involvement, multi-level governance, joint implementation
- Danube Tech Valley Initiative
- Multilateral Scientific and Technological Cooperation

[46] https://danube-region.eu/

EUSAIR (2014)[47] - The general objective of the EUSAIR is to promote economic and social prosperity and growth in the region by improving its attractiveness, competitiveness and connectivity with four EU members and six non-EU countries. The strategy will contribute to the further integration of the Western Balkans. The countries are aiming to create synergies and foster coordination among all territories in the Adriatic-Ionian Region in the four thematic areas/ pillars: 1. blue growth, 2. Energy & transport networking, 3. Environmental quality, 4. Sustainable tourism.

Eusair Flagships are coherent with Mission Oceans and Waters, from Pillar 1 Blue growth:

- Fostering quadruple helix in the fields of Marine technologies and blue biotechnologies for advancing innovation, business development and business adaptation in blue bio-economy

- Promoting sustainability, diversification and competitiveness in the fisheries and aquaculture sectors through education, research & development, administrative, technological and marketing actions, including the promotion of initiatives on marketing standards and healthy nutritional habits

- Bolstering capacity building and efficient coordination of planning and local development activities for improving marine and maritime governance and blue growth service

And from pillar 3 – quality environmental:

Development and implementation of adriatic-ionian sub/regional oil spill contingency plan

Promotion of sustainable growth of the Adriatic Ionian region by implementing integrated coastal zone management and marine spatial planning also to contribute common regional framework on integrated coastal zone management of barcelona convention and the monitoring and management of marine protected area

EUSALP (2016)[48] - The Alpine area is composed of territories with contrasted demographic, social and economic trends and a great cultural and linguistic diversity. This diversity goes along with a great variety of governance systems and traditions. Both the common specificities of the Alpine area and its variety and diversity call for cooperation. The Alpine region represents a living and working space and an attractive tourist destination for millions of guests every year. The Alps are the water tower of Europe and are known all over the world for their natural beauty, varied landscapes, rich biodiversity and cultural heritage. An Alpine macro-regional strategy would provide an opportunity to improve cross-border cooperation in the Alpine States as well as identifying common goals and implementing them more effectively through transnational collaboration. Better cooperation between the regions and States is needed to tackle those challenges. The priorities, in line with the Oceans & Waters mission, are economic globalisation, demographic trends (combined effects of ageing and new migration), climate change and its foreseeable effects on the environment, biodiversity and on the living conditions of its inhabitants and energy.

[47] https://www.adriatic-ionian.eu/

[48] https://www.alpine-region.eu/

There is a pressing need to achieve a simplification of the EUSALP priorities and the identification of flagship projects and initiatives. Embedding is about making the best use of funds available in order to increase the territorial impact. This process has a solid legal and policy basis in the 2021-27 programming period. The streamlining of EUSALP priorities should favour the emergence of flagship projects and initiatives in: digital technology, energy transition and sustainable mobility

EU's Atlantic Action Plan (2013-2020)[49]. It set out practical steps to be taken in the 4 Member States with Atlantic coasts (Ireland, France, Portugal, Spain) and their outermost regions in order to boost the Atlantic Ocean Area's sustainable blue economy by 2020.

The revised Atlantic Action Plan 2.0 was communicated by the European Commission on 23 July 2020. Its main objective is to unlock the potential of blue economy in the Atlantic area while preserving marine ecosystems and contributing to climate change adaptation and mitigation. Its aims are in line with the global commitments for sustainable development and are fully integrated in the European Commission's political priorities for 2019 - 2024, notably a European Green Deal, an Economy that works for people and a stronger Europe in the world.

The research activities implemented as part of the Galway (2013) and Belém (2017) Statements and the All-Atlantic Ocean Research Alliance cut across all pillars. The 1st meeting of the Atlantic Strategy Committee under the Portuguese Presidency was held in Porto de Lisboa on March 30th 2023.

WESTMED INITIATIVE[50] - It involves the western Mediterranean region involved in the '5+5 Dialogue': five EU Member States (France, Italy, Portugal, Spain and Malta), and five Southern partner countries (Algeria, Libya, Mauritania, Morocco and Tunisia). These countries are ready and willing to work together on their shared interests for the region: to increase maritime safety and security, promote sustainable blue growth and jobs, and preserve ecosystems and biodiversity. The Initiative follows up on the Economy endorsed by the Union for Mediterranean (UfM) which took place on the 17 November 2015.

UNION FOR MEDITERRANEAN[51] - The Union for the Mediterranean (UfM) is the intergovernmental Euro-Mediterranean organisation which brings together all countries of the European Union and 16 countries of the Southern and Eastern Mediterranean. The UfM provides a forum to enhance regional cooperation and dialogue, as well as the implementation of concrete projects and initiatives with tangible impact on the citizens of its Member States.

Albania, Algeria, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Jordan, Latvia, Lebanon, Lithuania, Luxemburg, Malta, Mauritania, Monaco, Montenegro, Morocco, The Netherlands, North Macedonia, Palestine, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Syria, Tunisia, Türkiye

[49] https://atlantic-maritime-strategy.ec.europa.eu/en/atlantic-strategy-glance/atlantic-strategy

[50] https://westmed-initiative.ec.europa.eu/

[51] https://ufmsecretariat.org/

The UfM promotes regional cooperation to protect the Mediterranean Sea and the natural resources of the countries belonging to its area, and supports partnerships inspired by ‘green/blue’ circular economy principles.

- https://medblueconomyplatform.org/vkc/news/13th-ufm-working-group-on-blue-economy-and-back-to-back-meeting-on-the-blue-economy-mediterranean-partnership-2594412227/
- https://maritime-spatial-planning.ec.europa.eu/
- https://oceanecostructures.com/contact-us/ -
- https://medblueconomyplatform.org/vkc/initiatives/blueware-slovenia-b229950284/ - Slovenian innovation community for sustainable blue economy
- https://www.submariner-network.eu/ - The submariner network promotes innovative approaches to sustainable use of marine resources and offers a cooperation platform to related actors and initiatives in the Baltic sea region.

Regional cooperation efforts are dedicated to higher education, research, and innovation as well as vocational training and mobility play an essential role in achieving a Positive agenda for the Youth in the Mediterranean because of their potential on increasing employability, promoting intercultural dialogue and preventing extremism.

14.3. Policy recommendations

- The portfolio includes a large amount of projects supported by R&I EU Framework Programmes. LIFE and Interred are also well represented. The analysis shows the importance of the synergies stablished between the projects resulting from these programmes.

- Synergies between R&I projects and ocean-related commitment of two European universities alliances, supported by ERASMUS + represent a good example and an asset for the future, long-term success of the Mission Ocean and Waters.

- To obtain concrete, long-lasting and useful results, the successful approach is to foster synergies between different funds and to have a strong coordination within the several European programs that could have common goals for individuals and collective benefit. It would also be beneficial to integrating local programs.

- Develop new approaches to take care of the needs and perspectives of local communities. This includes using co-management approaches that involve local communities in decision-making and management and recognizing the importance of cultural values and practices in marine conservation and further fields. Human capital is fundamental in capitalizing on solutions, methods, processes, products and knowledge generated.

- There is a need to create efficient governance mechanisms to support Mission Ocean related actions within European cooperation programs, particularly European Territorial Cooperation ones. It is suggested to promote capacity building for neighboring countries and initiatives in several field of the portfolio projects.

- Both of business and public bodies should be strengthened in EU projects to establish networking to transfer knowledge and foster partnerships and to avoid duplication of intervention. Strategies are effective to involve stakeholders and to raise funds in several programs. Enlarge partnerships and mix partners from the

different part of Europe to have balanced partnerships with shared common vision and aims.

Appendix 1. Glossary

The table below provides a glossary of terms used in this report.

EU Programmes	
Acronym	Meaning
CEF	Connecting Europe Facility
CEF2027	Connecting Europe Facility 2027
CIP	Competitiveness and Innovation Framework Programme
COSME	Programme for the Competitiveness of Enterprises and small and medium-sized enterprises
DIGITAL	Digital Europe Programme
EEPR	European Energy Programme and Recovery
EMFAF	European Maritime, Fisheries and Aquaculture Fund
EMFF	European Maritime and Fisheries Fund
EPLUS2020	The European Union Programme for education, training, youth and sport
ERASMUS2027	Erasmus+2027
ESF	European Social Fund
ESTAT	European Statistics
H2020	Horizon 2020
HORIZON	Horizon Europe
I3	Interregional Innovation Investments
INNOFUND	Innovation Fund
Interreg	European Territorial Co-operation
LIFE	Programme for the Environment and Climate Action
LIFE2027	Programme for the Environment and Climate Action 2027
SMP	The Single Market Programme

Types of Action	
Acronym	Meaning
RIA	Research and Innovation Action
IA	Innvation Action
ERC	European Research Council
MSCA	Marie Skłodowska-Curie Actions
ERA-NET-Cofund	European Research Area Networks Co-fund action
SME	Small or Medium-Sized Enterprise Instrument
CSA	Coordination and Support Action
FCH2	Fuel Cells and Hydrogen Joint Undertaking
PCP	Pre-Commercial Procurement Action
BBI	Bio-based Industries Joint Undertaking
CS2	Clean Sky 2 Joint Undertaking

IA-LS	Innovation Lump Sum actions
RIA-LS	Research and Innovation Lump Sum actions
ERDF;IPA/IPAII	European Regional Development Fund; Instrument for Pre-accession Assistance
ERDF	European Regional Development Fund
IPA/IPAII	Instrument for Pre-accession Assistance
ENPI/ENI	The European Neighbourhood and Partnership Instrument/The European Neighbourhood Instrument
EMFF-AG	EMFF Action Grant
LIFE-ENV	LIFE-Environment
CEF-TPT	Connecting Europe Facility Transport
CEF-TC	Connecting Europe Facility Telecom
COSME-GA	Programme for the Competitiveness of Enterprises and small and medium-sized enterprises Grant Agreement
EPLUS2020-AG	EPLUS2020 Action Grant
ESTAT-AG	European Statistics Action Grant
CEF-INFRA	
DIGITAL-CSA	DIGITAL Coordination and Support Action
DIGITAL-SIMPLE	DIGITAL Simple Grant
EMFAF-PJG	European Maritime, Fisheries and Aquaculture Fund Project Grants
ERASMUS-LS	ERASMUS Lump Sum Grants
ERASMUS-EMJM-UN	Erasmus Mundus Joint Masters
HORIZON-ERC	Horizon Europe European Research Council
HORIZON-COFUND	Horizon Europe Co-fund Action
HORIZON-RIA	Horizon Europe Research and Innovation Action
HORIZON-IA	Horizon Europe Innovation Action
HORIZON-CSA	Horizon Europe Coordination and Support Action
HORIZON-TMA-MSCA-DN	Horizon Europe Marie Skłodowska-Curie Actions Doctoral Networks
HORIZON-TMA-MSCA-Cofund-P	Horizon Europe Marie Skłodowska-Curie Actions Co-fund
HORIZON-TMA-MSCA-PF-EF	Horizon Europe Marie Skłodowska-Curie Actions Postdoctoral Fellowships - European Fellowships
HORIZON-EIC	Horizon Europe European Innovation Council
HORIZON-ERC-POC	Horizon Europe European Research Council Proof of Concept Grants
HORIZON-EIC-ACC-BF	Horizon Europe European Innovation Council Accelerator Blended Finance
I3-PJG	Interregional Innovation Investments Project Grants
LIFE-FPA-OG	LIFE Operating Grants Framework Partnerships
LIFE-PJG	LIFE Operating Grants Framework Partnerships Project Grants
SMP-GFS	Single Market Programme Grants for Financial Support

Appendix 2. Data corpus available to Cortex

Multiannual Financial Framework	Programme	Total number of projects analysed	Total EU financial contribution to analised projects[52]	Comments
2014-2020	CEF	1961	28.25B	Including: CEF Energy, CEF Transport, CEF Telecom
2014-2020	EMFF	147	98.63M	Directly managed component
2014-2020	H2020	35115	67.83B	
2014-2020	Interreg	7105	8.62B	Shared financing managed by the Interreg programmes, budget information not available for all the actions
2014-2020	LIFE	1400	2.69B	
2021-2027	CEF2027	284	7.35B	
2021-2027	EMFAF	33	18.94M	Directly managed component
2021-2027	HORIZON	6076	19.44B	
2021-2027	LIFE2027	317	639.74M	
2021-2027	ERASMUS 2027	3044	1.18B	
2021-2027	SMP	729	562.08M	
2021-2027	INNOVFUND	53	3.04B	
2021-2027	DIGITAL	273	897.26M	
2021-2027	ESF	121	55.75M	Directly managed component
2021-2027	I3	11	70.16M	
2014-2020	COSME	920	556.67M	
2014-2020	EPLUS2020	4955	136.48M	Partial data available in the eGrants
2014-2020	ESTAT	853	105.4M	
2007-2013	CIP	464	5.62B	
2007-2013	EEPR	41	3.44B	Partial data

[52] EU financial contribution is expressed in euro of a specific period of time (commitments)

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This report presents the results of the analysis of a portfolio of 841 EU projects - completed or ongoing - relevant to the EU Mission “Restore our Oceans and Waters by 2030”. These projects have been funded by sixteen EU programmes. The analysis has been performed by 12 independent experts in various fields related to the Mission Ocean & Waters. The findings of the analysis include: (1) An structured overview of the project’ portfolio in terms of their contribution to the objectives of the Mission, Green Deal targets, thematic areas of intervention, geographical areas, levers of change; (2) An overview of tangible results delivered by the projects’ portfolio and (3) Policy recommendations, including gaps and approaches to scale-up and roll-out solutions that would require further support at European level, as well as synergies between programmes, stakeholders and initiatives.

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