

Scalable full-cycle marine litter remediation in the Mediterranean: Robotic and participatory solutions

SeaClear2.0



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D1.2

Innovation and Risk Management Report

WP1 – Management & coordination of consortium & associated regions

Grant Agreement no. 101093822

Lead beneficiary: TU Delft


Date: 29/09/2023

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¹ R = Document, report, DEM = Demonstrator, OTHER = Software, technical diagram, etc., DMP = Data Management Plan

² PU = Public, C-UE/EU-C = EU Confidential under Decision 2015/444, SEN = Sensitive

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Definitions

- **Beneficiary:** A legal entity that is signatory of the EC Grant Agreement no. 101093822.
- **Consortium:** The SeaClear2.0 Consortium, comprising the list of beneficiaries below.
- **Consortium Agreement:** Agreement concluded amongst the SeaClear2.0 beneficiaries for the implementation of the Grant Agreement.
- **Grant Agreement:** The agreement signed between the beneficiaries and the EC for the undertaking of the SeaClear2.0 project (Grant Agreement no. 101093822).


Beneficiaries abbreviations

Beneficiaries of the SeaClear2.0 Consortium are referred to herein according to the following abbreviations:

- **TU Delft:** TECHNISCHE UNIVERSITEIT DELFT
- **DUNEA:** REGIONALNA AGENCIJA DUNEA
- **Fraunhofer:** FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
- **HPA:** HAMBURG PORT AUTHORITY
- **ISOTECH:** ISOTECH LTD
- **MDanchor:** M. DANANCHOR LTD
- **Subsea Tech:** SUBSEA TECH SAS
- **TECNOSUB:** TÉCNICAS Y OBRAS SUBACUÁTICAS, SLU
- **TUM:** TECHNISCHE UNIVERSITAET MUENCHEN
- **UNIDU:** SVEUCILISTE U DUBROVNIKU
- **UTC:** UNIVERSITATEA TEHNICA CLUJ-NAPOCA
- **VEO:** VEOLIA PROPRETE
- **VLPF:** VENICE LAGOON PLASTIC FREE

Abbreviations


- **AB:** Advisory Board
- **CA:** Consortium Agreement
- **D :** Deliverable
- **DoA :** Description of Action
- **EC:** European Commission
- **GA:** Grant Agreement
- **IP :** Intellectual Property
- **IPR :** Intellectual Property Rights
- **SC:** Steering Committee
- **TRL :** Technology Readiness Level
- **WP:** Work Package
- **WPL:** Work Package Leader

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● Executive summary


This document is the Deliverable 1.2 of the SeaClear2.0 project, in the context of WP1 ‘Management & coordination of consortium & associated regions’ and is related to Task 1.3 ‘Innovation and risk management’.

The main target audience are the direct project participants, but it also sets out the general operating principles of the project. Indeed the dissemination level of D 1.2. is public (PU).

The purpose of this document is to facilitate co-operation and streamlined collaboration across the consortium through the definition of guidelines and procedures to be followed for project specific documentation and communication. The ultimate objective of this Innovation and Risk Management Report is to serve as reference consistently used by the consortium members to ensure concrete and quality results in line with the work plan of the SeaClear2.0 project.

This plan is relevant across various activities of the project as it defines procedures concerning various managerial and operational aspects of the project. Considering the distinctive nature of these topics, the content has been divided into three parts:

1. **Project Management** : This presents the overall management to guarantee the quality of the deliverables;
2. **Innovation Management** : This provides how the project will ensure maximum exploitation opportunities for the project’s results;
3. **Risk Management** : This involves the identification, control and recording of risks, highlighting the consequences, mitigation plans and associated managerial actions.

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● Introduction


SeaClear2.0 will develop a holistic approach to address the full cycle of marine litter in a way that will help meet the objectives of ‘the Mission to restore, protect and preserve the health of our oceans, seas and waters’ by 2030, in the context of the Mediterranean sea basin lighthouse.

To this end, SeaClear2.0 aim to prevent and reduce marine litter pollution, particularly plastics and microplastics, in the Mediterranean through :

- Community activation.
- Scaling up and demonstrating an innovative solution with teams of autonomous, intelligent robots for effective monitoring and collection of marine seafloor and surface litter.
- Providing solutions for valorization of the collected litter.
- Adding novel dimensions in policy making
- Accelerating the uptake of our solution by demonstrating its scalability and replicability to the Mediterranean basin and beyond.



Figure 1. The SeaClear2.0 approach at a glance (read from top-left to bottom-right)

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1. Project Management

The general management of the project and the specific management of the deliverables are crucial for the successful implementation of the project.

○ 1.1. Quality Assurance Procedure

The QA procedure is part of WP1 'Management' with Task 1.1 'Administrative coordination' and Task 1.2 'Scientific and technical coordination'. The main objective of the QA procedure is a continuous quality assurance and timely submission of deliverables and reports.

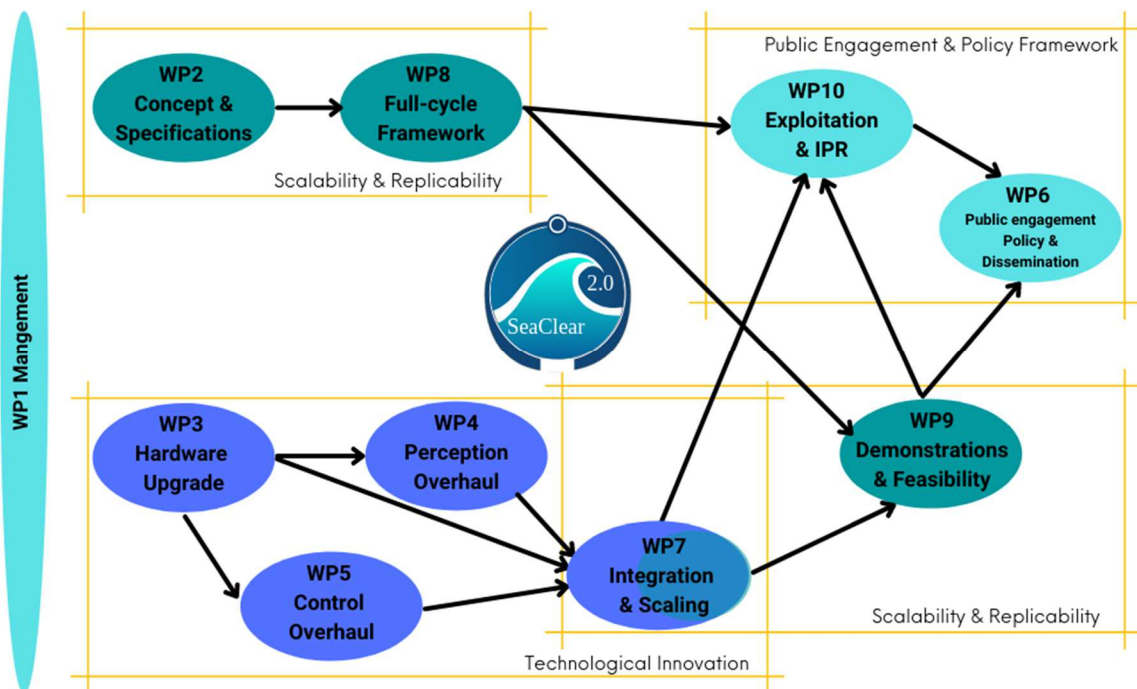


Figure 2. Overview of Work Package structure

○ 1.2. Management structure


To manage the project, a Steering Committee formed out of 1 person per partner meets at least monthly. During the Steering Committee, all ongoing work is presented and plans for coming period are discussed.

Project Coordinator (TU Delft) handles liaison with EC, financial issues, timely submission of deliverables and milestones, etc.

A Technical Coordinator (Fraunhofer) implements scientific decisions and handles deliverable reviews. A manager for associated regions (HPA) monitors their projects (technically), together with the coordinator (administratively).

WP and task leaders are entrusted with execution of project activities.

An Advisory Board will be set up, including external experts.

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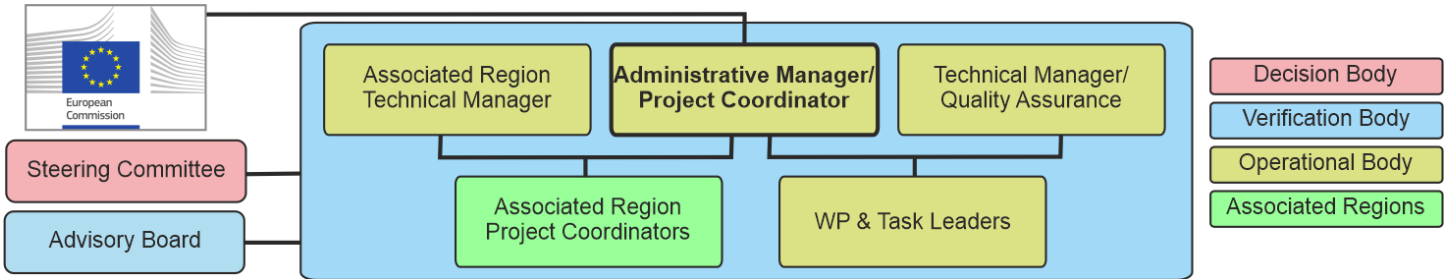


Figure 3. Management structure

o 1.3. Deliverable review process

The implementation of the QA procedure involves diverse participants and multiple steps. A Deliverable Review Process has been developed to support the deliverable approval process and document management. The entire process is coordinated by the Technical Coordinator who also implements scientific decision.

The listed lead partner is responsible for its deliverables. So the Deliverable Leader prepares the deliverable in the specific WP, with contributions from project partners involved in the task linked to the deliverable.

One month before the deliverable deadline the partner sends the first final draft to the selected two reviewers, c.c. to the Technical Coordinator as he will monitor the progress. In case the deliverable production occurs in a period with, e.g. public holidays the author should – timely - agree on an alternative feasible timeline with the reviewers and the Technical and Project Coordinator.


Within the following week, the reviewers can review the deliverable and send their comments to the responsible partner (1 week) so the document can be adjusted if necessary (1 week).

Within the remaining 1 week before the deadline the respective partner will send the final draft to the Technical and Project Coordinators.

Technical and Project Coordinators will do a final check and upload the document to the Participant Portal.

Project Coordinator will place a copy of the submitted version on shared network drive as well.

To ensure the quality level of the deliverables and technical outcomes throughout the project, a standard template for deliverable reports has been developed containing sections for history of changes and release approval.

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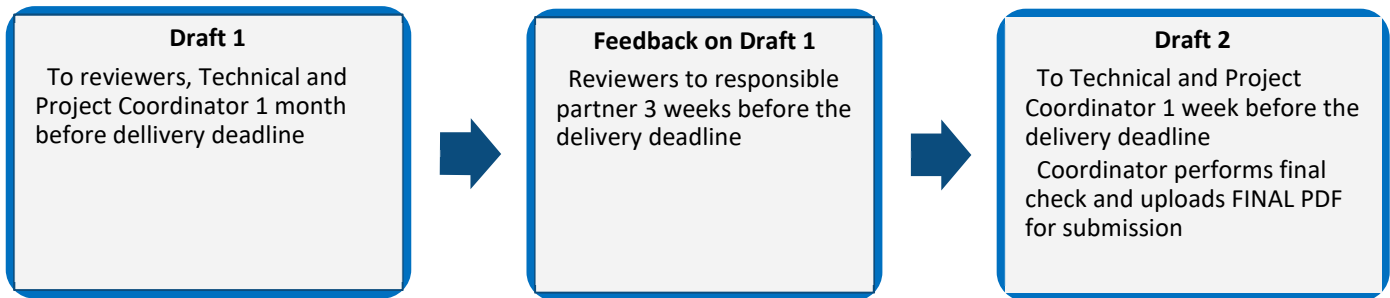


Figure 4. SeaClear2.0 deliverable approval process and timeline

o 1.4. Participants

The QA for deliverables is monitored and improved using a developed approval process involving two reviewers, the Technical project Coordinator and Project Coordinator. The main tasks and responsibilities of the QA participants are as follows:

- Deliverable Leader : prepares and submits the deliverable to the reviewers for review. The technical project coordinator has prepared a list with reviewers. The Deliverable Leader also informs the reviewers about their duties and the timeline of the review process.
- Reviewer : responsible for reviewing the deliverable of a WP by providing review comments in “track changes” and “comment” mode in the draft deliverable and evaluating the general deliverable acceptance. All reviewer comments should be clearly addressed in “track change” and “comment” mode in the draft deliverable.
- Technical project Coordinator : monitors the technical progress of the WPs based on their deliverables and indicates (in possible consultation with WPL) corrective actions when needed. The technical project coordinator manages the deliverable review process.
- Project Coordinator : performs the final check of the deliverables after the approval and submits the deliverables to the EC Funding Portal and to the shared Network Drive.


Members of the SC as well as members of the External Advisory Board can be consulted during this whole process.

o 1.5. Evaluation modality and criteria


During the deliverable review process, the comments of the reviewers and the Technical project Coordinator to the author(s) of the deliverable, and accordingly the updated deliverable by the author(s), are provided via reliable and traceable electronic correspondence.

Besides evaluating the technical content and consolidation results of the deliverables, the following checklist of general deliverable acceptance criteria is developed for reviewers to support the QA procedure :

- The description of the scope of the deliverable, as given in the DoA, is clearly presented in the Executive Summary and Introduction.
- The Table of Content clearly indicates where the main aspects in the description of the scope are addressed in the deliverable.

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- The key terms seen in the description of the scope are clearly used as part of the body of the deliverable.
- The consideration to other deliverables and other WPs/Tasks of the project is clearly addressed in Executive Summary.
- Explicit reference to earlier deliverables (on which the work of this deliverable is building) is made at least in the Executive Summary, Introduction and Conclusions.
- The content of the sections adequately covers what the titles of the sections indicate.
- It is explained where the data sets and code used in preparation of the deliverable can be obtained and/or has been uploaded.
- The Conclusions section concludes the deliverable with actual conclusions based on the content of the deliverable, and is not the same as the Executive Summary.
- The Conclusions includes an outlook on how and for which task the findings of this deliverable will be used.
- Descriptions must be technically correct and should be suitable for peer reviewers who are not experts in the specific technical domain.
- Consistency should be maintained in writing styles and text formats.
- Presence of project data and consortium information complies with the General Data Protection Regulation (GDPR).
- Avoid unnecessary use of acronym, always fully spell them at least at their first occurrence.
- Figures and tables should be readable when printed in A4 size.
- All text, figures and tables should be in the language of the Grant Agreement, the UK English.
- Avoid typos and misspelling, check the overall level of English language by selecting UK English.

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2. Innovation Management

Innovation Management will be conducted through a formal innovation process, monitoring defined performance indicators. An Innovation monitoring team has been formed for SeaClear2.0 and the progress will be monitored on a monthly basis during the development phase of the project.


o 2.1. Definitions

In a collaborative project like SeaClear2.0 that joins together different profiles (academic and industrial partners) with different expertise (electrical engineers and roboticists, biologists and recycling experts, economists and managers, coastal engineers, environmental engineers, aquaculturists, applied mathematicians and computer scientists, public engagement and policy expert) and different ambitions (scientific research, infrastructure development, commercialization), it is necessary to provide a shared definition of the innovation concept.

In the context of H2020, the Innovation Management Plan of the Project SeaClear2.0 will be based on the European Commission's (European Commission, 1995) definition for innovation, which is the "successful production, assimilation and exploitation of novelty in the economic and social spheres". From this perspective, invention is only a limited aspect of innovation, which entails all aspects of a project activity, ranging from vision to business, intellectual property (IP) and communications. In its wider definition, innovation offers new solutions to problems and responds to the needs of both the individual and society.

Innovation Management within European projects is a process that requires an understanding of market, legal, social, and technical issues, with the goal of successfully implementing appropriate creative ideas. The definition of innovation management adopted herein is "The way that an organization and its members manage their innovation activities, including processes and structures for monitoring and controlling of innovation".

According to the literature, the stages of development and pre-development activities belong to technology management (Specht, 2002), the field of R&D management is determined by adding upstream fundamental research, as well as product and process development. Finally, innovation management includes the final product and market introduction phase.

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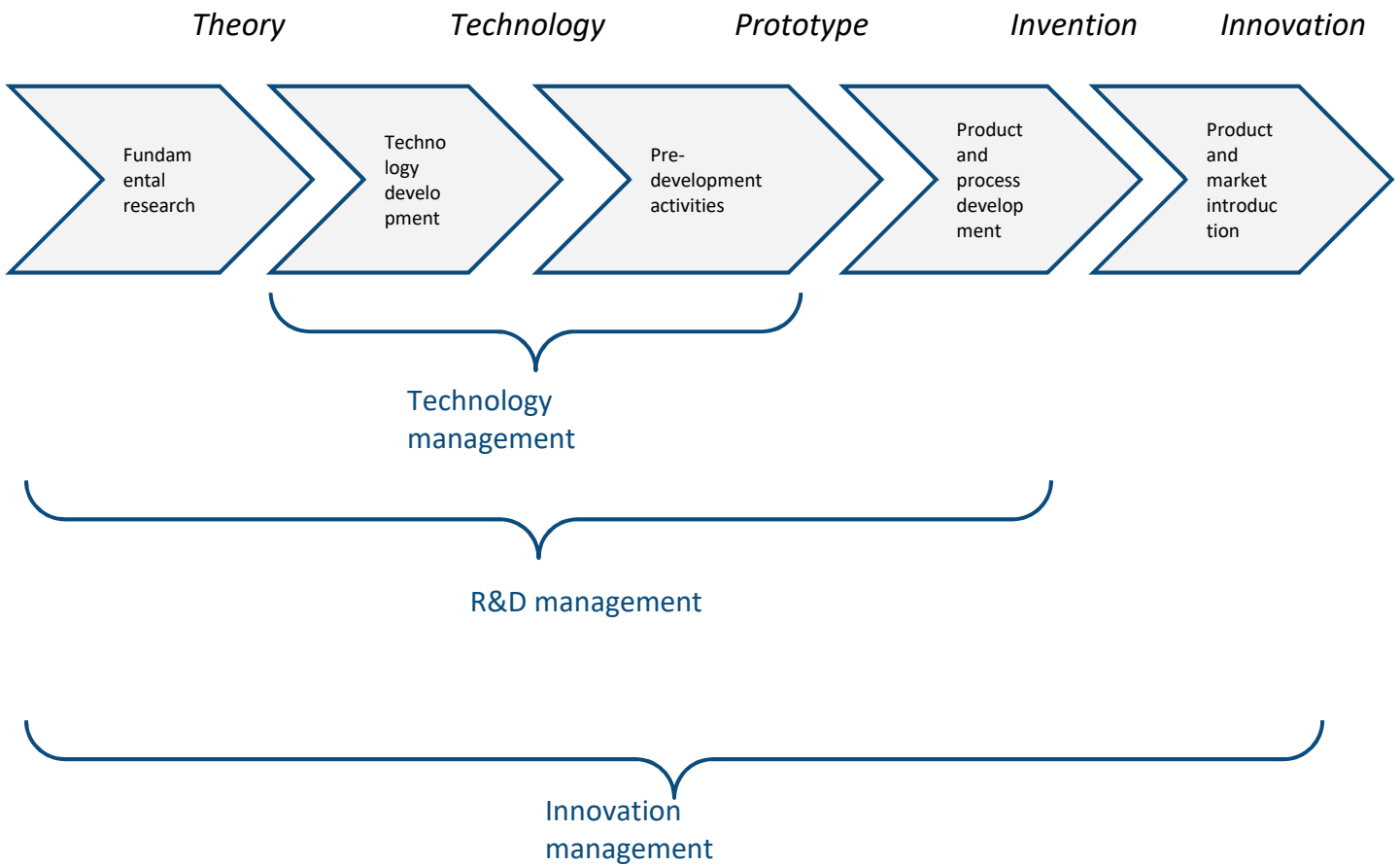


Figure 5. Classification of management phases (Specht, 2002)


○ 2.2. Innovation Management process

The innovation processes share some common basic activities that support the generation of ideas for new product and process development and the management of the entire innovation process. These fundamental activities are:

- Generation of ideas which potentially could become new products or processes after implementation.
- Acquisition of knowledge on the generated ideas.
- Implementation and market monitoring to verify customer satisfaction and after sales.

The Innovation Management Process as defined by the CEN standard 16555³ is shown below.

³ CEN/TS 16555 1-7 (2015) Innovation System

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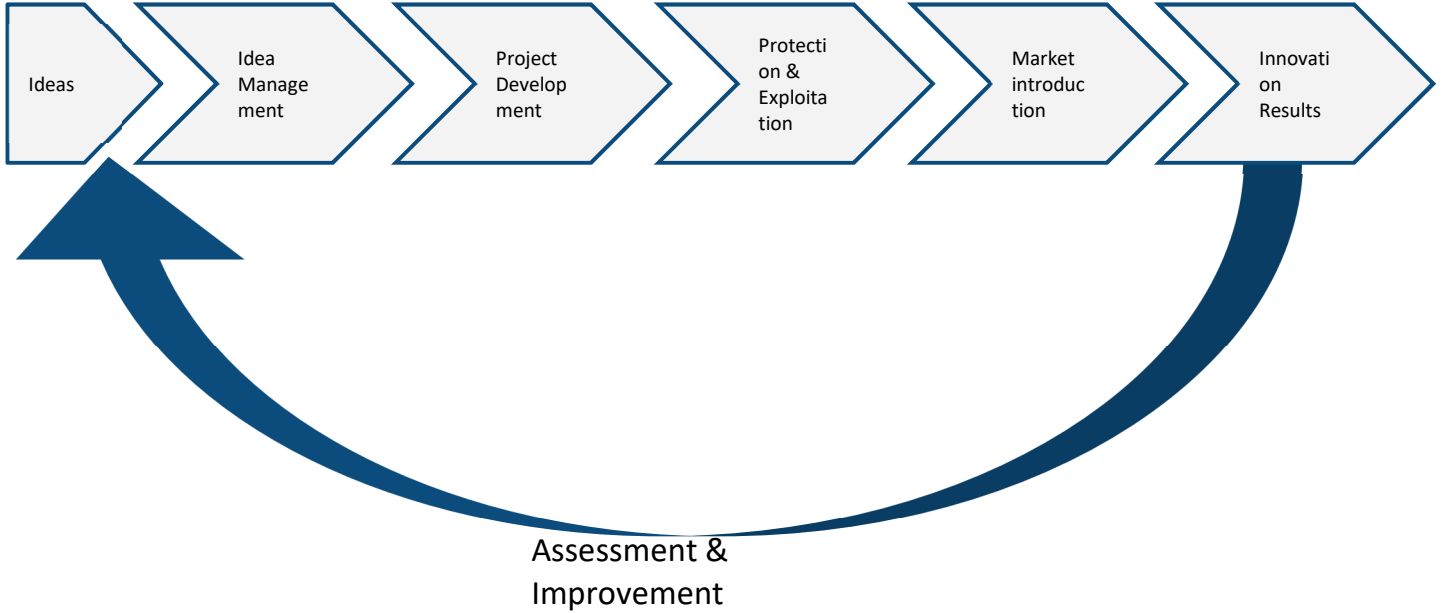



Figure 6. Innovation Management Process

○ 2.3. Key Project Objectives


The main project objective from the Introduction is refined next into five Key Objectives.

Table 1. SeaClear2.0 Key Project Objectives

| | |
|--|---|
| <p>Key Objective A :</p> <p>Reduce the pollution from litter and plastics in the Mediterranean sea basin and in regions outside the Mediterranean sea basin.</p> | <p>SeaClear2.0 will adopt a full-cycle strategy when it comes to addressing marine litter: Reduce, Analyze, Restore, Collect, Repurpose. We will begin by identifying site-specific solutions for preventing and minimising marine litter. Before collecting any litter, we will evaluate its potential impacts on the seafloor and marine wildlife. Collected litter will be sorted and analysed and its valorization, through recycling or repurposing, will be assessed.</p> |
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| <p>Key Objective B :</p> <p>Engage stakeholders, transfer knowledge and empower the citizens through innovative, participatory activities that will build ocean literacy and provide opportunities for active participation in marine litter identification, collection and monitoring.</p> | <p>The SeaClear2.0 systems consists of a team of collaborative, heterogeneous robots for in-situ mapping, detection, classification, and collection of marine litter from the seafloor and sea surface. Our team will build on the system that was developed in the EU-funded SeaClear project, to develop a more advanced system of autonomous robots with enhanced sensing that will be able to collect heavier litter items (up to 250 kg) from greater depths (up to 100m), and with greater autonomy.</p> <p>The SeaClear2.0 system components will be tested at three pilot locations, Ashdod (Israel), Venice (Italy) and Hamburg (Germany), whereas the entire system will be demonstrated in Dubrovnik (Croatia), Marseille (France), and Tarragona (Spain).</p> <p>As we want to maximise our work's impact, we will design an action plan and roadmap to scale and replicate our work through associated regions.</p> |
| <p>Key Objective C :</p> <p>Accelerated development of innovative SeaClear2.0 solution and proof of its technological readiness in an array of demonstrators and show-cases to minimize the pollution.</p> | <p>A key goal of SeaClear2.0 is to demonstrate the dual-system collaboration between SeaClear and SeaClear2.0. This will allow more efficient marine litter identification and collection, as well as the collection of heterogeneous litter (larger and smaller items) from diverse seafloor environments.</p> <p>The collaborative aspects between the SeaClear and SeaClear2.0 systems will be tested during a full size demo in Hamburg (Germany).</p> |
| <p>Key Objective D :</p> <p>Develop an upscaled technological innovative solution, both by demonstrating multiple systems working together to multiply the area covered, and by increasing the capabilities of the individual system with better sensing, collection, and handling larger objects and depths.</p> | <p>SeaClear2.0 will help create an ocean literate society by providing opportunities for citizen and other targeted stakeholder engagement in a series of activities and events planned at the project's demonstration and pilot sites. These will include cleanups for marine litter identification, collection, and monitoring through contests and digitalized gamification, workshops and exhibitions, calls for actions, and outreach events.</p> <p>Communities of Practice will be set-up at each of the demonstration and pilot sites. These Communities of Practice will include the main stakeholders at each site, those that can affect and be affected by the SeaClear2.0 project activities.</p> |

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| <p>Key Objective E :</p> <p>Outline the policy recommendations and a business plan to bring forth the innovative technologies for marine litter collection and reuse/recycling into everyday use.</p> | <p>SeaClear2.0 will contribute to better policy-making on two levels. At the local level, Communities of Practice and other stakeholders at the pilot and demonstration sites will be engaged, through participatory processes, in the identification of solutions for the minimization of site-specific marine litter. At the EU level, policies will be mapped and analysed to identify barriers, opportunities, synergies and coherence problems, and identify key factors and interactions that can support the uptake and wider use of our innovative solution.</p> <p>Information and data from the demonstrations and pilots, including the views of the engaged stakeholders, will be used to develop a feasibility study and a business plan that will facilitate the exploitation of the SeaClear2.0 system.</p> |
|---|--|


Each Key Objective is achieved by fulfilling ten Specific, Measurable, Achievable, Relevant and Timely (S.M.A.R.T.) Objectives, each backed by related Key Performance Indicators (KPIs).

o 2.4. TRL level

The TRLs that will be reached during SeaClear2.0 by the relevant technologies are summarized in Table 2, referenced to the current state-of-the-art TRL and to the TRL obtained within our first, SeaClear1.0 system.

| Technology | Existing TRL | SeaClear1.0 current TRL | Planned TRL |
|--|--------------|-------------------------|-------------|
| Experimental system prototype demonstrated in sea trials | - | 6 | 7 |
| UUV and UAV methodology for collaborative control | - | 4-5 | 6 |
| Prototype fuel-cell-powered USV: autonomous navigation and command of a smart grapple | 3 | 3 | 6 |
| Control system for autonomous navigation and grasping of submerged litter for a smart grapple | 3 | 3 | 6 |
| Prototype electrical-powered shuttle tender USV: autonomous navigation and collection of floating marine waste | - | - | 6 |
| Deep-learning underwater marine litter classification | 5 | 5-6 | 6-7 |
| Marine litter underwater mapping | 3 | 3 | 6 |
| Integrated marine debris identification & collection system | 6 | - | 6-7 |
| Social app for clean-up campaigns & awareness with data mgmt. | 3 | - | 5 |

Table 2. TRL advance brought by SeaClear2.0

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○ 2.5. IPR Management

The policy for securing IPR and for licensing is determined in the Consortium Agreement. The principles of IPR exploitation will comply with the European rules as laid down in the DESCA Model Grant Agreement.

In addition to the Consortium Agreement, SeaClear2.0 intends addressing further issues of acquired IPR within the exploitation plan. The exploitation plan will also include a section on Background IP which will allow the partners to clarify and agree :

- The essential background that they bring to the project,
- What the expected outcomes will be from using this background,
- And the benefits that could arise.

All this will ensure that the developments and the results of the project and IPR ownership rights are established before the execution of external advertisement.

Moreover, a deliverable [D10.2 IPR Strategy](#) presents the guidelines on the IPR management.

○ 2.6. Exploitation plans

The Consortium has already defined a business model canvas that forms the base to define a final business plan for the exploitation and commercialization of the system, either being operated as a whole or by single components.

Based on the canvas, our exploitation strategy and its expected impacts are summarized in Figure below.

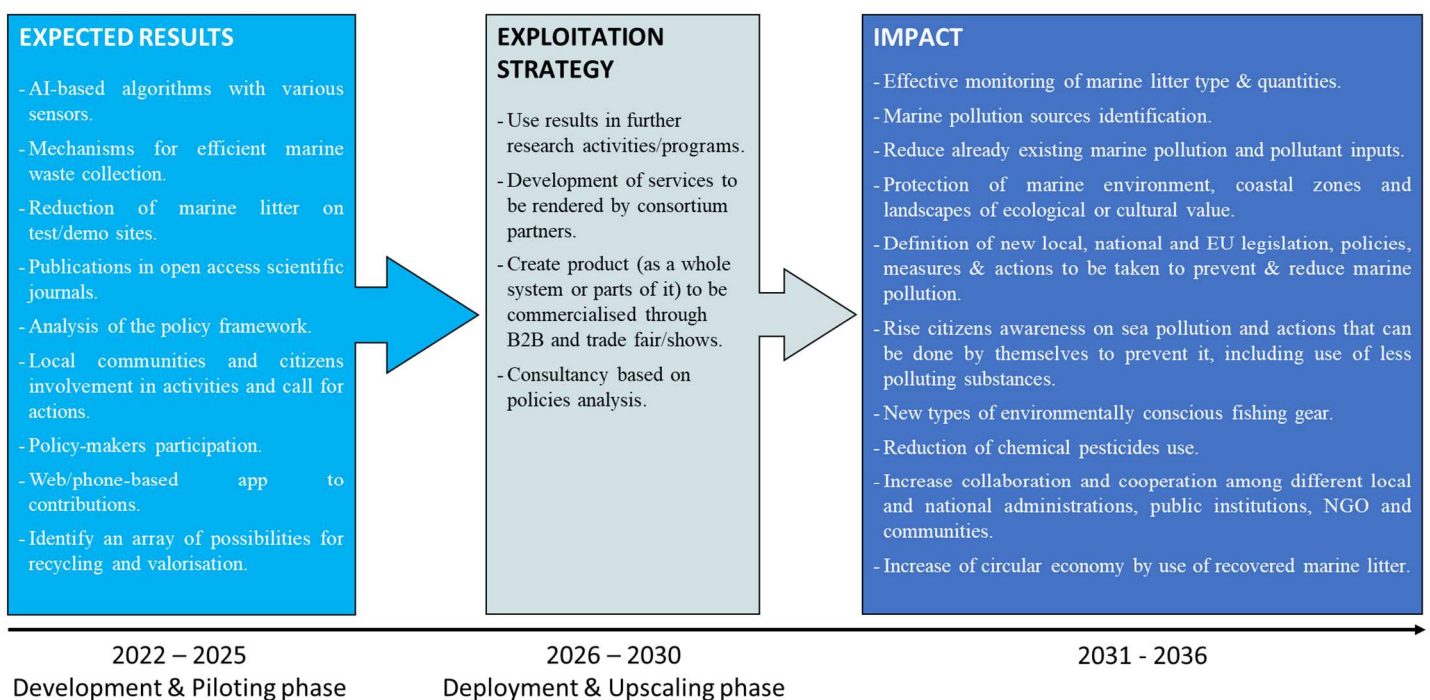




Figure 7. SeaClear2.0 position and exploitation strategy towards implementation and targeted impact

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3. Risk Management

This Risk Management plan intends to maximise the probability of success of the SeaClear2.0's project by identifying difficulties that the project could face and anticipating actions to prevent their occurrence or reduce their negative impact.

The SeaClear2.0's project brings together 13 partners from 9 different countries. In order to decrease the risks inherent from the complexity of such a large consortium, a management structure and related procedures were defined to cover key aspects of the project operation and coordination.

o 3.1. Risk Management process

Risk management is an on-going process to be carried out throughout the project life for identifying, quantifying, managing and monitoring threats.

The risk management process presented below is applicable for management, research activities or transnational access taking place within the SeaClear2.0's project. It describes how negative situations will be dealt with both at the project level and Work Package (WP) level.

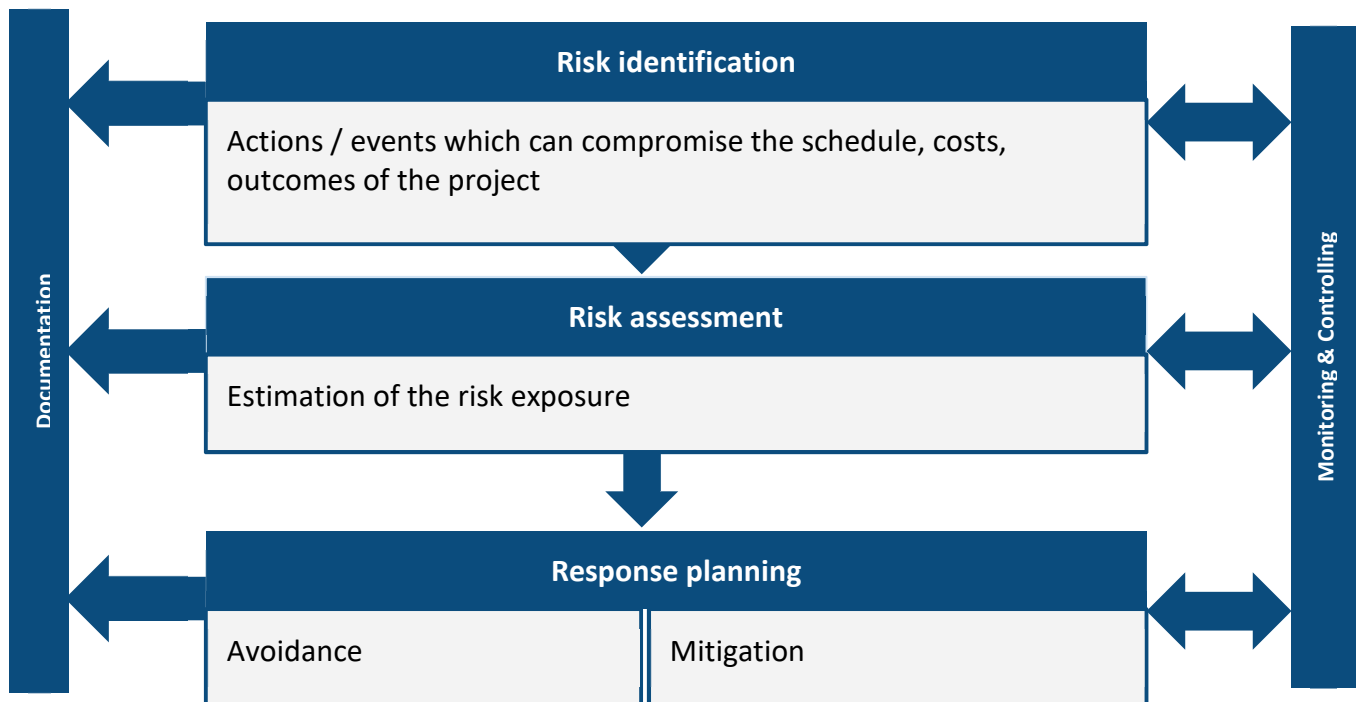


Figure 8. Risk Management Process

o 3.2. Risk identification

During the project building phase, a number of possible threats and their mitigation measures were identified. In the Grant Agreement, 22 risks were identified. These risks are discussed regularly and it might be that new risks will be identified during the implementation of the project.


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Table 3. Critical risks for implementation

| Foreseen risks as in DoA | Unforeseen Risks identified during project lifetime |
|---|--|
| <p>Right from the beginning of the project, all partners were urged to continuously assess the status of the risks identified in the project proposal and to identify new risks.</p> <p>This exercise is to be repeated every six months.</p> | <p>A regular assessment is set in place in order to identify new risks in time and anticipate on the consequences and come up with appropriate mitigation measures and contingency plans.</p> <p>This exercise is to be repeated every six months.</p> |

SeaClear2.0 is subject to a number of external factors that may influence the expected impacts of the project. The potential barriers, obstacles, and framework conditions were assessed through the PESTEL methodology.

Table 4. External risks

| Potential Barrier/Obstacle | | Mitigation Strategy |
|----------------------------|---|---|
| Political | The lighthouse mission is EU-backed, but significant impact in the Mediterranean basin requires (political) support of all adjacent countries. | The consortium already integrates members of non-EU states to widen the scope and impact of the project. Significant care will be taken to involve countries with pollution hotspots as either associated regions, in the citizen engagement or through informative campaigns. |
| Econom. | Financing project upscaling and follow up steps for upscaling service. | SeaClear2.0 intends to engage the customer pool of MDAnchor and TECNOSUB in the public demonstrations and pilot sites for attracting investments and contracts after the project's end. |
| Societal | Entry barrier into established clean-up communities and commercial diving operations, general public acceptance of robotic and app-based solutions. | SeaClear2.0 will organise informative campaigns to create understanding of the magnitude of marine litter compared to the actual job market for performing litter collection with human divers, the risks associated with these activities and also highlighting the complementarity with community actions. Consortium partners also have a strong track record in engaging with relevant communities / industry or leading key efforts. |
| Technological | Operating conditions throughout the Mediterranean sea show a great variety, requiring significant robustness of the technological solutions | The technological solutions for SeaClear2.0 are based on tested technology shown to work under various disturbances such as currents and turbidity. Emphasis is placed from the beginning of the project to identify potential issues in the concept case studies early on. |
| | Insufficient infrastructure for rapid scaling of the SeaClear2.0 solution and citizen engagement | Partners provide the resources for the initial scale-up phase of the project, both on the manufacturing side as well as in terms of cloud services. In case of overwhelming success of the |


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| | | citizen engagement platforms, flexible and scalable solutions such as AWS or Azure need to be integrated. |
| Environm. | Increased drought caused by the climate emergency and high tidal activity lower seasonal inland water levels and reduces USV accessibility to assets. | By intelligently combining the SeaClear1.0 and SeaClear2.0 solutions, the access to confined waterways and shallow waters will be manageable. In tidal ports such as Hamburg, the timetables of high and low tide are known in advance and operations are planned accordingly. |
| Legal | Legal constraints on drone and autonomous systems operations. | Legal framework regarding drones in all current demonstration and pilot sites has been checked. EU Regulation 2019/947, the legal framework for operating with unmanned vehicles has become homogenous among EU member states. Two partners (HPA and DUNEA) are experienced in obtaining permits for autonomous operations in port and coastal areas. |
| | Strict requirements on data management and GDPR compliance | SeaClear2.0 will develop a DMP, in which the entire work flow of the data used in providing the system's service is transparently explained and GDPR compliant design requirements are specified. Minimal data collected from individuals will be solely used for enabling normal usage of SeaClear2.0 services, such as the cloud services, to them. |


For the unforeseen risks, common risks and proposed risk-mitigation measures were identified.

Table 5. Internal risks


| Description of risk | WP(s) | Proposed risk-mitigation measures |
|--|---------------------------------------|---|
| Insufficiently trained personnel to run / maintain the system. | WP3,WP4, WP5,WP9 | Minimisation of user interaction, extensive technical guides, software testing with end-users is sought. |
| Partner underperforms or leaves the consortium | WPs in which that partner is involved | Redistribution of pending workload based on competencies of partners or identification of a replacement partner. The Consortium Agreement will foresee such situations and implement measures to prevent non-compliance to project activities. |
| Delays in the tasks' completion due to lack of resources | All WPs | Resources will be reallocated to ensure tasks complete with minimal delay and minimal impact of this delay. The work plan has buffers built-in so that minor delays do not impact downstream tasks. The Coordinator and management team will proactively identify possible critical paths in the project. |

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| Lack of permit obtention for demonstrations / tests | WP9, WP10 | The consortium will be early-on in close contact with authorities to assess requirements, contact for pilot/demo sites has already been established. |
| Insufficient number or quality of associated region proposals | WP1,WP7 | We proactively disseminate the project and call very early, intensifying as needed, together with targeted discussions with likely candidate regions. |
| Risk of dependency on results from the ongoing H2020 R&I project SeaClear | All WPs | The current state of development of the H2020 R&I project allows for implementation of a minimum viable product. Relevant hardware of SeaClear is finalised, tested and partially already in commercial use. Eventually required improvements in detection, classification and mapping will be targeted through sensors with better specifications and better datasets available through ongoing SeaClear trials. |
| Risk of dependency on IP background from the ongoing H2020 R&I project SeaClear | All WPs | All partners of the ongoing H2020 R&I project SeaClear are partners of SeaClear2.0 and agreed to carry over relevant IP background to the new project. Licenses are granted for the project duration within the grant agreement. |
| Partner underperforms or leaves the consortium | All WPs | Redistribution of pending workload based on competencies of partners or identification of a replacement partner. The Consortium Agreement will foresee such situations and implement measures to prevent non-compliance to project activities. For each WP, a co-lead is specified to seamlessly transfer WP management and ensure knowledge retention. |
| Export and import restrictions or bans on material or technology (e.g. Russia), protectionist trade policies reducing trade, delay in supply chains caused by pandemics | WP3,WP4, WP5 | Development of SeaClear2.0 components does not require technology, raw material, or software imports from sanctioned countries. Most hardware assemblies are done in France and Germany, with only subcomponents potentially subjected to global trade decrease. Delivery time for hardware will be conservatively estimated to avoid any blockages. |
| Unplanned environmental conditions | WP2,WP3, WP4,WP5, WP6,WP9 | Thorough evaluations of all environmental and seasonal impacts (water quality, turbidity, tides etc.). |
| Insufficient accuracy in litter detection | WP4, WP8,WP9 | Buffer time for adapting the existing litter detection to the respective environmental conditions of the various test sites is foreseen. |
| Embedded computing platform is insufficient to run the detection and classification algorithms at the required speed or the | WP4,WP5, WP6 | An additional full-size PC is included on the USV (the selected USV has the space and power for this contingency). We will centralize the computation as needed and move it to the USV to overcome this. Coordination between USVs can be supported via edge-computing on network resources. |

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| extended multilevel control architecture | | |
| The smart grapple cannot be manufactured / underperforms | WP3 | Off-the-shelf grapple systems can be adapted to ensure basic functionality of the system. |
| The desired level of autonomy cannot be achieved or errors in planning and action selection occur due to insufficient or imprecise knowledge of robots, environmental conditions or misinterpretation of perceptions | WP3,WP4, WP5,WP6 | Full integration and early tests of the framework and components will be a high priority in WP3/4/5/6 and reduce risks of insufficient knowledge for demonstrations. An analysis of components hindering a higher level of autonomy will identify candidates for replacement. If the problem cannot be isolated or is detected towards the end of the project, the autonomy goals will be revised. The TRL of the existing system guarantees baseline functionality. |
| High energy consumption | WP3,WP4, WP5 | Operation is restricted to areas within the energy budget. Optimisation of the system and software for the different environmental conditions is foreseen. |
| Malicious threats and cyberattacks carried out on the public SeaClear2.0 domains. | WP9 | In a pilot phase, our system is only accessible via internal networks. External interfaces will be rolled out after comprehensive tests, with state-of-the-art encryption. Sensitive data is stored in professional cloud services with proven resilience against attacks. |
| Presence of ammunition void the possibility to perform robotic-aided collection | WP9 | SeaClear2.0 increases the effectiveness of ammunition detection and disposal procedures by using electromagnetic devices for detecting possible dangerous targets and providing exact coordinates of potential threats to local authorities. |
| Conflicts over ownership | WP10 | Conflicts will be resolved per Management Procedures. The Consortium Agreement and ongoing IPR inventory, supported by the Quality Manager will ensure proper protection of generated and prior IPR. |
| Poor social acceptance of robotic systems by entities and unions providing the services, negative public opinion regarding the future of the job market for divers. | All | SeaClear2.0 will organise informative campaigns for creating an understanding of the magnitude of marine litter compared to the actual job market for divers collecting litter and the associated risks. The active dissemination strategy will outline safety, non-invasive usage and environmental benefits. |
| Divergence between the product developed by the SeaClear2.0 consortium and the needs of end users | WP2,WP7, WP10 | Continuous incorporation of end users' point of view into the design and refinement process. Analysis by categories: type of litter to handle, cost to deploy, characteristics of end user sites. |

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| High infrastructural costs | WP10 | Project targets efficient and low-cost solutions. Solutions from prior projects for scaling up are already within the budgeted cost range. |
| Risk of usage of collected data on third-party interest | WP6,WP9, WP10 | The data management plan coupled with our Ethics procedures provide a safe and transparent flow of data, ensuring compliance with GDPR. |

○ 3.3. Risk assessment

For each identified risk, the SC will estimate the probability for them to occur and the impact of these problems on the project (Low/Medium/High). The risk exposure matrix below will serve to estimate the risk level.

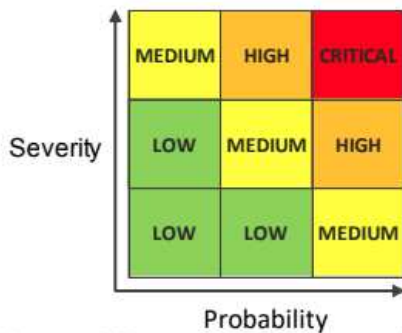


Figure 8. Risk exposure / Risk matrix

○ 3.4. Response planning

At project meetings, risks are a reoccurring discussion point. New or existing risks that become a threat to the project outcomes will be communicated directly.


Following the evaluation of the risk exposure, the following strategies will be taken (depending on the risk category):

- For high and medium - priority risks: Mitigation.

Risk mitigation involves reducing the probability and/or the impact of a risk to an acceptable level. Taking early and proactive action against a risk is often more effective than attempting to repair the damage a realised risk has caused. Contingency planning is an example of risk mitigation. The corresponding mitigation measures are also displayed in the Deliverable D2.3 Risk Management Plan

- For low-priority risks: Acceptance.

Acceptance is often taken as a risk strategy since it is very difficult to plan responses for every identified risk. Risk acceptance should normally only be utilised for low-priority risks. Risk acceptance can be passive, where no action is taken at all, or active. The most common active approach to risk acceptance is to develop a cost and/or schedule revision to accommodate known (or unknown) threats. Utilising a risk acceptance approach determines that the risk should be monitored rather than reassessed.

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○ 3.5. Monitoring and controlling

Each partner has the responsibility to immediately report any Innovation and/or Risk Management issues that arises and may affect the project objectives or its successful completion.

The SC meets monthly to coordinate and manage the Innovation and Risk Management activities and tasks. Also, the Technical Coordinator & Project Coordinator will monitor them closely.

Any new risks and/or challenges that might affect the intended outcomes of the project will be discussed and resolved in consultation with the EC Project Officer to ensure that the original goals of the project are fulfilled.

The risk exposure will be continuously reevaluated and modified accordingly. The list of risks will also updated throughout the project lifetime (in the periodic reports).

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4. Conclusion

As a result of a well-defined internal review procedure for the SeaClear2.0 deliverables, and by monitoring the defined risk matrix, the consortium ensures the project objectives and deliverables are under expert supervision and the risks are managed on time.

This ensures that SeaClear2.0 provides high quality deliverables on time, preventing approval issues by the European Commission. More importantly, this ensures that the SeaClear2.0 goals are met, and that we are creating maximum impact.