QUIETSEAS - Assisting (sub) regional cooperation for the practical implementation of the MSFD second cycle by providing methods and tools for D11 (underwater noise).

D7.1. Data management tools for harmonization and noise data sharing

This project has received funding from DG Environment of the European Commission within the "DG ENV/MSFD 2020 call" under grant agreement No. 110661/2020/839603/SUB/ENV.C.2.

Document information	
Deliverable	Data management tools for harmonization and noise data sharing
Document Number	QUIETSEAS – D7.1
Delivery date	31st December 2022
Call	DG ENV/MSFD 2020 call
Grant Agreement	No. 110661/2020/839603/SUB/ENV.C.2

No	Participant organization name	Participant short name	Country
1	Centro Tecnológico Naval y del Mar	CTN	Spain
2	Permanent Secretariat of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area	ACCOBAMS	Monaco
3	Service hydrographique et océanographique de la marine	Shom	France
4	Politecnico di Milano-Department of Civil and Environmental Engineering	POLIMI-DICA	Italy
5	Hellenic Centre for Marine Research	HCMR	Greece
6	Inštitut za vode Republike Slovenije/Institute for water of the Republic of Slovenia	IZVRS	Slovenia
7	Specially Protected Areas Regional Activity Centre	SPA/RAC	Tunisia
8	Maritime Hydrographic Directorate	MHD	Romania
9	Department of Fisheries and Marine Research	DFMR	Cyprus
10	International Council for the Exploration of the Sea	ICES	Denmark

Dissemination level	
PU: Public	X
PP: Restricted to other programme participants (including the Commission Services)	
RE: Restricted to a group specified by the consortium (including the Commission Services)	
CO: Confidential, only for members of the consortium (including the Commission Services)	

Date	Revision version	Company/Organization	Name and Surname
22/11/2022	Draft0	CTN	Noelia Ortega
29/11/2022	Draft1	CTN	Pablo Ruiz
29/03/2023	Draft2	ACCOBAMS/Sinay	Alessio Maglio
25/04/2023	Draft2.1	IEO	Manuel Bou
26/04/2023	Draft 2.2	Oceancare	Sigrid Lueber
27/04/2023	Draft 3	CTN	Pedro Molina
28/04/2023	Draft 4	CTN	Pablo Ruiz
28/04/2023	Final version	CTN	Tania Vera

Abstract

This document is the Deliverable "D7.1. Data management tools for harmonization and noise data sharing (31st December 2022)" of the QUIETSEAS project funded by the DG Environment of the European Commission within the call "DG ENV/MSFD 2020 call". This call funds projects to support the implementation of the second cycle of the Marine Strategy Framework Directive (2008/56/EC) (hereinafter referred to as MSFD), in particular to implement the new GES Decision (Commission Decision (EU) 2017/848 of 17 May 2017) laying down criteria and methodological standards on Good Environmental Status (GES) of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU) and Programmes of Measures according Article 13 of the MSFD. QUIETSEAS aims to support the practical development of the second implementation cycle under the MSFD for D11 (underwater noise). It covers thematic priorities 1e), 1f) and 2b) of the call by i) identifying specific impact indicators (for sensitive species-marine mammals) to enable D11C2 risk-based assessment; ii) promoting the consolidation of pressure and impact indicators for D11C1; iii) providing common methodologies to facilitate the implementation of assessment frameworks and setting thresholds values; iv) delivering two tools for effective risk based management of D11C1 and D11C2 to assist regional and subregional cooperation for the GES assessment ; v) assessing the effectiveness of potential coordinated measures to reduce the pressure caused by the opportunistic slowdown of the maritime traffic during COVID-19 and vi) building capacities to ensure knowledge transfer, capitalization of results beyond the life of the project and results that align with and support MSFD.

This document details both technically and functionally the common tool for underwater sound (D11 - MSFD) monitoring and assessment in the Mediterranean and Black Sea regions.

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List of Abbreviations

CTN	Centro Tecnológico Naval y del Mar
ACCOBAMS	Permanent Secretariat of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
DFMR	Department of Fisheries and Marine Research
IZVRS	Inštitut za vode Republike Slovenije/Institute for water of the Republic of Slovenia
HCMR	Hellenic Centre for Marine Research
UM	University of Malta -The Conservation Biology Research Group
POLIMI-DICA	Politecnico di Milano-Department of Civil and Environmental Engineering
SPA/RAC	Specially Protected Areas Regional Activity Centre
ICES	International Council for the Exploration of the Sea
Shom	Service hydrographique et océanographique de la marine
MHD	Maritime Hydrographic Directorate
MSFD	Marine Strategy Framework Directive
GES	Good Environmental Status
MS	Member States
MED	Mediterranean Sea
BS	Black Sea
CA	Competent Authority
NR	National representative
SO	Specific Objective
TB	Thematic Block
DB	Data Base

1. Introduction

The QUIETSEAS Project is funded by DG Environment of the European Commission within the call "DG ENV/MSFD 2020". This call funds MSFD development, in particular, the preparation of the next 6-year cycle of implementation.

The QUIETSEAS project aims to enhance cooperation among Member States (MS) in the Mediterranean Sea Region (MED) to implement the third Cycle of the Marine Directive and in particular to support Competent Authorities and strengthen cooperation and collaboration in the Mediterranean Sea and Black Sea regions through the following specific objectives:

- Specific objective 1 (SO1): To identify relevant indicators for criterion D11C2 (Anthropogenic continuous low-frequency sound in water).
- Specific objective 2 (SO2): To promote the consolidation of relevant indicators for D11 and support the operationalisation of indicators on the state, pressure and impacts of underwater noise in close coordination with TG Noise.
- Specific objective 3 (SO3): To promote harmonisation of regional work on threshold values with TG Noise recommendations.
- Specific objective 4 (SO4): To develop effective and efficient mechanisms for GES assessment and regional coordination by providing management tools for harmonization, reporting and assessment of D11.
- Specific objective 5 (SO5). To demonstrate the potential effectiveness of coordinated mitigation measures to reduce shipping noise.
- Specific objective 6 (SO6): To promote (sub)regional cooperation to ensure i) coordination across the region/ subregions ii) the involvement of Competent Authorities, and iii) long-term dissemination of the results.

To achieve its objectives, the project is divided into 4 work packages (thematic blocks) and 9 activities whose relationships are shown in Figure 1.

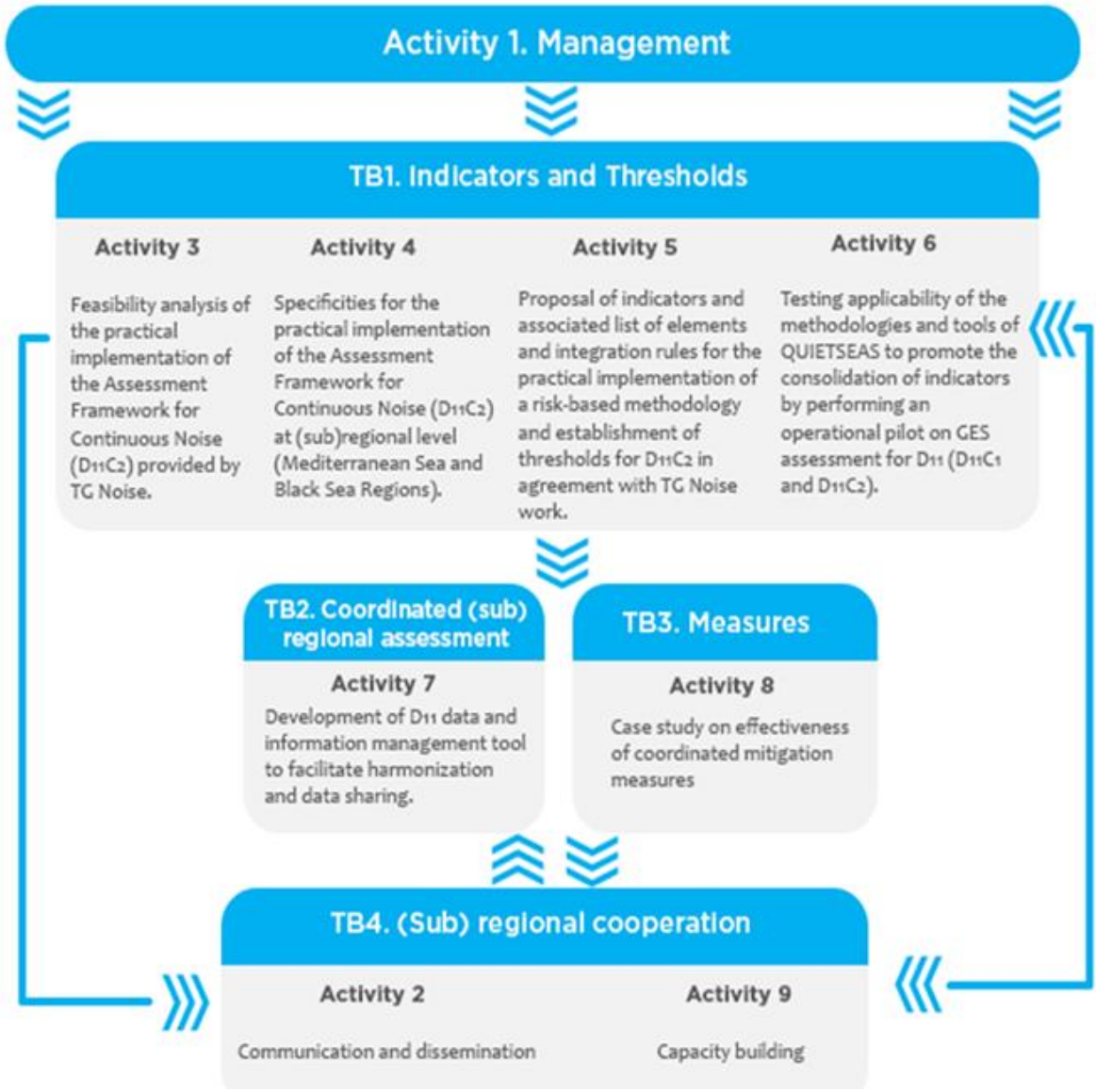


Figure 1.Diagram of project workflow

The project is developed by a consortium made up of 10 entities coordinated by CTN and it has a duration of 28 months starting on 1st February 2021.

2. Definition and specification of requirements of the tool.

2.1. General definition of the software project.

The main objective of the developed software is to provide ACCOBAMS with an integrated solution for the management of data on underwater noise at a regional level under the scope of the MSFD-D11. The solution can be used also for IMAP Common Indicators 26 and 27 under the EcAp initiative led by the Barcelona Convention, and is aimed at being the single gate for contributing countries to share their data according to the rules and procedures agreed with the ACCOBAMS Secretariat.

The specific objectives of this activity were:

- **D11C2 + D11C1 -** Implement and test a complete tool for D11 with new functionalities related to continuous noise (D11C2).
- **D11C2 Data Management -** Support the management, harmonisation, data sharing and reporting of continuous noise data.
- **Facilitate D11 GES Assessment -** Support of the implementation of the monitoring programmes on continuous noise.

The development of this tool is closely linked with other activities within the project:

1. *The practical implementation of the Assessment Framework for Continuous Noise, addressed in Activities 3 and 4.*
2. *The preparation and launch of Data Calls for continuous and impulsive noise data, under activity 6.*
3. *The first trials of application of the complete assessment methodologies for underwater noise, also under activity 6.*
4. *Supporting (sub)regional cooperation, especially through dedicated events for the identified users of the tool, organized under Activity 9.*

The tool facilitates access at different types of users:

1. *Competent Authorities and/or personnel responsible for the national implementation of MSFD-D11.*
2. *Marine scientists.*

2.2. Technical scope of the new portal.

The starting points for the development of this tool are the Impulsive Noise Register in the Mediterranean Sea Region (INR-MED) developed within the QUIETMED project[1], and NETCCOBAMS, the collaborative management tool of the ACCOBAMS Secretariat. The former was built to specifically tackle the implementation of D11C1, while the latter

[1] Project funded by the DG Environment-European Commission. http://www.quietmed-project.eu/

addresses continuous noise (D11C2) as one of the several topics falling under the scope of the ACCOBAMS Agreement.

The 3 main aspects to work on to harmonize and improve the two platforms were the following (Fig. 2):

- **Set up a single entry to access both tools.**
    - Main homepage
    - Descriptive content and introductory sections
    - Help, Contact, FAQ, etc.
- **Common user register/login system.**
    - To upload/download data
    - To manage the portal
- **Common design & UX/UI.**
    - Both tools should follow design guidelines.

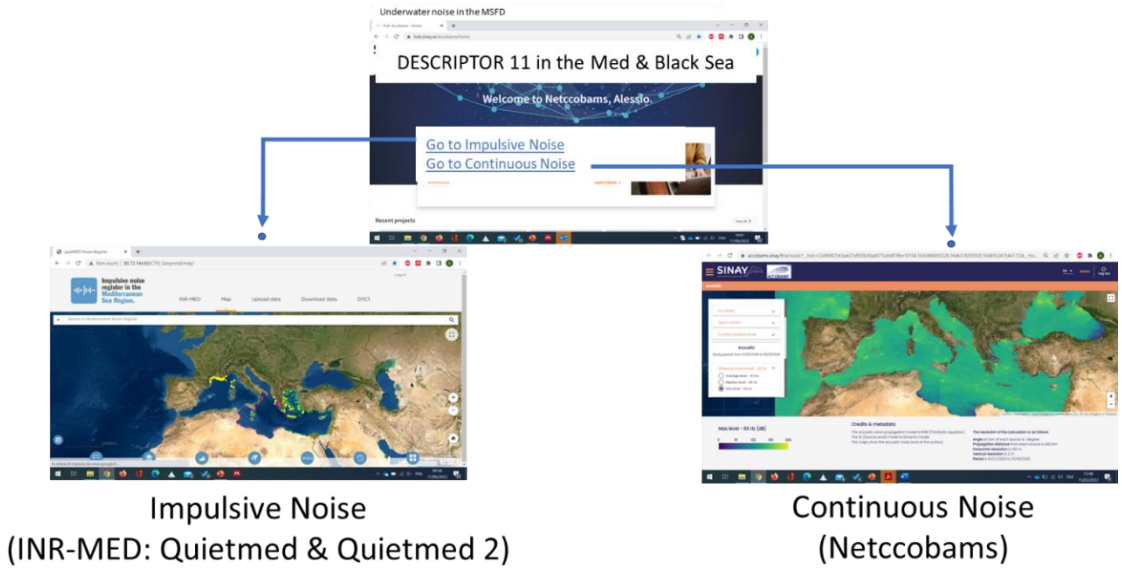


Figure 2. Overview of the technical scope: harmonisation of the INR-MED (bottom-left) and Acoustic Map module of NETCCOBAMS (bottom-right) into a single entry portal (upper picture).

Currently, this new portal for underwater noise monitoring and assessment in the Mediterranean and Black Sea regions can be accessed and explored from the following provisional URL (Fig 3): **https://quietseas.ctnaval.com/**

There is no open registration process. Quietseas tool access is granted to authorities and Quietseas partners. However, access credentials can be requested through the contact form in https://quietseas.eu/contact.

Figure 3. Detail of Quietseas homepage including INR-MED and Netccobams tool in relation with underwater noise for the Mediterranean and Black Sea.

3. Software Architecture

3.1. Main architecture

An **API-REST** type architecture has been adopted to carry out the communication between a *client* and a *server*, implicitly the *front-end* of the application is a client and the *back-end* of the application is a server. In this modality the front-end makes HTTP requests of type *get*, *post*, *put* and *delete* to the *back-end* and latter returns the appropriate response to the front-end whenever it is requested.

By having each part of the system composed in separate repositories some development advantages are achieved; these include programming language and technology independence between a client and a server, reliability, scalability and flexibility for handling various data payloads, improvements in user experience, and better computer resource usage at each part.

The *back-end* has been developed on the Django framework, which is also programmed with Python 3. In addition, the Django Rest Framework library is used to display the necessary API-REST endpoints.

For its part, the *front-end* has been based on the JavaScript library Vue.js, which caters to the creation of a modular component *Single Page Application (SPA)* with the very latest design advantages and qualities. In addition, the *Vuex* module is used to manage the state of the application whilst a user is interacting with a web page.

3.1.1. About external systems integration

API-REST architecture, and modular software design, grant this tool a great scalability value. These features allow, if required, to implement as many endpoints as necessary to access data, filtered, sorted, and formatted as needed. Therefore, noise data from Quietseas project may be integrated into external systems or applications.

3.2. Hierarchical description

A diagram is presented below where the relationships of each module in the application are conceptually shown.

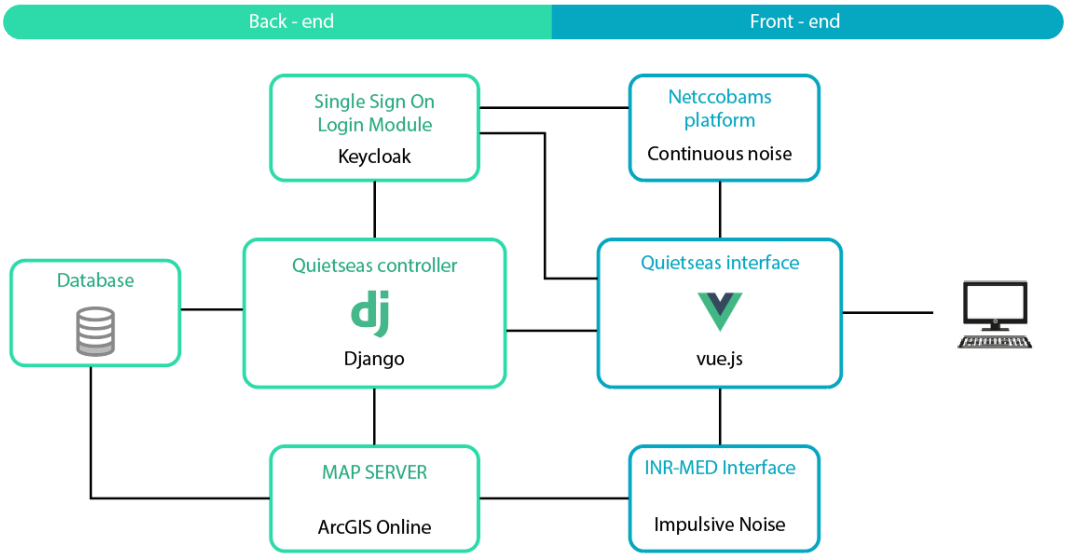


Figure 4. Conceptual view of the architecture of the tool.

3.3. Underwater impulsive and continuous noise utilities implemented

1. **Quietseas Interface:**

   - *General description:* This module serves as an entry point for users to interact with the system.

   - *Responsibility:* It is responsible for bringing together all the interface modules, and it connects with the login module to authenticate users, so they can browse between the rest of the modules.

2. **INR-MED Interface:**

   - *General description:* This module manages all functions related to **impulsive noise**, including visualization, data exchange, and calculation of indicators.

   - *Responsibility:* Its main function is displaying map layers with information about impulsive noise source events, and display the results of D11C1-MSFD calculations. It includes 3 sub-modules:

   Impulsive Noise Register: It is in charge of offering the information related to the impulsive noise register as set out in the TG-Noise technical guidance**.** As the most relevant functionality, Map Server provides:

   1. D11C1 Days: “pulse-block days” (PBD) proposed by TG-Noise, which considers the number of days one or more impulsive noise events (pulses) occur in a block.

2. D11C1 Area: spatial quantities in terms of area percentage, calculated as the ratio of the number of grid cells with pulse-block days (PBDs) to the total number of grid cells of a marine region or subregion.

Upload: This module allows data on underwater noise generating activities to be uploaded to the DB.

1. Upload module uses a reporting system based in an Excel template to ensure compatibility with OSPAR and HELCOM (ICES´s underwater noise registry).
2. XML files are generated using the Excel template, which are ready to be uploaded.

Download: This module allows users to download impulsive noise data to a local system, in different common formats such as CSV or SHP.

1. Raw data stored in data base, such as Mediterranean regions and noise activities.
2. Processed data stored in the map server.

3. NETCCOBAMS Hub:

- *General description:* This is the tool implemented by Sinay for ACCOBAMS to address the conservation objectives of the Agreement through digitalized and data-driven processes. It addresses 3 main scientific topics: shipping noise, climate change, and marine litter.

- *Responsibility*: through the NETCCOBAMS homepage, the user can access the Acoustic Map module, where information on shipping noise is offered in the frequency bands recommended by the TG-Noise technical guidance, and the "Project" page where the user can create a space (a project into the platform) of where to manage data and information related to monitoring and assessment activities.

Acoustic Map: this module displays mean, median and P95[2] shipping noise maps in the 1/3 octave bands centred at 63 Hz and 125 Hz. The maps are updated periodically since 2020. Maps can be used for the preparation of reporting and assessments.

Projects: this part of NETCCOBAMS is for the management of data and information:

[2] P95 = 95th percentile, i.e. the value that divides a statistical distribution in two parts, one containing 95% of the values (lower than P95) and the other the 5% of values (higher than P95). The P95 noise value provides information about the highest noise levels estimated in the study area.

1. *Creating a project, e.g., on the monitoring and assessment activity carried out by one or more institutions.*
2. *Uploading and downloading monitoring data in HDF5 format, consistent with the data exchange format established in other geographical areas of the EU (northern European seas).*
3. *Uploading and downloading reports and documents relative to the monitoring and assessment activities.*

4. **Single Sign On:**

- *General description:* This module contains the centralized user data base.
- *Responsibility*: It allows login from the main Quietseas interface and connects with the various modules that require authentication, such as the back end, INR MED, and the Netccobams platform, to verify user credentials.

5. **Map Server:**

- *General description:* This module represents the server that hosts the map information layers required in the tool.
- *Responsibility:* Map Server provides map information through the Internet, usually as images or vector graphics. The standard specification for such a server followed in this project is the OGC Web Map Service. As the most relevant functionality, Map Server provides:

1. Geolocated points with information (values) of any given parameter.
2. Geolocated polygons, that can be drawn on the map to mark areas or regions.
3. Geolocated lines, useful to show trajectories on the map.
4. Geotiff images that can be positioned on the map.
5. Graphic information styles, such as colours, transparency or legends, that make easier for the user to analyze the information displayed on the map.

6. **Quietseas controller:**

- *General description:* This module contains the program logic. The controller processes data and connects to the Data Base to store it and send it to the front-end interface.
- *Responsibility*: The program logic consists in all the functions to process data, and to make calculations to obtain D11C1 Days and D11C1 Area. This module stores all the information in the Data Base, and connects to the Map Server and interface modules to provide this information to the users.

7. **DB:**

- *General description*: Geospatial Data Base that allows storing data with spatial information.
- *Responsibility:* The sole purpose of the Data Base module is to store and provide all data needed for the rest of modules to work. A PostGIS DB is implemented to ensure this data can be positioned in a map. It is a geospatial extension of PostgreSQL DB that can store not only regular data, but also points, lines, polygons and raster files with spatial information, regardless of the geographic reference system used.

4. Technical Aspects.

This section details the technologies that have been used in the implementation of this project. An explanation of the following is provided: the back-end technologies, the front-end technologies, the external dependencies used and, lastly, tools that are necessary to deploy the application into production.

4.1. Back-end Technologies

For the development of the server part, or back-end technology, the open-source Django framework is used together with Python 3.x. This framework allows development of Python code in an elegant and effective way based on an MVC model (Model-View-Controller). This framework is currently in constant maintenance and expansion by its developers, which ensures the continuity and security of the framework, with regular updates. In support of Django, several libraries have been used that allow extra functionality.

As an important backend element, ArcGis Online platform is chosen as a map server. It stands out for its quality, functionality and robustness. The disadvantage is the need for a license to operate it in development (not for the end user).

Regarding the database engine, PostgreSQL has been used. It is open source and currently the most popular in the world for developments that involve storing geo-referenced information. PostgreSQL is a post relational database system and can encode a variety of data formats other than tables thus allowing for greater flexibility to meet data requirements and a reasonable performance with a high level of portability, security and robustness assured. These data tables are related in defined ways, making it possible to combine different data into multiple tables and connect them.

On the other hand, Nginx has been chosen as a lightweight and high-performance web server. It is free and open source software, licensed under the Simplified BSD License. In addition, it is cross-platform, so it runs on Unix-like systems (e,g. GNU / Linux, BSD, Solaris, Mac OS X) and Microsoft Windows.

Keycloak has been implemented to authenticate users and manage access between the CTN and the NETCCOBAMS Hub. It is an open-source identity and access management platform that allows users to authenticate and manage access to web applications and services. It provides features such as single sign-on, social login, user federation, and multi-factor authentication, among others.

4.2. Front-end Technologies

As the main technology for programming the rendering of the web application, the Vue.js framework has been selected. This is also open source, and it is based on JavaScript. One of the most important features of Vue.js is its component programming. This fact makes it possible to develop the project in a modular way and that, in turn, is easy to adapt and scale. To support Vue.js, Vuex has been adopted; it is a complete library that allows managing the state of the application whilst a user is interacting with it.

In relation to the actual style technology, the designs have been based on the Bootstrap framework. It is one of the most popular and widely used frameworks, since it allows a developer to prototype ideas and build a complete application with variables and Sass combinations, responsive grid system, extensive pre-compiled components and highly configurable plugins integrated in jQuery.

4.3. External libraries:

The project uses some external libraries to be able to carry out the functionalities required by the application and provide a good user experience.

1. *Maatwebsite Laravel Excel:* Is a library to export and import Excel documents, which optimizes its creation and editing from our application environment.
2. *Chart.js*. It is a JavaScript library that uses HTML5 canvas and allows for graphical artefact creation in web environments.
3. *Node Package Manager:* Is a package manager that allows the developers to manage node modules, compile vue and sass components.
4. *Sass:* The sass preprocessor is an improved version of CSS that facilitates the development of modular CSS code.

4.4. Production Environment

In relation to the deployment of the application, both in development and in production, it has been decided to use Docker. Docker is a set of open source tools with which you can easily create what are known as "virtual containers". These allow you to have all the necessary technology to deploy an application regardless of the operating system over which it is run. The main features of these containers are portability, lightness, and self-sufficiency. Its main advantage is that it provides for testing applications and systems in a safe environment equal to that of

production, thus reducing test times and adaptations to hardware changes from the environment test to production.

5. Annex - Main content available in the new D11 portal

5.1. Impulsive noise

The main content includes records of impulsive noise events in the Mediterranean Sea and Black Sea as well as hotspot maps and D11C1 indicators.

1. *Noise events*

A simple spatial map can be generated for each data entry. The portal allows selecting and plotting noise data and filtering these data in an interactive map.

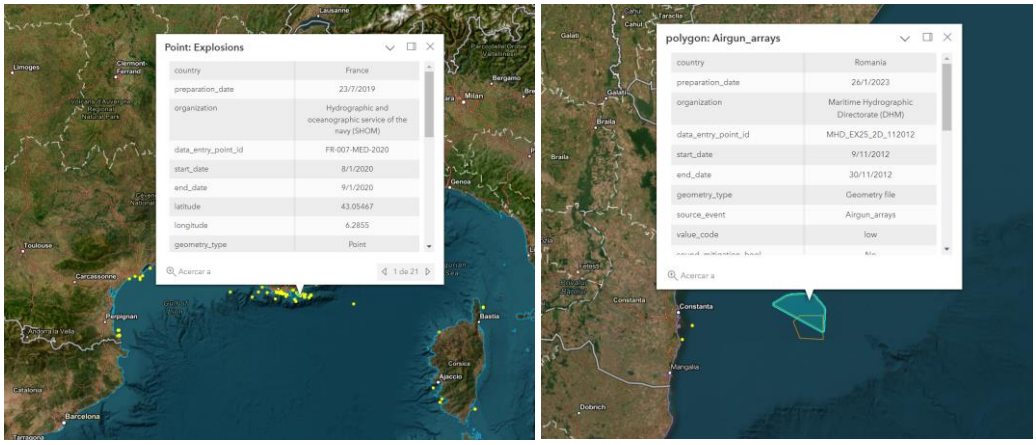


Figure 5. Plotting of noise events with display of metadata.

2. *D11C1 Days*

Hotspots maps in the INR-MED report the number of pulse-block days (PBD) per unit areas, per month or per year. The PBD is a metric proposed by TG-Noise which considers the number of days one or more impulsive noise events (pulses) occur in a block. Here the concept of "block" applies to grid cells of the spatial grid selected for the INR-MED, as well as to each subregion and to the whole region. For several impulsive noise events, in case they occur in the same day, only one day will be counted in the computation process.

3. *D11C1 Area*

The INR-MED provides spatial quantities in terms of area percentage, as one of the options implementing the Commission Decision 2017/848. The percentage is calculated as the ratio of the number of grid cells with pulse-block days (PBDs) to the total number of grid cells of a marine region or subregion. Therefore, when a block (grid cell) has an impulsive noise event contained in it (no matter how many PBDs), that block participates in the calculation of this percentage for the period of reference (month, or year).

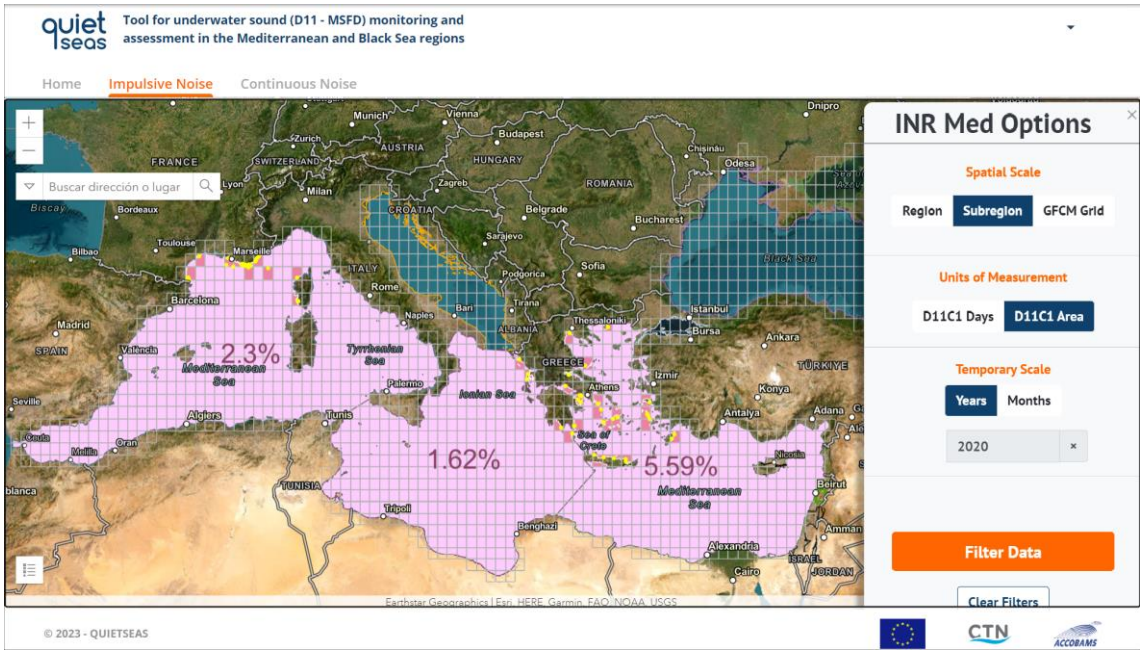


Figure 6. D11C1 area, following the methodology described in Deliverable 4.1. Joint register for impulsive noise in the Mediterranean Sea Region.

The Deliverable 4.1. Joint register for impulsive noise in the Mediterranean Sea Region produced under the QUIETMED project provides detailed specifications on how the calculations are made.

5.2. Continuous Noise

The main content includes the shipping noise maps in the Mediterranean Sea and Black Sea as well as the Project part for the creation of a dedicated map for monitoring and assessment activities. For more information on the scientific approach implemented for the noise modelling and mapping, the reader can refer to the document SC14.Doc36_Progress-report-on-the-implementation-of-NETCCOBAMS, available in the ACCOBAMS website.

1. *Average, median and P95 levels in the 1/3 octave band centred at 63 Hz and 125 Hz*

The following pictures show the median and P95 for 1/3 octave band centred at 63 Hz.

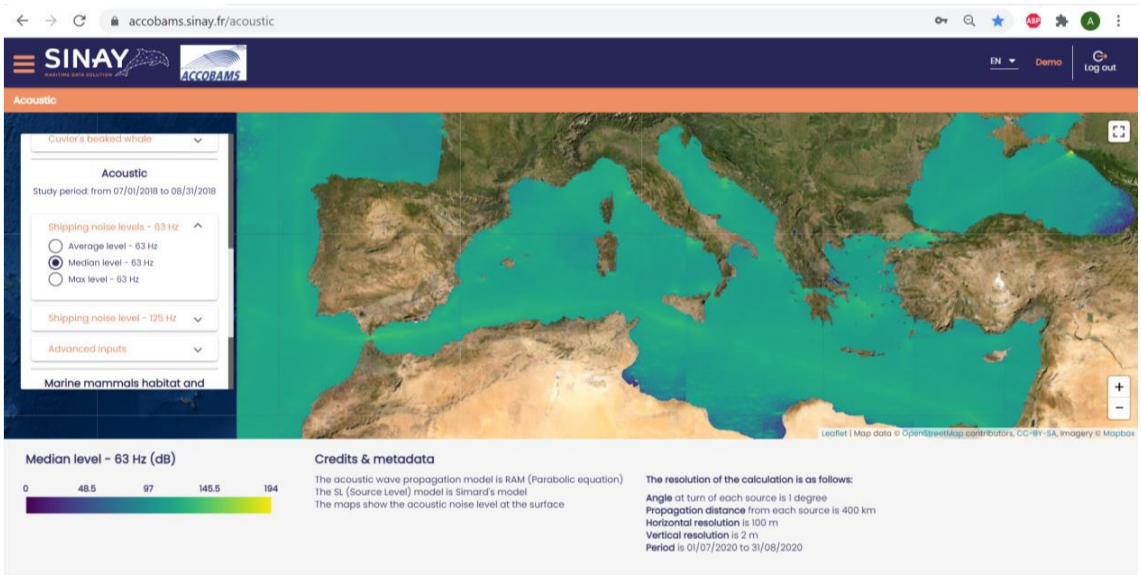


Figure 7. Median shipping noise

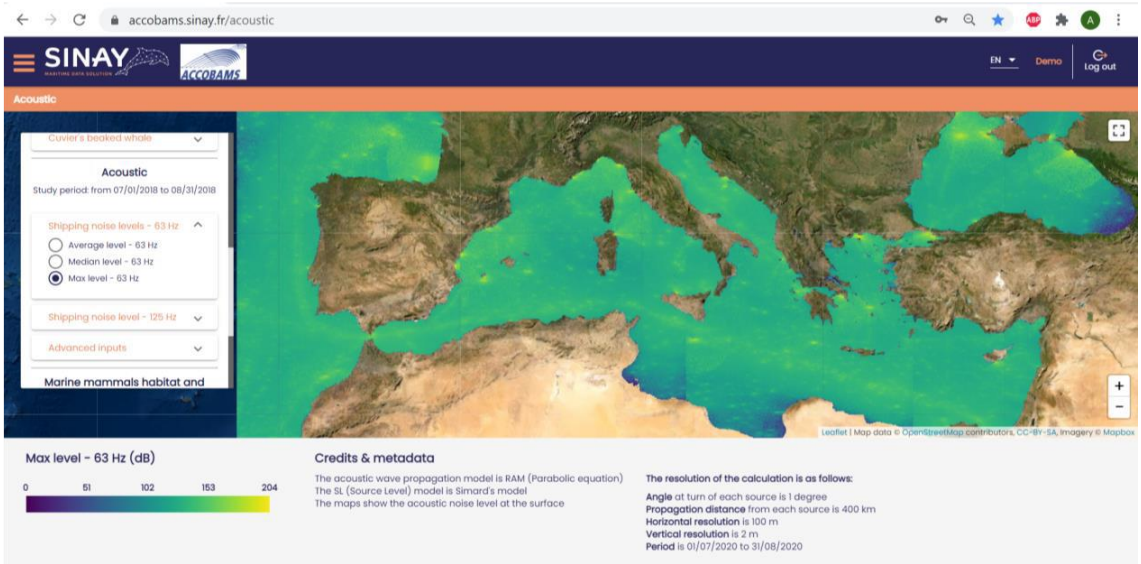
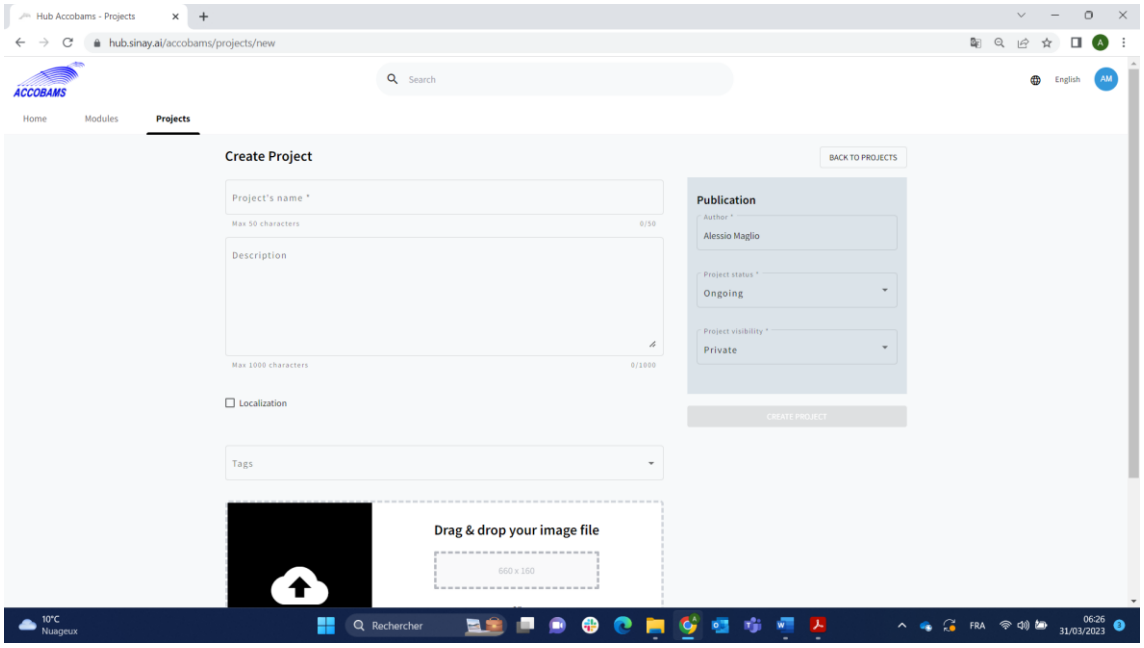


Figure 8. Max shipping noise (P95 value).

- *Projects*

From the Project page the user can create new projects:



The content of projects is provided by the users: