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EfxINNOs

Establishing and Operating an Innovative Marine Technology Transfer Network for
Enhancing the Transition to a Sustainable Blue Economy in the Black Sea Basin

Collection and Harmonization of Data, Images, and Videos from AUV

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https://envrio.eu/efxinnos/

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1. Utilization of AUV Technology in the Greek Pilot Site

At the current pilot site, we will deploy an Autonomous Underwater Vehicle (AUV) to support advanced underwater exploration and research activities. These vehicles represent a transformative step in data collection, enabling the acquisition of high-resolution images, video, and side scan sonar data of the seafloor and marine habitat structures. To ensure effective collaboration and data interoperability among partner institutions, it is essential to standardize the collected datasets in accordance with international best practices. This activity will establish the operational procedures for capturing sonar, imagery, and video using AUVs, while highlighting the importance of data harmonization to advance regional scientific initiatives aligned with the Priority Blue and Smart Region objectives of the NEXT BSB Programme.

The AUV to be used is the NemoSens by RTsys, a lightweight, modular system equipped with multiple features like a propulsion unit and stabilizing fins for maneuverability; an embedded transducer and side scan sonar for high-resolution seabed mapping; and a mast containing key functionalities such as power control, GPS, WiFi, and UHF communication. It also includes a handle for easy deployment, and the capacity for external payload integration, making it an ideal platform for the pilot exploration.

Figure 1. *Detailed map of the Poti New Port, Georgia, illustrating the location for the deployment of physicochemical buoy (in red).*

In addition, the *NemoSens*® AUV is a fully modular system, and for this pilot activity, we will be equipped with all available configurations to maximize operational versatility. As shown in Figure 2, the AUV is delivered as a basic platform, allowing for custom integrations based on mission needs. For this mission, we will be equipped with both the CTD and SSS sensors, enabling simultaneous environmental monitoring and high-resolution seafloor imaging. The CTD sensor, an RBR Legato CTD, will profile conductivity, temperature, and depth, while the Side Scan Sonar (SSS) will provide detailed mapping of the seafloor. This combined setup allows the AUV to efficiently gather comprehensive data, enhancing its flexibility and scientific utility in marine research.

Figure 2*. Detailed map of the Poti New Port, Georgia, illustrating the location for the deployment of physicochemical buoy (in red).*

2. Harmonized Data Management for AUV Surveys

The AUV, equipped with both side scan sonar and CTD sensors, allows for high-resolution seafloor imaging and environmental monitoring. By carefully planning survey routes, optimizing sensor settings, and maintaining data integrity throughout the survey process, we ensure the quality of the collected data.

All data and metadata collected by the side scan sonar (SSS) and the CTD sensor will be stored and processed in accordance with international standards, ensuring interoperability. This approach enables seamless and standardized data processing using the most suitable software, thanks to the adoption of common file formats. This harmonization process includes standardizing data formats, metadata conventions, and terminology, allowing researchers to merge and analyze data from multiple sources effortlessly. It also enhances the accuracy of georeferencing and simplifies the integration of diverse data types, leading to more comprehensive and reliable scientific conclusions.

Raw survey data will be initially stored on a local computer and subsequently replicated to a cloud server, following a standardized naming convention. Once a survey is completed, the interpreted survey data will be stored as a Map Package in the shared cloud, ensuring that all relevant interpreted files, sonar mosaics, ground-truthing points, CTD profiles, and baseline files are preserved. The Map Package will be structured so that it can be easily shared with potential users, allowing them to open all necessary files and data intact.

Since the AUV has not yet been delivered, we are currently focusing on harmonizing the sample data, which are in XTF format, to ensure a smooth transition once the system is operational. Developed by Triton Imaging, Inc, the XTF format stands for eXtended Triton Format. It is an open source format used for recording hydrographic data.

This preliminary work involves converting the data collected in XTF format to the OGC GeoTIFF format, a widely used and standardized format for geospatial raster data. The GeoTIFF format supports geographic metadata, which ensures that the spatial reference and coordinate system of the data are maintained, allowing for seamless integration with other geospatial data. By establishing these transformation procedures early on, we aim to streamline the processing and analysis of the data once the AUV is deployed, ensuring compatibility with the planned data management framework. This procedure is currently based on the use of open-source tools like the pyxtf library for Python (https://github.com/oysstu/pyxtf), which facilitates the conversion and handling of XTF data.

3. Preliminary survey for the strategy planning and handling of SSS data

A preliminary survey has been conducted to establish the strategy for planning and handling the Side Scan Sonar (SSS) data effectively (Figure 3). This initial phase focuses on understanding the specific requirements of the survey area, including seafloor characteristics, target detection, and optimal survey route planning. The aim is to develop a robust strategy for data collection that ensures high-quality, high-resolution sonar images while minimizing data gaps. Additionally, considerations for data storage, processing, and analysis are being addressed, with an emphasis on establishing standardized procedures for handling the SSS data. By analyzing sample data and testing various sonar configurations, we aim to fine-tune our approach to maximize the efficiency and accuracy of the final dataset (Figure 5). This early planning phase also includes selecting the appropriate software tools for data visualization (Figure 4), interpretation, and integration with other collected data, ensuring that all survey data can be processed harmoniously and contribute effectively to the overall research goals.

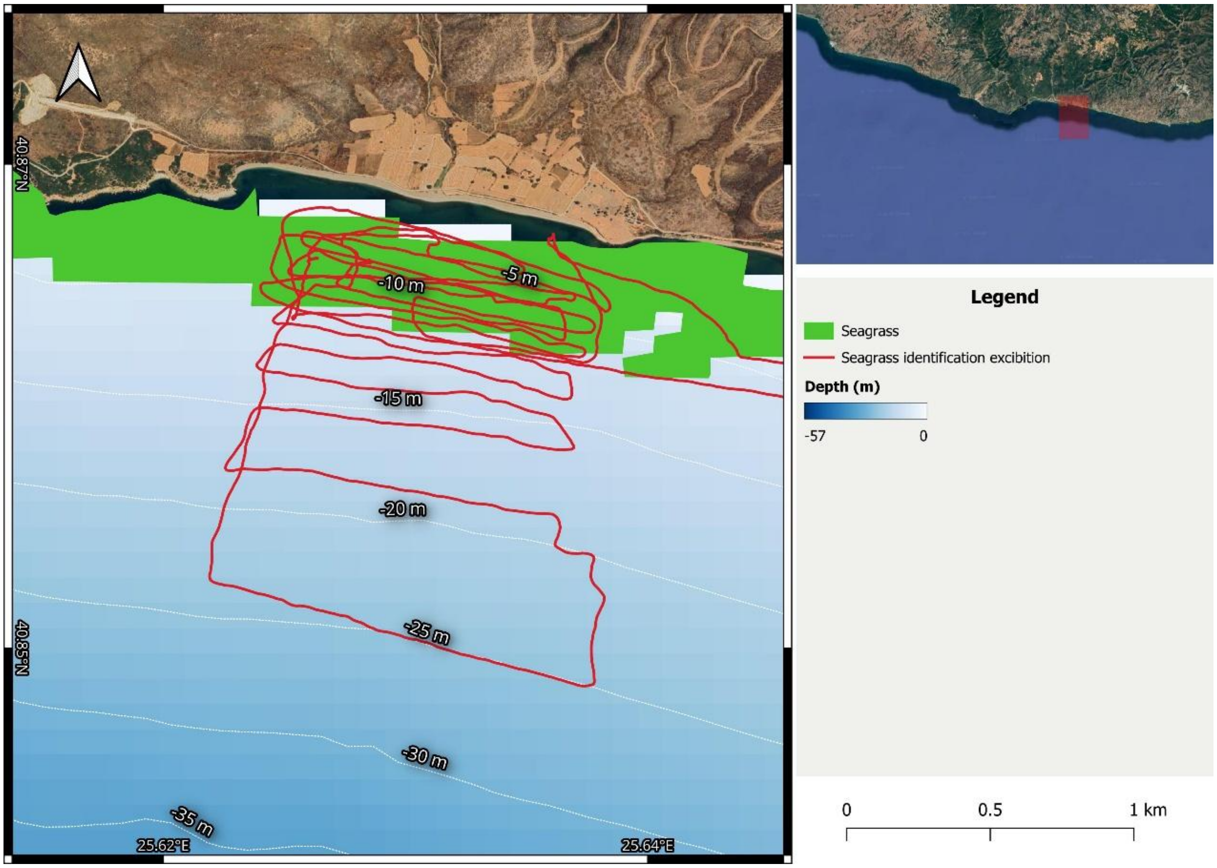

Figure 3. *Survey route as recorded by the Side Scan Sonar (in red), captured during the preliminary survey.*

Figure 4. *Side Scan Sonar data recorded during the entire survey, captured during the preliminary survey visualized using ReefMaster software.*

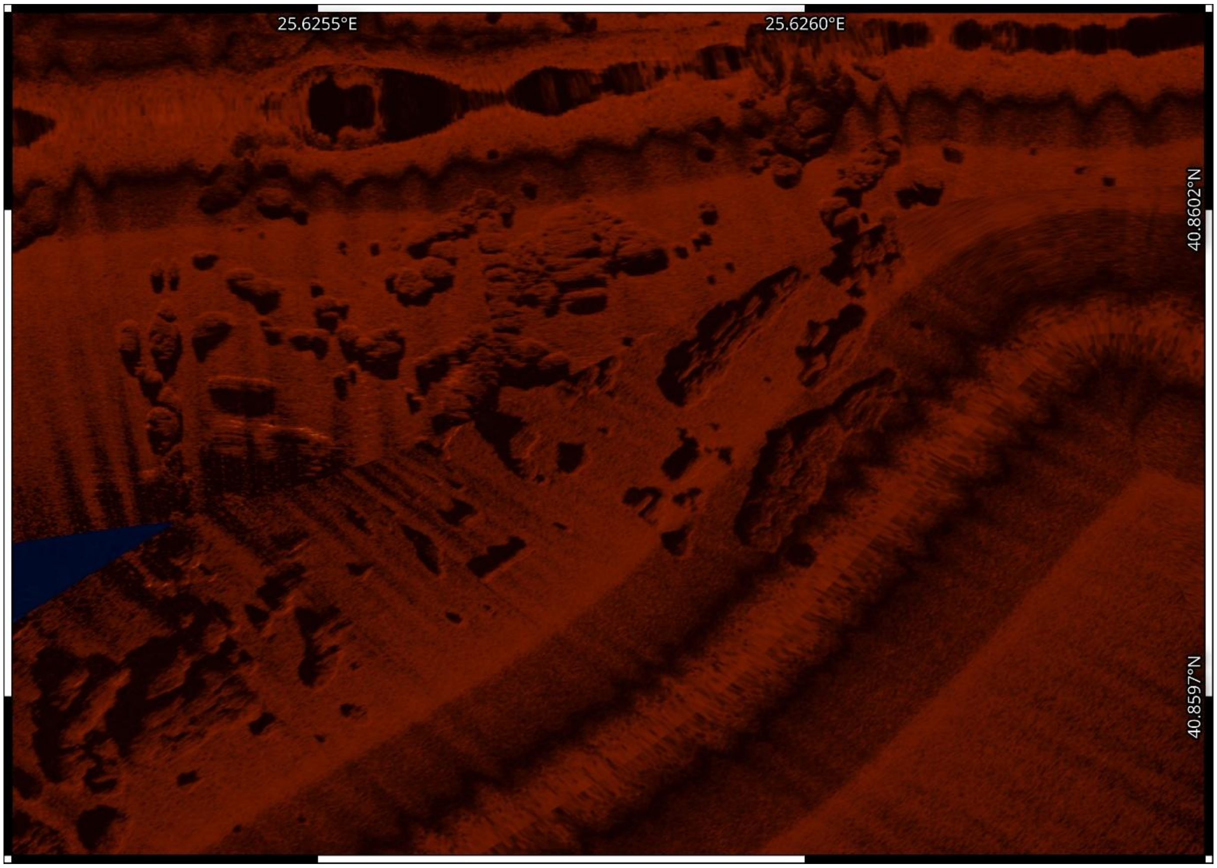

Figure 5. *Side Scan Sonar recorded data showing seafloor features captured during the preliminary survey visualized using Quantum GIS software.*

4. Harmonization of videos and images captured during preliminary survey

To ensure consistency, comparability, and scientific validity in the documentation process, the capture of underwater video and photographic material has followed a standardized protocol. This includes using fixed camera settings such as resolution, frame rate, and white balance to maintain image quality across different dives and locations. Cameras were mounted on poles or handheld at a consistent height above the seafloor to standardize the field of view and minimize variability in scale. Additionally, GPS coordinates and timestamps were synchronized with video recordings to allow for precise georeferencing. These standardized practices not only improve the reliability of species identification and habitat condition assessment but also facilitate future data integration and long-term monitoring efforts by enabling repeatable methodologies and accurate comparisons over time. A screenshot from the underwater identification process is shown in the Figure 6 below.

Figure 6. *Underwater image captured during the field expedition using a GoPro camera, showing healthy stands of Posidonia oceanica and Cymodocea nodosa meadows. The video served to confirm species presence and seagrass condition in situ.*