Hadriaticum DATA HUB. Data management, protocols harmonization, preparations of guidelines: cross-border tools for maritime spatial planning decision-makers

D3.1.

Exchange and exploitation of projects' results

D3.1.3 Guidelines for planners and policymakers
D3.1.4 Harmonized geodatabase
D3.1.5 Review of past strategies and experiences
D3.1.6 Planning and managers enablers

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SUMMARY

Over the years, several fundamental Interreg IT-HR projects have analyzed the Adriatic Sea to define its chemical-physical features, to characterize its habitats and to monitor the wildlife and flora present in it.
In this frame, HATCH project aims to provide tools exploitable by stakeholders and decision-makers in MSP application to preserve Adriatic Sea.
Data from chemical, microbiological analysis, distribution of the pollution, shipping, from the past experiences and from the capitalization of some previous Interreg IT-HR Std projects, are collected and organized to prepare data set ready to feed a hub of data then exploitable by stakeholders and decision-makers in MSP' application.
PPs involved in HATCH consortium intent capitalized the data collected with analytical and monitoring activities carried out during their STD projects (AdSWiM, CREW, ECOMAP, ECOSS, SASPAS, SOUNDSCAPE, WATERCARE) by analyzing, comparing, and organizing them into a single uniform format in order to upload them into a cross-border platform (named "Hadriaticum Hub") as a decision-making support for MSP implementation.

In particular, the WP3 "Clustering thematic activities" defines the activities necessary for the realization of the project outputs and goals: to create a set of tools that will support Maritime Spatial Planning in the Adriatic area, especially in regard of impacts and pollutants that sometimes show data gaps to be filled when managing maritime activities. Furthermore, the outputs should pave the road to similar actions to be replicated also in other sub-basins.

This deliverable shall contribute to the adaptive management of planning and matching some of the key points on which MSP is based: cross-border cooperation, incorporation of monitoring and evaluation in the planning process, the conceptualization of enablers for decisions based on clear information and scientific knowledge. This should support MSP but should also suggest greener and more sustainable uses of the sea.

In line with the project's O3.2, the review of past strategies and experiences in monitoring marine and coastal pollutants and anthropogenic pressures (D3.1.5 cap2), as well as the repository of Best Practices useful for MSP, described in this document, shall be spread also through the engagement of relevant stakeholders, planners and management enablers and other relevant target groups (D 3.1.6 cap 3), thanks to proper exploitation strategies (D 3.1.2 Exploitation plan). All the collected inputs were also helpful in "brainstorming" for the development of proper ideas for the next Programming period (D 3.2 Project ideas for 2021-2027 programming period).

1. INTRODUCTION

1.1 HATCH project and the “Hadriaticum DATA HUB”

The INTERREG V A Italy – Croatia 2014 – 2020 Cooperation Programme, set up in the framework of the European Territorial Cooperation (ETC), has launched the Restricted Call for Proposals (IT-HR Clusters) with the objective of maximizing the experiences and results achieved through the implementation of Standard+ and Standard Projects aiming to allow real synergies between them and to provide a better visibility and transferability of their results.
The goal of the CLUSTER n. 4 “Marine monitoring as a tool in Maritime Spatial Planning (MSP)” is also to support public administrations to take appropriate decisions related to Maritime Spatial Planning.
The aim of the MSP (directive 2014/89/EU) is to identify and organize the anthropogenic pressures for a rational use of the marine environment, in protecting it and preserving at the same time its ecosystems.

Over the years, several fundamental projects have analyzed the Adriatic Sea to define its chemical-physical features, to characterize its habitats and to monitor the wildlife and flora present in it.
In this frame, HATCH project aims to provide tools exploitable by stakeholders and decision-makers in MSP application to preserve Adriatic Sea.
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PPs involved in HATCH consortium intent capitalized the data collected with analytical and monitoring activities carried out during their STD projects (AdSWiM, CREW, ECOMAP, ECOSS, SASPAS, SOUNDSCAPE, WATERCARE) by analyzing, comparing, and organizing them into a single uniform format in order to upload them into a cross-border platform (named “Hadriaticum DATA HUB”) as a decision-making support for MSP implementation.

Figure 1. HATCH project and the 7 ST previous Interreg IT-HR projects.

In particular, the WP3 “Clustering thematic activities” defines the activities necessary for the realization of the project outputs and goals: to create a set of tools that will support Maritime Spatial Planning in the Adriatic area, especially in regard of impacts and pollutants that sometimes show data gaps to be filled when managing maritime activities. Furthermore, the outputs should pave the road to similar actions to be replicated also in other sub-basins.

WP3 outputs consists in:

D3.1.4 Provision of harmonized geodatabase useful for marine planners and marine managers containing the previous projects’ data on chemicals, microbiological, pollutants, nutrients and wildlife categories.

D3.1.5 Provision of a review of past strategies and experiences in monitoring marine and coastal pollutants and anthropogenic pressures as a repository of Best Practices useful for MSP, spread of such information also through the engagement of relevant stakeholders and target groups. All the collected inputs (through the past projects and the stakeholders’ engagement) will be the basis for the development of proper ideas for the next Programming period.

D3.1.6 Planning and management enablers: information on how data gathered for the geodatabase can be of use in planning and management/decisions-making.

In consideration of the existing webgis or data portal, it has observed with the survey performed as first step of this activity, that some flexibility was missed for them and data available were particularly connected with some defined uses i.e. data for specialists, platform requiring subscription or with limited access to only few of the information available in them. This frame suggested the concept for the “HADRIATICUM Data HUB”, or “HATCH data hub”: a reservoir of information available on one side for all projects performing monitoring and generating data about the status of Adriatic Sea and on the other side for different end-users, from decision makers of MSP to general public, because the hub was conceived as an open source, fair DNS system. The hub overlaps layers bringing information about chemical, microbiological, physical treats coming from the coastline to the sea areas as observed during the 7 projects here capitalised, with the layer of the planned maritime spaces, and offers a set of tools that will support the planners in the analyses of interaction among pressions to describe the cumulative impacts effect in the area, especially in regard to Land-Sea Interactions. This exercise it has been possible for the Italian side where the Maritime Spatial Planning (MSP) in the Adriatic area is applied (D3.3.2.1 & D3.3.3 in Marano Lagunare was conceived as storytelling about the experience of the MSP application in Friuli Venezia Giulia Region), as Croatia, due to the recent access to the EU is in progress with the policy application. Thanks to this effort of HATCH tool implementation, profitable discussions were performed among partners cross-borders and the platform is available also for reporting the Croatian side’s results. In fact, concerning the Croatian partners the MSP is still a in progress process, so the only data available are ascribable to the project’s results. HATCH Data Hub represents in this context a tool of paramount importance for the planification of Croatian MSP, where information about are still missing.

The tool is not a mere replication of the products of previous projects but the systematisation of information on a free and open platform, easily accessible and navigable by stakeholders. Interactive maps, dashboards and geostories for a facilitated and integrated display of information.

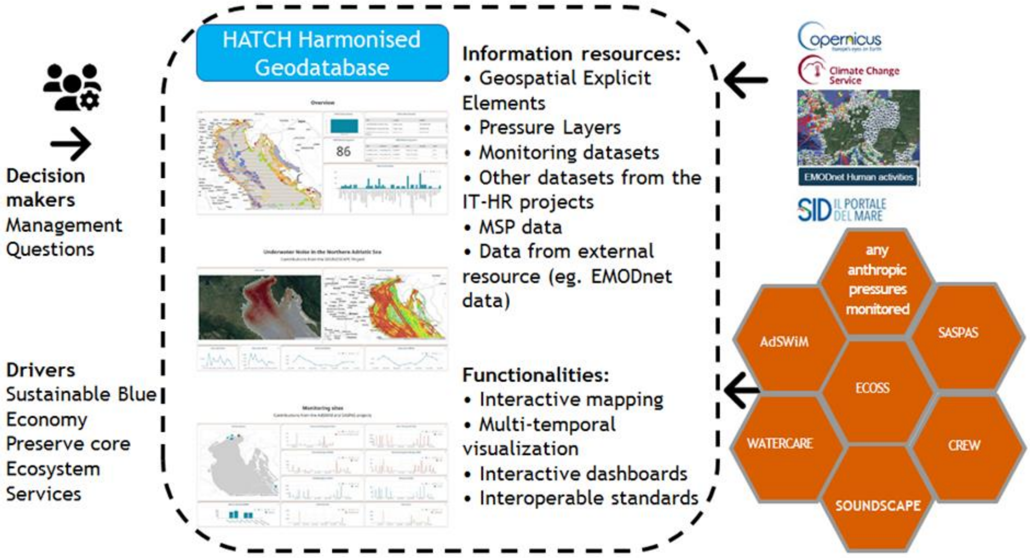

Figure 2. HADRIATICUM data HUB scheme.

The end users of such information are planners and policymakers; a first list is reported in chapter 3. The exploitation plan is the D3.1.2.

1.2 The stardard projects and their results to capitalize (D3.1.5)

1.2.1 AdSWiM

The AdSWiM project (Managed use of treated urban wastewater for the quality of the Adriatic Sea) was built around the Urban wastewater (UWW) and waste water treatments (DP) and it aimed of assessing whether the treated UWW from DP, respecting established EU limits, could be used as controlled points of nutrients supply, in particular phosphorus, with eliminated risks for both the hygienic quality of the bathing water and the ecosystem stability. This goal was obtained through several well defined activities either at DP level or in marine environment.

The project measured with assessed protocols of sampling and analytical methods **several chemical and microbiological parameters**, **at the DPs level and at the sea bottom** next to the respective wastewater discharge point. The chemical parameters analysed were ion metals, nutrients (N-NO_3, N-NO_2, N-NH_4, Si-Si$(OH)_4$, P-PO_4) particularly phosphate as general indication of the availability of phosphorous, which is a driver of the eutrophication. All analysed parameters are indicators of the anthropic pollution.

In addition to traditional microbiological methods, the investigations on the microbial pollutants were here performed by a **combination of molecular tools**, which represented an element of novelty for microbiological monitoring. Genes conferring resistance to major classes of antibiotics were quantified through RT-PCR. High-throughput sequencing of the 16S rRNA gene was utilized to resolve the bacterial community present in marine waters near to WWTP outfalls. This sequencing technique allowed for the investigation of potentially pathogenic bacteria as well as alternative indicators of fecal contamination.

Monitored parameters: ion metals (Hg, As, Cd), phosphate, fecal indicator bacteria, alternative fecal indicator taxa, potentially pathogenic bacteria, antibiotic resistance genes.
Website: https://programming14-20.italy-croatia.eu/web/AdSWiM
Link to data set: https://nodc.ogs.it/catalogs/doidetails?9&doi=10.13120/a19k-f376

1.2.2 CREW

CREW project (Coordinated Wetland management in Italy-Croatia cross border region) aimed at achieving the following objectives: set up a cross border Observatory to monitor best practices and data on Italian and Croatian coastal wetlands; protect the biodiversity in Italian and Croatian coastal wetlands by the implementation of a coordinated methodology for wetlands management (Wetland Contract); share a cross border strategy and strengthen synergies among Italian and Croatian coastal wetlands; improve the public awareness about the value of the wetlands ecosystems among policy makers, managers, professionals, and general public and strengthen their active engagement in territorial governance.

Iuav University of Venice proposes to capitalise two results of the Interreg CREW: the Wetland Contracts and the CREW Observatory.
Wetland Contracts aim to combine the management of water, hydro-morphological risks and local development in an integrated, collaborative and sustainable manner. The Contracts are intended as a voluntary act of commitment shared by various public and private stakeholders aimed at finding ways to pursue objectives of landscape and environmental rehabilitation and socio-economic regeneration of the territorial system. Among the expected outcomes of the wetland contract is the development of vertical and horizontal subsidiarity capable of fostering coordination between institutions at all levels involved, as well as rationalizing and integrating available resources such as funding, existing plans and local knowledge. In effect, by implementing multi-level governance, CREW will ensure greater coordination among stakeholders and decision makers, limiting and absorbing conflicts related to environmental conservation issues and economic activities (agriculture, aquaculture, tourism), with the aim of reaching proposals for development, conservation and land management that are sustainable in the long term.

CREW Observatory is a transnational hub that serves to monitor and share best practices and data on coastal wetlands in the cross-border region. CREW developed a management system of Wetlands in the cross-border area of Italy and Croatia by considering scientific, environmental and governance concerns through the implementation of a multilevel governance tool. The tool has the objective to achieve overall effects on coastal wetlands eco-systems and socio-economic related systems by overcoming fragmentations that are often jeopardizing the sustainable development and preservation of these fragile areas. CREW Observatory fosters activities for strengthening the network among Italian and Croatian coastal protected wetlands and for empowering international networking so to enhance the transnational exchange of expertise and data in order to create synergies with other EU partner.

Website: https://programming14-20.italy-croatia.eu/web/crew
GIS-DATABASE: http://crew-observatory.unicam.it/lizmap/index.php/view/map/?repository=002&project=2018_033_crew_database

1.2.3 ECOMAP

The aim of "ECOMAP" (ECOsustainable management of MArine and tourist Ports) was to help local ports to design better environmental strategies and to have access to suitable environmental management tools to remain competitive and to contribute to a more sustainable Programme area. Partners worked together to improve their environmental status, through investments in equipment and small infrastructure, education of staff and stakeholders, and environmental certifications. Best practices by leading-edge small ports wereadentified through project communication and study visits.

Two main results accomplished by OGS within the ECOMAP project can be capitalized in the HATCH project:

Monitoring protocol for the distribution and diversity of macrobenthos

In semi-enclosed basins, such as ports and small marinas, the effects of point source and synergistic forms of contamination are emphasized. The effects of human pressure on benthic macrofaunal assemblages inhabiting marinas and tourist ports are seldom studied, especially in the western part of the Adriatic Sea. In the framework of the international European project ECOMAP, we investigated the macrofaunal communities in three tourist ports, two in Croatia, namely Špinut and Strožanac, and one in Italy, namely Marina Dorica in Ancona. The macrofaunal abundance, diversity indices, species composition, together with the physical-chemical features of the surface sediments and their contamination levels, were used to evaluate the ecological status of the three marinas. The macrofaunal communities, along with other physical-chemical parameters in the water column and sediments, were sampled in July 2019 and April 2021 in the two Croatian marinas, and in September 2020 in Marina Dorica.

Monitoring protocol sea-and fresh-water interactions

Within the ECOMAP project several geophysical surveys have been carried out both in Italy and in Croatia. The surveys in Croatia, in the area of Split, detected important interaction between salt and freshwater which flows in the fractures of the rocks forming the shoreline and the sea bottom. In fact, thanks to resistivity data acquired on a beach in Podstrana and on some rocks in the Spinut marina, significant flows of freshwater towards the sea were identified. Furthermore, seismic data acquired offshore and freshwater springs both offshore Split and Podstrana were identified. In Italy, data were acquired in Bibione both on land and at sea. On land, we performed both seismic and geoelectrical surveys and, with an innovative integration method, we were able to identify freshwater penetrating towards the sea and the sea water intruding towards land. Furthermore, we identified the position of a river during the last glacial maximum and characterized the sediments forming the beach up to a depth of 30-40 m in great detail. Offshore, the seismic data acquired allowed us to identify several biogenic gas seepages. Finally, in Ancona, multibeam data acquired offshore and geoelectrical data acquired onshore, together with legacy seismic data, gave us further indications regarding the stability of the historical major landslide in the area.

Monitored parameters: grain size of surface sediments, benthic macrofauna communities.
Website: https://programming14-20.italy-croatia.eu/web/ecomap
GIS-DATABASE:
https://unifevcr.maps.arcgis.com/apps/instant/minimalist/index.html?appid=6ed2626b3b564deea9b7d1d4dd346b54

1.2.4 ECOSS

ECOSS (Ecological observing System in the Adriatic Sea: oceanographic observations for biodiversity) overall objective was the establishment of the ECOlogical observing system in the Adriatic Sea (ECOAdS), shared between Italy and Croatia, able to integrate ecological and oceanographic research and monitoring with Natura 2000 conservation strategies. Building on the facilities, infrastructures and long term ecological data existing in the Programme area and developing specific case studies, ECOSS enhanced 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 were assessed, basing on the connectivity among habitats and species in coastal and offshore waters.

ECOSS aimed to provide a contribution for improving the conservation status of the habitat types and species of the marine Natura 2000 (N2K) sites in the Adriatic Sea. The main outcome of the project ECOSS is the **Adriatic Ecological Observing System (ECOAdS**), whose design and first steps for establishment have been carried out within the project.
Through ECOAdS the project provided:

- A thorough **inventory** of the existing facilities, infrastructures, monitoring activities and data resources in the area, evidencing major strengths, weaknesses and gaps.
- An **in-depth** analysis of six Natura 2000 sites, which have been considered as case studies, assessing their environmental status, management level and priorities, socio-economic contribution to local activities, and existing monitoring activities.
- A **conceptual model**, highlighting the key role of the observatory for linking the socio-ecological and oceanographic dimensions with the protection of the coastal and marine environment and its management.
- A **platform for the harmonization** and optimization of the existing monitoring and management frameworks of the main EU directives (HBD, WFD, MSFD), to better respond and contribute to their requirements.
- The set up of a **stakeholder participatory process**, aimed at including in ECOAdS a plurality of voices and a wide range of knowledge, together with that derived from scientific communities and methods.
- The **ECOAdS web portal** (https://ecoads.eu/), providing relevant information, data, tools and services to a wide stakeholder community.

Monitored parameters: analyses of exiting data from monitoring programs and parameters about target species (animal or vegetal) characterizing the Natura 2000 pilot sites involved into the project ie sessile benthic organisms in Tegùne of Chioggia (IT3250047); bottlenose dolphins population for Cres-Lošinj (HR3000161) and Viški akvatorij (HR3000469); demersal and benthic fish species (Trezze San Pietro e Bardelli (IT3330009)); European Flat Oyster (Malostonski zaljev (HR4000015)), to apply and test an ecosystem-based approach of conservation strategies.
Website: https://programming14-20.italy-croatia.eu/web/ecoss
GIS-DATABASE: https://ecoads.eu/

1.2.5 SASPAS

The challenge of SASPAS (Safe Anchoring and Seagrass Protection in the Adriatic Sea) was to preserve and get a better status of conservation of biodiversity of the Adriatic Sea ecosystem in order to decrease its vulnerability. The overall objective of the project was to improve the state of conservation of the ecosystems present on the seabed of the Adriatic Sea through the development of ecological solutions, harmonized for the entire Adriatic area and applicable to other similar realities that face the same problems of protecting and restoring biodiversity.
Case studies and actions:

- Panzano bay (Monfalcone-FriulVenezia Giulia region-Italy): *Cymodocea nodosa* transplantation and laying of Eco-friendly buoys.
- Kornati National Park (Croatia): *Posidonia oceanica* transplantation and laying of Eco-friendly buoys.
- Regional Natural Park of Coastal Dunes from Torre Canne to Torre San Leonardo (Brindisi-Puglia region-Italy): *Posidonia oceanica* transplantation and biocenotic map.

The new buoys are equipped with ecological anchorages according to a logic of attention and protection of the seagrass meadows such as *Posidonia oceanica*, *Cymodocea nodosa*, *Zostera noltei* and *Zostera marina* which colonize the coastal area.
A DPSIR analysis for each site has been done to characterize and quantify pressures and impacts on seagrass meadows, water column, benthic communities and on the bivalve *Pinna nobilis*.
In all sites monitoring campaign on seagrass meadows have been carried on and monitoring of seagrass transplantation, too.
A WebPortal, a WebGIS and a documents repository have been set up and are being updated (www.saspas.eu).
In the WebGIS, for each study site, the SASPAS activities (monitoring, seagrass meadows maps, transplanting, buoy laying) and the activities that can impact the marine seagrass (human activities, fishing activities, navigation activities) have been reported.

The main output of SASPAS is the Marine Seagrass Safeguard Integrated Management Program (MSSIMP) including guidelines for the definition of the correct attitude and behavior in protected areas and for the correct management of the involved areas and areas with similar characteristic.
The guidelines describe in detail: transplantation methods, choice and positioning of buoys techniques, monitoring methods (*ex ante* and *ex post*) for seagrass meadows.
A biocenotic map in the marine area of the SAC IT9140002 Litorale brindisino, in front of the coast of the Regional Natural Park of Coastal Dunes, has been produced.
Mostly the managers of protected areas, local, regional and national public bodies, environmental associations and NGOs, as well as the general public will benefit from the project results.

Monitored parameters: surface sediments and nutrients, meadow communities.
Website: https://programming14-20.italy-croatia.eu/web/ecomap

GIS-DATABASE:
Monfalcone area http://webgis.saspas.eu/lizmap/index.php/view/map/?repository=3&project=SASPAS_panzano_bay_LIZMAP
Dune area http://webgis.saspas.eu/lizmap/index.php/view/map/?repository=2&project=SASPAS_dune_costiere_rp_LIZMAP
Kornati area http://webgis.saspas.eu/lizmap/index.php/view/map/?repository=1&project=SASPAS_kornati_np_LIZMAP

1.2.6 SOUNDSCAPE

The Northern Adriatic Sea (NAS) is an area highly impacted by increasing maritime traffic, tourism and resource exploitation, whilst having a very vulnerable biodiversity. The main objective of SOUNDSCAPE project (Soundscapes in the north Adriatic sea and their impact on marine biological resources) was to create a cross-border technical, scientific and institutional cooperation to face together the challenge of assessing the impact of underwater environmental noise on the marine fauna and in general on the NAS ecosystem. This cooperation aimed to ensure an efficient protection of marine biodiversity and to develop a sustainable use of marine and coastal ecosystems and resources. The objectives of the project were to be pursued in three ways: implementing a shared monitoring network for a coordinated regional and transnational assessment of the underwater noise, evaluating the noise impact on marine biological resources, developing and implementing a planning tool for straightforward management.

The main outputs of the SOUNDSCAPE project are representations of spatio-temporal distribution of the noise levels generated by human activities at sea, based on physical acoustic propagation models applied through Quonops ocean noise monitoring and prediction system. The models calculated monthly noise distribution in the northern Adriatic for four third-octave bands. Two of these correspond to 1/3 octave bands centered at 63 Hz and 125 Hz and are compliant with MSFD requirement, whereas additional two 1/3 octave bands were centered at 250 Hz and 4000 Hz. A web-platform enables various selections and ways of representation of the results of the models. Furthermore, results of SOUNDSCAPE project are also included in the Tools4MSP web-platform. Combined, these provide necessary input on **spatio-temporal distribution of underwater noise** in relation to marine traffic and physical properties of the sea to inform MSP.
To further enhance the applicability of the results, SOUNDSCAPE project has also produced detailed guidelines on the development of **mitigation measures** (due to the complexity of the problem, these measures were organized and categorized in 1.Strageic ,2.Spatial-Temporal**;** 3.Behavioral; 4.Technical and technological improvements; and as Support measures 5. Monitoring, control and surveillance; 6. Economical interventions) and finally to reduce underwater noise and its effects on biological targets, as well as a transferability plan for upscaling to basin level, considering legal frameworks, present strategies, international projects and particularly application in MSP.

Monitored parameters: underwater noise, spatial and temporal distribution of marine traffic.
Website: https://programming14-20.italy-croatia.eu/web/soundscape
GIS-DATABASE: https://geoplatform.tools4msp.eu/apps/137/view#/

1.2.7 WATERCARE

WATERCARE (Water management solutions for reducing microbial environment impact in coastal areas) aimed to improve the quality of the microbial and environment and resource efficiency in bathing and coastal waters reducing the microbial contamination by using innovative tools in waste management and treatment. WATERCARE developed an innovative **Water Quality Integrated System** (WQls) composed by a real-time hydro-meteorological monitoring network; realized an *ad hoc* infrastructure for bathing waters management in a pilot site through a forecast operational model; realized feasibility studies in other 4 target sites to improve planning and management of environmental problems of the marine system; developed a real-time alert system able to preventively identify the potential ecological risk from fecal contamination of bathing waters and to support governance decision processes in bathing water management.
The sampling sites are located in five target coastal area in the Adriatic Sea, near urban settlements and influenced by the discharge of a rivers collecting wastewaters from the local sewage system: Arzilla stream (Marche region, Italy), Pescara River (Abruzzo region, Italy), Raša River (Istria region, Croatia), Cetina River (Split–Dalmatia region, Croatia), Neretva River (Dubrovnik–Neretva region, Croatia).
In all the sampling stations (river and seawater) physical, chemical, and microbial parameters were collected. In each study area a real time meteorological data acquisition system and an automatic sampler (collecting physical and chemical parameters) near the river were installed. In each study area a numerical model of the coastal waters (FOM) to simulate and forecast bacterial dispersion in bathing waters and an alert tool were applied.

Two main results within the WATERCARE project that can be capitalized in the HATCH project are the implementation of a **innovative Water Quality Integrated System** and the development and execution of ***ad-hoc* infrastructure for bathing waters management** in order to reduce *Escherichia Coli* and Intestinal Enterococci's bacterial contaminations in coastal waters, and consequently to improve water management of urban areas through the warning for environmental protection authorities, including WFD and MSFD.

Monitored parameters: physico-chemical water parameters, nutrients in water, fecal bacteria.
Website: https://programming14-20.italy-croatia.eu/web/watercare
GIS-DATABASE: https://watercare.com.hr/map

Table 1. Selection of relevant outputs from the 7 ST Interreg Projects and their transferability.

Outputs to be capitalized (Project)	Coherence with 2021-2027 priorities	Successful and validated solution	Innovative solution (added value)	Ready to use solution	Transferable solution
Waste Water Treatment Plant interactions with sea water for chemical, microbiological contaminants and nutrients – P contents (AdSWiM)	Monitoring systems and integrated management tools (Priority 2; SO 2.2); market-drive researche and R&D cooperation; support to researchers (SO1,1)	**YES**. Data set of chemical and microbiological analyses have been performed selecting the sampling points not following the directive to evaluate other approaches of monitoring. New analytical devices sensors-based for monitoring chemical parameters/pilot operations were not foreseen/meetings have been organised for general public and publications were produced for specific stakeholders to be infromed	YES. It has been confirmed that the treatments of the wastewater is of paramount importance to protect the sea water. It has been demonstrated that new tool of analysis both for chemical/nutrients and microbiological characterization are absolutely required to improve the knowledge of the system and better organise system of protection/eventual remediation	**YES**. Technical documents are freely available, data set were published on the web sites (https://programming14-20.italycroatia.eu/web/adswim/docs-and-tools ; https://nodc.ogs.it/catalogs/doidetails?9&doi=10.13120/a19k-f376; https://nodc.ogs.it/catalogs/doidetails?0&doi=10.13120/j23k-n088) and information about of the sensors optimised during the project lifetime have been made available through scientific publications	YES. No constrains exist to transfer the AdSWiM methodology. All interested public, public administrations could take advantage from AdSWiM experience and implement some of the activities faced during the project to improve their current situation regarding urban waste water treatments and coastal water management
Launch of a voluntary act “Wetland Contracts” and of an observatory to monitor and share best	https://www.italycroatia.eu/documents/4208634/5145597/Programme_intervention_logic.pdf/b653ca86-ed03-5098-a776-0bc073c76aa9?t=1669650958166 Awarness rising actions; conservation	**YES:** Wetland Contracts were developed through Territorial Labs, such as platforms that directly involved territorial stakeholders. The Observatory has been a tool for the implementation of multilevel governance	**YES:** Both Wetland Contracts and the Observatory are proposed as innovative tools to support governance of coastal wetlands, bringing together instances raised from the bottom with the traditional tools used to govern wetlands	**YES:** all documents produced are available on web platforms; the formats can be used as a valuable reference by other entities or organizations with similar purposes	**YES:** CREW project outputs may be replicable by other agencies and organizations involved in managing lagoon environments and territorial governance

Outputs to be capitalized (Project)	Coherence with 2021-2027 priorities	Successful and validated solution	Innovative solution (added value)	Ready to use solution	Transferable solution
practices and data on coastal wetlands (CREW)	measures; strategydevelopment (SO2,2);sterghtening multi-levelgorvancnce (SO 5,1)				
Monitoring of macrobenthos and sea and fresh water interaction (ECOMAP)	https://www.italycroatia.eu/documents/4208634/5145597/Programme_intervention_logic.pdf/b653ca86-ed03-5098-a776-0bc073c76aa9?t=1669650958166 Monitoringsystems and integratedmanagement tools;conservations measures;awerness-rising actions;strategy development(Priority 2; SO 2.2)	**YES**. The metholodogies have been tested in several sites showing very different geological, biological and logistical settings and have proven to be effective in all case studies.	**YES.** As for the geophysical methods, the integration of seismic and geoelectrical data via a petrophysical inversion constitutes an innovative solution to characterie the shallow subsurface. As for the monitoring of the macrobenthos, the innovative Biological Traits Analysis was applied to detect functional adaptations of assemblages to contaminated sediments and multiple anthropogenic stressors.	**YES.** All documents are available in the repository (https://www.italy-croatia.eu/web/ecomap/docs-and-tools-details) and all the data can be seen in the webgis application (https://unifevcr.maps.arcgis.com/apps/instant/minimalist/index.html?appid=6ed2626b3b564deea9b7d1d4dd346b54)	**Yes**. The monitoring technques applied in the ECOMAP project can be applied to several other sites in very different environments. Furthermore, the need to assess the effects of tourist marinas on the local fauna are common to many coastal areas in Europe and in the world. Similarly, the monitoring of the interaction between sea and freshwater is a subject of growing importance and the geophysical methods used in ECOMAP have proven to be a valuable tool.
Design and first steps for	https://www.italycroatia.eu/documents/4208634/	**Yes.** In particular for what concerns the ECOAdS	**Yes.** Through the setting up of ECOAdS, different crucial ecological	**YES .** All the deliverables are publicly accessible on the	**YES.** The whole structure of the observatory and, in

Outputs to be capitalized (Project)	Coherence with 2021-2027 priorities	Successful and validated solution	Innovative solution (added value)	Ready to use solution	Transferable solution
establishment of the Adriatic Ecological Observing System-ECOAdS (ECOSS)	5145597/Programme_intervention_logic.pdf/b653ca86-ed03-5098-a776-0bc073c76aa9?t=1669650958166Monitoringsystens and tools;strategy development(SO 2,2); sterghteningmulti-level gorvancnce(SO 5,1)	webportal (https://ecoads.eu/) which gives access to the infornation available for the observing system created in the project	and management elements have been integrated and made avilable, generating an addedd value.	Italy-Croatia website (https://www.italy-croatia.eu/web/ecoss).Besides, all the information are accessible through the ECOAdS web portal https://github.com/CNRISMAR/ecoads	particular, the ECOAdS webportal have been conceived and realized with the aim to be shared , used and transferred also in other context, whenever needed.
Monitoring, protection and transplanation of seagrass meadows, environmentally eco-friendly anchoring systems (SASPAS)	https://www.italycroatia.eu/documents/4208634/5145597/Programme_intervention_logic.pdf/b653ca86-ed03-5098-a776-0bc073c76aa9?t=1669650958166Monitoring systems and integrated management tools; conservations measures; awerness-rising actions; strategy development (Priority 2; SO 2.2)	**YES.** SASPAS, even in a limited context of representative sites, tested the concrete actions in addition to a monitoring control of site and meadow conditions:seagrasses transplantation,installation of experimental eco-buoy fields.	**NO.** The monitoring methodologies adopted in SASPAS refer to national and international protocols;transplanting methods are the ones most used in the Mediterranean Sea.The innovative aspect that goes beyond the existing practices consists of joint cross-border biodiversity protection and restoration. In addition specifically guidlines which include concrete sustainable management of the marine seagrass resource, related to the problem of anchorages, have been developed.	**YES.** A WebPortal, a WebGIS and a documents repository have been set up.Concrete actions, activities, and results, together with all gathered data are summarized, analysed, discussed, and presented in the Marine Seagrass Safeguard Integrated Management Program (MSSIMP) available on line.	**YES.** SASPAS solutions are suitable for the typology of the sites studied but harmonized to a reasonable extent for the Adriatic area and then applicable to other similar realities facing the same biodiversity protection and restoration issues.

Outputs to be capitalized (Project)	Coherence with 2021-2027 priorities	Successful and validated solution	Innovative solution (added value)	Ready to use solution	Transferable solution
Monitorinf of underwater sound and environmental assessment of the underwater noise on the target species: *Tursiops Truncatus* and *Caretta Caretta* (SOUNDSCAPE)	Monitoring systems andtools; Conservationmeasures; awarenessrising actions; strategydevelopment (SO2,2)	**YES:** Soundscape set up a shared monitoring netwarok of underwater noise recording stations with shared monitoring and processing protocols both in Italy and Croatia. About 15 months of underwater sound data were collected, validated and processed.	**YES:** Soundscape provided the first dataset at basin scale in the Mediterranean monitoring underwater sound continously over 9 stations for the first time. Soundscape provided monthly maps of underwater noise distribution in the Northern Adriatic Sea though a innovative 3D calibrated noise propagation model. The maps were used included in the Maritime Spatial planning platform Tools4MSP to assess the impact of the target species.	**YES .** All the deliverables are publicly accessible on the Italy-Croatia website (https://www.italy-croatia.eu/web/soundscape). Besides, all the dataset were submitted for publication to the journal Scientific Data and will be open access).	**YES.** SOUNDSCAPE acquisition and processing protocols were applied for the Adriatic area and are applicable to other similar realities facing the same biodiversity protection and restoration issues.
Heavy rainfall events on bathing water quality (WATERCARE)	https://www.italy-croatia.eu/documents/4208634/5145597/Programme_intervention_logic.pdf/b653ca86-ed03-5098-a776-0bc073c76aa9?t=1669650958166 Monitoring systems and integrated management tools (Priority 2; SO 2.2; SO 5.1 cross-border obstacle)	**YES.** The WQIS (Water QualityIntegrated System) purposelydeveloped is still operative inmeasuring the quality of thewater; recent heavy rain eventswere buffered by the SewageStorage Tank build in the contextof the project period confirmingits efficacy in marine waterprotection.	**YES**. WATERCARE obtained an estimation of microbial contamination associated to the environmental status and meteorological conditions that was entirely absent, up to now, in the governance processes scenario with provisional forecasting of faecal dispersion along coastal areas. A new small-scale Infrastructure (Sewage Storage Tank) and the implementation of a	**YES.** Technical documents on theoutput and project results areavailable thanks the publication ofall project deliverables in the WATERCARE section within the ITHR official webpage(https://programming14-20.italycroatia.eu/web/watercare/docsand-tools). Guidelines represent	**YES.** All interested publicadministrations could takeadvantage from Guidelinesand WATERCAREexperience and implementthe most suitable solutionto improve their currentsituation regarding urbanwaste water treatmentsand coastal watermanagement

Outputs to be capitalized (Project)	Coherence with 2021-2027 priorities	Successful and validated solution	Innovative solution (added value)	Ready to use solution	Transferable solution
			WQIS (Water Quality IntegratedSystem) able to correlate theenvironmental conditions andimpacts generated by the spillage of wastewater was put in place.	anextremely useful document toguide all other organizations alongAdriatic coasts characterized by similar situations like those onesdealt within WATERCARE project	

1.3 The Deliverable D3.1.3

One of the mandatory activity for WP3 is "Exchange and exploitation of projects' results" and within this activity the partnership of HATCH decided to produce this deliverable D3.1.3 "Guidelines for planners and policymakers". This document can contribute to the adaptive management of planning and matching some of the key points on which MSP is based: cross-border cooperation, incorporation of monitoring and evaluation in the planning process, conceptualization of enablers for decisions based on clear information and scientific knowledge. This should support MSP but should also suggest greener and more sustainable uses of the sea. The visualization of the actual uses/pressures/activities is considered helpful in term of planning and it has considered that overtime will support corrective interventions to guarantee the sustainability by reducing interferences and overlapping of the pressures among them.
This tool provides a functional instrument for the Driver-Pressure-State-Impact-Response (DPSIR)[1] methodology: this framework provides a structure within which to present the indicators needed to enable feedback to policy makers on environmental quality and the resulting impact of the political choices made, or to be made in the future.

This deliverable aims in achieving the project's output "Good practice for Adriatic sea and MSP application", by capitalising the results of the STD projects involved for the preservation of sea habitats from pollution due to anthropogenic impacts. Thanks to proper exploitation strategies (D 3.1.2 Exploitation plan) this deliverable will be provided to the stakeholders which could be involved in the adoption and utilization of guidelines and monitoring protocols.

In Chapter 2 a review of Best Practice and monitoring protocols defined in the seven STD IT-HR projects involved in the Hatch consortium have been done. (D3.1.5)
In Chapter 3 the end users of the HATCH geo-platform, as well as of such Best Practice and monitoring protocols have been identified, especially in relation with MSP sectors. (D3.1.6)
In Chapter 4 some examples of visualization and use of the capitalized information are reported.(D3.1.5)

[1]https://www.fao.org/land-water/land/land-governance/land-resources-planning-toolbox/category/details/en/c/1026561/
The Driver-Pressure-State-Impact-Response (DPSIR) Framework provides a structure within which to present the indicators needed to enable feedback to policy makers on environmental quality and the resulting impact of the political choices made, or to be made in the future. The DPSIR framework assumes a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, indicators). Establishing a DPSIR framework for a particular setting is a complex task as all the various cause-effect relationships have to be carefully described and environmental changes can rarely be attributed to a single cause.

2. BEST PRACTICES IN MANAGING AND MONITORING MARINE AND COASTAL AREAS: A REVIEW OF PAST STRATEGIES (D3.1.5)

2.1 Best practices

2.1.1 The Ecological Observing System of the Adriatic Sea (ECOAdS): structure and perspectives within the main European biodiversity and environmental strategies (ECOSS project)

Project sites, from North to South (Figure 3):
Trezze San Pietro e Bardelli (IT3330009), Friuli-Venezia Giulia Region, Italy;
Tegnùe di Chioggia (IT3250047), Veneto Region, Italy;
Po river delta (IT3270017 and IT3270023), Veneto Region, Italy;
Cres-Lošinj (HR3000161), Primorje-Gorski Kotar County, Croatia;
Viški akvatorij (HR3000469), Dubrovnik-Neretva County, Croatia;
Malostonski zaljev (HR4000015), Dubrovnik-Neretva County, Croatia.

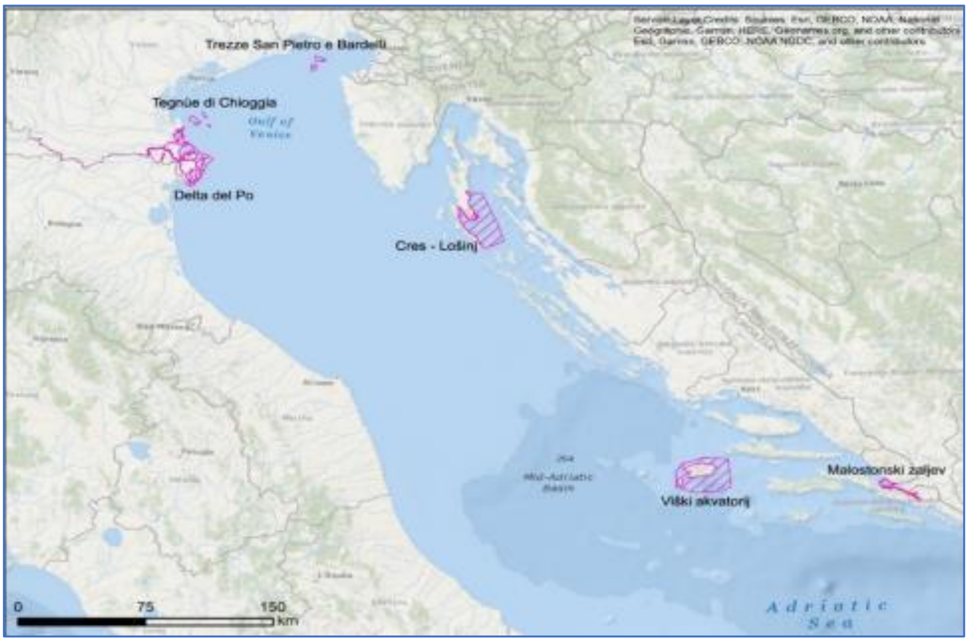

Figure 3. ECOSS project sites.

Possible Adriatic sites for replication:
The main components and attributes of ECOAdS could be applied to the wider Adriatic microregion.

Title of the document:
The Ecological Observing System of the Adriatic Sea (ECOAdS): structure and perspectives within the main European biodiversity and environmental strategies.
Keywords: Marine Ecological Observatories, Transboundary Coordination, Essential Variables, MSFD, WFD, Natura 2000, Governance and Management Systems (GMS).
Direct link to the documents:
https://doi: 10.3897/rio.8.e82597

References: Pugnetti et al. (2022) The Ecological Observing System of the Adriatic Sea (ECOAdS): structure and perspectives within the main European biodiversity and environmental strategies. Research Ideas and Outcomes 8: e82597.

Topic:
Presentation and description of the Ecological Observing System of the Adriatic Sea (ECOAdS), aimed at integrating the ecological and oceanographic dimensions within the conservation strategy of the Natura 2000 network, and proposals for its future development and maintenance.

Description:
Marine Ecological Observatories broaden the spectrum of marine observations, arrange and maintain harmonized and coherent long-term ecological observations, and link marine ecosystem monitoring with the effectiveness of the protection and restoration measures. Crucial to this kind of observatories is the integration of the ecological connectivity concept, which is one of the main driving forces of the functioning of marine ecosystems, embracing the complex interconnections among natural processes, species and their life cycles, and the environment. The Adriatic Sea is a strategic area for the establishment of an ecological observatory, due to the concurrent presence of biodiversity richness, sensitive habitats and ecosystems, numerous ongoing monitoring and research activities. The heavy and diversified human pressures, as well as the economic interests, make this basin one of the most impacted regions of the Mediterranean Sea. Moreover, the Adriatic is scarcely covered by marine protected areas and the implementation of the N2000 network in the basin is ongoing, but suitable and fulfilled management plans and adequate monitoring programs are still lacking.

The Ecological Observing System of the Adriatic Sea: how it was designed and realized

The Ecological Observing System of the Adriatic Sea (ECOAdS) was designed and started to be developed within the Interreg Italy-Croatia project ECOSS (ECOlogical Observing System in the Adriatic Sea: oceanographic observations for biodiversity; www.italy-croatia.eu/ecoss), with the overall purpose to contribute to the improvement of the conservation status of the habitat types and species of the coastal and marine Natura 2000 sites in the Adriatic Sea, integrating the ecological and oceanographic dimensions with the N2000 protection strategies.

The ECOAdS key elements are reported in the Figure 4 and they are accessible through the ECOAdS web portal (https://ecoads.eu/), which provides an overarching view of information on available resources. It connects to existing geospatial services from both ECOSS partners and external initiatives (such as Copernicus, EMODnet, LTER networks) and it develops and makes available tools for interlinking information on N2000 sites, parameters, directives, target species and habitats. The portal is conceived as an open platform to be enriched and improved in the coming years with the contribution of new or existing projects, data, and tools to support evolving requests and needs. It implements an open science approach, and it is addressed to a wide stakeholder community (e.g., environmental managers, policy-makers, researchers, citizens).

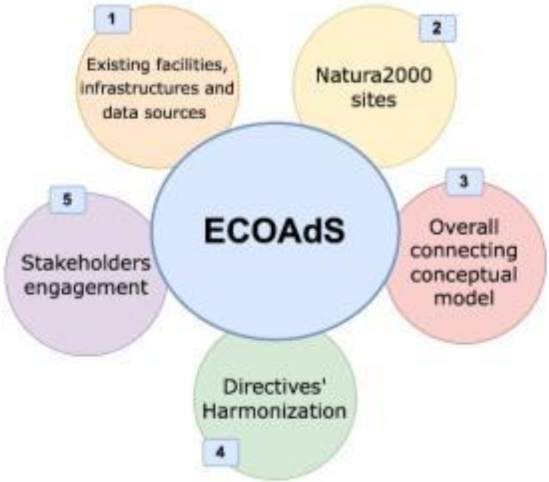

Figure 4. ECOAdS key elements.

Specifically, the key elements (Figure 4) on which ECOAdS is built are:

1. **The existing facilities, infrastructures and data resources already present in the area** – Grounded on the ECOSS partners' knowledge and expertise, an inventory of the several monitoring initiatives and research programs and of the fixed-point observing systems (i.e. pylons, buoys, tide gauges, oceanographic platforms, coastal stations) in the Adriatic has been made available (https://ecoads.eu/), evidencing through a SWOT analysis their major strengths, weaknesses and gaps. A wide variety of data are collected in the area, ranging from those related to the quality of transitional, coastal and marine waters, to the monitoring of N2K target species and habitats (e.g., dolphins, sea turtles, seagrass meadows, coralligenous outcrops) and other biotic components (e.g., plankton communities). These observing and monitoring systems hold different aims and maturity levels. In particular they lack a coherent and harmonized coordination, from the local to the whole Adriatic basin scale. It should be highlighted that none of them has a transnational nature. The list of the observing systems, of the ongoing monitoring activities and the links to the data sources are available on the ECOAdS web portal, in the sections dedicated to the sites and to the observing systems (https://ecoads.eu/sitesoss/), and to the information resources (https://ecoads.eu/inforesource/list/).
2. **The N2K sites** - The N2K network of protected areas, both at land and at sea, is the main biodiversity conservation instrument in Europe, legally based on the Habitats and Birds directives. Six N2K sites (https://ecoads.eu/) have been considered as case studies within the ECOSS project (https://ecoads.eu/sites/natura2000/), reviewing their management goals and objectives, their socio-economic contribution to local activities, the knowledge on their target species and ecological processes and related protection status, and the existent monitoring activities. This analysis evidenced overall a lack of management plans and coordinated and systematic monitoring both in Italy and in Croatia.
3. **An overall connecting model** – A conceptual model has been developed in order to highlight the key role of ECOAdS for linking the social, ecological and oceanographic dimensions with the conservation of the coastal and marine environment and its management. Several aspects of the management of the N2K sites have been identified, broken down into different parts and connected according to the

main relationships among them. Examples of the application of the models are available on the ECOAdS web portal, in the tools' section of each N2K site (https://ecoads.eu/sites/natura2000/).

4. **The directives' harmonization** – ECOAdS has been tested as a monitoring platform that may respond and contribute to the requirements of the main EU directives, in particular the Habitats and Birds, the Water Framework, the Marine Strategy Framework and the Maritime Spatial Planning directives. The harmonization and optimization of the existing monitoring and management frameworks, at national and trans-regional levels, are actually a crucial issue for the most effective and coordinated application of directives. As a part of ECOAdS, we assessed the level of implementation of these policy documents to the focus area following their general objectives and targets of protection, approach to conservation, spatial application, reporting period, human activities and derived pressures considered, ecosystem services approach (if entailed), criteria and performance indicators definition, and indications for monitoring. Then, we proposed the harmonization and prioritization of monitored variables, necessary for the setting up of a coherent ecosystem-based monitoring system, rooted in the ecosystem-based management (EBM) core elements).
5. **The stakeholder involvement** – Complex ecological and conservation issues require scientific evidence to be used alongside other types of knowledge in order to find the best and most feasible solutions. This calls for the development of a well- organized participatory process, which has started within the ECOSS project, aiming at including in the development of ECOAdS a plurality of voices and a wide range of knowledge, including local and indigenous knowledge, together with these derived from scientific communities and methods. In three dedicated workshops, we involved MPA managers, NGOs, and PhD students, with the aim of starting to share visions about what the main needs, expectations and challenges in the design and development of ECOAdS could be. Convincingly, the structure of the ECOAdS portal has been improved addressing the main needs, requirements and gaps that emerged during this participatory process.

ECOAdS in the wider regional, national and European strategies, to address its medium and long-term sustainability

ECOAdS may effectively contribute to the fulfillment of relevant macro-regional and European strategies and programs for the next decades (Figure 5) such as: EUSAIR, the EU Biodiversity strategy for 2030, the BlueMed Initiative, the Global Ocean Observing System (GOOS) 2030 Strategy, the European Ocean Observing System Implementation Plan, and the Implementation Plan for the United Nation Decade of Ocean Science for Sustainable Development.

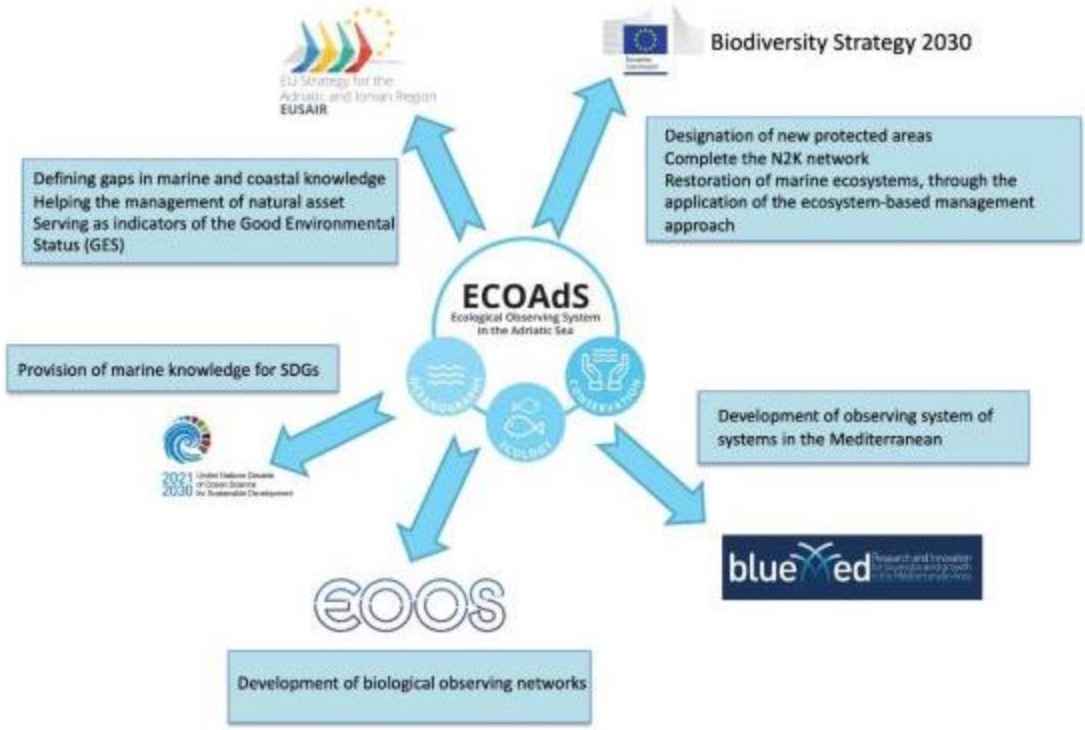

Figure 5. ECOAdS and macro-regional and European strategies.

The medium- and long-term sustainability of ECOAdS might be realized through various activities, which includes creation of efficient cross-Adriatic collaborations, transparent data sharing following FAIR principles, and effort to minimize the duplication of activities, thus also facilitating the financial issues. In short:

- The overall ECOAdS framework, the action plans proposed for the monitoring and management of the N2000 sites, and the web portal, could contribute to a more effective and coordinated implementation of the directives (HBD, WFD, MSFD, MSPD) at the national and regional/county level in Italy and Croatia.
- The main components and attributes of ECOAdS could be applied to the wider Adriatic macroregion. The Adriatic could, in this way, become an exemplary case study for the whole Mediterranean Sea, also in agreement with the BlueMed Implementation Plan.
- Many Environmental Research Infrastructures (RIs), included in the European and national RIs roadmaps at different stages of their development, are active in the Adriatic Region (e.g. Danubius RI, eLTER RI, EMBRC-ERIC, ICOS ERIC, JERICO S3, LifeWatch ERIC). ECOAdS could rely on, contribute to, and benefit from these RIs, sustaining their components that are under development in the Adriatic area.
- The technological development and the engagement of Small and Medium Enterprises is a prerequisite for the future development of ECOAdS, embracing and leveraging the emerging technologies, thus enhancing cross-border collaboration with the private sectors. ECOAdS could be the suitable platform for developing and testing innovative in situ technologies (e.g., from chemical, imaging, acoustic, and molecular sensors to robotic platforms) and for the improvement of data storage, data discovery, computation capabilities and modeling, which might support novel ecological views and perspectives. This will be in line with the action plan of the European Green

Deal, by investing in environmental-friendly technologies and supporting industry to innovate, sustaining the legally binding conservation and restoration targets.

- ECOAdS could foster the so called “Action Ecology” i.e.:
    - Collaborative and transdisciplinary, able to incorporate sociological into ecological researches
    - Innovative and aggregative, relying on large datasets and rapid synthesis for theory testing and development
    - Designed and realized with the intention to inform policy and management, providing immediate and effective insights into current, pressing issues.
- ECOAdS should incorporate into its plans a new narrative, where Nature protection and restoration shall not be a strategic specialty within our economic system, but rather become an ethical challenge and transformation, moved by the ultimate goal to attain the health and durability of natural and human communities, instead of profits.

2.1.2 Water Quality Integrated System – WQIs (WATERCARE project)

Project sites, from North to South (Figure 6):
Raša river, Istria County, Croatia;
Arzilla stream, Fano, Marche Region, Italy;
Cetina river, Split-Dalmatia County, Croatia;
Neretva river, Dubrovnik-Neretva County, Croatia;
Pescara river, Pescara, Abruzzo Region, Italy.

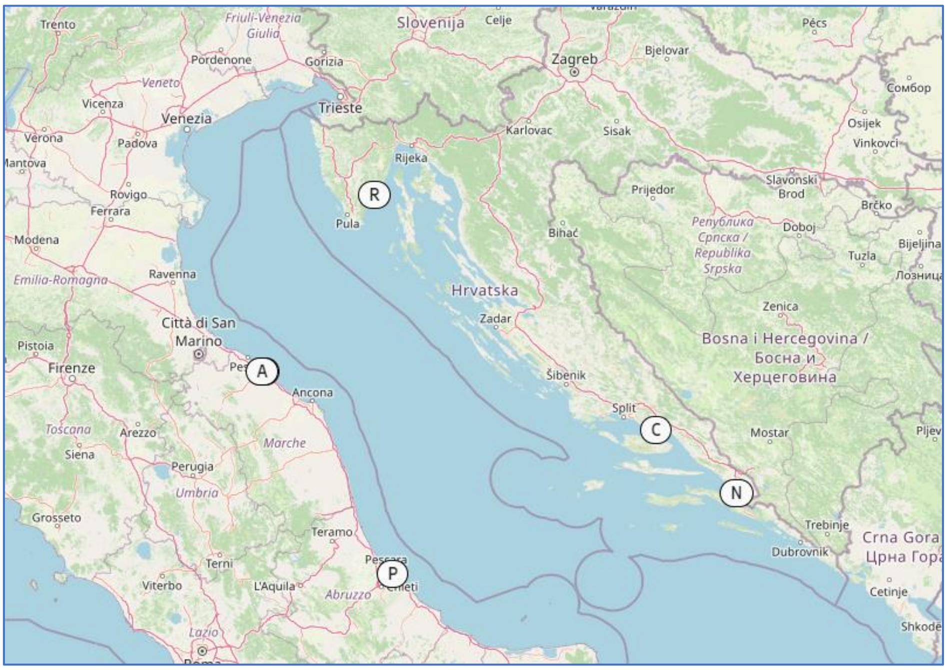

Figure 6. WATERCARE project monitoring sites. A) Fano and Arzilla stream, P) Pescara and Pescara River, R) Raša River canal, C) Omiš and Cetina River, N) Ploče and Neretva River.

Possible Adriatic sites for replication:
Potential sites for replication of WATERCARE actions are the bathing sites near river and stream mouths, such as Mirna River, Zrmanja River canyon, Krka River (Croatia) or River Po Delta, Emilia Romagna Region (Italy).

Title of the documents:
1) D.3.3.1 – WATERCARE WQIS implementation
2) D.4.1.1 – Development and execution of an ad-hoc infrastructure tank
3) D.5.2.2 – Alert Tool final release
4) D.5.3.1 – WATERCARE-Final Governance Guidelines

Keywords: Water Quality Integrated System, Bathing Water Quality, Forecast Operation Model, Alert Tool.
Direct link to the document:
1) https://www.italy-croatia.eu/documents/294645/0/D.3.3.1_WATERCARE+WQIS+Implementation_vfinal_revised.pdf/9e0aea0b-0848-6170-479b-2d4626067228?t=1649749078098
2) https://www.italy-croatia.eu/documents/294645/0/D.4.1.1_Development+and+execution+of+an+ad+hoc+infrastructure+tank+%282%29.pdf/144f98d6-309a-7b0d-9cb1-c30f61a61727?t=1636544622801
3) https://www.italy-croatia.eu/documents/294645/0/D.5.2.2_WATERCARE_Alert+Tool+Final+Release_Final.pdf/15acef03-b80d-3bcc-47ee-e38549397a30?t=1648633504526
4) https://www.italy-croatia.eu/documents/294645/0/D.5.3.1_WATERCARE_Final+Governance+guidelines.pdf/4a9c3b89-5034-186a-95c3-acbee6f1037f?t=1648633535631

References:
DIRECTIVE 2006/7/EU, OG 96/19, OG 73/08
https://www.mdpi.com/journal/water/special_issues/treated_urban_wastewater

Penna P.etal(2021). Water quality integrated system: a strategic approach to improve bathing water management. *J. Environ. Manage*., 295, 113099.

Topic:
System and guidelines to help improve bathing water quality monitoring.
Description:
WATERCARE aimed to improve microbial and environmental quality and resource efficiency in bathing and coastal waters reducing the microbial contamination by using innovative tools in wastewater management and treatment. The project brought into practice two essential aspects for a reliable WFD implementation, which represent a fully innovative phase:
- Water Quality Integrated System (WQIS)
- Sewage storage tank

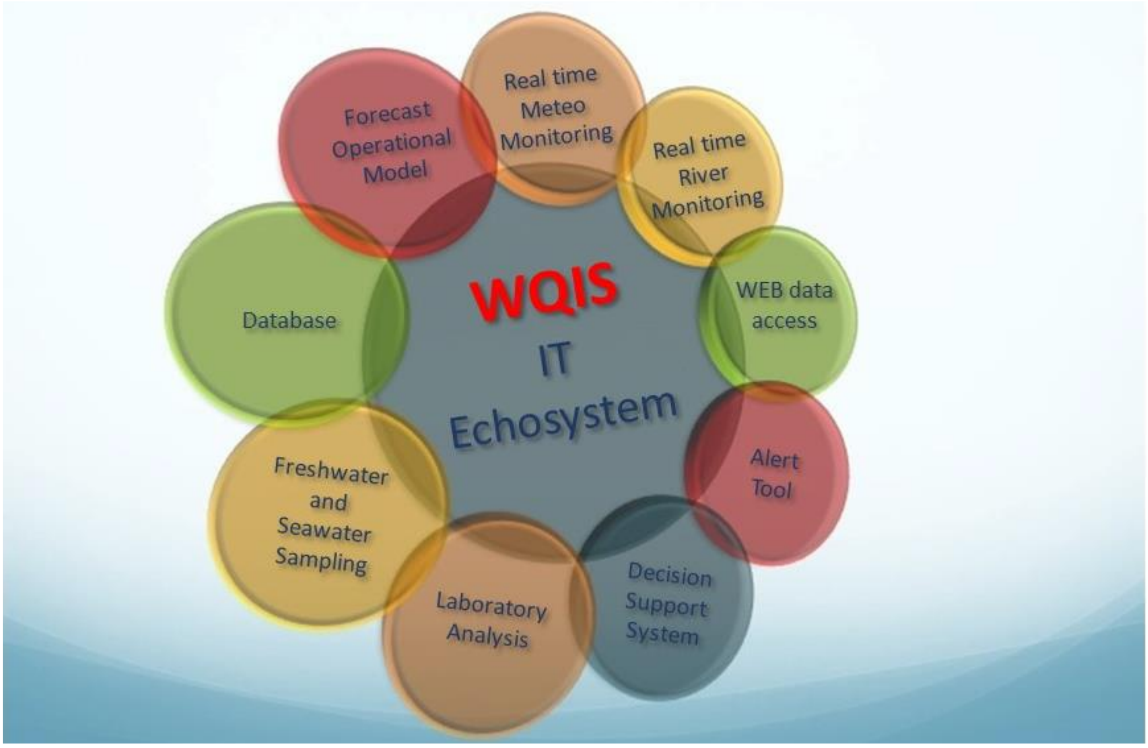

Figure 7. The WQIS IT ecosystem and the integrated subsystem (from D.3.3.1. – WATERCARE WQIS implementation).

<u>*Water Quality Integrated System (WQIS) (Figure 8)*</u>

WATERCARE developed a Water Quality Integrated System (WQIS) to correlate the meteorological events and drainage system response in relation to microbial impact on bathing waters. This kind of estimation is innovative because is at that moment entirely absent in the scenario of the governance processes with provisional forecasting of faecal dispersion along coastal areas.

The system was implemented in each of the study areas and it focused on urban areas in sewers, riverine and rivers. The model provided a real-time alert system of sewage water quality and flow rate into the sea, as well as the faecal bacterial dispersion in coastal waters.

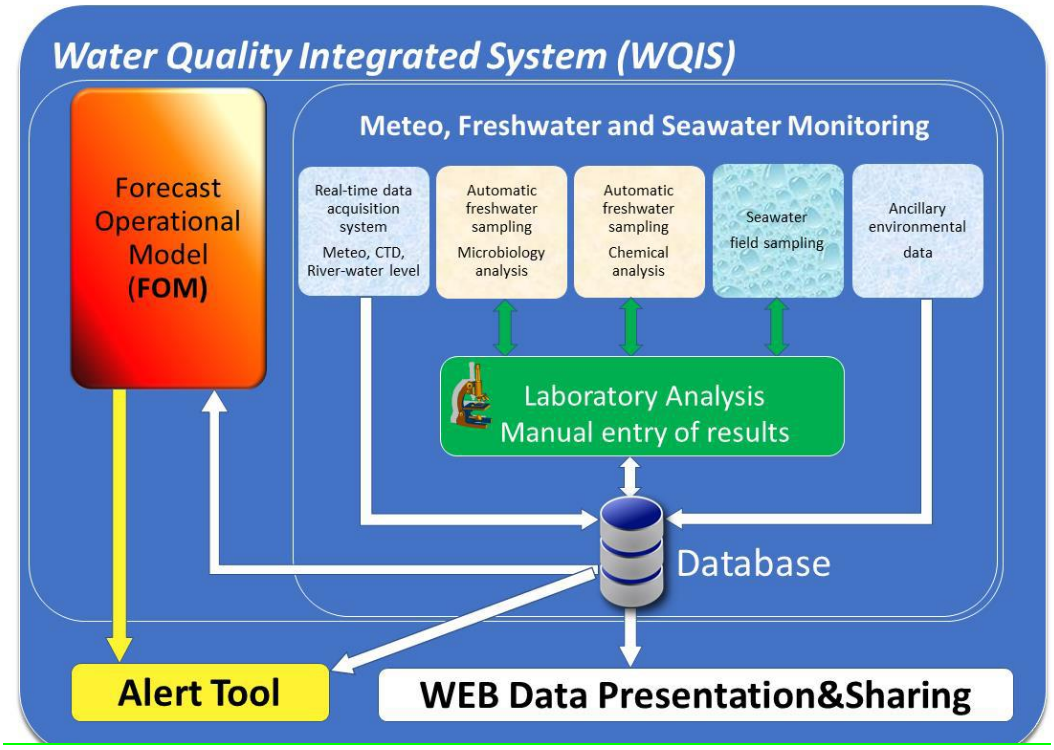

Figure 8. Water Quality Integrated System data flow scheme (Penna P. et al., 2021).

WQIS is composed of:

1) a monitoring system consisting of:
   - a meteorological, hydrological and microbiological monitoring network based on sensors, analyses and alert system along sewers, river, stream and bathing coastal waters,
   - freshwater and seawater sampling,
   - laboratory analysis,
   - database.

   The monitoring system is described in detail in Chapter 2.2.6.

2) a numerical model of the coastal waters (FOM) to simulate and forecast bacterial dispersion in bathing waters.
   The impact and evolution of a critical scenario in predictive terms can be achieved thanks to a hydrodynamic analysis of the application area, which can be represented and described by the FOM (Forecast Operation Model), that is by the hydrodynamic finite element model, as well as applied to the five study areas in the Adriatic Sea, which differ from each other in terms of urban, oceanographic and morphological conditions.
   Through the FOM is it possible to identify the bacterial dispersion, and so, the critical areas where the bathing should be forbidden.
   FOM is based on the System of HydrodYnamic Finite Element Modules (SHYFEM, Umgiesser et al., 2014) code, an open-source unstructured ocean model for simulating hydrodynamics and transport processes at very high resolution. The modelling suite consists of:
   - a 3D hydrodynamic model, that describes currents and mixing of water mass in the system;

- a transport and dispersion module, that simulates the dispersion of solute and microorganisms through the system;
- a microbial decay module, which defines the decay of microorganisms considering various environmental conditions.

The horizontal discretization of the state variables is carried out with the finite element method, with the subdivision of the numerical domain in triangles varying in form and size. Such a method has the advantage of representing in detail complicated bathymetry and irregular boundaries in coastal areas. Thus, it can solve the combined large-scale oceanic and small-scale coastal dynamics in the same discrete domain by using unstructured meshes.

The operational system chain (FOM) consists of a daily cycle of numerical integrations. Every day a two-day forecast is produced, with the initial conditions from a hot start based on the FOM forecast of the previous day. The system performs a 2 day-long simulation, and the results (water temperature, salinity and *E. coli* concentration) are shared through a THREDDS data server and integrated into the project's WEB system jointly river discharge and rain forecast (Figure 9).

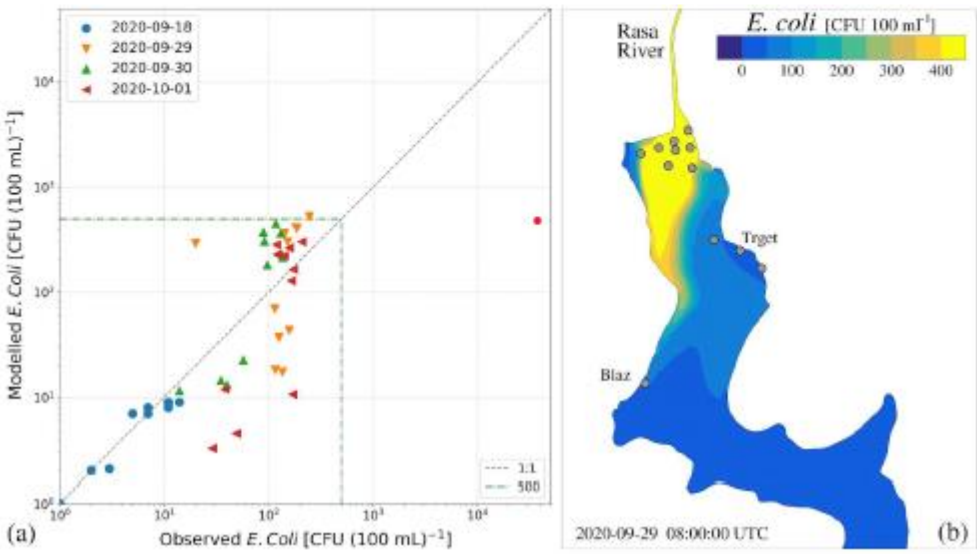

Figure 9. a) Scatter plot of simulated versus observed E. coli concentrations (2020 surveys) on Raša River site. b) Simulated distribution of E. coli on 29 September 2020 at 08 UTC. The grey dots mark the sampling stations. (Ferrarin et al., 2021).

3) an innovative real-time Alert Tool which predicts potential ecological risks related to the bacterial contamination of bathing water after extreme raining events;it allows a reduction of the negative environmental impact (microbial and healthy) and the designing of new rules in the future, in order to set up adapted management systems, if a contamination exists.

The realization of an integrated and smart WATERCARE decision processes system helped the responsible authorities and stakeholders (operators of the facilities and tourist services, swimmers and bathers, etc.) to improve the management of urban water areas through a smart system of support for the control on meteorology, bacterial load and discharge of overflow sewerage network. The project design innovation is significant for the consideration of specific sites with different characteristics, which can be represented and driven by the same management project. The alert tool is a dedicated software that runs continuously in real time using the data stored in the WQIS database (Penna et al, 2021). The alert tool provides the notification to the responsible authorities and stakeholders through a predetermined communication channel (email, SMS or Telegram). Alert Tool consists of a hydrodynamic model, a transport and diffusion model and a microbial decay model. The adopted approach realizes a seamless transition between different spatial scales, from the river mouth to the open sea, and adopts a high spatial and temporal resolution of the forcing and boundary conditions that drive the simulations. The hydrodynamic model, the transport and diffusion model and the microbial decay model have been applied to the five pilot sites in the Adriatic Sea for a total of 15 simulations. The model is evaluated against observations in the coastal areas, illustrating the capability of this tool in simulating the water circulation as well as the dispersion and decay of microbial pollutants. The model evaluation is limited by the availability of site-specific observations.

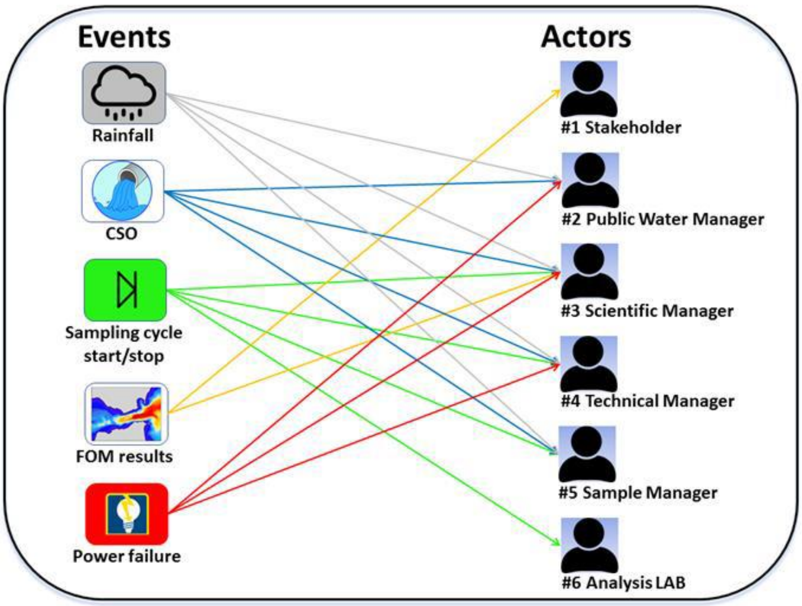

Figure 10. A simplified scheme with some correspondence relationships between the events and the WQIS actors/recipients (Penna et al., 2021).

<u>*New infrastructure realization of sewage storage tank (Implementation of the WQIS)*</u>

Within WATERCARE, in Fano pilot area, a new infrastructure realization of sewage storage tank was designed and realized. Tank's specific objective is to retain the first rainwaters during the rainstorm that are mixed with the wastewater sewerage system; such wastewaters have the greatest microbiological pollutants loads derived from the drainage runoff at the beginning of the rainy event. The amount collected will allow, if the meteorological event is quantitatively important, and therefore impossible to be contained by the sewage system, to minimize the impact on the receptor river or coastal waters used for bathing. It's now possible to verify exactly the positive impact of tank infrastructure in environmental terms and to measure the amount of pollutants released into the environment and not properly treated in the purification plant. Monitoring was implemented through the installation of sensors. They transmit all measurements to a specific remote-control system that allows monitoring and processing of data in order to spill into sewage network of the second rainwaters, which are characterized by a very low physical-chemical and microbiological pollutants loads. Therefore, the result reached thanks to this specific objective consists on a significant improvement of the bathing water quality, in the first place avoiding to discharge the most polluted wastewater and then letting a better wastewater treatment when the rainstorm is ended.

2.1.3 Eco-friendly anchoring systems (SASPAS project)

Project sites, from North to South (Figure 11):
Monfalcone (Bay of Panzano-GO), Friuli-Venezia Giulia Region, Italy;
Kornati National Park (Nacionalni Park Kornati-ŠI), Šibenik-Knin County, Croatia.

Figure 11. SASPAS anchoring sites.

Possible Adriatic sites for replication:
SASPAS actions can be replicated in other marine areas of the Adriatic Sea with similar characteristics to the study sites selected in the project. These areas were chosen on the basis of specific criteria:

- the presence of a protected area (MPA, National or Regional Park) or a Natura 2000 site;
- the area's tourist vocation, especially in terms of boating and anchoring;
- the presence of marine phanerogams.

Potential areas in which to replicate SASPAS methodology are, for example: **a**rea near Gabicce Mare (Marche Region, Italy), Pakleni islands (Hvar, Croatia), Nature Park Strunjan (Coastal-Karst Region, Slovenia).

Title of the document:
Marine Seagrass Safeguard Integrated Management Program (MSSIMP) including guidelines for the definition of the correct attitude and behavior in protected areas and for the correct management of the involved areas and areas with similar characteristics.
Keywords: Marine Seagrasses, *Posidonia oceanica*, Natura 2000, Habitat Conservation, Anchoring Systems, Monitoring, Stakeholders, Replicability.

Direct link to the document: https://programming14-20.italy-croatia.eu/documents/290205/2777414/D+5.2+Marine+Seagrass+Safeguard+Integrated+Management+Program.pdf/eb5bcbe8-b173-df23-86ec-5d7f818598b3?t=1665916231656

References: Francour et al. (2006). Management guide for Marine Protected Areas of the Mediterranean sea, Permanent Ecological Moorings. Université de Nice-Sophia Antipolis & Parc National de Port-Cros, Nice. MedPAN

Ize S. (2017). Capitalisation sur les Mesures de Gestion au Sein des Aires Marines Protégées de Méditerranée

Topic:

Indications for the setup, the installation, and the operation of the ecological anchorage systems.

Description:

The indications for the setup, the installation, and the operation of the ecological anchorage systems are supported by accounts of Mediterranean experiences.

The ecological anchoring systems solution based on pins fixed in the sea bottom made it possible to avoid the laying of concrete blocks (dead weight) which cause considerable disturbance to the ecosystem and which, in the case of seagrass meadow, are a disturbing element for the plants. The impact of such a new system is negligible both on the seabed and seagrass beds of *Posidonia oceanica* and other protected species. Detailed information is provided for each of the following steps:

Preliminary surveys

A preliminary survey is necessary to gather the general information on seagrass distribution and related problems (fishing, areas of major pressure due to free anchoring or traffic, points of erosion and retreat of the meadows, typology of sediments, etc.) and identified potential sites for the installation of the ecological mooring field.

Criteria for choosing the site locations

The environmentally friendly anchoring systems should be placed in areas where the ecological requirements for the marine seagrasses survival are ensured, but plant are disappearing due to tourism activities (presence of mooring areas for pleasure boats or mooring areas for recreational diving boats). To be successful, the chosen sites should meet two basic requirements: a) historical presence of the meadows; b) termination or absence of impacts preventing their growth and development (assured also by placement of anchoring eco-buoys).

Depending on the type of sites, the sandy areas were preferred rather than the rocky areas, where the collateral damage for the installation could be greater.

Positioning geometry of the buoy field

The buoy field have two specific objectives:

a) to push the small boat owner to moor at the buoys, outside the seagrass meadows;

b) to moor at the buoys, rather than dropping anchor on the meadows if any.

For these reasons, the intention was to position the buoy field partly inside and outside the meadow, to embrace the dual objective.

Several criteria were considered:

- proximity to the seaside area of interest for the smaller yachting fleet;
- rules related to port regulations and minimum distances from the shoreline and from the commercial port breakwater for the installation of structures;
- size of vessels that will likely moor and to define the relative distances between the buoys;
- possibility of sailing around the buoy depending on the wind direction.

Laying methods

Considering stopping the use of large concrete blocks and anchoring chains that negatively impact the environment, especially the seabed, the Manta Ray underwater system was preferred and specifically modified and adapted as in Figure 12.

Figure 12. SASPAS ecological anchorages.

The anchorage consists of the following elements:
1) drilled underwater folding anchor;
2) anchor rope;
3) smaller submerged buoy, as a jumper;
4) anchor chain;
5) anchor rope;
6) anchor buoy.

To prevent scratching of the chain on the seabed, a submerged floating-buoy was inserted between the seabed and the surface buoy. A long anchor chain was installed above the jumper, connected by a floating clamp on one side and an anchor rope on the other. The role of the anchor chain is to ensure elasticity and thus durability of all movable elements of the anchorage exposed to constant movement due to the influence of wind and waves.

Installation procedure and permits

The installation of the mooring equipment included the process of collecting the necessary documentation and permits to obtain a concession by the competent authorities.

Management and controls of the buoy field

During the period of activity, along the summer bathing season, the executor has to provide a general surveillance of the buoy field which included:

- general surface check of the tightness of the equipment;
- control of equipment after any significant meteorological event;
- verification of the tightness and possible replacement of the indication stickers affixed to the buoys;

- prompt interventions, when necessary, for operations for maintenance of stranded buoys and their relocation.

Requirements for the use of buoys and moorings by users

The buoys have on the top a free ring suitable to tie the vessel of users. This ring, in fact, is connected to the mooring line by means of a through steel shaft which absorbs all shocks. To moor the boat, it is advisable to proceed alternatively in two ways:

1) tie or hook a mooring line equipped with a carabiner to the upper ring of the buoy, taking care to leave a few meters of line between the buoy itself and the coupling point on board;
2) use a “double” line by passing one end inside the ring of the buoy and fixing subsequently both ends on board. In this way it will be easier, at the moment of unmooring, to free the boat from the buoy as it is sufficient to loosen one of the two fixing points on board and retrieve the line without having to approach the buoy again.

2.1.4 Seagrass transplantation (SASPAS project)

Project sites, from North to South (Figure 13):
Monfalcone (Bay of Panzano-GO), Friuli-Venezia Giulia Region-Italy;
Kornati National Park (Nacionalni Park Kornati-ŠI), Šibenik-Knin County-Croatia;
Regional Natural Park (RNP) of Coastal Dunes from Torre Canne to Torre San Leonardo (BR), Apulia Region-Italy

Figure 13. SASPAS transplanting sites.

Possible Adriatic sites for replication:
SASPAS actions can be replicated in other marine areas of the Adriatic Sea with similar characteristics to the study sites selected in the project. These areas were chosen on the basis of specific criteria:

- the presence of a protected area (MPA, National or Regional Park) or a Natura 2000 site;
- the area's tourist vocation, especially in terms of boating and anchoring;
- the presence of marine phanerogams.

Potential areas in which to replicate SASPAS methodology are: area near Gabicce Mare (Marche Region, Italy), Pakleni islands (Hvar, Croatia), Nature Park Strunjan (Coastal-Karst Region, Slovenia).

Title of the document: Marine Seagrass Safeguard Integrated Management Program (MSSIMP) including guidelines for the definition of the correct attitude and behavior in protected areas and for the correct management of the involved areas and areas with similar characteristics.
Keywords: Marine Seagrasses, Posidonia *oceanica*, Natura 2000, Habitat Conservation, Pilot Transplantation, Monitoring, Stakeholders, Replicability.
Direct link to the document: https://www.italy-croatia.eu/documents/290205/2777414/D+5.2+Marine+Seagrass+Safeguard+Integrated+Management+Program.pdf/eb5bcbe8-b173-df23-86ec-5d7f818598b3?t=1665916231656
References:
Calvo et al., 2014
Curiel et al., 2003
Sfriso et al., 2019

Topic: *Posidonia oceanica* and *Cymodocea nodosa* transplantation techniques,
Description:
About the seagrass species considered in SASPAS project, *Cymodocea nodosa* in Panzano Bay - Monfalcone and *Posidonia oceanica* in NP Kornati and RNP Dune Costiere, the literature reports different transplantation methods currently used in the Mediterranean Sea.
In SASPAS project, for *P. oceanica* have been carried out two similar manual techniques for rhizome transplantation; *C. nodosa* transplants were carried out using two different manual techniques for sods and shoots.
In each case, to choose the donor site, several criteria have to be considered: the site must be in good condition, able to provide sufficient material (about 1000 cuttings) for transplantation with negligible disturbance to the conservation status of the habitat and located adjacent the transplant areas to minimize the duration of the transport.

1) *Posidonia oceanica* transplant
   Technique 1
   The rhizome transplantation method was carried out using an innovative staple made up of a totally biodegradable polymer (Mater-Bi®; Biosurvey S.r.l. and IDEA S.r.l.), consisting of a purpose-designed star-shaped anchoring system with 5 arms to which fasten the seagrass rhizomes (Figure 14).

Figure 14. P. oceanica *shoots fixed to the star-shaped biodegradable staples.*

The transplant consists of different steps:
- collection of *P.oceanica* shoots by hand (at the donor site);
- temporary storage of planting units in plastic containers filled with seawater;
- transport to transplanting site;
- fastening of *P. oceanica* rhizomes to the arms of the biodegradable staples, using tear-off bands;
- assembling the biodegradable supports to the central node and then anchoring to the bottom sediment, by fastening the star staple centers with linchpins inserted in pre-installed biodegradable pickets.

Technique 2

Shoots are mounted on exotic wood supports, heavy enough and of low degradability, to resist on the sea floor at least for a couple of years.

The transplant consists of different steps:
- to collect the shoots (at the donor site)
- to attach the cuttings, each of which is formed of at least three shoots of leaves, with biodegradable plastic ties to the wooden supports
- to fix the wooden base on matte with iron pin (Figure 15).

Figure 15. P. oceanica *shoots mounted on the wooden support; wooden base fixed on matte with iron pin.*

2) *Cymodocea nodosa* transplant

<u>Technique 1</u>

The first technique consists in the collection and planting of sods (units made up by plants with leaves, roots and rhizomes plus the native sediment that surrounds the rooting apparatus).

The transplanting has to be carried out when the seagrasses are not in their growing period (since September to April) to minimize plant stress.

The transplanting steps are:

- collection of *C. nodosa* sods (at the donor site) from the substrate through a steel core drill (Figure 16 left);
- placing of each sod in a perforated bucket, covered with hemp fabric;
- transport to the transplant site maintaining sods constantly wetted to avoid drying;
- creation, in the transplant site, of holes with the same size of the collected sods through the air-lift samplers;
- positioning of the sods in the sediment together with the hemp fabric (Figure 16 right).

Figure 16. LEFT: Steel core drill used to extract C. nodosa *sods from the donor site. RIGHT: Sods in the sediment together with the hemp fabric.*

Technique 2

The second technique consists in the manual collection of shoots (planting units made up by bare root cuttings), which were subsequently re-planted thanks to anchoring staples.

During the removal and cleaning of seagrasses, it was important to ensure the presence of apical meristems of the growing rhizome in the individual planting units, as they provide a source of new shoots and horizontal growth for the colonization of new areas.

The transplanting steps are:

- Collection of the plants (at the donor site) using air-lift samplers, which allowed to free rhizomes and leaves from the sediment;
- Placing of into tanks with flowing seawater, floating baskets, or similar carriers (Figure 17 left);
- Transport to the planting site;
- Planting the seagrasses directly into the seabed using U-shaped metal (Figure 17 right).

Sprigs have to be attached to the staples by manually inserting the rhizome root portion of the plant fragments under the curved part of the staple and fixing the plants to the bottom sediment, to limit the impact of hydrodynamics and waves.

Figure 17. LEFT: Floating baskets used to carry C. nodosa shoots collected from the donor site. RIGHT: Planting of C. nodosa shoots.

2.1.5 Wetland Contracts (CREW project)

Project sites, from North to South (Figure 18):
Marano Lagoon (Udine), Friuli Venezia Giulia Region, Italy;
Northen Lagoon of Venice (Venice), Veneto Region, Italy;
Special Ornithological Reserve Palud, Rovinj, Istria County, Croatia;
Veliko I Malo blato, Zadar, Croatia;
Protected natural area of Dubrovnik-Neretva, Dubrovnik-Neretva County, Croatia;
Sentina Natural Regional Reserve, San Benedetto del Tronto (Ascoli Piceno), Marche Region, Italy;
Ofanto River (Bari), Apulia Region, Italy.

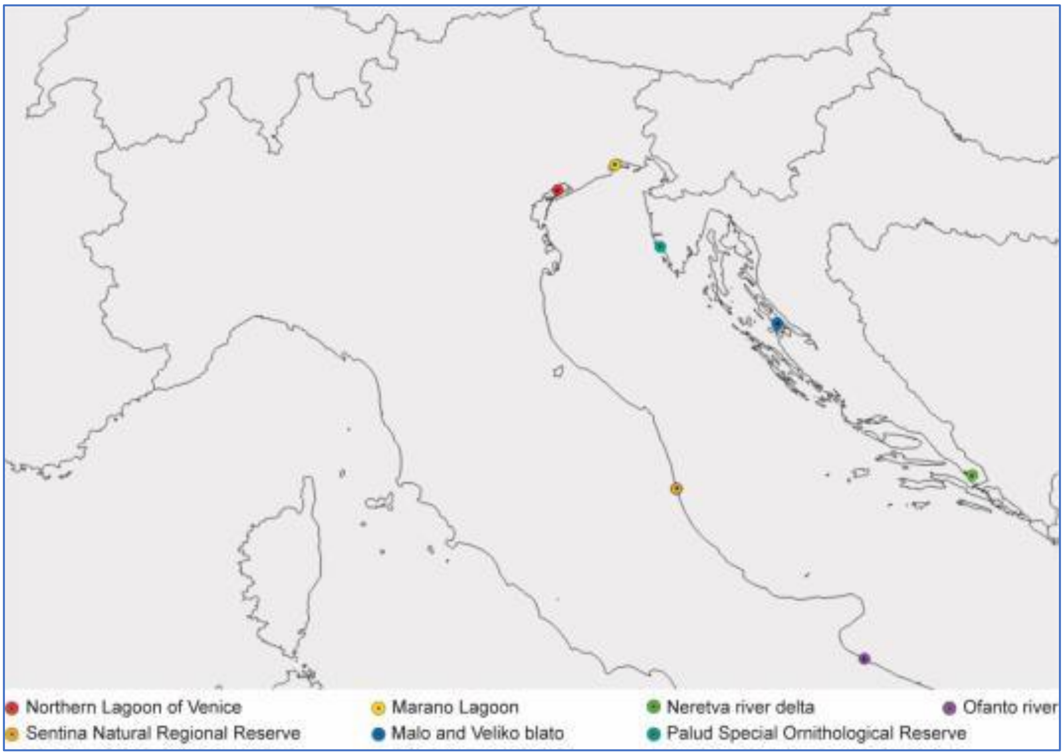

Figure 18. CREW project sites.

Possible Adriatic sites for replication:
CREW actions can be replicated in other wetlands of the Adriatic Sea with similar characteristics. Furthermore, two wetlands involved in CREW project as target areas are just portions of wider areas. CREW can be extended to the hole areas, including Southern Lagoon of Venice (Venice, Veneto Region, Italy) and Grado Lagoon (Gorizia, Friuli Venezia Giulia Region, Italy).

Title of the documents:
D.3.2.2 Evaluation report (comparing wetland contracts experiences)
D.4.3.4 Wetland contract
D.4.1.2 Wetland contract toolkit
Keywords: Governance, Wetland Contract, Stakeholder Engagement, Citizen Management And Protection, Citizen Science.
Direct link to the document:
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=30
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=42
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=35

References:
Convention on Wetlands. (2021). *Global Wetland Outlook: Special Edition 2021*. Gland, Switzerland: Secretariat of the Convention on Wetlands.
Polajnar Horvat K, Smrekar A. "The Wetland Contract as a Tool for Successful Wetland Governance: A Case Study of Ljubljansko Barje Nature Park, Slovenia". *Sustainability.* 2021; 13(1):425.
Verniest, F., Galewski,T., Julliard, R., Guelmami, A., & Le Viol, I. (2022). "Coupling future climate and land-use projections reveals where to strengthen the protection of Mediterranean Key Biodiversity Areas". *Conservation Science and Practice*, 4(11).

Topic:
Environmental components addressed in Wetland Contracts: biodiversity, water quality, ecosystem services, protection level.
Description:
GENERAL AIM AND SPECIFIC OBJECTIVES
Wetland Contracts (Figure 19) aim to combine the management of water, hydro-morphological risks and local development in an integrated, collaborative and sustainable manner. The Contracts are intended as a voluntary act of commitment shared by various public and private stakeholders aimed at finding ways to pursue objectives of landscape and environmental rehabilitation and socio-economic regeneration of the territorial system. The Wetland Contracts submitted through CREW project involved a wide set of actors, both institutional and non-institutional, public and private stakeholders, arising a sense of responsibility for the management of fragile territories. This kind of people-engagement also fosters citizen empowerment. Wetland Contracts take the form of a bottom-up protection tool that reverses traditional forms of ecosystem protection (not just top-down) in which all actors contribute according to their skills and abilities.
Wetland Contract is presented as a coordinated methodology (integrated tool) for the implementation of wetland management, in coherence with the ICZM principles. Although the 7 Pilot Areas are very different in size and from a morphological and functional point of view, all of them are vulnerable and fragile areas that need protection on different levels. CREW project shares a cross border approach for actions in setting up protocols for wetland contracts, in reference to: biodiversity, water quality, ecosystem services, and protection level.
It is able to:
- assure higher coordination among stakeholders and decision makers;
- limit and absorb raising conflicts between preservation issues and economic activities;
- enhance the achievement of sustainable long-term results;
- improve public awareness about the value of wetland ecosystems and strengthen active people engagement in territorial governance.

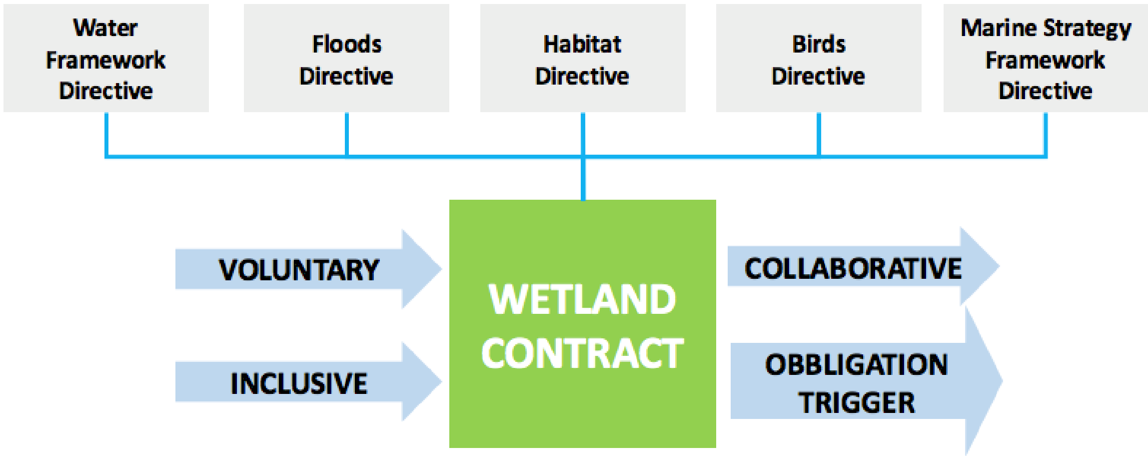

Figure 19. Wetland Contract characteristic and regulatory framework.

MULTI-LEVEL GOVERNACE IMPLEMENTATION

Wetland Contract supports local policies in a logic of greater integration, to optimize public and private investments in a synergistic and collaborative way, and to attract new resources to a better environmental and socio-economic management of the lagoon system. It is a program, not a plan: it intends to create programmatic bases from which other projects can arise, without imposing new constraints.

This voluntary and inclusive practice arises important strengths and opportunities for the implementation of territorial fragile territory governance:

- it is capable of building consensus for local governments, and activating processes of empowerment in the area;
- it allows to develop both vertical and horizontal subsidiarity capable of fostering coordination between institutions at all levels involved, as well as rationalizing and integrating available resources such as funding, existing plans and local knowledge;
- All people involved bring not only economic and time resources, but also other resources, such as knowledge of existing social networks and a necessary readiness for action that will be particularly useful over time.

Thus, Wetland Contract is an innovative practice aimed at commit people to share responsibility to protect territorial biodiversity. It also aimed at reinforcing existing institutional actions. It's moving simultaneously at multiple scales: on the one hand raising awareness and promoting the issue of wetlands at the regional and supra-regional levels, and on the other encouraging multi-level governance tools capable of fostering plural forms of representation. This dual endeavor proposes a complex challenge:

- strengthening the network of existing projects dealing with wetlands so as to influence European policies;
- translating the results of territorial pathways into practical feedback, even in the short term, that can be nimbly integrated into existing policies.

WETLAND CONTRACT AGREEMENT PROCEDURE

The Wetland Contract is a multistage process (Figure 20) that is defined by the following key steps:

1. Definition of a structured and integrated knowledge base, shared and updatable, on the state of the target area (strengths/weaknesses from the environmental and socio-economic point of view) and

the risks/opportunities connected to it, as well as the framework of the programmatic tools (existing plans, programs, projects).

2. Establishment of the governance structure that has the task of coordinating the Wetland Contract process and share the main common objectives. If applicable, this step can be formalized by signing a Memorandum of Understanding (MoU) among local key stakeholders involved at the beginning of the process (e.g. the formalization of the MoU is mandatory in the Italian River/Wetland Contracts context).
3. Identification – through the organization of several Territorial Labs (participative planning workshops) – of concerted future medium-long term scenario, a strategic vision to be adopted, capable of coordinating various planning tools and adopting the principles of sustainable development.
4. Development of an Action Plan that establishes the priority actions, the roles and the methods for implementing the strategy and a plan to monitor its actual implementation;
5. Signature of the Wetland Contract as a formal commitment document to carry out the actions developed and shared in the participated path;
6. Realization of the activities foreseen in the Action Plan;
7. Monitoring of the activities and the effectiveness of the Wetland Contract process.

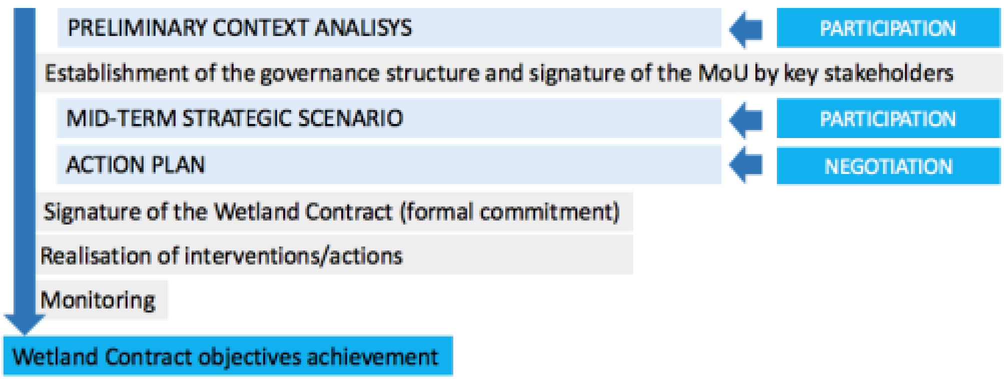

Figure 20. Wetland Contract process.

In this described process through seven templates (Figure 21)(based on the ones developed by WETNET) codifying the minimum requirements (qualitative requirements and coherence with the objectives of the tool) to be included in the key documents of the Wetland Contract process, which are:

STAGE 1: CONTEXT ANALYSIS

1) Regulatory framework
2) Scientific description
3) Stakeholders' map

STAGE 2: TERRITORIAL LABS

4) Alternative scenarios
5) Sharing and assessing scenarios
6) Territorial Lab experience
7) Action Plan and Wetland Contract

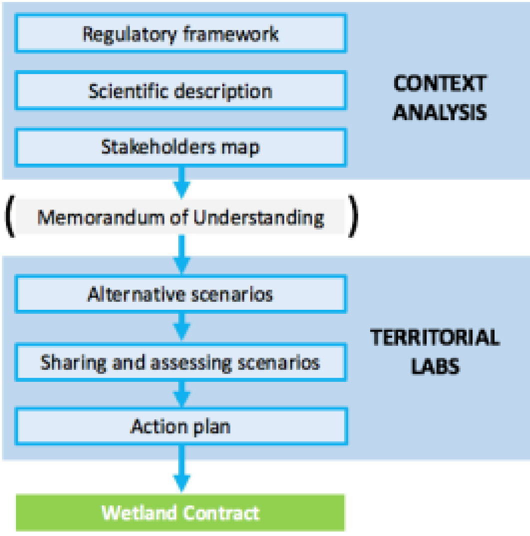

Figure 21. CREW Methodology for Wetland Contract Implementation.

STAGE 1

The first stage of the process is the **context analysis** collection; it aims at preparing the subsequent pilot activities related to the actual implementation of the Wetland Contract.

This stage investigates the regulatory framework in local wetlands management, concerning territorial and landscape planning and policies; it collects the existing knowledge about the criticalities and the environmental and territorial values to base the strategic scenario; finally, the stakeholders mapping identifies and lists the actors to be involved in the Territorial labs among civil society and key groups.

The stakeholders involved share the main common objectives on which the process will focus its activities. If applicable or necessary (as for example in the Italian context), this step can be officially formalized by signing a **Memorandum of Understanding** (MoU) among local key stakeholders involved at the beginning of the process.The Memorandum of Understanding contains the general reasons and objectives, also established for the pursuit of the obligations referred to in article 4 of directive 2000/60/EC and the daughter EU Environmental Directives, the specific critical issues covered by the Wetland Contract and the working methodology shared between the actors taking part in the process.

STAGE 2

The second stage of the process aims at implementing the Wetland Contract in the target wetland through the following progressive steps:

- identify the institutional management bodies for the Wetland Contract process;
- establishing **the Territorial Labs** for the participated governance;
- defining, sharing and assessing the alternative scenarios with the target groups through 4 Territorial labs;
- drafting the **Action Plan** and subscribing the Wetland Contract which includes activities and responsibilities to be carried out.

Governance structure and first commitment

The governance structure of the Wetland Contract has the task of coordinating the Wetland Contract process. It is composed by three management bodies (Figure 22):

- **Basin Forum**: is the organ of public participation extended to the entire Community of the territory under the competence of the wetland system, in which all public and private subjects can participate.
- **Management Board**: is the institutional body made up of public entities adhering to the Wetland Contract. This body undertakes to direct, instruct and validate the work of the Basin Assembly and the Technical Secretariat.
- **Technical Secretariat**: is the operating body supporting the Management Board and the Basin Assembly.

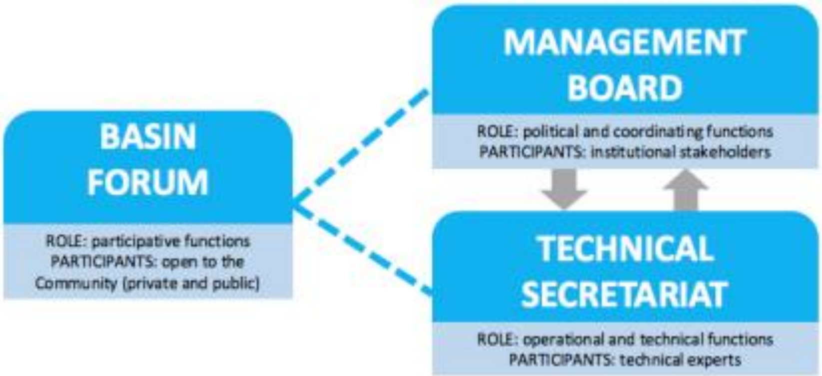

Figure 22. Institutional management bodies of the Wetland Contract.

2.1.6 Observatory (CREW project)

Project sites, from North to South (Figure 23):
Marano Lagoon (Udine), Friuli Venezia Giulia Region, Italy;
Northen Lagoon of Venice (Venice), Veneto Region, Italy;
Special Ornithological Reserve Palud, Rovinj, Istria County, Croatia;
Veliko I Malo blato, Zadar, Croatia;
Protected natural area of Dubrovnik-Neretva, Dubrovnik-Neretva County, Croatia;
Sentina Natural Regional Reserve, San Benedetto del Tronto (Ascoli Piceno), Marche Region, Italy;
Ofanto River (Bari), Apulia Region, Italy.

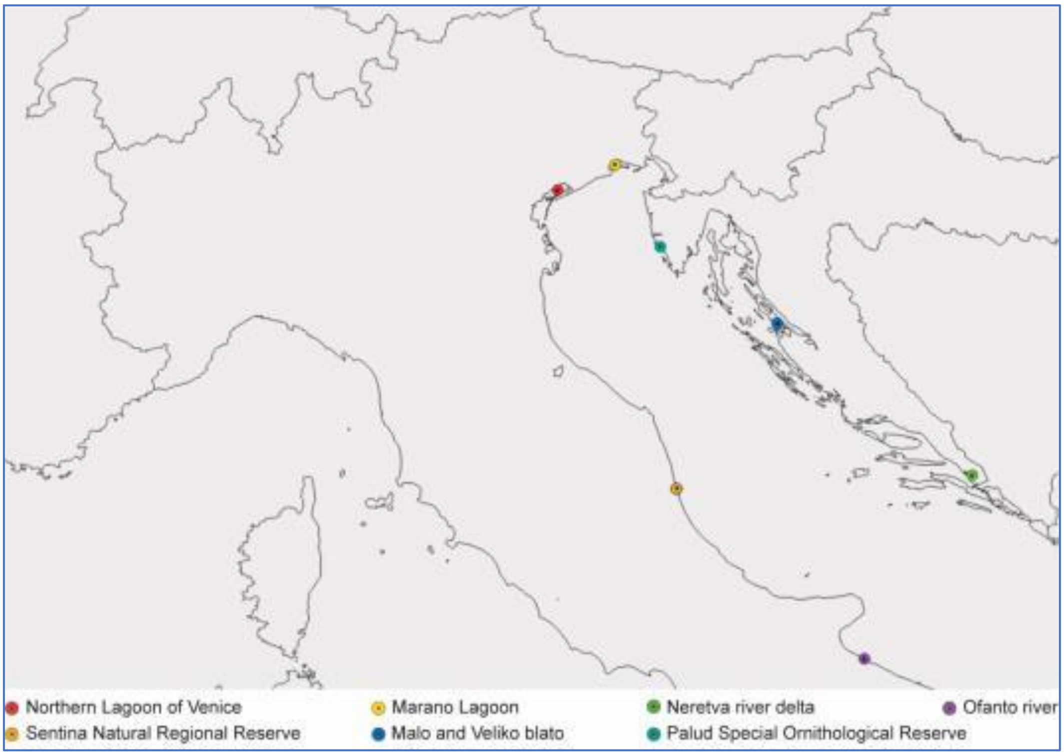

Figure 23. CREW project sites.

Possible Adriatic sites for replication:
Observatory set up by CREW can be replicated in other coastal wetlands and, in general, to monitoring processes supporting MSP.

Title of the documents:
D.3.1.1 OBSERVATORY
D.3.2.1 IT-HR BORDER PRIORITIES
D.3.2.3 IT-HR CROSS BORDER STRATEGY (RECCOMANDATION)
Keywords: Multilevel Governance Tool, Wetland Biodiversity, Stakeholder Engagement, Citizen Management And Protection, Networking, Transferability of results
Direct link to the document:
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=28
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=29
https://programming14-20.italy-croatia.eu/web/crew/docs-and-tools-details?id=2762728&nAcc=3&file=31
http://crew-observatory.unicam.it/wordpress/
References:
Bonnet B., Aulong S., Goyet S., Lutz M., Mathevet R., Integrated Managemen of Mediterranean Wetlands, in Conservation of the Mediterranean Wetlands, n 13
Mediterranean Wetland Observatory, Tour du Valat, available at https://tourduvalat.org/en/mediterranean-wetlands/mwo/

Topic: Cross border monitoring tool for the long-term assessment of the conservation status of wetland ecosystems, sharing knowledge and ensuring their protection.

Description:
CREW developed a management system of Wetlands in the cross-border area of Italy and Croatia by considering scientific, environmental and governance concerns through the implementation of a multilevel governance tool. The tool has the objective to achieve overall effects on coastal wetlands eco-systems and socio-economic related systems by overcoming fragmentations that are often jeopardizing the sustainable development and preservation of these fragile areas.
CREW Observatory is a transnational platform that serves to monitor and share best practices and data on coastal wetlands in the cross-border region. This hub works on three levels:

- **collecting and monitoring all the data related to the project and the cross border protected wetlands**: indicators (such as habitat conservation status maps, water quality, ecological function, biodiversity level), evaluations, and best practices related to the conservation and sustainable management of wetlands, eco-system services and Wetland Contracts. An ICT tool, the CREW platform with a web-GIS, has been developed to monitor all data collected through the monitoring systems installed in each target area and ensure wider dissemination of the project results. It is a forum devoted to collect data and to make them accessible to interested stakeholders, who thus is able to participate in the CREW Observatory activities;
- **strengthening the network** among Italian and Croatian coastal protected wetlands, defining and sharing beyond the project partnership the cross-border priorities and strategy, and thus disseminating them within a wider audience. The Observatory cooperates with international networks, like the ADRIAPAN and MEDPAN (some of the Protected areas involved in CREW are active members of these networks), and with other EU financed projects. Indeed, each PPs member appointed in the Observatory board engaged its competent regional authorities, thus ensuring a wider public engagement on the project and drawing attention to wetlands challenges, recommend appropriate interventions and promote responsible governance;
- **empowering networking for future projects and the transferability of the cross-border strategy and of the project results**: all the information collected during the project implementation and through the monitoring tools installed in the target areas (digitalized on the GIS database available on the web platform), has been transferred to the platform and so available for other organization and further research interested even after the end of CREW, and so to enhance the transnational exchange of expertise and data to create synergies with other UE partners.

The CREW web platform collects:

- documents, reports, georeferenced (WebGIS) data (CREW Wiki);
- Good practices;
- Wetland Contracts;
- Scientific support;
- Regulatory framework.

CREW Observatory fosters activities for strengthening the network among Italian and Croatian coastal protected wetlands and for empowering international networking so to enhance the transnational exchange of expertise and data in order to create synergies with other EU partners, such as:

- Conferences at national and international level;

- Workshops;
- Webinars;
- Annual meetings.

2.1.7 Comparative analysis of the legislative framework for the management of the wastewater treatment plan /purifiers in Italy and Croatia with proposing legal issues to improve local water quality objectives (AdSWiM project)

Title of the document: Report on analyzing legislative framework of WWT processes in both countries with proposing legal issues to improve local water quality objectives
Keywords: water protection; legal framework; shared management in wastewater treatments; legal issues; flowchart of wastewater management in HR and IT
Direct link to the documents: https://programming14-20.italy-croatia.eu/documents/292115/4995519/Deliverable+5.3.1.pdf/8d25c847-2cce-6724-993e-2c3743b09506?t=1645865746982
References:
Susmel S. et al. (2022). The Interreg Project AdSWiM: Managed Use of Treated Wastewater for the Quality of the Adriatic Sea. *Water*, 14(16), 2460

Topic:
Comparative analysis of the legislative framework for the management of the wastewater treatment plan /purifiers in Italy and Croatia with proposing legal issues to improve local water quality objectives.
Description:
The AdSWiM project aimed to bring together cross-border research centers, universities, and municipalities with Waste Water Treatments company's managers to investigate whether there were gaps between the microbiological/analytical data resulting from the application of individual directives (e.g., the Urban Waste Water Treatment Directive, the Bathing Water Directive), and the ecological quality of marine waters as indicated by the Good Ecological Status indications set by the Marine Strategy Framework Directive. Among the activities foreseen by the project, emerged the need of survey the legislative frame governing the process of waste treatment and discharge. Due to the common derivation of the national standards from the EU regulations, there is a substantial uniformity in the relevant legislative guidelines between Italy and Croatia. For this reason, finding any significant differences in the compliance to keep the concentration of chemicals below legislative thresholds in treated waters to be discharged at sea is improbable. However, there are significant differences in the way the two countries manage the entire water cycle, the integrated water system, and the agencies in charge of water quality control. Indeed, while the Italian administrative model is characterized by substantial uniformity, on the Croatian side, the same uniformity is not found in the organization of the operational, management, and control schemes. These discrepancies show that the possibility of proposing a common legal framework enhancing the protection of the Adriatic Sea in consideration of the local needs is obviously complicated and, in the end, it still falls under EU authority. However, the stipulation of a series of agreements between the Italian agencies responsible for integrated water management and Croatian administrative bodies responsible for water purification appears to be feasible. So that the investigation about these discrepancies has been considered the first step to reason, in practical, on harmonization and two legal experts, a Croatian and an Italian, were involved to survey the legislative framework in which wastewater treatment plant have to act. The document is organized in sections, namely showing the Croatian Legal framework (part 1), the Italian one (part 2) and finally the framework in which to move for proposal aiming to improve the local water quality objectives (part 3).

Croatian Legal framework

The Croatian survey started presenting how the competence of state bodies and local and regional self-government bodies in relation to environmental protection in general, and water protection against pollution in particular, is regulated in the Croatian legal system. In doing so, due attention is paid to both the legislative and implementing competences of these bodies. So this, the analyses starts by introducing the general organization and constitutional division of competences between State and local and regional self-government units, describing the economical independence of bodies, the organization of the municipalities in relation to the inhabitants and reporting the basic EU regulations governing the protection of the environment from municipal wastewater, transposed into Croatian law by the adoption and subsequent amendments to the 2019 Waters Act. **Hrvatske vode** is a legal entity for water management, established on the basis of the Waters Act, and the founder is the Republic of Croatia. The activities of Hrvatske vode are financed from water fees, which are regulated by the Financing Water Management Act. The Republic of Croatia is jointly and severally liable for the obligations of Hrvatske vode. The governing body of Hrvatske vode is the Management Board, which consists of seven members and six of them are appointed and dismissed by the Government of the Republic of Croatia, at the proposal of the Minister. Waters act entrusts Croatian waters of a wide range of competences devoted to the protection of the water quality and management and supports also the institution of Water Institute (Institut za vode) with the legal status of a public institution. The document describes the policy for water management adopted by Croatian water in Croatia. It is also reported about the adoption in March 2021 by the Government of the Republic of Croatia of theMarine Environmental and Coastal Area Strategy Action Program; Following and Monitoring Systemfor Continuous Assessment of the State of the Adriatic Sea (2021-2026) which have to be considered in the frame of the strategies and policies adopted for the protection of water from pollution.

Italian Legal framework

The same organization was adopted in the document prepared by the Italian expert analyzing the organization of the **Italian** system. As main treat emerged the foundation of the **Integrated Water Service** (IWS) organization, a hub in charge of the protection and rational use of water. It established from 1994, it is now thoroughly governed, in organization and operations, by the environmental code. The integrated water service is made up of a combination of public catchment, conveyance, and distribution services of water for civil sewage uses and purification of wastewater, and it must be managed in accordance with principles of efficiency, efficacy, and affordability. The organization is structured on a local base. The municipalities, through the **optimum territorial ambit body (OTAMB)**, carry out the functions of organizing the integrated water service, selecting the form of management, determining the utility tariffs, assigning management, and relative control. the water services are organized based on the **optimum territorial ambits (OTA)** defined by the regions. The document in annex reports about the full competences and roles of OTAMB and OTA, tariff, sludge treatments and regional plan for water protection, as well as, for Croatia, all the competences of Hrvatske vode and Water Institute and the relation with the territories were reported. In consideration of the aim of AdSWiM project, aiming to eventually modify the composition for nutrients of the waste water treated and discharged into the sea, the experts were invited to highlight the eventual counterparts to involve in the process of legislative adaptation. It emerged for the Italian administrative model a substantial uniformity in form, which is supported by two strong points: the center-suburb coordination between the mixed bodies (the permanent institutional conference, pursuant to Art. 63 of the environmental code) and the OTA "system" on a regional level, where the OTA coincides with the entire regional territory in numerous cases (see Friuli Venezia Giulia). This system anticipates an addressing, management, and control process assigned on a regional level and coordinated on the central level which can be adapted to various geographical settings, but comparable in terms of performance of the processes that are structured based on the same dynamic.

What we learned and perspectives

From what is shown by the analysis conducted on the Croatian side, the same uniformity is not found in the organization of the operational – management and control scheme. This obviously complicates the possibility of proposing legislative changes (in any case, the jurisdiction of the State in both cases), such to be realistically useful in improving the level of protection of the Adriatic. In addition to this, it must be considered that many decisions, especially on the issue of technical standards on limits anddetection methods of the chemical substances in the water, still fall under EU jurisdiction. If the objective is to draft special guidelines for the Adriatic, and particularly for its northern area, based on the effects that are occurring specifically consequential to the currently practiced water purification techniques, the reference regulatory structure must be considered and a common strategymust be drafted. The way to obtain exceptions and therefore a sort of special arrangement for certain areas is anticipated by the same directive 2000/60/EC in Art. 12, where it is envisaged that, should a member State become aware of an aspect that presents repercussions for management of its waters, but whichcannot be resolved internally, it can delegate the question to the Commission and to any other member State involved, recommending solutions if applicable. In these cases, the Commission responds to each report or recommendation from a member State within six months. Nevertheless, the uncertainty in defining what can be considered "in excess" of the individual State's capabilities, the need for this procedure to be activated specifically by the States themselves, despite hypothetically concerning limited areas, and the realistic possibility of obtaining significant results, lead to this instrument being considered to be of dubious effectiveness, unless preceded and accompanied by a series of coordinated operations between the involved States and, within these, between the States and the respective local or decentralized governments. The starting point for these coordinated operations could be represented by the stipulation of a seriesof agreements between the agencies responsible for integrated water management, on Italy's part, and water purification on Croatia's part. The content of these agreements should include, first and foremost, the exchange and sharing of the information on the purification operation and the techniques used, the quality of the marine waters, and the sharing of best practices. This constant exchange of information can lead to the drafting of targeted strategies, which bring to light common elements and differences in approach. As for the Italian side, the main point of contact, as said, is constituted by the OTAMB (Optimal Territorial Ambit Management Body) - "Ausir" for FVG - precisely because it is representative of the entire area involved and the hub between the regional authority and the integrated water managers and, in any case, in a privileged position to be able to dialogue with both. On the other hand, the OTAMB must also have capabilities on a district basin conference level, because this government body coexists with the state administration, in other words, the subject able to interact with its counterpart on the Croatian side and, at the same time, on the level of the community that must be interacted within order to definitively determine, if necessary, exemption arrangements and the contents thereof.
Therefore, during the institutional conference, the best solutions can be drafted to bring to theattention of the European Commission, following discussion with the Croatian (state) partner.

The operational structure can summarily be traced as follows:

- the OTAMBs dialogue with the Croatian bodies that carry out the same functions (perhaps a "permanent round table" or something similar can be proposed?);
- each OTAMB interprets requests from the integrated water system managers and returns theresults drafted by the "permanent round table" to them;

- the OTAMBs are invited to participate in the permanent institutional conference, partly for the purpose of contributing what has come out during the "permanent round table" to the discussion;
- the permanent institutional conference invites the relevant Minister (State representative, in Italy the Minister of environment) to be the spokesperson (with their Croatian counterpart) atthe EU Commission.

It is a difficult course but, if followed steadfastly, it may produce some significant results over time

2.2 Monitoring protocols

2.2.1 An ecosystem-based system of variables to enhance marine species and habitat monitoring and conservation: The Adriatic Natura 2000 case study (ECOSS project)

Project sites from North to South (Figure 24):
Trezze San Pietro e Bardelli (IT3330009), Friuli-Venezia Giulia Region, Italy;
Tegnùe di Chioggia (IT3250047), Veneto Region, Italy;
Po river delta (IT3270017 and IT3270023), Veneto Region, Italy;
Cres-Lošinj (HR3000161), Primorje-Gorski Kotar County, Croatia;
Viški akvatorij (HR3000469), Dubrovnik-Neretva County, Croatia;
Malostonski zaljev (HR4000015), Dubrovnik-Neretva County, Croatia.

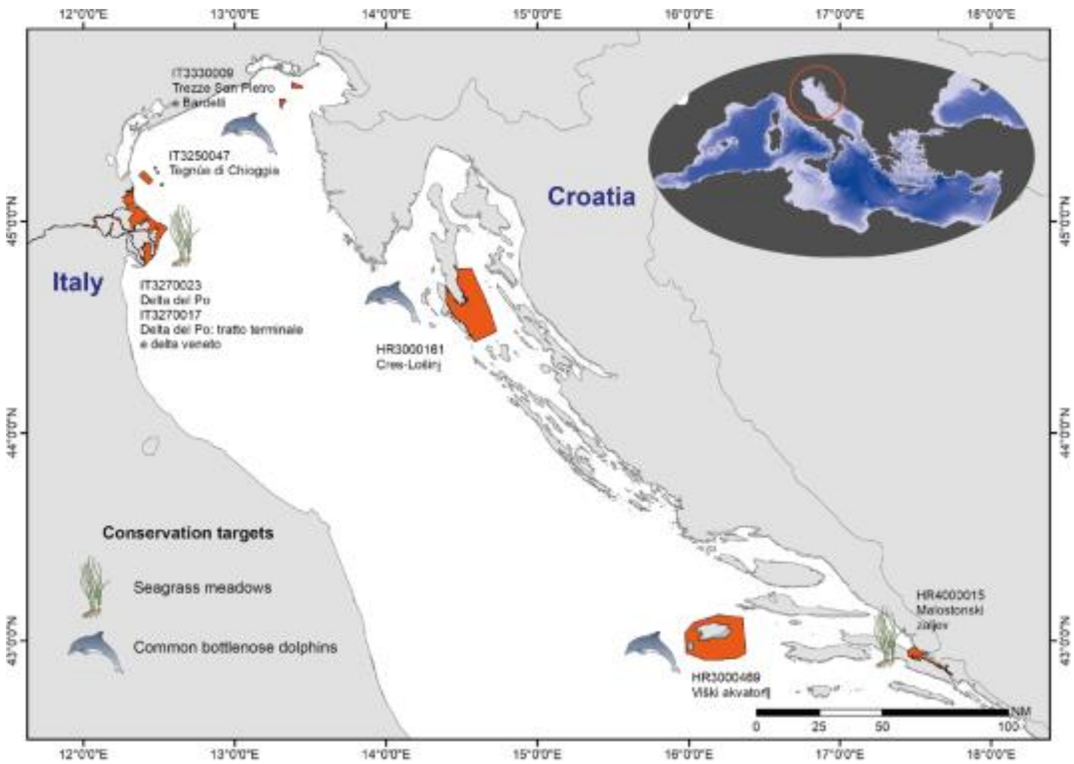

Figure 24. ECOSS project sites.

Title of the document:
An ecosystem-based system of variables to enhance marine species and habitat monitoring and conservation: The Adriatic Natura 2000 case study.

Keywords: Essential Variables, MSFD, WFD, Natura 2000, Marine Ecological Observatory, Transboundary Conservation.

Direct link to the document:

Manea et al. (2022). An ecosystem-based system of variables to enhance marine species and habitat monitoring and conservation: The Adriatic Natura 2000 case study. *Front. Mar. Sci.* 9:920366.
https:// DOI 10.3389/fmars.2022.920366

Topic:

To build a coherent ecosystem-based system of monitoring variables for target marine species and habitats, able to integrate the existing monitoring frameworks set up by the Water and the Marine Strategy Framework directives, and the Essential Ocean and Biodiversity Variables, with the aim to contribute to their harmonization and implementation.

Description:

Implementing effective marine monitoring to detect and track ecosystem shifts, biodiversity alteration, and habitat loss is one of the most crucial challenges to meet the objectives set out by the Post-2020 Biodiversity Framework and by the United Nations Sustainable Development Goals. The lack of coordinated and harmonized monitoring frameworks at different spatial scales and their weakness in accounting for ecological processes, due to incomplete sets of monitoring variables, strongly hinder the achievement of conservation objectives. We propose an approach to build a coherent ecosystem-based system of monitoring (Figure 25) variables for target marine species and habitats. The approach is designed to integrate the existing monitoring frameworks set up by the Water and the Marine Strategy Framework directives, and the Essential Ocean and Biodiversity Variables, with the aim to contribute to their harmonization and implementation. Furthermore, by embracing a holistic vision, it aims to incorporate ecological processes and socio-ecological aspects, considering the benefits of public engagement through citizen science, and of the ecosystem services approach for policies' implementation. The study stems from the Ecological Observing System of the Adriatic Sea (ECOAdS), which was developed in the framework of the Interreg Italy-Croatia project ECOSS, using as exemplary monitoring test cases two relevant conservation targets for Natura 2000 sites of the Adriatic Sea, the common bottlenose dolphin and seagrass meadows. The potential of this approach in guiding the prioritization of monitoring variables under ecosystem-based criteria has been tested, and insights into the benefits delivered by an integrated system of observatories' networks and monitoring frameworks to support marine conservation at both local and regional scales have been provided. The proposed approach can be transferred to other contexts and scales to help build a common knowledge and monitoring framework for conservation and management strategies, saving costs by relying on available resources and on consolidated and long-lasting approaches that might converge towards global initiatives.

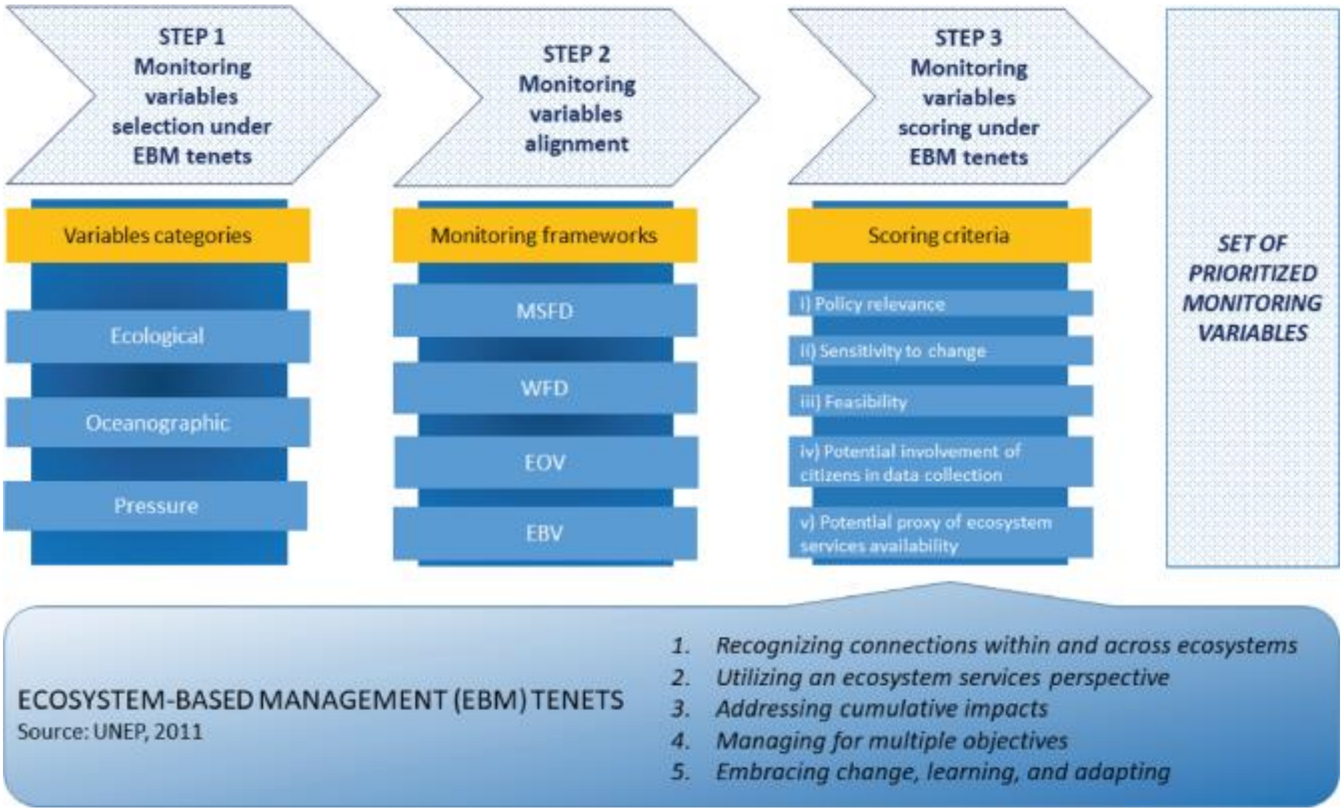

Figure 25. Ecosystem-based system of monitoring.

The list of monitoring variables for the two case studies, common bottlenose dolphin and seagrass meadows is reported in Table 1 and Table 2.

*Table 1. List of monitoring variables for common bottlenose dolphin—*Tursiops truncatus *(Montagu, 1821), species under protection in Cres- Lošinj, Viški akvatorij, Trezze San Pietro e Bardelli, and Tegnùe di Chioggia N2K sites (from Manea et al., 2022)*

	Variable
Ecological Variables	Density abundance
	Sex
	Age
	Recruitment rate
	Spatial distribution
	Dispersal
	Emigration rate
	Immigration rate
	Genetic diversity
	Prey abundance
	Prey distribution
	Population size
	Dolphin behavior metrics

	Variable
	Birth growth and mortality rate/mortality rate from incidental by-catch or incidents with boats
	Biometric measures
Oceanographic variables	Temperature
	Water quality (dissolved oxygen, chlorophyll *a*, transparency, and pH) salinity
Pressure variables	Interaction with fishing activities and fish farms (site fidelity, group dynamics, and seasonal and yearly occurrence)
	Contaminant concentration in water
	Contaminant concentration in tissues
	Spatial extent and duration of significant acute pollution events
	Effects of significant acute pollution events on the health of individuals and the condition of habitats
	Type, number, and proximity of vessels to dolphins
	Spatial distribution, temporal extent, and levels of noise pollution by traffic boats
	Amount, type, weight, and spatial distribution of litter and micro-litter in the water column and on the bottom
	Amount, weight, and type of litter and micro-litter ingested, the number of individuals that are adversely affected due to litter
	Birth growth and mortality rate/mortality rate from incidental by-catch or incidents with boats

Table 2. List of monitoring variables for seagrass meadows, in particular of Cymodocea nodosa *(Ucria) Asch.,* Posidonia oceanica *(L.) Delile,* Zostera noltii *Hornem.,* Zostera marina *L., habitat under protection in Malostonski zaljev and Delta del Po: tratto terminale e delta Veneto site (from Manea et al., 2022).*

	Variable
Ecological variables	Biomass
	Cover
	Growth rate
	Leaf elongation rate
	Net primary productivity
	Erosion-recolonization rate
	Spatial distribution
	Patch size
	Biometric measures
	Phenological measures
	Genetic diversity
	Habitat characterization
	Density of herbivores
	Abundance of herbivores
	Biomass of epiphytes
	Density of reproductive shoots
	Biomass of reproductive shoots

	Variable
	Reproductive rate
	Flowering frequency
	Shoot density
	Number of leaves per shoot
	composition and abundance of associated organisms
	Presence/abundance of invasive species
	Presence/abundance of invasive species
Oceanographic variables	Salinity
	PAR
	Wave exposure
	Depth
	Current velocity
	Current direction
	sediment type
	Sedimentation rate
	Nutrient concentration in water
	Nutrient concentration in sediments
	Organic matter in sediments
	Chlorophyll *a*
	Dissolved oxygen
	Transparency
	pH
	Redox potential of sediments
	Oxygen concentration in sediments
Pressure variables	Contaminant concentration in water
	Contaminant concentration in sediments
	Area cover destructed by anchoring-trawling
	Intensity and spatial and temporal variation of physical disturbance
	Spatial extent of the suitable habitat that is adversely affected through change in its biotic and abiotic structure and its functions by physical disturbance
	Spatial and temporal variation of hydrographical conditions
	Spatial extent of each habitat type adversely affected due to alteration of hydrographical conditions
	Spatial extent and duration of significant acute pollution events
	Effects of significant acute pollution events on the health of individuals and the condition of habitats
	Heavy metal concentration in tissues
	Organic pollutant concentration in tissues
	Presence/abundance of invasive species
	Percentage cover of invasive species

2.2.2 Underwater noise monitoring system: pre-deployment preparation, deployment, recovery and redeployment of instrument using bottom mounted system (SOUNDSCAPE project)

Project sites from North to South (Figure 26):
Trieste, Friuli-Venezia Giulia Region, Italy;
Venice, Veneto Region, Italy;
Ivana D/E**,** *Istrian County, Croatia***;**
Lošinj, *Primorje-Gorski Kotar County, Croatia;*
Susak, *Primorje-Gorski Kotar County, Croatia;*
Rimini, Emilia Romagna Region, Italy;
Žirje, Šibenik-Knin *County, Croatia;*
Ancona, Marche Region, Italy;
Split, *Split*-Dalmatia *County, Croatia.*

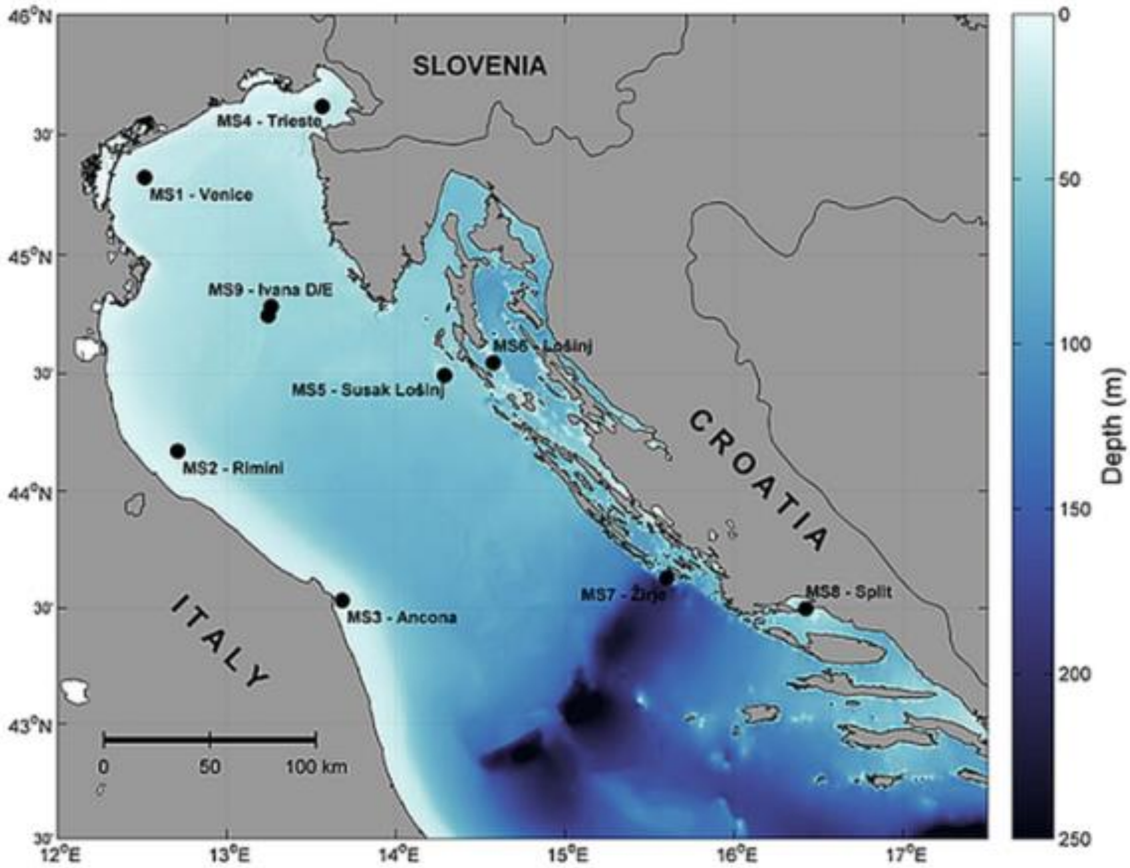

Figure 26. The acoustic monitoring stations in SOUNDSCAPE project.

Title of the document:
Recommendations for the underwater noise monitoring procedure.
Keywords: Underwater noise, Monitoring procedure, APUAR.

Direct link to the document:
Vukadin P. et al (2019). Recommendations for the underwater noise monitoring procedure. SOUNDSCAPE project; WP3; 18pp.
https://programming14-20.italy-croatia.eu/documents/290825/5004928/D3.2.2_Recommendations+for+the+underwater+noise+monitoring+procedure.pdf/13ea2cad-c4b8-64c4-433c-e6b18d963f60?t=1646038426399
References: ISO 17208-1; 2016, ISO 17208-2; 2016

Topic:
The protocol defines the underwater noise monitoring system, pre-deployment preparation, deployment, recovery and redeployment of instrument using bottom mounted system.
Description:
This protocol was developed as a prerequisite for deployment of a network of 10 acoustic monitoring stations within the northern Adriatic Sea to ensure successful deployment and consistent procedures, enabling collection of data in the same fashion. As such, it provides technical description of how the autonomous passive underwater acoustic recorders (APUAR) need to be set up prior to deployment (Figure 35), how to deploy, recover and re-deploy them. It also includes description of procedure of data retrieval and storage, prior to analysis (described in Chapter 2.2.3).

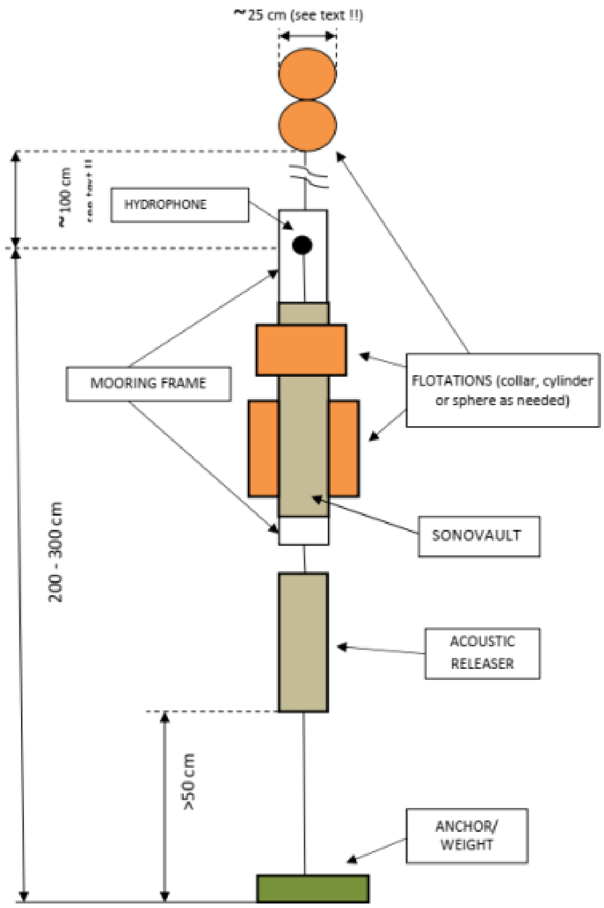

Figure 27. Continuous underwater noise measuring system setup using acoustic releaser for employment.

2.2.3 Procedures for assessing the source levels of underwater noise (SOUNDSCAPE project)

Project site (Figure 28):
Island of Oruda, Primorje-Gorski Kotar County, Croatia.

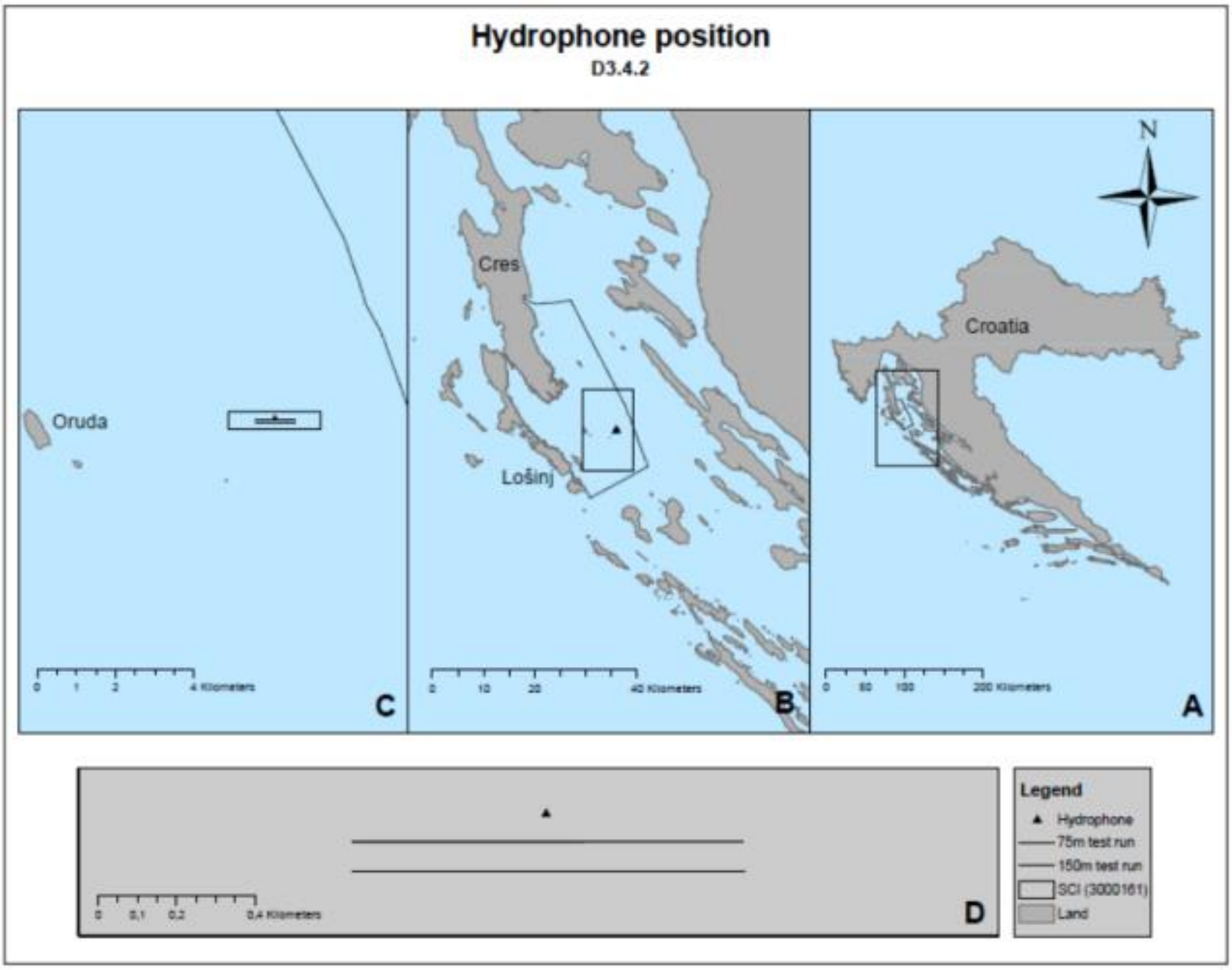

Figure 28. Measurement test site showing the hydrophone location and the 75m and 150m test run within the Cres-Lošinj SCI (HR3000161) Natura 2000 site.

Title of the document:
Rako-Gospić N; Picciulin M. Procedure and Recommendations for the source level assessment. SOUNDSCAPE project; WP3; 15pp; 2020.
Keywords: Recreational boat noise, Nautical tourism, SPL, Data processing
Direct link to the document: https://www.italy-croatia.eu/documents/290825/5004928/D3.4.1_Recommendation+for+the+source+level+assessment.pdf/545c2327-ec5c-256d-ab51-74979c5f61ca?t=1646208960843
References: Developed specifically for Soundscape project, based on standards listed in Table 3.

Topic:

The protocol defines procedures for assessing the source levels of underwater noise.

Description:

Recreational boating noise represents a considerable contribution to the overall underwater noise. Within the Adriatic Sea, recreational boating is especially intense in the summer months due to nautical tourism and the presence of numerous ports and marinas visited by these leisure boats along the coastline. Evaluating the noise inputs of leisure crafts to the local sea background noise is therefore essential when identifying the most dominant anthropogenic noise sources in this region.

In the absence of requirements for the measurements of noise from the small boats in shallow water environments such as the North Adriatic Sea, this document provides guidelines to follow for recreational boat noise assessment for the purposes of the Soundscape project, but which is based on the available standards listed in Table 3.

Table 3. Consulted underwater noise measurement standards.

Internationally Recognized Standards	
ANSI/ASA S12.64-Part 1, 2009	Quantities and Procedures for description and Measurement of Underwater Sound from Ships – Part 1: General Requirements
ISO 17208-1, 2016	Underwater acoustics -- Quantities and procedures for description and measurement of underwater sound from ships -- Part 1: Requirements for precision measurements in deep water used for comparison purposes
ISO 17208-2, 2016	Underwater acoustics -- Quantities and procedures for description and measurement of underwater sound from ships -- Part 2: Determination of source levels from deep water measurements
ISO 17208-3, 2016	Underwater acoustics -- Quantities and procedures for description and measurement of underwater noise from ships -- Part 3: Requirements for measurements in shallow water
ISO 18405:2017	Underwater acoustics — Terminology
ICES. Cooperative Research Report No. 209.	Underwater noise of research vessels: review and recommendations
ITTC recommended procedures and guidelines, 7.5-04, 04-01	Underwater noise from ships, full scale measurements
Rules of Classification Society	
DNV, 2010	Silent Class Notation, Det Norske Veritas (DNV), Rules for Ships, January 2010, Pt 6, Ch. 2
BV, 2014	Underwater Radiated Noise (URN), Bureau Veritas Rule Note NR614

According to the available standards, a testing sequence should involve a boat sailing along the straight line track (Figure 29), from the start point (COMEX) to the end (FINEX), passing the spot closest to the location where the hydrophones are deployed so called Closest Point of Approach (CPA). The CPA represents the closest horizontal distance the vessel passes to the hydrophone array index location as measured from the ship acoustic center (the location from which all underwater noise originates as if ship acoustic radiation is from a single point source). Accuracy of CPA is to be +/-10 m.

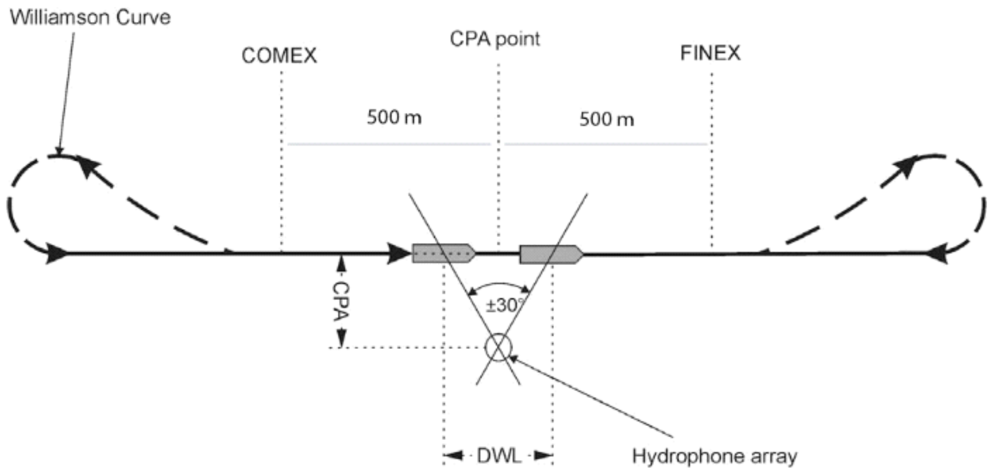

Figure 29. Layout of the testing sequence.

The testing in Soundscape project involved the following vessel classes (Figure 30):

- Class 1, motor boat (size and HP: 1 - 5 m / max 20 HP; MB) and sailing boat on engine (8 – 20 m / 18 – 100 HP, SailB)
- Class 2, motor yacht (4 - 30 m / 40 – 200 HP; MY) and speed boat (7 – 15 m / 130 – 320 HP; SB)
- Class 3, trawler (TW) and gillnetter (GN); 7 – 20 m / 50 – 250 HP, diesel engin
- Class 4, tour boat (TB); 10 -25 m / 130-300 HP, diesel engine
- Class 5, sailing boat on sails (SS).

The test site needs to be far away from coast to reduce reflections. Furthermore, the tests need to be conducted when in the absence of other marine traffic. Data about the test needs to be entered into a datasheet, containing information on characteristics of tested vessel, conditions, test site characteristics, position, and measurement system used. A single omnidirectional hydrophone with sensitivity of -165 to -215 dB re 1V/µPa, frequency range of up to 24 kHz, and resolution of 24 bit, mounted at depth of 60 m is to be used for testing. Background noise is to be recorded for at least 1 minute before and after each run. During one test run, the boat should maintain the same speed and course. A total of 8 test runs should be made for both port and starboard aspect, at 75 m and 150 m CPA.

Data processing comprises analysis of recordings during the data window length (DWL) which is distance between two points along the track either side of the CPA defined by a ± 30° angle from the hydrophone position (Figure 29). Furthermore, analysis of data in 1/3 octave bands for all the frequency range up to 20 kHz plus additionally avg over the range 20Hz to 20 kHz, for the narrow band (typically 1 Hz) in this frequency range is to be performed. From these, SPL (Sound pressure level) and RNL (Radiated noise level) are to be calculated.

Figure 30. Representative boat types.

2.2.4 Procedures for processing the raw acoustic data (SOUNDSCAPE project)

Project sites from North to South (Figure 31):
Trieste, Friuli-Venezia Giulia Region, Italy;
Venice, Veneto Region, Italy;
Ivana D/E, *Istrian County, Croatia;*
Lošinj, *Primorje-Gorski Kotar County, Croatia;*
Susak, *Primorje-Gorski Kotar County, Croatia;*
Rimini, Emilia Romagna Region, Italy;
Žirje, Šibenik-Knin *County, Croatia;*
Ancona, Marche Region, Italy;

Split, *Split*-Dalmatia *County, Croatia.*

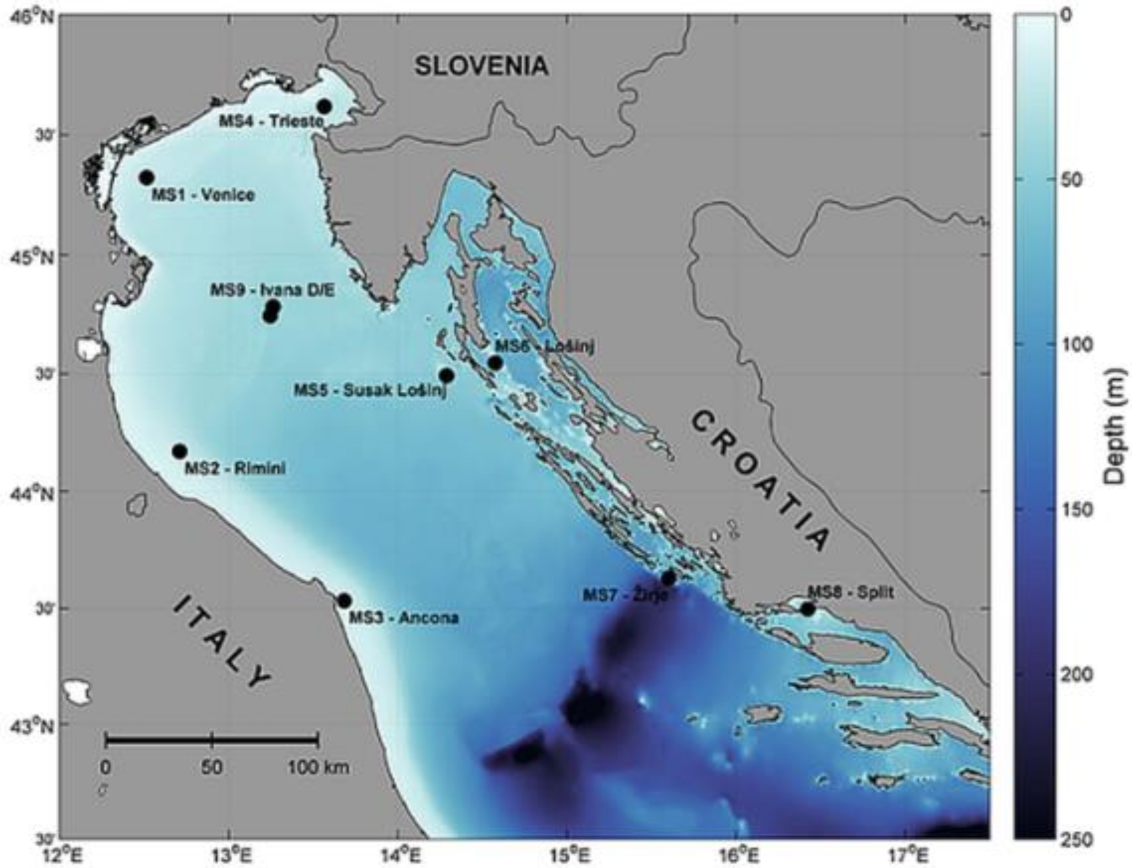

Figure 31. The acoustic monitoring stations in project Soundscape.

Title of the document:
Report on the definition and implementation of the processing protocols.

Direct link to the document:
Madricardo F. et al. (2020). Report on the definition and implementation of the processing protocols; WP3; 14 pp; 2020.
https://programming14-20.italy-croatia.eu/documents/290825/5004928/D3.5.1_Report+on+the+definition+and+implementation+of+the+processing.pdf/f9a577bd-91b2-5ea0-3c9c-10679e6d42e8?t=1647612763834
References: ISO 17208-1; 2016, ISO 17208-2; 2016

Topic:
The protocol defines procedures for processing the raw acoustic data.
Description:
The main interest of Soundscape project is to evaluate anthropogenic noise from ships and recreational boats, creating a methodology for evaluating the underwater noise. As described in the D11 of the Marine

strategy Framework criterion D11C2 for continuous low-frequency sound sources, there are specific measures of the spatial distribution, temporal extent and levels of anthropogenic noises that should not exceed levels that adversely affect populations of marine animals. Noise measurements consist in performing some data acquisition and extracting the corresponding noise indicators. Many different approaches can be used for that purpose, but it is important that the steps taken guarantee that noise indicators can be compared among different countries.

This document specifies the signal processing procedures that were accepted by all partners of the Soundscape project. The main topic is restricted to digital signal processing, identification of the common acoustic metrics for describing underwater noise, including definitions and units, and how these metrics should be reported including quality check. For each step relevant in the processing of the data, a general description is given to what has been done in the Soundscape project with some justification to why it has been done based on the previous knowledge and MSFD recommendations.

Furthermore, recommendations for presentation of results are given.

1. Pre-proccesing.

   The protocol requires checking the raw data prior to calculation of any corresponding ambient noise indicator. This includes test measurement prior to deployment to verify that self-noise of the recording device is below ambient noise threshold. Next, size, time stamp, gaps and appearance of non-numerical values or clipping in each recorded file must be checked. Finally, a “transfer function” must be applied to raw data to calibrate for sensor sensitivity, preamplifier, filter board gain and ADC factors.

2. Signal processing.

   All basic filtering and processing are made using algorithms implemented on the server available to Soundscape project partners, and on data with signal range limited to 20Hz. In the first step, an FFT-analysis is done over consecutive 1second periods, giving amplitude spectra with a 1 Hz resolution to calculate the sound pressure levels (SPL) as defined above in the required 1/3- octave bands over 1 second. These SPL’s are corrected due to gain and sensitivity factors. Sensitivity curve is delivered by the manufacturer of hydrophones and interpolated for every Hertz and averaged to cover all necessary 1/3-octave bands. The 1s SPL averages are then further processed to averages over 20 seconds. A standard method for time-averaging spectra is used (Welch, 1967).

   Estimates such as hourly, daily and monthly averages are calculated based on the 20s averages, depending what information’s are required for further modelling. Finally, the annual mean is also derived using the 20s averages.

   The extraction of the energy through 1/3-octave bands is made with an FFT-filter. Frequencies of the 1/3 octave filters as well as bandwidth corrections were computed following the standard (IEC 61260, 1995). The spectrum is derived by calculating the Discrete Fourier Transform (DFT) of the signal. The filters used in Soundscape are all 1/3-octave bands until 32 included (Table 1), even though only bands 18 and 21 that are the 1/3- octave bands centred at 63 Hz and 125 Hz, respectively, are required by the MSFD.

   Following BIAS (BIAS, 2015) recommendations with regards to the filtering it is suggested to derive the DFT with a nominal bandwidth of 1 Hz. This is a compromise between time resolution and the possibility of implementing FFT-based band-pass filters with reasonable shape even at low frequencies. Using a segment size of 1 s for the DFT, the nominal bandwidth of the DFT-bins becomes 1 Hz.

   In general it is recommended by EU TSG Noise group with regard to averaging of noise data to use arithmetic mean and median. Arithmetic mean is in that case the average of the snapshot (analysis time window) values expressed as mean square sound pressures (or RMS values). This method is very much influenced by high amplitude events. Median of the snapshot values is an equivalent to the 50th percentile. It is much less sensitive for high amplitude events occurrence.

3. Presentation of results.

   The results of the raw data processing are to presented using three basic representations for ambient noise indicators: SPL versus time, SPL histograms and Spectral representations.

SPL versus time might be visualize as example of the 1/3 octave indicators (63 Hz, 125 Hz) computed during6 hours. SPL can be averaged for 1 second, 20 seconds, 1 minute, 10 minutes and 1 day.

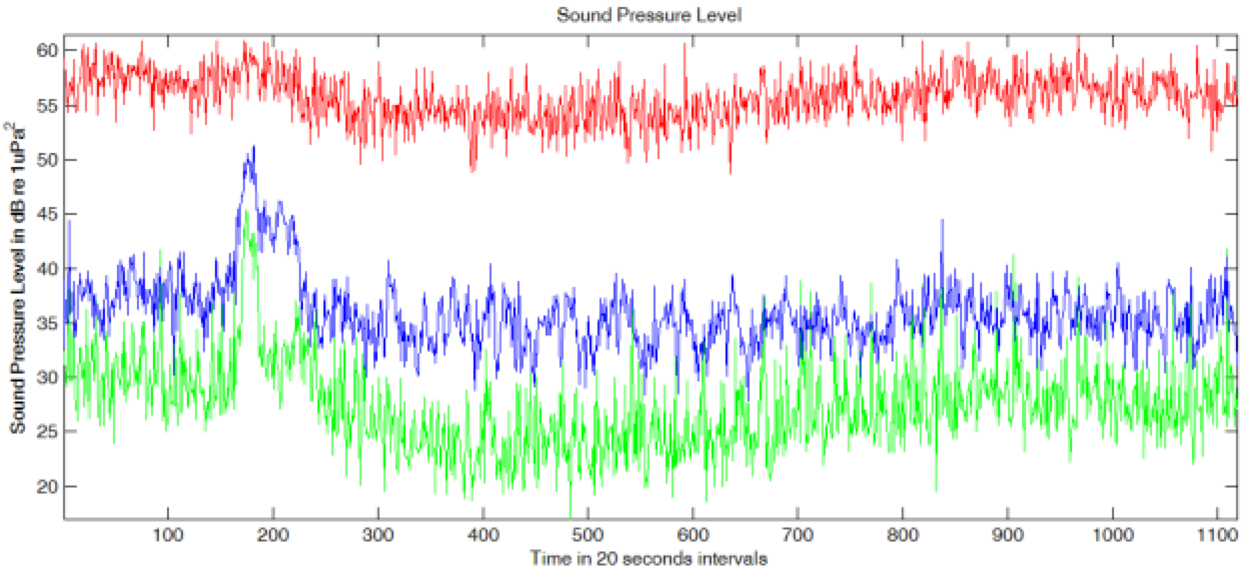

Figure 32. Example of sound pressure level at intervals of 20 seconds - arithmetic averaging, red line – total signal, green line – 63 Hz, blue line – 125 Hz.

SPL histogram representations (Figure 33) show contribution of SPL levels for certain 1/3 octave band within time period (weekdays and weekends, winter and summer), giving an estimate of dominant SPL levels to be compared between different time frames.

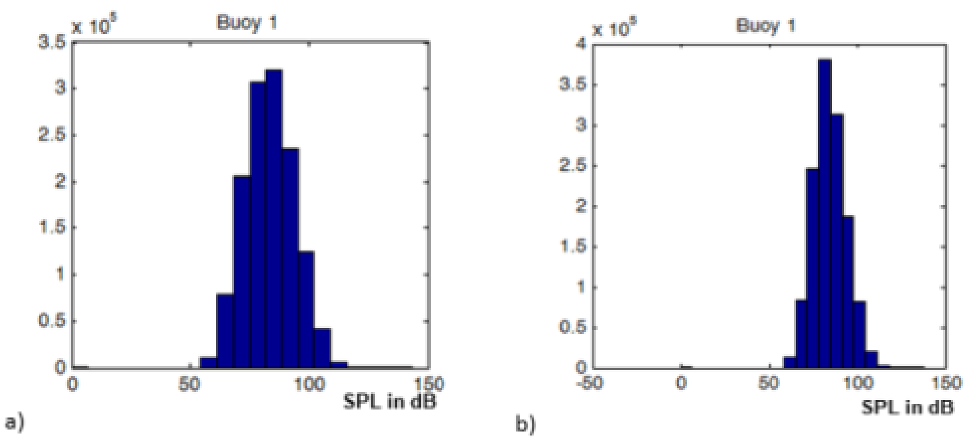

Figure 33. Example of histogram of Sound Pressure Levels (SPL) in a) 63 Hz band, b) 125 Hz band averaged for the one year of registration.

Acoustic noise spectrum level presented as well for certain time period. This kind of graph (Figure 34) can show dominant frequencies for noise sources.

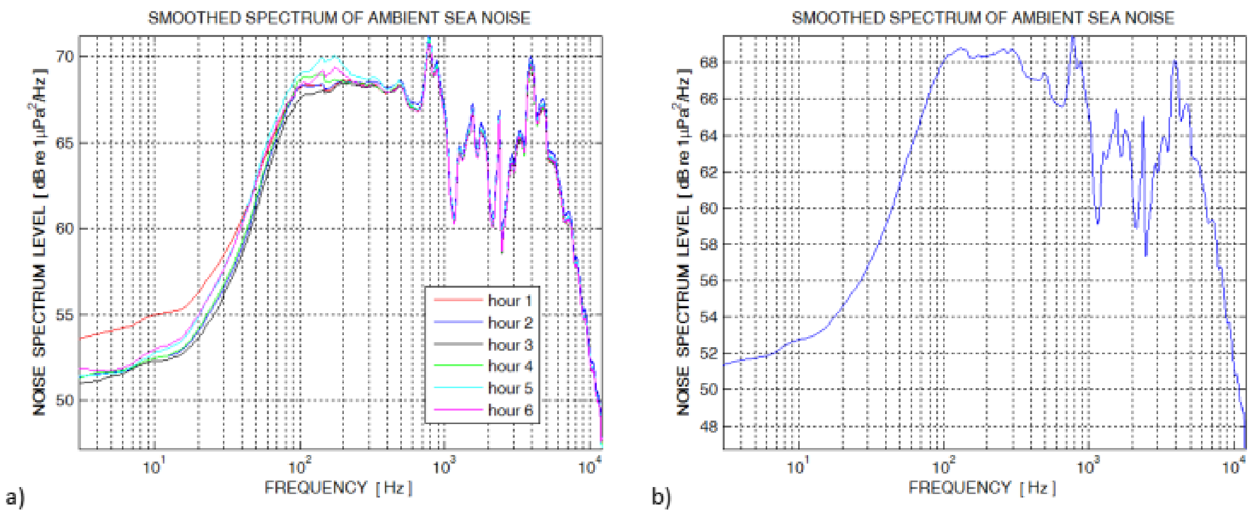

Figure 34. Example of noise spectrum level for 6 hours registration (figures 6.1 ÷ 6.5) a) averaged for 1 hour consecutive registrations, b) averaged for total 6 hours registration.

2.2.5 Monitoring protocol for seagrasses (SASPAS project)

Project sites from North to South (Figure 35):
Monfalcone (Bay of Panzano-GO), Friuli-Venezia Giulia Region, Italy;
Kornati National Park (Nacionalni Park Kornati-ŠI), Šibenik-Knin County, Croatia;
Regional Natural Park (RNP) of Coastal Dunes from Torre Canne to Torre San Leonardo (BR), Apulia Region, Italy.

Figure 35. SASPAS seagrasses monitoring sites.

Title of the document: Marine Seagrass Safeguard Integrated Management Program (MSSIMP) including guidelines for the definition of the correct attitude and behavior in protected areas and for the correct management of the involved areas and areas with similar characteristics.
Keywords: Marine Seagrasses, *Posidonia oceanica*, Natura 2000, Habitat Conservation, Pilot Transplantation, Monitoring, Stakeholders, Replicability.
Direct link to the document: https://programming14-20.italy-croatia.eu/documents/290205/2777414/D+5.2+Marine+Seagrass+Safeguard+Integrated+Management+Program.pdf/eb5bcbe8-b173-df23-86ec-5d7f818598b3?t=1665916231656
References: OSPAR Commission, 2009; ISPRA, 2012; APAT-SIBM-ICRAM, 2003.

Topic:
SASPAS Monitoring Protocol for seagrass meadows
Description:
SASPAS Monitoring Protocol refer to national and international protocols developed to evaluate the Ecological Status of seagrass meadows, with specific implementations in relation to taxa.
The sampling methodology scheme (
Figure 36), taken from the ISPRA *P. oceanica* monitoring protocol (ISPRA, 2012) for WFD monitoring, has been simplified to be adapted to the objectives and timing of the SASPAS project; the indications reported in the RAC/SPA - UNEP/MAP (2014) monitoring protocol for *P. oceanica* have also been considered to achieve the integration of the two protocols. Only status indicators able to provide meaningful and useful answers within the timeframe of the project have been selected for the monitoring protocol. The Table 4 shows the indicators selected for the protocol. The protocol describes, for each indicator, in a detailed way the measurements that have to be done during monitoring campaign and in the laboratory.

In deep waters, scuba divers are necessary to carry out monitoring activities (Figure 37,Figure 38). During monitoring campaign is important to observe also pressures and human disturbances as litter on the seabed, fishing-nets, anchoring.

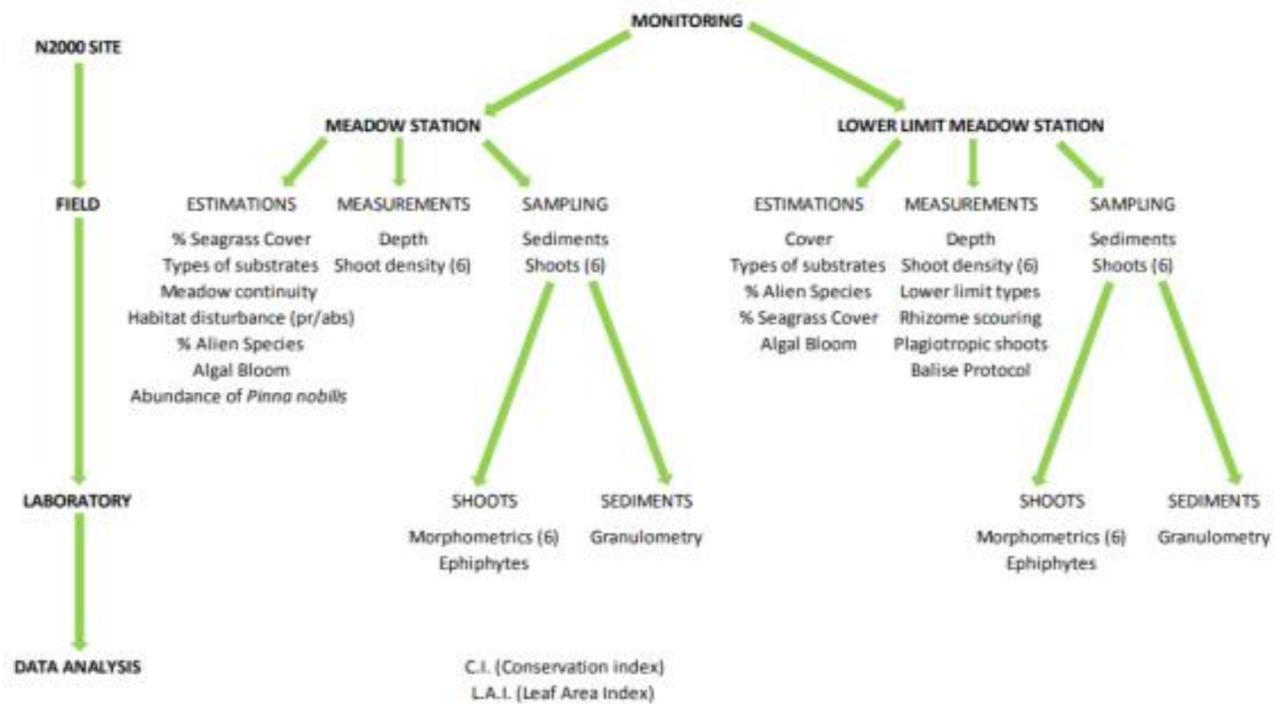

Figure 36. Sampling methodology scheme (ISPRA, 2012, modified).

Figure 37. Shoots monitoring: the method includes, with several replicates, counting the shoots inside a quadrat arranged on the meadow with random mode.

Table 4. Indicators selected for SASPAS protocols.

Indicators	Seagrass Meadows		
	Posidonia oceanica	*Zostera* spp.	*Cymodocea nodosa*
Meadow Cover (%)	x	x	x
Continuous/discontinuous meadow	x	x	x
Dead matte (%)	x		
Depth limit (m)	x		
Substrate type	x	x	x
Shoot density (shoots/m^2)	x	x	x
Shoot morphometric measurement	x	x	x
Balisage protocol	x		
Blooms and filamentous algae	x	x	x
Epiphytes (phyto-zoobenthos)	x	x	x
Pinna nobilis Abundance	x	x	x
Alien species (e.g., *Caulerpa* spp.)	x	x	x
Presence/absence of habitat disturbance	x	x	x

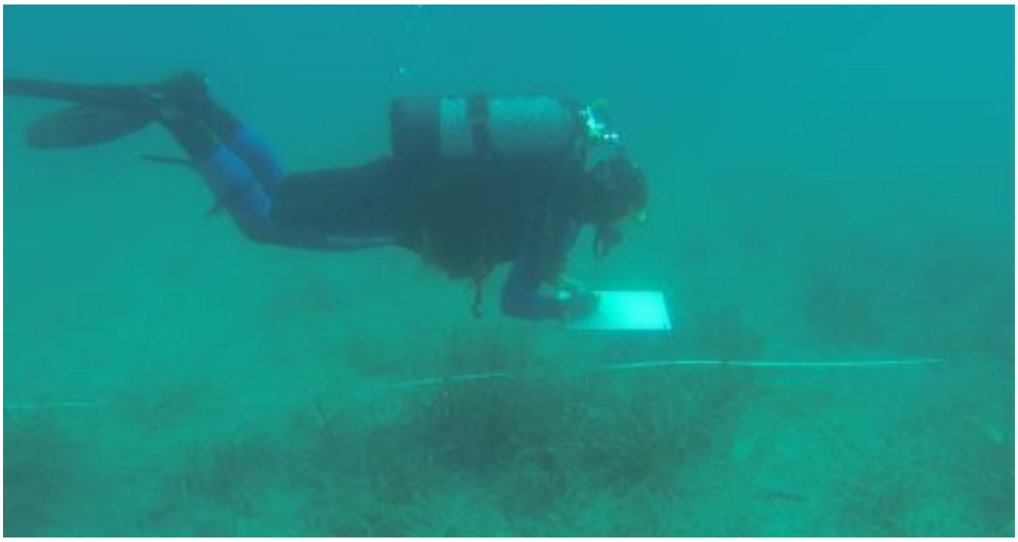

Figure 38. Scuba diver carring out monitoring of seagrasses meadows.

2.2.6 Monitoring protocol for coastal and bathing waters by using innovative tools in wastewater management and treatment (WATERCARE project)

Project sites from North to South **(**Figure 39**):**
Raša river, Istria County, Croatia;
Arzilla stream, Fano, Marche Region, Italy;
Cetina river, Split-Dalmatia County, Croatia;
Neretva river, Dubrovnik-Neretva County, Croatia;

Pescara river, Pescara, Abruzzo Region, Italy.

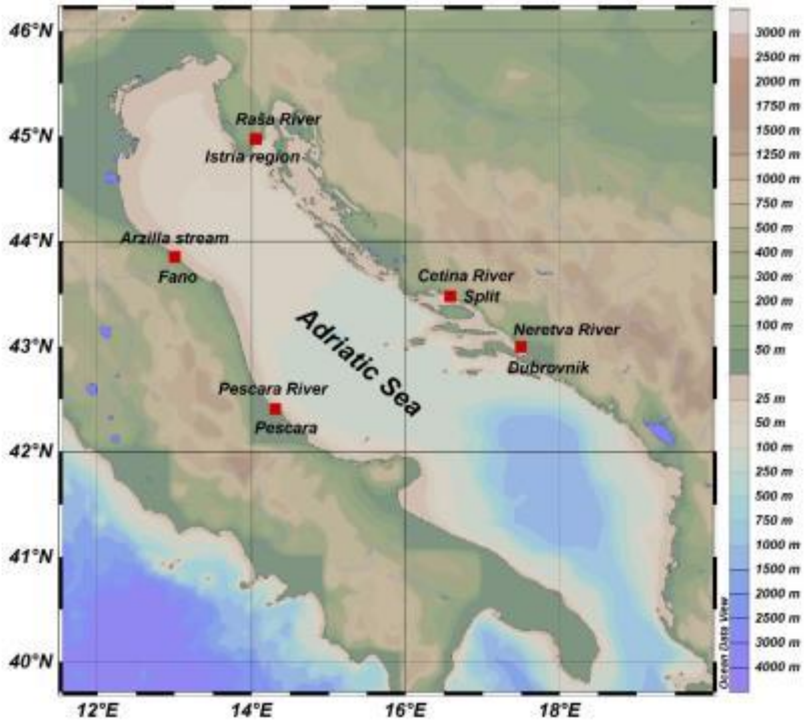

Figure 39. WATERCARE project sites.

Possible Adriatic sites for replication:
Potential sites for replication of WATERCARE actions are the bathing sites near river and stream mouths, such as Mirna River, Zrmanja River canyon, Krka River (Croatia) or River Po delta, Emilia Romagna Region(Italy).

Title of the document:
1) D.4.3.1 – Guidelines to assess the quality of urban wastewater and coastal system
2) D.3.2.1. – Generation of Sampling Data set
3) D.3.3.2 – Sensor Data Web
4) D.3.3.1. – WATERCARE WQIS implementation
5) D.3.1.2 – Development of WATERCARE WQIS

Keywords: Human Health, Bathing Water Quality, Faecal Indicator Bacteria, Monitoring Activities, Forecast Operation Model.

Direct link to the document:

1) https://programming14-20.italy-croatia.eu/documents/294645/0/D.4.3.1_Guidelines+to+assess+the+quality+of+urban+wasterwater+coastal+system_vfinal.pdf/bb019ec3-7d03-31ff-f5ab-e976ba760ad1?t=1648633458839
2) https://programming14-20.italy-croatia.eu/documents/294645/0/D.3.3.2_WATERCARE_Sensor+Data+Web_vfinal+%281%29.pdf/fe246572-abfc-4c9d-eec4-cb3b42f19366?t=1636544540610

3) https://programming14-20.italy-croatia.eu/documents/294645/0/D.3.3.1_WATERCARE+WQIS+Implementation_vfinal_revised.pdf/9e0aea0b-0848-6170-479b-2d4626067228?t=1649749078098
4) https://programming14-20.italy-croatia.eu/documents/294645/0/D.3.1.2_Development+of+WATERCARE+WQIS_vfinal.pdf/e1f629f9-8612-8e0b-2a82-cbd2c50ca3a6?t=1652087174027

References:

https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32006L0007;
https://narodne-novine.nn.hr/clanci/sluzbeni/2008_06_73_2426.html
https://www.mdpi.com/journal/water/special_issues/treated_urban_wastewater
Umgiesser G. et al. (2014). Comparative hydrodynamics of 10 Mediterranean lagoons by means of numerical modeling. J. Geophys. Res. Oceans 2014, 119, 2212–2226.

Topic:
WATERCARE Water Quality Integrated System (WQIS)- monitoring system
Description:
The Water Quality Integrated System (WQIS) monitoring system was applied and implemented for each study area and focused on urban areas in sewers, riverine and rivers. It is based on a thorough knowledge of the magnitude, frequency, and impacts of microbial contamination of bathing water due to high rainfall. The system was developed to protect public health, the environment and the economic activities that rely on tourism. Its proactive approach to coastal water quality management can be applied to a variety of coastal sites characterized by extreme raining events.
Monitoring network
For the implementation of Water Quality Integrated System (WQIS), each site in WATERCARE project shared the same set-up for the monitoring network(Figure 40): from meteorological/hydrological sensors as remote stations at each site, the datalogger firmware responsible for interfacing with the sensors and connected to the centralized database and the dashboards designed for data visualization (courtesy of partner CNR-IRBIM) all the way to the parameters examined needed to comply with the Directive 2006/7/EU and national legislation.

Figure 40. The Block Diagram shows the datalogger connections with sensors, communication stage, centralized database, and web data presentation. (from D.3.3.2 WATERCARE - Sensor Data Web).

All the sites had the following sensors installed:

- Meteo station (measuring in real-time): wind (speed, gust, direction), air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.
- Multiparametric probe for river water monitoring (measuring in real-time): temperature, salinity, conductivity, Optical Dissolved Oxygen (concentration and saturation), turbidity, pH, redox potential.
- (In Fano and Arzilla stream pH and redox, but the parameters were measured with portable CTD probe, and also this site had additional water level sensor in the probe).
- Datalogger for data collecting and sharing.
- Energy source: 230 VAC (Fano and Arzilla stream, Pescara and Pescara River, Raša River canal) or solar panel and batteries (Omiš and Cetina River, Ploče and Neretva River).

Meteorological and hydrological parameters evaluate surface run-off phenomena; further information is collected reporting the time lapse between each rainfall event and the previous one.

<u>Sampling</u>

In addition, all the sites had at least one automatic sampler; a multi-bottle, refrigerated portable sampler with the remote operating system on web interface designed within WATERCARE project. The separate web interface allowed the operator to choose sampling times and different types of triggers for the start of the automatic sampling: it could be set at a number of mm/m^2 of rain fallen through the meteorological station set up, operator forced start of sampling or time indicated time of sampling.

The sampling strategy to be carried out must define the spatial and temporal scope of impact duration and for this the sampling must be repeated for the time necessary to describe the restoration of the usual conditions and compliance of the site, in order to avoid or reduce the closure of bathing areas for periods of time needed, as is now the case. The representation of the events and the simulations defined for critical scenarios allow the competent bodies to adopt very limited and defined actions and measures, capable of concretely protecting the bathers.

In the Croatian sites (Table 5) the sampling of seawater transects were carried out during sunny periods and directly after the rain periods of different intensities for the laboratory analyses of *Escherichia coli* and gastrointestinal enterococci, as well as other parameters. The sampling frequency was adjusted to the weather conditions during the bathing seasons of 2020 and 2021. At least one stable sunny weather was used for analyses of all parameters along the locations of the project implementation and during the rain events of different intensities, the automatic sampler collected the river samples during the event, while the transitional sea water transects were analyzed immediately after the end of the rain event and depending of the duration of the rain event once in the consequent 24h, 48h and 72h. This type of monitoring allowed us to follow and evaluate the dispersals of the microbiological contamination from the source (river and adjacent canals) to/through the sea water.

Table 5. List of monitored parameters at all Croatian target sites.

PARAMETERS	River	Seawater
Physical-chemical		
Air temp (°C)	AS probe	Probe
Water temp (°C)	AS probe	Probe
pH	AS probe	Probe
Redox (mV)	AS probe	Probe
Conductivity (mS/cm)	AS probe	Probe
Mutnoća (NTU)	AS probe	Probe
Salinity (PSU)	AS probe	Probe
Oxygen saturation (%O_2)	AS probe	Probe
Dissolved O_2 (mg/L)	AS probe	Probe
BOD_5 (mg/L)	LAB	NO
COD_{Mn} (mg/L)	LAB	NO
Ammonia (mgN/L)	LAB	NO
TN (mgN/L)	LAB	NO
TP (mgP/L)	LAB	NO
Mikrobiological		
Escherichia coli (CFU/100 ml)	LAB	LAB
Fecal enterokok (CFU/100 ml)	LAB	LAB

In the pilot area of Fano and other Italian target sites, at each emission points, the microbial and environmental sampling (Table 6) have been done along five three transects for Fano site in front of Arzilla mouth (each transect is composed by at several points sampling stations: located at the emission of the discharge, then at 50, 100, 150, 200 and 300m from the coast within the recreational waters) and for the Pescara site in nine sampling stations at sea and four sampling stations on the river. The sampling has been done in 2019, 2020 and 2021 during the overflow period (based on the interval of 1-6 hours). The microbial sampling has then been used to analyse the distribution of faecal discharge.
The results of microbiological analyses are useful to assess the quality of recreational waters and to provide information concerning the health status of urban wastewater and coastal system through an innovative WQIS to forecast or provide an alert system for the safe recreational bathing along the coasts at the target sites of this project.

Table 6. List of meteorological, physical, chemical, and microbial parameters analysed in river and seawater in Italian target sites.

	Method (Manual, Automatic, Lab)	
Parameters	**Riverine**	**Seawater**
Meteorological data		
Rainfall	x	
Wind	x	
Solar Radiation	x	
Sea water current	x	
Sea state (waves)	x	
Chemical/physical data		
Salinity	x	x
Temperature	x	x
Redox	x	x
pH	x	x
Conductibility	x	x
Turbidity	x	x
Dissolved O_2	x	x
Chlorophyll *a*	x	x
TSS	x	x
POM	x	x
Ammonium-NH_4	x	x
Nitrates N-NO_3	x	x
Nitrites N-NO_2	x	x
TN	x	x
TP	x	x
Ortho-phosphate P-PO_4	x	x
BOD_5	x	
COD	x	
Microbiological data		
Faecal Indicator Bacteria (*Escherichia coli and Enterococcus*)	x	x

Laboratory analysis

- *Microbiological analysis*

E. coli and enterococci bacteria were analysed using culture-based methods. E. coli abundance was determined by membrane filtration. An appropriate volume of water (from 1 to 100 ml) was vacuum-filtered (pore size 0.22 µm, diameter 47 mm; Millipore) in triplicate and the filters were placed on m-FC agar plates and were incubated at 44.5 °C for 24 h. Only blue colonies were considered. The abundance was reported as CFU (Colony-Forming Units) 100 ml−1 of water. Enterococci abundance was assessed by membrane filtration and an appropriate volume (from 1 to 100 ml) were filtered in triplicate as described above and filters were placed on Slanetz Bartley agar plates. Plates were incubated at 37.5 °C for 48 h. Only red or reddish-brown colonies were considered as presumptive enterococci. The abundance was reported as CFU 100-1 ml of water filtered.

- *Environmental parameters analyses*

River and seawater samples for nutrient analyses were filtered (nitrocellulose Millipore, 0.45 µm) and stored at −20 °C in polyethylene bottles until analysis, whereas water samples for TSS (total suspended solid), POM (particulate organic matter) and Chl a were filtered on GF/F Whatman, 0.7 µm and on nitrocellulose Millipore, 0.45 µm filters, respectively, and immediately processed. Nutrient concentrations were measured using a colorimetric method following Strickland and Parsons (1972). N-TOT and P-TOT were determined on unfiltered water samples according to the method of Valderrama (1981). TSM concentrations were determined gravimetrically by filtration of a known volume of water sample through 0.7 µm pre-combusted and pre-weighed GF/F membrane filters (Millipore, Bedford, MA, USA) following APHA (2017). For PIM and POM determination the filters were then ashed at 500°C for 1 h following the APHA Loss On Ignition (LOI) method. POM concentrations were calculated by difference between TPM (total particulate matter) and PIM (particulate inorganic matter. The Chl a was analysed spectrophotometrically.

In Croatia, river samples were analysed in the laboratory for: chemical oxygen demand using titration with permanganate (HRN EN ISO 8467:2001), determination of the biochemical oxygen demand of waters of undiluted samples using HRN EN1899-2:2004 norm, determination of ammonium using manual spectrometric method (HRN ISO 7150-1:1998), P-TOT using ammonium molybdate spectrometric method (HRN EN ISO 6878:2008) and N-TOT using calculation from total N-organic and N-inorganic from spectrophotometric measurements.

Database

CNR-IRBIM staff has developed a centralized database (WQIS CDB) using the relational database management system (RDBMS) MySQL and a procedure to elaborate and collect the physical data received from the stations installed in-situ, the chemical and microbiological analysis data and other ancillary data. The interoperability of data was guaranteed using an internationally recognized vocabulary (British Oceanographic Data Centre-NERC Vocabulary Server) and data format (ODV Ocean Data View). The data acquired and collected were analysed and visualized using Grafana (Grafana Labs, 2020) open-source software installed on a dedicated web server at the CNR-IRBIM.

Once the situations in which the five pilot sites are located, both Italian and Croatian, have been summarized, it was possible to verify how the various contaminations develop in these places: for example, with reference to the Arzilla stream, they are strongly linked to the rainy phenomena. These aspects allow the development for the construction of infrastructures, adequately identified, which can reduce or eliminate the impact on bathing waters. A concrete example was that relating to the construction of the first rain tank in the terminal section of the Arzilla stream before entering the bathing water facing the mouth of the stream itself.

2.2.7 Monitoring protocol for treated wastewater and seawater (AdSWiM project)

Project sites, from North to South (Figure 41):
San Giorgio di Nogaro, Friuli-Venezia Giulia Region, Italy;
Lignano Sabbiadoro, Friuli-Venezia Giulia Region, Italy;
Zadar, Zadar County, Croatia;
Katalinića brig, Split-Dalmatia County, Croatia;
Stobreč, Split-Dalmatia County, Croatia;
Francavilla al Mare, Abruzzo Region, Italy.

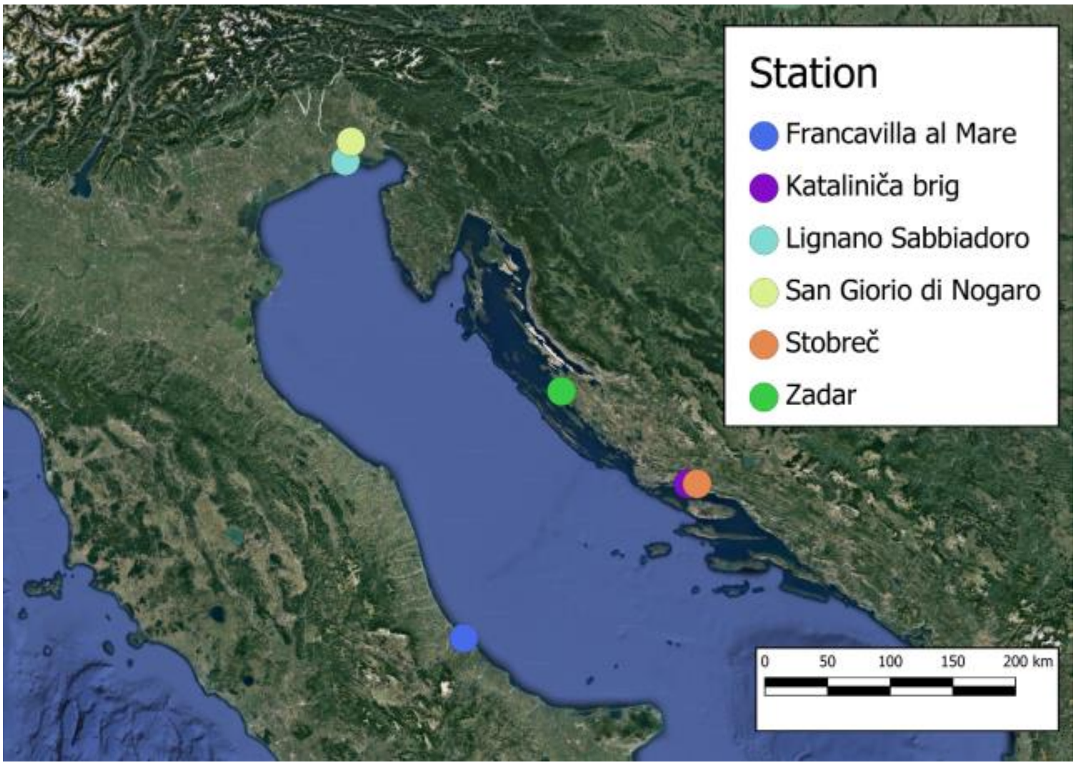

Figure 41. AdSwiM project sites.

Title of the document: The Interreg Project AdSWiM: Managed Use of Treated Wastewater for the Quality of the Adriatic Sea

Keywords: Wastewater Treatment Plants (WWTPs); Sewage Outflows; Marine Coastal Water; Nutrients; Metals; Faecal Pollution; Potential Pathogenic Bacteria; Phosphate Sensors; Biosensors; Pollution Control; Management Solutions; Best Practices.

Direct link to the document:

Manuscript https://www.mdpi.com/2073-4441/14/16/2460

Dataset of water column features https://nodc.inogs.it/catalogs/doidetails?doi=10.13120/j23k-n088

Dataset on potentially pathogenic bacteria https://nodc.inogs.it/metadata/doidetails?doi=10.13120/a19k-f376

References:

Directive 2006/7/EU, Directive 91/271/EEC, Directive 2008/105/EC, Directive 2013/39/UE

https://www.mdpi.com/journal/water/special_issues/treated_urban_wastewater

Susmel et al. (2022). The Impact of Treated Urban Wastewaters and Flood Discharge on the Quality of Bathing Water. Water.

Fanelli et al. (2022). Impact of depuration plants on nutrients levels in North Adriatic Sea. Water.

Girolametti et al. (2022). Dissolved Potentially Toxic Elements (PTEs) in relation to depuration plants outflows in Adriatic coastal waters: a two-years monitoring survey. Water.

Fonti et al. (2022) Antibiotic Resistance Genes and Potentially Pathogenic Bacteria in the Central Adriatic Sea: Are They Connected to Urban Wastewater Inputs? Water.
Parada et al. (2016). Every base matters: assessing small subunit rRNA primers for marine microbiomes with mock communities, time series and global field samples. *Environmental microbiology*, 18(5), 1403-1414.
Fonti et al. (2021). Antibiotic Resistance Genes and Potentially Pathogenic Bacteria in the Central Adriatic Sea: Are They Connected to Urban Wastewater Inputs? Water 2021, 13(23), 3335.
Figueredo et al. (2021). Plastic electrode decorated with polyhedral anion tetrabutylammonium octamolybdate [N(C4H9)4]4 Mo8O26 for nM phosphate electrochemical detection. *Analytica Chimica Acta*, Volume 1161, 29 May 2021, 338469
Susmel et al. (2022). The Impact of Treated Urban Wastewaters and Flood Discharge on the Quality of Bathing Water. *Water* 2022, 14(16), 2552. https://doi.org/10.3390/w14162552

Description:
The AdSWiM project investigated the reuse of WWTPs effluent (after applying appropriate pollution control and management strategies) as a solution to phenomena of trophic state alteration in localized marine areas, as low productivity problems are reportedly due to low nutrient availability or imbalance. Modulating the nutrient composition (nitrogen, phosphorus, potassium, etc.) of treated wastewater on the basis of their environmental values would support local marine life while returning nutrients back to natural biogeochemical cycles. However, the hypothesis of wastewater reuse has several critical environmental implications, including legal and technical aspects.
The project evaluated/compared/validated i) conventional approaches used to measure chemical derivatives (i.e., nutrients and metal ions) and microbial pollutants, ii) the optimization of existing sensors and biosensors for a rapid assessment of the treated wastewater toxicity, iii) DNA-based technologies for the detection of faecal bacteria and potential pathogens, and iv) new and alternative technologies for reducing pollutants and the microbial load. The project objectives were achieved through cross-border comparison of technologies, facilities, and the legislation to identify gaps and disharmonies between the two countries resulting from the application of individual directives.

Project activities involved the characterization of treated wastewater and the analysis of the seawater in the areas affected by WWTP discharges. Considered parameters were:
- Nutrients (nitrate, nitrite, ammonium, phosphate, and silicate)
- Metal ions (e.g., Pb, Cd, As, Hg)
- Temperature
- Salinity
- Electrical conductivity
- pH
- Dissolved oxygen
- Oxidation potential
- Chlorophyll a
- Turbidity
- Antibiotic resistance genes
- Prokaryotic communities
- Faecal indicator taxa
- Potentially pathogenic bacteria

Sampling: Samples of treated sewage were taken upstream the injection into the discharging pipeline just before unloading. Seawater samples were collected in the proximity of each WWTP outfall 1 m above the main pipe diffusion point.

Frequency: wastewater and seawater samples (Figure 42) were collected at monthly intervals during the bathing season (between April and September) in 2019 and 2020.

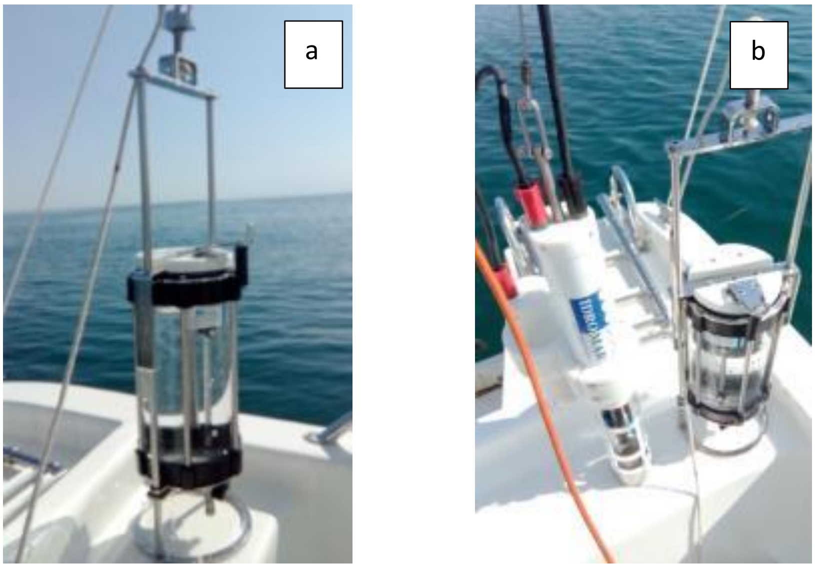

Figure 42. Ruttner' bottles for seawater sampling and multiparametric probe for the physical parameter measurements (Idromar APWIN IP041D).

Analysis:

- Microbiological pollution: fecal indicator bacteria (i.e., *Escherichia coli*, enterococci) and emerging pathogens (i.e., *Pseudomonas aeruginosa*) were enumerated by incubation onto selective media, as described in Fonti et al., 2021.
- Detection of alternative faecal indicator taxa and potentially pathogenic bacteria: genomic DNA was isolated from samples, amplified through PCR targeting the 16S gene (i.e. for Prokaryotes) and then sequenced in the V4V5 region using universal primers (Parada et al., 2016) in Illumina chemistry. Obtained sequences were processed bioinformatically for filtration, denoising, merging and taxonomy assignation. Datails are provided in Fonti et al., 2021.
- Antibiotic resistance genes: DNA isolates were analyzed by RT-PCR (SYBR green chemistry) for the detection and quantification of 8 antibiotic resistance genes conferring resistance to commonly used antibiotic families were. Datails are provided in Fonti et al., 2021.
- Nutrient analyses: samples were filtered in situ with 0.45 µm mixed esters of cellulose filters. $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_3$, $P\text{-}PO_4$, and $Si\text{-}SiO_2$ concentrations were determined colorimetrically using the Systea EasyChemPlus discrete analyzer. Details about methods were reported elsewhere (Fanelli et al., 2022).
- A plastic electrode (Figure 43) decorated with Mo-anion was also developed for improving the detection limit for phosphate in seawater.

- metals (Figure 44): samples were filtered through decontaminated cellulose mixed esters (0.45 µm pore size), diluted with ultrapure grade HCl 2% (v/v), and analyzed with an AFS Titan 8220 spectrofluorometer (Fulltech Instruments, Rome, Italy) [40].

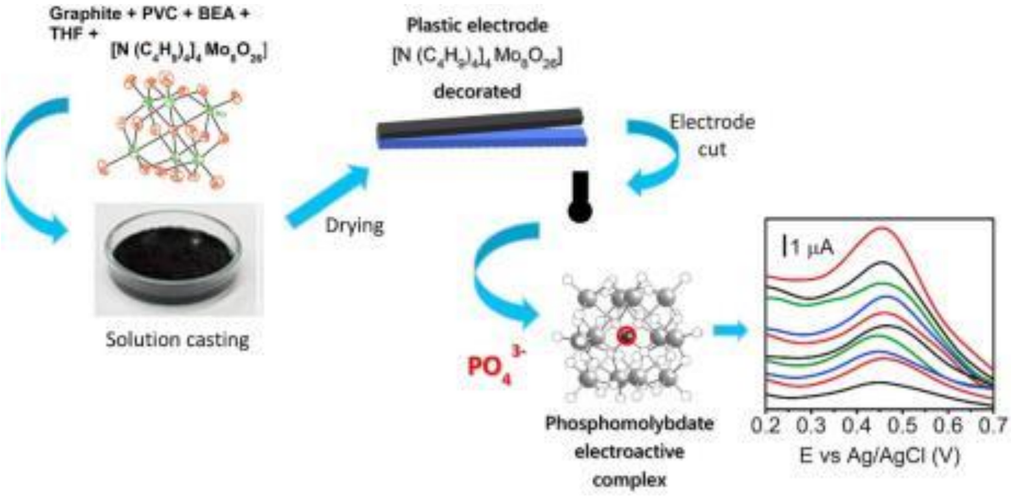

Figure 43. Stand-alone plastic electrode development.

Figure 44. Analytical procedure for metals determination.

2.2.8 Monitoring protocol for distribution and diversity of macrobenthos (ECOMAP project)

Project sites, from North to South (Figure 45):
Marina Dorica, Marche Region, Italy;
Marina Špinut, Split-Dalmatia *County, Croatia.*
Marina Strožanac, Split-Dalmatia *County, Croatia;*

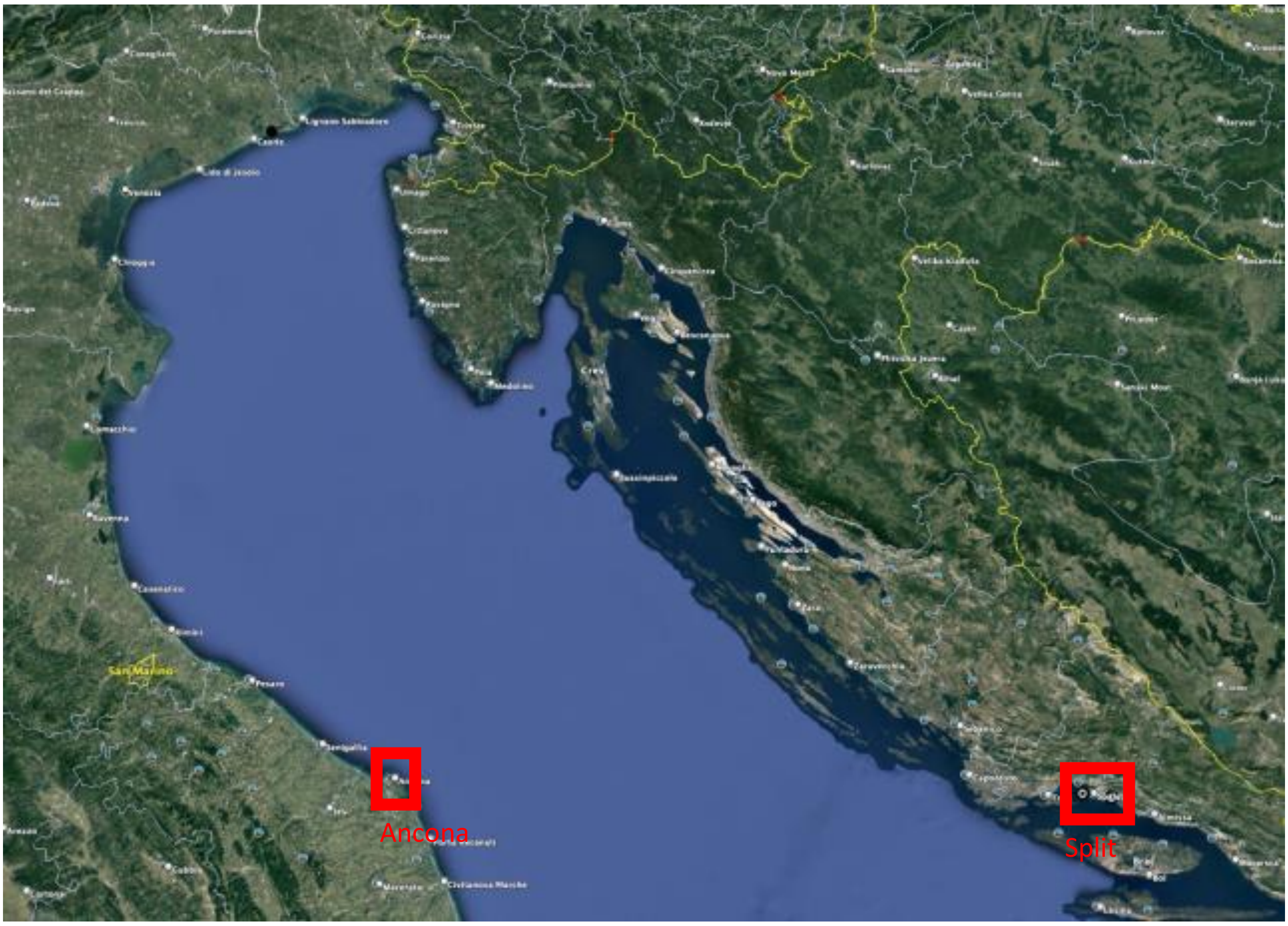

Figure 45. ECOMAP monitoring sites.

Title of the document:
Distribution and diversity of benthic microinvertebrates

Keywords: Macrozoobenthos Communities, Total Organic Carbon, Total Nitrogen, Benthosbiomonitoring, Heavy Metals.

Direct link to the document: https://programming14-20.italy-croatia.eu/documents/292735/2774744/D.3.3.1-3.3.4+Distribution+and+diversity+of+bent.+macroinv..pdf/fce35774-7cc7-d6dc-177c-91ec16c68b6e?t=1663332814883

References: Morri et al. (2004). Principles of bionomy: definition of assemblages and use of taxonomic descriptors (macrobenthos). Mediterr. Mar. Biol. 11, 573– 600.
Singh and Turner (2009). Trace metals in antifouling paint particles and their heterogeneous contamination of coastal sediments. *Mar. Poll. Bull.*, 58(4), 559-564.
Wentworth, C. K. (1922). A scale of grade and class terms for clastic sediments. *J. Geol.* 30 (5), 377–392.
WoRMS Editorial Board (2022). World Register of Marine Species.

Topic:
ECOMAP monitoring of microbenthonal communities in marine tourist ports.

Description

In semi-enclosed basins, such as ports and small marinas, the effects of point source and synergistic forms of contamination are emphasized. The effects of human pressure on benthic macrofaunal assemblages inhabiting marinas and tourist ports are seldom studied, especially in the western part of the Adriatic Sea. The aim of the monitoring was to use benthic communities inhabiting the port sediments as bioindicators of the environmental status of these port areas.

The macrofaunal abundance, diversity indices, species composition, together with the physical-chemical features of the surface sediments and their contamination levels, were used to evaluate the ecological status of the three marinas.

- Sampling sites located considering the confinement gradient (i.e. distance from the main entrance of the port, the time required for renewal of marine water) and the major sources of contamination in basins.
- Macrofaunal communities collection using a van Veen grab (0.1 m2) (Figure 5), and three replicates were taken at each station.
- One additional replicate for the sediment physical-chemical characterization
- Analyses of Total Organic Carbon-TOC, Total Nitrogen and heavy metals (i.e., Sb, As, Al, Bi, Cd, Cr, Cu, Pb, Mn, Ni,Se, Tl, V, Ag, Be, Ba, Co, Fe, Mo, Sn, Zn and Li.
- Analyses of the macrofaunal community identifying the animals to the highest possible taxonomical level using a stereomicroscope at 7-80X final magnification and counted them. For organism identification, we used specific taxonomical keys (Morri et al., 2004). Names of identified taxa were checked using the World Register of MarineSpecies database (WoRMS; http://www.marinespecies.org).

2.2.9 Monitoring protocol for sea- and fresh-water interactions (ECOMAP project)

Project sites, from North to South (Figure 46):
Bibione, Veneto Region, Italy
Ancona, Marche Region, Italy
Marina Špinut, Split-Dalmatia County, Croatia;
Podstrana, Split-Dalmatia County, Croatia.

Figure 46. ECOMAP project sites.

Title of the document: Geophysical surveys
Keywords: Geophysics, high-Resolution Bathymetry, Seawater Morphology, Geological Geometries.
Direct link to the document: https://programming14-20.italy-croatia.eu/documents/292735/2774744/D.3.1.1.-3.1.4_Geophysical+surveys+%281%29.pdf/962a7143-3ce0-b8a7-a746-a15594fda7ba?t=1663665983116
References:
Böhm et al. (2014). Cat3D. Computer Aided Tomography for 3-D models. User Manual, *OGS*
Bondesan et al. (2004). Geomorfologia della provincia di Venezia. *Esedra editrice*, Padova.
Da Col et al. (2021a). Characterization of a coastal area from integration of resistivity and active multicomponent seismic data. EAGE Near Surface Geosciences Conference and Exhibition 2021.
Da Col et al. (2021b). Characterisation of shallow sediments by processing of P, SH and SV wavefields in Kastela (HR), 293,106336.

Topic:
ECOMAP geophysical surveys to characterize the shallow subsurface and fresh-sea water interaction.
Description
Geoelectrical and seismic measurements (Figure 47) have been performed within the ECOMAP project. Geoelectrical surveys consists in planting electrodes in the terrain, which inject a current into the ground and

measure the electric potential. This allows to obtain resistivity maps, which are a proxy for the type of soil present in the subsurface, its fluid saturation and the salinity of the fluids. These surveys can be carried out both onshore and offshore, deploying the electrodes on the seafloor.
Within the project, seismic surveys have been performed both on land and at sea. On land, several 2D seismic lines have been acquired in all project sites. To achieve this, a line of 10 Hz vertical and 14Hz horizontal geophones were deployed (Figure 48). As a source, a wheelbarrow-mounted small vibrator was used, capable of energizing both P- and S-waves.
At sea three systems were used. The first is the so-called boomer (Figure 49), a high-frequency system based on a capacitor which releases at regular intervals an impulsive signal which is the recorded by an array of hydrophones (pressure sensors). This system allows a very detailed characterization of the first few decimetres of sediments below the seafloor.

Figure 47. Left: example of geoelectrical line. Right: electrode planted in the ground and connected to a wireless transreceiver.

Figure 48. Top left: planted geophone. Top right: example of deployed seismic line. Bottom: vibrating source.

Figure 49. Boomer acquisition setup.

The second system is similar, but with a stronger, lower-frequency source and a longer array of hydrophones, which allows to reach larger depths than the boomer. The third, called multibeam sounding (*Figure 50*) , allows an in-depth, precise characterization of the features of the sea bottom.

Figure 50. Multibeam instrumentation.

For all the methods used, the determination of the optimal acquisition parameters as well as processing procedures is a very complex issue. In fact, they depend on the target size, depth, on the type of soil to be investigated, as well as on the weather conditions and presence of sources of noise. For this reason, there cannot be simple guidelines and the surveys should be always carried out by professional geophysicists. The best location of the survey is based on the available geological information and on the logistical constraints. The acquired geophysical data always contains geographical coordinates with a precision of less than a meter. Therefore, georeferenced maps can be produced to optimally display the results of the surveys. For this specific project, the results obtained are of great importance, both in Italy and in Croatia, proving that the proposed geophysical methods are a valuable tool to detect the contact between fresh and saltwater in the subsurface. Specifically, in Croatia (Split area) we acquired geoelectrical data on land and boomer (seismic) data at sea. From the geoelectrical data freshwater flowing in the sea inside fractures in the rocks was identified. From the boomer data, several freshwater springs flowing from the seabottom, even very far from the coastline, were identified.

In Italy, data were acquired in Bibione both on land and at sea. On land, we performed both seismic and geoelectrical surveys and, with an innovative integration method, we were able to identify freshwater penetrating towards the sea and the sea water intruding towards land. Furthermore, we identified the position of a river during the last glacial maximum and characterized the sediments forming the beach up to a depth of 30-40 m in great detail. Offshore, the seismic data acquired allowed us to identify several biogenic gas seepages.

Finally, in Ancona, multibeam data acquired offshore and geoelectrical data acquired onshore, together with legacy seismic data, gave us further indications regarding the stability of the historical major landslide in the area.

3. PLANNING AND MANAGEMENT ENABLERS (D3.1.6)

TRASFERABILITY OF THE OUTPUTS OF THE PROJECT

The collection of best practices and guidelines is functional to the improvement of adaptive planning management and an alignment of some of the key points on which MSP is based such as:

- cross-border cooperation,
- the integration of monitoring and evaluation into the planning process,
- the conceptualization of enablers for decisions based on clear information and scientific data knowledge.

This should support MSP, but should also suggest more ecological and sustainable uses of the sea.

All the best practices and the monitoring plans extensively described in the previous chapter are easily accessible in the HATCH Data Hub geo-platform (see Deliverable 3.1.1 “Impact Database inventory” and https://geoplatform.tools4msp.eu/apps/133/embed#/), which allows the visualization on a map of harmonized results of the afore mentioned research and monitoring programs, integrated with information coming from other free sources, as well as the possibility to directly download the reference documents.
Particular interest lies in the section of best practices and guidelines where, with a simple spatialisation of the documentary part of the best practices and guidelines, it allows to associate information relating to the activities carried out during the research projects to the territorial contexts. Spatial interrogation allows to investigate the territory “vertically”, layer by layer, providing an overview of the actions already carried out in that context. In the context of planning, this often plays a key role in the construction of a broad and authoritative cognitive framework.

The project is expected to bring benefits in the planning and management of coastal and marine spaces at national but also at transnational and macro-regional level: indeed HATCH’s approach, which wishes to ensure impacts’ data (on chemicals, microbiological, pollutants, nutrients and wildlife within the Programme area) is taken into account in maritime spatial planning and marine management, could be replicated in other areas, namely other Italian Maritime Areas of the Adrian-Ionian area or more.

However, how to transfer the project results to other regions, administrative bodies and target groups and how the project results can influence policies and behaviors is a process that will requires constant and continuous commitment by all project partners at different levels, on multiple tables.
The exploitation strategy is better described in deliverable D3.1.2 “Exploitation plan”; here we want to present some examples on the functionalities and the potential use of the HADRIATICUM Data Hub, related to different kinds of stakeholders.

Indeed there are 3 kinds of end users that can be interested in the use of the HATCH geo-platform and all its contents:

1. stakeholders involved in MSP;
2. other stakeholders involved in the local planning process, such as regional or more local authorities and decision-makers;
3. any kind of stakeholders or general public interested in sea water quality, state of biodiversity or anthropogenic influences in the Programme area.

In particular, in the next table the best practices and monitoring protocols capitalized in HATCH are reported, combining each with the list of end users that could be interested in applying them. The end users are gathered in categories, related to the only MSP sectors[2] to which the results that HATCH capitalizes may be of interest.

[2] https://maritime-spatial-planning.ec.europa.eu/sectors

Table 7. List of HATCH end users' categories, connected to MSP sectors.

Best practice and ST Project	End users' category			
	General/All sectors	Coastal and maritime tourism sector	Shipping and ports sector	Fishing sector
The Ecological Observing System of the Adriatic Sea (ECOAdS): structure and perspectives within the main European biodiversity and environmental strategies (ECOSS)	Local Authorities Regional Authorities	Environmental Agencies Environmental associations Managers of N2000 sites and of Marine Protected Areas	Small harbors Marinas Port Authority Maritime Authority	Fishing associations
Eco-friendly anchoring systems (SASPAS)	Local Authority Regional Authority	Environmental associations N2000 sites managers Marine Protected Areas managers Parks and natural reserves managers	Small harbors Marinas Port Authority Maritime Authority Harbour Master's Office yachting associations	Fishing associations
Seagrass transplantation (SASPAS)	Local Authority Regional Authority	N2000 sites manager Marine Protected Areas manager Parks and natural reserves managers Environmental associations		Fishing associations
Wetland Conctracts and Observatory (CREW)	Local Authority Regional Authority	Environmental Agencies N2000 sites managers Marine Protected Areas managers Parks and natural reserves managers Research institutes and Universities	maritime tourism association	Fishing cooperatives

Best practice and ST Project	End users' category			
	General/All sectors	Coastal and maritime tourism sector	Shipping and ports sector	Fishing sector
		Environmental, and non-profit associations		
An ecosystem-based system of variables to enhance marine species and habitat monitoring and conservation: The Adriatic Natura 2000 case study (ECOSS)	Local Authorities Regional Authorities	Environmental Agencies Environmental associations Managers of N2000 sites and of Marine Protected Areas	Small harbors Marinas Port Authority Maritime Authority	Fishing associations
Underwater noise monitoring system: pre-deployment preparation, deployment, recovery and redeployment of instrument using bottom mounted system (SOUNDSCAPE)	Local Authorities Regional Authorities National authorities EU authorities	Environmental Agencies MPA managers	Port Authority Maritime Authority	
Procedures for assessing the source levels of underwater noise (SOUNDSCAPE)	Local Authorities Regional Authorities National authorities EU authorities	Environmental Agencies MPA managers	Port Authority Maritime Authority	
Procedures for processing the raw acoustic data (SOUNDSCAPE)	Local Authorities Regional Authorities National authorities EU authorities	Environmental Agencies MPA managers	Port Authority Maritime Authority	
Monitoring protocol for seagrasses (SASPAS)	Local Authority Regional Authority	N2000 sites manager Marine Protected Areas managerParks and natural reserves manager Environmental associations		
Monitoring protocol for treated wastewater and seawater AdSWiM	Depuration plants Local Authority Regional Authority	Environmental associations Environmental Agencies		

Best practice and ST Project	End users' category			
	General/All sectors	Coastal and maritime tourism sector	Shipping and ports sector	Fishing sector
Monitoring protocol for coastal and bathing waters by using innovative tools in wastewater management and treatmen (WATERCARE	Local Authority Regional Authority	Environmental Agencies		
Monitoring protocol for distribution and diversity of macrobenthos (ECOMAP)	Local Authority Regional Authority	Environmental Agencies	Small harbors Marinas Yachting associations	
Monitoring protocol for sea- and fresh-water interactions (ECOMAP)		Marine Protected Areas manager Parks and natural reserves manager Environmental associations Local Authority Regional Authority Environmental Agencies N2000 sites manager		

3.1 HATCH DATA HUB for stakeholders involved in MSP: the SOUNDSCAPE example

Increasing awareness around the negative impacts of underwater noise on the marine environment have made it the subject of ongoing research in recent years. Many of the reasons as to why it is crucial to include it in all phases of the Maritime Spatial Planning (MSP) process are also those making it a complex problem. Firstly, noise emissions are produced by a variety of human activities at sea, from the continuous noise caused by marine traffic to the impulsive emissions generated by different types of construction activities carried out underwater (e.g., cables and pipelines, offshore wind farms, etc.). Moreover, a wide range of sea creatures, from marine megafauna to plankton, depend on noise for a variety of life functions such as communication or reproduction, all of which are potentially disrupted when they come into contact with anthropogenic noise emissions. The main negative effects of underwater noise on marine fauna include disturbance and stress, masking of communication, physical injuries and, in extreme cases, death. Finally, it is important to note that many of the species manifesting negative effects due to underwater noise are highly mobile. Equally, a number of significant sources of underwater noise are of transboundary dimension. Together with the fact that noise travels long distances in water, its inclusion in MSP is a typical transboundary issue. It thus comes as no surprise that underwater noise made the list of the 11 descriptors identified by the Marine Strategy Framework Directive (MSFD, 2008/56/EU) for the achievement of Good Environmental Status (GES). As many European countries are currently approaching their second cycle of MSP, and after the recent release of new guidelines by the Technical Group on Underwater Noise (TG-Noise), a conscious and effective inclusion of noise in all phases of the MSP is as crucial as timely.

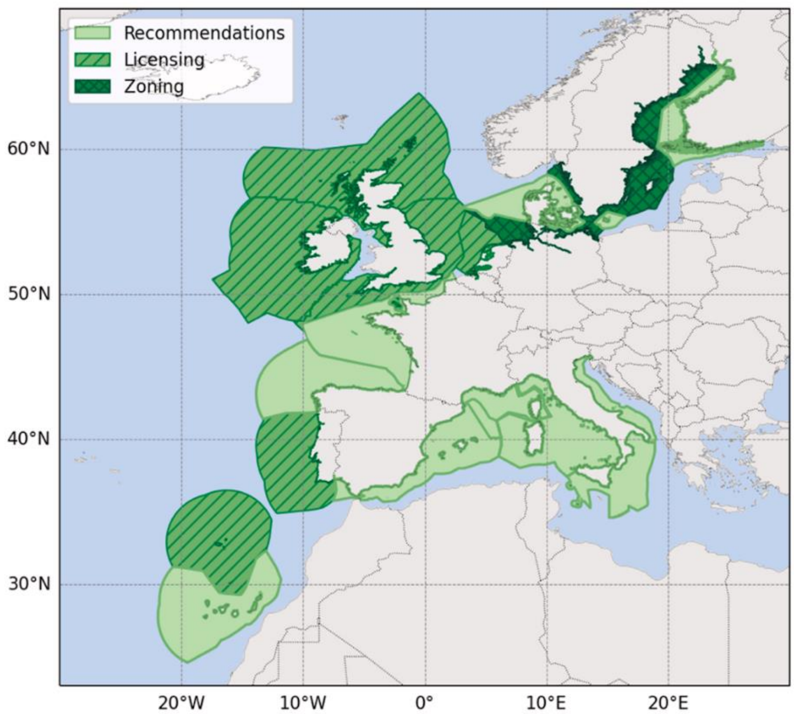

Fig. 4. Planning approaches adopted in relation to underwater noise. Polygons represent the planning domains of MSP plans considered in this study. The green shading refers to the chosen approach, from a list of recommendations (lighter shading), to particular attention being given to underwater noise in the guidelines on how to perform EIAs and apply for licensing (medium shading), to a more spatial approach where underwater noise influences the allocation of human uses to marine areas (darkest shading). The planning approaches are to be understood as overlapping layers, i.e., countries shown here to have adopted a "zoning" approach may also provide recommendations, but not vice versa. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Figure 51. Underwater noise and planning (from Bosi et al., 2023).

According to a recent review of existing policy around underwater noise in 11 European countries, covering areas in the Mediterranean, Baltic and North Sea, there is discrepancy between the perceived importance of the inclusion of underwater noise in MSP and the implementation of measures acting towards this goal (Bosi et al., 2023). The main issues seem to be i) the difficulty in assessing noise impacts on marine biota, especially at population level, in a quantitative and spatially explicit manner, ii) the lack of common methodologies allowing for comparison of results and compatibility of measures across national boundaries and iii) the insufficient harmonization of existing policies and their governance around noise. As a result, existing planning measures consist mainly of voluntary-based recommendations for the avoidance, reduction or mitigation of noise impacts and virtually no mandatory or spatial measures are taken, with a few exceptions (for details see Bosi et al., 2023). This appears to be true especially for the Mediterranean region (see Figure 51). A first step towards a better implementation of noise within MSP might then be to capitalize on existing research projects centered around underwater noise and ground decision-making on more spatially explicit and quantitative information. This would be made easier by a common agreement on the methodologies to be followed and metrics to be adopted across different countries, bearing in mind that this is no easy task as different approaches may be adopted depending on the desired output.

The IT-HR SOUNDSCAPE project has taken a significant step in this direction. The main objective of the project was to create a cross-border technical, scientific and institutional cooperation to face together the challenge of assessing the impact of underwater environmental noise on the marine fauna and in general on the Northern Adriatic Sea ecosystem. A dedicated methodology was devised to directly utilize underwater noise model outcomes for conducting risk analysis. This approach serves as a crucial and informative foundation to effectively manage such risks in accordance with the stipulations of the MSFD and MSP directives.

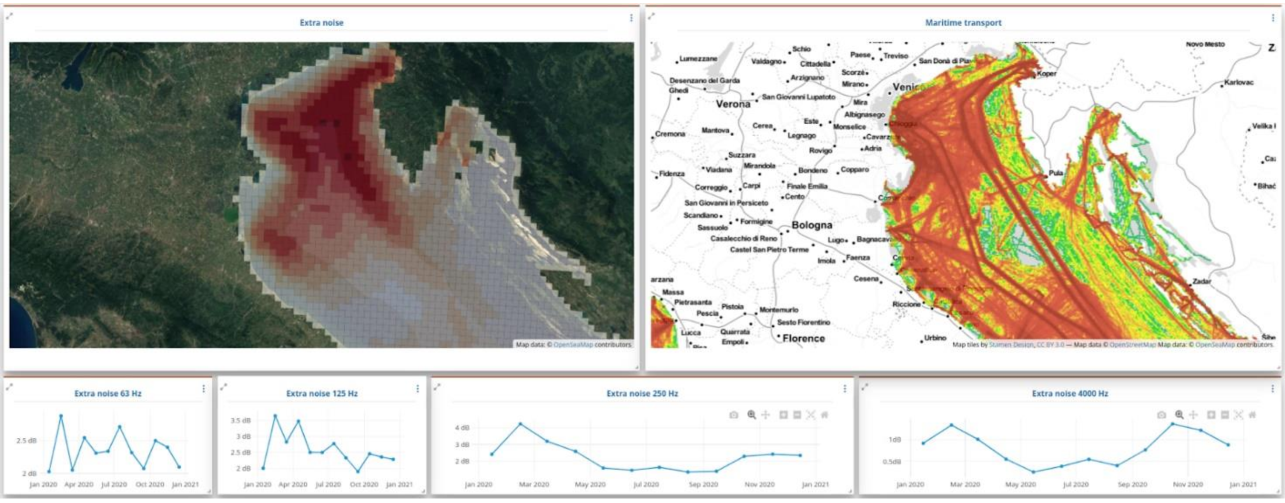

Figure 52. Source of extra-noise comparative dashboard.

An essential aspect of the suggested approach involves the spatially detailed depiction of “Extra Noise,” which represents a monthly aggregated indicator of Underwater Noise arising from anthropogenic activities, notably marine traffic (see Farella et al., 2021, for more details).

More in detail, the term “Extra Noise” denotes the dB difference between the mean values of baselines (current conditions) and naturals (reference conditions) for every grid cell, representative frequency, and month. This data was employed to explore pressure functions and indexes in various target areas, chosen based on potential occurrences of megafauna species like *Tursiops truncatus* and *Caretta caretta*. To exemplify another way of using HATCH data hub, as Croatia is still at an early stage with respect to the application of the Maritime Spatial Planning Directive, its decisors involved in MSP application and planning of the maritime spaces could use the maps (Figure 53 and Figure 54) showing the variation in the location of the megafauna population in the Losinj area due to underwater noise (results of SOUNDSCAPE project) which are already elaborated, uploaded in the HATCH data hub and freely available.

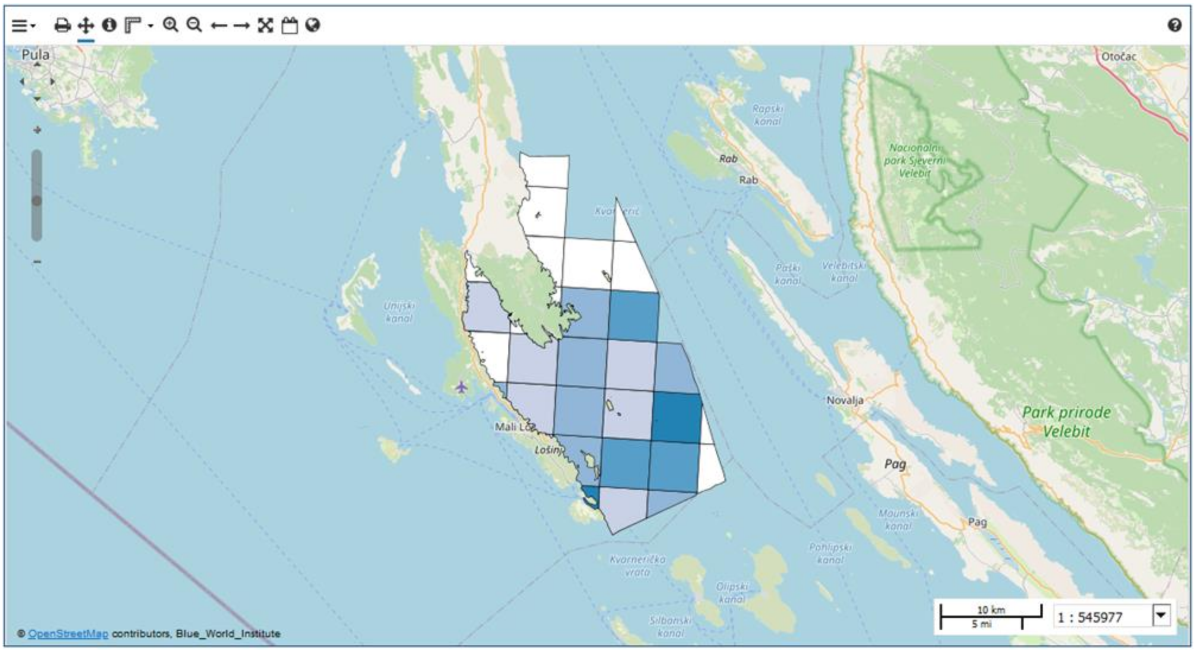

Figure 53. An example of map of relative encounter rates which is a measure of how bottlenose dolphins utilize their habitat, e.g. their spatial distribution.

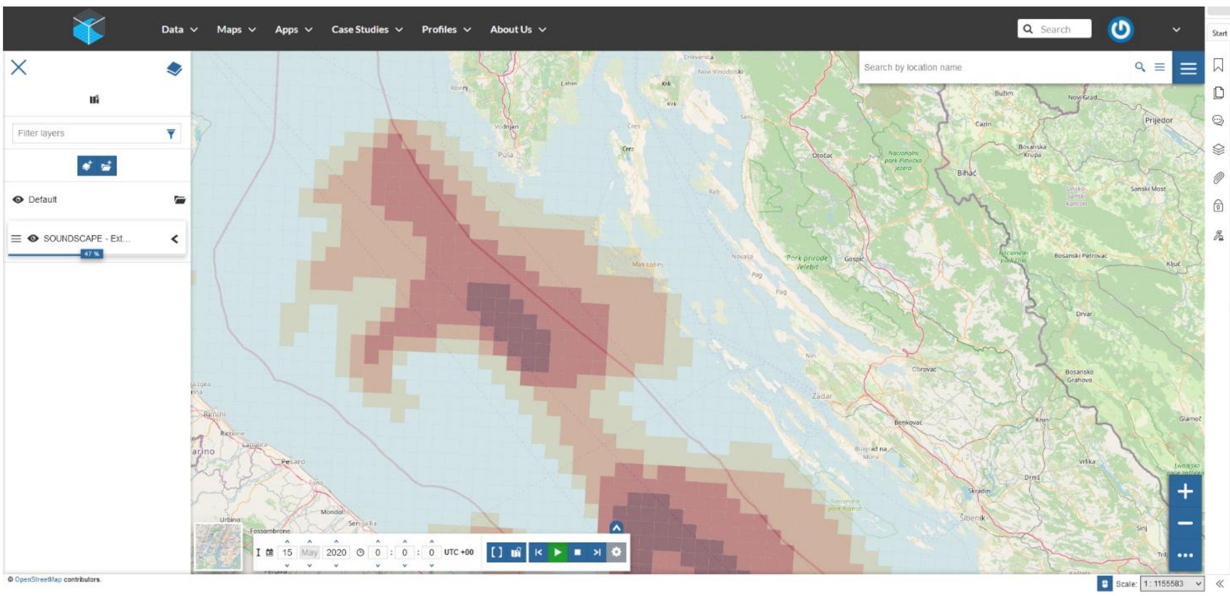

Figure 53. A map of distribution of underwater noise based on data and modelling conducted within SOUNDSCAPE project and included in Hadriaticum Data Hub.

To enhance the dynamic and flexible nature of such analysis, a specialized dashboard was created as a component of the HATCH project (refer to Figure 52). The dashboard provides the ability to correlate the spatial patterns of extra-noise, considering various reference frequencies and different months throughout the year, with the corresponding distribution of marine traffic density. Users can conveniently zoom in on specific regions of the map simultaneously, enabling them to explore and assess particular hotspots or areas of interest in detail. The dashboard's graphs automatically update, providing real-time feedback on the level of attention and the concurrent presence of marine traffic in the selected areas.

This dashboard serves as a valuable tool directly applicable to MSP, benefiting both the analysis of the current situation and the planning phase. It offers the potential for future utilization in implementing monitoring measures within the plans as well.

Update of the application status of the MSP (periodic monitoring of the vocation of the areas)

The Maritime Spatial Planning Directive sets the obligation for the 22 coastal Member States to establish maritime spatial plans by 31 March 2021 at the latest. While the majority of the coastal Member States now have a maritime spatial plan in place while eight states have not yet finished fully adopting their plans. However, all States decided how to perform the transposition of the MSp directive in the national legislation. Croatia amended legislation on spatial planning or environmental protection as Italy adopted new specific MSP legislation and both our countries designated competent authorities, either ministries or government agencies.

Italy and Croatia were part of the group that received, by the Commission, letters of formal notice for failure to comply with several articles (ie Article 8(1), Article 15(3) and Article 14(1)) of the MSP Directive. In other words, our States are both at various stages of drafting their maritime spatial plans or are looking for the approval at national level but the process is not fulfilled yet and in due time. It is however confirmed at EU level that maritime spatial planning (MSP) is an effective and strategic tool to coordinate the different activities at sea and prevent conflicts over the use of maritime space and the EU remains global leader in this area

3.2 HATCH DATA HUB for stakeholders involved in MSP: Hadriaticum Data HUB portal for the Interreg Programme

The HATCH data hub is a model able to capitalize on existing data and information without defining specific protocols for the different types of environmental monitoring used in different projects. Within the project, a web platform to organize scientific geospatial information and visualize and present them through MPS-oriented narrative geostories has been implemented and made public available. This represents a new approach to support the challenges that the MSP processes have to address in the next features for reducing pollution and fostering a sustainable blue economy. More specifically, the implemented platform comprises a well-structured combination of geospatial layers, derived from the HATCH capitalized projects, providing, for the study area, insights into various aspects including distribution of human activities and anthropogenic pressures. It also includes interactive maps and dashboards that enable multifaceted spatial and temporal data exploration. Additionally, as anticipated before, all these elements are combined into the geostories for facilitating exploration by the Planners and by the other users involved in the MSP processes. Harmonizing and organizing geospatial information from different projects is a complex process that requires a systematic and collaborative approach. For this reason, within the HATCH project a specific geographical data model (HATCH data model) has been also developed to allow the resources produced by the different projects to be indexed in a spatial and temporal manner. On the basis of these considerations, we argued that HATCH data hub could be proposed as a repository of data analyses emerging from the projects performing monitoring in the Adriatic area of this or other EU and national Programmes relevant for geographical area. "In practice, within the planned areas of the Marine Spatial Planning (MSP), the ongoing incorporation of data from analytical, microbiological, and physical parameter assessments, as well as broader monitoring efforts, serves to enhance and refine our understanding of specific zones. Simultaneously, it aids in verifying whether the designated "intended use" for a particular maritime area aligns with its environmental preservation goals.

The HATCH data hub has been designed with careful consideration of the characteristics of territorial projects that encompass a wide range of diverse information. Within this context, EU programs (and other fundings promoting research and international cooperation) choosing to utilize the HATCH data hub as a repository for their project outcomes can become actively engaged in the adoption of the Marine Spatial Planning (MSP) at the Adriatic basin level. By doing so, they provide neighboring states in the region with a readily available tool for implementation. Additionally, the visualization of well-organized and standardized data can inspire and guide the development of new project ideas. This, in turn, reduces the risk of redundant operations and can enable the inclusion of specific requests related to MSP policy in future project calls for proposals. This approach streamlines the application process for the Directive and ensures greater coherence.

However, it's important to note that the loading of data into the hub necessitates rigorous quality and consistency verification. Therefore, collaboration or agreements should be established to ensure the ongoing operation and maintenance of the HATCH data hub. This addresses a common issue in many projects where the sustainability of results is compromised due to the lack of assurance regarding tool longevity.

It is reasonable to expect that by consolidating information within a single repository, resources can be allocated to guarantee its continued functionality. In recognition of the benefits derived from MSP implementation, the Commission has already designated funds to support this instrument.

3.3 HATCH DATA HUB for stakeholders involved in the integrated management of coastal zones: the bathing water quality example (WATERCARE)

HATCH Harmonized Geo-database, thanks to the ability to collect and integrate information from multiple hyper sources (e.g. EMODnet, Copernicus,), is a tool for easily treating interactive maps that help the description of the territory and the analyses of interaction among pressions to describe the cumulative impacts effect in the area, especially in regard to Land-Sea Interactions, and support the decision making process, even putting at disposal the best practices on a spatial map.

One example, focused on the Italian coast of the Marche region, shows the overlapping of information at a regional level on the analysis of the area and the chemical-physical state of the waters, in evaluating the possibility of using bathing water quality monitoring as a tool to obtain information about the area and to protect the coastal environment and improve environmental and coastal zone management.

The Marche Region considers as fundamental the sustainable development of the maritime economy of its coastal system, which involves many sectors ranging from coastal and maritime tourism to fishing, aquaculture and trade. The overall strategy to allow a harmonious and sustainable systemic development of these sectors will necessarily have to guarantee the protection of the environment and landscape, addressing the criticalities resulting from interferences. To this end, specific actions should be implemented in order I) to develop, as an example, the tourism system integrated with the development of the territory through a strategic management of its landscape and environmental resources able to guarantee environmental, economic and social sustainability; and II) to protect the quality of the marine environment (Directive 2008/56/EC and Directive 2000/60/EC), to improve the quality of bathing waters and to increase the effectiveness of marine control actions and prevention of environmental risks, also through the improvement of the observation and monitoring capacity of the sea.

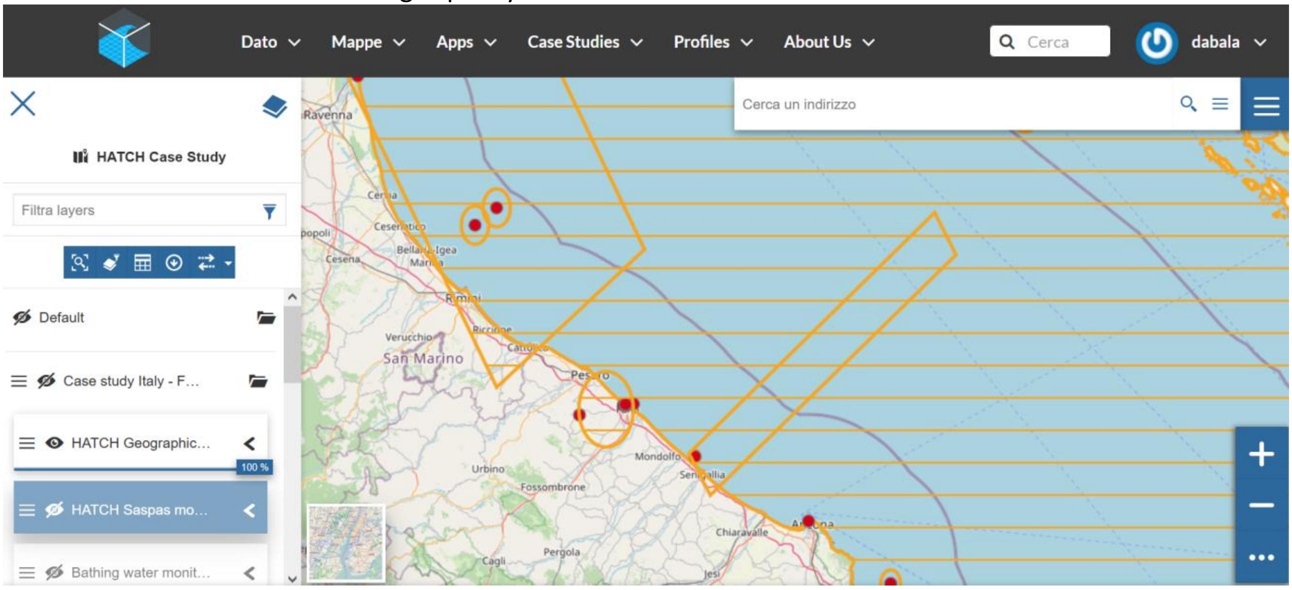

Figure 54. Data and information available in the Marche region area and coming from the 7 st Projects capitalized in HATCH.

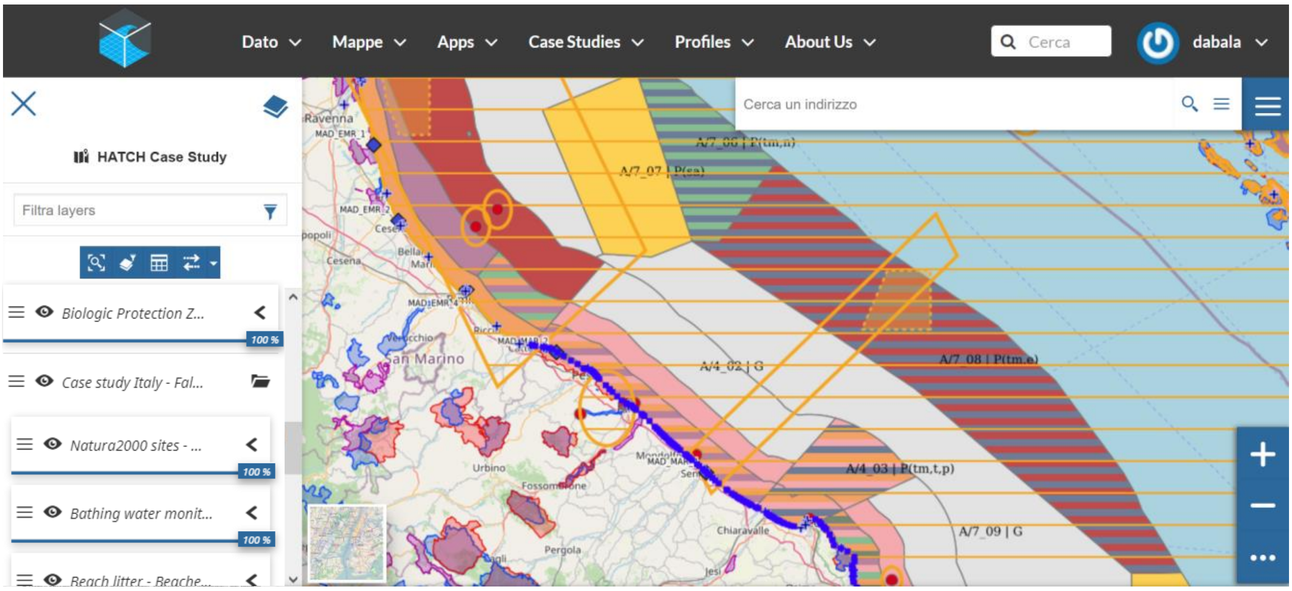

Figure 55. Map of the Marche region area; data from different sources (HATCH project; MSP Adriatic Sea-SID portal; Regione Marche; European portal Emodnet).

The monitoring of bathing water quality and quality of seawater generally is a good tool to obtain information about the area when establishing the Coastal Zone Management Plans, but also to control their application as well as the application of the measures introduced by the plans. This is especially important in vulnerable areas subject to sporadic point pollution, such as marinas (in Figure 55, Figure 56), anchorages, and waterways, and nonpoint pollution during abnormal situations. Since the management of bathing waters in "abnormal situations," such as after heavy rains, is not optimally regulated in legislation, local authorities should define their own measures to protect the environment and human health. These measures should be included in Coastal Zone Management Plans. This will make an important contribution to the protection of the environment and human health. Marinas, anchorages, and waterways areas are usually not monitored, and "responsible behavior" in these areas is left solely to the good will of the users. The introduction of seawater quality controls in these areas would help prevent pollution but would also raise awareness among users of these areas of the importance of protecting them from pollution.

Bathing water quality management is regulated by the Bathing Water Directive, which is relatively outdated, so some procedures are not well regulated. For example, it is questionable whether the current minimum number of samples per season is relevant for a reliable quality assessment; whether spatial and temporal variations in water quality have been considered when defining sampling points (in Figure 55), or whether the quality assessment is representative for the whole bathing water; whether the public is informed about quality in a timely manner,... For this reason, it is questionable whether the Directive successfully fulfils its main purpose of protecting the environment and human health. However, the Directive does not prevent Member States from introducing stricter criteria and additional measures. Local authorities could actively participate in additional measures and support monitoring by introducing and funding additional activities. These activities should be specified in the Coastal Zone Management Plans and could include the involvement of local authorities in improving monitoring by funding additional sampling at additional points, building water quality prediction models, etc. This would not only lead to better protection of the environment and human health but would ultimately have a positive impact on tourism and the development of local communities.

In particular, WATERCARE project developed the innovative Water Quality Integrated System (WQls), composed by a real-time hydro-meteorological monitoring network, linked to a forecast operational model (cfr. Cap. 2.1.2).

3.4 HATCH DATA HUB for stakeholders involved in the wastewater purifiers management: the marine water quality and the bathing water quality examples (ADSWIM)

Adriatic marine waters are generally classified as good to excellent based on the Bathing Water Directive (2006/7/EC). Nevertheless, issues of low productivity of marine areas or the lack of nutrients have been often suggested, especially on the Italian side. ADSWIM addresses the question of whether wastewater treatment plants (WWTPs) discharging to the sea, after applying appropriate pollution control and management technologies, can modulate the nutrient content of their effluents to support localized depleted areas. This idea is borrowed from one of the motivations that support the reuse of treated wastewater for irrigation, thus leading to the return of nutrients (nitrogen, phosphorus, potassium, etc.) to natural biogeochemical cycles. However, the hypothesis of modulating the nutrient composition of wastewater opens up to several critical aspects, including legislative and technological ones. Being aware of the delicate environmental implications, the project involving WWTPs, research centers, municipalities, and legal experts aimed to investigate on several points of view the problems related to wastewater reuse, especially with regard to the

content of nutrients. The experimental approach aimed to evaluate appropriate and possibly new treatment technologies to reduce the microbial load and to implement chemical and microbiological tests on the treated wastewater. Results have shown that it can be tricky to draw decisive conclusions because (i) the wastewater management systems differ between the two sides of the Adriatic sea due to the different levels of technological development of WWTPs; (ii) the Italian and Croatian coasts deeply differ in geographic characteristics (i.e., topography, orography, current circuits, presence of rivers) and anthropogenic pressure (i.e., exploitation levels, population density); (iii) the new treatment technologies to lower bacterial contamination need further efforts to raise their technological level of readiness (TRL) and make them implementable in the existing WWTPs. Components of domestic/urban wastewater include several critical elements: pathogens, nutrients, suspended solids, salts, emerging contaminants (e.g., antibiotics, drugs, etc.), and the so-called “oxygen-consuming materials” (e.g., microbes and decomposing organic waste). In addition, with the introduction of the concepts of sustainability and reuse, WWTP managers have been considering how to reduce their environmental impacts using new technologies. Wastewater reuse is a discussed topic in the context of the “unconventional” water sources debate. Reusing wastewater in irrigation is classically proposed as an option, due to its content in nutrients (nitrogen, phosphorus, potassium, etc.), which thus would return into the natural biogeochemical cycles. Therefore, it was reasoned that the off-shore discharging of treated wastewater (WWT) with modulated nutrient concentrations (i.e., based on the values of the receiving marine waters) can represent a way to support local marine life, while simultaneously reducing pollutants (thanks both to the implementation of the existing technologies or by adopting new ones). These analyses were performed both on WWT samples collected at the WWTPs and, almost simultaneously, on seawater samples collected close to the discharging line offshore (deliberately, no specific directives were followed in the organization of the sampling). The cross-border legislation related to the management of WWTPs, as the EU directives need be integrated into the national/local organization was analysed and compared. It emerged that although there are no apparent critical issues as the directives are respected within the limits imposed, this does not guarantee that over extended periods there may be altering effects on environmental quality. In consideration of this, HATCH data hub becomes a useful tool for visualizing the evolution of environmental state quality because it superimposes the detail of the timely information deriving from the analysis on the macro subdivision of marine areas made by MSP which acted, with a larger zoom, by performing an analysis of the territory and of the land-sea interactions.

Over time stratifying analysis data of both chemical and microbiological parameters can offer a methodology for verifying the compatibility of the identified use (by MSP) and the pressures and impacts that exist in this space. The selection of samples to be analyzed, along the purifier discharge line is a working approach adopted in ADSWIM and which ADSWIM proposes to focus the monitoring efforts and detail the information framework within these known pressure points. Furthermore, the sensor optimized during Adswim's lifetime, for rapid and sensitive measurement of the nutrient phosphate below the threshold offered by classical instrumentation, suggests that this is a strategy of increasing the level of knowledge of the marine system. It also suggests the need to explore new ways for measuring the parameters of interest given the complexity of the ecosystem subjected to increasingly and more diversified anthropic interference

3.5 HATCH DATA HUB for stakeholders involved in the monitoring of the stability of the marine ecosystems: monitoring protocol for sea- and fresh-water interactions (ECOMAP)

The interaction between sea- and fresh-water is an increasingly popular topic among hydrogeologists. In fact, freshwater outflow at sea can give a relevant contribution to the hydrological balance, but it's a little studied topic and no standard method for the detection of freshwater springs has been established. Furthermore, the presence of freshwater springs at sea can have an impact on the species populating that area. In fact, such springs can carry nutrients, but also pollutants if the water which infiltrated on the mainland was somehow contaminated.

At the same time, the intrusion of saltwater towards land ("salt wedge intrusion") is an increasingly worrying phenomenon which leads to the salinization of aquifers even several kilometres away from the coastline. Since groundwater is still the most important source of drinking water for most of Europe, this phenomenon should be studied in as detail as possible, especially in the prospect of an increasing number and intensity of dry periods.

Within the ECOMAP project, protocols for the detection of both freshwater intrusions at sea and of the salt wedge towards land were developed. These make wide use of innovative geophysical methods, namely seismic and geoelectrical surveys.

In case the area of interest is on the coastline, the best solution to distinguish between salt- and fresh-water is a geoelectrical survey. In fact, the resistivity of a water-saturated will depend on the salinity of the fluid. During the ECOMAP project, the method was tested both in Italy (Bibione beach) and in Croatia (Spinut and Podstrana beaches). The results show evident presence of flowing freshwater towards the sea in Croatia, while an evident saltwater wedge was detected in Bibione. More specifically, in the case of the Bibione, the saltwater wedge intrudes in the water-saturated sands forming the ground in the area. On the other hand, the freshwater flows in the karstic fractures present in the limestone directly in the sea.

It is also possible to detect freshwater springs offshore. In fact, using a very-high-resolution seismic system (boomer), the geophysicists were able to detect several freshwater springs offshore the Croatian coast (Split area). Furthermore, several gas seepages were detected offshore Bibione, which most likely carry water from the subsurface to the seafloor.

4 MSP the Frame for the projects' valorization and perspectives for the incoming projects

The Maritime Spatial Plan was prepared by the Technical Committee referred to in art. 7 of Legislative Decree no. 201 of 17 October 2016 - on "implementation of Directive 2014/89/EU establishing a framework for maritime spatial planning" established at the Competent Authority (MIMS - Department of Transport and Navigation - Directorate General for the supervision of port authorities, port infrastructures and maritime and inland waterway transport), which includes representatives of Central Administrations (five Ministries with responsibilities for issues related to sea and coastal uses) and Regional Administrations (15 coastal Regions) designated by their respective administrations and appointed by D.M. 13 November 2017, n.529 as amended.

Three maritime reference areas have identified for the drafting of three inter-coordinated Plans, referable to the three sub-regions of the Marine Strategy (art. 4 of Directive 2008/56/EU):

- The western Mediterranean Sea;
- The Adriatic Sea;
- The Ionian Sea and the central Mediterranean Sea.

The Maritime Spatial Management Plan has been configured by the domestic law transposing the Directive as a plan that is superordinate to all other plans and programs capable of affecting the same scope of application The Plan provides strategic level indications and guidelines for each Maritime Area and their sub-areas, to be used as a reference for other planning actions (sector or local level) and for the granting of concessions or authorizations. Depending on the characteristics of the sub-areas and planning needs, the Plan provides more or less detailed indications, both in terms of spatial resolution and in terms of defining measures and recommendations.

The reference time horizon of the Plan is 2032, the year in which, at the latest, an initial update of the Plan will be due, taking into account, where possible and necessary, a longer time horizon (year 2050). The possibility of a mid-term review, or if deemed necessary following the monitoring of the implementation of the Plan or events that require revision, is foreseen.

Draft Plans are still under finalization based on the expected final results of the Public consultation and the Strategic Environmental Assessment consultation.

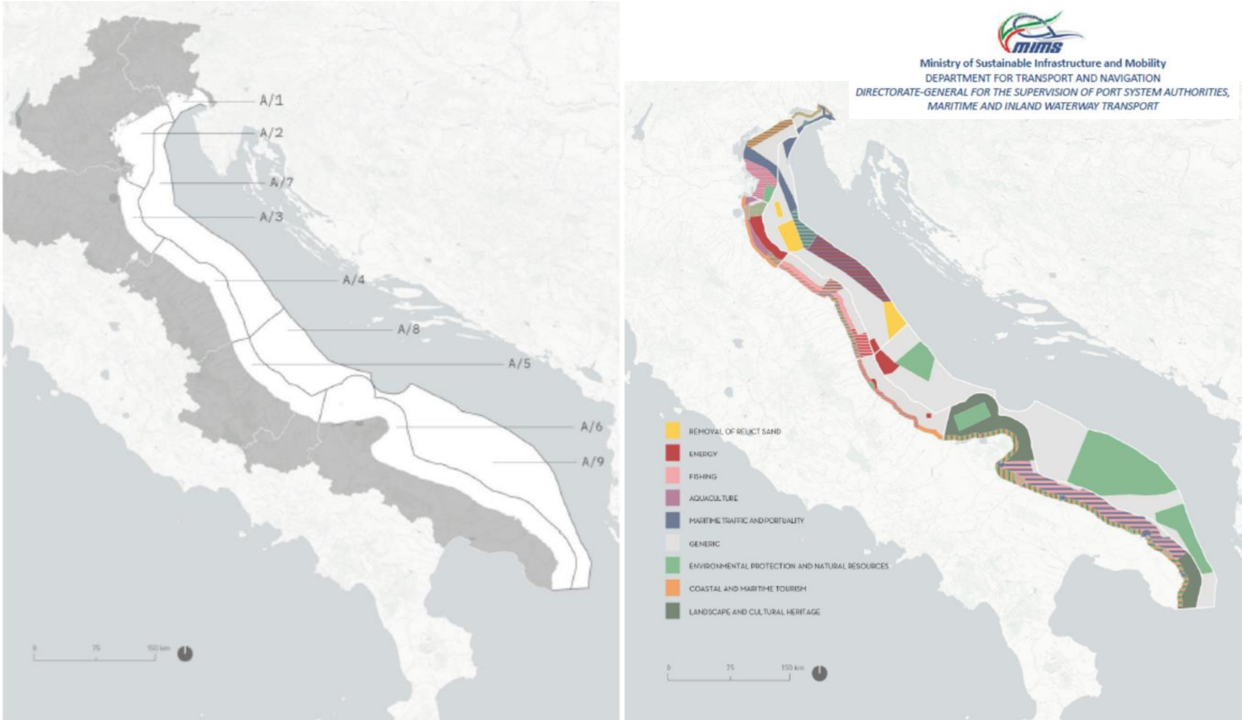

Figure 56. Left) Delimitation and internal zoning of the "Adriatic" Area; Right) Planning Unit of the Maritime Area "Adriatic".

Spatial planning in Croatia is regulated by the Physical Planning Act (Official Gazette 153/13) which defines aims, principles and subjects to spatial planning as well as the procedures for development and adoption of spatial plans. According to this Act, the entity in charge of spatial planning at national level is the Directorate for Physical Planning and Permits of State Significance within the Ministry of Physical Planning, Construction and State Assets. Spatial planning on county level is the responsibility of their respective Directorates for Physical Planning. Furthermore, the Act enables major cities to establish own Directorates for Physical Planning, whereas smaller cities and municipalities may engage certified firms.

The Ministry of Physical Planning, Construction and State Assets was delegated to implement the Directive 2014/89/EU. This was done by adding the Maritime Spatial Planning to the existing legislation through the Amendment of the Physical Planning Act in 2017 (Official Gazette 65/17). Accordingly, MSP is foreseen to be implemented at various levels, including state physical development plans, physical plans of EEZ and fishery zones, physical plans of national parks and nature parks that encompass marine area, physical plans of counties, cities and municipalities encompassing marine areas.

Even though many counties, cities and municipalities have included provisions for marine component within their Physical Plans, the main obstacle is the lack of clearly defined internal borders at sea. Also, there is currently no single, state-wide MSP plan for the entire Croatian marine area.

5 CONCLUSIONS

The continuous expansion and growth of human activities at sea exposes the marine environment to numerous threats stemming from various sectors such as tourism, fisheries and aquaculture, hydrocarbon extraction and marine traffic, to name but a few. Climate change and pollution present additional pressure that the fragile ecosystems of the Adriatic Sea are exposed to. Through maritime spatial planning we want to help find the best way to preserve the health of the marine environment and biodiversity in coexistence with a conscious and sustainable use of water. It is a process that involves stakeholders from various sectors with the aim to organize human activities at sea and harmonize often conflicting requirements: ecological and socio-economic. Therefore, for MSP to be successful, a thorough understanding of the state of the marine environment and the anthropogenic impacts upon it is required. The decision-making in MSP should be based on scientifically obtained data.

There are multiple monitoring campaigns carried out for scientific, and not institutional, purposes which can equally provide an updated and authoritative cognitive framework. The research and monitoring programs conducted within the previous projects of the Interreg Italy-Croatia Programme have significantly improved our knowledge of the state of the Adriatic Sea and its exposure to human impacts. In particular, the research included diffusion of chemical compounds in marine environment, microbiological and nutrient parameters at and near the river mouths of several Adriatic rivers and near the sewage and purification plants outlets. Furthermore, the state of biodiversity, distribution and conservation status of sea plants and benthic habitats were researched, along with the marine litter and levels and distribution of underwater noise.
HATCH is a first step to give continuity among to environmental monitoring campaigns and the drafting of best practices and guidelines formalized within Interreg research Programme, which can give added value to institutional knowledge frameworks.

Thus, the main result of the HATCH project is the development of a new tool for implementation in MSP – HATCH Data Hub geo-platform, which includes harmonized results of the afore mentioned research and monitoring programs. This geo-platform enables flexible visualizations of the results on maps and is therefore an excellent aid to all stakeholders involved in MSP, such as authorities and decision-makers, but also useful to anyone interested in sea water quality, state of biodiversity or anthropogenic influences. Within this context, the HATCH Data Hub geo-platform, enables assessment of various human activities and their overlaps, which can help overcome potential conflicts between sectors and thus contribute to long-term sustainable use of marine resources and ecosystem services.

The conservation of the Adriatic and its ecosystem, which is rich in biodiversity but also very fragile, depends on protection measures based on knowledge obtained from multidisciplinary research. Several research projects conducted within the European Program Interreg Italy-Croatia 2014-2020 represent a significant progress in the knowledge of the problem of the protection of the Adriatic, but have also revealed the need to make the information generated easily accessible and usable for the benefit of decision-making processes for safeguarding and environmental protection.
HATCH Project, "Hadriaticum Data Hub", was created to exploit the results of 7 standard Interreg projects financed with the European Cross-border Cooperation Program Italy-Croatia 2014-2020, which had monitoring activities of different forms of anthropic pollution acting on the Adriatic Sea as a common thread.

The result of the process of harmonizing such different data, for purposes and spatio-temporal extension, is the development of a tool, or rather a "hub", which collects and makes this information (not only as data and

maps, but also as including best practices and developed monitoring strategies) freely on-line available to all stakeholders involved in the maritime spatial planning (MSP) process or at a more local level (e.g., environmental managers, policy-makers,) and other kind of users (e.g., researchers, citizens), together with guidelines for its use.
The tool is not a mere replication of the products of previous projects but the systematisation of information on a free and open platform, easily accessible and navigable by stakeholders. Interactive maps, dashboards and geostories for a facilitated and integrated display of information.

In this sense, HATCH proposes a different approach than usual, dictated by the timing and resources of the project itself. The objective of homogenizing such heterogeneous data, conforming them to European regulations, and the aim of creating a common standard would not have been achievable in the only 1 year of work made available to HATCH; therefore, it was decided for a more pragmatic approach that would equally allow the systemisation of the results of the 7 capitalized projects. To do this, we didn't focus on data information but on answering the questions: who?, what?, when, and where? By managing to give an answer to these 4 questions, we are starting building a solid cognitive framework which shall be built by partial increments of knowledge. This will only occur if the HATCH platform can be developed and implemented over the next few years, under penalty of a new zeroing of knowledge and a restart in the construction of an updated and authoritative knowledge framework.

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