CoCoNet Project

Collaborative project
Theme: OCEAN.2011-4
Grant agreement no: 287844

CoCoNet

Towards COast to Coast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential.

Report regarding the Black Sea pilot sites activities in 2015-2016

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Relevant WP: WP10

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Background

The core objectives of CoCoNet are: 1 - The production of guidelines for the establishment of networks of Marine Protected Areas (MPAs) in the Mediterranean and Black Seas; 2 - a wind chart of both basins, aimed at testing the feasibility of the establishment of Off Shore Wind Farms (OWF).

The Consortium spans over three continents (Africa, Asia, Europe) involving 22 states and 39 institutes and SMEs, with hundreds of scientists and operators. The necessary disciplines to meet the objectives span from physical oceanography to meteorology, geology, biology, ecology, socio-economy, national and international law, computer science, media communication, engineering, education, ocean literacy and many other sub-disciplines.

Objectives WP 10:

1. Acquisition of new geological, biological, oceanographic data in the Black Sea pilot area relevant for MPAs implementation;
2. Identification, within the pilot area, of key variables regarding connectivity (distance, size, strength and direction of currents, genetic connectivity, propagule supply) to be considered in the design of MPA network.
3. Definition of what is specific to the Black Sea and what can be generalised at larger scale within management plans in terms of connectivity processes.
4. Examination of the main natural and human driven causes of changes, potentially affecting the functioning and dynamics of the Pilot Areas ecosystems and description of potential implications for establishment of MPA networks.
5. Assessment of ecosystem vulnerability and implications for MPA network design and management in the Pilot area.
6. Identification of socio-economic impacts caused by offshore wind farm development within the network of MPAs
7. Transfer of the field data generated by WP10 to the WP9 Geodatabase, and to contribute via other WPs to the final synthesis

Task 1 - Multi scale mapping of geological, biological, oceanographic features characteristic for different habitats

Subtask 1.1 Geological, geophysical and biological mapping

This report shows the techniques used for integrating Multi Beam bathymetry and backscatter data to produce a wide scale map of the abiotic elements of marine benthic habitats.

There was analyzed and classified the high resolution bathymetric data and the backscatter data collected both with multi beam and Side Scan Sonar. We produced a geomorphological and a substrate map interpreting respectively the multi beam bathymetric data and the backscatter data. The next step was to classify the seafloor morphologies (GeoLevel) and the substrate (SubtrateLevel) most relevant to benthic habitat with GIS tool, applying a hierarchic legend properly designed for COCONET in the framework of WP2.

The work was focused on 4 key sites of the Pilot project area: the southern lobe of Zernov's Phyllophora Field (RO), Cape Aurora (RO), Ropotamo-Kiten (BG) and Sile(TR).

The Multi Beam data processing methodology implies the creation of a 2D and 3D best-fit interpolated surface using different algorithms and grid resolutions.

The first processing step is the analysis of the data errors and the definition of a strategy to solve them.

The latter includes:

1) the correction of the motion sensor calibration parameters;

2) the sound speed correction applying the ray-tracing technique after data acquisition;

3) the manual cleaning of the spikes (beam removal) only in the area where they are visible on the 2D and 3D surface;

4) the automatic filtering for a depth window, by beam number or slope between points.

The second processing step is the creation of a new surface after the data correction and cleaning using a different resolution grid for a given water depth range. During the data processing step it is crucial to assess the reliability of the seafloor features detected on the grid surface and to identify and possibly remove all the possible noise.

The last step is the integration of the multi beam data processed as uniform subset areas in terms of acquisition period, instruments water depth range and seabed morphology. This step implies the accurate correction of the errors possibly occurring at the borders between different areas particularly if acquired through different systems, periods and processing approaches. The final GRID surface is stored in the GIS Geodatabase as ArcGIS Raster file and it is useful to create different products such as contours, slope maps or hill-shade maps.

In the framework of WP10 GeoEcoMar organized two joint cruises, onboard of the R/V Mare Nigrum. Both cruises had Constanta, Romania as port of departure and arrival. The primary objective of the two cruises has not been a habitat mapping survey, but to search for the extension of Zernov's *Phyllophora* Field (ZPF) south of Romanian-Ukrainian border and to assess the associated recovery processes. According with the above mentioned objectives of the cruises, very little MBES surveying has been done, and only in between the sampling activities (dredging and Van Veen grabs) and no side scan sonar surveying.

The bathymetry was recorded with an ELAC Nautik Seabeam 1050D model Multibeam. The Multibeam is a dual freqency model with 50 KHz and 180 KHz sensors, 126 beams with a maximum swath width of 153°. The data were collected in two cruises which took place in 2013 (August 16-19), designated as MN115 and in 2014 (June 24-29), designated MN123.

The acquisition software is Hydrostar (version 4.3) under MS Windows and the processing software are: HDPEdit and HDPPost that run on Linux machines. In the acquisition software two real-time corrections were done :

1) from the motion reference unit the corrections for the ship movement including heading, heave, roll and pitch;

2) the sound speed correction from a CTD probe.

The motion reference unit is an IXSEA Octans III fiber-optic model, which provide heading, roll, pitch, yaw, heave, surge, sway in real-time. CTD Probe is an Sea & Sun CTD Model 60M with sensors for pressure, temperature, conductivity. The position of the ship was given by a differential GPS, model Omnistar LR3200, with a maximum horizontal error of 1 m (VBS subscription).

For processing each file was imported and processed separately. First step is to identify and remove spikes (aberrant values). This is done with HDPEdit and can be done for each beam, for a number of beams or for all beams within a file. The original file remain the same, the changes are recorded in a separate file. Next step has been accomplished with HDPPost, where the files are be imported (more files at once), analyzed and gridded and then exported to various formats, including ASCII formats. There are several filters which can be applied in HDPPost, including filters for depth range or covering percentage.

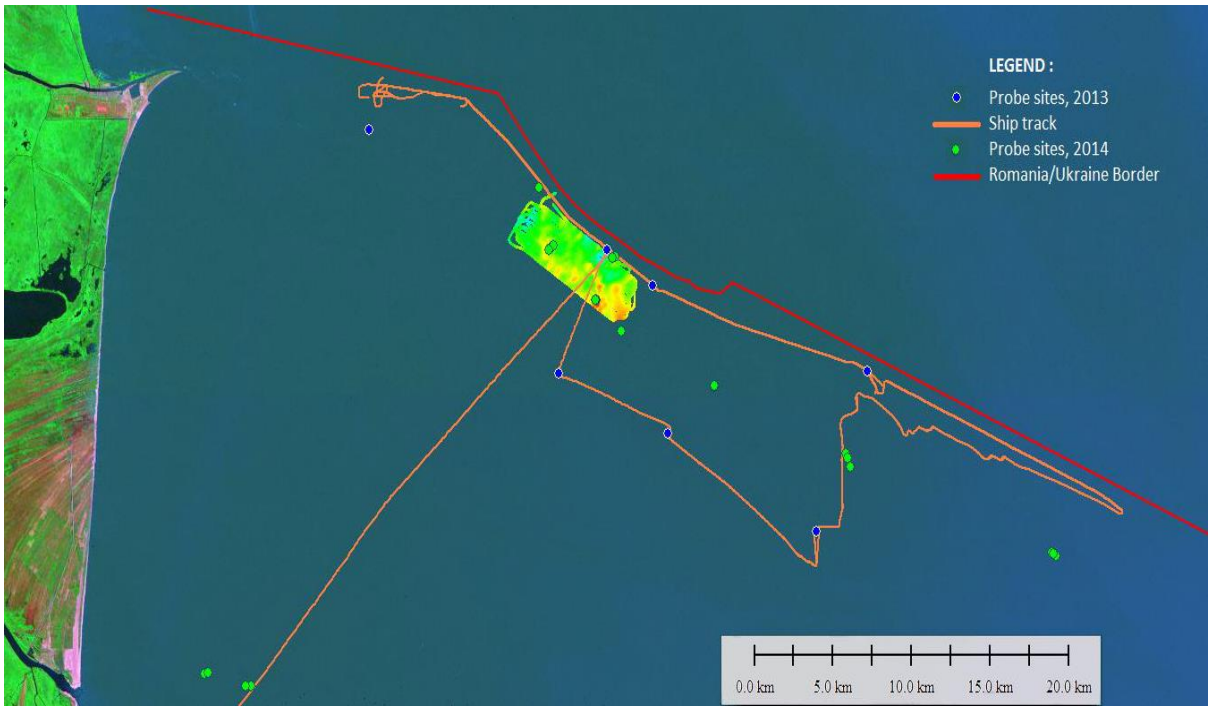

Fig. 1 Overview map with ship tracks, bathymetry, sampling points and surveyed area in COCOBLAS cruises, 2013 and 2014.

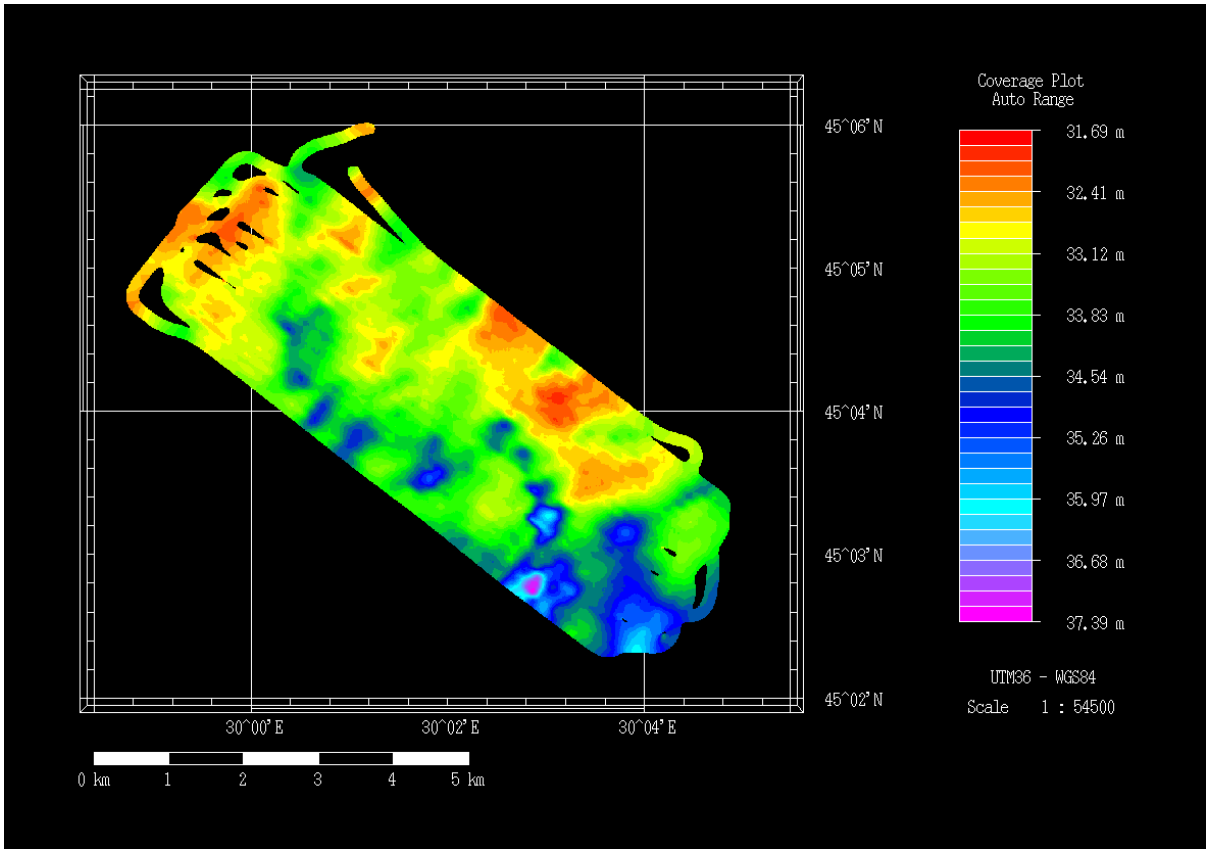

Fig. 2 MBES map - cruise MN123 (screenshot from HDPPost software)

NIMRD organized several cruises with smaller craft in the pilot area Costinesti – Cap Aurora during August 2014, the primary objective being bathymetric mapping of the seafloor around the experimental site for simulating OWF foundations (artificial reef).

The bathymetry was recorded with an Odom Multi Beam echo-sounder, MB1 (integrated with Topcon GPS and MRU, within Hypack Software) with an operating frequency of 170 to 220Khz, up to 512 beams with a maximum swath width of 120°.

The acquisition software is Hypack processor which includes specific methodology in connection with the data of a 2D and 3D best-fit interpolated surface using included specific processing algorithms at different grid resolutions. The MB data were automatic filtered and the errors were examined based on the motion sensor calibration parameters and sound speed profiles data. Certain manual corrections were applied after data acquisition especially for cleaning of the spikes around the areas of sharp slopes in order to complete the 2D and 3D surfaces. Thus, the seafloor data were better emphasized, with certain high pitched features detected on the areas of interest. Processed data were stored as raster data within BS pilot-project Geodatabase and analysed based on GIS tools in connection with existent side-scan and underwater images recorded by diving at different periods and investigations approaches.

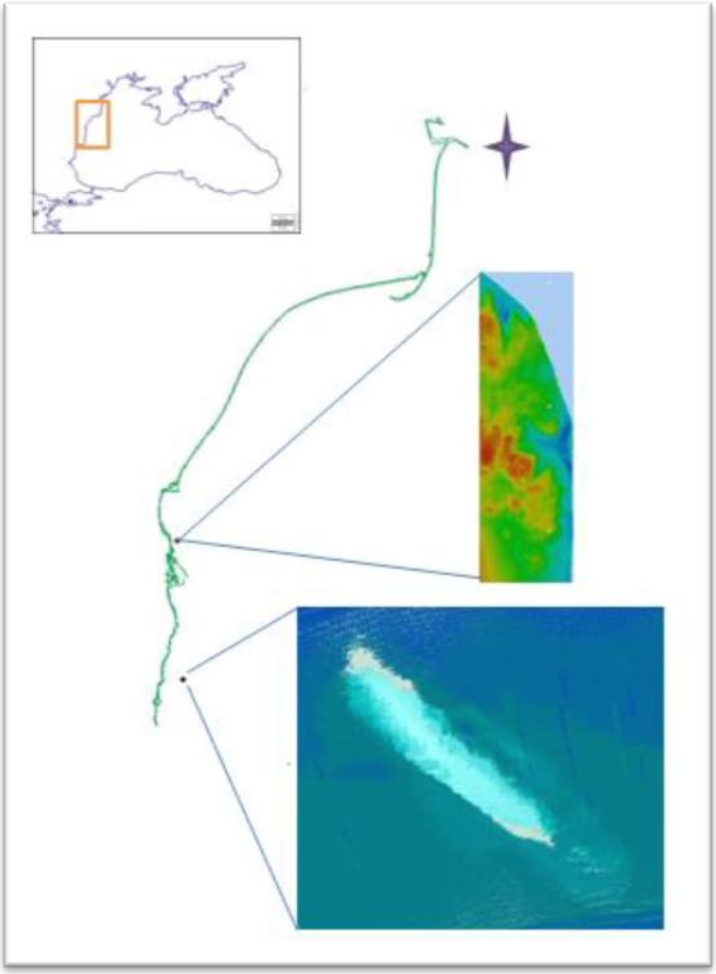

Fig. 3 Areas ensonified with MBES from the southern Romanian Black Sea (HDPPost software)

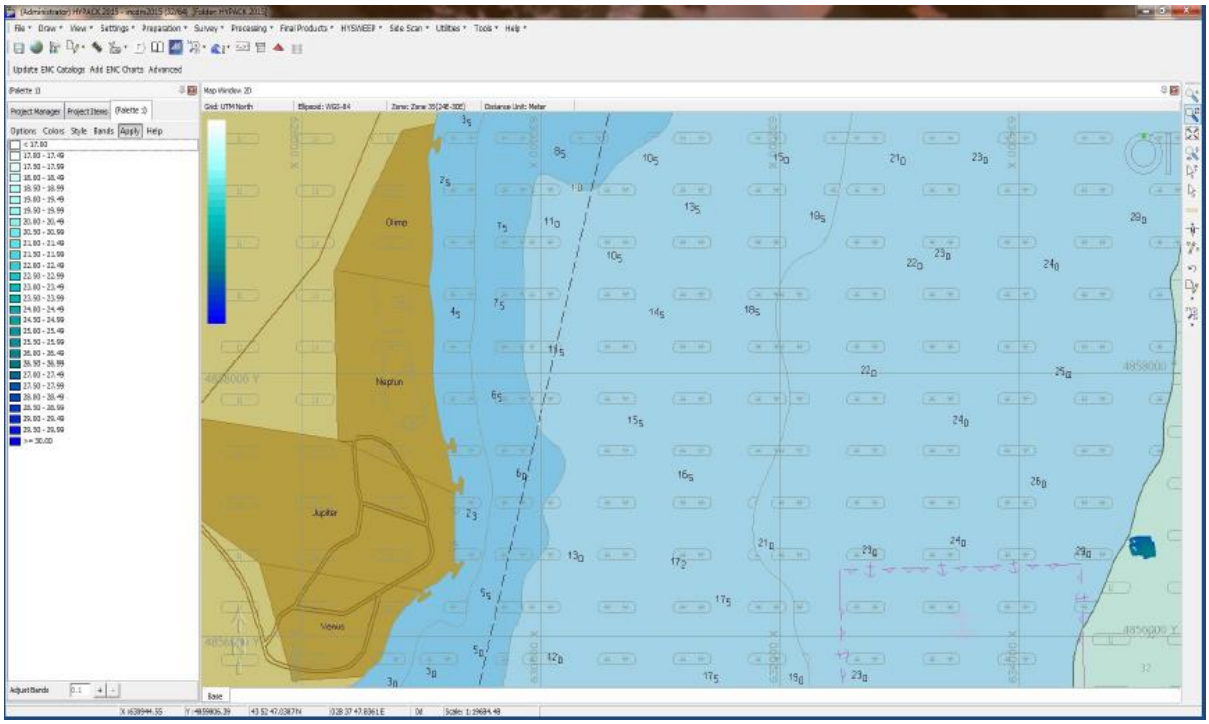

Fig. 4 Slope map in front of Cape Aurora and area ensonified with MBES (dark blue)

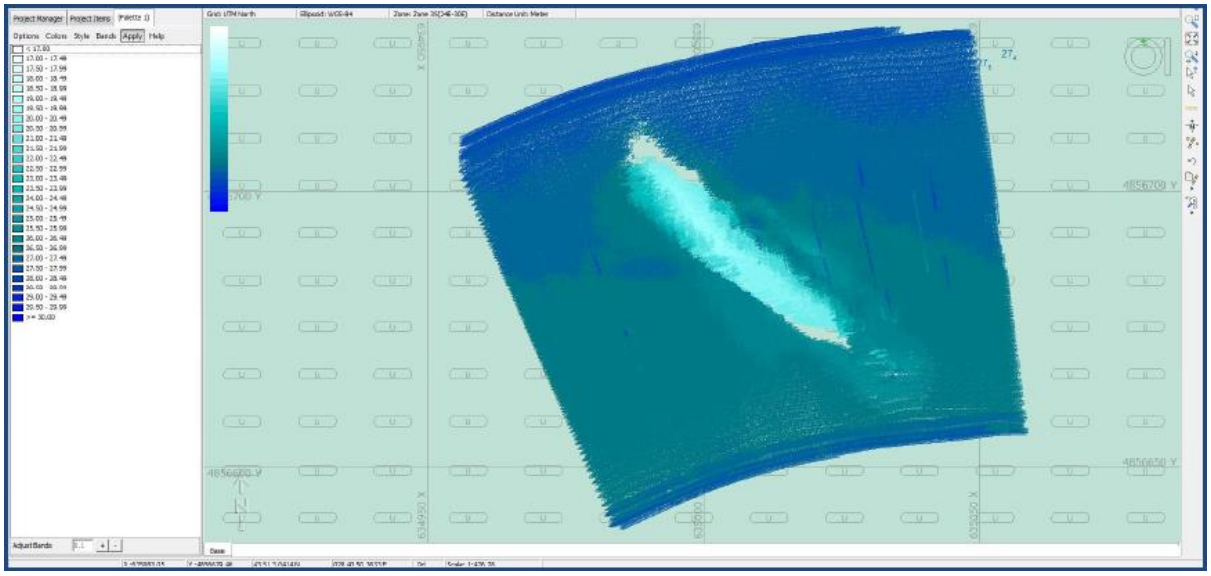

Fig. 5 MBES map of the experimental site

After completion of the bathymetric mapping and analysis, the areas of potentially different bottom substrate were identified based upon assumptions regarding bathymetrically related substrate distribution, and the survey transects were selected and examined taking in consideration pre-determined substrate categories, obtained with side-scan, and also the closely clustered acoustic characteristics (energy of the first bottom echo) which permits unsupervised classification identifications, through approximation with areas producing similar measurements are classified as a bottom type, without assigning specific physical characteristics to the class. The examination of several interest areas resulted in the selection of certain common sediment/rocky types without vegetation.

Until October, 2011, the only information about the bathymetry of the present day MPA "Complex Ropotamo" was the official maritime navigation charts in scales of 1:200,000 and

1:100,000. In October, 2011 a reconnaissance multibeam survey was performed by IO-BAS. In 2013 three survey campaigns using multibeam sonar system SeaBat 7111 as a main survey tool, connected with the CoCoNet Project were performed: 2 dedicated to mapping program of CoCoNet Black sea pilot area and under the national contract with MEW the third one. A total of about 230 square kilometers (27% of the MPA Complex Ropotamo) were mapped with 100% coverage. In 2009, the first in Bulgaria combined airborne LiDAR survey was done under the national project E/701/08 - „Bulgarian Black Sea bathymetric LiDAR" coordinating by the Center of Under Water Archaeology (CUWA) based in town of Sozopol. The processed data (a DTM with sell of 3 m covering very shallow waters of the coastal area) was kindly provided by the CUWA for the purpose of the CoCoNet Project.

Up to now, all of the multibeam echo-sounder data have been processed, cleaned and two DTM were created: for the open sea a DTM with sell of 3 m and with sell of 2 m for the coastal area. The DTM of the coastal area was combined with both, the DTM of the open sea and with the bathymetric LiDAR data and a common DTM with sell of 3 m was produced. Based on this DTM bathymetry of the studied area with interval of 1 m was digitized. The density and accuracy of the data allow plotting charts in a scale of less than 1:1,000.

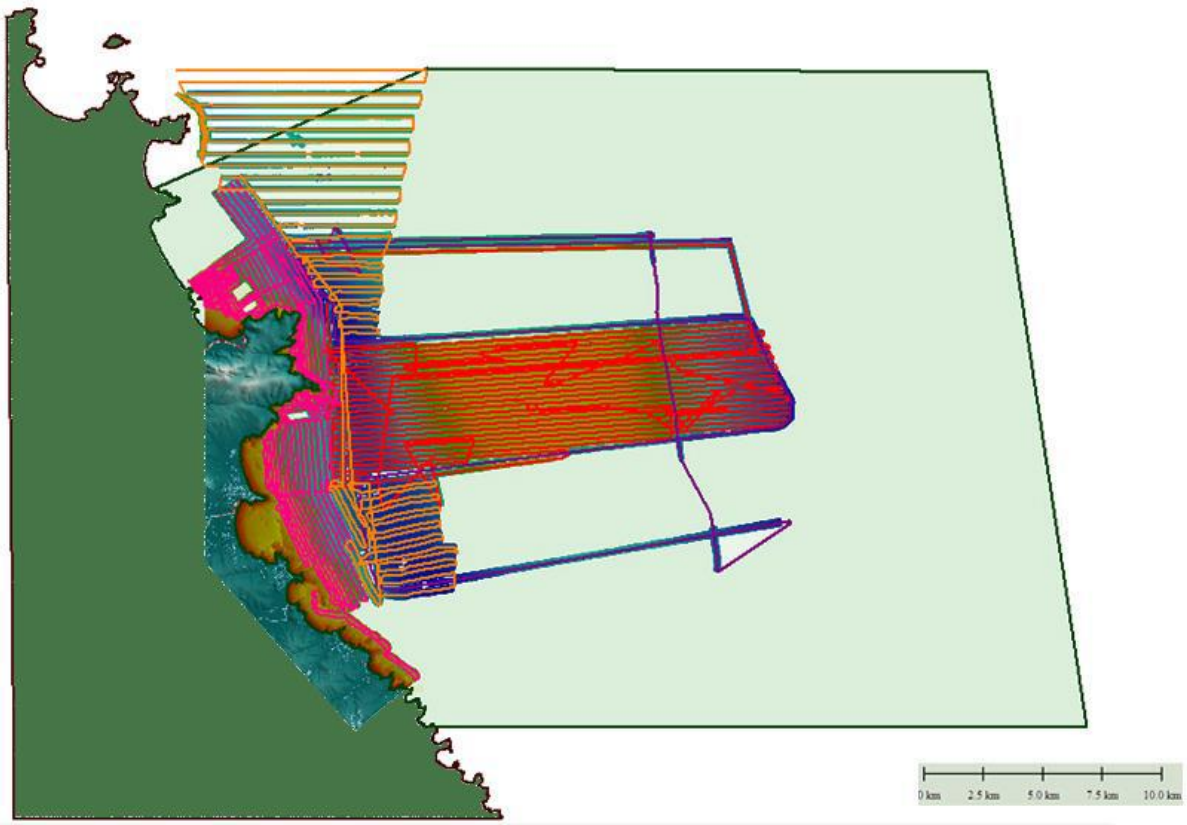

Fig. 6. A scheme showing multibeam data coverage with line tracks and LiDAR data.

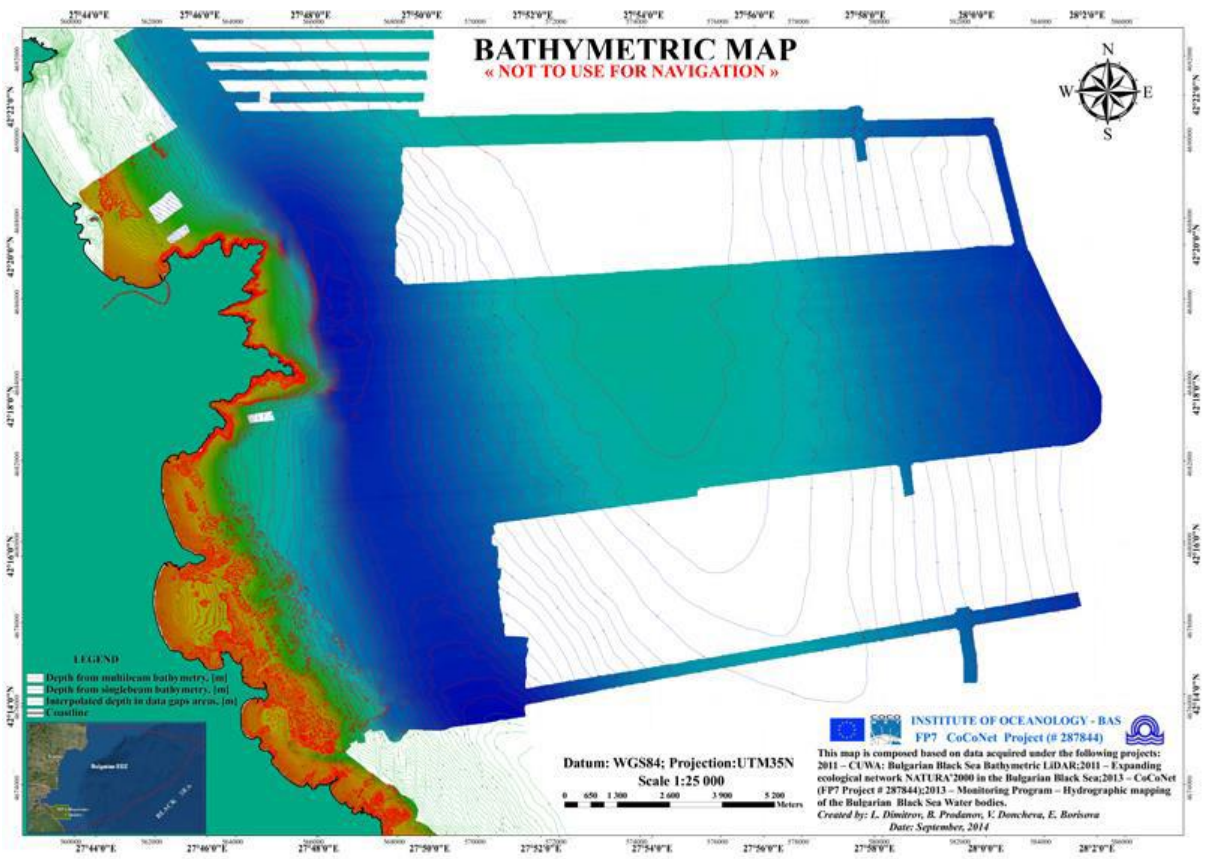

Fig. 7 Bathymetric map of the Ropotamo-Kiten pilot area

Backscatter mosaics

The seafloor backscatter is defined as the amount of acoustic energy being received by the sonar after a complex interaction with the seafloor. This information can be used to determine bottom type, because different bottom types "scatter" sound energy differently. For example, a softer bottom such as mud will return a weaker signal than a harder bottom, like rock. Backscatter data were collected in the Black Sea both with different Side Scan Sonar and Multi Beam systems.

Multibeam system logs both water depth and reflectivity at the same time. The two types of data are coregistered, meaning they are geographically referenced together, ensuring the backscatter snippet data will always be shown in the right place on the seafloor. This is an improvement over traditional sidescan sonars, where reliable positioning the data on the seafloor is more difficult. Both in acquisition and processing, backscatter imagery is typically displayed in grayscale. Multibeam backscatter has more to offer than simple practicality. Before there was the option of multibeam backscatter, sidescan sonars were used solely to determine seafloor type determination (one among many of different types of ocean research). This requires a towed instrument to acquire data from a specific point in the water column in between the ship and the seafloor. This changes what on the seafloor is ensonified because a towed body will produce shadows from looking at only one side of every object. With multibeam backscatter, there are no shadows because the sonar head is on the ship's hull and looking down over objects from a higher angle, instead of from one side or another. Both methods can offer important ways to determine bottom type but now with multibeam backscatter there is another data collection option available in the exploration toolbox.

The SIDE-SCAN images are inverted and greyscale coded as follows in this study: high backscatter values are represented by light tones, while low backscatter values are indicated by dark tones and acoustic shadows appear black on the images. Backscatter data are influenced by the angle of incidence, the sediment composition and the roughness of the seabed.

Multi beam and back scatter data integration: application on physical habitat mapping

The concept of benthic habitat mapping is derived primarily from a combination of elements that include both physical structure and dimension, and biological characteristics of specific species or groups of species under consideration. A habitat is more than substrate or structure, although these properties are undoubtedly key components for providing cover and protection for the resident fauna, because it has other supporting qualities for the target species, such as providing trophic support. The concept of sediment as a substrate should therefore not be considered as synonymous with the concept of habitat.

Indeed, implicit in using the term 'habitat' is the consideration of all aspects of an organism's life history, including how a particular location meets these needs relative to substrate, water quality, and cover. In this framework, the geological characterization of the seafloor in terms of seabed morphology, sediment grain size, and sediment dynamics, represents the first key step for classifying and mapping marine habitats.

The acoustic survey methods record information relating to seafloor bathymetry, acoustic backscatter strength, or a combination of these two features, and from the integration of these primary data sets we can generate wide scale seafloor physical habitat maps.

All Black Sea pilot areas are situated entirely within the confines of the continental shelf, with no prominent geological and sedimentary features. Consequently, a geomorphological map of the area was not produced.

Conclusion. Where available, the integration of multi beam bathymetry and backscatter data revealed to be effective for mapping of physical habitat at mesoscale in the pilot project areas. We analyzed bathymetric data to derive the geomorphologic features relevant to habitat and the backscatter data to extract the substrate composition. We applied the hierarchic legend designed within WP2 for features classification producing the GeoLevel and the Substrate Level as independent layers.

Task 6 - Impacts of OWF development on wild-life in the selected sites.

This deliverable consists of the identification of Economic Instruments (EI) that can be used in Marine Protected Areas (MPAs) in order to provide insights for their use in current management in the Mediterranean and Black Seas.

For this purpose, the work consists of three steps:

i) the identification of the most relevant literature on marine economic instruments per geographical area;

ii) the review and recording of the relevant information from these case studies; and

iii) the calculation of a marine index to compare the performance of the different economic instruments. As a result, we provide recommendations for the incorporation of economic instruments into MPA management in the Mediterranean and the Black Seas.

Economic Instruments are defined as instruments that operate through market processes or other financial incentives. We provide in the following sections a comprehensive list of economic instruments that can potentially be used in MPA management.

This includes a description and examples for each. The objective of this deliverable is to show consistent evidence of the performance of economic instruments for MPA management in the Mediterranean and Black Seas. For this purpose we have developed a methodology that allows us to conduct a systematic review of the literature (Section 2) and to identify potential studies to be analyzed in more detail.

We also identify the main criteria to be explored in order to assess the performance of the economic instruments. In total, 88 studies were retrieved that were relevant to our work. From these, a final detailed review was conducted for 34 studies, based on the availability of the information gathered. Results are shown in Section 3, where studies are analyzed together by instrument type. We look specifically at the following criteria: equity, efficiency, effectiveness and feasibility in order to address whether different instruments are successful or not, and whether they are applicable to the Mediterranean and Black Sea marine management, and specifically, protected areas. We finish in Section 4 with the conclusions of the analysis and ideas for improvements and further research.

Subtask 6.7. **Report on analysis of MPA cost/benefits using TEEB methodology**

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Institutions: Basque Centre for Climate Change (BC3); Tecnologia & Ricerca, Stazione Sperimentale per lo Studio delle Risorse del Mare (COISPA); Consorzio Nazionale Interuniversitario Per Le Scienze el Mare (CONISMA); Nature Bureau (NCB); National Institute for Marine Research and Development "Grigore Antipa" Constanta (NIMRD); Institute of Marine Biology, Ukraine (IMB).

For the purposes of the study, we develop our research in one region in the Mediterranean (the Adriatic Sea), and one region in the Black Sea (the Danube Delta). Both areas are very different and comparisons will be hard to make. While in the Adriatic, many MPAs exist, the Danube Delta is an international Biosphere reserve so it's a single protected area although transboundary.

In the socioeconomic tasks of CoCoNet EU Project, the Deliverable 6.7 is expected to produce the final output from the work done in task 6.1 that focused on the socio-economic aspects of MPAs in the Mediterranean and the Black Sea.

The overall **objective** of this deliverable is therefore to elucidate economic tools (incentives and disincentives) encouraging the designation of MPAs and sustainable resource management in the Mediterranean and the Black Sea. These results will form the basis for developing an analysis on management options, which will in turn feed in to the guidelines for MPA network management and monitoring in WP6.

The data gathered on stakeholder's interviews about their priorities for sustainable management of economic activities in the marine and coastal zone (D6.1), together with the development of a Marine Economic Instrument Index (D6.4) is combined to understand how we can improve management in MPAs in order to meet environmental, economic and social outcomes.

This deliverable is based on the CoCoNet, guidelines, but is adjusted to the projects process and evolution. A series of **workshops** have been conducted during these four years, where partners had the chance to discuss with experts the needs on socioeconomic management and research for MPAs, especially in the Black Sea and the Mediterranean. These workshops have guided the evolution of the tasks in CoCoNet, and evolved into the stakeholder consultation in D6.1, and the development of a marine economic instrument in D6.4. In the last virtual workshop held in December 2014 (D8.17), one of the objectives was to agree on the contents of this Deliverable 6.7 on Costs and Benefits of MPAs in the Mediterranean and the Black Sea.

As a result of the discussions, it was clearly stated by a number of interventions that t**he approach should go beyond the traditional cost-benefit analysis, which is purely economic, and try to integrate a broader set of indicators**. It was suggested that this is possible with **Multi-criteria methodologies (MCA)**, such as Fuzzy Analytical Frameworks (Deliverable 8.17). Based on this outcome, the present deliverable applies a Multi Criteria Approach, as opposed to a purely economic cost-benefit analysis. The advantages of a Multi-Criteria Approach is that 1) it allows for the analysis of MPA management from different perspectives, named environmental, social and economic; 2) we can study and rant the set of economic indicators reviewed in D6.7; 3) it is possible to apply the method in the Mediterranean and the Black Sea by conducting stakeholder interviews building on the work done in D6.1.

The comparison of economic instruments based on environmental, social and economic criteria offers a much richer perspective in order to help MPA management and adapt the best options to the goal of a given MPA. A multi-criteria analysis offers a flexible framework that is needed given that MPAs in Southern European waters have different ways of operating, vary in design and purposes, and since stakeholders have different perspectives in the regions analyzed. As a consequence, an economic instrument that is good in one area may not be in the other, and the choice of economic instruments may change as well depending on the aim of the MPA. The results presented in this deliverable show these complexities and provide some guiding to understand the effects of implementing economic instruments in MPA management in these areas. This will elucidate economic tools encouraging the designation of MPAs and sustainable resource management.

For the purposes of the study, we develop our research in one region in the Mediterranean (the Adriatic Sea), and one region in the Black Sea (the Danube Delta). Both areas are very different and comparisons will be hard to make. While in the Adriatic, many MPAs exist, the Danube Delta is an international Biosphere reserve so it's a single protected area although transboundary.

The Adriatic and the Ionian Sea, linked by the Strait of Otranto, represent a significant maritime zone in Europe due to their central position in the northern Mediterranean. Furthermore, the configuration of two connected seas, the presence of a strait and the variety of coastal landscapes (formed by islands and peninsulas) make it a complex area, characterized by the inequity of coastal countries in terms of experience, technical capacity, financial resources and know-how.

As occurs with enclosed seas, the management of the Adriatic Region involves cooperation of coastal states, and especially with the prospect of enlargement of the European Union, which could lead to an increase in the development of all economic activities and further exacerbate the pressures which are already being faced by coastal and marine areas. Previous work in CoCoNet illustrated the amount of economic activities that coexist in the Adriatic, highlighting economically important uses such as maritime traffic, off-shore wind farm projects, coastal tourism, artisanal and industrial fishing.

Lessons learnt from D6.1 on the Stakeholder Analysis of the socioeconomic impacts of MPAs in the Adriatic case study are helpful for the design and analysis of the present deliverable. Stakeholders interviewed came from the artisanal fisheries sector (22%), followed by industrial fisheries (17%) and conservation and management (11 and 14% respectively). Results from this consultation illustrated that fishing activities (in particular industrial and recreational) are believed to be poorly managed by the majority of the respondents. Other activities, including enforcement and control, and marine conservation are also believed to be poorly managed by the majority of the respondents. On contrast, scientific research, tourism, and recreational activities were relatively well or sufficiently managed in the region.

In addition, people were asked to indicate and describe the major weaknesses and difficulties related to the management of the different sectors. From the results, we can highlight management problems related to fishing, including the fragmentation of the sector and its complicated management, the lack if effective management plans the lack of spatial planning and the lack of coordination among actors. Other problems are related to access to fishing markets for the artisanal fleet, the problems with control and enforcement and the competition with recreational fishing (which includes hidden illegal commercial fishing).

It was clear from the questionnaire that the fishing fleet is conflicting with artisanal fleets in the area and an excessive effort together with lack of management plans and non-compliance is leading stocks to overharvest. Based on this evidence, property rights over fishing could be an interesting economic instrument to explore in the area.

Another outcome from this previous questionnaire was that tourism in MPAs is putting a lot of pressure in sensible places and there is increasing urbanization of the coastline and crowding effects in MPAs. Charge systems seem to be a potential economic instrument to address these problems in the area.

In the area, there are other economic activities which are impacting the marine environment. Aquaculture is seemed to lack clear rules to release concessions, and to lack development and management plans that guarantee the sustainability of the activity. In relation to this, there is a lack of 'voice' in products marketing and trading, incapacity to face foreign markets. On the other hand, extractive activities are highly impacting and not always a proper environmental restoration is guaranteed after extractive activities. New regulations and instruments are needed to sustainable address extractive and productive uses of the marine environment in the area. Taxes for environmental compliance and performance could be a potential solution as well as subsidies for good environmental practices.

In relation with the above results, respondents were directly asked to list which activities, plans or development options might be especially desirable for their sectors of interest. Their answers included:

i) the extension of MPAs, increase in participatory processes in fishing management plans;

ii) the modernization of fishing sector, sustainable development in fishing areas, better management and rationalization of fishing activities;

iii) the development of local management plans for fisheries, in accordance with the Common Fishery Policy; and

iv) the improvement of fishery products trading and marketing, limiting imports of foreign fishing products.

Work done in CoCoNet on economic instruments can also help us understand the case study area. From the literature review on economic instruments worldwide conducted in Deliverable 6.4, a few example emerged in the Mediterranean Sea. The majority of instruments are addressed towards tourism regulations, such as *entrance fees* to protected areas, and *user fees*, for example for fishing boats and shore recreational fishing cruises. But there are also financial instruments like grants and sponsorship for marine conservation initiatives and effectiveness in MPA management to NGOs and managers. Regarding property rights, there are some concessions fomenting stewardship of marine resources. And for taxes, there are green taxes mechanisms for conservation as well, taxes on tourism (accommodation), activities (fishing, hunting, resource extraction) (Deliverable 6.4).

Danube Delta Biosphere Reserve (DDBR) (Black Sea)

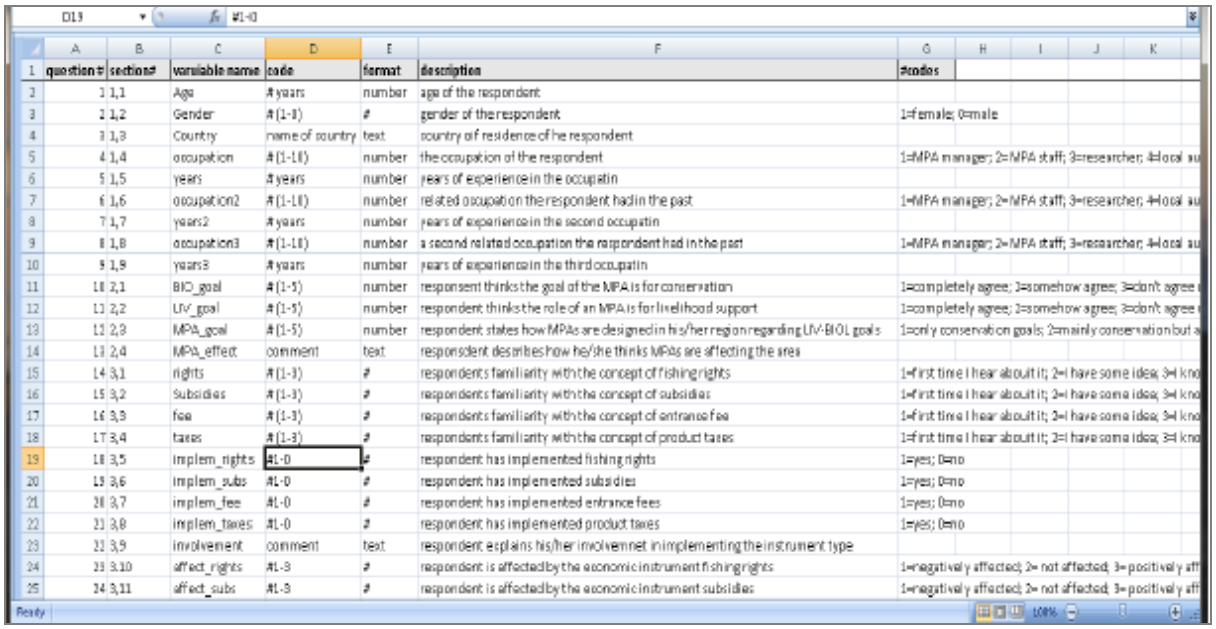
The Danube Delta Biosphere Reserve covers a total area of 564,000 hectares, 122,000 ha within Ukraine and 442,000ha in Romania. The Delta Biosphere Reserve is the 22nd most extensive reserve worldwide and the third one in extension in Europe. The Danube Delta has one of the greatest seabed extensions of red algae and is one of the largest wetland area for birds in the region. The main competing economic uses in the Danube Delta include fishing, tourism, and also agricultural practices in the delta and forestry. The local people of the Danube delta have traditionally used the area for cereal and other crops, and for cattle. The agrarian activity is based on environment authorizations for the dry lands and temporary dry lands in the Delta. Forests are concentrated in the fluvial delta and mainly produce timber, mushrooms, medicinal plants and hunting services. These activities only suppose a small fraction of the labour force in reserve. The hunting of species at the Reserve is still an existing activity hat is regulated.

The work done in Deliverable 6.1 on the stakeholder analysis on the Danube Delta provides some interesting insights that in which we base the following work on the region. The consultation gathered stakeholder's perceptions on the different activities that can be developed in the future, and responses vary between Ukraine and Romania.

In Ukraine, respondents suggest developing rules that would allow the development of sustainable fisheries and avoid certain conflicts between amateur fishermen and locals which already occur. Respondents believe that measures should be taken in the area to increase fishermen income level and revenues from fishing. On the same hand, a simplification of border procedures, as well as a greater involvement of the authorities in solving of the problems of tourism, could full guarantee of nature conservation, against land privatization. Respondents perceive tourism as a very important economic activity in the area and are willing to promote tourism in the area. They state that a reduction on tourism taxes and the development of new tourism infrastructures, especially roads and other means of communication are extremely necessary measures to develop in the area in the short term.

In Romania, respondents would like in the future to increase conservation, including the number of MPAs and the area covered. They also want to promote to a certain extent marine renewables, tourism and recreational activities in the area. Current fishing rates are seen as sufficient, and extractive uses of the marine environment should decrease in the future. A number of regulatory and legal barriers where identified and respondents also stated the necessity to have clearer and simpler regulations and laws as well as having a unique supervising and executive management authority that would intercede between existing local authorities.

Economic Instruments in Place:



question #	section#	variable name	code	format	description	#codes
1	1,1	Age	# years	number	age of the respondent	
2	1,2	Gender	# (1-0)	#	gender of the respondent	1=female; 0=male
3	1,3	Country	name of country	text	country of residence of he respondent	
4	1,4	occupation	# (1-10)	number	the occupation of the respondent	1=MPA manager; 2=MPA staff; 3=researcher; 4=local au
5	1,5	years	# years	number	years of experience in the occupatin	
6	1,6	occupation2	# (1-10)	number	related occupation the respondent had in the past	1=MPA manager; 2=MPA staff; 3=researcher; 4=local au
7	1,7	years2	# years	number	years of experience in the second occupatin	
8	1,8	occupation3	# (1-10)	number	a second related occupation the respondent had in the past	1=MPA manager; 2=MPA staff; 3=researcher; 4=local au
9	1,9	years3	# years	number	years of experience in the third occupatin	
10	2,1	BIO_goal	# (1-5)	number	responsent thinks the goal of the MPA is for conservation	1=completely agree; 2=somehow agree; 3=don't agree
11	2,2	LIV_goal	# (1-5)	number	respondent thinks the role of an MPA is for livelihood support	1=completely agree; 2=somehow agree; 3=don't agree
12	2,3	MPA_goal	# (1-5)	number	respondent states how MPAs are designed in his/her region regarding LIV-BIOL goals	1=only conservation goals; 2=mainly conservation but a
13	2,4	MPA_effect	comment	text	responsdent describes how he/she thinks MPAs are affecting the area	
14	3,1	rights	# (1-3)	#	respondents familiarity with the concept of fishing rights	1=first time I hear about it; 2=I have some idea; 3=I kno
15	3,2	Subsidies	# (1-3)	#	respondents familiarity with the concept of subsidies	1=first time I hear about it; 2=I have some idea; 3=I kno
16	3,3	fee	# (1-3)	#	respondents familiarity with the concept of entrance fee	1=first time I hear about it; 2=I have some idea; 3=I kno
17	3,4	taxes	# (1-3)	#	respondents familiarity with the concept of product taxes	1=first time I hear about it; 2=I have some idea; 3=I kno
18	3,5	implem_rights	#1-0	#	respondent has implemented fishing rights	1=yes; 0=no
19	3,6	implem_subs	#1-0	#	respondent has implemented subsidies	1=yes; 0=no
20	3,7	implem_fee	#1-0	#	respondent has implemented entrance fees	1=yes; 0=no
21	3,8	implem_taxes	#1-0	#	respondent has implemented product taxes	1=yes; 0=no
22	3,9	involvement	comment	text	respondent explains his/her involvemnet in implementing the instrument type	
23	3.10	affect_rights	#1-3	#	respondent is affected by the economic instrument fishing rights	1=negatively affected; 2= not affected; 3=positively aff
24	3,11	affect_subs	#1-3	#	respondent is affected by the economic instrument subsidies	1=negatively affected; 2= not affected; 3=positively aff

Fishing Rights

- Family fishing permits. This permission validate for inhabitants and have the right to fish up to 3 kg each day/per family member or a single fish exceeding 3 kg, for their own consumption. The Biosphere Reserve issues the family fishing permits and eligibility criteria refer only to the residence of the family/person: to be registered in the Danube Delta. A family fishing permit is a personal document, non-transferable, issued for an undetermined time period, for a determined fishing area, that is verified on annual basis. The law also stipulates the only gears allowed (2 rods, or 2 gillnets, or 2 pots). Water areas where family fishing is allowed are administrated by local authorities (municipalities). The activity of family fishing is a right awarded to the local resident families in the Danube Delta, in order to secure a living standard for the inhabitants (EC, 2006).

- Sport fishing license (sport fishing permit). This type of license validates amateurs represented by individual fishermen. This type of license is issued by sports fishermen associations legally established for recreational/leisure purposes. Also, tourists that occasionally fish in the Danube Delta need such a permit. The legislation also stipulates that the allowed amount of fish catches per day is up to 5 kg or one fish exceeding 5 kg, per sports fishing permit. The National Agency for Fisheries and Aquaculture issues permits also specifying the allowed gears (EC, 2006).

- Permit for professional fishermen (commercial fishing permits). On 2009 the total number of registered employees in the fisheries sector working for registered companies must be added to the 1,500 self-employed professional fishermen. In order to become a professional fisherman a person has to attend a course of fishing and submit a set of papers to obtain a permit issued by Danube Delta Biosphere Reserve Administration (EC, 2006).

Entrance fees

- Permits for boats/ships access (EC, 2006).

-Tourists entrance fees to the biosphere reserve.

Subsidies

- Subsidies for water transport. Development of the transport is necessary for fishery and aquaculture development (EC, 2006).

- Subsidies for development of basic level of endowment. The costs for electricity and water consumption are very high, due to the isolation (EC, 2006).

- Financial support (subsidies). The main form of subsidizing is represented by environmental fund, created to directly finance environmental protection (Belacurencu, 2007).

Market creation

In order to improve the local market it has been proposed to set an online fish auction project, developed under public-private partnership. The purpose of the auction is to enable free competition on the local market, with direct impact on poaching and monopole prices at second fish sale level. Fish is currently traded mostly on the black market, and the people trading fish are guilty of tax evasion. In the absence of a regulated market, the fishermen sell the fish at a very low price dictated by the fish collecting centre in the vicinity of its fishing area. In order to regulate the market, several measures are proposed under the project: the fish will be recorded in fish collecting centres, also through tax documents, and an online auction will operate in Tulcea or other locality near the Delta. This new market organization will generate competitive prices, increased revenue for fishermen and reduced black market, increased quality of monitoring and additional revenues from the state budget. The project is was pre-feasibility phase in 2010 (EC, 2006).

- Green label (eco-label). It is used for tourism and local goods (Belacurencu, 2007, NF, 2009). Urgent Ordinance of Romanian Government no. 91/2000 that introduced a methodology for implementing the basic principles and recognition of products with low impact on the environment (Belacurencu, 2007).

Taxes

They represent direct payments for use of a resource, for a waste treatment service or for pollution reduction by an institution or a public organization. The most usual are the dues for natural resources, used water treatment taxes, domestic waste collection. This kind tax depends on the volume and poured substances characteristics (Belacurencu, 2007).

- Administrative taxes. The authorisation taxes for the organisation and the carry on of some economical productive activities, for tourism and entertainment on DDBR territory, established by Tulcea County Council, on the bases of the founded proposal of Danube Delta Biosphere Reservation Administration. These taxes are justified and approve annually (Belacurencu, 2007).

- Tax cancellation. In case of unleaded gasoline let the price of this to be lower than the common gasoline, encouraging the use of this clean fuel by the inhabitants and the tourists come in the Danube Delta, for fishermen boats and especially for recreational crafts which are in a great number and of high power (Belacurencu, 2007).

Financial instruments

- Investments (from the national budget). It is made in the last 10 years (1990 - 2001) for the improvement of the ecological conditions in the natural fish and reed culture complexes from Danube Delta Biosphere Reservation. Nowadays, it is used for environmental protection (Belacurencu, 2007). Also it is investments in tourism, development to birds watching, environmental reconstruction of agricultural land, etc. (EC, 2006).

- Investments of the concessionary companies. They make investments concerning the resource protection, to provide its regeneration and to make adjacent investments of the resource exploitation process (Belacurencu, 2007).

Methodology

The proposed methodology is to perform a Multi Criteria Analysis (MCA) following the Non-Structural Fuzzy Decision Support System. The Non-Structural Fuzzy Decision Support System (NSFDSS) (Chen, 1998; Tam et al., 2002a; 2002b; Tam et al., 2006) is a multiple criteria decision analysis (MCDA, e.g. Belton and Stewart, 2002; Leung, 2006) tool, belonging to the methods of deterministic preference modelling. NSFDSS is used for ranking a set of possible decisions on the basis of agreed-upon decision factors; this problem-solving technique is often employed for integrating and supporting expert judgements and also as alternative to other decision-aiding models (i.e. AHP).

The NSFDSS requires, as other MCDA tools, that the problem is structured in different steps: decomposition, comparative judgement and synthesis of priorities.

Thus, first a goal is outlined then a decision tree is built moving downward to the lower levels to reaching more specific decision factors (figure 1).

The **decision factors (level 1)** or criteria deemed to be important for contributing to the goal are thus elicited, belonging to different domains. Each criteria can be measured by one or more indicators. Then, a number of different **alternatives (level 2)** are also defined to reach the goal. A respondent will face the problem in such a way that she or he has to do pairwise comparison between alternatives, according to how each of the alternatives meets the criteria by means of the indicator given. For example, a respondent comparing taxes with subsidies. If the criteria are economic, the respondent will have to decide what alternative (taxes or subsidies) leads to more economically efficient outcomes.

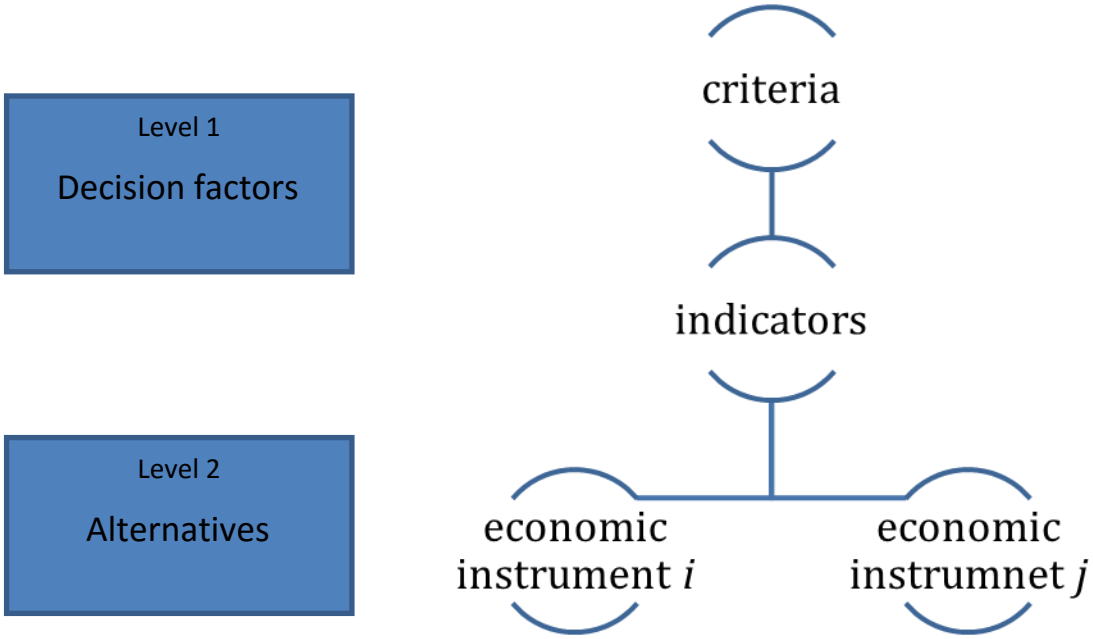


Figure 1. Structure of the MCA Fuzzy design

Comparative judgment is applied to construct pairwise comparisons of the relative importance of elements on a given level. These alternatives are scored against each decision factor and then pairwise comparison is made also between decision factors. The third step is the synthesis of priorities. Local priorities are multiplied by the priority of their corresponding criterion on the level above and then weighted by means of classification of criteria "built" by the stakeholder, constructing a sort of composite priority.

Among the MCDA techniques, the NFSDSS modelling has the advantage, compared to similar methods, of a major accuracy of the solution, because of automatic consistency checking (Tam et al., 2006). In addition NFSDSS allows the improvement of expert judgements analysis by the integration of fuzzy set theory and semantic operators (Chen, 1998; Tam 2002a; 2002b); a further strength is that stakeholder has only three possible answers to give: prefer A to B, prefer B to A; A and B are equally important. This simplifies the decision process and may reduce errors.

This Deliverable applies the Non-Structural Fuzzy Decision Support System methodology in order to evaluate the perception of stakeholders about the potential of the Economic Instruments for MPAs explored in Deliverable 6.4 using a specific set of indicators.

The reference for the Economic Instruments is the Deliverable 6.4, where we looked at: 1) Property rights; 2) Market creation; 2) Fiscal instruments; 4) Charge systems; 5) Financial instruments; 6) Bonds and deposit refund systems; and 7) Liability systems (Figure 2).

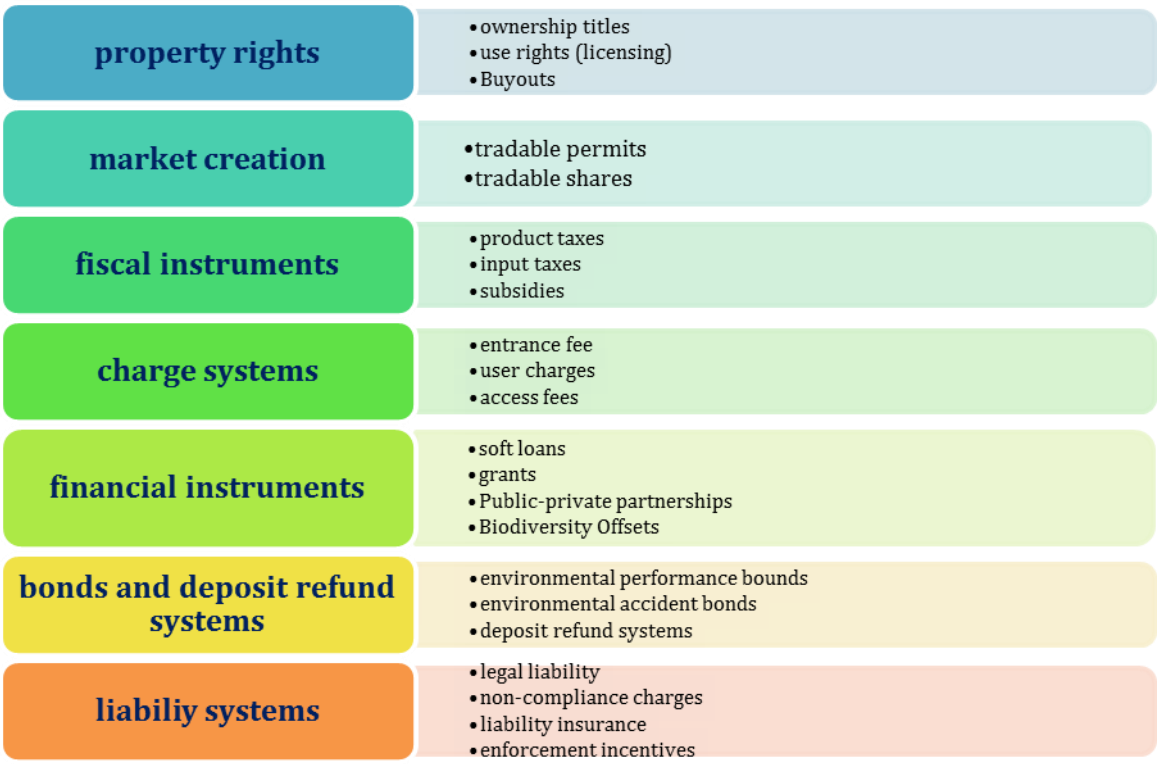


Figure 2. List of Economic Instruments

Additionally, the set of indicators already used also in Deliverable 6.4 were: Effectiveness; Economic efficiency; Equity; Community acceptability; Participation. Since all 7 instruments and 5 criteria would lead to a very extensive set of choices for the fuzzy approach, the first part of the analysis is on the design of the Fuzzy approach. We need a number of combinations of alternatives that can be answered by a single stakeholder, without compromising the reliability of the response due to, for examples, fatigue effects from questionnaires that are too long.

Deliverable 6.4 on the analysis of economic instruments for MPA management showed that there are some instruments that can potentially perform better than others in the Mediterranean and Black Sea MPA context. This performance was measured with indicators on efficiency, effectiveness, equity, community acceptance and participation. The resulting best performed economic instruments are charge systems, market creation and Property rights instruments. Financial instruments and fiscal systems result in lower scores.

With this objective in mind, the methodological steps or tasks that we follow in this deliverable are:

- *Task 1. Identification of Criteria and relevant economic instruments:* from the set of criteria and economic instruments from D6.4, we select a subset of criteria and economic instruments that allows us to design a suitable questionnaire and perform the analysis. Economic instruments will be presented as a way to obtain effective conservation.
- *Task 2. Stakeholder identification:* partners are asked to deliver a list of relevant stakeholders in the case study areas. Following previous work where stakeholders have been identified, this task aims to update the lists and expand them if possible.
- *Task 3. Survey design:* A survey is designed in order to provide the stakeholders on each of the case studies with a series of options that they will rank. The survey has been designed in English and partners have translated it to local languages from the case study areas. As a result, the questionnaire has its version in Russian for Ukraine, in Romanian for Romania (both in the Danube Delta region), and to Italian for the consultation in the Adriatic (see annex A for the English version of the questionnaire).

- *Task 4. Questionnaire implementation:* the questionnaires, once translated and pretested by coconet WP6 researchers, are distributed by email using the stakeholder list from Task 2. Surveys were conducted in between august and September 2015.
- *Task 5. Multi-Criteria Analysis:* Results from the questionnaires are collected and coded into a common database for all the responses. The data is then analyzed to understand the priorities in conservation of MPA networks in the Mediterranean and Black Sea case studies.

Identification of Criteria and Indicators

Were identified a set of criteria according to which different economic instruments will be rated in terms of their capability to comply, with the ultimate goal of enhancing conservation and livelihood systems in MPA networks. The criteria were selected based on expert judgement between a series of exchanges among WP6 researchers, and the questionnaire design requirements regarding size and number of combinations. The selected criteria fall into three groups: economic, environmental and social. Each criteria can be measured using one single indicator. Table 1 summarizes the criteria and the indicators, and includes a definition of the criteria and examples of how the different instruments can fall under it.

Table 1. Set of criteria and indicators used in the questionnaire design.

Criteria	**Indicators**	**Definition**	**Examples and more information**
economic	Efficiency	An instrument will be economically efficient if it can achieve the expected outcomes (enhancing conservation and livelihood systems in MPA networks) at the lowest possible economic cost.	If an entrance fee is enforced by a park, the infrastructure and surveillance required will have costs. The benefits of the measure therefore should overcome the economic costs.
environmental	Effectiveness	Relates to whether the economic instrument is technically suitable for achieving MPA conservation and whether it will deliver a desired target contributing to the sustainable management of the area.	An entrance fee may be set to control access within the carrying capacity limits, so the instrument will be effective if it succeeds to do so.
social	Equity	Examines the distribution effects of a policy instrument in terms of who bares the costs and who enjoys the benefits. It refers to an equitable distribution across social groups at present and across generations in the future.	A property rights system is distributive if it does not leave social groups out of the benefit sharing, for example poor fishermen without access rights, or women. Costs should also be collectively assumed, on a just manner.

The compliance of each instrument with each criterion is measured by the stakeholders, who will rate the instruments. The resulting scheme for the questionnaire regarding the fuzzy approach is summarized in Figure 3. The goal set for the economic instruments is to "enhance conservation and livelihood systems in MPA networks. At Level 1 the criteria to rank instruments are economic criteria, environmental criteria and social criteria, as defined in Table 1. Each of the criteria has a single indicator, efficiency for the economic criteria, effectiveness for the environmental criteria, and equity, for the social criteria. At Level 2, the economic instruments are presented and respondents face pairwise comparisons (see Annex A).

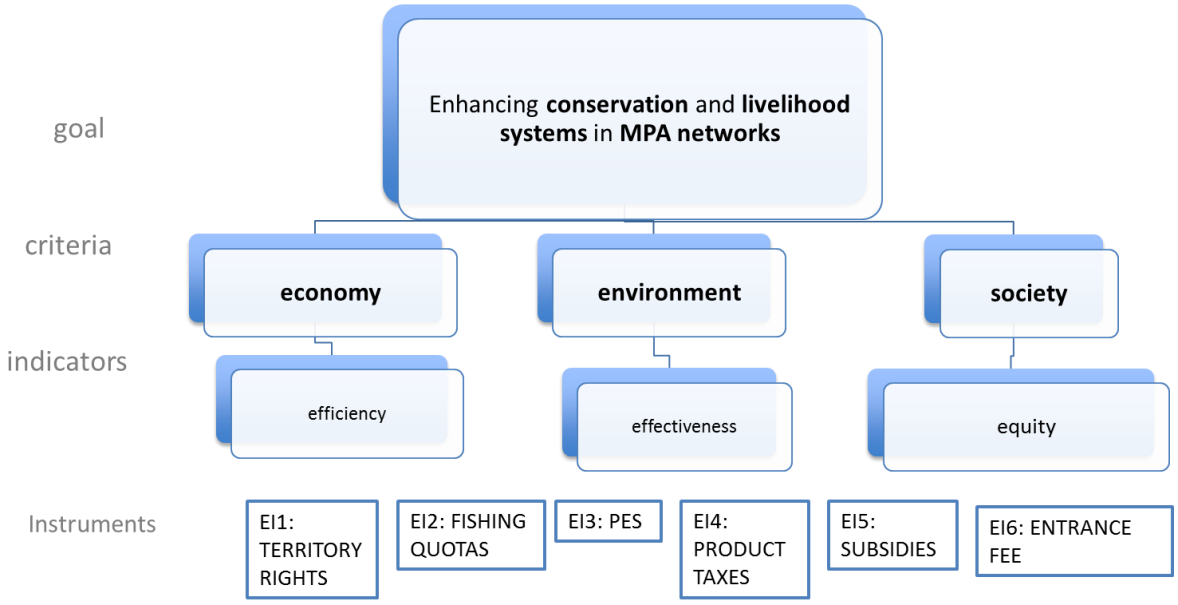


Figure 2. Final design of the Fuzzy Approach for the questionnaire design.

Identification of the Economic instruments

Based on an exhaustive literature review (presented in the deliverable 6.7) on the use of economic instruments in marine management decisions, with a particular focus on the Mediterranean and Black Sea, we have identified six major categories of economic instruments that can be useful for MPA management (table 1 above). From these, a sub set of economic instruments needs to be selected in order to apply the Fuzzy Multi-criteria analysis in the case study areas.

The criteria for selecting the economic instruments was the following: 1) we chose the instruments that ranked best in Deliverable 6.4, based on the literature review, and from these 2) we presented the expert partners a choice of economic instruments for their case study area. This way, economic instruments that perform relatively well in the literature are selected on a first phase, leading to a subset of 6 instruments: territory rights, fishing quotas, PES, product taxes, subsidies and entrance fees.

On a second phase, researchers provide their perspective on the use or potential use of the 6 economic instruments pre-selected, in their regions, and in particular concerning the case study areas. From this procedure, we end up with 4 economic instruments that are applicable to both the Mediterranean and the Black Sea case study areas (Table 2). The final set of instruments is: fishing rights (property rights); entrance fees (charge systems); taxes and subsidies (fiscal instruments).

Table 2. Economic instruments used in the questionnaire

Economic Instrument (EI) NAME	**Description**	**Category**
EI1: FISHING QUOTAS	Fishing rights are property rights given to an individual fisher or a community over a period of time in order to exploit the natural resource sustainably. The administration gives rights to fishermen to exploit the resource, but establishes guidelines that include: the fish size, quotas, gear, and/or periods for fishing	Property rights
EI2: SUBSIDIES	Subsidies are financial help given to individuals or groups of stakeholders in order to promote better environmental practices and decrease the environmental damage of their activities. For example in fishing, fishermen can have	Fiscal instruments

	subsidies on fuel costs, or in vessels and materials if they are complying with the rules established.	
EI3: ENTRANCE FEE	Entrance fee is a charge system to users of an environmental good, for example an economic fee for tourists visiting a Marine Protected Area or a Biosphere Reserve, with the aim of investing that money on conservation in the area.	Charge System
EI4: PRODUCT TAXES	Environmental taxes are set to charge users for the environmental damage of a given activity. Taxes can be on products from the area, like aquaculture and fisheries resources that will have a tax associated that consumers should pay.	Fiscal Instruments

Survey implementation

With the set of criteria and the subset of economic instruments, the final questionnaire and MCA approach is designed and tested.

The final questionnaire (fully available in Annex A) is structured in four parts:

1) About you: the questionnaire begins with questions about the respondent's background and experience in relation to MPA networks.

2) Marine Protected Area (MPA) Goals: the second part seeks to obtain information on the perceptions of the stakeholders towards the objectives of MPAs. Respondents are asked questions to understand if they believe an MPA should pursue conservation, livelihood support or both goals at the same time. They are also asked to share their views on how current MPAs in the area are performing in relation to these goals.

3) Economic Instruments for MPAs in the Case Study region: third set of questions present the four economic instruments to consider for the case study area. Respondents can state their previous knowledge on the instruments, if any. Then, respondents are asked if they have interacted with the instruments previously, and if they have been affected by then in any way.

4) Assessing the performance and potential of the instruments: the final set of questions presents the structured Fuzzy Approach, with the pairwise comparison of economic instruments. First, one criteria is introduced and described, followed by the pairwise comparisons where respondents need to choose how the different economic instruments perform respect to that criteria.

Surveys are implemented in three languages: Romanian and Russian on the Danube Delta, and Italian for the Adriatic case study in the Mediterranean. Questionnaires were sent via email to the stakeholders previously identified and responses where coded into a common database.

Results

A final sample of 50 responses was collected in a two month period, during the months of August and September 2015. The response rates were around 47% in the Mediterranean and 30% in the Danube Delta. The final sample of responses was coded into a binary database in order to conduct the MCA analysis. Surveys are being answered in Albania and Italy. Responses are being refined and anomalies and inconsistences are being analyzed in order to have a minimum biased sample.

Conclusions. Most respondents reply that MPAs should have conservation goals primarily (63%), while current MPAs are seen as not fulfilling this goal primarily. When asked whether livelihoods and social goals for MPAs are crucial, respondents affirmed they completely agree in 34%.

As a result of the questionnaire implementation, a majority of respondents have not been directly impacted by economic instruments so far, with some exceptions, mainly for fisheries rights (25%) and charge systems (20%).

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