



# Policy-oriented marine Environmental Research in the Southern EUropean Seas

## Reporting

### Project Information

PERSEUS

Grant agreement ID: 287600

Status

Closed project

Start date

1 January 2012

End date

31 December 2015

Funded under  
FP7-ENVIRONMENT

Overall budget  
€ 16 994 500,54

EU contribution  
€ 12 973 123,40

Coordinated by  
**HELLENIC CENTRE FOR  
MARINE RESEARCH**  
 Greece

## Final Report Summary - PERSEUS (Policy-oriented marine Environmental Research in the Southern EUropean Seas)

### Executive Summary:

The PERSEUS project created an effective and innovative research-based governance framework able to bring together the scientists and decision-makers and the public to support the Good Environmental Status (GES) across the Mediterranean and the Black Sea (Southern European Seas-SES). The main objectives were to: a) identify the interacting patterns of natural and human pressures on the SES and assess their impact on marine ecosystems, b) develop tools for the evaluation of the environmental status using existing and upgraded monitoring and modelling capabilities, c) implement the principles and objectives of the MSFD and promote them across the SES and, d) develop a framework for future implementation of adaptive policies and management schemes.

A definition of the main pressures, processes and issues at risk in open seas and coastal areas, and an analysis of their impact were prepared for the regional basins. Studies sharing common methodologies were well-coordinated across the SES, collecting new data on pelagic and benthic ecosystems, non-indigenous species and pollution, litter and noise. Ecoregions (biogeochemical, species distribution and

pressures & impacts) in the Mediterranean Sea were defined and can be used as a tool for policy purposes. A comprehensive inventory of the SES Ocean Observing Systems, to upgrade and expand the observing capacity and address the MSFD monitoring needs was prepared, driving the vision for the creation of an integrated system of observing and forecasting systems in the SES. Models were used to provide an integrated assessment of the state of marine ecosystems of the SES, encompassing the ecosystem “end-to-end” framework, based on fundamental ecosystem properties. PERSEUS collaborated closely with the Regional Convention in the SES and helped to achieve integration by bringing together scientists and decision-makers. It contributed by giving timely and relevant scientific advice to UNEP MAP’s and BSC marine environment’s policy, by providing concrete assessment tools, models, scenarios and methodologies that can be used and enhanced at regional level. The concept and budget of an innovative small research/survey vessel for the shallow areas were also studied. The blueprints included a novel dynamic positioning and an innovative propulsion system. Compilation of information on existing environmental status assessments in EU and non-EU countries, collaboration to improve data and knowledge under the MSFD/EcAp umbrella as well as connection with stakeholders from 6 non-EU countries were among the project’s achievements. PERSEUS initiated the connection of all EU Projects

working in the SES, as their coordinators met twice (2013 & 2014), resulting in some common activities (e.g. stakeholders meetings, General Assemblies) and creating the basis of a greater collaboration. Tools were developed, to evaluate the environmental status and connect science to policy, namely the Adaptive Policy Framework (APF) to support adaptive management schemes; the Tool for the identification and assessment of Environmental Aspects in Ports (TEAP) to assist port authorities in identifying and assessing environmental aspects; the Early Warning System for Managing Oil Spills Tool to support national, regional and local authorities and; the Improvement of methodologies for data analysis of the Vessel Monitoring System (VMS) and map visualization of the spatial distribution of fishing effort. PERSEUS organised a series of Summer Schools, training courses and training visit schemes. The project’s website and the communication & outreach activities were very effective in communicating the results to scientists, policy makers and stakeholders. PERSEUS launched innovative public engagement campaigns (e.g. jellyfish spotting, litter watch, PERSEUS@schools) thus disseminating its results to the wider public, while focusing mainly on the younger generation.

#### Project Context and Objectives:

The overall scientific objectives of PERSEUS were to identify the interacting patterns of natural and human-derived pressures on the Mediterranean and Black Seas (SES: Southern European Seas), assess their impact on marine ecosystems and, using the objectives and principles of the Marine Strategy Framework Directive (MSFD) as a vehicle, to design an effective and innovative research governance framework based on sound scientific knowledge. Well-coordinated scientific and social and economic research has been applied over the course of 4 years, at a wide-ranging scale, from basin to coastal. The new knowledge that has emerged has advanced our understanding on the selection and application of the appropriate descriptors and indicators of the MSFD, while new tools have been developed in order to evaluate the current environmental status, by way of combining monitoring and modelling capabilities. To support this, existing observational systems have been upgraded and extended while PERSEUS developed a concept of an innovative, small research vessel, to serve as a scientific survey tool, in very shallow areas, where the currently available research vessels are inadequate or unable to perform, with special focus on vessel's innovative systems of positioning and propulsion.

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The overarching aim of the project was to provide a science-based platform for PERSEUS to develop new policy-oriented framework of strategic adaptive policies and management schemes, to develop tools for policy makers and to promote/ implement the principles of the MSFD across the SES. By engaging all stakeholders, scientists, policy-makers and the public, from the very beginning in a clear and structured way, it enabled a shared understanding and informed decision-making process, as an example of a key societal driver, based on concrete scientific knowledge and in reference to the MSFD as well as other key policies and initiatives (e.g EcAp). PERSEUS is thus a unique project having produced significant findings and engaging all levels of society to support Good Environmental Status (GES) accomplishment in the SES, while it conducted marine and socio-economic research at a scale and magnitude, which has not been attempted before in the Mediterranean and the Black Sea basins.

Finally, significant emphasis was given to the training and the communication of the project results to the general public in the Mediterranean, the Black Sea, and beyond, thereby increasing the existing capacity and supporting in this way the evolution of the “knowledge society” through citizen-science campaigns and outreach activities.

PERSEUS' main objectives were defined from the onset of the project as follows:

1. Identify the interacting patterns of both natural and human-derived pressures on the SES and proceed with the assessment of their impact on marine ecosystems;
2. Develop tools for the evaluation of the environmental status using existing and upgraded monitoring and modelling capabilities;
3. Implement the principles and the objectives put forward in the MSFD and promote them across the SES – with emphasis on non-EU areas;
4. Develop a framework for future implementation of adaptive policies and management schemes.

The first objective was to identify the interacting patterns of both natural and human-derived pressures on the SES and proceed with the assessment of their impact on the marine ecosystems. To this end, well-coordinated scientific research was applied at both basin and sub-regional scale as well as on selected coastal areas. It was achieved through synchronized coordinated multi-disciplinary process oriented experiments in the open sea and coastal areas; an Umbrella Workshop was planned, and successfully completed, in the first year, which helped to identify short term data gaps, and set to address them by means of targeted actions aiming to determine currently insufficiently resolved mechanisms through which natural and human-induced pressures impact the ecosystems. PERSEUS also used the objectives, principles and criteria put forward in the MSFD for the benefit of the countries involved. More specifically, a critical review of the Initial Assessments has led to the identification of the approaches and assessment elements used in the EU countries. Finally, PERSEUS also adopted a gap scoring system quantifying the main types of gaps and indicating related scientific priorities. Moreover an economic and social analysis and assessment (ESA) of the human activities, which exert pressures and their environmental impact on marine and coastal ecosystems in pilot cases areas, were done. Key processes transmitting the pressures to the marine ecosystem were studied, and the interactions of natural and human pressures were thoroughly investigated through the assessment of the cost of degradation on ecosystem goods and services (e.g. fisheries and aquaculture, maritime transport, tourism, hydrocarbon extraction desalination etc.).

PERSEUS addressed its second objective, to develop tools for the evaluation of the environmental status, using existing and upgraded monitoring and modelling capabilities and proposed options to ensure that these capabilities remain well-coordinated on a constant basis in the long-term and beyond the project's duration. To accomplish the science and society related objectives set in PERSEUS different scales were addressed, from global basin processes to sub-basin and local ones. The project created, for the first time

addressed, from global basin processes to sub-basin and local ones. The project created, for the first time, a complete inventory of the observing systems in the SES, which identified gaps in coverage (geographic and temporal), in types of observations. These gaps in turn, lead to an overall strategy for the observing systems to be used for MSFD monitoring. PERSEUS used the existing structures in SES for getting MSFD-related information, while at the same time tried to upgrade them and develop new ones, where needed, in line with the latest technological developments. The upgrade was done, on fixed stations, by having new biogeochemical & acoustic sensors; at the same time it supported the launching of Argo floats, while new technologies (gliders, VMS and CPR-MED) were proposed to be used, through cross border, cooperative ‘projects’. To further this aim, a small research and survey vessel concept was designed for use in areas where currently available research vessels cannot operate effectively, and in order to become a scientific survey tool that will be used as a common platform for coastal surveys for all EU and non-EU countries. This was carried out through a participatory approach involving the consortium and relevant stakeholders in the preliminary design. The vessel has been designed to operate in very shallow waters, shifting sands, navigation canals and ports, based on scientific and operational needs, with a special focus on the innovative systems of positioning and propulsion. Blue prints and economic analysis of the building and the operational costs were also delivered.

Advanced remote sensing techniques and modelling systems in an “Ecosystem End to End” perspective, were established addressing the SES marine ecosystem state both, at basin and coastal scales. Specific quantitative/qualitative descriptors of the MFSD, and supported a results-based approach that allowed identification of the most efficient strategies to achieve or maintain a GES were established. The model-based assessment was carried through numerical simulations in hindcast (reconstructing the past) and scenario (projecting in future according to specific assumptions) modes. The assessment addressed basic ecosystem properties of the ecosystem “health”: ‘Vigor’ (productive capacity), ‘Organisation’ (structure) and ‘Resilience’ (recovery potential after stress).

All the above work was used to promote and implement PERSEUS 3rd objective, on the principles and objectives put forward in the Marine Strategy Framework Directive (MSFD) across the SES. A basin-wide promotion of the MSFD principles was accomplished, which was based on the development of a state of the art methodology. This allowed harmonized assessments, enabled comparison of the environmental status across the different marine sub-regions -both across EU and non-EU countries- and finally applied them in non-EU case studies in a number of stakeholder workshops. The project provided a crucial opportunity for assembling a broad interdisciplinary, multinational network of scientists and stakeholders from EU and non-EU countries (also including capacity building) in the SES, who joined forces in a research effort targeted towards GES achievement.

The PERSEUS project has worked towards its 4th and final objective by promoting better governance and GES achievement across the SES, through a framework for future implementation of adaptive policies and management schemes. Vulnerable marine sectors/groups/regions have been defined and ranked based on the underlying ecosystem structure and functioning which govern/constrain the provision of goods and services. A metric for their adaptive capacity was developed and, subsequently, in accordance with the MSFD priorities, appropriate environmental state scenarios have been used on a suitable time and spatial frame; the latter would allow to explore hypothesized interactions and linkages between projected anthropogenic and natural pressures and the capacity of the SES to provide good and services to their surrounding populations. Consistent economic and social analysis of the use of the SES waters and an assessment of the cost of degradation was performed as a first step towards the development of the Adaptive Policy Framework. To achieve the objective, PERSEUS brought together scientists and policymakers and its success in doing so was manifested through the setup of 5 stakeholder platforms

policymakers and its success in doing so was manifested through the setup of 3 stakeholder platforms, that have actively engaged almost 100 policymakers, at regional and basin scale, ensuring that the adaptive policy framework is developed in response to specific needs. Through special workshops and in an effort to assist creating relevant monitoring programmes and management plans towards achieving GES, PERSEUS was able to ensure participative and reflexive processes to scenario planning for the Adaptive Policy Framework, developed, through a participatory approach. The development of the Adaptive Marine Policies (AMP) Toolbox assisted policy-makers in facilitating and preparing the future implementation of adaptive policies and management schemes, in view of a better governance of the human-made pressures, achieving or maintaining the GES and enabling the sustainable use of goods and services of marine ecosystems.

PERSEUS organised specific training courses dedicated at training stakeholders, which helped them not only to improve the quality of their provided services, using existing and new data, but use the tools developed in PERSEUS especially, in compliance with the MSFD targets.

It is widely acknowledged that healthy marine ecosystems supply a host of services, which provide direct and indirect benefits to the world's population. In this context, PERSEUS tried to provide clear evidence-based answers to questions like: how 'healthy' are the marine ecosystems of the Mediterranean and Black

Seas? Is marine protection really a good social investment? It is clear that policymakers want to protect our seas, as do EU citizens, but they also need to consider the economic aspects of these measures. PERSEUS scientists were challenged and had the main objective to getting the right balance between environmental/economic and policy aspects. It is an on-going process and scientists need to help policymakers understand that 'business as usual' is no longer an option.

Engaging society to evolve to a "knowledge society was one of the prime targets of the Project. Citizen-science campaigns like the Jellyfish Spotting Campaign, Marine LitterWatch App, PERSEUS@Sailing were launched aiming to increase the general public's awareness and to promote volunteer engagement on environment protection actions. A "Clean Seas Communication & Outreach Best Practice Guide", prioritised the communication and awareness raising that can improve general public behaviour and reduce human pressures. Acknowledging the importance of the younger generation in shaping the future, PERSEUS aimed to involve schools and educators, through the creation of an ocean literacy programme. The International Network 'My school "voyages" with PERSEUS - PERSEUS@School' was established with the purpose to help and enhance environmental education, focusing on clean sea stewardship in schools across the Mediterranean and the Black Sea and developed a range of activities, which engaged children and advance ocean literacy at school. PERSEUS@Art aimed to promote science to the wider public through arts exhibition

PERSEUS focused on training and capacity building, mainly on young scientists and stakeholders through specially designed summer schools and training courses for professional personnel, thereby aiming to improve and upgrade their current know-how and skills. The overarching objective was to bolster human resources within the SES on themes related to the various stages of the implementation of the MSFD, through training activities focusing on innovative tools in the fields of ecosystem assessment, monitoring and measures towards GES. The participants evaluated these actions as high important and very relevant for their potential carriers.

Project' results were disseminated by "translating" and presenting them in an attractive, user-friendly format that is meaningful and targeted to each stakeholder group (Scientists, Policymakers, Media and & Advocacy and General Public.). PERSEUS has conducted a genuine and constructive dialogue with policy & decision-makers at national, EU, regional and International levels, throughout the PERSEUS project implementation, involving them from the beginning of the project

implementation, involving them from the beginning of the project.

Considering the wealth of data and information that a large, multidisciplinary project like PERSEUS would produce, we aspired to manage and share the data, information and knowledge through the development of the data management system and ensure that their widely use. The idea was to create an oceanographic information management system to provide user-friendly and fast on line access to physical, geochemical and biological data of the Mediterranean and Black Seas ecosystems to a wide spectrum of users, in a timely manner, available to the scientific community even after the end of the project.

### Project Results:

PERSEUS has worked on four integrated ‘clusters’ since it acknowledged the well-defined policy needs and knowledge gaps, especially the ones related to the interaction of anthropogenic pressures and natural processes in relation to the implementation of the MSFD.

- The “Policy” cluster, focusing on the MSFD promotion and adaptive policies development, was central to the project and represented the main driver of PERSEUS.
- The “Knowledge” and “Tools” clusters were the place where the core scientific and technological work

was carried out.

- The “Users” cluster was where the results and capacities developed by the project were shared with internal and external “Stakeholders” through both training and outreach activities.

The “Knowledge” and “Tools” clusters advanced the capacity of PERSEUS to support policy-making in the SES with the best possible scientific guidance. They delivered results (integrated new knowledge, new data, and new methods) to the “Policy” cluster which demonstrated the implementation of the MSFD and developed a new Adaptive Policy Framework. All results were delivered to the “User” (training and outreach), cluster which, in turn, enhanced the capacity for science-based policy making both internal and external to the PERSEUS consortium and communicated the results to the wider stakeholders’ community.

Integrated new KNOWLEDGE: identification of the natural and anthropogenic pressures, the understanding of their interactions and the assessment of their impact on the SES ecosystems at coastal, sub-basin and basin scale.

The overall objective of PERSEUS's work towards New Knowledge - ‘Pressures and impacts at Basin and Sub-basin Scale and coastal ecosystems’ was to provide the necessary scientific understanding for assessing GES in a coherent and holistic manner in support of the MSFD. In order to achieve this, it aimed for the definition of the main pressures, processes and issues at risk in the Mediterranean and Black Seas open sea and coastal regions. The accomplished actions within the PERSEUS lifetime concerned the gap analysis on data and knowledge in scientific and social and economic terms, and the subsequent realisation of process-oriented experiments (field studies and modelling) on main ecosystem elements to fill specific scientific gaps in an effort to support GES. Especially for open seas, effort also focused on the definition of ecoregions and associated human pressures. All this information was provided to support the development of the PERSEUS Adaptive Policy Framework to assist policy makers in developing the most appropriate measures to achieve GES.

The preliminary assessment, carried out in the initial phase of the project, addressed the description of the Mediterranean and the Black Sea ecosystem state with respect to natural and human pressures and their impact.

In relation to the open seas, and regarding the natural pressures, the project reviewed the role of the hydro-meteorological variability, the strait dynamics, and the atmospheric dust deposition. Regarding

hydro-meteorological variability, the sand dynamics, and the atmospheric dust deposition. Regarding human pressures, it reviewed the effect of the maritime transport in terms of accidental oil spills and invasion of alien species, and the impact of the over-exploitation by fisheries of many commercial species on the decline of the mean trophic level of the Mediterranean. Overall, lack of data and lack of long time series and in many cases poorly constrained processes, were the major gaps identified. Absence of data was more evident for in the Black Sea. This assessment also indicated that data availability was generally better for physical variables than for biogeochemistry, which are essential for the evaluation of several MSFD descriptors (biological diversity, ecosystem structure, contaminants, etc.). It has to be underlined that data were almost completely lacking for some MSFD descriptors, such as marine litter and noise. Preliminary analysis of pressures and their impacts on coastal ecosystem in the SES- Gap Analysis has resulted in 15 extensive reports, particularly valuable as they contain many unpublished data and also information from non-EU countries. These reports synthesised and evaluated the information compiled in order to characterise the selected coastal ecosystems in the SES, to describe human activities and the related pressures on the marine environment and to determine their impact at semi-qualitative scale. Existing gaps in data and/or in the knowledge of the mechanisms, by which pressures produce impacts, were highlighted and prioritised as these form the basis for quantifying the impact and designing mitigation policies.

The identified pressures and impacts in open seas and coastal areas of the SES have been, as far as possible, described and linked to the corresponding GES descriptors and associated criteria indicated in the MSFD.

The preliminary results, along with all the results and progress of all PERSEUS activities, were discussed during the PERSEUS Umbrella Workshop (January 2013) organised on a regional scale (Western Mediterranean, Central Mediterranean, Eastern Mediterranean and Black Sea) and attended by more than 180 PERSEUS participants. The workshop highlighted the achieved scientific results with emphasis on knowledge and data gaps, provided information on the risks of non-achieving the GES, addressed, where possible, the MSFD 11 descriptors referring to associated GES criteria and indicators and the MSFD guidelines/methodologies for the environmental assessment. It set the scene and dictated thereafter, the sampling strategies and proposed future actions, elicited potential synergies between the different WPs and common work that needed to be done, and materialised the concept of integration. Emphasis was given on integrating natural and social and economic science (finalisation of the environmental issues of socioeconomic importance to be treated within PERSEUS and the definition of the socioeconomic storylines at the inception of the scenarios to be modelled), the promotion and applicability of MSFD and GES into non-EU countries, and gearing the project to support the science-based advice to policy makers on adaptive management towards GES.

The first key result of PERSEUS under 'New Knowledge' was the determination of the main environmental risks for not achieving the GES in open sea and coastal areas in environmental and socio-economic terms in relation to the 11 GES descriptors of the MSFD; a detailed risk analysis was provided per sub-region (Western Mediterranean, Central Mediterranean, Eastern Mediterranean and Black Sea). The relative table is provided in the attached fact sheet ('Main environmental risks of not achieving 'Good Environmental Status' (GES) in the Southern European Seas'). For example, in the Black Sea, the main risks have been identified in descriptors D7 (coastal and basin wide scale), D8/9 (coastal and basin wide), D5 (coastal), D6 (coastal), D2 (coastal and basin wide), D3 (basin), and D10 (coastal and basin wide). Out of these, D2 and D3 were to be addressed in socio-economic terms at basin scale.

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An integration and analysis of existing environmental data (22 physical-chemical parameters) and biological observations (more than 1500 species from phytoplankton to top predators) was done at basin scale to define and characterise the Mediterranean Sea's open sea ecosystems. Based on a novel multi-clustering methodology and on environmental niche modelling, a two-level partition of the Mediterranean Sea with the biogeochemical regions (biotopes) and the Ecoregions (associated biocenoses) were proposed. This work allowed us to characterise the main environmental divisions of the basin as well as the biodiversity and mean organisms' size gradient at each trophic level. Finally, an ecological characterisation of each Ecoregion was proposed along with a perturbation index based on 13 human pressures. This work under Data integration and eco-regionalisation was popularised with the assistance of WP9 through the production of a fact sheet (attached) on 'Defining ecoregions of the Mediterranean Sea', used for the dissemination of the results to policy makers and the public at various targeted events (e.g. EMD 2015, PERSEUS Stakeholder workshops, PERSEUS Summer Schools, Ocean Of Tomorrow 2015 etc.) along with the rest of the projects' fact sheets. The work was further developed into an online mapping Regionalisation Tool 'Visualizing regions in the Mediterranean Sea' available through the PERSEUS website, where informative maps can be produced on environmental variables species modes, biogeochemical regions, ecoregions, anthropogenic pressures (climate change, fisheries and other direct pressures) per depth layer and trophic level.

To fill in the identified knowledge and data gaps at basin and sub-basin scale and advance knowledge to support MSFD and GES, 28 cruises conducting process-oriented experiments were carried out during the project's lifetime, in different sub-regions of the Mediterranean and the Black Seas, namely the Strait of Gibraltar and Alboran Sea, the Gulf of Lions and Ligurian Sea, the Adriatic and Ionian Seas, the Levantine Sea, the Aegean Sea, the Turkish Straits System and Marmara Sea, and the western Black Sea. The experimental work or process modelling addressed the (sole or combined) impacts of natural and human-made pressures on a component of the marine ecosystem. The natural pressures considered were the exchange fluxes at straits, the hydro-meteorological variability, the dense water formation, and the atmospheric deposition. The human pressures taken into consideration were overfishing, the introduction of contaminants, and the introduction of alien species.

Results improved knowledge on nutrient exchanges through the Gibraltar Strait and the Turkish Straits Systems, which are the two primary exchange points with neighbouring seas (Atlantic Ocean and Black Sea), on the ocean acidification trend in the Mediterranean Sea due to the drawdown of anthropogenic carbon in the basin, and on the improvement of the derivation of Chlorophyll-a data from satellite products for the oligotrophic Aegean Sea, allowing therefore for a better assessment and prediction of phytoplankton dynamics in this region.

New evidence on the key role of the oceanic circulation variability at different spatial and temporal scales were obtained with the identification in the Levantine Basin of increasing temperature and salinity trend of surface and intermediate waters, together with a multiannual variability affecting the nutrient and chlorophyll levels. Other experimental and modelling results emphasised the impacts of the meso-scale (i.e. with sizes ranging from few tens to few hundreds km) and sub-mesoscale processes (i.e. with sizes ranging from few km) on the vertical and horizontal transfer of nutrients and on the functioning of the planktonic ecosystems.

New information on the status and condition of occurrence of some non-indigenous species, such as the invasive ctenophore *Mnemiopsis leidyi* in the Marmara Sea and in the Black Sea, and the *Physalia physalis* jellyfish in the western Mediterranean, were obtained. New knowledge on anchovy spawning sites in the Black Sea and the dynamics of deep-sea red shrimp were obtained, which will be used for improving the management of those open ocean and deep fisheries.

New observations provided clear evidences on the transfer and levels of contaminants and litter in the deep sediments in the north-western Mediterranean Sea, due to episodic and highly energetic processes such as dense shelf water cascading and storms. Litter appeared to be mostly-land-sourced, with almost 80% of plastics dominating samples from water column and bottom. Worth mentioning are the large abundances of plastic microfibers that were found in deep sediments.

The gap analysis performed in the first phase of PERSEUS on the pressures and impacts on coastal ecosystems has allowed us to better focus the process-oriented experiments carried out on 18 coastal areas of the Mediterranean and the Black Sea (Barcelona, Mediterranean coastal area of Morocco, Rhone River and Marseilles, Naples, Northern Adriatic, Southern Croatia, Gulf of Tunis, Saronikos gulf-Athens (Elefsis Bay), Haifa, Sea of Marmara and Istanbul, Varna, Constanta and Danube delta, Northern Western Black Sea and Gelendzhik). An effort was placed on the coordination of the work at the various study sites and on sharing common methodologies. New data were collected on pelagic and benthic ecosystems, non-indigenous species and pollution by chemicals, litter and noise. The analysis of these new field data and of historical data sets provided new knowledge on the pressures exerted on coastal marine ecosystems in the SES. These results are summarised below.

Although the inputs from Po and Danube rivers show high inter-annual variability, trends in nutrient fluxes can be observed over the last decades. After an increase of eutrophication over the 70-80s, a decrease of nutrients inputs, especially of phosphate, was recorded since 1990. Positive impacts are seen on phytoplankton communities and in the decrease of hypoxia events. At a smaller scale, in the vicinity of most coastal big cities the policy measures taken in order to reduce polluted water discharges show their effectiveness, although some local issues still exist.

Microbial food web studies highlighted the importance of picoplankton, both in open as well as coastal waters, indicated functional responses of the microbial community to nutrient conditions, and showed the important role of micro-zooplankton in transferring biomass to upper level consumers. New data were obtained on diet and seasonal patterns of feeding of small pelagic fish. Results showed that under *Mnemiopsis* depleted zooplankton conditions, anchovy switch to phytoplankton as alternative food source. The screening of a large panel of chemical organic contaminants in 3 hot spot areas (Marseilles, Split and Constanta) has showed comparable concentrations of pollutants in seawater in these areas. It was also observed that levels decrease rapidly when the distance increases from point sources. Attention should be paid to the fate and the impact of new emerging pollutants. The fate of selected contaminants (Pb and PCB) was studied using a hydro-sedimentary model available for Marseille and filed data. Model and field data showed that a large amount of coastal inputs is exported offshore while a high proportion of contaminants is discharged and exported during flood events.

At basin scale, contaminant concentrations in biota show very different patterns depending on substances. For some substances, trace metals in particular, the biogeochemical background and the environmental conditions play an important role in the contamination of marine organisms. Differences between Mediterranean sub-regions are not significantly marked. However, a decreasing gradient of the concentrations from the north coast towards the southern coast can be clearly seen for several chemicals in the Mediterranean Sea.

PERSEUS carried out a comparison of the coverage of sea grass meadows with historical data in 6 coastal areas of the Mediterranean under heavy human pressure. Results reflect that there was no evidence of degradation or clear trend of degradation. The meaning of these findings is that human pressure has not permanently affected sea grass meadows in the Mediterranean and the Black Sea.

*Seagrass habitats can recover (slowly) when pressures decreases*

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Data compilation on non-indigenous species (NIS) from various sources, including field-work, has led to the addition of 9 new alien and cryptogenic species in the Saronikos Gulf during the PERSEUS study period (10% increase)/ 8 new species in the Gulf of Tunis (11% increase)/ and 11 new species in the Haifa Bay (6.4% increase). No new records were noticed in Constanta and the Turkish Straits. Worth to underline that the rate of new introductions of NIS has been increasing at all coastal study areas after 2000, while an increase of the Lessepsian species migration has been noticed, linked to climate change. The analysis of 18 years of data about demersal fish communities showed a geographic variability in Functional Group (FG) biomass trends. Nearly half of the studied Mediterranean areas showed an increase of FG biomass. Changes respond mainly to nutrient inputs trends and, to a lesser extent, to fishing pressure.

Marine litter was proven to be an increasing pressure on marine ecosystems. Litter has been found everywhere in the coastal and open seas. Higher densities were observed in the vicinity of harbours, cities and touristic areas. The majority of items were made up of plastic often exceeding the global average of 75%. Some harmful effects on fauna were documented (birds, turtles...) however, impact is poorly known. Recommendations to reduce litter related to tourism have been proposed.

As a general conclusion on pressures and impacts on coastal seas in the SES, it appeared that some management measures taken in the past in some domains (nutrient discharge, legacy pollutants, and fisheries) were proved to be efficient and to have positive effects on environmental status. The effort must be maintained in these domains. It has also been shown that some pressures (physical damage/loss of habitats, non-indigenous species, emerging pollutants, litter and noise) are still increasing and represent a major concern and a risk of non-achieving the GES in the SES. In these thematic fields, the lack of observing data and of knowledge, regarding the links pressures and impacts, remains an obstacle to overcome and to design efficient management measures to achieve GES.

The research work carried out in PERSEUS has confirmed that coastal marine ecosystems of the SES are changing under anthropogenic and climatic pressures. This emphasised the need to improve tools and define sound methods for assessing environmental status and defining GES.

In PERSEUS, methodological studies have offered advances in the following domains:

- Identification and assessment of Environmental Aspects of Ports (TEAP).
- Benthic indices (soft bottom indices, seagrasses indices).
- Sediment toxicity tests.
- Pelagic food web characterisation (NBSS: normalized biomass-size spectrum).
- Assessment of coastal anthropogenic pressures using high resolution satellite images.
- Automatic litter monitoring (SeaLitter Cam, Wave glider, MarineLitter Watch application).
- Submarine noise recording.

An analysis of the environmental impact that is generated by the socio-economic activities that take place in ports contributed in assessing the performance of the Mediterranean and Black Sea ports [Barcelona (Spain), Thessaloniki (Greece), Constanta (Romania) and Varna (Bulgaria)] concerning their environmental protection. This analysis also evaluated the performance of their environmental management. From this research it was concluded that ports had been improving their environmental performance year by year. However, they were not following any standardised method in the identification and assessment of Significant Environmental Aspects (SEA). As a result, a new tool was developed in the framework of PERSEUS to assist ports to identify and assess their SEA. The TEAP Tool (Tool for the identification and assessment of Environmental Aspects in Ports) presents a new methodology, applicable to all types of ports no matter the size or its commercial profile. The most appreciated characteristic is its

to all types of ports no matter the size or its commercial profile. The most appreciated characteristic is its capacity to be used by any port and, at the same time, to provide specific and targeted results for each one. TEAP is a user-friendly, practical and time-saving tool for port managers to easily determine significant environmental aspects and put in place an effective environmental management system. The tool is available online on the PERSEUS website ([www.perseus-net.eu](http://www.perseus-net.eu)) and is demonstrated in the PERSEUS fact Sheet series ('Environmental impact of ports in the Mediterranean and Black Seas - TEAP')(attached in this report)

As demonstrated in the PERSEUS fact Sheet series 'Marine litter - a growing threat in our seas', (attached,) marine litter research within PERSEUS was carried out, for the first time at basin scale level for the Mediterranean and Black Sea, based on common methodological approaches as well as on new approaches with the aim to support MSFD monitoring and reduction measures. Marine litter studies within PERSEUS can be classified into four main categories through the use of different data-collection methodological approaches: beach litter (Marine LitterWatch Campaign), floating litter (Sealittercam), seafloor litter (Trawlers) and deep sea litter (Remotely Operated Vehicles (ROV). PERSEUS was able to monitor each of these litter categories. The Marine LitterWatch (MLW) application developed by the European Environment Agency (EEA) and tested and supported by PERSEUS (in its dedicated

"PERSEUS Marine LitterWatch Campaign") and the Sealittercam were the new and innovative tools endorsed and developed within the framework of the project to facilitate the monitoring of marine litter. With respect to the Marine LitterWatch, PERSEUS joined forces with EEA with the main goal to promote the uptake and use of the Marine LitterWatch smart phone application by relevant NGOs and individual beachgoers in the Mediterranean and Black Seas, ultimately hoping to increase the general public's awareness on the importance of preventing marine litter, to promote volunteer beach clean-up activities by engaging the with the public. PERSEUS FP7 Project is mentioned in the contributors of the application in the iTunes and GooglePlay. Since the launch (1 May 2014) of the PERSEUS-MLW Campaign, a total of 41 PERSEUS-beaches have been adopted by PERSEUS partner Institutes in Tunisia (2), Morocco (4), France (6), Italy (8), Malta (1), Israel (5), Spain (3), Turkey (1), Greece (2), Cyprus (1), Bulgaria (4), Romania (5). These beaches were surveyed for beach marine litter by using the Marine LitterWatch application.

The MSFD calls for 'an economic and social analysis of the use of those waters and of the cost of degradation of the marine environment' and the specific interest PERSEUS has, is socio-economically assessing the pressures impacting the Mediterranean and Black Sea marine and coastal environments. Therefore, an economic and social analysis and assessment (ESA) of the human activities, which exert pressures and their environmental impact on marine and coastal ecosystems of four pilot cases areas (Balearic Sea and Gulf of Lyon, Northern Adriatic, Aegean Sea/Saronikos Gulf in the Mediterranean and Western Black Sea) have been performed. This assessment followed the initial identification of such human pressures and their impact in tandem and in support to the work on the pressures and impacts on the ecosystem described above. It focused on main marine sectors such as fisheries and aquaculture, maritime transport and ports, recreational activities and coastal tourism, submarine cable and pipeline operations and marine hydrocarbon (oil and gas) extraction as well as on the main land-based activities impacting the coastal marine waters. It is also attempted to estimate the cost of degradation (based on Initial Assessments of the MS and economic values extracted from the V-MESSES data base developed in the Adaptive Policy Framework) due to the differences between the present environmental status and the GES to be achieved. Impacts on the marine ecosystems have been characterised mainly in qualitative terms. For some sectors, it has been attempted to make projections, for the next decade, in a qualitative way. Parameters studied include production means, production values, and employment

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The gap analysis demonstrated really diverse situations among them. In particular, it showed that a significant part of required data to perform these assessments are missing or is not publicly available, especially those needed to assess value added and employment wages as well as cost of degradation. Following the DPSIR model, the Gap Analysis provided an overview of the socio-economic drivers (D) exerting pressures (P) on the open sea ecosystems whose knowledge is required to prepare the responses (R) aiming to reduce the impacts (I) to an acceptable level. Eventually it was used to design of a programme of measures to achieve or maintain GES, at the scale of the PERSEUS Adaptive policies and scenarios,

Development of TOOLS to evaluate environmental status using existing and upgraded monitoring and modelling capabilities

One of the scopes of New Tools in PERSEUS has been to respond to scientific and societal needs through new multi-platform and coordinated observing systems, with emphasis on the characterisation of ocean state and ocean variability at local, sub-basin and basin scale, i.e. by ‘upgrading-expanding the existing observational systems and fill short-term gaps’. These observing systems were to provide data

and products in response to international scientific priorities (e.g. climate change, frontal instabilities, mesoscale eddies and ecosystem response, etc.) and also respond to society needs, in particular in relation to MSFD implementation and achieving GES. The activities were carried out along 5 well-identified tasks that resulted in 11 Deliverables, all publically available through Research Gate and with ISBN numbers.

Activities started with the delivery of a careful review of the observing capacity in the SES that also identified observing system gaps and needs. A program of sensors upgrade -focused on biogeochemical sensors-, expansion -covering under-sampled southern regions-, and support and operation of the multi-platform observing capacity was executed in conjunction with the initiation and advancement of new observing platform capacities, including moorings, Continuous Plankton Recorder (CPR), Vessel Monitoring System (VMS), Argo profilers, gliders, as well as R/V repeated cruises, and multi-platform experiments. An open data system for cross platform, real time (RT) and delayed mode (DM) data visualisation and archive was designed and implemented to capture observations across platforms and regions into a single open system in full compliance with EU open data policies and well-coordinated with initiatives such as EMODnet and CMEMS, also addressing harmonisation of quality control and validation procedures in the SES in a new Data Handbook. Finally, a strategy for the future, for a sustainable, effective, and fit for purpose Integrated Mediterranean and Black Seas Ocean Observing System, was developed and synthesised with inputs from past and present initiatives and the views of leading international and European experts in this area. In summary, through this combination of tasks, from observations to data and to strategy, PERSEUS has achieved all the stated objectives of this activity and contributed significantly and consistently to developing observing capacity in the SES and to setting the vision for the future. It is also important to mention that all the work was strongly coordinated with the scientific needs from the other PERSEUS activities ('Pressures and impacts at Basin and Sub-basin Scale and coastal ecosystems' and 'Developing Integrated Tools for environmental assessment'), in coordination with dissemination activities.

The fact sheet 'The Role of ocean observing system in the Mediterranean and the Black seas' (attached in this report) summarised the PERSEUS work on Observing Systems, the support to decision making, main results and actions and future challenges. A summary, extracted from the fact sheet of the conclusions from the review on Observing Capacity in the SES, the key issues identified, conclusions and main actions

FROM THE REVIEW ON OBSERVING CAPACITY IN THE SES, THE KEY ISSUES IDENTIFIED, CONCLUSIONS AND MAIN ACTIONS taken by PERSEUS, are provided below:

**Geographical coverage:** SES are under-sampled; Gliders are under-utilised; Significant gaps exist in geographical coverage of multi-parameter moorings. PERSEUS has supported an increase in coverage. New multi-parametric moorings have been installed and new glider transects were supported, specifically in southern Mediterranean. New Argo floats were deployed in the Black Sea and sustained ship campaigns have been supported in key locations. However, significant gaps remain.

**Biogeochemical observations:** Scarce across the SES, in particular in the southern regions. Under PERSEUS, multi-parametric moorings were upgraded with new sensors, and new bio-Argo floats were launched. New observing platforms were implemented (CPR-Continuous Plankton Recorder). However, much more is required in this area.

**MFSD descriptor focused observations:** Marine litter and noise are two examples of descriptors that have not yet been considered in ocean observing systems and are missing a SES strategy for sustained and reliable observations. PERSEUS acknowledged that appropriate methods of observations need to be defined and/or tested. Multi-parametric moorings have been upgraded with new acoustic sensors. Specific field experiments were carried out to test new monitoring tools for marine litter. A SES strategy is still

required.

**Data management, quality control and products for society:** Not all Ocean Observing data are managed at SES level. Standard quality control procedures are not yet established for a number of platforms, e.g. biogeochemical and acoustic sensors. Products for evaluating ecosystem attributes relevant to MFSD are not always available or well planned. PERSEUS data policy, data management and quality control elements directly addressed the data access and management issues at a SES level. A view from data to relevant products for society is still required.

**Multi-platform approach to scales:** Different platforms, observations and experiments are required to study multi-scale ocean processes and characterise the ocean variability at these key scales, from large basin scale to sub-basin and local and from weeks to months and years. PERSEUS undertook a variety of multi-platform experiments in order to study multi-scale ocean processes. The knowledge gained from this needs to be incorporated into a multi-platform observing systems strategy for the future.

PERSEUS has identified data gaps and improved existing observation capabilities and has advanced towards an integrated monitoring system following the work done under the ‘Upgrade-expand the existing observational systems and fill short term gaps’. Furthermore, it contributed to the development of a new concept of open and multi-platform observing system that responds to societal needs related for example to climate change, MSFD and CFP implementation. The upgrades of additional sensors, to measure parameters such as CO<sub>2</sub>, nitrates, hydrogen sulphide, current profiles, sediments and underwater acoustics, have contributed (and will contribute in the future) to the estimation of MSFD quantitative descriptors, improve our understanding and modelling of physical to biogeochemical processes and expand our knowledge of human impact on the marine environment. The expansion and higher regional coverage using the multi-platform approach, for example using surface drifters, Argo profilers and gliders, allowed monitoring under PERSEUS of Southern Mediterranean and Black Sea regions that are usually under-sampled and in the Black Sea including the latest biogeochemical sensors on new Argo profilers.

Fishing effort is a crucial component of the MSFD and the Common Fisheries Policy (CFP), and in PERSEUS an innovative methodology was developed for the assessment of fishing effort using the Vessel Monitoring System (VMS). The ‘Vessel Monitoring System (VMS): new ways to use its data’ Fact sheet ([Under New Tools](#)) clearly describes the new methodology for better estimations of fishing intensity via two

(under New Tools) clearly describes the new methodology for better estimations of fishing intensity via two modules: (1) methodological steps to analyse the VMS dataset, which allow to estimate fishing effort indicators and define common spatial references for visualisation; and 2) Fishing effort implementations that combine the fishing effort estimates with environmental, oceanographic and data from surveys, in order to identify important fishing areas and target species in line with the requirements of national and European legislation. The factsheet is attached in this report

In addition and in collaboration with modelling, tools for predicting Bluefin tuna spawning grounds have been setup, a key contribution to sustainable fisheries. It is also important that data on trends in the abundance and spatial distribution of Non-Indigenous Species (NIS) and NIS pathways have been obtained through systematic CPR monitoring and capacity building.

The PERSEUS Data System is one of the key contributions from PERSEUS New Tools and is a significant contribution to the global observation system in the Mediterranean and Black Sea. A cross platform data submission protocol has been established and data from 26 Argo floats, 8 gliders/63 missions, 20 surface drifters, over 65 ship missions and 20 moorings are currently available covering the 4 years of PERSEUS Project.

Finally, PERSEUS developed a long-term vision and strategy for an Integrated Ocean Observing System in the Mediterranean and Black Sea, with and for society.

The following extract from the facts sheet ‘The role of Observing systems in the Mediterranean and Black Seas –PERSEUS contribution to observing systems’, provides an example of the links between the Multi-Platform Ocean Observation approach adopted in PERSEUS and its relation to Policy and Societal needs. The full summary on the other needs (Impact of climatic change, and Socio-economic) is provided in the fact sheet (attached). Societal needs, i.e. Environmental policy (MSFD, WFD, CFP, Habitats Directive), requirements on observing / monitoring on Descriptor’s (Biodiversity, alien species, Fish stocks, food webs, Eutrophication, Seabed integrity, Hydrographical conditions, Litter, Noise/Energy), key parameters such as Fish capture, Plankton, Chlorophyll, Nutrients, Benthic habitats, organic pollutants, biotoxins, metals, were monitored in PERSEUS through multiplatform observing systems like CPR, Moorings, Gliders, Satellite remote sensing, Ship surveys, VMS and the Automatic Identification System (AIS) . Data availability is the first step for exploitation of results: accordingly, all PERSEUS monitoring data collected are available on the PERSEUS website, a single open system in full compliance with EU open data policies and well-coordinated with initiatives such as EMODnet and CMEMS. PERSEUS, SeaDataNet-II and MYOCEAN-II had signed in 2014, a MoU for the in-situ data management. The 3 projects have agreed to collaborate to make available a comprehensive dataset of in-situ observations from operational oceanography programmes and scientific surveys in order to serve both the operational oceanography and research communities as well as other users.

The overall work of PERSEUS towards ‘Developing Integrated Tools for environmental assessment’, (the other scope of PERSEUS, New Tools) focused on the elaboration of scientific tools to evaluate the SES environmental status by engaging existing and upgrading remotely operated monitoring and modelling capabilities. Ecosystem End-to-End (E2E) modelling and remote sensing techniques have been used to provide an integrated analysis of ecosystem attributes underlying criteria related to the MSFD descriptors and towards the GES in a suitable time frame for the implementation of the MSFD. The work progressed, along the PERSEUS lifetime, coherently with the initial objectives and in collaboration with the rest of the activities towards the common goal to advance science and provide science-based advice and tools to policy makers under the framework and the needs of the MSFD.

The preliminary work carried out in the initial project phase concerned the development of modeling tools

The preliminary work, carried out in the initial project phase, concerned the development of modelling tools enabling the achievement of the E2E (resolving the “full” trophic web: “from plankton to fishes”) perspective and the definition of the forcing functions necessary to accomplish numerical simulations in hindcast (reconstructing the past) and scenario (projecting into the future according to specific assumptions) mode. The scenario adopted (defined in cooperation with the PERSEUS socio-economic work ‘Adaptive policies and scenarios’) was coherent with the MSFD time horizon (ahead into future up to 2020) and considered changes in the land-based nutrient inputs (through river discharge) and in the fisheries pressure over the higher trophic levels (fishes).

The analysis and the assessment of the marine environmental state was carried out by selecting the basic attributes underlying (in a general sense) the ecosystem “health” and (more specifically) the MSFD descriptors, and the GES definition. The selected attributes were: “Vigor” (ecosystem productive capacity), “Organisation” (Ecosystem structure and connection among its components) and “Resilience” (Recovery potential after a stress). Each of them has been addressed in specific tasks, through dedicated modelling at the regional scale and advanced remote sensing techniques applied at the SES basin scale. Concerning “Vigor”, remotely sensed estimate of the SES primary productivity, strongly contributed to an improved understanding of the SES productivity temporal and spatial patterns, as well as to a better

definition of the regional SES basins trophic state and spatial-temporal variability. In addition, the remotely sensed estimates established an important data set for comparison with the corresponding model simulated primary productivity. The E2E models implemented in several SES regional basins provided indications of the systems productive capacity at different trophic levels: primary (phytoplankton), secondary (zooplankton), tertiary (fishes), in relation to large scale oceanographic properties linked to meteorological variability.

The task facing the analysis of the “Organisation” attribute also benefited from the provision of advanced, remotely sensed products. In fact, the remote sensing activities made available to the rest of the project partners the remotely sensed estimation of the functional type phytoplankton surface composition (phytoplankton population resolved into its micro-, nano- and pico-phytoplankton components) in the SES. This is again an important achievement per se, as it allowed to resolve at the large scale the spatial-temporal variability of the primary producers population structure (indicative of the prevailing branch of the trophic web). Moreover it offered to the numerical modelling of the marine ecosystem a unique validation opportunity. Analysis of the “Organisation” attribute for the Adriatic Sea benefited also from a specific effort aimed to evaluate the skill of a numerical model in replicating the Environmental indices TRIX and CSI023+. Such indices, computed from “in situ” (TRIX) or from remotely sensed (CSI023+) observations, provided indication on the trophic environmental state (from oligotrophy to eutrophy) and on the temporal trends affecting the evolution of the primary producers. The results obtained by computing such indexes with numerical model derived data, confirmed that models have a potentially significant skill in replicating indices addressing the state of the environment.

In addition to the above, the modelling activities provided in-depth indications about the marine ecosystem organisation along a wide range of trophic structures (from the lower to the higher trophic levels), as the model results highlighted the spatio-temporal variability of the alternation of the two main lower trophic web branches (herbivorous and microbial), as well as changes and variability in other organisation indicators addressing the higher trophic levels.

Work within the task concerning “Resilience” based on numerical simulations was carried out in scenario mode over the MFSD time horizon. The scenario simulations considered the variability in the land-based nutrient load, as well as changes in the fishery exploitation pressure over the higher trophic levels, and complied with current consensus estimates of climatic and anthropogenic induced variability in the forcing

compared with current consensus estimates of climatic and anthropogenic-induced variability in the forcing functions acting on the SES environmental dynamics.

The development of tools focused also on intermediate and higher trophic levels. Work concerning intermediate trophic levels was mostly devoted to the analysis of jellyfish dynamics in the SES through monitoring and data analysis activities and generated the development of an individually-based approach to the modelling of the jellyfish dynamics, while work on higher trophic levels was mostly concerned with Mediterranean Sea Bluefin tuna spawning habitats identification (based on hydrological properties) through observations and modelling. This allowed the development of a promising data-driven model for the identification of such areas. The importance of these outcomes in term of environmental policy planning was straightforward.

This was highlighted in the production of a fact sheet to effectively communicate and exploit PERSEUS results to all stakeholders and policy makers “A multi-disciplinary approach to managing Atlantic Bluefin tuna in the Mediterranean Sea (Science-based Policy). As described therein, PERSEUS research has concluded that long-term sustainability of tuna stocks can only be achieved by integrating knowledge acquired from various disciplines and stakeholders in order to better understand, respond, and adapt to changes acting the marine environment and its resources. This fact sheet (attached) summarised the

research findings and provided specific insights for science-based policymaking for the management and conservation of the blue fin tuna.

Finally, all the results of the work concerned with the assessment of the basic ecosystem properties (“Vigor”, “Organization” and “Resilience”) were synthesized in a final task providing some assessment on the current state and the possible evolution of the SES environment.

Provided that the MFSD time horizon is quite short, the variability of the ecosystem state, due to the “climatic” (atmospheric) forcing resulted to be (as expected) quite negligible. Also, the alteration in the ecosystem properties induced by scenario of change affecting the lower (change in the land based nutrient input) and the higher (changes in the fishery pressure) did not provide very large modifications with respect to the current evolution. However, some useful (for policy planning and management) indications emerged from the PERSEUS extensive modelling exercise addressing basic ecosystem properties, as the Mediterranean Sea appeared to be more influenced by “scenario” changes considering higher trophic levels (fishery pressure). On the other hand, the Black Sea appeared affected mostly by “scenario” changes in the land based inputs.

All these considered, the ‘Development of Integrated Tools for environmental assessment’ experience within PERSEUS can be summarised by saying that it provided a development of a suite of integrated tools (based on modelling and/or remote sensing) with a potential effective skill to contribute to the provision of a sound science-based information to the environmental policy, management and protection domains following the needs of MSFD and EcAp towards GES. In particular, it has to be stated that, rather than proposing lines of actions to the policy making process, this PERSEUS outcome can strongly contribute (within known limits and uncertainties) to the ex-ante and/or ex-post (with respect to a policy implementation) environmental assessment, providing therefore useful information to define a policy (ex-ante assessment) and/or to evaluate its effective (or expected) efficiency (ex-post assessment). The Information arising from the PERSEUS modelling and remote sensing tools can, therefore, contribute (in a general way) to assess the system trajectories towards/away-from GES and, in particular, it can be embedded (in a relatively easy way) into multi-layered (interdisciplinary) information systems policy planning with respect to (for example) marine spatial planning and/or regulation of exploitation strategies. Finally, it is worthwhile to mention the fact that the PERSEUS ‘modelling’ outcome has very evident integration and synergy potential with outcome from PERSEUS works and achievements like the

Integration and synergy potential with outcome from PERSEUS works and achievements like the ecoregion definition and observational sustained “nowcasting” of ecosystem state.

PERSEUS's final contribution to 'New Tools' was the development of the concept of an innovative small research and survey vessel which can be evolved into a prime scientific survey tool to be used in coastal areas of the Mediterranean and the Black Sea, estuaries, ports and shallow navigation channels. The main steps to achieve this objective were: the identification of scientific and operational needs and evaluation process, the design of novel propulsion system and innovative positioning system and finally the design of the new vessel.

The identification and evaluation of the operational and scientific needs covered a wide range of needs such as the specificities in sampling in terms of the vessel's capabilities as well as the activities to be carried out on board, and the research instruments required. The evaluation process also included the study of the existing and active ships in the Mediterranean basin and in the Black Sea and particularly the participation of a large number of field researchers through workshops with scientists and end - users (e.g. port-authorities) and an extensive online survey. The interaction of all these stakeholders (scientists, stakeholders, port authorities and engineers) was reflected in the design of a versatile, custom-built vessel with highly innovative propulsion and positioning systems, aiming to develop them using technologies not

yet available on the market - with particular attention to be used in highly sensitive areas and in very shallow waters.

The two principal results achieved in this work were: 1) the identification of the possibility to utilise a hybrid propulsion system based on dual fuel LNG/diesel engine that together with the battery pack could satisfy the requirement of low and zero emissions (for a short period) in restricted areas, and 2) the identification of one innovative propulsion system based on a marine cycloid propeller derived from the Kirsten-Boeing solution, the PIVOT (Pasetto Innovative Variable Orientable Thruster).

In the first account, an innovative main energy distribution system proposed by SIEMENS that suggested the utilisation of a DC bus has been investigated thoroughly. This solution allowed the connection of different generators or accumulators on the system determining the effective flexibility of the system itself. As a result, the possibility to connect on the system a power pack of batteries allowing the vessel to work for a limited period in configuration of zero emission has been shown.

The new conceptual vertical axis propulsion system with orbital blades, PIVOT was constituted by a pair of coaxial contra-rotating impellers, which provide directional thrust to 360°, allowing in each case a centred thrust working as a dynamic positioning system, avoiding parasitic components. The innovation comes from the option of modifying both the direction of the thrust around 360° as well its intensity instantly, developing thus more power compared to similar propulsion systems, and providing a better performance in terms of manoeuvrability, stop and crash procedure, and higher efficiency. The research vessel is therefore characterised by an innovative power distribution system that enables the connection of alternative power generators directly on the main power line of the vessel.

The final step included the blueprints of the new vessel and went even a step further by providing a comprehensive economic analysis of the building and operational costs of such a vessel. The design provided the general drawings, diagrams and calculation, i.e. general arrangement plan, full technical specifications, lines and body plans, capacity plan, main engine systems and machinery systems, structural drawings i.e. midship sections, scantling plans, structural calculations, innovative propulsion system, innovative positioning system, and power/speed estimation. The specifications of the PERSEUS versatile aluminium vessel have been set as: Length overall (LOA): 19.5 m; Maximum beam at deck: 6.70 m; Length at waterline: 17.40 m; Depth: 3.20 m; Maximum Service displacement: 48 t; Main engines maximum Power (100% MCR) abt. 2 x 262 kW; crew 4; scientists 4 + 1

The result of these studies was a concept vessel under 20 meter of length, developed as an ideal platform due to its stability, large deck area, versatility, flexibility and manoeuvrability. The design corresponds to multiple vessel configurations varying from operator (institute, stakeholders, etc.) able to adapt to changing needs and customizable for different scientific purposes. The innovative design optimised the vessel's space dedicated to the work/scientists/ instruments on board, providing a full flat area on the main deck. The working area is fully customizable in the building phase to each costumer (institute) and can simply and can be easily adapted to specific functions and requirements.

The finalisation of the PERSEUS research vessel concept, included the analysis of its building and operational cost. Building cost estimation relied and depends on the purpose of the vessel and the items to be installed on board, whereas the analysis of the operational costs has been carried out through the evaluation of items that are commonly considered as the ones more affecting the running costs of the vessel. The building cost has been developed taking into consideration the type of service, and the simplicity of construction and maintenance. The operational cost analysis was based on data available in the literature and has been developed studying some main items that are commonly considered as preeminent to the total running cost. The economic significance of these items can be influenced by

decisions on the operation mode and depend on the policy and the framework implemented by the ship operators. As a summary, the total Building Cost has been estimated at 3.000.000 € and that of the Operational at 674.000€ per year.

**POLICIES:** Supporting the implementation of the MSFD principles across the SES and development of an appropriate adaptive policy framework

PERSEUS has set as one of its key targets under the 'Policy' cluster, to implement the principles and the objectives put forward in the MSFD and promote them across the SES. The way to achieve the 'Basin-wide promotion of MSFD principles' had been structured as a three-step process: 1) Identification of MSFD assessment elements in EU case study areas; 2) Data compilation for marine environmental status assessment within non-EU study areas; 3) Application and Communication of the assessment elements in non-EU study areas.

Within 'Identification of MSFD assessment elements in EU case study areas' work focused on reviewing and compiling approaches used for the available MSFD Initial Assessments (IAs) and GES definition reports in selected EU countries (also outside the SES area). A qualitative database that includes information at three different levels, related to coverage of Descriptors, to the strategic approach followed per Descriptor, and to the assessment strategy at criteria and indicator level, has been created, and a compilation table was provided to facilitate further visualisation and uptake of the outcomes by the end-users. This work constituted the starting point for mapping strategies adopted in MSFD environmental status assessments and can be used as a tool that enables identification of assessment elements linked to each of the descriptors. Furthermore, commonalities and differences in MSFD environmental assessment approaches across EU countries in the Mediterranean and the Black Sea basins have been highlighted. The main data and knowledge gaps, considering the descriptors' scope, the methodologies, the data availability and the information reported by each country at criteria and indicator level, have been reported. Through the development of a gap scoring system, PERSEUS attempted to quantify the main types of gaps highlighted by the countries in their IAs and GES reports and to indicate scientific priorities for further methodological developments and monitoring needs. Moreover, under this task, the assessment methodologies and/or principles used in the study areas were presented, and indicators were classified according to the process used for their quantification, aiming mainly to identify those based on common

according to the process used for their quantification, aiming mainly to identify those based on common methodologies. Aggregation of indicators for GES assessment at descriptor level and overall has also been presented along with the methodology that had been followed. Depending on data availability, these methodologies have been devised for non-EU countries, to promote coherency of environmental status assessments and adoption of consistent harmonised approaches in setting criteria and targets for GES in the SES. This process had been considered of particular importance since it constitutes a harmonisation platform bridging the relevant efforts under the MSFD and the Mediterranean and Black Sea RSCs. This New Knowledge with direct implication on Policy has been depicted in the Fact Sheet Series PERSEUS has produced ‘Mediterranean and Black Seas; Good Environmental Status? Identifying science gaps in determining current status (attached in this report)

Under ‘Data compilation for marine environmental status assessment within non-EU study areas’ work concentrated on the data compilation for marine environmental status assessment within non-EU study areas. Existing data and assessment elements provided by PERSEUS non-EU partners, which were reviewed and classified per descriptor, considering the outcomes of the work described above, have been included, along with new data and assessment elements collected through the experimental work of PERSEUS (specifically under ‘Pressures and impacts at coastal and basin and sub-basin scale’, and

‘Upgrade-expand the existing observational systems and fill short term gaps’) in selected non-EU study areas of representative geographical coverage. Exceptionally, in the case of Georgia, data collection was performed under this activity. Hence, inter-linkage of activities was quite pronounced between the different tasks, and also among WPs under which data collection has been performed. The collected information offered an insight of existing marine environmental assessments in the considered non-EU study areas, which referred mainly to biodiversity, invasive species and eutrophication along with contaminant levels. It should be highlighted that PERSEUS non-EU partners focused mainly on acquiring further data through targeted experiments regarding environmental assessments for which they either already had an expertise and/or available data aiming at a more thorough and solid quantification of the relevant indicators.

Moreover, new data have been also collected in certain cases aiming to quantify more GES-related indicators, for which no information was provided in the first part of this report. Through all these efforts, the PERSEUS partners contributed to the provision of further knowledge on the “Main Environmental Risks of not achieving GES in the Southern European Seas” that were identified in each sub-region. The compiled information constituted the baseline material for the non-EU stakeholders’ workshops foreseen for the ‘Application and Communication of the assessment elements in non-EU study areas’. It should be pointed out that through this network that has been established and strengthened between PERSEUS non-EU and EU partners, familiarisation of non-EU partners with MSFD principles and concepts, as well as adoption of common methodological standards were achieved, being among the key achievements of PERSEUS.

Finally, within ‘Application and Communication of the assessment elements in non-EU study areas’ a synthetic report on the application and implementation of the MSFD/ GES assessment elements for SES basin-wide application has been delivered. It integrates the developed relevant indicators from the work under PERSEUS other activities (‘New Knowledge’ and ‘Tools’), introduces the policy scenarios formulated by ‘Adaptive policies and scenarios’ and highlights the stakeholders’ perceptions, from the foreseen workshops organised under this task. More specifically, assessment elements for basin-wide application in both offshore and coastal areas were synthesised per Descriptor. Finally, different policy scenarios suggested within the related PERSEUS activity, along with the decision making tool developed to be used for adaptive management (Adaptive Marine Policy Toolbox), were also included in this work, with the aspiration to achieve an overall integration of main results, tools and outcomes. Additionally, six

with the aspiration to achieve an overall integration of main results, tools and outcomes. Additionally, six national workshops were organised (May-November 2015) in conjunction with planned activities in the respective non-EU case studies (Croatia, Tunisia, Turkey, Morocco, Georgia, and Ukraine) aiming to build regional and at some point national cooperation between scientists and stakeholders, and to create a platform for the establishment of effective regional cooperation between EU and non-EU countries for the basin-wide management of the marine ecosystem, under the Marine Strategy Framework Directive (MSFD) and the EcAp concept. Participants in these events were representatives of governmental institutions, scientists from universities, research institutions as well as companies acting in the areas connected with marine issues. The representatives of Regional Sea Conventions had been also invited to this series of events.

PERSEUS was one of the first research projects to work with stakeholders from several EU and non-EU countries around the two basins. Overall it has succeeded in this activity by identifying, developing and promoting tools and methods to assess environmental status across the Mediterranean and the Black Sea basins with emphasis on non-EU countries, in accordance with the principles and objectives of the MSFD and EcAp. Moreover, it created and provided the opportunity for scientific cooperation and networking between scientists and stakeholders from EU Member States and non-EU member countries, created a

platform for strengthening human capacity building in interdisciplinary science and enhancing the involvement of researchers in policy-related, science-based management as a two-way process towards achievement of GES and the long-term objectives for sustainable management of the SES. Additionally, and in close collaboration with the other activities, PERSEUS contributed to the improvement of marine research and monitoring infrastructure, strategy and collaboration in the region.

The work of PERSEUS on 'Adaptive policies and scenarios' (Policy cluster, 2nd target), focused on developing, through a participatory approach, a specific framework for the preparation of policies contributing to promote better governance across the Southern European Sea's (SES) marine waters. This framework aimed to support the elaboration of a set of multi-scale management schemes and policies, the implementation of which will aim at reaching the GES in the SES.

To achieve this, two complementary technical tasks had been achieved:

1. Building a specific decision support system to help policy makers to develop environmental adaptive policies. The Adaptive Marine Policies (AMP) Toolbox draws on the characterisation of present and future pressures, including socio-economic aspects, to facilitate elaboration and assessment of adaptive policies.
2. Establishing Stakeholder platforms with relevant experts and decision makers, who were involved from the onset in the design process of the AMP Toolbox.

These have been reached through 4 main interacting tasks, according to a usual scheme for the development of knowledge systems: Knowledge stocktaking (State of play), interactions with mirror user groups (Stakeholder dialogue), development of the system (AMP Toolbox development) and implementation, tests, improvements and dissemination (Implementation and Lesson learned).

The Adaptive Marine Policy (AMP) Toolbox has been built and its web version was launched on the project's website ([http://www.perseus-net.eu/en/about\\_the\\_apf\\_toolbox/index.html](http://www.perseus-net.eu/en/about_the_apf_toolbox/index.html)) for public online access (from Oct. 2014, allowing time for tests (Oct-Dec 2014), improvements (Jan-April 2015) and demonstrations (June-Dec 2015). The Toolbox has undergone a series of structured and articulated building phases (setting the conceptual framework of the PERSEUS AMP Tool Box; specifications of the Web knowledge base on the state of play reviews; Report on the state-of-the-Art of the potential principles and methods for the elaboration of the APF; and finally the documentation of the PERSEUS APF Tool Box: technical and functional specifications, development process, contents description, scenario construction

technical and functional specifications, development process, contents description, scenario construction, tests and experimentation. Alternative scenarios and outputs, in order to allow for properly taking into account possible future developments impacting marine ecosystems were provided by the PERSEUS modelling exercises in collaboration with this activity. The storylines were based on the analysis of existing foresight exercises, and were treated more in depth under the “Inventory and critical assessment of existing foresight analyses and scenario planning.”

Key work included a number of studies, inventories and assessment that were incorporated into the resources part of the Tool (Inventory and critical assessment of: existing foresight analyses and scenario planning; the legal, policy and institutional frameworks dealing with marine policies in the SES; the possible measures to be taken to achieve GES; and the existing economic valuation studies on marine goods and services in the SES). Information from the latter is collected in a specific valuation database, Valuation database for Marine Ecosystem Services of Southern European Sea, V MESSES. This unique decision support system aimed to provide to its users useful resources structured in levels of information, i.e. Main page, Steps, Key activities, Resources and Tutorials & examples.

The five steps (1-Set the scene; 2-Assemble a basic policy; 3-Make the policy robust; 4-Implement the policy; and, 5-Evaluate and adjust the policies) are presented in a uniform format, including some basic

information such as: What is the step about?; Why is the step necessary?; Who should be engaged in the step?; and What should the outcome be?.

In addition, the steps provide access to the 12 key activities, which represent a series of basic actions which need to be taken to achieve the steps, such as: “Involve experts and stakeholders”; “Gather information and determine existing conditions” or “Check conditions warranting the use of adaptive management”.

The resources comprise: (i) the “Knowledge base”, including 7 databases (i.e. Research Projects; Marine valuation; Inventory of Measures; Inventory of Foresight exercises; Inventory of Ecosystem-Based Assessment Studies; Legal Inventory; and Institutional Inventory); (ii) different “Tools and methods” (e.g. stakeholders analysis and multi-criteria decision analysis); (iii) the “Regional assessments and models dedicated to the Mediterranean and the Black Seas”; and, (iv) “Further reading”. One of the most important objectives of the AMP toolbox is to make available scientific data, information and models to users. The last section proposes screencast tutorials presenting the Toolbox functions and examples, as a source of inspiration for the users.

An important outcome has been to clarify the concept of “Adaptive policies” as an intuitive and potentially effective way to make decisions in the face of uncertainties, frequent in the marine and maritime domain. The basic idea is to pursue management objectives and simultaneously learn about management consequences, in order to adapt to them. Simple to adopt in the day-to-day life, this principle is not so easy to apply in legislations and regulations where stability is also required by the citizen and promoted by the legal systems. Despite frequent assertions that adaptive management is being used, evidence on its success is still limited. Indeed, it is difficult to bring the different elements of adaptive management together in a robust way and to choose the appropriate tools to do it. We have developed the AMP Toolbox to provide an innovative practical framework to operationalize the elaboration of policies on the basis of the EcAp principles to implement the MSFD and regional sea conventions marine strategies in the SES. It should be stressed that the AMP Toolbox development is very timely, in phase with the elaboration of programme of measures within the MSFD.

Dialogue with the Stakeholders greatly helped to understand in depth the various contexts influencing the design and implementation of marine environmental policies and thus to build the AMP Toolbox. Four (4) stakeholder platforms at sub-regional scales were set up including personal identification of key

Stakeholder platforms at sub-regional scales were set up including personal identification of key stakeholders involved in the elaboration of marine strategies (i) West Mediterranean: Gulf of Lions - Catalan Sea; (ii) Central Mediterranean: Northern Adriatic Sea; (iii) East Mediterranean: Aegean Sea - Saronikos Gulf, and; (iv) Western Black Sea: Romania and Bulgaria. At basin scale, the PERSEUS Advisory Board was regarded as the representative Stakeholder body. Stakeholder platforms were actively consulted for the design of the AMP Toolbox and provided valuable insights and ways for improvement. At the start, reports were compiled and reviewed the expectations and goals of the end users of the AMP Tool Box, at sub-basin Pilot Cases and SES levels and their feedbacks following the presentation of the AMP application and then revisited at the final stages of the AMP development. In addition to these set Platforms, the AMP Toolbox was presented and demonstrated in a number of key stakeholders events (e.g. EMD 2015, PERSEUS Stakeholder workshops (under Basin-wide promotion of MSFD principles, PERSEUS & MareFrame Joint Stakeholders' Workshop) and PERSEUS Summer Schools. Details on these events can be found under the dissemination section of this report.

The AMP Toolbox has been tested by approximately ninety (90) users, mixing policy makers and scientific experts involved in environmental policy issues. AMP experimentations were conducted on sub-basin Pilot case studies and basin scale, leading to a synthesis report on the AMP experimentations, lessons learned

recommendations and perspectives.

Synthesis suggested that the AMP toolbox is well-perceived, rich in useful information and capable of becoming a valuable decision support instrument for policy makers. A synthesis of the lessons learned and the insights gained from the AMP toolbox experimentation led to the following key takeaways:

- The AMP Toolbox appeared able to accommodate the needs of diverse user groups
- Scientifically-trained users are expected to use the toolbox more efficiently
- The trade-off between simplicity of use and coverage of informational needs were hard to overcome.
- Communicating to the user the type and degree of uncertainty in specific management issues is problematic.
- The AMP Toolbox seemed to be reliable in normal use, bug-free, while all the provided links were reliable and the time response of the toolbox was satisfactory.
- The provision of best practices and examples was highly appreciated by the users.

Overall, it was concluded that Toolboxes at large and the AMP toolbox specifically, may not be the best way to articulate a science/policy interface. A two way, continuous communication in person between scientists and policy makers is surely the best option - as it was the case with the stakeholder platforms in PERSEUS - but it is undoubtfully the lowest-cost option. Besides, the AMP Toolbox has the advantage of being available to continue to provide support to policy makers after the end of the project. It is definitely one of the PERSEUS project legacies in this domain.

### Interaction with USERS (stakeholders)

Reaching out to scientists and society, PERSEUS elaborated and executed a comprehensive a special plan to have interaction with users. It was based on extended the transfer of science and technology, instigated the involvement of policy makers and stakeholders and assisted countries to develop expertise related to the PERSEUS objectives. It bolstered human resources within the SES on themes related to the various stages of the implementation of the MSFD through a number of Summer Schools, training courses and training visits schemes, focusing on innovative tools emerging in the fields of ecosystem modelling, monitoring and environmental assessment with particular emphasis on the involvement of stakeholders relevant to MSFD implementation.

The scientific component within the different training and capacity building initiatives embarked upon

THE SCIENTIFIC COMPONENT WITHIN THE DIFFERENT TRAINING AND CAPACITY-BUILDING INITIATIVES EMBARKED UPON within PERSEUS was pronounced. This is evident both through (i) the choice of themes covered, (ii) the content of the material delivered and also through (iii) the direct participation of leading European scientists. Moreover, the initiatives had a clear ‘policy-driven’ dimension in supporting both EU and non-EU countries in implementing the GES across the basins and promoting the coupling of MSFD and EcAp in support of the area’s Regional Sea Conventions (UNEP/MAP and BSC).

A summary of the scientific themes addressed within the various training and capacity-building activities is presented below:

- Chios training course (June 2012), “Training on the Marine Strategy Framework Directive (MSFD)” - Themes: Increase in the capacity of Black Sea countries for ecosystem state assessment; definition of Good Environmental and Quality Status; monitoring and management based on the MSFD descriptors and WFD Quality Elements; provision of tools for the application of MSFD and WFD principles.
- Constanta summer school (June 2013), ‘The contribution of environmental indices in meeting the objectives and principles of the Marine Strategy Framework Directive’ - Themes: Assessment of water quality, benthic ecological status and fishing stocks through satellite-derived indices.
- Gelendzhik training course (June-July 2014), “Challenge for Good Environmental Status in coastal waters”- Themes: Monitoring for changes in coastal ecosystems.
- Athens summer school (June 2015), ‘Supporting monitoring in the Mediterranean Sea towards GES’ - Formulation of joint monitoring strategies and plans.
- Cyprus MedCPR training course (September 2015), ‘Training Course on the Implementation of the CPR within the Mediterranean and the Black Sea’- Themes: Application to Mediterranean scenarios of the Continuous Plankton Recorder (CPR) protocols.
- Malta stakeholder training course (October 2015), “Supporting Policymakers to develop Measures to maintain GES across the SES”- Themes: Formulation of the Programme of Measures (PoM).
- Training visits schemes (2013-2015) – Themes: Automated counting, sizing and recognition of zooplankton; Marine Carbon Cycle & Dissolved organic matter dynamics and marine ecosystem health; Biochemical biomarker techniques for the assessment of pollution effects in marine organisms.

Scientific approaches, equipment and contexts were availed of during the delivery. For instance, the Constanta summer school, the Gelendzhik training course and the MedCPR training course all involved boat-based surveys and the extensive use of scientific hardware as part of the training agenda. The training visits scheme, an innovative training component of PERSEUS, featured intensive hands-on training periods on specialised themes at leading research institutes for participants who had already embarked upon such research trails. Furthermore, leading PERSEUS and associated experts participated in the design, organisation and running of the events. The scientific relevance of the various PERSEUS training activities is also confirmed through the positive evaluation of the same activities made by participants themselves, results for which are all available within the respective milestone documents. The fulfilment of the Training and Capacity building tasks within PERSEUS resulted in direct S&T outcomes as well as long term benefits to the science-driven (adaptive) policy management. PERSEUS paved the way for the establishment of a Mediterranean capacity and network for regular CPR-based monitoring, bridging the gap between this basin and other seas, most notably the eastern Atlantic. A Mediterranean network of plankton researchers interested in sharing their datasets and in implementing CPR protocols has been established. Along the same lines, the training visiting schemes provided direct training and synergies on key themes resulting in examples of work such as that by Tsangaridis et al., 2015. Biochemical biomarker responses to pollution in selected sentinel organisms across the Eastern Mediterranean and the Black Sea. Environ Sci Pollut Res DOI 10.1007/s11356-015-5110-x

More strategically PERSEUS achieved the:

- a) strengthening of the human resources within the SES riparian countries, through formal training, with respect to themes related to the GES under the MSFD/EcAP and
- b) building a bridge with key stakeholders engaged in marine policy formulation within the same marine regions. Key stakeholders were engaged in the training activities in order to synchronise PERSEUS initiatives within ongoing programmes.
- c) close liaison with UNEP-MAP's EcAp initiative and with UNEP-MAP's Monitoring Correspondence Group (CORMON). UNEP-MAP and the Black Sea Commission (BSC) were also consulted in identifying the best recipients of the training during the Athens summer school and Malta training course so as to ensure maximum impact of the same training. The degree of convergence between the MSFD and EcAp approaches was demonstrated to participants, whilst the relevant MSFD obligations were demonstrated to non-EU participants who don't need to comply with such obligations, however, still work towards GES under the EcAp principles.

Perhaps most importantly, the implementation of the training activities contributed to a slow but steady shift in the mind-set of those benefitting from such training away from the compartmentalised approach

and in favour of research which is more policy-oriented and which addresses the needs of society at large. This was also true by engaging a number of 'trainees' from different disciplines and, more importantly, different countries including the non-EU ones.

A summary of the trainees in the different training opportunities is presented below:

- Chios training course: 16 scientists from 6 Black Sea countries (Armenia, Azerbaijan, Bulgaria, Georgia, Romania, Turkey) and Greece as participants.
- Constanta summer school: 20 post-graduate scientists from different SES countries (Italy, Spain, Croatia, Turkey, Russia, Romania, Bulgaria and Ukraine).
- Gelendzhik training course: 15 non-Russian post-graduate students, 38 post-graduate Russian students from 6 different Mediterranean and Black Sea countries (Croatia, Greece, Italy, Malta, Russia and Ukraine).
- Athens summer school: 14 policy-makers from different SES countries (Spain, Italy, Bosnia & Herzegovina, Cyprus, Greece, Turkey, Israel and France).
- Cyprus MedCPR training course: 15 scientists from Mediterranean and Black Sea countries (Cyprus, Italy, Bulgaria, Croatia, Lebanon, Greece and UK).
- Malta stakeholder training course: 18 regional stakeholders from 16 countries (Montenegro, Slovenia, Croatia, Romania, Bulgaria, Georgia, Cyprus, Malta, Palestine, Israel, Tunisia, Egypt, Algeria, France, Greece and Malta), 21 local (Maltese) stakeholders hailing from 7 different entities.
- Training visits scheme: 22 post-doctoral or doctoral candidates from different SES countries (Italy, Croatia, Greece, Bulgaria, Romania, Turkey, Russia, Cyprus and Slovenia).

PERSEUS has developed 'A prototype of an "Early Warning System for Oil Spills" Tool to support national, regional and local authorities. This scenario-planning tool is a user-friendly web GIS information platform that acts as an early warning system for controlling environmental and ecological hazards from an oil spill for the ecological protection of coasts. It is capable to provide the decision-makers strategic information regarding environmental and security issues for limiting the damaging effects of oil spills. The system provides an innovative "24 hours advance notice" on how an oil spill will spread given forecasted climatic conditions (e.g. wind, temperature, currents, etc.). The key innovation is that the system uses a time bar (scroll bar) on the map interface which allows the user to see a "minute by minute" forecast of the

time bar (scroll bar) on the map interface which allows the user to see a minute-by-minute forecast of the oil spill drift at specific time intervals over a 24-hour period following the beginning of the oil spill. By viewing how the oil spill spreads over time on an interactive map, decision-makers are in a much better position to take appropriate measures to contain the spill and focus directly on the threatened areas, without wasting time or resources. The tool is available online for all users with all the necessary functionalities in a user-friendly interface.

Finally, the PERSEUS Oceanographic information management system provided user-friendly and fast online interface accessing physical, geochemical and biological data of the Mediterranean and the Black Seas ecosystems to a wide spectrum of users, in a timely manner to the scientific community (and will continue to do so) even after the end of the project. The sources of the data were: a) recent European projects (SESAME, MyOcean, SeaDataNed, EMODnet i.e. historical data) and b) new data collected in the framework of PERSEUS. An online interface allows for flexible data selection and download. Up to 250 cruises can be selected for download in a single ODV collection. Up to 100,000 selected casts can be downloaded as a single MS ACCESS file with an automatic harmonisation of parameters and units. Dedicated software, developed in the PERSEUS framework, is available for mapping and other visualisation of the data stored in the MS ACCESS DB files.

At the end of the project, the PERSEUS Cast DB contained 348,897 casts with 375 different oceanographic parameters (in terms of P01 vocabulary). The total amount of casts increased by 51% compared to the amount of casts assembled until the end of 2009 in the SESAME Cast DB. PERSEUS partners submitted 14,667 CTD and Bottle (Rosette) casts acquired by research vessels during oceanographic cruises.

In terms of papers and presentations of its scientific work, PERSEUS has a very good record, so far. A total of one hundred and seventy three (173) paper and four hundred and thirty three (433) presentations have been produced during the life time of PERSEUS.

#### Potential Impact:

PERSEUS was an EU multidisciplinary research project with the aim to achieve the connection of science and policy and help the countries in the Southern European Seas (SES) to implement as best as possible the Marine Strategy Framework Directive (MSFD) and achieve Good Environmental Status (GES). At the same time, the project tried to engage in this process all levels of society of the Mediterranean and the Black Sea. These two major objectives were the most difficult ones to achieve. The involvement of Stakeholders, from different levels, nations, and areas from the beginning of the project, assisted in achieving co-design and co-ownership of the final results. This has been a very interesting process, which has a major impact on the Mediterranean and the Black Sea.

The structure and coordination effects, the design of objectives aiming to contribute to the process, and the answer to questions and gaps set at policy level, showed that PERSEUS, as an individual research project, had a real effect on the entire SES community. Based on its publications record, PERSEUS also showed that projects with policy impact could have a strong publication outcome serving science, while producing results for the policy makers.

From the beginning, PERSEUS tried to coordinate and cooperate with other EU projects. It has initiated the coordinators of EU projects meetings (two dedicated EU coordinators meetings in 2013 & 2014), especially on stakeholder's involvement and co-organisation of activities, exploring ways to enhance scientific knowledge and communication. MyOCEAN II, SeaDataNet II and PERSEUS have signed an MoU for the in-situ data management with the aim to serve both the operational oceanography and research communities as well as other users.

research communities as well as other users.

The involvement of stakeholders/key actors and the advanced training courses of PERSEUS with support from the Regional Conventions (UNEP/MAP and Black Sea Commission) had helped the project but also the Conventions. A fruitful cooperation between the two Conventions, on actions in both Basins has started, which resulted in an increase of their network capacity.

PERSEUS also collaborated closely with two projects that worked on the MSFD implementation and joint monitoring in the SES financed from the European Commission (DG ENV): MISIS Project for the Black Sea, and IRIS-SES project for both the Mediterranean and the Black Sea. PERSEUS held various stakeholders meetings within the framework of these projects, and its impact is manifested through the results and deliverables of PERSEUS that were used by them.

At countries' level, PERSEUS provided the means to enhance collaboration and networking between and within countries through the established stakeholders' platforms, bringing, in some cases, different user groups together to discuss MSFD issues in workshops, meetings and summer schools. This alone was important, and even more so, if we consider that non-EU countries were also involved in the process. The impact at basin level was maximized, since these workshops/summer schools were open to all countries in the Mediterranean and the Black Sea, while at the same time the role of the individual countries was

significantly enhanced.

Finally, PERSEUS has harmonised protocols and good practices (i.e. the real time and delayed mode data from different platforms) and increased public awareness, promoted common issues and elicited joint actions.

#### A) Potential Impact

PERSEUS promoted its activities through visibility in its actions, which were mainly targeted at policy and decision-makers. Results and scientific findings were 'translated' to recommendations through the PERSEUS Policy Brief as well as the several fact sheets, which were produced on the major project outcomes. PERSEUS young scientists had got, or are in the process of getting, 27 PhDs. The active involvement of the young scientists in the two basins underlines the scientific impact that the project could have on future actions. Regarding the society, and in addition to scientific impact created, we carried out outreach and citizen science programmes to engage the public (e.g. on Jellyfish Spotting and Marine LitterWatch campaigns) and involve schoolchildren through the PERSEUS@School ocean literacy programme.

PERSEUS managed to share its wealth of data, information and knowledge developing an open data management system that had captured all the projects' results (along with related historical data) and making these available online in a user friendly and fast access interface to all interested groups for further use.

A series of Events, Stakeholder Workshops and Meetings, were organised, bringing all different parties (science, policy-makers, public bodies, academia, NGOs, Regional Sea Conventions, private sector etc.) at the same table, focusing on a more collaborative work among the different groups, thus avoiding duplication and fragmentation among projects and initiatives; that was also a key issue in the non-EU countries. It is strongly believed that the partners and relevant stakeholders, because of these actions, have established good communication, collaboration and, in a lot of cases, networking activities. Synthetic work, in scientific, social and economic terms, was presented during the Final Scientific Conference (Brussels, 2015).

a. Jellyfish Spotting: outreach to gain the support of more “citizens scientists” - The PERSEUS Jellyfish Spotting Campaign was officially launched on the 20th of May 2013 and run until the end of the project. The Campaign depended on “citizen scientists” who were encouraged, through the PERSEUS website and the Campaign’s sub-site, to record their sightings and post them on the website. The Jellyfish Spotting Campaign has been developed with a purpose to produce an overriding campaign on reporting the sightings of jellyfish, which contributed in helping scientists to monitor changes in jellyfish migration patterns. The wider regional PERSEUS Jellyfish Spotting Campaign was also extended to national level campaigns with the support of national focal point organisations (currently in 10 countries), working in close co-operation with the PERSEUS Communication team.

b. Marine LitterWatch - For the Marine LitterWatch campaign, PERSEUS took the decision to support and join forces with the European Environment Agency (EEA) to promote the use of the new Marine LitterWatch smart phone application by relevant NGOs and individual beachgoers in the SES. The decision was not to “re-invent the wheel” but rather to support the existing initiative in the best way possible, allocating enresources and actions in order to increase the general public’s awareness on the

importance of preventing marine litter and propose methods for developing a “Clean Seas” framework. So, while the objectives have remained the same, the approach has been slightly altered, as PERSEUS pursued to reach out more to the community of relevant NGOs, regarding the use of the Marine LitterWatch application, help its full scale launch in early 2014 and create the basis for the SES observations. The results verify that the approach mentioned above was the right one. PERSEUS is mentioned as one of the contributors in the description of this application in GooglePlay and iTunes.

c. PERSEUS@Sailing Campaign - Over the summer of 2014, PERSEUS teamed up with myweekcharter, a nautical charter agency specialised in finding and renting sailboats all around the Mediterranean, on a special outreach action: the PERSEUS & Sailing “eco-campaign”, aimed at the sailing community in the Mediterranean in the summer of 2014 and encouraged visitors, to adopt an eco-friendly approach during their sailing experience. A leaflet on “5 eco-friendly tips” for sustainable sailing was produced and disseminated to chartered sailboats across the Mediterranean through Myweekcharter. In this leaflet, the Sustainable Sailing Photo Contest was launched. During the summer of 2014, twelve (12) more chartered sailboats agreed to promote the PERSEUS & Sailing campaign – through the distribution of the “5 eco-friendly tips” leaflet. Approximately 100 photos participated in the Sustainable Sailing Contest

d. PERSEUS@Art - PERSEUS organised the “Images of the Sea” Exhibition under the framework of the “PERSEUS@Art” Contest, co-organised with the Athens School of Fine Arts (ASFA). 140 art works were submitted in the contest themed with the activities and objectives of PERSEUS. An Award Ceremony for the best arts works contest 'Images of the Sea' was organised in January 2014 at the Athens School of Fine Arts. Many of PERSEUS partners had the chance to attend the ceremony as it took place at the same time as the projects’ General Assembly. The 3 winning art works and 3 distinctions given are exhibited today at the entrance of the Hellenic Centre for Marine Research, highlighting the contribution of PERSEUS@Art.

e. PERSEUS @ SCHOOL- In 2014, the International Network ‘My school “voyages” with PERSEUS - PERSEUS@School’ was established under the auspice of the Greek Ministry of Education. Its purpose was to help and enhance environmental education, focusing on clean sea stewardship in schools

was to help and enhance environmental education, focusing on clean sea stewardship in schools.

Information about the network can be found on the dedicated webpage in PERSEUS website. Educators, along with marine scientists had a role in supporting and inspiring children to acquire the knowledge, skills and stimulate their awareness to live and work as responsible and concerned citizens. A pilot scheme involved a network that was formed in Greece, run by the Institute of Educational Policy and materialised with two oceanographic expeditions were performed, one in 2014 and one in 2015 in Greece. 45 students in total (20 in 2014 & 25 in 2015, respectively) from Junior High and High Schools, 28 educators, more than 20 researchers and 22 crew members worked together onboard the R/V AEGAEON (2014) and R/V FILIA (2015). The results of the network were successfully communicated in the EMSEA conferences. The PERSEUS@School activity was opened internationally in July 2014 and 5 more PERSEUS partners from Spain (CSIC), Italy (CNR), Malta (IOM), Romania (NIMRD) and Turkey (IMS-METU) adopted the scheme and created similar activities in their countries. Based on this activity, partners from Spain, Malta, Greece, Turkey and Romania responded to the call for participating in the 'PERSEUS Ambassadors' initiative. This activity gave the opportunity to one student from each country to be trained by PERSEUS scientists in order to become "Ambassador" for PERSEUS and their countries school network overall. The PERSEUS "Ambassadors presented their views on project results to the European Stakeholders Event in

Brussels, on the 10th of December 2015. The involvement of the children in the process was a fantastic experience for them but also for the participants. A declaration from the PERSEUS "Ambassadors" conveyed the message of the future actions that need to be done in order to keep our ecosystem functioning properly.

The overall impact of the PERSEUS training activities must also be assessed in terms of the MSFD life cycle, illustrating the relation between the different components of such a life cycle and the PERSEUS training activities (Initial assessment = Chios training course & Constanta summer school; Monitoring programmes = Gelendzhik training course, Athens summer school & Cyprus MedCPR training course; Measures = Malta stakeholder training course). By dove-tailing closely the timing and scope of the various training activities, PERSEUS gave a sterling service to national environmental authorities entrusted within the SES with meeting the obligations of the MSFD. The fact that the targeted participants were hand-picked by virtue of their profile within their countries (i.e. such participants were all involved in marine policy formulation within their countries) should extend the legacy of PERSEUS training beyond the lifetime of the project.

### Impact of PERSEUS Tools

Five (5) tools were produced by PERSEUS, which can have a great impact in managing the marine ecosystems. It was a result of combined activities between information, modeling efforts and social and economic principles, in a range of issues, mentioned under the Main Science and Technology Results section of the final report. These include, the Ecoregion approach and management of hot spots in the Mediterranean of species distribution and anthropogenic pressures; the Management of data from the Vessel Monitoring System for tracking the fishing fleet and measuring the fishing effort; the TEAP tool for having Ports in their best condition; the GIS Management Tool for oil Spills and; the Adaptive Marine Policies (AMP) Toolbox for designing policies. The description of each tool is mentioned in the previous section.

The impact of these tools individually but also collectively have, is significant in managing activities and projects with respect to better ecosystem management in the future. AMP Toolbox, especially, is a major tool for professionals involved in marine environmental management in various countries of the Mediterranean and the Black Sea, has been publicised through numerous presentations and

Adaptive management and the Black Sea, has been publicised through numerous presentations and demonstrations. The Black Sea Commission was very impressed by the AMP Toolbox and informed the Coordinator that all these presentations have raised the interest of the experts in the Black Sea countries to use it immediately, also asking for a translation of the tool into other languages (e.g. Georgian). Adaptive management is one of the principles of the Ecosystem Approach (EcAp), promoted both by the EU MSFD and the two Regional Sea Conventions (Barcelona and Bucharest Conventions) Marine strategies. The AMP Toolbox had a strong impact on the stakeholders concerned by these strategies both during its development stages, its design and tests involving the stakeholder platforms at sub-regional and SES scales and through the demonstrations given afterwards. If we consider that people (specialised policymakers, scientific experts etc.) in charge to elaborate marine strategies at national and regional levels are relatively few in number, it can be said that a significant fraction of them has been involved in the AMP toolbox development, testing and demonstration. The AMP Toolbox is now publicly available on the PERSEUS website. The potential use of the AMP toolbox can alter the way that some countries could achieve marine-related policy options as it provides all the necessary information for the policy makers and the ways to conduct them.

The result of all these activities under PERSEUS, created very good networking bonds between different groups of stakeholders and scientists. Additionally, PERSEUS scientists have presented a great part of project's results to local and regional stakeholders upon request (examples in Greece, Italy, Spain, Malta, Romania etc).

## Capacity Building

The PERSEUS Capacity Building Scheme in the form of summer schools, training courses and training visit schemes (short term training of scientists in partners labs) have increased the potential of people and countries to better implement the MSFD and contributed in the strengthening of human resources within the SES countries.

These activities have resulted in direct outcomes such as long-term benefits to the science driven (adaptive) policy management. Along the same lines, the training visit scheme provided direct training and synergies on key themes resulting for example works such as Tsangaris C. et al, (2015), Environ Sci. Pollut. Res. DOI 10.1007/s11356-015-5410-x.

In the case of non-EU countries, capacity building was particularly important, as it spanned from the 'MSFD principles' in 2012 to the 'Joint Monitoring Proposals' in 2015 and involved all interested countries in the two regions. The impact of these actions to government administrators in EU and non-EU countries was clearly expressed in the evaluation of these courses by the participants.

PERSEUS created a bridge with key and influential stakeholders, engaged in marine policy within the same marine regions. Key stakeholders were engaged during in order to fine-tune PERSEUS initiatives with on-going programmes. As an example, close liaison with UNEP/MAP's EcAp initiative and with UNEP-MAP's Monitoring Correspondence Group (CORMON) was sought, thereby leading to the Athens Summer School on Monitoring in 2015. UNEP/MAP and the BSC were also consulted in identifying the best recipients of the training during the Athens summer school and Malta training course (2015), to ensure the maximum impact of the same training. The degree of convergence between the MSFD and EcAp approaches was demonstrated, whilst the relevance of the MSFD obligations to participants hailing from non-EU countries was also clearly identified. The training course in Malta in 2015, on identifying the major issues hindering the achievement of the GES within their marine region and proposed Programme of Measures, was expected to contribute towards the achievement of GES within their regions and, to that

of measures, was expected to contribute towards the achievement of GES within their regions and, in that end, it showed a great potential to be repeated in years to come.

Finally, PERSEUS laid the groundwork for the establishment of a Mediterranean Continuous Plankton recording (CPR)-based regular monitoring. A Mediterranean network of plankton researchers interested in sharing their datasets and in implementing CPR protocols has been established. CPR could be maintained and because of its crucial position (from Cyprus to Israel) it can be used to alert for NIS invasions in the Mediterranean Sea especially from the Suez Canal.

## B) Main Dissemination Activities

The main dissemination activities were based on the “PERSEUS Communication Strategy” that was created by the PERSEUS Consortium and updated throughout the project life-time. Dissemination activities were targeted mainly to stakeholders at 4 levels (which were not always clearly distinguished) namely, the European Commission and other international stakeholders, the Regional Sea Conventions, national stakeholders and the Public at large.

### 1. At European Commission and Other International Stakeholders Level:

At European level the oral and panel participation of PERSEUS at the two Ocean of Tomorrow

Conferences in 2014 and 2015 opened the results of the project to targeted European Stakeholders. The Coordinator of PERSEUS acted as an expert in the BLUAMED Initiative meetings in 2014 and 2015, bringing in the meetings the experience and views to involve stakeholders beyond marine science.

PERSEUS actively participated in the two European Maritime Days (EMD) in Malta (2013) and Athens (2015), with a booth, where the results achieved by the project so far were presented to international stakeholders, and the co-organisation of two workshops: “Harnessing natural capital to deliver blue growth: Lessons learnt from the Ecosystem Approach” (2013) co-organised by PERSEUS (HCMR), KNOWSEAS (Scottish Association for Marine Science) and MONGOOS/EUROGOOS (CMCC); and “Development of a methodology for the identification of Significant Environmental Aspects in Mediterranean and Black Sea ports” (2015) The latter Workshop was co-organised with the Sea For Society EU Project, the Municipality of Piraeus and the CIVILSCAPE (International Association of Civil Society Organizations) where the results of the TEAP Tool has been presented. In Athens the booth also gave the audience the opportunity to have a hands on experience and test the Tools of the project.

PERSEUS was invited to participate in the MarineScape Forum, organised by the Mediterranean Institute for Nature and Anthropos (Med-INA) and CIVILSCAPE in Piraeus-Greece, on the occasion of the European Maritime Day 2015. A dedicated talk on the results and tools developed by the PERSEUS was given in the Forum "Future prospects for Mediterranean MarineScapes" contributing to its aim i.e. to bring together stakeholders from Europe and the Mediterranean and foster a dialogue towards solutions that could mitigate the current threats and challenges to coastal landscapes and marinescapes of the Mediterranean region.

Finally, PERSEUS organized its Final Stakeholder Meeting “Policy-oriented marine research in the SES: Lessons Learned and the way ahead” in Brussels, at the European Parliament Building, on the 10th of December 2015, hosted by Mr. Ricardo Serrão Santos (MEP) back-to-back with the final PERSEUS Scientific Conference. The event brought together international and European stakeholders aiming to contribute to the successful MSFD implementation and provide results and recommendations based on the project's scientific results, which could then be taken up and applied effectively by policy-makers and stakeholders. Short presentations by school children advocated the “Clean Seas Young Generation concept” by the PERSEUS “Ambassadors”, who proposed solutions and recommendations to ensure their right to CLEAN SEAS. Senior EU Officers (Mrs. Siglinda Gruber - DG Research & Innovation, Mr. E

Lamplmair - DG MARE, Mr G. Hoermanninger - DG ENV) along with the PERSEUS Project Coordinator and Mr. Ricardo Serrão Santos participated in the round table discussion “Bringing Science & Policy together for Future Needs of the SES” on shaping the way forward in the SES.

Regarding other International Stakeholders PERSEUS organised, in 2014, a special Interactive Stakeholders Session “Blue Growth for Green Cities: Documenting Anthropogenic Impacts and suggesting Policy Options”, (Izmir, 8-10 May 2014) exploring the relation of Marine Litter and Tourism as threats towards achieving Clean Seas by 2020. This time, high level Stakeholders from the Mediterranean Basin reached a consensus on the best design options and solutions through negotiations and voting, once they had identified and agreed upon the main barriers posed by ‘Tourism’ to achieving ‘Clean Seas’ by 2020 and a sustainable marine ecosystem. A final declaration, the 'PERSEUS Message from IZMIR', has been drafted with the consent and approval of all participants. More information can be found on the PERSEUS website ([http://www.perseus-net.eu/site/content.php?locale=1&locale\\_j=en&sel=419&artid=1621](http://www.perseus-net.eu/site/content.php?locale=1&locale_j=en&sel=419&artid=1621)).

## 2. At Regional Sea Conventions' Level

The main contribution of PERSEUS to the Regional Sea Conventions work was the networking through activities and participation in high-level events of UNEP/MAP and the Black Sea Commission. We believe that the dialogue with policy makers and end-users has been enhanced through this collaboration. A similar approach was followed with the Black Sea Commission. The PERSEUS strategy included the presentation of the project's research activities, results and tools in UNEP/MAP and Black Sea Commission Meetings and Workshops.

Regarding UNEP/MAP, PERSEUS followed the actions related to the Ecosystem Approach in UNEP/MAP's workshops and meetings in order to convey its experience and findings and facilitate interconnection. The MedPol Programme invited PERSEUS, to demonstrate the AMP Toolbox, during the MED POL Focal Point Meeting (Malta, 6-19 June 2015), as a side event. The demonstration was regarded as a success story by all participants.

As the project evolved and trust between UNEP/MAP and PERSEUS was strengthened, there were several events and actions that established PERSEUS as the key partner in UNEP/MAP's approach to establish the EcAp Process in the Mediterranean basin. Examples are:

- 1) the joint UNEP/MAP-PERSEUS publication 'Atlas of Riverine inputs to the Mediterranean Sea' (in e-copies (<http://www.perseus-net.eu/assets/media/PDF/5567.pdf>) as well as hard copies)
- 2) the active participation of the coordinator in the Inception Workshop "Implementation of the Ecosystem Approach in the Mediterranean: strengthening the Science-Policy Interface" (15th-16th December 2015, Plan Bleu premises, Sophia-Antipolis, France)
- 3) the active participation of PERSEUS Project Manager in all the COR-MON meetings that have been held by UNEP/MAP, showing the results of the project and the potential of the collaboration/contribution of PERSEUS in the EcAp process (which was achieved eventually in 2015 through the EcAp Biodiversity Expert Workshop- see exploitation section).

PERSEUS experts participated and chaired some of the working groups in the 2015 Meeting and their work was taken into account in the final outcomes of the meeting.

However, the most striking feature in this collaboration was on one hand the continuous input that PERSEUS provided through many informal meetings with the project officers in UNEP/MAP, and on the other hand the requests coming from the Officers in UNEP/MAP for solutions. This shows that trust had been developed and achieved through concrete and valid actions.

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Regarding the Black Sea Commission' Permanent Secretariat, PERSEUS's support was highly appreciated, on the level of cooperation between the secretariat and the outcomes of the PERSEUS Project in the Black Sea where PERSEUS contributed to several BSC activities aimed at improving the Black Sea marine environment.

One of the important things that the Black Commission referred to was that PERSEUS brought together the scientists and decision-makers, fostering and supporting cooperation between the two Regional Sea Conventions in the Southern Seas, linking also the Black Sea Commission to UNEP/MAP, realising this link as a very strategic one for the SES.

PERSEUS was present in most of the international events organised by the Black Sea Commission, such as the International Black Sea Days in 2014 and 2015. During the latter, PERSEUS was able to evaluate its achievements, discuss new challenges and raise the public awareness regarding the protection of the Black Sea. We organised the 1st Black Sea Stakeholder Meeting, back-to-back with the International Black Sea Day 2015, where PERSEUS scientists presented to the audience the major PERSEUS tools: (TEAP); the Innovative Research Vessel; the Early Warning Management Tool for Oil Spills; the Marine LitterWatch Smartphone Application (developed with EEA) and the Integrated Vessel Monitoring System

in the Med (VMS). As a matter of fact the International Black Sea Day 2014 acted as the first official and high-level trial of the AMP.

Scientists from PERSEUS attended and presented deliverables in relevant meetings of Advisory Groups (AGs) and the Black Sea Commission. It is worth mentioning the following quote from the relevant decisions taken during the PMA/LBS AGs meetings in April, 2015: "The groups appreciated the information presented by the PERSEUS Project and requested the project to provide the BSC with access to the tools developed so far" and the 31st BSC Regular Meeting in October, 2015: "The Commission took note of the progress in cooperation with projects".

Finally, PERSEUS collaborated with the BSC towards the production of the BSC - State of Environment Report Meeting (SoER) by participating with key Black Sea Experts in the meeting of the State of Environment (SoE) Report Group (October, 2015, Istanbul, Turkey). The Black Sea Commission Secretariat has expressed the intention to sustain the relevant deliverables and publications elaborated under PERSEUS Project for dissemination among the members of the Black Sea Scientific Community and the wider public in the very near future.

### 3. At National Level

A series of six regional Stakeholder Workshops were foreseen under the PERSEUS project's WP5 "Basin-Wide Promotion of the MSFD principles" and were organized under the title "Towards a Good Environmental Status of the Mediterranean and Black Sea Basins" in Split-Croatia (5-6 May 2015, including also participants from Bosnia-Herzegovina and Montenegro), Tunis-Tunisia (4 September 2015), Ankara-Turkey (9-10 September 2015), Tangier-Morocco (29-30 September 2015), Tbilisi-Georgia (8-9 October 2015) and Odessa-Ukraine (24 November 2015). The aim of these workshops was to inform stakeholders about the PERSEUS project and provide an opportunity for close interaction with regional authorities and scientists. Dissemination of PERSEUS activities and results were made directly and to several groups of people (representatives of governmental bodies and scientists from Academia) from EU and Non-EU Countries, as well as the Mediterranean Regional Activity Centers PAP (Croatia) and RAC (Tunisia). The AMP Toolbox was demonstrated during these events. A wider audience has been informed through the PERSEUS website and dedicated leaflet on AMP ToolBox was issued.

The discussions were productive and emphasized the need for networking and collaboration among the

THE DISCUSSIONS WERE PRODUCTIVE AND EMPHASISED THE NEED FOR NETWORKING AND COLLABORATION AMONG THE different countries along the Southern European Seas (SES); for setting common policy agreements with the aim to achieve GES and develop joint monitoring programmes to evaluate progress towards achieving GES.

At the annual meeting of the MAREFRAME Project, PERSEUS co-organised with MAREFRAME a joint meeting of National Stakeholders in Constanta, Romania (19-20 November 2015), held at the premises of the National Institute for Marine Research and Development “Grigore Antipa”. In that meeting, in a dedicated session, PERSEUS scientists presented the major PERSEUS tools mentioned above to the audience attending the meeting. Romanian Media covered the event and had several interviews with the PERSEUS scientists presenting the tools of the project.

A broad audience (more than 400 people) attended the 11th Panhellenic Symposium of Oceanography & Fisheries, organised by the Hellenic Centre for Marine Research (HCMR) and the University of the Aegean (Dept. of Marine Sciences). PERSEUS was presented by the Coordinator, as an invited speaker, with the title “Aquatic Horizons, Challenges and Perspectives”, giving also the future perspective following the work done in PERSEUS.

### C) Exploitation of Results

One of the most meaningful PERSEUS results for exploitation was the design of the new innovative vessel to be used in highly sensitive areas and in very shallow waters like estuaries and lagoons. The design of the innovative novel propulsion and positioning systems was completed through the identification of scientific and operational needs and upon thorough interaction with several stakeholder groups that were also part of PERSEUS activities (scientists, stakeholders, port authorities and engineers). The actual blue prints that have been delivered from PERSEUS showed a design of a versatile, custom-build vessel with highly innovative propulsion and positioning systems. Technologies -not yet available on the market- can be used for this innovative aspect. In addition to this innovative part, PERSEUS designed a research vessel that is characterized by a novel power distribution system that enables the connection of alternative power generators directly on the main power line of the vessel. The design corresponds to multiple vessel configurations varying from operator (institute, stakeholders, etc.) able to adapt to changing needs and customizable for different scientific purposes. The innovative design optimizes the vessel's space dedicated to the work/scientists/ instruments on board providing a full flat area on the main deck. By providing, together with the blue prints, the building and operational costs, this vessel seems ideal for multitasking work at shallow waters.

Regarding the Regional Seas Conventions, PERSEUS organized the EcAp Biodiversity Expert Workshop, for UNEP/MAP (Greece, April 2014). The purpose of the Workshop was to ensure policy-science interaction and strengthen scientific input of various EcAp-related projects taking place in the Mediterranean in line with the recommendations of the February 2014 Integrated Correspondence Group on EcAp GES and Targets. COCONET, DEVOTES and IRIS-SES, also helped in providing experts at the request of PERSEUS. The recommendations of the Workshop, (such as the agreement on a possible minimum list of species, common monitoring specifics and cost-efficient methodologies, next to recommending the usage of MPAs as key areas for monitoring), were key for the development of the Biodiversity and NIS part of the Draft Integrated Monitoring and Assessment Guidance.

The Atlas of the riverine inputs in the Mediterranean is the result of the successful collaboration between UNEP/MAP and PERSEUS. The Atlas describes, in a few pages, the riverine input of nutrients and water discharge in the Mediterranean Sea for the period 1980-2010 and aims to enhance access to river management processes in the Mediterranean. All contributors believe that this Atlas signals a strong message of collaboration between policy and science bodies, urging for better monitoring and

message of collaboration between policy and science bodies, urging for better monitoring and management, enhancing regional governance, and raising public awareness. It could be further explored by projects (e.g. EMODNET Check-point) and policy makers, as it was distributed by UNEP/MAP to all Mediterranean countries -and beyond- giving an overview of the major rivers' runoff as well as four different scenarios for the future.

For the Black Sea Commission, the tools developed under the PERSEUS Project contributed to the preparation of the Black Sea State of Environment Report (SoE Report) for 2009-2014. The Policy Brief Document can be used for further decision-making in the Black Sea region, as it will soon be presented to the Black Sea Commission by the Secretariat.

More specifically, the PERSEUS tools presented in the region raised the interest of the experts in Black Sea countries. Tools such as the AMP Toolbox and the Tool for the identification and assessment of Environmental Aspects in Ports (TEAP), especially for the two Black Sea ports (Constanta and Varna), received most of the attention. The TEAP tool will be presented and used by the shipping Advisory Group (ESAS AG) of the Black Sea Commission. The impact assessment of Marine Litter on Coastal Ecosystems in the SES was greatly appreciated as it was one of the few integrated results on this issue. The case of the Black Sea and PERSEUS Marine LitterWatch Campaign in the Black Sea (featuring

surveys carried out at several Romanian and Bulgarian beaches) also made an impression. These results will be presented in the upcoming Workshop on Marine Litter of the BSC planned for spring, 2016 and some decisions are expected after these presentations. VMS maps with spatial distribution of fishing effort, common methodological procedures for analysis of VMS data, the "Early Warning System for Managing Oil Spills" prototype, for national, regional and local authorities are planned to be tested by the Black Sea Commission, during the upcoming shipping AG meeting, with the aim to contribute to the implementation of Contingency Plan' oil-spill preparedness exercises.

PERSEUS was one of the first research projects to engage stakeholders from several EU and non-EU countries in the two basins at this scale. The pronounced need and interest for transnational cooperation, was the key message from the series of workshops around the SES. Moreover, the role of the Regional Sea Conventions in providing a networking platform and ensuring harmonisation of scientific and policy approaches related to environmental issues was highlighted, along with a link to other research projects such as PERSEUS. Setting regional and basin-wide policy agreements, but also integrating between existing and single-sector policies was emphasised, in order to contribute to effective management and enable the achievement of GES of marine waters. Within this context, PERSEUS activities at this level could contribute to the establishment of joint monitoring programs. The tools that have been developed during PERSEUS were considered of high relevance, and likewise, the joint experimental activities carried out within PERSEUS were greatly appreciated overall, while the results achieved through these activities were considered to have shortened the respective data and knowledge gaps.

PERSEUS made a substantial contribution in defining the strategy in the Marine Observing Systems in the Mediterranean and the Black Sea. It co-organised the "Kostas Nittis" Workshop in 2015, where all actors on observing systems were invited to Athens as a tribute to the scientist Kostas Nittis, with a view to achieve consensus on the strategic document on observing systems in the two basins. This strategic document can be used in the future as PERSEUS has created the platform to achieve a common strategy and vision in order to improve scientific knowledge and environmental status across the basins, overcoming threats, supporting opportunities, identifying trends and delivering sustainability, at the SES level.

PERSEUS has produced a Policy Brief that has been presented in the Final Stakeholders Meeting in Brussels in December 2015. This Policy Brief distilled the major scientific findings, portrayed PERSEUS

Brussels in December 2015. This Policy Brief distilled the major scientific findings, portrayed PERSEUS results in terms of new knowledge gained; it presented the new tools developed and set out evidence-based recommendations for policy and decision makers in the SES. Many of the elements reported in this Policy Brief, since it focuses on translating the new knowledge gained into meaningful recommendations for policy makers, can be used in developing and implementing future policies and measures, especially with regards to the MSFD. Details of the Policy Brief can be found in <http://www.perseus-net.eu/assets/media/PDF/5570.pdf>

Finally, we think that the main impact that PERSEUS has achieved is to build trust between science and policy actors coming from all levels, nations, and areas, giving them the opportunity to the potential exploitation of science-based results. It also used science as a catalyst and brought together the two Regional Conventions in the SES, in a very interesting collaboration, which will have a major impact on the Mediterranean and the Black Sea in the future.

List of Websites:

[www.perseus-net.eu](http://www.perseus-net.eu)

## Related documents

-  [final1-perseus-ges-factsheet.pdf](#)
-  [final1-perseus-amptoolbox-flyer.pdf](#)
-  [final1-perseus-policy-brief.pdf](#)
-  [final1-perseus-identify-leaflet.pdf](#)
-  [final1-perseus-ports-factsheet.pdf](#)
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**Last update:** 14 July 2016

**Record number:** 186956