

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

POLICY BRIEF

This EU-funded research project brings together new scientific knowledge on how ecosystems work in the Mediterranean and the Black Sea. New decision-support tools and recommendations for policy makers are also part of the project's contribution to the development of sustainable marine environment management policies.



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About this policy brief

PERSEUS is a large-scale, four-year project (2012-2015) involving 53 partners from 21 countries and 300+ scientists. It was one of the first EU-funded scientific research projects with a mandate to develop science-based policy recommendations for the better governance of the marine environment in the Mediterranean Sea and the Black Sea, also referred to as the Southern European Seas (SES).

This policy brief distils the major scientific findings of the PERSEUS project and sets out evidence-based recommendations for policy and decision makers in the Southern European Seas (SES) based on work carried out in several areas of the two basins as shown in Figure 1 below.

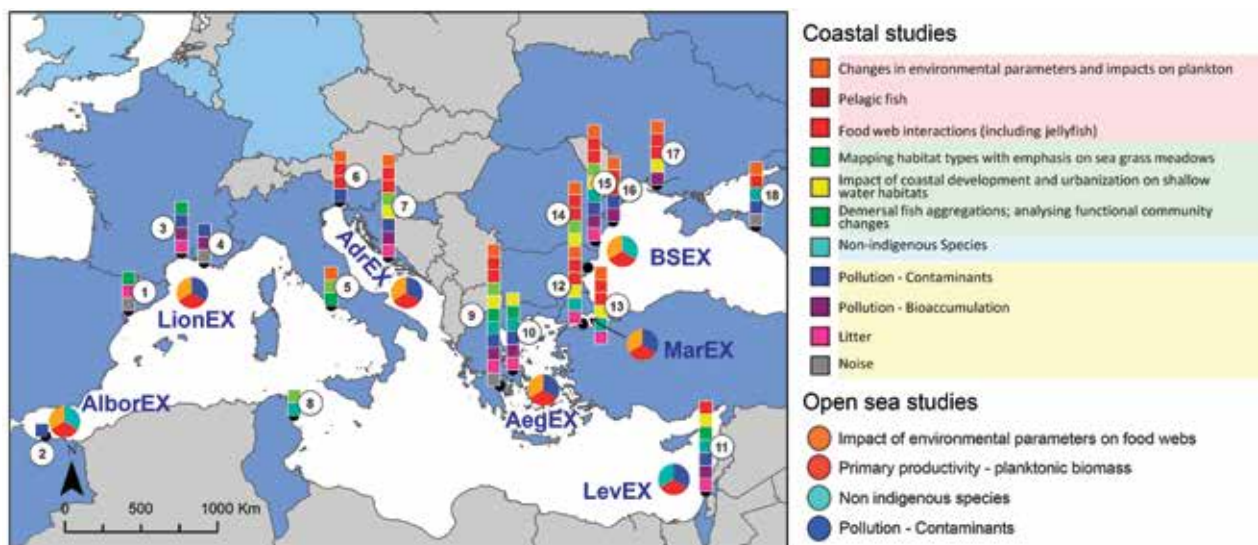


Figure 1: PERSEUS study areas

Countries sharing the two basins depend on the productivity and health of their common seas. The protection and management of their marine resources depend on close collaboration between science and management. Substantial efforts have been made in the past decades, but there is still a need to advance scientific understanding, to fill observational and knowledge gaps, and to improve assessments for more science and ecosystem-based management.

The PERSEUS Policy Brief focuses on translating the new knowledge gained into meaningful recommendations for policy makers so as to protect and manage these two precious bodies of water which are so vital to the over 600 million people living on their coastlines.

This policy brief synthesises the PERSEUS results to respond to the key questions below:

What are the main environmental risks in the Southern European Seas?

What new knowledge does PERSEUS contribute to help reduce the environmental risks in the SES?

What new observing systems and other new tools does PERSEUS provide to better manage these risks?

What lessons does PERSEUS hold for engaging policy makers, stakeholders and citizens?

What are the overarching PERSEUS messages and recommendations?

The recommendations are numbered sequentially for the first five questions above, while the overarching recommendations are set out using letter sequencing to set them apart.

Setting the scene

PERSEUS scientific findings show that pressures on both the Mediterranean and the Black Sea are still increasing. Resource exploitation, industrial pollution, tourism and transportation affect their ecosystems, but can also have negative effects on socio-economic activities.

Three overarching Marine Policy Frameworks are in place for safeguarding the SES (Figure 2):

- The Marine Strategy Framework Directive for European waters (MSFD)
- The Barcelona Convention and the Mediterranean Action Plan implementing the Ecosystem Approach for the Mediterranean Sea (UNEP/MAP); and
- The Bucharest Convention for the Black Sea (BSC).

These legal frameworks constitute the basis for coordinated monitoring and the implementation of measures to support a good environmental status in the SES; they all depend on scientific knowledge and tools, in order to support decisions and implementation, in the most efficient way.

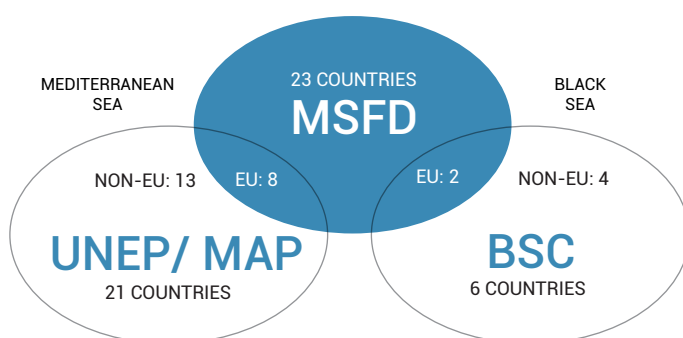


Figure 2: Overarching Marine Environment Policy Frameworks in place in the Southern European Seas

Marine Policy Frameworks depend on scientific knowledge to plan, setup and implement their provisions. Although the policy frameworks are different, the scientific principles are the same.

Due to the multiple dimensions of many issues, a close linkage between the policy frameworks and harmonisation of their strategies is required. Marine science needs to develop, integrate and exchange knowledge across national borders. Assessments and prioritisation depend on reliable data across different spatial and temporal scales.

The oceans and seas vary across a wide range of scales that interact with each other and ultimately make up ocean variability. Multi-platform observing systems (including remote acquisition and new autonomous technologies) today enable a greater range of monitoring capabilities at different scales and the integration of this data into models in quasi real-time. However, as it remains impossible to monitor all places at all times, it is also still vital to identify key hot spots/sections/areas in order to capture and understand this variability. Detailed local assessments must be aggregated to sub-regional and regional assessments in order to provide the whole picture and allow measures at the right spatial and appropriate political scale. Often the mechanisms of interaction among the various elements of the ecosystem, including impacts from external pressures, are still not well understood.

The contribution and work scope of PERSEUS can be summarised as follows:

- It provided assessments of the current situation, identified the gaps, needs and risks, providing new scientific knowledge and recommendations. As PERSEUS worked on all the descriptors of the MSFD, gaps, needs and risks could be a valuable reference for future projects.
- It collaborated across national, regional and continental borders through its research community and stakeholders, specifically incorporating the Black Sea and the Southern Mediterranean region.
- It developed innovative tools for monitoring, assessment and evaluation.
- It developed attractive educational campaigns and scientific literature targeting different societal groups

This policy brief has been prepared for policy makers in the SES and presents **PERSEUS results** in terms of new knowledge gained, new tools developed and key science-based recommendations, for use in developing and implementing future policies and measures.

What are the main environmental risks in the Southern European Seas?

A first key result of the PERSEUS project is the determination of the main environmental risks of not achieving Good Environmental Status (GES) in the Mediterranean and Black Sea. The MSFD and the corresponding non-EU frameworks are based on the concept of defining and achieving GES of the marine ecosystems. Environmental issues and socio-economic aspects constitute risks of not achieving GES in the SES.

Through a methodological process of gap and impact analysis, **PERSEUS updated and prioritised the main environmental risks** in relation to each of the 11 GES descriptors of the MSFD.

The main key factors placing biodiversity and resources under pressure in the Mediterranean and Black Sea are:

- eutrophication & pollution
- fisheries
- non-indigenous species
- marine litter

The maps below (Figure 3) set out the risks by sub-region and a descriptor for both the open seas and coastal areas.

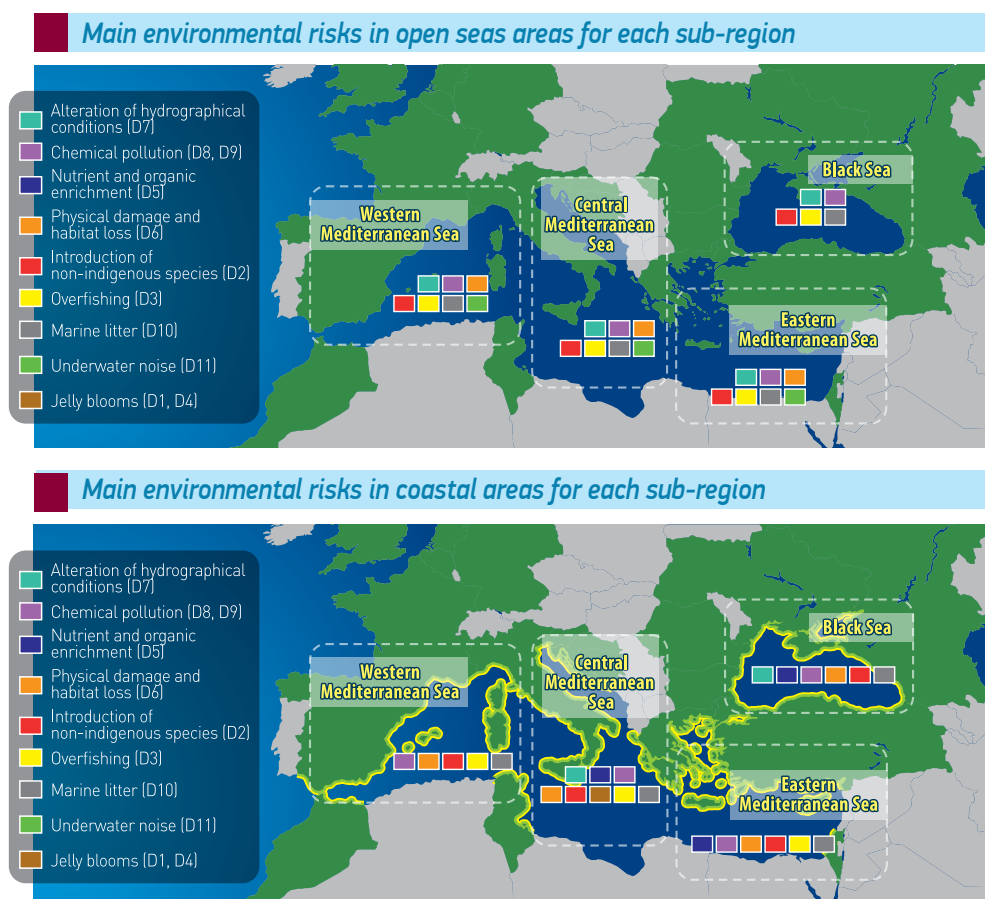


Figure 3: Risks by sub-region and descriptors for open sea and coastal areas.

It is important to highlight that, **there are gaps in the data coverage and in the availability of assessment methodologies**. The analysis of gaps provides an overview of the need for the development of improved monitoring and methodology.

What new knowledge does PERSEUS contribute to help reduce the environmental risks in SES?

Risk factor 1: Eutrophication & pollution

The findings

PERSEUS provides the analytical tools for the identification and quantification of contaminant inputs and concentrations at scales in different orders of magnitude. Regionally limited impacts, hot spots and basin wide redistribution can be observed.

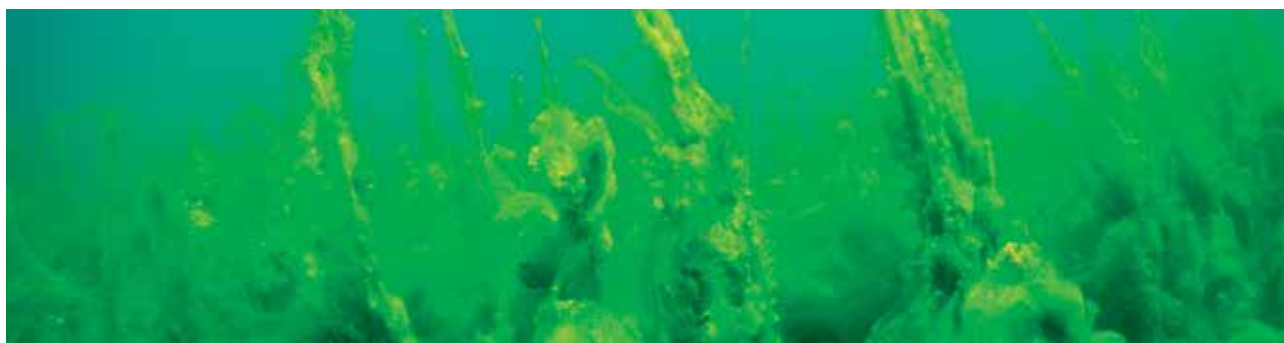
Human activity, whether industrial, agricultural, urban or maritime, causes chronic and accidental releases of pollutants into the marine environment. In the Mediterranean and the Black Sea, this has been a concern for a long time.

Eutrophication results from an excess of or an imbalance of nutrient inputs. Although the Mediterranean Sea is oligotrophic (nutrient-poor), eutrophication can have a significant impact on certain confined areas. PERSEUS carried out a comparative study of long-term nutrients and phytoplankton biomass and diversity in selected sites of the Mediterranean and Black Sea,¹ which revealed an improvement in the state of the ecosystem in most areas. The trends observed since the 1990s show an improvement of the status of the ecosystems marked by less hypoxia events especially in the Black Sea ecosystems, a decrease in phytoplankton biomass and an increase in species abundance. These changes were mainly coupled with those of nutrients. The good news is that policy measures aimed at controlling phosphorus and fertilizers are working on a coastal scale, although some local issues still exist.

water discharge and of the improvement of treatment plants in urban coastal cities is clearly visible on benthic communities.² This finding demonstrates that early policy measures (such as the Water Framework Directive for European Countries) based on scientific findings do work and the effort to reduce the discharge on untreated or poorly treated waters should be continued.

Contamination by chemical pollutants and their effects remains a significant environmental risk in the Mediterranean and Black Sea.³ The contaminants are subject to basin-wide transport, redistribution, bio-accumulation and biomagnification, and their pathways and processes are now better understood, though not completely. Legacy pollutants as well as emerging pollutants are among the substances of concern. They are widespread and are found in coastal areas and in the open sea and deep sea environments.

The consideration of the different spatial scales in the setting up of monitoring programs is needed to appropriately address both hot spots and basin wide processes.



¹ More information in PERSEUS Deliverable 2.5 "Response of pelagic ecosystems to coastal pressures in the SES"

² More information in PERSEUS Deliverable 2.6 "Response of benthic ecosystems under the influence of coastal pressures in different sub-regions of the South European Seas (SES)" (MSFD descriptors D1 and D6)

³ More information in PERSEUS Deliverable 2.7 "Impact of pollution (including contaminants, litter and noise) on coastal ecosystems in the SES" (MSFD descriptors D8, D9)

The solutions/tools

Tool for the Identification and Assessment of Environmental Aspects in Ports (TEAP)

Ports can have significant environmental impacts that affect ecological systems and natural resources. The environmental aspects of each port vary according to the activities conducted within the port. Key environmental priorities identified in relation to ports are: air quality, port waste, water quality, noise, dust, hazardous waste and energy consumption.

PERSEUS research findings⁴ indicated that most European ports do not use standardised methods for the identification of their significant environmental aspects (SEA). In order to address the need for harmonisation in the reporting system, PERSEUS has developed a Tool for the identification and assessment of Environmental Aspects in Ports (TEAP) to assist port authorities in the identification and assessment process of relevant SEAs. This online tool for ports is available on the PERSEUS website.

Recommendations

Key recommendation 1: Environmental **policies aiming to reduce the release of pollutants** into the sea (and into rivers) by urban and industrial centres, harbours, and maritime activities **should be strengthened and implemented at the basin level.**

Key recommendation 2: Regional and national authorities should take the initiative for **supporting coordinated observing and research programmes to improve knowledge on contamination**, especially by emerging pollutants, and also in less investigated areas such as the open and deep sea.

Key recommendation 3: Policy makers should support science-based evidence for pollution reduction measures. **Further research on contaminants in the marine environment is needed** in order to better understand their effects and impacts, and to provide information about final sinks, transfer into the food webs and impacts on the ecosystem.

⁴ More information in PERSEUS Deliverable 2.4 “Environmental and accidental risk assessment of the big ports around the SES” and relevant PERSEUS Fact Sheet: “Environmental impacts of ports in the Mediterranean and Black Sea”.

Risk factor 2: Fisheries

The findings

PERSEUS has provided new knowledge on key aspects of fishery resources, such as changes in functional communities of demersal fish and identification of essential fish habitats. Also, innovative methodologies/tools have been developed for the estimation of fishing pressure. The outcomes support effective decision-making regarding the sustainable exploitation of fishery resources.

It is common knowledge that the fishery resources in the Mediterranean and the Black Sea are under pressure; fish stocks in the Mediterranean Sea and the Black Sea are overfished by 88%.⁵ PERSEUS has tackled a number of issues related to fisheries in both coastal and offshore areas that contribute to improved knowledge of the status of the resources in the area.

With the development of an ecosystem approach to fisheries, there is an increasing interest in analysing fish communities as networks of "functional groups", which are assemblages of species that play similar roles in the food web and whose dynamics can be considered to be consistent. PERSEUS studied⁶ biomass changes in functional groups of demersal fish species in 12 areas of the Mediterranean over 19 years. Geographical and temporal trends were identified which mainly correlated with time trends in near bottom nitrate, minimum bottom temperature and mean catch levels. The study provided evidence that the Mediterranean fish communities have changed over the past two decades. PERSEUS has provided a method of defining functional groups of species to assess food web indicators – the natural interconnection of food chains.

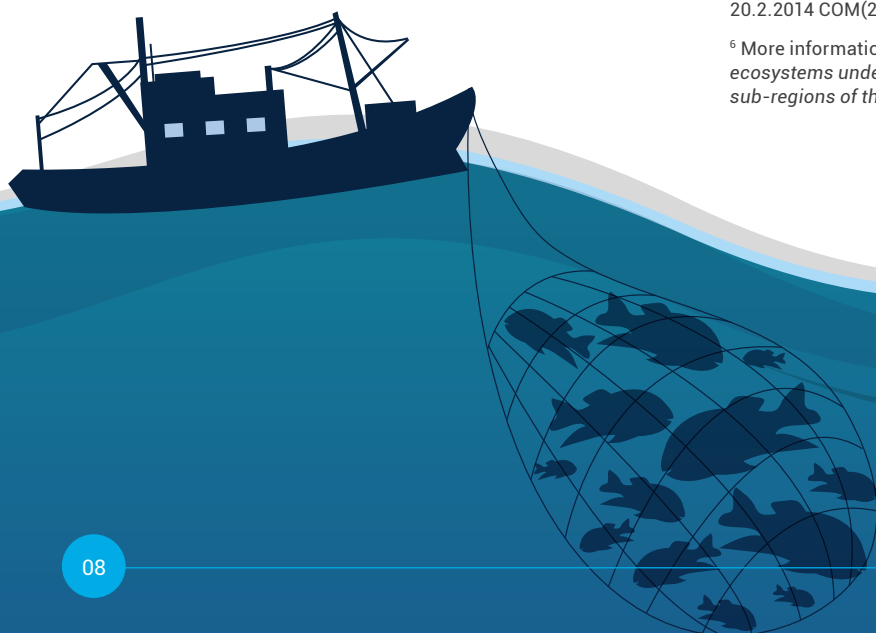
So, as Bluefin tuna (*Thunnus thynnus*) is a key species in Mediterranean fishing, PERSEUS has provided infor-

mation on specific essential habitats for this species and particularly on its spawning areas in relation to environmental variability. PERSEUS outcomes suggested that long-term sustainability of tuna stocks can only be achieved by integrating knowledge acquired from various scientific disciplines, as well as from stakeholders (e.g. fishermen) in order to better understand, respond, and adapt to changes affecting the marine environment and its resources.

Another area of the work of PERSEUS focused on providing reliable estimates for fishing effort, which constitute valuable information for estimating total catch and is used for management purposes, especially with regard to meeting the requirements of the Common Fishery Policy (CFP). An innovative methodology was developed for which assessed the fishing effort using the Vessel Monitoring System (VMS) as well as for estimating fishing pressure from coastal fisheries, where most of the vessels' operation/fishery statistics are unrecorded. An example of this methodology has been applied in Greek waters, and can also be used for other types of fisheries/fleets (e.g. trawl fisheries in non-EU countries) to provide basin-wide estimations of the fishing pressure from the different fleets.

⁵ Report from the EC to the Council and the European Parliament, 20.2.2014 COM(2014) 97 final

⁶ More information in PERSEUS Deliverable 2.5 "Response of benthic ecosystems under the influence of coastal pressures in different sub-regions of the South European Seas (SES)"



The solutions/tools

Building simplified food web models in different Mediterranean areas to study their evolution

Ascribing species to “functional groups” and assessing their spatial and temporal variability is an objective way to identify dominant pressures and links between these groups. The methodology developed by PERSEUS proposes that **functional groups can be used to monitor the state and dynamics of Mediterranean food webs**.

Application of predictive modelling for Bluefin tuna spawning grounds

PERSEUS has setup a **decision-support tool to predict spawning areas of the Atlantic Bluefin tuna**.⁷ The key oceanographic factors that influence tuna spawning must be considered, as oceanographic conditions play an important role in influencing Bluefin tuna ecology and represent a key factor in determining where it spawns.

Vessel Monitoring System (VMS) Geoportal Tool

PERSEUS has developed a **Vessel Monitoring System Geoportal Tool**⁸ for the identification of areas with high fishing pressure. This tool shows the operation strategies of fishing fleets, identifies fishing grounds, etc., and visualises the results of the analysis through a web-based GIS platform, making it easier to monitor fishing pressure. The online tool is available on the PERSEUS website.

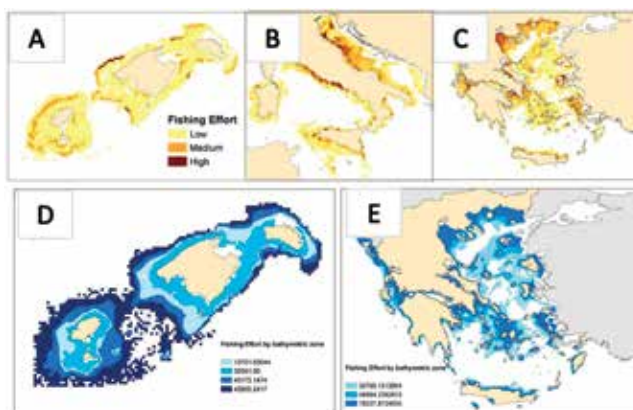


Figure 4: VMS system output sample - fishing effort from bottom trawlers in A) Balearic Islands, B) Italy, C) Greece and fishing effort by bathymetric zone, D) Balearic Islands and E) Greece.

Recommendations

Key recommendation 4: Policy makers should ensure funding for the **collection of science-based evidence to capture the state and dynamics of food webs** (which can be used as signals for ecosystem regime shifts) and to **identify “Essential Fish Habitats”** (e.g. tuna spawning grounds) that would lead to the adoption of suitable spatio-temporal management measures.

Key recommendation 5: Policy makers should support the **development of solid and innovative methodologies for estimating fishing pressure** on a basin-wide scale, which could contribute to the effective management of fishery resources in the SES thus avoiding overfishing of stocks. Methodologies developed by PERSEUS for fisheries management could be shared and implemented together.

⁷ PERSEUS Fact Sheet “A multi-disciplinary approach to managing Atlantic Bluefin tuna in the Mediterranean Sea” available at: http://www.perseus-net.eu/assets/media/PDF/EU_Maritime_Day_May2015/4263.pdf

⁸ The PERSEUS Vessel Monitoring System Geoportal can be accessed from the PERSEUS website.

Risk factor 3: Non-indigenous species

The findings

Numbers of non-indigenous species have been increasing in most study areas after 2000. They are a threat to ecosystems and communities. Climate change is an important factor in their spreading.

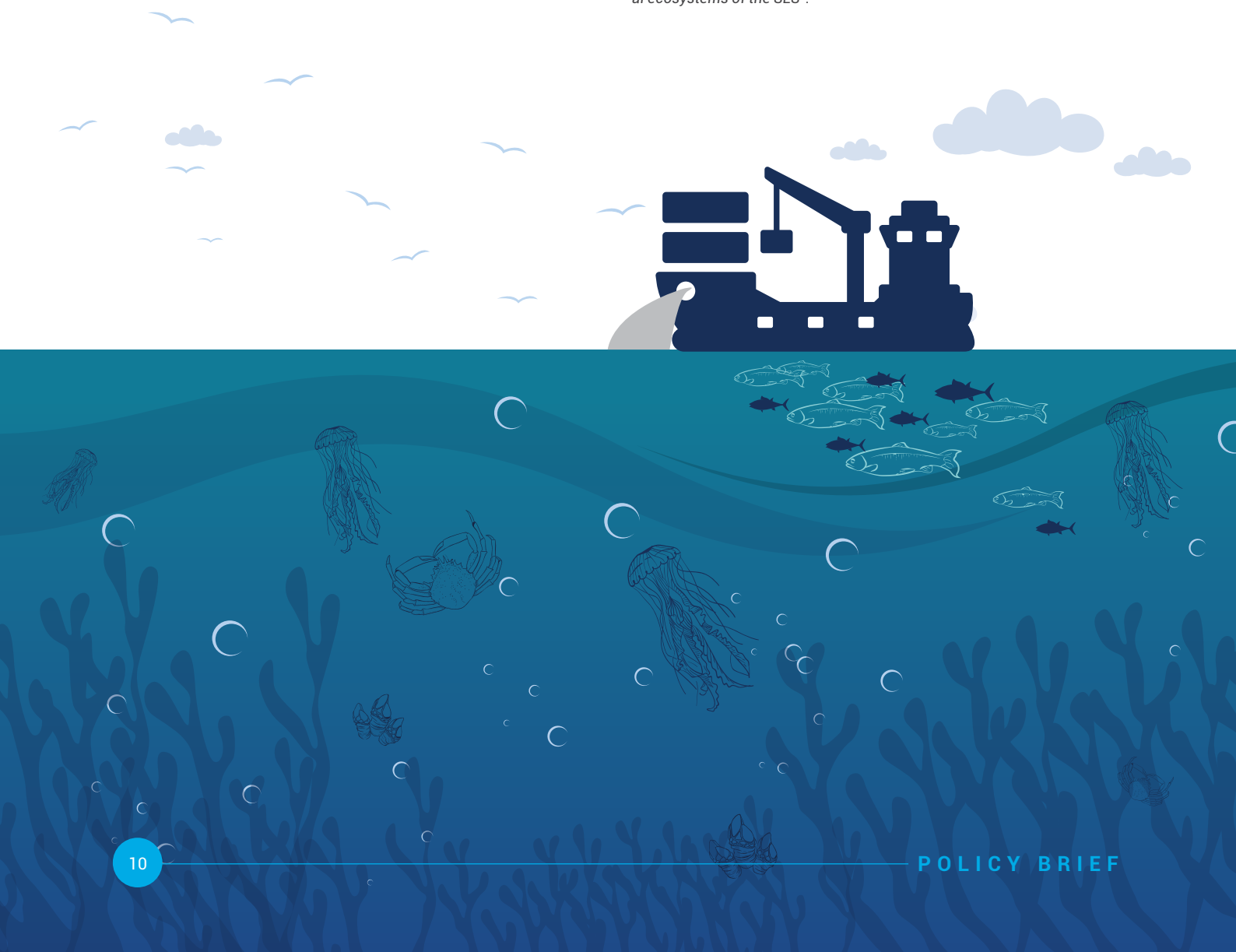
PERSEUS has obtained data on trends in the abundance and spatial distribution of non-indigenous species (NIS) as well as an estimation of the ratio between invasive NIS and native species. This has contributed to filling gaps in the understanding of ecosystem response to this pressure.⁹

Preventing the introduction of Red Sea species into the Mediterranean and the Black Sea via the artificial canal (Suez) unaided may not be feasible, but preventing entry and spread of NIS introduced via shipping is an option. To this end the ratification of the International Maritime

Organization (IMO) Ballast Water Conventions by Mediterranean and Black Sea countries is essential.

In the same vein, the accidental release of further species from marine aquaria (both private and public) could be reduced by raising public awareness of the threat this may pose. Managing the already established and expanding NIS within the Mediterranean, might sound like utopia, but some measures for reducing them could prove effective, especially after the recent widening of the Suez Canal.

⁹ More information in PERSEUS Deliverable 2.8 *"Impact of NIS on coastal ecosystems of the SES"*.



The solutions/tools

Tool: Jellyfish Spotting Citizen Science campaign

PERSEUS and other research projects have highlighted that the gelatinous plankton referred to as jellyfish is particularly hard to monitor because their patterns of occurrence are often unpredictable. Consequently, field observations to detect/monitor jellyfish blooms and especially the non-indigenous jellyfish (which can be dangerous) are difficult. As a result, visual observations remain the main method for monitoring jellyfish populations. In this respect, PERSEUS has launched a large-scale outreach activity called the “Jellyfish Spotting Campaign”.¹⁰

The campaign is aimed at encouraging “citizen scientists” mostly beachgoers to record jellyfish sightings and to submit them, together with photos where possible, on the dedicated online facility on the PERSEUS website. Thanks to this campaign, since its launch in 2012, recordings of this species have helped in identifying non-indigenous jellyfish in the Mediterranean with over 10,000 sightings registered since the launch of the campaign. Interestingly, a new species of yellow jellyfish was discovered in the North Adriatic Sea through this citizen science project. As this species has never been identified, the PERSEUS team had the privilege of naming the new NIS in the Mediterranean as *Pelagia benovici*.

Tool: Continuous Plankton Recorder (CPR)

In a new initiative for the SES, NIS pathways have been studied through systematic CPR monitoring and capacity building. This has been undertaken for the first time in the Mediterranean Sea. PERSEUS deployed a CPR on a tanker located in a line from Cyprus to Haifa. This allowed the PERSEUS team to monitor the pathway of NIS from the Suez Canal to the rest of the Mediterranean (Levantine waters) and in this way, served as an early warning system.¹¹



Recommendations

Key recommendation 6: Since the impact of most NIS has not been quantified, policy makers should foresee the **regular monitoring of hot spot areas** for assessing changes in the community structure **using CPR instruments and DNA meta-barcoding monitoring tools**. This also includes the development of a scanning list of potentially invasive harmful marine species in the Mediterranean.

Key recommendation 7: National and local authorities need to encourage the **set-up of an “Early Warning system”** through contribution to/from national and EU-scale registries.

A strategy also needs to be established for the management of already established and expanding NIS within the Mediterranean. Among the suggested measures in this strategy could be: i) developing target species fishing, and ii) promoting the consumption of edible NIS among crabs, fish and molluscs to the general public.

Key recommendation 8: Programmes for raising public awareness should be established especially for the most threatening among these species. Engagement of all relevant stakeholders, including citizens, for the further **development of existing national networks** in order to identify, report and register the distribution of NIS within each country can be established.

¹⁰ The Jellyfish Spotting Campaign can be accessed through the PERSEUS website.

¹¹ More information in PERSEUS Deliverable 3.3 “New Observing Components”.

Risk factor 4: Marine litter

The findings

Marine litter is among the MSFD descriptors with the most gaps in data and method availability.

Marine litter, according to the recent G7 Science Ministers meeting and the resulting Declaration (8 & 9 October 2015 in Berlin), is a top priority among environmental concerns.

Research conducted by PERSEUS was based on the collection of harmonised data from beaches, surface waters, the deep sea floor, as well as the accumulation of micro-plastics. This research was carried out for the first time across basins involving a number of countries around the Mediterranean and Black Sea, based on common methodological approaches. In addition, new approaches, based on visual observation of floating marine macro litter, were introduced. Marine litter studies in PERSEUS were organised to provide the necessary scientific and technical basis for further implementation of monitoring within MSFD and the adequate knowledge to support reduction measures.

The Mediterranean Sea is an accumulation zone of marine litter, with pathways and sinks still unclear. **The main component of this floating litter is plastic, which comprises up to 95% of litter accumulated on shorelines, ocean surface waters and the sea floor.** Cigarette butts are the main marine litter component found on Mediterranean beaches, while plastics bags on the sea floor comprise almost 50% of all plastic litter.

The Black Sea, on the other hand is one of the many marine regions where abundance and distribution of marine litter remains unknown and/or hard to quantify. PERSEUS carried out dedicated marine litter studies on the sea floor of the basin where the MSFD protocol was used, which showed that plastics (45%) and metals (22%) were predominant.



The solutions/tools

Tool: Multi-disciplinary approach to surveying marine litter

Innovative approaches were used by PERSEUS to survey and harmonise data from all different types of marine litter – i.e. beach litter, seafloor litter, deep sea litter and floating litter.¹² By applying the same data protocol across all survey types, the resulting data provides a more solid scientific and technical basis for further implementation of monitoring within the MSFD and knowledge to support reduction measures.



Tool: Marine LitterWatch

Beyond the scientific results, the project provided scientific support for the Marine LitterWatch¹³ (MLW) smart-phone application, which was developed by the European Environment Agency (EEA). The app is a modern tool for monitoring beach litter, based on a scientific protocol which can be used for both MSFD monitoring and environmental awareness (citizen science). PERSEUS helped to harmonise the monitoring protocols and provided a number of pilot tests before its launch.

Following its launch in Spring 2014, PERSEUS created an extensive survey network dedicated to beach marine litter by launching the **PERSEUS Marine LitterWatch (MLW) Campaign**. A total of 41 beaches have been adopted by PERSEUS partner institutes and have been regularly surveyed for marine litter. The data collected through the Marine LitterWatch app is submitted to a central database hosted by the EEA which is readily available (open-access), thus providing a central repository for this information across Europe.

Recommendations

Key recommendation 9: Regional and national authorities need to work towards the **organisation of large-scale, harmonised monitoring to produce quality-controlled data**. Coordinating monitoring will enable better understanding of the links between pressures and impacts on marine ecosystems, while helping to identify marine litter pathways and sources (hot-spots) and support policy makers in establishing reduction targets and measures.

Key recommendation 10: National and local authorities need to take all necessary steps to **prevent losses of plastic material during production and use**. This can be done through increasing public awareness, encouraging better consumer behaviour through recycling programmes and reducing most single-use every day plastic items.

Key recommendation 11: National and local authorities need to **effectively reduce marine litter at source**. This includes improving the collection of municipal waste, introducing efficient and effective management schemes (especially for urban and coastal areas), as well as implementing coordinated, transnational, environmental education and campaigns across countries.

¹² More information in PERSEUS Deliverable 2.7 “Impact of pollution (including contaminants, litter and noise) on coastal ecosystems in the SES” and relevant fact sheet on Marine Litter.

¹³ Links to access the Marine LitterWatch app are available on the PERSEUS website.

What new observing systems and other new tools does PERSEUS provide to better manage these risks?

New Ocean Observing Systems

The findings

PERSEUS has identified data gaps and improved existing observation capabilities and has advanced towards an integrated monitoring system. PERSEUS has developed a long-term vision and strategy for an Integrated Ocean Observing System in the Mediterranean and Black Sea.

The Mediterranean and Black Sea are important seas with well-known scientific and societal specificities that demand a strategy for a sustainable Integrated Ocean Observing System (IOOS).

Our potential to implement knowledge-based management in facing environmental challenges will be based on our capacity to monitor temporal and spatial variability that range from global to regional ocean variability and coastal to open ocean exchanges. This includes streams, fronts and eddies at mesoscale and sub-mesoscale patterns of flow. However, the three-dimensional nature of marine space, along with the temporal variations on different time scales, poses a huge challenge to data acquisition, treatment and evaluation. In addition, data availability, data coverage and data quality are not sufficient for assessing the basic features of ecosystem processes.

In the long term, a system of systems should be created in the SES, where each region is responsive to local needs, harnessing the power of a common strategy and vision to improve scientific knowledge and environmental sta-

tus across the basin and overcoming threats, supporting opportunities and identifying trends and delivering sustainability.

PERSEUS has reviewed information on the data currently available across multiple observing platforms to understand the gaps and needs in ocean observations. It is on this basis, that the development of the long-term IOOS in the Mediterranean and Black Sea is considered not only vital, but also possible.

PERSEUS¹⁴ has addressed scientific and societal needs through new multi-platform observing systems, with emphasis on the characterisation of the state of the ocean and its variability, across a range of scales, to support the needs of society to better understand and model the ocean, within the long-term context of climatic change, whilst supporting sustainability initiatives such as the achievement of GES through MFSD.

¹⁴ PERSEUS Fact Sheet on Ocean Observing Systems can be found at: http://www.perseus-net.eu/assets/media/PDF/EU_Maritime_Day_May2015/4256.pdf

The solutions/tools

An Integrated Ocean Observing System for the SES

The Vision for 2030 is a system of observing and forecasting systems in the Mediterranean and Black Sea, providing key ocean variables ranging from days to decades and from the coast to the open sea, in response to science and societal needs, contributing to citizens' quality of life and welfare, supporting the sustainable use of our common ocean resource and contributing to the challenges posed by climate change. The pathway to achieve this is outlined in Deliverable D3.11 "Strategy for an Integrated Ocean Observing System in the Mediterranean and Black Sea (Recommendations for European long-term sustained observations in the SES)".



Recommendations

Key recommendation 12: Policy makers need to **optimise the existing infrastructure of observing and forecasting systems** in the Mediterranean and Black Sea. This should start from improvements in their coordination based on strong partnership, real multidisciplinary integration that responds to science, technology and societal drivers, with open and interoperable data principles, and involving key international organisations and sound governance.

Key recommendation 13: National and local authorities need to **create and reinforce strategic coordination with other regional in-situ ocean observing systems**, as well as with the operational modelling and satellite communities. This deeper connection with the numerical modelling community, through a two-way dialogue, will provide tools for the optimisation of the observing strategy which will result in better forecasting. There should be similar interaction among the satellite remote sensing community in order to improve satellite calibration and products.

Key recommendation 14: National and local authorities together with the wider scientific community need to **assess the system's gaps and needs**. In particular, the under-sampling of the North African coast is an issue that requires specific coordinated (political) action and vigorous capacity building, in tandem with continued effort at the regional level through local contacts.

Key recommendation 15: Regional and national authorities need to guarantee that **existing observing systems are widely adopted and operate in coordination**. This action is perceived as urgent and of high importance. The **long-term life and sustainability of the existing observing systems** should be pursued and continued even after the end of the PERSEUS project in 2015.

Key recommendation 16: Regional and national policy makers should fund the development of **long-term observations of the ocean environment**, which are today essential in the climate change framework, both on the ocean coasts and on the open seas. A harmonised methodology is needed, from processing into a meaningful set of numbers to the final gathering in user-friendly databases. The lack of these **long-time series** hinders progress for better assessment and the attainment of good environmental status (GES) of the marine environment.

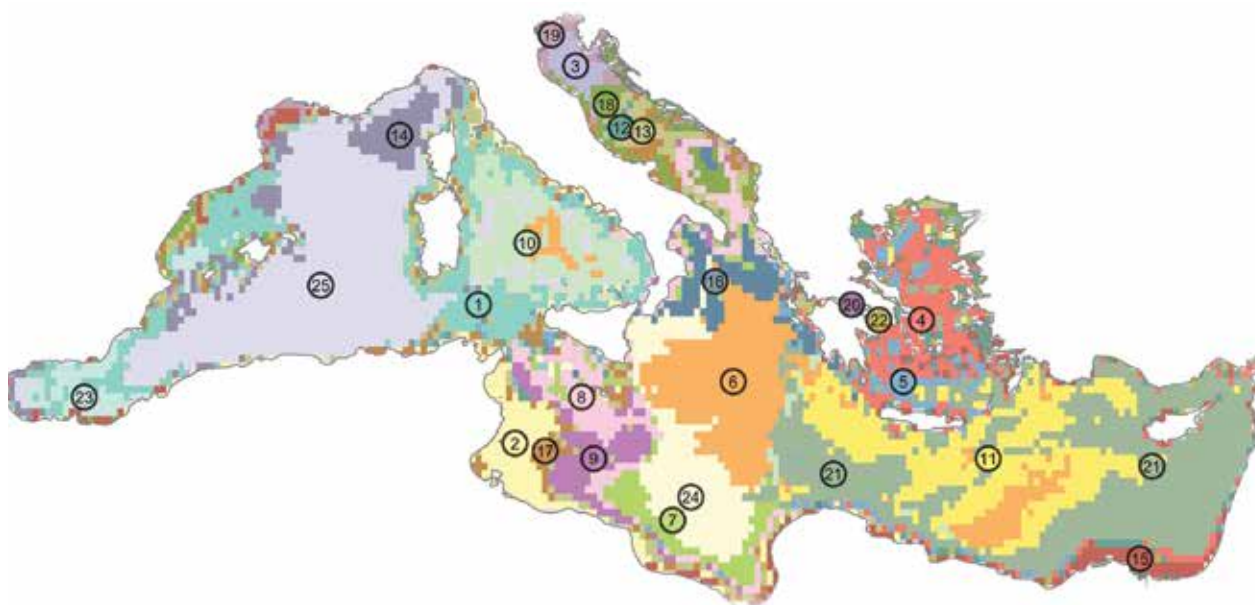
Key recommendation 17: Regional and national authorities need to ensure that **data portals are available and easily accessible**. National statistics authorities need to strengthen their collaboration in order to facilitate the comparison and the harmonisation of data which are essential for developing programmes of measures and adaptive marine policies.

The findings

PERSEUS has introduced a new approach, ecoregionalisation, for characterising the present state and variability of marine ecosystems.¹⁵

Ecoregions are unique macro-assemblages of flora, fauna and the supporting geophysical environment which is contained within distinct but dynamic spatial boundaries. Such ecological partitioning provides a better understanding of biogeochemical or ecological processes on a regional scale, and is an innovative tool for ecosystem management. PERSEUS has provided an ecological, geographical framework characterising the main assemblages of species and their environmental features, and quantifying the various environmental and human factors at play in the Mediterranean Sea.

The Mediterranean Sea has been divided into 26 ecoregions based on the identification of these main biological assemblages. Out of these 26 ecoregions, PERSEUS has identified seven ecoregions with the highest risk of environmental disturbance, namely: the Algero-Tunisian coast, the Adriatic Sea, the Aegean Sea, the Gulf of Gabes, the Catalan coasts, the Gulf of Lions and the Egyptian coast.



Recommendations

Key recommendation 18: Research should be targeted to **update analytical tools for detection and modelling of changes** in the ecosystem and its biodiversity in relation to human and natural pressures, as this will enable its effective and long-term management. The modelling of long-term scenarios in the Mediterranean Sea and Black Sea is needed in order to support decisions on measures, in particular with regards to the long response times of marine environment.

¹⁵ PERSEUS Fact Sheet: "Defining ecoregions of the Mediterranean Sea". Available at: http://www.perseus-net.eu/assets/media/PDF/EMD_Megaro_Mousikis_May2015/4252.pdf

What lessons does PERSEUS hold for engaging policy makers, stakeholders and citizens?

Adaptive marine policy development

The findings

PERSEUS is a first-of-its-kind, marine environmental research project that is targeting a large part of its activities at creating science-based governance tools for policy makers and supporting them in developing adaptive policies for the achievement of Good Environmental Status (GES) across the Mediterranean and Black Sea.

PERSEUS has acknowledged that there is a lack of a set of tools to assist policy makers involved in implementing marine policies. This gap between scientific knowledge and policy making processes makes it difficult to develop

new policies and adaptive measures in a coherent manner, as well as to identify reference points for the current and future GES of European seas.

The solutions/tools

Adaptive Marine Policy (AMP) Toolbox

PERSEUS has developed an Adaptive Marine Policy (AMP) Toolbox,¹⁶ which provides a set of knowledge bases, models, tools and concrete examples to increase the overall capability of policy makers who are developing marine environmental policies to create the appropriate regulatory framework for achieving and maintaining GES. The AMP Toolbox is an online "decision support system" which provides user-friendly tools to support stakeholders and policy makers in defining suitable adaptive policies and management schemes for better governance of the human-made pressures on the Southern European Seas. The online interactive AMP Toolbox is available on the PERSEUS website.

Science-decision-makers interface and stakeholder dialogue

PERSEUS has employed a participatory approach to building a science-decision-makers interface enabling better management of the human activities affecting the Mediterranean and the Black Sea. This interface included both the Adaptive Marine Policy (AMP) Toolbox (see above) and Stakeholder Platforms (SHPs) built at the pilot case and basin level. The role of the SHPs was two-fold: (i) to help with the design of the AMP Toolbox; and (ii) to contribute to its testing and improvement.

Recommendations

Key recommendation 19: National and local authorities need to produce adaptive measures and policies, with cost and performance data, which can facilitate marine environmental management and improve the implementation of marine policy framework provisions. Decision-making tools such as the Adaptive Marine Policy Toolbox can contribute to the development of programmes of measures. Authorities need to continue to update, develop, and disseminate the AMP Toolbox to build up a repository of best available results, practices, and science-based evidence for policy makers and stakeholders. This rich resource centre supports the definition of adaptive policies and management schemes in support of GES of marine environments.

Key recommendation 20: Adaptive policy mechanisms need to be developed and integrated into national and local strategies supported by strong collaboration between policy makers and scientists involved in political processes to contribute to the harmonisation and optimisation of marine environmental policies and ultimately achieve GES. Further development is necessary at the criteria and indicator level, along with the establishment of appropriate reference

Key recommendation 21: Maintain and foster the momentum of stakeholder dialogue activities by continuing and consolidating stakeholder platforms, both at the pilot case and basin levels, to build a bridge between scientists and policy makers and to encourage the exchange of experience.

¹⁶ PERSEUS Fact Sheet "The PERSEUS Adaptive Policy Framework (APF) Toolbox" is available online.

The findings

Training young scientists and raising awareness of citizens and civil society at large in the management of the marine environment is not optional; it is mandatory.

The PERSEUS project has undertaken a series of communication actions and activities ultimately targeting the general public with a view to changing their behaviour and facilitating the achievement of GES. The project's outreach strategy included activities such as: training

opportunities for students and mid-career professionals, capacity building programmes for scientific and technical personnel and visit schemes among and for PERSEUS partners. All details are available on the PERSEUS website.



The solutions/tools

Engaging citizens through ocean literacy, citizen science and outreach

PERSEUS activities target young and mid-career professionals to further the dissemination of tested and approved MSFD implementation methodologies and increase their knowledge. They range from scientists to policy makers, to managers of protected marine areas, to stakeholders involved directly in a range of marine sectors. This in turn further promotes a new scientific vision within SES for the judicious management of the marine environment and its resources while protecting its assets.

PERSEUS has recognised and highlighted the importance of fostering active public participation in marine research and has identified best practices for public involvement. In light of this, PERSEUS has organised major outreach campaigns, including:

1. PERSEUS@School Ocean Literacy programme.¹⁷ This initiative offered an opportunity for school students to study environmental issues and problems in their region and to share opinions about the different ways in which young people can help to protect the historic waters of the Mediterranean and the Black Sea.
2. PERSEUS@ART: Images of the Sea.¹⁸ This campaign involved the organisation of an art competition in order to introduce the art dimension into the world of science and vice versa.
3. The "Citizens Scientists" programmes.¹⁹ These programmes include the "Jellyfish Spotting" and "Marine LitterWatch campaign" (see above), which give the general public an opportunity to help the scientific community conduct its research.

Clean Seas Communication & Outreach Best Practice Guide

Policy makers are called upon to create legislation and regulations and put in place strategies to protect and manage our precious marine environment; however, in many cases this does not gain wider public acceptance. Not enough attention is paid to educating the public on their important role in mitigating their negative impact on the marine environment, especially when they are interacting with the seas in many ways.

The *Clean Seas Communication & Outreach Best Practice Guide* of PERSEUS has been developed to provide clear information on the types, scope and ways of undertaking citizen communication and public awareness activities that can make a significant difference to the state of the marine environment in the SES.

This guide, a first of its kind, is addressed to policy and decision makers, who are encouraged to integrate awareness raising and communication campaigns as a key policy measure to stimulate changes in behaviour among citizens to adopt eco-friendly practices. Clearly, such changes in behaviour can have a far-reaching positive effect on the Good Environmental Status of the Southern European Seas.

Recommendations

Key recommendation 22: National and local authorities need to **organise education, exchange and capacity building activities for professionals at different organisational levels**. These are crucial for basin-wide and long-term success of any marine policies.

Key recommendation 23: National and local authorities need to adopt policy measures aimed at **promoting information, education and capacity building activities for the general public** as part of a successful long-term strategy.

¹⁷ More information on the PERSEUS@School initiative is available on the PERSEUS website.

¹⁸ More information on PERSEUS@ART can be found on the PERSEUS website.

¹⁹ More information on the "Citizens Scientists" programmes can be found on the PERSEUS website.

What are the overarching PERSEUS messages and recommendations?

While specific recommendations have been provided above to specific themes that PERSEUS has addressed, a few important overarching messages and recommendations are aimed to catch to the attention of policy makers in the Southern European Seas. Even if some of these are "known", they bear repeating so as not to lose sight of the big picture issues that underpin all marine policy frameworks.

PERSEUS has had the privilege of working closely, not only with the European Commission within the framework of the MSFD, but also with the UNEP MAP and the Black Sea Commission (BSC), supporting their respective marine policy frameworks which are based on the same scientific principles.

"PERSEUS not only contributed scientific advice to UNEP MAP's marine environment policy work, but also led the way in putting in place a real collaboration. For the last four years, we had the opportunity to work closely with the scientific community of PERSEUS and through this regular formal and informal exchange, many positive results were achieved. The most important result, however, has been a better understanding of the true added value of the policy-science interface."

Tatjana Hema, Programme Officer, United Nations Environment Programme,
Mediterranean Pollution Assessment and Control Programme (MED POL)
Mediterranean Action Plan for the Barcelona Convention (UNEP MAP)

"The role of the PERSEUS project in the Black Sea Commission's activities cannot be underestimated. It simply helped us to link the two important, but at the same time, challenging components: on the one hand, maintaining the policy-science dialogue and on the other hand, ensuring synergy between approaches in the Black Sea and the Mediterranean Sea, our strategic partner."

Irina Makarenko, Permanent Secretariat, Black Sea Commission,
Commission on the Protection of the Black Sea Against Pollution

Science-policy interface

Key messages

Marine policy frameworks depend on scientific knowledge to plan, set up and implement their provisions. The three marine policy frameworks in the Southern European Seas (MSFD, UNEP/MAP and the BSC) need to continue close collaboration for a truly integrated approach across the basins.

For four years, PERSEUS has worked closely with the Regional Sea Conventions, UNEP/MAP and the BSC. PERSEUS has acted as a "scientific advisor" in support of their respective policy frameworks. This collaboration broke new ground and provides a real working example of the effectiveness of linking scientists to policy makers:

Recommendations

- A. Establish a permanent, institutionalised science-policy interface for the SES in order to provide targeted, neutral and reliable scientific knowledge for these policy processes.
- B. Give priority to funding scientific work that specifically supports the marine policy framework priorities in the SES.
- C. Establish from the inception of the problem/issue, a direct connection between science and policy players, in the spirit of mutual benefit and trust.

Basin-wide collaborations

Key messages

PERSEUS was one of the first research projects to work with the stakeholders from all countries around the two basins. At the concluding national stakeholder events held in several countries across the two seas, i.e. Croatia, Georgia, Morocco, Tunisia, Turkey and Ukraine, one clear message was heard repeatedly from all stakeholders: **there is a sincere need for and interest in transnational cooperation.**

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 the needed link to research projects such as PERSEUS, which enhance the interface between policy and science.

Recommendations

- D. Support the development and implementation of collaborative projects between EU and non-EU actors to coordinate actions, provide spatial coverage and have effective knowledge transfer.
- E. Support the adoption at EU and non-EU level of a common framework and regional approach with regards to (i) environmental policy development; (ii) common monitoring practices and (iii) use of common assessment tools. Scientific projects can help in this direction.
- F. Encourage the scientific community to share data, information knowledge, know-how, and tools across the basins to produce wider regional solutions for keeping our seas sustainable. Above all, the scientific community should be able to provide the scientific “wisdom” and deliver answers to policy questions and issues.

Advocating for interdisciplinary scientific teams

Key messages

PERSEUS has successfully implemented an interdisciplinary collaboration by bringing together experts belonging to the natural sciences and socio-economic disciplines. Although this collaboration was not always easy, the work has proved to have a positive effect on both groups of experts as each realised the needs of the other. In addition, by merging these experts, policy makers get a better result as the hard science is transformed into various policy option scenarios.

The interdisciplinary approach, although still challenging, creates opportunities for good collaboration between the social and the natural sciences to manage complex environmental issues.

Recommendations

- G. Promote cross-disciplinary research and cross-sector research collaboration to address complex marine challenges, bringing together natural and social sciences, marine law and governance with expertise from both the public and private sectors.
- H. Encourage collaboration among individuals and experts belonging to different disciplines.

Smart monitoring

Key messages

PERSEUS has led the way to developing a smart monitoring strategy in the SES which combines traditional methods, integrated observing systems and models.

Despite significant scientific progress in the few last years, there is still a fundamental need for process-oriented knowledge to gain an accurate understanding of the state of the ocean today and its variability in the past and future. For this, sustained and reliable monitoring systems on different scales are needed. The set-up of a clear and fully-integrated system would help in enhancing the predictability of the oceans as well as the understanding of its complexity across a wide range of parameters and scales.

Recommendations

- I. Support the adoption of a long-term Strategy for an Integrated Ocean Observing System in the Mediterranean and Black Sea as developed by PERSEUS.
- J. Establish a coordinated and sustainable monitoring system across basins and sub-basins. This should involve the harmonisation of methodologies in order to provide reliable synoptic and long-term time series data. Countries' involvement and national investments, together with crucial EU coordination, are also needed to support these efforts.
- K. Enhance cooperation for a common framework and regional approach for both EU and non-EU states with regards to:
 - environmental policy development
 - common monitoring practices
 - common assessment tools.
- L. Encourage the use of a harmonised methodology for data management across basins.

Dissemination of knowledge & capacity building

Key messages

As part of its outreach and communication activities, PERSEUS has produced so far, over 145 published peer-reviewed papers, supported 29 PhD students and organised capacity building programmes to help key actors around the basins use an ecosystem approach in the SES.

Capacity building, exchange programmes and awareness raising through training and dissemination, should be considered as long-term investments for future successful policy implementation.

Recommendations

- M. Encourage the dissemination of research results, the exchange of knowledge and methodologies and the sharing of the capacity developed by the project with internal and external stakeholders through both training and outreach activities.
- N. Raise public awareness on the impact of human behaviour on our seas and generate excitement for "Clean Seas" – using intermediaries such as environmental organisation and the media – on what can be done by individuals to help save the "health" of our seas.
- O. Encourage widespread and on-going consultation between all stakeholders, ranging from scientists and marine experts to policy makers and the society at large, to achieve effective management of the marine environment.

Involvement of citizens

Key messages

The involvement of citizens is crucial for the successful implementation of marine policies. PERSEUS has successfully organised and rolled out many citizen engagement initiatives, as for example the PERSEUS@School Ocean Literacy programme for schools in SES. .

Recommendations

- P. Establish and develop ongoing education programmes and awareness campaigns as complementary to the design and implementation of any policy measure linked to the marine environment. Communication and awareness raising programmes are crucial elements for success in policy implementation, as a mean of gaining citizen support and stimulating positive behaviour changes.
- Q. Establish programmes and initiatives, which embed ocean literacy approaches into marine research projects and promote science communication to educate society to value marine ecosystems, goods and services.

PERSEUS Project Identity

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