Mediterranean Sea Acidification in a changing climate (MedSeA)

Patrizia Ziveri, Rahiman Abdullah and the MedSeA Consortium
MedSeA Project Office, Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona

What is MedSeA?

MedSeA assesses uncertainties, risks and thresholds related to Mediterranean acidification and warming at organism, ecosystem and economic scales. As a practical outcome, it will propose policy measures for adaptation and mitigation that may geographically vary and at the same time require coordination between regions or countries. It involves 18 institutions from 11 countries mainly from the Mediterranean. The project further aims to convey acquired scientific knowledge to a wider audience of policy-makers, decision-makers, marine managers and other stakeholders through the formation of the Mediterranean Reference User Group (MRUG).

Why the Mediterranean?

Although the general impact of acidification on water chemistry is globally well understood, fine-scale regional models are needed to resolve the complexity of the physical and ecological interactions of small and complex basins, such as the Mediterranean Sea. This process poses a threat to marine ecosystems and may bring potentially large changes in global biogeochemical cycles. In addition, this acidification may well have large socio-economic impacts ranging from those on tourism (e.g., owing to coral degradation and invasion of non-endemic species) to those on wild fisheries and aquaculture (owing to altered life cycles of key surface- and bottom-dwelling organisms, including shellfish).

Goals

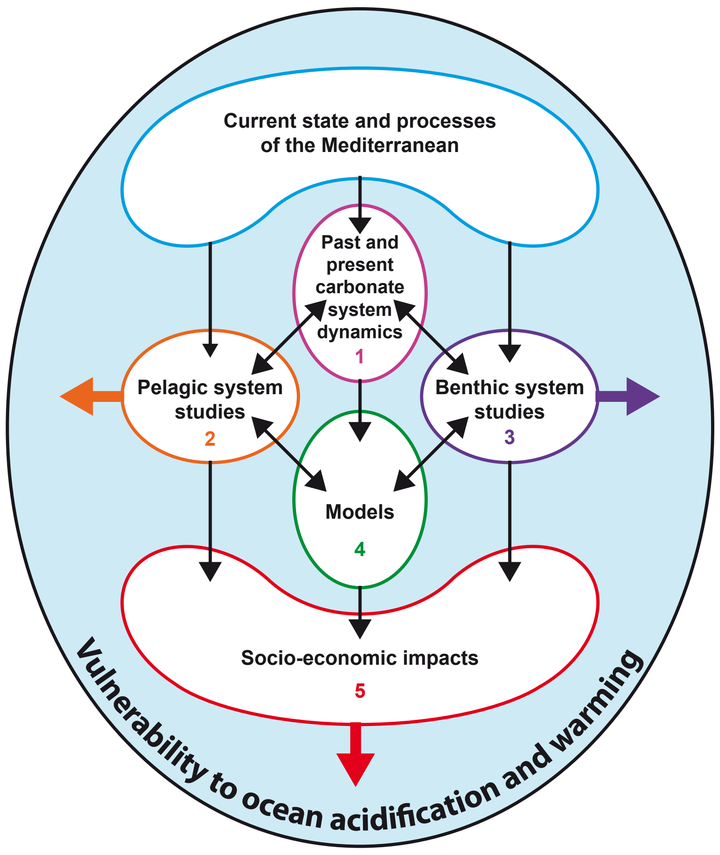
1/ Identify where the impacts of acidification on Mediterranean waters will be more significant (ocean chemistry ➞ marine ecosystems ➞ socio-economic costs).

2/ Focus on a selected set of key ecosystem and socio-economic variables that are likely to be affected by both acidification and warming, studying the combination of both effects.

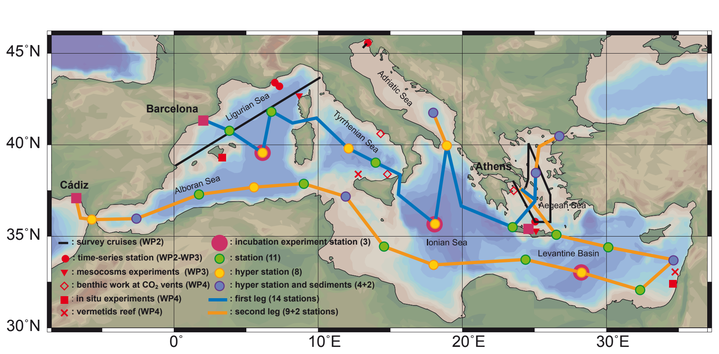
3/ Provide best estimates and related uncertainties of future changes in Mediterranean Sea pH, $CaCO_3$ saturation states, changes in habitat suitability of relevant ecological and economically-important species.

Overall Research Strategy

Research strategy is developed in 5 main overall themes :



Conceptual scheme of the MedSeA scientific work



MedSeA project sites and survey cruises

Dynamics of the Mediterranean carbonate chemistry from inter-annual to millennial timescales

- quantifying the rate of pH decrease in the Mediterranean water masses and ultimately provide maps to identify sectors of the Mediterranean Sea that are currently most affected by pH changes.
- improving anthropogenic carbon determination
- understanding the temporal evolution of the penetration of anthropogenic carbon into the Mediterranean Sea
- knowledge of long-term natural variability of the basin by providing proxy-based reconstructions of seawater pH, carbonate ion concentrations, and pCO_2 along with the response of the marine calcifiers during key intervals of the Late Quaternary

Projected impacts of acidification on biogeochemistry and Mediterranean target species

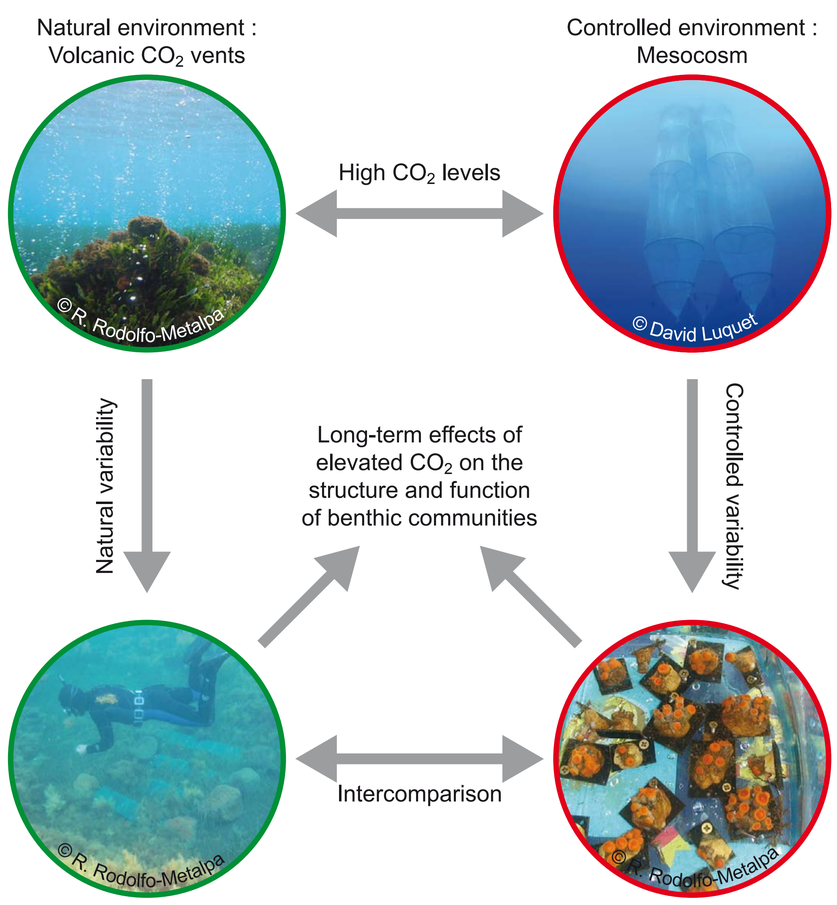
- Expanding projections of acidification to include the Mediterranean Sea by relying on modelling tools, which will aid to bridge experimental results with socio-economic studies.
- Future system responses will include differences between climate scenarios, models, and assumptions about processes. The design of simulations will allow us to (1) isolate impacts from increasing CO_2 and climate change on the carbonate system variables and (2) examine the role played by pelagic biotic processes.
- Moving this investigation from the level of biogeochemical response to the ecosystem level, one task is dedicated to constructing response functions of selected target species (shellfish, coralligenous organisms, etc.) to environmental parameters

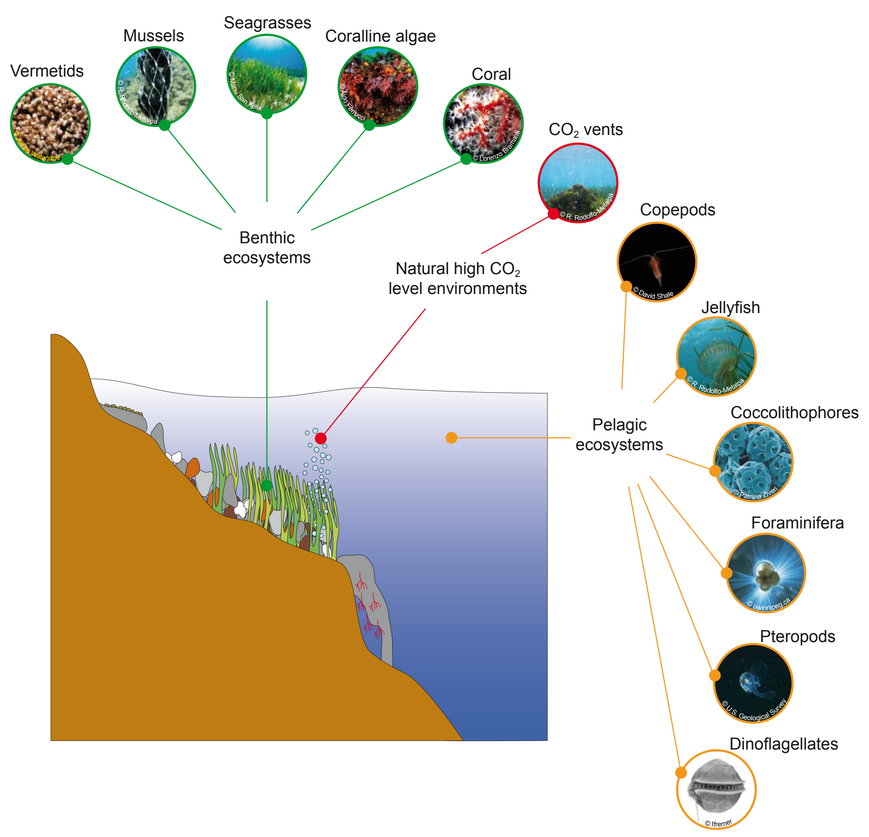
Ecosystem responses, Mediterranean key-stone species and economic impact

- Defining the susceptibility and resilience of key-stone species and endemic ecosystems to Mediterranean acidification and warming.
- Analysing our experimental results will allow projections of changes to the services that these ecosystems and species provide. Services such as nurseries for fisheries, coastal protection, tourism, carbon sequestration, and climate regulation are likely to be very sensitive to climate change.
- Constrained projections taking an interdisciplinary approach looking at physiological responses as well as ecological responses to environmental change.

In order to address geographical variability we are comparing responses between the Western and Eastern Mediterranean basins and Adriatic using:

- Plankton monitoring at selected time-series stations and regional cruises to characterize present conditions,
- Laboratory experiments, to gain information on the response of single species and strains,
- Mesocosm experiments, to determine the biogeochemical and community responses,
- Natural analogue experiments in areas acidified by CO_2 vents to determine the long-term effects of acidification across multiple generations of marine organisms.



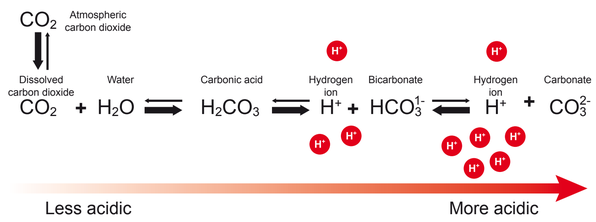


We target the study of key habitat-forming species of coralline algae, seagrass, corals and vermetids that are endemic to the Mediterranean as well as the commercially important species that these habitats support. MedSeA combines laboratory, mesocosm and volcanic CO2 vents to examine the long-term effects of elevated CO2 on the structure and function of benthic communities.

What is ocean acidification?

1. Up to 25-30% of the anthropogenic carbon dioxide (CO_2) over the past 200 years (~24 million tons CO_2 per day) has been absorbed by the world's oceans decreasing pH at an unprecedented rate.

2. This process leads to shifts in seawater acid-base chemical speciation decreasing the concentration of carbonate ions and lowering the calcium carbonate saturation state. This can pose a threat to marine ecosystems and may bring large changes in global biogeochemical cycles having important socio-economic implications.



Socio-economic effects of Mediterranean Sea acidification and potential adaptation strategies and policy tools

- Developing a conceptual framework for studying the direct and indirect socio-economic (welfare) impacts of ocean acidification and warming in the Mediterranean Sea comsidering relevant dynamics and time scales, regional patterns, mechanisms (costs, prices, etc.), valuation categories (use and non-use values and various sub-categories), economic demand categories and sectors (supply), and interactions between marine-resource based and other sectors (indirect effects).
- Sectors potentially affected by ocean acidification are tourism, fisheries, aquaculture and jewelry production from red coral. Mediterranean acidification may affect the occurrence of harmful algal blooms, jellyfish distribution patterns, shellfish physiology and major contributors to habitat building.
- Adaptation strategies and policies will be formulated on the basis of the qualitative and quantitative assessments by the natural and social science studies in the project.

Overarching activities

This project is the first one which aims to offer a comprehensive view on the physical, biological and socio-economic impacts of ocean acidification in the Mediterranean area using a so-called scale-basin approach. On the basis of this, further evidence for the social (welfare) costs of human emissions of carbon dioxide can be obtained. In addition, the results will allow to identify particularly sensitive spots in the area and formulate effective and cost-effective adaptation policies and strategies at different scale levels.

Data Management

The MedSeA Data Management in collaboration with the Marum-Pangea database collects quality controls of direct measurements from paleo-reconstructions (proxy data), seawater chemistry, field work, mesocosms, laboratory experiments; model outputs and archives data in order to facilitate a consistent information exchange.

Dissemination and Outreach

The countries surrounding the Mediterranean Sea rely on a healthy marine environment; however, they may be highly vulnerable to both these global change issues. Thus the scientific evidence must be delivered in an understandable way to policymakers and other key stakeholders in Mediterranean countries and elsewhere. The science and policy must be connected effectively and in a timely fashion. The Mediterranean Reference User Group will ensure the relevance, user- friendliness and outreach of the research.

Contact
MedSeA Project Office
Patrizia Ziveri,project coordinator
Rahiman Abdullah, project manager
Universitat Autònoma de Barcelona (UAB)
Institute of Environmental Science and Technology (ICTA)
Edifici Cn, Campus UAB, 08193, Bellaterra (Cerdanyola del Vallès), Barcelona, Spain
Phone: +34 93 586 8363
Fax: +34 93 586 8008
pr.medsea@uab.cat

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http://medsea-project.eu

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