# Rising concerns *about Ocean Acidification and Warming in the Mediterranean Sea*

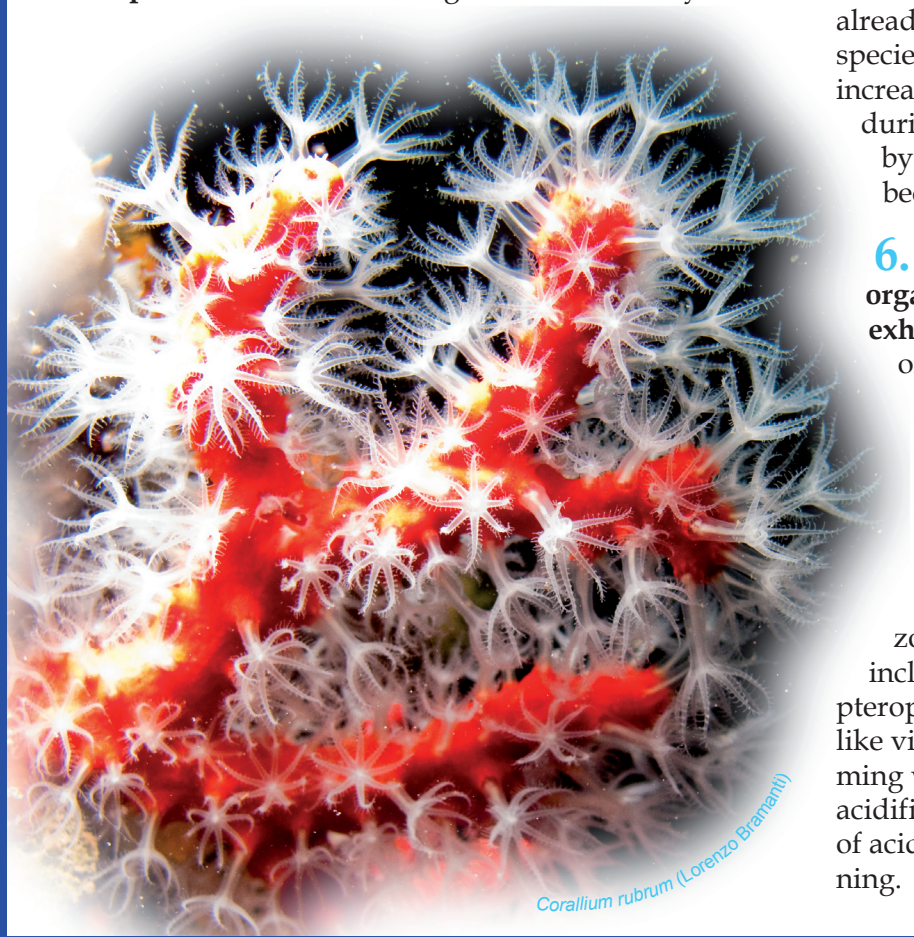
## Executive summary of the MedSeA project

**This fact sheet has been compiled as part of the European project Mediterranean Sea Acidification in a changing climate (MedSeA). It is intended to aid scientists, science communicators, and science policy advisors. The MedSeA project included more than 100 scientists from 22 institutions in 12 countries. For information and contacts please consult www.medsea-project.eu.**

**1. As carbon emissions increase and carbon dioxide levels ($CO_2$) in the atmosphere rise, so does the concentration of $CO_2$ in the ocean.** The ocean has been very efficient in absorbing $CO_2$ and this has decreased the accumulation of $CO_2$ in the atmosphere and thus reduced the potential 'warming' effect on our climate. However, we have reached a point where the ocean is absorbing so much $CO_2$ that it is changing the chemistry of the ocean resulting in 'ocean acidification'. This poses a threat to open ocean and coastal marine ecosystems, including the Mediterranean Sea.

**2. The Mediterranean Sea has shown an average temperature increase of 0.67°C over the last 25 years.** This deep semi- enclosed sea is characterized by an active exchange of waters from the surface to depth, a process known as 'ventilation', which effectively distributes the heat and anthropogenic carbon to the interior of the basin so not only are the deep waters warming but they are acidifying too.

**3. Atmospheric $CO_2$ is projected to reach a concentration of 550 parts per millon (ppm) by 2050 if urgent measures to reduce carbon emissions are not implemented.** There is a high level of certainty that this change to the atmosphere will lead to an average surface warming from 1 to 1.5°C in the Eastern Mediterranean, Aegean and Adriatic Sea between 2000 and 2050. In summer, the average surface temperature is very likely to constantly exceed 29°C in the South Eastern Mediterranean.



*Corallium rubrum* (Lorenzo Bramanti)

**4. Absorbing anthropogenic $CO_2$ from the atmosphere is by far the largest driver of the acidification of Mediterranean Sea surface waters.** The few, available,data sets from the Northwestern Mediterranean Sea indicate that in the 18-year period 1995–2013 alone, acidity has already increased more than 10 %. Projections of $CO_2$ emissions indicate a sustained uptake of anthropogenic carbon in the ocean and a 30% increase in acidification between years 2010 and 2050 if we continue to emit $CO_2$ at the same rate. This implies, since the industrial revolution and within only a few decades, acidification of the Mediterranean Sea is likely to increase by 60%, and by 150% at the end of the century.

**5. Both ocean warming and acidification are altering the marine life of the Mediterranean Sea.** Consequences for Mediterranean Sea warming are already apparent, including northward shifts of species from the southeastern shores of the basin and increasing incidences of marine organisms dying during unusually warm summers. The risks posed by warming and acidification are expected to become more acute in the next decades.

**6. Impacts of ocean acidification on marine organisms will vary, because different groups exhibit a wide sensitivity.** Several planktonic organisms are affected by acidification suggesting that Mediterranean plankton food web may be altered in the future. Several plankton organism are essential in the diet of fish larvae and consequently this can also have a negative impact on fisheries population. Acidification and warming modify the abundance and the functioning of both phytoplankton and zooplankton groups living in the Mediterranean, including those of shell-forming organisms like pteropods and coccolithophores. Other marine biota, like viruses and bacteria appear less sensitive. Warming will probably have a more important effect than acidification on plankton, and may enhance the effect of acidification on the planktonic ecosystem functioning.

**7.** **Iconic Mediterranean ecosystems such as sea grass meadows, Coralligene reefs and Vermetid snail reefs are threatened by ocean acidification and warming.** These ecosystem-building species create rich key habitats and homes to thousands of species, and also protect shores from erosion as well as offer a source of food and natural products to society. Sea grass meadows are essential habitat as feeding ground and nursery areas for many fisheries species. These hot-spots of Mediterranean Sea biodiversity prospered over millennia and served human populations in the region, but are now facing considerable decline. The slowly growing Mediterranean red coral (*Corallium rubrum*) is extremely sensitive to ocean acidification conditions. This has major implications for the Red Coral industry which has not only economic significance but also cultural importance in the Mediterranean region.

**8.** **Impacts of ocean acidification and warming may extend to several Mediterranean marine and coastal ecosystem services, including providing food, supporting recreational activities, absorbing carbon, climate regulation, and coastal protection.** Coastal areas with economic activities directly depending on marine resources may face serious impacts on employment and benefits in sectors like aquaculture, open sea fisheries and tourism which is relevant to many Mediterranean countries. In addition, coastal protection by Vermetid reefs may be negatively affected by ocean acidification, which is relevant to certain areas in south central and eastern Mediterranean.

Mussels farming (Andrea Ciambra)

**9.** **Sensitivity of shell-forming species such as bivalve mollusks (e.g. mussels, clams and oysters) to changes in pH and temperature represent a threat to the aquaculture sector of this region, which is an important source of income, employment and food.** Total production of this sector amounts to about 153,000 tons in 2012, representing a total value of approximately € 225 million. Increasing of jellyfish outbreaks could also determine the total mortality of the fishes in the cages as it is already occurred in some areas of South of Mediterranean.

**10.** **Tourism may be affected by ocean acidification and warming through degradation of marine ecosystems (loss of iconic species from the coralligenous, such as gorgonians - soft coral) on diving experiences and through jellyfish outbreaks.** Initial cost estimates for such effects have been obtained. For example, on the Israeli coast, a jellyfish outbreaks would reduce the number of beach trips between 3% and 10.5%, corresponds to an annual monetary loss in the range of € 2.4–6.2 million. In the marine protected area of Medes Islands (Spain) an assessment of the behaviour of scuba divers under conditions of sea warming and ocean acidification gave the following results: disappearance of gorgonians was regarded as the most undesirable environmental change requiring a compensation of approximately €4 million for all dives in a year; abundance of stinging jellyfish would increase this compensation with €2 million.

**Adaptation and mitigation strategies, and policies at global, regional and local scales need to be implemented as they are the only certain, effective way to reduce $CO_2$ emissions to the atmosphere and associated ocean acidification. Mediterranean Sea acidification may be more severe in areas where human activities and impacts, such as nutrient runoff from agriculture, further increase acidity. Agricultural run-off from land and other pressures linked with human activities on Mediterranean ecosystems needs to be more strictly regulated. In addition, adaptation policies are required as an increase in atmospheric $CO_2$ concentration seems unavoidable. The combination of mitigation and adaptation can assure that the Mediterranean can continue to sustain livelihoods, provide food and protect shorelines.**

MedSeA
MEDITERRANEAN SEA ACIDIFICATION IN A CHANGING CLIMATE

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This document was produced jointly by MedSeA scientists and members of the Mediterranean Reference User Group (MRUG) (medsea-project.eu/mrug/). All suggestions or comments to these talking points should be addressed to pr.medsea@uab.cat or patrizia.ziveri@uab.cat.