

A new priority in the regional cooperation agenda: the fight against the climate crisis

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Climate change is one of the most serious challenges facing the planet. 2019, with a global mean temperature 1.1 ± 0.1 °C above pre-industrial levels, is likely to have been the second warmest in instrumental records, the past five years are the five warmest on record, and the 2010-2019 decade is also the warmest on record [1].

The Mediterranean Basin is in no way alien to this global emergency. In fact, climate change is one of the most serious systemic challenges for this region. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) considered the Mediterranean region as highly vulnerable to climate change and warned that it is one of the two regions of the world most responsive to climate change globally. Specifically, this report pointed out that the Mediterranean 'will suffer multiple stresses and systemic failures due to climate changes. Changes in species composition increase of alien species, habitat losses, and degradation both in land and sea together with agricultural and forests production losses due to increasing heat waves and droughts exacerbated also by the competition for water will increase vulnerability' [2].

In recent years, science has provided us with new scientific evidence on the evolution of climate and environmental change in the Mediterranean. Of particular interest is “Climate change and interconnected risks to sustainable development in the Mediterranean” [3]. In this article, published in 2018 in Nature, a selected group of scientist pointed out that ‘observed rates of climate change in the Mediterranean Basin exceed global trends for most variables’ and pointed out that ‘recent accelerated climate change has exacerbated existing environmental problems in the Mediterranean Basin that are caused by the combination of changes in land use, increasing pollution and declining biodiversity’. In addition, they stressed that ‘for five broad and interconnected impact domains (water, ecosystems, food, health and security), current change and future scenarios consistently point to significant and increasing risks during the coming decades’.

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Twenty-five years after the launch of the Euro-Mediterranean Process in Barcelona, climate and environmental change occupy a very high place in the priority ranks of state, regional and local governments throughout the Mediterranean. It is also a priority with regard to multilateral cooperation in the Mediterranean Basin. In this sense, it is worth recalling the importance of the action framework that emerges from the Mediterranean Strategy for Sustainable Development 2016-2025 (UNEP/MAP, 2016) and the Regional Framework for Climate Change Adaptation in the Mediterranean, promoted by UN Environment / Mediterranean Plan of Action. Equally noteworthy is the work being carried out by the Union for the Mediterranean (UfM) and its Expert Group on Climate Change (UfM CCEG) and the UfM Environment Task Force.

A science-policy interface on climate and environmental change

Climate change policies need to be based on sound scientific knowledge and data, coupled with awareness raising and technical capacities to ensure informed decision-making at all levels, recognising and protecting the climate adaptation and mitigation services of natural ecosystem. This is a main message from the Mediterranean Strategy for Sustainable Development (MSDD 2016-2025) [4] which recognises that ‘scientific knowledge and tools on climate change are not sufficiently accessible and used for decision-making’.

Consequently, the strategy aims to strengthen and expand the science-policy interface, to support decision-making by providing better scientific analysis and data, through research fora, seminars, among other tools. Actually, the Flagship Initiative for the MSSD Objective 4 (Addressing climate change as a priority issue for the Mediterranean) consists on ‘the establishment of a regional science-policy interface mechanism (...) with a view to

preparing consolidated regional scientific assessments and guidance on climate change trends, impacts and adaptation and mitigation options’.

The network of Mediterranean Experts on Climate and Environmental Change (MedECC), launched in Paris in 2015, is an open and independent international scientific expert network acting as a science-policy interface providing decision-makers, stakeholders and the public with reliable scientific knowledge. The MedECC has the following objectives:

1. To update and consolidate the best scientific knowledge about climate and environmental changes in the Mediterranean Basin and render it accessible to policy-makers, key stakeholders and the public in order to facilitate ownership of scientific knowledge by them.
2. To gather the scientific community working on climate change in the Mediterranean Basin.
3. To contribute to future IPCC, IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) or related assessments in the Mediterranean Basin.
4. To bridge the gap between research and decision-making, contributing to the improvement of policies at all levels.
5. To identify possible gaps in the current research on climate change and its impacts in the Mediterranean.
6. To help building the capacity of scientists from southern and eastern Mediterranean countries.

MedECC includes more than 600 scientists from 35 countries, including 19 Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention). The network is jointly supported by the Secretariat of the Union for the Mediterranean and the Plan Bleu Regional Activity Centre (UNEP/MAP) and its secretariat is funded by the UfM thanks to the Swedish International Development Cooperation Agency (SIDA). Other supporting institutions include, among others, the French Agency for Ecological Transition (ADEME), Mediterranean Integrated STudies at Regional And Local Scales (MISTRALS), Principality of Monaco, Laboratory of Excellence OT-Med (France), Aix-Marseille University, the French National Research Institute for Sustainable Development (IRD) and the Advisory Council for Sustainable Development of Catalonia

Climate change in the Mediterranean: the main facts

MedECC has been actively working in its first assessment report on the current state and risks of climate and environmental change in the Mediterranean (MAR1). Although some preliminary conclusions were already anticipated [5], the report will be published at the end of 2020. It confirms that climate is changing in the Mediterranean Basin, due to anthropogenic emissions of greenhouse gases, and warns that this change exceeds global trends, and that the Mediterranean will continue to be one of the most affected regions in the world by climate change.

According to MAR1, annual mean temperature (combined land and sea) is 1.54°C higher than in pre-industrial times (1861-1890). It is also 0.4°C higher than current global warming trends (+1.1°C). Moreover, climate simulations project that annual mean temperatures will rise until 2100 by additional 3.8-6.5°C for a high greenhouse gas emissions scenario (RCP8.5) and 0.5-2.0°C for a scenario (RCP2.6) compatible with the UNFCCC Paris Agreement. Furthermore, high temperature events and heat waves are likely to become more frequent and/or more intense, both in duration and in peak temperatures.

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The concern should extend about precipitation. Frequency and intensity of droughts have increased significantly since 1950 and both observations and projections warn about drier conditions over the Mediterranean Basin due to a combination of reduced rainfall and warming. Climate models project a decrease by 4-22% (depending on the scenario) at the end of the current century and heavy rainfall events are likely to intensify by 10-20% in all seasons except for summer.

The Mediterranean Sea surface is also warming: it is estimated at 0.4°C per decade for the period between 1985 and 2006 (+0.3°C per decade for the western basin and +0.5°C per decade for the eastern basin), and projections for 2100 vary between +1.8°C and +3.5°C in average compared to the period between 1961 and 1990. This is not the only change experienced by the sea: its level rose at about 3 mm per year during last decades and there are important uncertainties concerning global mean sea level rise in the future. Finally, the report warns about the progress of seawater acidification.

Impacts of climate and environmental changes and associated hazards in the Mediterranean

The MAR1 warns that recent accelerated climate change has exacerbated existing environmental problems in the Mediterranean Basin, which are caused by the combination of changes in land and sea use, increasing pollution, non-indigenous species and declining biodiversity. In most impact domains (such as water, ecosystems, food, health and security), current changes and future scenarios consistently point to significant and increasing risks during coming decades.

Water resources

The Mediterranean population having access to less than 1000 m³ per capita per year is projected to increase from 180 million people in 2013 to over 250 million within 20 years. Countries on the southern and eastern rim of Mediterranean with semi-arid climate are more subject to water shortage and high interannual variability of water resources. Water availability will reduce due to:

1. Precipitation decrease
2. Temperature increase
3. Population growth, especially in countries already presently short in water supply.

The increase of evapotranspiration and reduced rainfall will decrease fresh water availability in the Mediterranean region by 2 to 15% (for 2°C warming), among the largest decreases in the world. The length of meteorological dry spells and the length and severity of droughts are expected to increase significantly. Irrigation represents between 50% and 90% of the total Mediterranean water demand and irrigation requirements are projected to increase between 4 and 18% by the end of the century due to climate change alone (for 2°C and 5°C warming, respectively).

Ecosystems

Land and marine ecosystems face unprecedented threats due to nature overexploitation, pollution, land and sea use transformations, and climate change.

Warming of 2°C or more above the preindustrial level is expected to generate conditions for many Mediterranean land ecosystems that are unprecedented in the last 10,000 years. The coupled effect of warming and drought is expected to lead to a general increase in aridity and subsequent desertification of many land ecosystems. If global temperatures are kept below 2°C above preindustrial values at the end of 21st century, most Mediterranean forest could resist to warming. However, higher temperatures might reduce the CO₂ fertilization effects and will affect most western Mediterranean forests if no unexpected physiological adaptation occurs. This change would imply not only the loss of many resources drawn from forests but also a lost carbon sink, especially during the drought years.

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In arid and semi-arid lands, drought has increased tree mortality and resulted in degradation and reduced distribution of entire forest ecosystems. Many plants and animals adapt to climate change at the level of phenology. However, adaptation may have negative consequences, as there is a potential decoupling of plant responses and their interacting organisms such as insect pollinators or increasing risk of frost damage in the early spring season.

Forests, wetlands and coastal ecosystems are also likely to be affected by changes in extreme temperature events and droughts. Fire risk increases due to drought and heat waves, but also to changed land management, bringing longer fire seasons, and potentially more frequent large, severe fires. The megafires triggered by extreme climate events, especially heat wave events, have caused record maxima of burnt area in some countries during the last decades.

The Mediterranean Sea accounts for 0.8% of the global ocean surface and hosts 4% to 18% of the world's known marine species. Increasing water temperatures lead to changes in species composition and abundance. In general, cold-water species become less abundant or extinct and warm-water species become more abundant, leading to homogenization of the Mediterranean biota with warm-water species. Furthermore, 700 non-indigenous marine plant and animal species have been recorded so far in the Mediterranean.

Changes in the abundance of species may have an important and sometimes irreversible impact on many other species. Increasing water temperature provokes an increase in the proportion of small-sized species, young age classes and a decrease in size-at-age. Therefore, in the Mediterranean Sea, the average maximum body weight of fish is expected to shrink by 4 to 49% from 2000 to 2050 due to water warming and decreased oxygenation, and because of overfishing.

Coastal ecosystems are very exposed to climate and environmental change due to their special position at the interface of the land and the sea. Human activities, like urbanization and tourism, but also chemical pollution, have a strong impact on these areas. Construction in coastal regions, sand erosion and instabilities in beaches have destructive effects on fauna and flora and, in particular, on endemic species. The primary production of some coastal areas may be impacted by the reduction in freshwater discharge from rivers.

Finally, freshwater ecosystems and inland wetlands are affected by falling water levels and reduced water quality. Climate change increases flood risk and streamflow variability. Consequently more dykes and dams are constructed, which influences freshwater ecosystems. Stream biota responses to climate change include shifts of organisms to higher latitudes and/or elevations and subsequent changes of community composition often resulting in homogenization and loss of diversity. Inland wetlands are particularly vulnerable to climate change, but also to human activities, which alter flooding regimes and affect the vital rates, abundance and distributions of wetland-dependent species. Wetlands in dry environments are hotspots of biological diversity and productivity, and their ecosystems are at risk of extinction if runoff decreases and the wetland dries out.

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Food security

Climate, environmental and socioeconomic changes threaten food security in the Mediterranean, although pressures are not homogeneous across the region and sectors of production. Factors affecting agriculture and livestock production include water scarcity, soil degradation and erosion, but also extreme events, such as droughts, heat waves and heavy rainfall. In river deltas currently of crucial importance for agricultural production, sea-level rise and land subsidence reduce the area available for agriculture. In addition, food safety is threatened by pests and mycotoxins formed on plant products in the field or during storage whose development is linked to climate conditions.

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The current consumption patterns imply high ecological, carbon, and water footprints. Within a period of 50 years, the population in the North Africa and Middle East region has increased by a factor of 3.5, while dietary habits have become more westernized (i.e., the diet include more meat). Livestock production, mainly located in the semiarid and arid lands of the southern Mediterranean, has shifted from extensive modes to systems heavily dependent on feed grain, increasing poverty and rural exodus and rendering production sensitive to climatic shifts at the global scale. Dependence of these countries on imported food is expected to increase.

Fisheries and aquaculture are impacted mostly by overfishing and coastal development, but climate change and acidification may sometimes play an important role. 90% of fish stocks are categorized as overfished and professional fishing is expected to decline at an uncertain rate at the basin level, contrasting by the increase in aquaculture production in Mediterranean countries of the EU between 2010 and 2030.

Human health

Climate change has direct effects on human health, including those caused by higher temperatures, increased UV radiation, droughts and other extreme events such as storms and floods. An increase in the intensity and frequency of heat waves, or a shift in seasonality, will have significant health risks for vulnerable population groups, in particular those who live in poverty with substandard housing and restricted access to air-conditioned areas.

Several outbreaks of different vector-borne diseases have been documented in the region. Climate change contributes to their transmission potential but it is difficult to predict its consequences for infectious disease severity and distributions because of complex interactions between hosts, pathogens and vectors or intermediate hosts.

Climate change has also indirect health effects associated to the deterioration of air, soil and water quality changes in food provision and quality or other aspects of the social and cultural environments. The concentration of gases and particles in the air increases because of desertification and wildfires resulting from climate change, as well as due to direct human activity, especially in large cities.

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Saltwater intrusion into groundwater caused by sea level rise may deprive some population of drinking water, which may have serious health consequences. Floods cause personal injuries, enteric infections, allergies and asthma, increase in mental health problems and potential contamination by toxic chemicals. Human activities, like transportation of goods, animals and people, disappearance of natural wetlands, coastal planning, dam construction on large Mediterranean rivers, may enhance natural cycle transmission of infectious agents.

Finally, other health aspects include the increased production of pollen and pollen allergens, and increased transmission of many contagious illnesses due to urbanization and growing human population density in coastal areas.

Human security

Climate and environmental changes threaten human security in multiple ways. Rising sea levels, storm-surges, flooding, erosion and local land subsidence affect coastal infrastructures, as well as wetlands and beaches. About 15 fifteen mega cities (with a population greater than 1 million in 2005) are at risk from flooding due to sea level rise, unless further adaptation is undertaken. By 2050, for the lower sea-level rise scenarios and current adaptation measures, cities in the Mediterranean will account for half of the 20 global cities with the highest increase of the average annual damages. The areas at extremely high risk are predominantly located in the southern and eastern Mediterranean region.

Other consequences of climate change and human activities threatening human security is salinization of groundwater resources, but also flood risk due to extreme rainfall events, which will increase these areas, increasingly sealed surfaces in urban areas and ill-conceived storm water management systems. Finally, increased frequency and severity of fires, due to warming and changing land management, especially at the periphery of the inhabited areas also represents a significant additional security risk for the Mediterranean population.

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**Katarzyna Marini**

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Arnault Graves is, since October 2017, Senior Climate Adviser of the Secretariat of the Union for the Mediterranean (seconded by the French Ministry for Ecological Transition). He holds a degree in Environment and Public Works Engineering from the École Nationale des Travaux Publics (France), with a promotion to the upper grade of chief engineer "hors classe". He has more than 25 years of experience (including 15 years abroad), and has developed a strong expertise in several climate policy sectors. Between 2012 and 2017 he was senior officer and head of the team Energy Climate - Sustainable Buildings at the French National Center for Studies on Risks, Mobility, and Urban and Country Planning (CEREMA). He was deputy chief counselor for sustainable development, industry and transport at the Regional Economic Service of the French Embassy in Moscow between 2009 and 2012. Previously he had worked as project director for the private sector, and as senior officer in the French public administration, both in France and abroad (Russia and Uzbekistan).



Grammenos Mastrojeni

Grammenos Mastrojeni is Senior Deputy Secretary General at the Secretariat of the Union for the Mediterranean since September 2019. He is an Italian diplomat, professor and writer who has focused for the past 25 years on the societal, geo-strategic and economic impacts of environmental degradation, as well as on topics related to environmental protection, human cohesion, peace and security. He has taught sustainability and conflict resolution in various universities in Italy and abroad, and in 2009, the Ottawa University in Canada entrusted him with the first class by a University on the issue of Environment, resources and geostrategy. Formerly, until August 2019, he was the Coordinator for the Environment and Head of the Science-Policy Interface at the Italian Development Cooperation, heading Italian delegations on lands, water and oceans and joining negotiations on climate and biodiversity. Chair of the UN Mountain Partnership, and Co Chair of the Global Islands Partnership, he is President of the largest Italian association for sustainable development education "Isola della Sostenibilità" and member of the Scientific Boards of numerous university courses and entities. Author of numerous articles and official reports on the environment, he published 8 books.



Joël Guiot

Joël Guiot és director de recerca del CNRS al Centre Europeu de Recerca i Formació en Geociències Ambientals (CEREGE, Universitat de Aix-Marseille, França). La seva principal recerca se centra en l'impacte dels canvis climàtics passats, presents i futurs en els ecosistemes mediterranis, en particular en el bosc mediterrani, utilitzant sèries dendrocronològiques i models de creixement d'arbres. El 2008 va cofundar la xarxa ECCOREV (Ecosistemes Continentals i Riscos Ambientals) per promoure la interdisciplinarietat en les ciències ambientals, en particular amb les ciències socials, i el 2012 va crear el Laboratori d'Excel·lència OT-Med per estudiar els riscos relacionats amb el canvi climàtic i els perills naturals a la conca del Mediterrani. El 2015 va posar en marxa, amb W. Cramer, el Grup d'experts del Mediterrani sobre el medi ambient i els canvis climàtics (MedECC), per transferir els coneixements científics sobre el canvi climàtic als agents de la societat de les dues ribes del Mediterrani. És un dels principals autors de l'informe especial de l'IPCC sobre l'impacte de l'escalfament global d'1,5 °C. Va rebre la medalla de plata del CNRS el 2005.



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