CLIMATE AND ENVIRONMENTAL CHANGE IN THE MEDITERRANEAN:
Grasping the Scope of the Challenge

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The Mediterranean Basin is nowadays a hot spot of various phenomena related to climate and environmental change: biodiversity loss, marine plastic pollution, rise in temperatures, and increased water scarcity. The region is indeed a world hotspot for biodiversity with 15,000-25,000 flora species. 60 % of the Mediterranean flora and one-third of the regional fauna are endemic. The Mediterranean Sea is also, unfortunately, heavily polluted by marine plastics, with one plastic item per cubic meter of seawater. This concentration of plastics is similar to that found in the five gyres of plastic trash polluting the world's oceans, sometimes referred to as "plastic continents" in the middle of the oceans. The historical data show that, since the pre-industrial times (1880), the global temperature has seen a net increase of 1.5 degrees (2018). The increase in temperature is very similar in the Mediterranean region and witnesses an acceleration at the beginning of the 1980s. However, the current trend in the Mediterranean Basin shows that the region is warming 20 % faster than the rest of the world. Under a "business-as-usual" scenario of high greenhouse gas (GHG) concentration, responsible for the so-called greenhouse effect and increased infra-red radiations in the atmosphere, the temperature means in the Mediterranean could increase by 5°C by the end of the century. This rise in temperatures could be limited to 1.5 degrees if the GHG emissions were to be drastically reduced.

Climate and environmental changes influence the essentials of living: water, food, air, and accommodation. Based on a medium scenario of GHG concentrations, the Mediterranean Sea level rise is expected to reach one meter by 2050, thus causing substantial flooding in all exposed low-lying coastal areas, such as Venice (Italy), the Kerkennah archipelago (Tunisia), the Southern coast of Misrata (Libya), Alexandria and Port Said (Egypt). It is important to note that this scenario is only a freeze-frame shot, and keep in mind that, if no mitigation measures are taken, the sea will continue to rise and take over a large swath of lands in Mediterranean coastal areas, including wetlands, putting at risk human activities such as tourism, agriculture, as well as urban settlements.

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On the other hand, the sea level rise induced by climate change and human action will further increase underground freshwater salinity. Many coastal wells in the Mediterranean Basin are already abandoned due to the seawater intrusion and salinization of groundwater aquifers caused by their overexploitation. Sea level rise will intensify this phenomenon with more frequent seawater intrusion into coastal aquifers.

The Mediterranean area is characterised by water scarcity, especially its southern shore where 180 million people suffer from water scarcity (total yearly renewable water resources per capita inferior to 1000 m^3) (FAO, 2016). Conventional water sources include surface water (rivers, wadis, and lakes) and underground water. The rise in temperatures and radiation increase will increase evaporation, which will lead in turn to the depletion of surface water like lakes, wadis, and rivers. For instance, the waters of the Kasseb dam, one of the most important in Tunisia, will be completely evaporated by 2085, by taking into account a 6% evaporation rate (Baouab & Cherif, 2015). Indeed, it is important to highlight that evaporation rates have increased through the years: while standing at 3% between 1970 and 2008, this rate has reached 6% between 2008 and 2013 and is very likely to further increase in the years to come due to higher temperatures and lower rainfall. This phenomenon is common to all surface waters and is depleting rivers, lakes, and wadis, which are for some countries the main, if not the only, water resource.

If the quantity of water is highly threatened by the increase in water evaporation and sea level rise, its quality is very poor due to various forms of pollution observed both in surface and underground waters. The scale of chemical contamination is huge, and its sources are multiple: pesticides, heavy metals, nutrients coming from agriculture, polycyclic aromatic hydrocarbons (PAH), antibiotics, human and animal medicines, and endocrine disruptors among thousands of other factors. The latter are molecules acting at very low concentrations to mimic hormonal actions in the body and could cause an array of functional diseases. As regards physical contamination, it is mainly caused by plastics and nanomaterials. The latter are very small, nanometre-sized compounds that are found in all electronic devices but also in everyday manufactured products like toothpaste, and which can migrate to all parts of the body, creating various interferences in the biochemical reactions in the brain, heart, or any other organ, due to their small size. The biological contamination is also very diverse, as faecal coliforms, viruses, protozoa, and parasitic worms are widely found in surface and groundwaters. In fine, the quality and quantity degradation and depletion of all conventional water sources pose a considerable threat to water security in the region.

When considering the consequences of climate change on food security, it is necessary to understand the huge influence that the rise in temperatures will have on the growth and

quality of food, either plants or animals, farmed or wild. In the Mediterranean region, wheat is massively grown: the region represents in fact 60% of the world's growing area for durum wheat. Whether in the forms of bread, pasta, or couscous, it lies at the base of the food pyramid and is an avoidable element of the daily meals of the Mediterranean populations (Royo et al., 2017). Yet, this crop is put under severe threat by climate change. Each degree of temperature rise is estimated to lead to a wheat yield reduction of 7.5 %. Consequently, a 5°C rise in temperature means under a High GHG scenario in 2090 would lead to a dramatic 37.5% yield reduction in wheat production.

Marine food production is another important source of Mediterranean food whose sustainability is seriously threatened by climate and environmental degradation. From 1950 to 2011, about 41 % of top marine predators and 34 % of fish species totally disappeared in the Mediterranean Sea. From 1994 to 2017, Mediterranean total fishery landings declined by 28%, mainly due to overexploitation and unsustainable fishing practices. In turn, climate change is and will be taking its toll on marine biodiversity. As a matter of fact, an increase of 1°C in water temperature leads to a decrease of about 20-30 % of the fish size in response to the lack of oxygen supply in water. As a consequence, it is estimated that up to 50% of locally exploited fish and marine invertebrates, wild as well as from aquaculture, will become extinct. In present conditions, the threat to food security in the Mediterranean region should thus be carefully considered and multiple solutions should be immediately proposed.

Measures to curtail socioeconomic activities (lockdowns) implemented to fight the COVID-19 pandemic can be considered as a short full-scale test of pollution reduction: it has led to a general decrease in NOx air pollution and a serious improvement regarding water pollution, as well as noise reduction. However, no long-term positive outcomes are to be expected due to the very limited time of lockdown measures compared to the 150 years of the massive and increasing release of contaminants and gases in the environment. Moreover, the COVID-19 pandemic led to an increase in solid wastes (masks, gloves, plastic bottles, disposable products) polluting the environment, followed by a rebound effect after the end of the lockdowns.

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