IMPACTS OF CLIMATE CHANGE ON BIOMES AND WATER BUDGET IN THE MEDITERRANEAN ISLANDS BETWEEN 2000 AND 2050

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ABSTRACT

Sectorial impacts of climate change (CC) tends to elude interaction between various factors for instance between hydrological processes and vegetation despite GCM includes elements on water resources and biological evolution. Nevertheless, GCM with their coarse resolution need to be downscale to take into account the local context especially on coastline and islands.

The present paper is an attempt to bind together the expected "biomic shift" (BS) and "water depletion" (WD) in the context of Mediterranean islands in 2050. The annual and monthly temperatures and precipitations as given by the WorldClim dataset (Hijmans et al. 2005) are used to estimate BS and WD via simple methods suitable for the Mediterranean regions that is to say the Holdridge classification (Holdridge et al. 1971, Holdridge 1976) for the BS and the ombrothermic curves (Bagnouls and 1957 , Gaussen 1960) for the WD. The WorldClim dataset provides CC scenarios on three GCM Models downscaled to a resolution of 1 km² for 2050.

The CC on the Mediterranean islands in 2050:
Thanks to this resolution, a regionalization from 410 islands is proposed with a special focus on the Aegean islands, Crete and Rhodes. The temperature rise for all the Mediterranean islands is comprise between 1.9°C in the North-West (Corsica) and 2.9°C in the East (north Aegean islands). The evolutions of precipitation appears to be more erratic and imprecise with almost no change in the North-West (Corsica, Balearic, Dalmatian islands) and a deficit greater than 10% in the Aegean Sea and Cyprus.

Nevertheless, the most contrasted evolutions at sub regional scale are observed on the Greek islands. The evolution of the Ionian islands in the eastern part of Greece is quite similar to what happen in most islands in the North-West part of the Mediterranean: low precipitation deficit and limited increase of temperature. For the Aegean Sea including the Marmara Sea, the tendencies are more drastic with even there is a steady contrast for the evolution of temperature between the southern and the northern part with +2°C for Crete and Rhodes but as much as +3°C for Thasos, Samothrace and Marmara islands. There is also a northern trend for the evolution of precipitation deficit within Aegean Sea. The deficit is limited to 9% in the South but can reach 11% in the North and on Cyclades islands which seems to have a specific type of evolution. It is worth noting that the northern islands of the Aegean Sea should experience the most manifest impacts of CC with a warming of +2.7°C and a precipitation deficit of -10%. The extreme case is given by Samothrace with respectively +.2.8°C and -11.5%.

Impacts of CC on BS on the Mediterranean islands:
Both latitudinal and altitudinal shifts of the BS should be sweeping with large extension of semiarid bioclimates along the coastline and shrinking or even fading of sub humid ecosystems on highest elevation on the Mediterranean islands. As a consequence the biogeography of biomes shall be facing a four degrees shift in latitude northward combined with an altitudinal shift of 300 meters upward on mountainous islands. In the context of a fragmented patchwork of islands, the latitudinal shift supposes an “island hooping” that will jeopardize even more the biodiversity of island biotopes already weakened by multi secular exploitations by human populations.

The Cretan date palm or Theophrasti palm tree (*Phoenix theophrasti*) has to be considered as an emblematic case of impact of BS on the survival of an endemic species. These tree is strongly influenced by local hydroclimatological conditions and can be found on coastlines at mouths of rivers in few spots in Crete, few Aegean islands and Turkey peninsula. The shift of four degrees in latitude of biomes means that the equivalent bioclimates will be located in northern Aegean by 2050 and not anymore at their present location in southern Aegean. There are several possibilities for this unique European date palm tree to cope with this situation: adaptation on the spot including colonization of equivalent biotope at highest elevation (altitudinal shift), island hooping (latitudinal shift) throughout the Aegean Sea, conservation in botany gardens or even plantations in northern Aegean appropriate.

Impact of CC on WD on the Mediterranean islands:

The WD phenomenon is three folds. The most evident is the direct effect from the precipitation decrease which could be as much as 10% or even more locally. The second element is based on the fact that surface water runoff tends to amplified precipitation deficit by a factor 2 in the considered Mediterranean regions. The last factor stands on the fact that an increase of temperatures will automatically rises the evapotranspiration and therefore lessens the amount of water available for river flows and infiltrations.

By taking into account all these elements, the streamflow deficit on islands may well be as much as 50% on Samothrace and Marmara. On two watershed of Crete and Rhodes, the reduction of river flows will be respectively about 29% and 40% with consequently major impacts on irrigation, electricity production and domestic uses especially for touristic activities during summer. As a matter of fact, tourism is the backbone of most Mediterranean island economies and water shortage may be one of the key factors that could limit or even lay on the line this strategic activity with no simple alternative. In the Mediterranean islands context, the multi sectorial approach of Integrated water resources management (IWRM) appears to be more than an option. It is a necessity.

Conclusion:

Due to uncertainties in GCM scenario and downscaling at local scale, the results cannot be consider as predictions but provides insights on magnitudes of changes for the environmental system including both vegetation and hydrological budgeting. These proxies aim to contribute to a better planning for major investments regarding water resources and environmental policies at the scale of islands and their catchment basins.

This general outlook of CC impacts on BS and WD on Mediterranean islands must be considered as proxies at local scale because many factors that are not related to climate have a noticeable influence on ecosystems and hydrological budget. Those factors are of various nature: past degradation of original vegetation and soils by agriculture and overgrazing, present abandonment of agricultural land, urbanization of coastal zone, geology especially karst … On the seashore, the sea level rise may also impacts locally coastal processes and interfere in the equilibrium of groundwater table and aquifers with salt and brackish waters, with have many consequences on hydrological factors that regulate shore biotopes.

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