Climate Change in the Mediterranean: Impacts for agriculture?

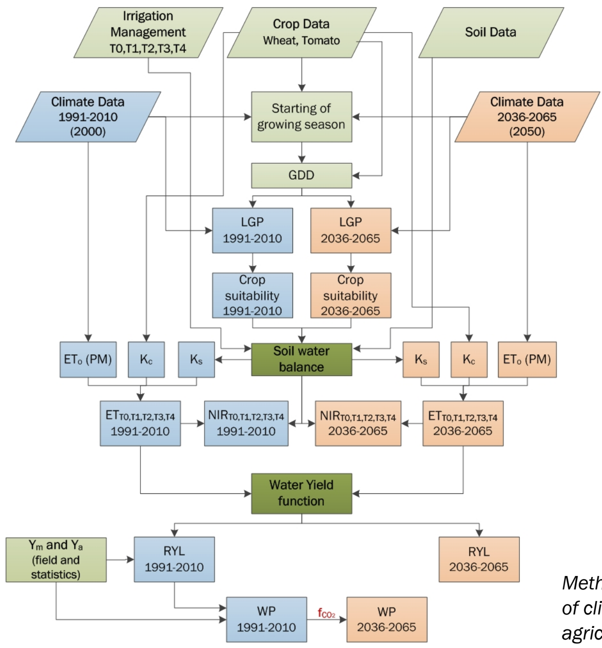
The analysis is based on A1B SRES and input climate data developed within the WASSERMed project. Analysis results have shown that, in the Mediterranean region, over the period of 50 years (2000-2050) the annual mean temperature would increase on average from 0.8°C in Spain to 2.3°C in Morocco. The overall increase in air temperature would be the greatest in areas of Northern Africa and the Middle East and in Southern Turkey. Seasonal patterns indicated that, in winter, the continental interior of SE Europe and Eastern Mediterranean would warm more rapidly than elsewhere. On the other hand, in the summer, the western Mediterranean would warm more than the other regions.

For the same period (2000-2050), the average annual precipitation could have a decreasing trend of around 6%. The expected range of variation at the national level is between –21% (for Cyprus) and +1% (for France and Slovenia). The spatial pattern of annual precipitation indicates an increase over most of France and the Alps, while a decrease is observed in almost all other regions. There is a marked contrast between winter and summer patterns of precipitation change. Most of Europe could get wetter in the winter season with the exception of Greece, Southern Italy and Turkey. In summer, a overall decrease of precipitation could be expected in Europe, while an increase is foreseen in some areas of Northern Africa and the Middle East.

Thus, Mediterranean agriculture might be particularly vulnerable to climate change, particularly in areas already characterised by water scarcity and land degradation. In fact, the warming trend and changes in precipitation patterns might further affect the water balance, and the composition and functioning of natural and managed ecosystems.

The WASSERMed approach: Methods and tools

The analyses were done on monthly and daily basis, using the support of different models (CROPWAT, AquaCrop) and of Geographical Information Systems. In particular, reference evapotranspiration (ETo) was calculated using the Penman-Monteith method. The Growing Degree Day (GDD) concept was applied for estimating the length of the growing season and crop development.



Methodology for the estimation of climate change impacts on agriculture

In brief:

- *Agriculture is an important economic sector of the Mediterranean, likely to be impacted by climate change*
- *WASSERMed focused on the analysis of crop water and irrigation requirements for the A1B SRES*
- *Results indicate that ETo would increase over the Mediterranean region, whereas the length of the crop growing season is likely to be shorter*
- *As a result of the decreased crop growing cycle, an overall reduction of Crop Evapotranspiration and Net Irrigation Requirements could be expected for most crops (except for perennials)*
- *Negative impacts of climate change could be more evident in the Southern countries where water scarcity is already a limiting factor for agricultural production*

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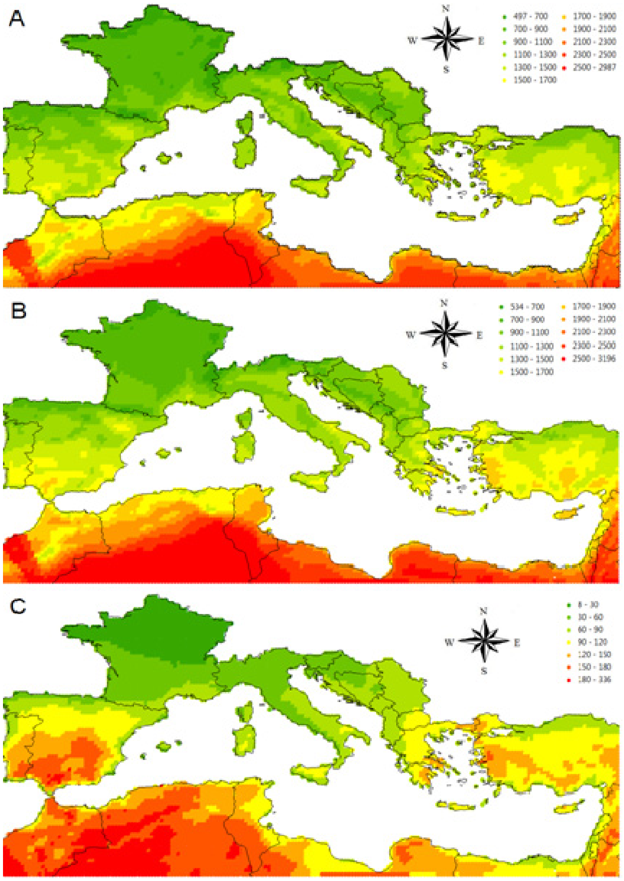
Main results

By the middle of the century, ETo would increase over the whole region by 108 mm/yr (7.2%), from 3.9% in France to about 9.8% in Spain. In general, ETo shows an increasing trend from North to South and from East to West. Due to temperature increase, potentially cultivable areas could increase and the overall cultivation period be extended, particularly in the Northern countries (5-25%). However, the length of the crop growing season is likely to be shorter (in average by 15, 13, 12 and 9 days for winter wheat, maize, tomato and sunflower, respectively). For olive trees, the occurrence of flowering is likely to be anticipated on average by 9 days. Due to the shorter growing season, the average crop evapotranspiration (ETc) is expected to decrease on average by 8% and 4% for winter wheat and maize, respectively, while a 5% decrease is expected for sunflower and tomato. For perennial crops (e.g. olive trees), ETc could remain stable with slight regional variations. The average Net Irrigation Requirements (NIR) would decrease by 12% for winter wheat, 7% for sunflower and tomato, and 4% for maize. The NIR of olive trees could vary from place to place due to the spatial variability of precipitation change. In the future, yields should not decrease, as the increase of CO_2 concentration could alleviate the negative effects of temperature increase and reduction of intercepted photo-synthetically active radiation. Future agricultural production could be strongly affected by frequent and intense extreme events.



Spatial patterns of reference evapotranspiration (mm/yr) for the baseline scenario (A), the future scenario following A1B SRES (B) and differences (C)

Key findings and considerations

- The results of simulations are in agreement with other studies. If no adaptation will occur, an overall reduction of Crop Evapotranspiration and Net Irrigation Requirements could be expected for most crops (except for perennial ones), due to the decrease of crop growing cycle. The air temperature increase could have a dominant role on the shortening of the crop growing cycle, rather than on the increase of Crop Water Requirements. Water Productivity (the ratio between yield and ETc) could slightly increase in the future, as a result of the combined effects of changes in air temperature, precipitation and CO_2 concentration.
- The negative impacts of climate change could be more evident in the Southern countries, where water scarcity is already a limiting factor for agricultural production. Adaptation strategies should include: a) the anticipation of growing season, b) deficit/supplemental irrigation; c) application of more efficient irrigation technologies; d) introduction of new more resistant (to water/salinity/heat stresses) and slow-maturing crop varieties, e) smart, locally tailored, agricultural practices.
- The overall adaptation capacity is greater in the Northern than in the Southern Mediterranean countries, due to more favourable climate, resources availability and institutional setting. These results depict one of the possible future scenarios and should be integrated into a complex system linking bio-physical, socio-economic, and policy issues.

Further reading

- Saadi S., 2012. Assessing the impact of climate change on water productivity in the Mediterranean agriculture. CIHEAM – Mediterranean Agronomic Institute of Bari, Collection of Master of Science N° 650, 134pp.
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- Todorovic M., B. Karic, L.S. Pereira, 2013. Reference evapotranspiration estimate with limited weather data across a range of Mediterranean climates. J. Hydrol., DOI: 10.1016/j.jhydrol.2012.12.034