CIRCLE2 POLICY BRIEF

Adaptation to Climate Change: Revegetation to restore the hydrological cycle

Summary

The Mediterranean is a hot-spot of climate change, with projections of increased temperatures and a reduction of precipitation. In some semi-arid areas of the Mediterranean there has been a **significant reduction of summer storms** that bring rainfall in the driest period of the year, being crucial for many sectors (e.g. agriculture, forests, and for the recharge of aquifers). This reduction in summer storms has been attributed to a **change in land cover**, in particular, to the growing coastal urbanized areas that have led to a loss of coastal wetlands and irrigated crops, as well as to an increase of large forest fires.

However, the full impact of land cover change on the local climate and hydrological cycle is still not well understood. On one side, some evidence shows that air temperatures can increase when forested areas are replaced by urbanized areas, and that trees increase air moisture content through evapotranspiration, pumping water from the soil to the atmosphere, thereby contributing to the development of clouds and inland summer storms (Figure 1). On the other hand, hydrological studies show that trees may compete for water resources reducing runoff and soil moisture and increasing the risk of forest fires. The **limitations of scientific knowledge on the connections between ecosystems and the climate system, due, in large part, to the lack of integration of scientific results from different disciplines**, impose constraints on how we interpret the output from current models that are used by the scientific community to advise decision and policy makers.

Aside from their effects on local climate, forests provide many other important services to local populations. Thus, reforestation may constitute a no-regret adaptation measure to a changing climate, as long as potential trade-offs, such as the increased risk of wildfires, are taken into account. Therefore, this policy advises and proposes the following actions for Mediterranean areas:

(i) European cooperation to fill in the knowledge gaps about the effects of reforestation on the local hydrological cycle and climate in the form of funds for research projects that could benefit from field campaigns (e.g. meteorological measurement towers) and practical actions (e.g. large scale biodiversed revegetation in specific locations);

(ii) European cooperation in the form of funds for research projects to gather scientific data from past European projects in different disciplines related with hydrology, ecosystem services and climate/meteorology in order to integrate available knowledge and improve the current climate models (e.g. increase of the number of vegetation types simulated, increase resolution for correct parameterization of the boundary layer) to increase the confidence about the potential impacts of land cover change;

(iii) Local independent actions to restore natural ecosystems, such as reforestation using autochthonous species, fire prevention management approaches and improvement of local water management using available techniques that enhance water retention and infiltration.

CIRCLE 2
CLIMATE IMPACT RESEARCH & RESPONSE COORDINATION FOR A LARGER EUROPE
EU FP7 ERA-NET

[CIRCLE-2] Workshop on "Adaptation to Climate Change: revegetation to recover hydrological cycles as an Ecosystem Service."

10 to 12 of September, 2013 – Teruel (Spain)

This policy brief is directed towards funders and managers of research programs in the areas of climate change impacts and adaptation and ecosystem services, as well as **policy makers and decision developers in the area of spatial planning and water management**. It notes various challenges in addressing climate change research and policy of coastal Mediterranean regions and provides recommendations on research needs, and on regional and local actions. It was based on the presentations and discussions held during the CIRCLE-2 Workshop on "Adaptation to Climate Change: revegetation to recover hydrological cycles as an Ecosystem Service" on the 10th to 12th of September 2013 in Teruel, Spain[1].

In the last decades there has been a significant reduction of summer storms in the East of Iberia Peninsula. This has been felt by the local population and is supported by observed climate data. The reduction of summer storms has significant negative impacts on the local economy of this semi-arid area, and has led to growing concerns from the local population.

Significant change to the land cover is proposed to be the primary explanation for the reduction of summer storms in East Iberia, particularly near the coastal areas where a considerable amount of wetlands and agricultural areas have been replaced by urbanized areas. According to this hypothesis, these land-use changes have led to an increase in the temperature of air which moves inland from the Mediterranean Sea and a decrease in evapotranspiration. The combination of these two effects reduces air moisture and impacts the formation of clouds and, subsequently, rain on the inland mountains (Figure 1). Land use change to urbanized areas is also occurring in other coastal Mediterranean regions, with similar regional impacts on precipitation regimes. This has potential impacts on the frequency of summer flood events in Central Europe because water that should have precipitated on the mountains near the coast is being transported to Central Europe. In the last ten years summer floods have increased in Central Europe at the rate of several events each summer, which is contrary to the predictions of the last IPCC reports. These problems will be exacerbated when combined with an increase of surface temperature of the Mediterranean, as expected from climate change projections. This means that addressing the loss of summer storms in Mediterranean areas requires both a local/regional and international response.

Current climate and meteorological models do not accurately capture the atmospheric circulation patterns in this region. For instance, the boundary layer parameterization (based in flat terrain values) presents errors in complex terrain, such as mountains. Furthermore, the models also do not agree on the impacts of forests on the local climate and hydrological cycle, which is mainly a consequence on the knowledge of ecosystem-type effects on the hydrological cycle and, hence, the climate. For example, models do not necessarily show an increase of air moisture in areas where forest cover is increased.

[1] More information is available here: http://www.circle-era.eu/np4/RecoverHydrologicalCycle.html

If the proposed hypothesis to explain the decrease of summer storms is confirmed, reforestation, or in a more broad sense revegetation, is a potential good adaptation solution for restoring the regional hydrological cycle. It was agreed that, generally speaking**, revegetation is a no-regret adaptation approach** for the area, with several tangible and potential benefits: restoration of the hydrological cycle, increase of biodiversity richness and diversity, soil creation, food production, springs revitalization, and air and water quality improvement.

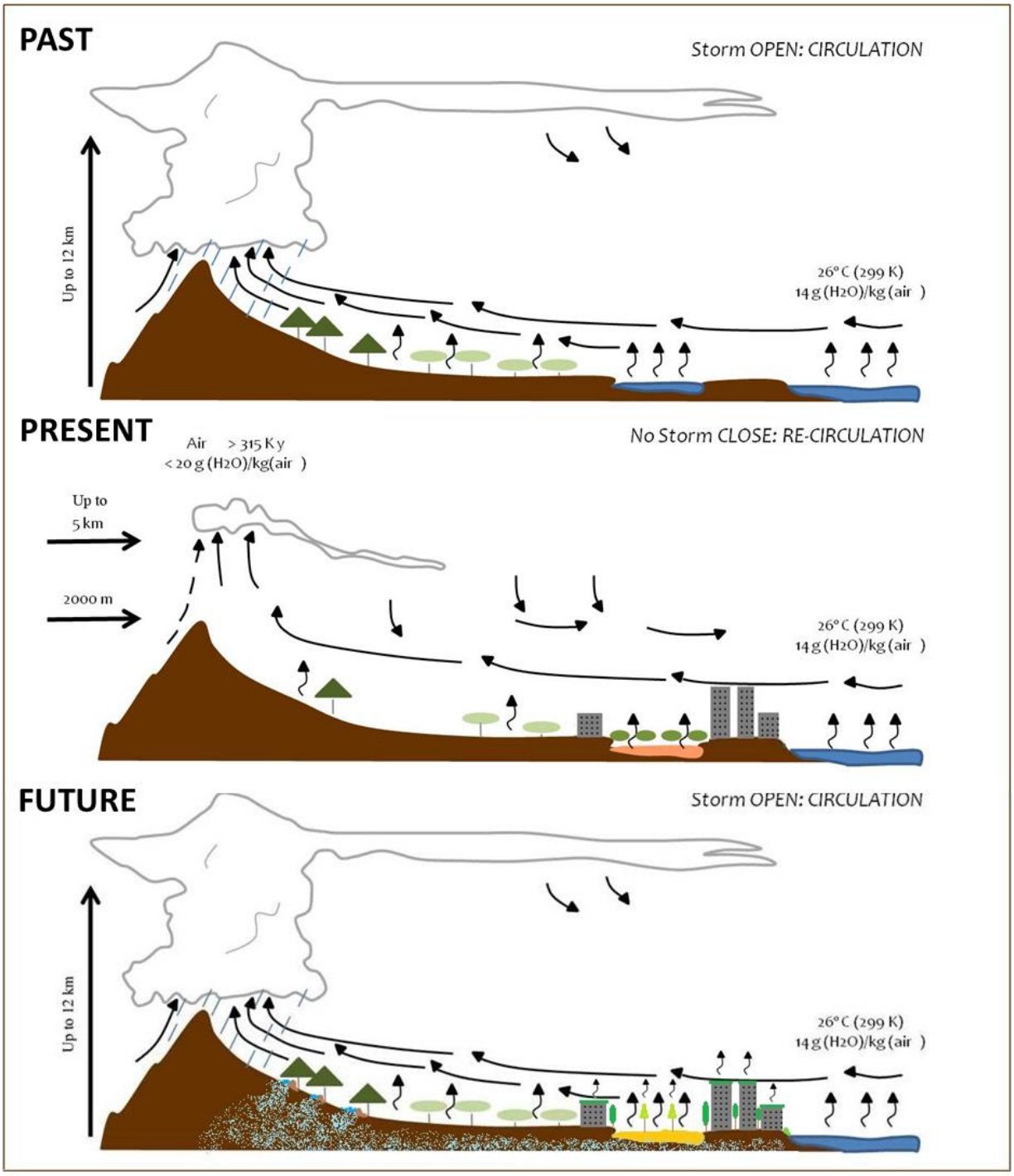

Figure 1 - Influence of (re)vegetation on the formation of clouds and rainfall in Mediterranean coastal areas. (*Adapted from: Millán Millán, Gammeltoft-RACCM-CIRCE Report*)

However, revegetation needs to be implemented using correct approaches and techniques to avoid potential negative impacts: total runoff may decrease, because trees will intercept a significant fraction of rainfall and forest fires may increase, due to the increased availability of "fuel" material. Thus, one of the main opportunities for action identified during the workshop was the need to develop mechanisms to fill **knowledge gaps about the local and regional climate impacts of reforestation** in Mediterranean areas.

The importance of wildfires, including the risk of vegetating with fire-prone species and the need to consider **pre and post fire innovative management techniques** was highlighted. Also, **Water retention landscapes** are seen as good adaptation solutions because they retain runoff, and promote water infiltration and aquifer recharge. These approaches can be used at different scales, from small agriculture fields of individual producers, to much larger areas (e.g. Tamera in South of Portugal).

There can also be other non-climatic or hydrological impacts depending on the type of vegetation change that will be implemented. The context of the local and regional needs, not only in terms of water availability but also at the social-economic and biodiversity levels, must to be taken into account when deciding which species to use and how to revegetate. Therefore, **a good practices guide for reforestation/ revegetation in Mediterranean areas has been identified as a high priority action for the region**.

Due to the dynamics of the hydrological cycle, **revegetation in one place might benefit a different region.** Therefore, local cooperation of different populations is necessary for developing a coherent revegetation strategy. The high level of organization involved with this type of adaptation measure was identified as a potential barrier, because there is no stimulus for the investor since there is no direct benefit to the local precipitation regime. A **compensation mechanism approach was suggested**.

Workshop participants:

Adriana Silva (CBA, University of Lisbon), Alberto Pérez (Region of Gúdar-Javalambre), Alejandro De Juanes (INCLAM), Ana Olivan (Government of Aragón), Bernd Muller (Tamera), Christoph Ulbig (Tamera), Daniel Hawtree (TU Dresden), David Avelar (CCIAM, University of Lisbon), Edward Pope (UK Met Office), Emilio Pérez (Government of Aragón), Enrique Asin (AGUJA), Esther Salvador (Region of Gúdar-Javalambre), Esther Garcia (Provincial Government of Teruel), Felipe Rosado (Government of Aragón), Guillermo Morales (MINECO), Isidro Holguera (Government of Aragón), João Nunes (CESAM, University of Aveiro), Joaquim Gargallo (Region of Gúdar-Javalambre), José González (Government of Aragón), José Martínez, Julio Perales (ATRUTER), Laura Gascón (Provincial Government of Teruel), Luis Muñoz (Provincial Government of Teruel), Manuel Ramos (Region of Gúdar-Javalambre), Maria João Cruz (CCIAM, University of Lisbon), Mário Pulquério (CCIAM, University of Lisbon), Millán Millán (CEAM), Pedro Pinho (CERENA, IST and CBA, University of Lisbon), Ramón Vallejo (CEAM and University of Barcelona), Sandra Garcia (University of Cartagena and MINECO), Tatiana Garza (Government of Aragón), Teresa David (INIAV), Trevor Self (University of Oxford), Vânia Proença (IST), Victor Sanz (Region of Gúdar-Javalambre).