BRIEFING / 3.3

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GLOWA

Plant species cannot escape climate change but may be less vulnerable than previously thought

Key findings

- Species are largely unable to escape climate change due to very restricted dispersal ability.
- Increasing frequencies of dry years have a negative effect of population performance in semi-arid and arid areas.
- The changes in precipitation patterns as predicted until 2065 do not pose an immediate threat to most species.

Overview and Objectives

The Mediterranean region under climate change – A Biodiversity Hotspot under pressure?

Its rich and unique flora makes the Mediterranean region a hotspot of global biodiversity, including many wild progenitors of important crop species. Since water availability is the key limiting abiotic factor in these ecosystems, the main impact of climate change is expected to result from changing rainfall patterns, namely an increasing frequency of dry years, rather than from raising temperatures or CO_2 levels.
Even small changes in precipitation are believed to have a large impact and pose a major threat to plant diversity. However, Mediterranean and arid ecosystems are already now characterized by their large intra-annual precipitation variability. Therefore plant species growing there must be adapted to a wide range of conditions and may thus be more resilient to climatic shifts than commonly thought.
It was our objective to find out to what extent the diverse plant communities are really threatened by climate change and which species are the most vulnerable. This knowledge will help developing efficient management strategies and to target investment into conservation to those actions that are most urgently needed and effective.

Research Methods

Climate Change: Surviving or Escaping!

Under changing conditions, plant species have only two options in order to avoid extinction: either they are able to successfully grow and reproduce under the new conditions - they adapt - or they are able to efficiently disperse their seeds to track their preferred climate in space.
Because field experiments are limited in time, models are used frequently to assess extinction risks of organisms. So-called matrix population models can utilize detailed demographic data

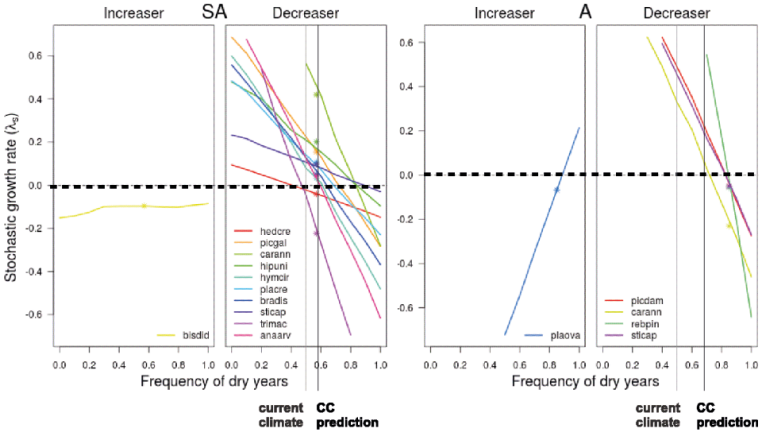

Figure 1: Most species at semi-arid (left) and arid (right) field sites suffer from increased frequencies of dry years, but maintain positive population growth (values above 0) at conditions predicted by regional climate models in the period 2035-2065.

Teams of researchers from Germany, Israel, Jordan and the Palestinian Authority work on how best the hazards posed by global change to the future of the Jordan River basin can be faced and overcome.

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The GLOWA Jordan River project is part of a larger research initiative launched by the German Federal Ministry of Education and Research under the title "Global Change and the Hydrological Cycle".

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(birth, growth, reproduction, and death) to assess species performance under increased frequency of dry years. We combined these models with regional climate change scenarios (Smiatek et al. 2011) making use of detailed demographic data collected for many species at four field sites (mesic Mediterranean, Mediterranean, semi-arid, arid) over eight years. In addition, we conducted a field experiment for assessing whether and how far plants may be able to disperse.

Species performance under climate change

Climate change will have a negative affect on population growth rate of most species growing under arid and semi-arid conditions. However, those species seem to be able to cope well with conditions drier than the predicted (2035-2065) climate and thus may be relatively resistant to short-term climate change (Figure 1). In wetter climates, i.e. our Mediterranean and esp. the mesic Mediterranean field site, other factors than rainfall (e.g. competition) are the main drivers of population dynamics.

Species potential to escape climate change via seed dispersal

Dispersal was hardly measurable at all. This indicated that the ability of species to track their climatic requirements may be very poor (Figure 2; Siewert & Tielbörger 2010).

Conclusions

Our study suggests that escaping climate change via seed dispersal is no option. Thus, species will have to deal with changing conditions or go extinct. The changes projected until 2065 are well within the conditions under which most species can maintain positive population growth. However, increasing frequencies of dry years have a negative effect and further changes will eventually increase extinction risk. If it comes to that, populations from arid and semi-arid areas are likely to be more threatened than the ones from more humid areas, for which we could not find a direct link between population performance and rainfall. This implies that any effort to restrict climate change to the unavoidable minimum is worth fighting for since the magnitude of change will make the difference between survival and extinction of species.

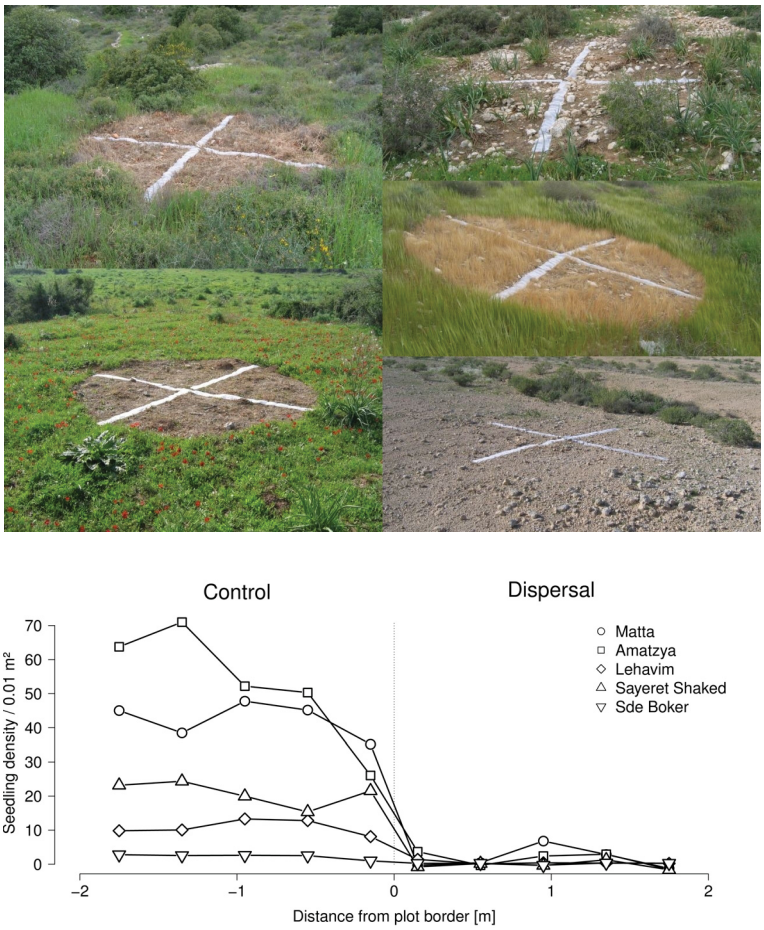

Figure 2: Experimental design to measure species' dispersal ability at 5 field sites (top). At each site, dispersal was so low that it was hardly measurable (bottom).

References

Siewert, W. and Tielbörger, K. (2010). Dispersal-Dormancy Relationships in Annual Plants: Putting Model Predictions to the Test. The American Naturalist, Vol. 176: 490-500.

Smiatek, G., Kunstmann, H. and Heckl, A. (2011) "High resolution climate change simulations for the Jordan River area" Journal. Geophysical. Research 116, D16111.

GLOWA JR Briefings present relevant scientific results of the GLOWA Jordan River project concerning the effects of climate and global change in the Jordan River basin.

Written by Wolfgang Siewert and Katja Tielbörger, University of Tübingen, Department of Plant Ecology, Germany
wolfgang.siewert@uni-tuebingen.de

Contact: Prof. Dr. Katja Tielbörger
University of Tübingen, Germany
coordination@glowa.uni-tuebingen.de
Tel. +49 7071 29 74246