Preventing forest decline in Germany

December 9 2019

Credit: CC0 Public Domain

Summers in Central Europe are becoming hotter, summer rainfall less and droughts longer and more frequent. Climate change is altering weather patterns and having an impact on woodlands in the process. Where water supply is at present still good, climate change is expected to lead to only a moderate shift in species composition towards varieties that can cope better with drought in the medium term. Woodlands

which, however, are already growing in extreme conditions with poor water supply today will not survive future droughts unharmed. This can already be seen in a large part of Frankfurt City Forest, where as a result of the 2018/19 droughts a total of 97 percent of all trees are damaged. That is why researchers from the Institute of Ecology, Evolution and Diversity at Goethe University are exploring in the "South Hesse Oak Project" (SHOP) which strategies can counteract the loss of woodlands, in order to preserve them as a habitat characterized by rich biodiversity and as a CO_2 store despite rapidly advancing climate change.

They have now presented first strategic recommendations:

- Mildly affected areas, where water supply will remain sufficient in future, are in principle able to defy climate change without anthropogenic intervention through natural regeneration of the tree population, climatic selection of individual varieties and adjustment of species composition.
- For moderately affected areas where increasing drought damage is to be expected, targeted reforestation with drought-resistant endemic tree varieties, such as sessile oak or Scots pine, is a suitable approach.
- In strongly affected regions, such as the sandy ground in the Rhine-Main area, it is necessary to plant varieties from drier climate zones. Mediterranean varieties or species are possible here, as are ones from overseas.

The "Ecophysiology of Plants" working group at Goethe University began studying Mediterranean oak species as long ago as 2007. In 2009 at the start of the LOEWE "Biodiversity and Climate Research Centre" (BiK-F), the project born out of it—"The Forest of the Future"—was rewarded with the "Landmark in the Land of Ideas" innovation prize. Out of this project, SHOP developed in 2011 in cooperation with external partners.

The project is concerned with the introduction of Mediterranean oaks as alternative tree species. "Here in Germany, pedunculate oak is one of the ecologically most important forest trees," says Wolfgang Brüggemann, biology professor and head of SHOP. "However, it frequently grows in extremely dry areas and will therefore be particularly severely affected by climate change." Alternative tree species must not only be more resistant to drought than pedunculate oaks but also endure the winters here, which today are still cold. An important aspect for the researchers is that these tree species can also take on the ecological functions of the ones lost. "In order not to weaken the ecosystems further, it's important to maintain biodiversity," says Vera Holland, postdoctoral researcher at the Institute of Ecology, Evolution and Diversity.

In the framework of SHOP—and the "Futureoaks-IKYDA" collaborative project developed out of it in 2017 with partners from Italy and Greece—between 2009 and 2017 the researchers planted more than 10,000 oaks at four sites in South Hesse as well as in Greece and Italy. They have studied their growth, physiology, ecological potential and molecular biology over many years. The results of their research work substantiate that some Mediterranean oaks have excellent potential for being planted as alternative tree species in strongly affected areas, for example the downy oak (Quercus pubescens) or—under certain conditions—the evergreen holm oak (Quercus ilex).

"On the basis of model-assisted forecasts, a shift in the distribution ranges of Mediterranean species in the direction of Central Europe as a result of climate change has already been predicted for years," says Vera Holland. "However, climate change is advancing far more rapidly than the natural immigration of these varieties can firstly keep pace with and secondly fill the holes quickly enough that are caused by extreme weather events. The introduction of the Mediterranean species propagated by us via assisted migration would bridge this process and thus preclude the loss of woodland, a major drop in CO_2 storage and

accelerated soil erosion in deforested areas," she says.

More information: Peter Kotrade et al. Expression profiles of 12 drought responsive genes in two European (deciduous) oak species during a two-year drought experiment with consecutive drought periods, *Plant Gene* (2019). DOI: 10.1016/j.plgene.2019.100193

Provided by Goethe University Frankfurt am Main