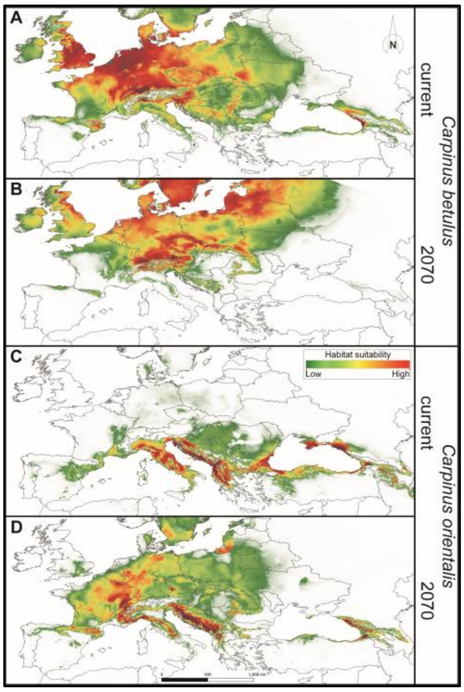
Forests are essential ecosystems on Earth, playing a crucial role in mitigating the effects of climate fluctuations. However, trees are under great pressure trying to adapt to new environmental conditions in a world of anthropogenic climate and land use changes. They can shift their geographic range to avoid extinction in search of favourable habitats. Yet, this is a slow process, as they can effectively do this only through seeds. Species resilience and adaptability depend on genetic diversity. There is a concern that the speed of climate change will disrupt these local adaptations, rendering many species vulnerable to decline and extinction. This may have negative consequences for the stability and functioning of forest ecosystems, which will adversely affect the entire environment, and also deteriorate the quality of human life. Therefore, much attention is paid to predicting the effects of climate change on the distribution and adaptation of forest trees to develop tuned conservation, management and restoration practices. Assessing species' vulnerability to climate change requires inferring past demographic history and factors influencing current genetic diversity and predicting their changes under evolving environmental conditions. Currently, species-level responses to climate change can be predicted through advanced computational methods and genetic studies.



In this project, our team focused on assessing the vulnerability of tree species to climate change using a range of novel approaches that combine population and landscape genomics with advanced modelling techniques. We selected two closely related hornbeam species, *Carpinus betulus* and *C. orientalis*, with partially overlapping ranges but different ecological preferences. They also interbreed to produce a hybrid species. Both hornbeams are important elements of forests in Europe and Western Asia. Precisely, we will reconstruct the evolutionary history of *Carpinus* species, investigate factors driving intraspecific genetic diversity, and predict the impact of climate change on the distribution of both species, including range shifts and local declines. We also aim to identify hybrid populations and potential contact zones across the range of both hornbeam species.

The investigation of these issues becomes particularly important in the face of predicted range reorganisations for both *Carpinus* species in the coming decades, which could bring negative evolutionary and ecological consequences. For instance, with the expected loss of habitat in some parts of the species' range, the most vulnerable populations could lose their genetic resources, reducing the species' adaptive potential and, consequently, the resilience of forests. Regarding potential hybridisation between these species, we anticipate that this may increase genetic variation and, hence, drive species adaptation to new conditions.

Compared to economically important species such as beech, oaks, or pines, the genomic resources, local adaptation, and hybridisation consequences of hornbeam species have never been thoroughly investigated, especially in the context of climate change. This project aims to fill this gap by providing insights into potential risks and supporting regional climate adaptation strategies to conserve hornbeam resources. Additionally, studying the hybridisation of the two hornbeam species using advanced genomic methods is undeniably fascinating from an evolutionary perspective. This genetic mixing provides insights into the geographic variation among species. The results of our studies may offer new insights into the evolutionary history of these species.

The outcome of this study will be a comprehensive assessment of the genetic resources of both hornbeams at the highest resolution ever applied to these species. The knowledge gained from the extensive genomic resources of the hornbeams can support genetic monitoring programmes, aid conservation efforts, or guide advanced mitigation strategies such as assisted migration. Conservation and sustainable use of forest tree resources are critical for biodiversity conservation, especially in the context of climate change and the increasing demand for multiple forest services. This study will provide a solid understanding of the future persistence of both hornbeams and guidance on the strategies needed.