1. Tree Adaptive Responses to Climatic Variability

In a changing climate, forest trees have to deal with a range of altered environmental conditions. Within this Special Issue, researchers aimed at revealing the responses of different forest species to various globally changing abiotic parameters, such as increasing atmospheric CO$_2$, elevated temperatures, and limited water availability.

In an experiment with open-top chambers, Kim et al. [1] studied the physiological and transcriptome responses of Poplar hybrids to elevated CO$_2$, being one of the main components of global change. They identified differentially expressed genes and alterations in chlorophylls, starch, and soluble sugars in response to increasing CO$_2$. The impact of elevated CO$_2$ was also assessed by Wang et al. [2], who reported photosynthetic declines in *Phoebe bournei* Hemsl., an endemic tree threatened by habitat loss in China. However, they concluded that this negative impact of increased CO$_2$ may be alleviated by the application of ammonium or nitrate fertilization. The effect of drier growth conditions on the tree radial profile of sap flow was assessed in a coastal Mediterranean Aleppo pine ecosystem [3]. A steeper decline in sap flux density with increasing sapwood depth was observed in drier periods. The limiting role of water availability in such xerothermic environments was further supported by the fact that sap flow responded positively to a favorable microclimate only when water availability exceeded a certain threshold. The effect of rising temperature was studied by Sambayo-Maldonado et al. [4] who assessed the thermal time and cardinal temperatures of *Cedrela odorata* in order to estimate changes in the germination of red cedar under different climate change scenarios. It was found that as the temperature increases in line with the predictions for 2050 and 2100, the germination of the soil seed bank will accelerate, which may have implications for the future distribution of this important forest species in tropical environments.

1. Forests 2021, 12, 1728. https://doi.org/10.3390/f12121728
2. Responses to Changing Climate at the Ecosystem Level

Climate change is also expected to induce alternations in the distribution range of forest species, species’ replacement and losses of forest land, with important economic and ecological consequences.

In this context, Zindros et al. [7] monitored the changes in tree line over a 40-year period in the core of Olympus Mt. National Park in Greece and reported a warming-related upward shift in the tree line. Apart from spatial shifts, temporal shifts in forest ecosystems ecophysiological and phenological responses are also related to climate change. Marquardt et al. [8], compared the sensitivity and temporal stability of climate–growth relationships in Pinus arizonica, and P. ponderosa var. brachyptera consisting of two needle-types, in Arizona, USA, in order to characterize their growth responses to changing climate. They concluded that the species responded to summer precipitation pre-1950 but are now responding to spring precipitation post-1950, representing a shift in allocation of tree resources from maximizing biomass in the summer to reproduction spring. In the same lines, Ogaya and Peñuelas [9] found that a small but continuous decrease in soil water availability for 21 years in a Mediterranean holm oak (Quercus ilex L.) forest resulted in the gradual replacement of holm oak by another evergreen shrub (Phyllirea latifolia L.), which is more tolerant to hot and dry conditions.

3. Conclusions

The above-mentioned and other forest trees’ and ecosystem responses to rapidly changing climate are reviewed by Kijowska-Oberc et al. [10]. In their review, they brought together literature reports on a range of adaptive responses to both forest abiotic threats (such as drought and heat) and biotic threats (such as pathogens and insects) and they discuss the role of epigenetics, phenology, and phenotypic plasticity for tree adaptations to climate change.

The studies included in this Special Issue illustrate the clear effects of climate change on forest trees’ function, evidenced by different responses on genes expression, biochemical, and physiological levels. However, it is also indicated that different forest species from a broad range of climate zones and ecosystem types are able to develop adaptive mechanisms to cope with the current climatic variability. On the ecosystem level this may lead to distribution shifts and changes in vegetation composition. Further research is needed to identify if measures, such as assisted migration or others, may facilitate the transition to climate change resilient forest ecosystems.

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