Warming-mediated drought stress decreases tree growth of delavay fir

December 20 2021, by Zhang Nannan

Abies delavayi (Delavay's Fir). Credit: S. Rae from Scotland, UK/Wikimedia Commons, CC BY 2.0

Several tree-ring studies have been carried out in the Hengduan Mountain (HM) region. However, long-term growth trends and physiological responses of high-elevation forests to atmospheric carbon dioxide (CO_2) rise and climate change in the HM region is still not clear.

In a study published in *Forest Ecology & Management,* researchers from the Xishuangbanna Tropical Botanical Garden (XTBG) of the Chinese Academy of Sciences evaluated the long-term trends, climate responses and physiological adjustments of delavay fir (Abies delavayi), a high-altitude mountain tree, in the Cangshan Mountains, HM region.

The researchers applied the dual-isotope approach (tree-ring $\delta^{13}C$ and $\delta^{18}O$) to detect the shifts of tree physiological responses from extreme cold to warm conditions.

They found that tree growth of delavay fir has been declining since 1950s in the Cangshan Mountains, which is attributed to the combination of increasing temperature and decreasing moisture availability. The declining growth trend can be explained by the negative effects of temperature and positive effects of moisture availability on tree growth. But during the earlier period 1800–1951, there was a stable growth trend.

Additionally, they detected a decreasing trend of leaf inter-cellular CO_2 and atmospheric CO_2 ratios, suggesting an active response to CO_2 rise via reduction of stomatal conductance. Intrinsic water-use efficiency was increasing, especially after the 1950s.

Dual isotopic analyses revealed increasing tree-ring stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) ratios, indicating a shift from cold/wet to more warm/dry conditions, suggesting a reduction of stomatal conductance, and stable or decreased photosynthetic assimilation rate.

The negative growth trends during recent decades were mainly driven by regional drying trends and/or warming-induced moisture limitations. However, increasing intrinsic water use efficiency did not mitigate the negative effects of warming and drying on tree growth.

"Our results serve as an early warning for tree growth and productivity of A. delavayi forests at the southern distribution limits under the ongoing warming climate," said Dr. Fan Zexin, principal investigator of the study.

More information: Rao-Qiong Yang et al, Long-term growth trends of Abies delavayi and its physiological responses to a warming climate in the Cangshan Mountains, southwestern China, *Forest Ecology and Management* (2021). DOI: 10.1016/j.foreco.2021.119943

Provided by Chinese Academy of Sciences