Reconstruction of climate using dendrochronology

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Forest tree species respond to climate change, and dendro-climatological investigations of such species provide valuable insights into climate variations. These investigations are instrumental in reconstructing historical climate data and facilitating the development of effective mitigation and adaptation strategies. This study focuses on utilizing the climate-sensitive tree rings of Himalayan fir (Abies pindrow Royle ex D. Don) to reconstruct monthly temperatures during the growing season (pre-monsoon) in the climate-vulnerable western Himalayan region of Pakistan. We constructed a tree ring width chronology spanning 1773 to 2020 CE. The findings indicate that Abies pindrow exhibited negative growth responses (r = -0.46) and (r = -0.50) to the May minimum temperature (May Tmin) and May-June average temperature (Tav MJ) for the Murree Meteorological Station, respectively. Similarly, negative responses were observed (-0.34, -0.522, -0.60, and -0.64) for the calculated May minimum temperature (May Tmin), May average temperature (Tav-May), May maximum temperature (May Tmax), and mean May-June maximum temperature (Mean MJ Tmax) of the Kakul Meteorological Station, respectively. Only Mean MJ Tmax (Kakul MET Station) was found to be having valuable reconstruction potential and reconstruction of the same was under taken with an explained variance of around 40%. The reconstruction spanned from 1855 (with an expressed population signal > 0.85) through 2020, revealing 16 recorded cold and 16 recorded warm years. The reconstructed temperatures aligned with some commonly reported hot and cold years in regional studies. Additionally, short frequency cycles (2.43–3.57 years) attributed to El Niño Southern Oscillations and a geographical correlation with precipitation and potential evaporation were observed. Reconstructed temperature anomalies coincided with major global volcanic eruptions, highlighting the broader impacts of climate change on trees in the western Himalayas. This study serves as a valuable resource for researchers exploring regional climate change dynamics, providing comprehensive insights into the intricate relationships between climate variations and tree growth in the western Himalayas.

Keywords: Dendrochronology; climate change; reconstruction; Himalayan; variations