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Capturing stress legacy: From tree physiology to forest resilience

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Extreme droughts combined with heatwaves are intensifying in frequency and severity. The impacts on tree and forest functioning are manifold, and span from declining tree growth to reduced forest health and tree die-back as observed in many regions world-wide. These detriments have clear consequences for the well-documented contemporary carbon dioxide sink of forests and hence, their role in buffering climate change. Yet to date, we lack a comprehensive understanding to quantify long-term impacts on forest resilience and productivity beyond specific individual stress events. A striking knowledge-gap persists on what determines tree recovery and survival following drought release, including the thresholds causing functional damage and the role of repair mechanisms. Here, novel insights into physiological thresholds and post-stress recovery focusing on tree hydraulic processes and carbon metabolism are presented. A conceptual framework indicates that the persistence of stress legacy depends and on the degree of functional impairment, for instance hydraulic dysfunction or leaf senescence, and the ability for repair and regrowth. I argue that an improved physiological understanding of thresholds resulting in functional damage and how fast trees can repair and/or regrow tissues provides a promising avenue in order to integrate stress legacy into forest ecosystem models.