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When acclimation backfires: how chronic heat and atmospheric drought reshape plant water-use strategies and mortality risk

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Rising air temperature and atmospheric evaporative demand are fundamentally altering plant water relations, yet their long-term consequences for drought vulnerability and mortality remain poorly constrained. While short-term physiological responses to heat and high vapor pressure deficit (VPD) are increasingly well documented, far less is known about how *chronic exposure* reshapes plant water-use strategies, hydraulic regulation, and the mechanisms underlying mortality risk under future climates.

Here, I synthesize experimental and field evidence showing that exposure to elevated temperature and evaporative demand can induce lasting acclimation in plant water-use behaviour. Results from manipulative experiments in mature forests and controlled conditions reveal that acclimation to atmospheric conditions can modify stomatal regulation, whole-plant transpiration, crown structure, and the coordination between soil and atmospheric drought responses. In some cases, these adjustments maintain carbon gain under moderate stress but accelerate soil water depletion and shift physiological thresholds governing stomatal closure and hydraulic safety during drought. Such acclimation effects can translate into altered drought outcomes, including changes in mortality risk. Together, these findings suggest that acclimation to warmer and drier atmospheric conditions does not necessarily confer increased drought resistance, but may instead reconfigure vulnerability by modifying how and when plants restrict water loss.

By linking physiological acclimation, water use, and emerging mortality patterns, this presentation highlights the need to explicitly account for atmospheric history and acclimation processes when predicting vegetation responses to future climate scenarios. Understanding when acclimation buffers stress, and when it amplifies risk, will be critical for improving projections of forest resilience under continued warming and intensifying atmospheric drought.