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Tree mortality in the eastern Mediterranean, causes and implications under climatic change

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The eastern Mediterranean has experienced repeated incidents of forest mortality related to drought in recent decades. Such events may become more frequent in the future as drought conditions are projected to further intensify due to global warming. We have been investigating the causes behind such forest mortality events in Pinus halepensis, (the most drought tolerant pine in the Mediterranean). We cored tree stems and sampled various tissue types from dry habitats close to sea level and explored growth responses, stable isotope signals and non-structural carbohydrate (NSC) concentrations. Under intense drought that coincided with pine desiccation events in natural populations our result indicate a significant reduction in tree growth, the most significant in more than a century despite the increase in atmospheric CO_2 concentrations in recent decades. This has been accompanied by a lengthening in the integration periods of rainfall needed for pine growth, reaching even 5-6 years before and including the year of mortality occurrence. Oxygen stable isotopes indicate that these signals were associated with a shift in tree water utilization from deeper moisture pools related to past rainfall events. Furthermore, where the driest conditions occur, pine carbon reserves were found to increase in stem tissue, indicating that mortality in these pines cannot be explained by carbon starvation. Our findings suggest that for pine populations that are already water limited (i) a further atmospheric CO_2 increase will not compensate for the reduction in growth because of a drier climate, (ii) hydraulic failure appears as the most likely cause of pine desiccation, as no shortage occurs in tree carbon reserves, (iii) a further increase in mortality events may cause these systems to become carbon sources.