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Persistence of evapotranspiration impacts from mountain pine beetle outbreaks in lodgepole pine forests, south-central Rocky Mountains, USA

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The current extent and high severity (percent tree mortality) of mountain pine beetle outbreaks across western North America have been attributed to regional climate change, specifically warmer summer and winter temperatures and drier summers. These outbreaks are widespread and have potentially persistent impacts on forest evapotranspiration. The few data-driven studies have largely been restricted by the temporal availability of remote sensing products. This study utilized multiple mountain pine beetle outbreak location datasets, both current and historical, within lodgepole pine stands in the south-central Rocky Mountains. The full seasonal evapotranspiration impact of outbreak events for decades after outbreak (0 to 60 years) and the role of outbreak severity in determining that impact were quantified. We found a 30% reduction in evapotranspiration peaking at 14-20 years post-outbreak during the spring snowmelt period, when water was not limited, but a minimal reduction in evapotranspiration during the remainder of the growing season (June – August). We also found a significant increase in evapotranspiration, relative to non-attacked stands, in intermediate aged stands (20-40 years post-disturbance) corresponding with a peak in LAI and therefore transpiration. During the snow-cover months evapotranspiration initially increased with needle fall and snag fall and corresponding increases in albedo and shortwave transmission to the surface. We found that changes in evapotranspiration during all seasons dissipated by 60 years post-attack. MODIS evapotranspiration values responded most strongly to mountain pine beetle driven changes in net radiation or available energy, and vegetation cover (e.g. LAI, fPAR and EVI). It also appears that the post-attack response of evapotranspiration may be sensitive to precipitation patterns and thus the consequences of a disturbance event may depend on the directionality of climate change conditions.