Global Change, Climate-Induced Forest Dieback, and Wildland Fire Risk

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Abstract

Global climate change models predict substantial shifts in climatic patterns over coming decades in many regions, including warmer temperatures and increases in extreme drought events. Such changes may increase stress on long-lived woody vegetation, directly causing mortality and forest dieback. Forest stress and dieback have recently become apparent in many parts of the world, including: extensive forest mortality in western North America, such as >1,000,000 ha of *Pinus edulis* dieback in the southwestern USA since 2002; dieback of *Pinus* and *Quercus* species in parts of Mediterranean Europe; drought impacts in the Amazon Basin; and eucalyptus dieoff in Australia. Warm, dry conditions also enhance wildland fire risk, illustrated by years with extreme fire activity in these same regions over the past decade. But it's not as simple as "dead trees increase fire risk", as the feedbacks/interactions between climate-induced forest mortality and wildland fire risk are variable and not well characterized. Moisture-stressed live vegetation is maximally flammable, but once woody vegetation dies it rapidly loses aerial fine fuels (by shedding needles and leaves) and associated volatile (and flammable) biochemical compounds (like aromatic terpenes). This creates standing woody fuel structures that no longer can propagate running crown fires, as standing coarse woody fuels do not burn explosively, so risks of unsuppressable crown fires may decrease initially. Conversely, surface fine fuels often increase rapidly once forest canopies open up from dieback, due to leaf drop and increased herbaceous growth, increasing short-term surface fire risks. And later as dead trees fall and woody vegetation regenerates they create complex and heavy surface and ladder fuel loads, and risk of higher severity fire increases again. Uncertain vegetation successional outcomes from both forest dieback and stand-replacing fire in the face of ongoing climate change also challenge our capabilities to project future fuel conditions, and thus fire regimes. Assessing potential interactions between climate-driven forest dieback and altered fire regimes is an emerging global change research topic, since woody vegetation losses due to climate-induced mortality and severe fire activity can be rapid and extensive, with pervasive and persistent ecological effects, including substantial losses of sequestered carbon back to the atmosphere.

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