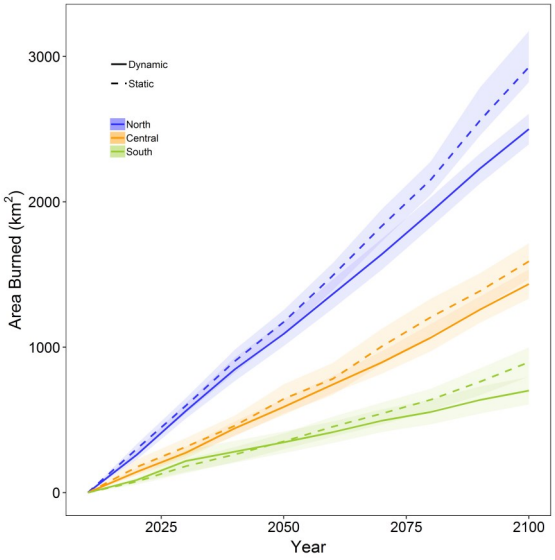
Earth Systems Ecology Lab



Cumulative area burned for a latitudinal gradient of transects in the Sierra Nevada under projected climate. Dynamic simulations (solid lines) include decadal re-estimated area burned distributions that account for prior fire events and projected climate. Static simulations (dashed lines) only account for projected climate.

Vegetation-Fire Feedback Reduces Area Burned

Climate influences vegetation directly and through its effect on disturbance processes, such as wildfire. While area burned generally increases with increasing temperature, fire is a self-limiting process. If there is insufficient vegetation to support fire, climatic conditions do not exert influence over area burned. Yet, many fire projections under future climate assume there is sufficient vegetation to support fire. We ran simulations that accounted for the vegetation fire feedback in order to quantify the effects of prior fires on future area burned and to estimate how changes in area burned would influence future fire emissions. We combined an ecosystem model and a statistical fire model to re-estimate fire size distributions for each decade from 2010-2100 for three transects across the Sierra Nevada.

We found that accounting for the vegetation-fire feedback reduced cumulative area burned by 9.8-21.8% across the three transects. Scaled to the mountain range, this equals a 14.3% reduction in cumulative area burned through 2100. By late-century, our simulations that accounted for previous wildfires showed a 20.9% reduction in the average fire size. When we estimated the effects that the vegetation-fire feedback would have on emissions, we found that the emission constituents (e.g. carbon dioxide, particulate matter, etc) did decrease, but were still substantial. The 2013 Rim Fire was estimated to have emitted 12 Tg of carbon dioxide equivalents. Our emissions from simulations with the vegetation-fire feedback were equal to one Rim Fire occurring on average every 3.8 years. Even after accounting for the effects of prior wildfires on subsequent area burned, the Sierra Nevada will continue to be a flammable environment and fire events will have significant impacts on air quality.

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Management Implications

The effects of prior wildfires will limit area burned under projected climate, but the limitation is transient and lasts approximately 10 years.

The vegetation-fire feedback reduces the size of the largest fires by mid-century when compared to simulations that do not account for the fuel limitation.

Even with the reduction in area burned from the vegetation-fire feedback, the increasing area burned with ongoing climate change will continue to present air quality challenges as the amount of emissions increases.

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