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Reducing forest carbon vulnerability to forest wildfires through climate-smart management

Piazza, Natalie, Malanchini, Luca and Vacchiano, Giorgio

University of Milan

Abstract

Forests are crucial for regulating global carbon and mitigating climate change. The increasing frequency and intensity of forest disturbances in the future may put at risk many ecosystem services like carbon sequestration. After a disturbance, carbon is released into the atmosphere and forests may change from carbon sinks to source. Climate-smart forest management can improve the forest carbon balance by reducing disturbance vulnerability to avoid emissions and increase carbon sequestration. We here propose a method to estimate wildfire-induced risk to forest climate mitigation by combining fire hazard assessment with estimate of the vulnerability of forest carbon stock and sinks. We assessed fire hazard using a burn probability indicator calculated by the FlamMap simulation tool. The model was initialized using vegetation and topography data collected in the field in combination with existing forest plans, and climate scenarios reflecting expected impacts of climate change on atmospheric and vegetation moisture. The study area at Galeata (Apennines, Italy) is composed by heterogenous forest stands ranging from coniferous afforestation to broadleaved coppice stands dominated by hop-hornbeam and pubescent oak. For each forest stand we calculated the burn probability and carbon sink and source, and combined these to create a fire risk map to inform priorities for silvicultural prevention. We analysed the main factors increasing the fire risk in this region. The burn probability was highest in stands dominated by hop-hornbeam and pubescent oak. The most important driver of burn probability was indeed the forest type, in which case the broadleaved stands were more exposed to fire. Additionally, elevation and aspect affected burn probability with lower elevation forests at E- through S- to W-exposed slopes being more susceptible. A combination of burn probability map together with maps of carbon sink and source may help to evaluate the overall risk to carbon release in case of wildfire. Such maps may be used to efficiently plan climate-smart forest management and help in decision-making and cost-benefit analysis

Keywords: climate-smart forestry, wildfire disturbance, fire risk maps