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Forest management under changing climate conditions: Is timing a tool for Sustainable Forest Management? Relevant questions for research development

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Change of climate conditions influence energy fluxes applicable to forest ecosystems. These affect cycles of nutrients and materials, primary productivity of the ecosystem, biodiversity, ecological functionality and, consequently, carbon equilibria of the forest ecosystem. Temporal factors influence physical, biological, ecological, and climatic processes and functions. For example, seasonality, cycles, periodicity, and trends in climate variables; tree growth, forest growth, and forest metabolic activities (i.e. photosynthesis and respiration) are commonly known to be time-related. In tropical forests, the impacts of changing climate conditions may exceed temperature and/or precipitation thresholds critical to forest tree growth or health.

Historically, forest management emphasises growth rates and financial returns as affected by species and site. Until recently, the influence of climate variability on growth dynamics has not been influential in forest planning and management. Under this system, especially in climatic and forest regions where most of species are stenoecious, periodical wood harvesting may occur in any phase of growth (increasing, decreasing, peak, and trough). This scenario presents four main situations: a) harvesting occurs when the rate of growth is decreasing: future productivity is damaged; the minimum biomass capital may be altered, and CO_2 storage is negatively affected; b) harvesting occurs during a trough of the rate of growth: the minimum biomass capital necessary to preserve the resilience of the forest is damaged; the damage can be temporary (decades) or permanent; CO_2 storage capacity is deficient – which may be read as an indirect emission of CO_2 since the balance appears negative; c) harvesting occurs when the rate of growth is increasing: the planned wood mass can be used without compromising the resilience and recovery of the forest; CO_2 storage remains increasing; d) harvesting occurs during a peak period of growth: the wood mass harvested can be even higher than planned, and the rate of CO_2 storage can be above the average.

A real risk for SFM under changing climatic conditions is that negative effects may be amplified; critical thresholds of temperature and/or rainfall for tree growth and stress may be exceeded with impacts on growth response, resilience, and CO_2 balance that are not completely known. Furthermore, temporal changes in silvicultural and harvesting operations may lead to increased carbon emissions.
Under this scenario and the consequent risks to SFM forestry operations should be planned or scheduled in periods when climate variables influencing tree growth and stress are within the relative thresholds. In this way, silvicultural operations and harvesting are going to be optimised to climate variability and forest growth responses, rather than just forest timber production.