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Use of hydrological indexes to estimate the potential for deforestation and fires in vegetation models for Amazonia

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Due to climate and hydrology, large tropical areas would potentially be covered by forests. These areas, however, may differ from their potential original states because land use and indirect associated processes such as fires. Here we present a method to refine estimations of spatial distribution of forests and savannas in the Brazilian Amazonia, based on relations between hydrological indexes and deforestation and fires for the region. We also underline strategies for implementing it in large-scale vegetation models. The method is based on relations between contemporary fire occurrence and hydrology factors that drive the potential distribution of major biomes in the region. One factor is a soil-moisture seasonality index (D) which is lower (higher) for places where the soil presents longer (shorter) dry periods. Other is an above-ground wetness index (H) which is lower (higher) for longer (shorter) periods of dry atmospheric conditions. Our analyses indicate the most common values for both indexes in areas potentially covered by tropical forests that had low, medium and high fire activity. For each fire-activity class, we determined the distribution of values for both D and H indexes and found the values below which deforestation/fire degradation were relatively more frequent. These relations are now being applied to refine projections of the spatial distribution of forests and savannas in the region. For that, we initially assume that land-use dynamics and policy currently observed in the Brazilian Amazon will remain in the future, and that deforestation/fires will affect forests only in grid cells of tropical and seasonal forests that are located adjacent to savannas, because the access to the forests is facilitated by the savannas where fires are also a natural feature. For example, if a place projected to be covered by tropical or seasonal forest presents both indexes H and D below certain thresholds, and the area is adjacent to a savanna, then tropical forest will be adjusted to seasonal forest. In case of a seasonal forest it will be adjusted to savanna. Although our method may represent an underestimation of fire effects by not considering direct transitions from tropical forests to savannas, it helps quantifying long-term changes in vegetation cover including human factors and is based on simple general relations derived from data for the region.