CASCADING EFFECTS OF INCREASED DRYNESS AND REDUCED FOREST RESILIENCE IN THE AMAZON REGION

Delphine Zemp[1,2], Carl-Friedrich Schleussner[3], Marina Hirota[6], Henrique Barbosa[4], Gilvan Sampaio[5], Anja Rammig[1]

[1]Potsdam-Institut für Klimafolgenforschung, Potsdam, DE, delphine.zemp@pik-potsdam.de
[2]Humboldt-Universität zu Berlin, Berlin, DE, delphine.zemp@pik-potsdam.de
[3]Climate analytics, Berlin, DE
[4]Universidade de São Paulo, Sao Paulo, BR
[5]Instituto Nacional de Pesquisas Espaciais, Cachoiera Paulista, BR
[6]Universidade Federal de Santa Catarina, Florianopolis, BR

Previous studies suggested that increasing dryness in the Amazon region combined with forest degradation could lead to critical transitions of vegetation states. Typically, it is assumed that tropical evergreen forests may be replaced by seasonal forests or savanna. This process could be amplified by feedbacks in the vegetation-climate system such as moisture recycling. In this way, the tropical rainforest pumps water from the soil and releases it to the atmosphere. This atmospheric moisture returns then to the land as precipitation either locally or over somewhere else after transport by winds. On the way, atmospheric moisture might run through a certain number of re-evaporation cycles (evapotranspiration followed by precipitation) before being transported out of the Amazon river basin.

The degradation of tropical forest affects cascading moisture recycling. Unlike tropical dense forest with deep-rooted trees, a degraded forest experiences water deficit and decreases evapotranspiration rate during the dry season. As a result, the moisture recycling weakens, intensifying the dry season locally and downwind. This in turn affects the resilience of the remaining forested areas.

Here, we examine how perturbations of the hydrological cycle (induced by deforestation or reduced incoming moisture from the ocean) lead to cascading effects of increased dryness and reduced forest resilience. We combine a simple empirical model based on remote sensing data together with an Eulerian moisture tracking model to quantify the probability of cascading vegetation change in present day and future Amazonian rainforest.