Loss of Amazon rainforest resilience since the early 2000s

Chris Boulton¹, Timothy Lenton¹, and Niklas Boers¹²³
¹Global Systems Institute, University of Exeter, UK
²Department of Mathematics, Free University of Berlin, Germany
³Potsdam Institute for Climate Impact Research, Potsdam, Germany

The resilience of the Amazon rainforest to both climate and land use change is of critical importance for biodiversity, regional climate, and the global carbon cycle. Some models project future climate-driven Amazon rainforest dieback (Cox et al. 2000) and others argue that land-use and climate change have already pushed the Amazon close to a tipping point of rainforest dieback and transition to savanna (Lovejoy & Nobre 2018, 2019). But competing effects between rising temperatures, changing precipitation patterns, and CO₂ fertilization, make the future of the Amazon uncertain. An alternative approach is to look for direct observational signals of changing rainforest resilience from timeseries analysis - here of remotely-sensed vegetation optical depth (VOD) (Moesinger et al. 2018), which correlates well with changes in broadleaf tree fraction coverage. Our results indicate that the Amazon rainforest has been losing resilience since the early 2000s, with statistical characteristics evolving consistently with critical slowing down on the way to a bifurcation-induced transition. Specifically, changes in lag-1 autocorrelation of VOD show that resilience is lost faster in regions with less mean annual rainfall. Parts of the rainforest that are closer to human activity are also losing resilience more quickly. Given observed increases in dry-season length, and expanding areas of land use change, the loss of Amazon rainforest resilience is likely to continue. Our results provide direct empirical evidence that the Amazon rainforest is losing stability, risking a sudden dieback that would have profound implications for biodiversity, carbon storage and climate change.

References


This work was funded by the Volkswagen foundation and the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820970.