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Assessing water stress dynamics of the Amazonian rainforest through root zone storage capacity: A time-series approach

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Extended exposure to change in rainfall patterns and permanent land-use change (LUC) have reduced the capability of the forests to withstand any external stresses, also defined as forest resilience loss. Major parts of the Amazon forest is under threat of tipping towards a treeless savanna state due to these changes in rainfall patterns and LUC. This loss in forest resilience thus also prevents the forest to return to its pre-disturbed state of the natural cycle and makes the forest more prone to tipping. Yet, this change in natural cycle is not sudden and involves a certain time lag for the forest system to respond. Previous studies determined the forest resilience, but have only considered precipitation or climatological drought to be the key influencing factor. However, neither are a direct measure of the water stress of the forest and thus do not fully reflect the hydrological dynamics underlying forest resilience loss. This study addresses the research questions: (i) do change in climatic patterns have a significant effect on forest resilience?, (ii) how does the change in rainfall patterns or LUC affect the environmental dynamics of the forest over time?, (iii) whether the quantification of rainfall, root zone storage capacity and LUC patterns at a temporal scale better for understanding the resilience loss of the forest?

The present study aims at understanding the complex dynamics of the resilience of the forest system using a time-series approach. Advanced remote sensing resources allow us to determine and understand patterns in the tipping behaviour at a temporal scale as well as to understand the hydrological dynamics and environmental triggers. For this, we combined precipitation data, root zone storage capacity and satellite-based forest cover and LUC data analyzed along a time-series. This is to better represent the resilience loss of the forest towards hydrological interactions and also provide a better understanding of the hydrological process for the forest tipping rather than a statistical relation. Landsat-7 data is ideal for determining the forest change, due to its regional time series availability from early 2000's until today. This study provides a better understanding of the hydrological dynamics of the rainforest by utilizing a time-series approach. Root zone storage capacity represents the water stored in the roots of the forest (a.k.a., water available to the forest) and it is a much better representation for assessing water stress of the Amazonian rainforest than precipitation. Thus, also a better parameter for evaluating forest resilience loss over time.