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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Scaling properties reveal regulation of river flows in the Amazon through a "forest reservoir"" *by* Juan F. Salazar et al.

Anonymous Referee #2

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This work by Salazar et al. is an interesting study and presents original ideas. The authors study scaling properties of river flows of the Amazon basin and its subbasins. Identifying whether a basin attenuates or amplifies extremes in the flow regime, they propose that (Amazonian) river basins can go through tipping points of river flow regulation if forest loss exceeds a critical level.

Despite the interesting features of this study, I have a number of concerns that leave me yet unconvinced of some of the interpretations and conclusions drawn from them. These issues need to be addressed in a major revision before I can recommend publication of this manuscript.

The authors hypothesize that, generally, river flows in Amazonian basins are regulated by the forests, meaning that extreme lows and highs in flows are attenuated by the for-

est. Mainly forest-induced precipitation recycling would be responsible for this attenuation. Indeed, this provides a positive feedback between the land/biosphere and rainfall, and such positive feedbacks are necessary for tipping points to occur (Van Nes et al. 2016, Trends in Ecology & Evolution 31:902-904). It should, however, be made more clear how land-atmosphere interactions cause both higher minima and lower maxima in river flows. Moisture recycling also has a typical spatial scale and direction. How does this affect the regulation of river flows and could the finding that the Tapajos is unregulated be an artefact of its size (and possibly shape)?

Key for understanding the feedbacks in the system should be figure 6. However, it rather confused me, for the signs of the arrows do not seem to represent the sign of individual interactions: for example, evapotranspiration does not decrease (as is indicated now), but increase atmospheric water storage. And how could atmospheric water storage increase direct runoff? Both the figure and the text should be revised to guide the reader more to understand the core of the idea that is proposed.

Furthermore, I am not convinced of the threshold of 60% tree cover below which river basins shift from regulated to unregulated. The evidence for this threshold is that the Tapajos, inferred to be the only unregulated subbasin in the Amazon, is also the only one with an average tree cover of below 60%. This correlation is too weak to draw the conclusion that this threshold exists, let alone that deforestation has caused the Tapajos to pass a tipping point.

The authors also relate the 60% threshold to its correspondence to the threshold that can separate forests and savannas as alternative stable states. However, the latter threshold applies at local scales instead of at basin scale. A basin-scale average tree cover does not provide information about how far from such a threshold a forest is in any particular location; having a larger extent of grasslands in a basin does not necessarily mean that the forests in the basin are closer to a threshold. Indeed, the southern subbasins have more naturally occurring savannas and therefore lower average (subbasin-sclae) tree cover. The presence of these savannas is a result of rainfall

seasonality (Staver et al. 2011, Science 334:230-232), which, as pointed out by referee 1, itself affects the regulation of river flows.

If the hypothesis that river flow regulation can pass tipping points holds, what would be the concrete consequences of such transitions? Obviously the limit case of infinitely high and low river flows will not be reached, so how do the authors see the future of the Tapajos and other basins if land use change continues? The paper lacks explicitness in this sense, which will leave readers like myself to question the validity of the forest reservoir concept.

Minor points:

In figure 5 the bar charts for tree cover are presented relative to a baseline of 60%, suggesting independent evidence for such a baseline, whereas the results in the figure itself are the evidence for a threshold of 60%. Please change to bar charts for tree cover starting at 0.

In figure 3e, the dots indicate that the exponents are significantly different. Yet, it is also said that it cannot be rejected that the exponents differ from 1. One of these statements must be wrong.

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