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Earth System Dynamics Discussions

Interactive comment on "River logjams cause frequent large-scale forest die-off events in Southwestern Amazonia" *by* Umberto Lombardo

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Thank you very much for taking the time to read the paper and provide so many useful suggestions.

DIXON: Abstract line 15 (and elsewhere in discussion). I'm not sure about the terminology of logjams "migrating" upstream. I think what the author is referring to is that the formation of logjams "propagate" upstream, i.e. that logjams form in the downstream sections and that over time they are identified further and further upstream. Descriptions need to be refined here, as I was not 100% sure if this was referring to "propagation", or to individual logjams moving upstream (migrating) or to a single logjam growing larger and larger and effectively turning into a huge log raft whose extent effectively migrates upstream through growth of its upstream edge.

REPLY: The terminology has been changed and descriptions refined in order to make it clear that I am referring to different logjams forming further and further upstream

DIXON: Line 25 – I felt that: Collins BD, Montgomery DR, Fetherston KL, Abbe TB. 2012. The floodplain large-wood cycle hypothesis: A mechanism for the physical and biotic structuring of temperate forested alluvial valleys in the North Pacific coastal ecoregion. Geomorphology, 139-140: 460-470. DOI: 10.1016/j.geomorph.2011.11.011. Is missing from the discussion here. Certainly the information in this paper somewhat runs counter to parts of this hypothesis and so it is really important to address this. And highlights how tropical forests may be very different.

REPLY: Collins et al., 2012 has been added to the references in line 25.

DIXON: Paragraph ending line 36 – I think it would be good here to really spell out that therefore logjam mediated flood disturbances are really important in this context. (It's only really inferred at the moment).

REPLY: This paragraph is part of the introduction and it specifically refers to studies that have linked fluvial activity to forest disturbance in Amazonia. The fact that logjam mediated flood disturbance is important in this region is not a fact previously established in literature and hence cannot be cited here (other than the observations by Gullison et al., 1996, which is extensively cited elsewhere). The importance of logjam mediated flood disturbances is stressed in the results and discussion sections of the paper.

DIXON: Line 68 – I recommend ending the intro with a specific statement of aims.

REPLY: the description of the study area at the end on the introduction has been moved to methods. The introduction now ends with a statement of the aims of the paper. It now reads: "The aim of the paper is to describe the processes behind logjam-induced floods in the Bolivian Amazon and how they affect modern forest disturbance/recovery cycles and pre-Columbian land use in the past. The paper hopes to encourage debate

and further research into a type of large-scale Amazonian forest disturbance that has been largely overlooked in the literature."

DIXON: Line 70 – methods. As stated above I think this needs a bit more info. Specifically it is not stated what the fieldwork was for or what it was trying to do (I guess some element of ground trothing to remote sensing?) I also think more specifics are needed for the analysis of remote sensed data to make it clear it was systematic. I think there were two parts 1) identification in GEE, 2) detailed analysis. There isn't anything about how landsat was processed etc, which composite bands were used (if any), what programs (ARC?). I couldn't see anywhere how logjams were identified? Is this just from the presence of the flood event aftermath in the images? This needs to be stated.

REPLY: These issues have been addressed in the methods section, which now reads: "The visual analysis of Landsat imagery allows the identification of the areas where the water is diverted overbank and the river channel dries out. In the paper I refer to this phenomenon as river collapse. [. . .] LandsatLook images are compressed and stretched full resolution files derived from Landsat Level-1 data products. The band combination is 5,4,3 for Landsat 7 ETM+ and Landsat 4-5 TM; 6,5,4 for Landsat 8 OLI (https://landsat.usgs.gov/landsatlook-images). [. . .]Field work was carried out during the dry season of 2016 in order to confirm the observations described in Gullison et al. (2016) for the Cuberene River and validate the results of the visual analysis of the satellite images of the other rivers investigated here."

DIXON: Also given the results of distance for logjams, more info about exactly how this was measured – assume in ARC using route events? Or was it a straight line distance? Given avulsions was a base line year use for measurement along the river, or was a new distance calculated along the river for each year? Not sure about how this was measured.

REPLY: As stated in the text: "The location of the logjams (shown in Fig. 5) has been measured as the distance between the logjam and an arbitrary line parallel to the

Andean piedmont". This is a straight line running parallel to the Andes. I have added "which serves as a common reference for all the rivers." to make its function clearer. The aim of Figure 5 (and of the paper) is to describe a general process that occurs in many lowland rivers in the region. Therefore, I define one, arbitrary common "zero" to measure the location of the logjams. As the rivers flow perpendicular to the Andes, these measures are very similar (plus o minus a constant) to measuring along valley distances for each river. Other methods could be used but I doubt they would produce very different results.

DIXON: One key thing I think is missing is the timing of the images, it is implied that there is continuous coverage from 1987-2016, but knowing Landsat this seems unlikely! I think specifically identifying gaps in annual coverage for each river is important, perhaps this could be a table in supplemental info?

REPLY: This information is provided in table 1, first two columns. The first column indicates the number of good quality available images and the second column the year when the record starts. For each river there are always a few years missing (for instance 2012 is always missing because of satellite malfunction), but the overall coverage is extremely good.

DIXON: Line 89 – I think this first line could be reworded. Something like "The spatial characteristics of forest die off triggered by logjam-induced floods are shown in Figure 2."

REPLY: Changed as suggested

DIXON: Line 91 – Not sure about use of "total collapse" of the river. I think this is referring to an avulsion?

REPLY: A definition of what is meant with "collapse" has been added in methods. "A visual analysis allows the identification of the areas where the water is diverted overbank and the river channel dries out. In the paper we refer to this phenomenon as river

collapse".

DIXON: Line 95-105 – a lot of this paragraph feels more like a site settings part of a methods section? Maybe consider moving it to methods and making it part of an explicit site section?

REPLY: This paragraph deals with the settings of the very rivers that are affected by the logjam-induced floods, which are here described for the first time. Therefore, I think that their identification, location and geographical setting is part of the results.

DIXON: Line 116 – I wasn't sure about the use of the word "killed", as it implies a direct effect, rather than just causality. I'm not sure we can say the flood "killed" the forests, as opposed to the effects of the flood led to the death of (specific species?) within the forest. Maybe reword.

REPLY: I used the term "killed" because this is the term used by Gullison et al.1996: "Mahogany (Swietenia macrophylla King) regenerates in areas of erosion on high terraces and in forest killed by flooding and deposition of alluvial sediments in the Chimanes Forest, Bolivia." But following Dixon's suggestions I have changed the wording in the text.

DIXON: Line 117 – I think a bit more info about the characteristic V-shape would help. It can be inferred at the moment, but better to spell it out to avoid potential confusion – I.E. where the point of the V is, etc?

REPLY: The following has been added to line 117: "a characteristic V shape, with the vertex of the "V" placed on the logjam and the two sides branching out on either side of the channel."

DIXON: An example of the migrating terminology I'm not sure about. Also maybe worth looking at our 2014 paper – at the end we make some interesting observations about how logjams can retain position and ostensibly the same architecture, but in fact are exchanging individual logs – i.e. even in apparently stable jams the logs are changing.

Given this it seems unlikely individual jams are migrating, strictly speaking. Dixon SJ, Sear DA. 2014. The influence of geomorphology on large wood dynamics in a low-gradient headwater stream. Water Resources Research, 50: 9194- 9210. DOI: 10.1002/2014wr015947.

REPLY: The terminology problem has already been addressed above. The following has been added to the discussion: Further studies are needed in order to understand whether, over time, new logjams always form further upstream or whether, in some cases, existing logjams 'grow upstream' by the addition of new wood. It is also yet unclear what happens during years when logjams maintain their position, is it that not enough wood is added or is it that new logs replace old ones, which decay fast(Dixon and Sear, 2014)?

DIXON: Line 152 – The pre-columbian info seems to come out of nowhere here! It is not immediately obvious what the relevance is at this point - but once I've read the whole thing the importance/relevance comes out, but here it seems out of place. I suggest perhaps signposting it earlier in the intro/methods/aims section. Or alternatively remove from the results and just introduce as an incidental observation in the discussion where you introduce the main point/implications of these observations. I don't think it has to be in results strictly speaking.

REPLY: in the introduction it is stated: "I discuss why logjams form in these rivers and how they affect modern forest disturbance/recovery cycles and pre-Columbian landuse in the past". To this, I have added a further intro: "Pre-Columbian earthworks in the area are identified and used to infer the past extent of logjam-induced floods."

DIXON: Line 181 – I think the discussion of river morphdynamics could be given a bit more general context by reference to general geomorph literature. The following springs to mind Constantine JA, Dunne T, Ahmed J, Legleiter C, Lazarus ED. 2014. Sediment supply as a driver of river meandering and floodplain evolution in the Amazon Basin. Nature Geoscience, 7: 899-903. But think there is a fair bit out there to

provide a bit more context/reference support to the geomorph context. Could potentially introduce these themes in the intro as well? I don't think it needs a lot, but a bit of context would enhance it.

REPLY: The following has been added to the text: "In the Bolivian Amazon, the behavior of large rivers, such as the Beni and the Mamoré, is significantly different from that of their tributaries. The Beni and the Mamoré are characterized by high sedimentary loads, high meandering rates and increasing discharge downstream (Aalto et al., 2003; Constantine et al., 2014; Guyot et al., 1996). They do not form logjams and they undergo avulsions on a millennial scale, mostly driven by neotectonic events and/or changes in climate (Dumont and Fournier, 1994; Lombardo, 2014; Plotzki et al., 2013). On the contrary, their smaller tributaries often show downstream decrease in discharge, which is accompanied by the frequent formation of crevasses that often evolve into full river avulsions (Lombardo, 2016). The 22 rivers studied here show similarities with some of the Mamoré's tributaries (i.e. the Maniqui and Secure rivers as noted above), but are unique in the impact they have on the forest and in the fact that logjam-induced floods occur on an almost yearly basis."

DIXON: Figure 1 – This really needs an elevation scale bar, especially given that a different scale is used for the topography in the two panels. Could also use a map georeferenced/coordinates, either on the edge of the panels, or a spot reference.

REPLY: Elevation scale bars have been added to both panels. As the panel A shows the country borders of Bolivia, Brazil and Peru, I think adding geographic coordinates is not necessary

DIXON: Figure 2 – On the inset panels, I know they are all flowing in the same broad direction, but flow direction arrows on the rivers would improve instant clarity.

REPLY: The following has been added to the figure caption: "All rivers flow from southwest to northeast."

DIXON: Figure 3 – again, flow direction arrow might help

REPLY: The following has been added to the figure caption: "The river flows from southwest to northeast."

DIXON: Figure 4 – I'm not sure about the colour ramp here! Seems a bit vivid! It's also not quite clear what is going on with the rivers in these images, as the rivers seem discontinuous in places? They appear to be headwaters, but I'm not sure this is actually the case?

REPLY: This is an attempt to use SRTM DEM to actually see the gaps in the forest. As the gaps are visible as small changes in elevation, a vivid colour scale is needed, otherwise the change would not be obvious. The Tequeje river underwent 3 important avulsions, this is why there are 3 different courses in inset D. I have added the years of the 3 courses to make the figure easier to understand.

DIXON: Figure 5 – The meaning of the arrows is not immediately clear. Some of the arrows are short and some long, (and some angled) does this refer to the length of the avulsion relative to the X-axis? If so I'd explicitly state this and also make sure that the arrows are neutral in the Y-axis, as at the moment some are angled and it is not clear if this therefore refers to multi-year avulsions.

REPLY: No, there is no special meaning attached to the arrows, other than to indicate that an avulsion took place. I have changed them and now they are all horizontal.

DIXON: Figure 6 – flow direction arrows would be useful here, as would coordinates. In panel F it is hard to see how the individual points for the logjams correspond to the area(s)

REPLY: The following has been added to the figure caption: "The river flows from west to east." The symbol level of the areas' polygons has been changed and the size of the point has been made smaller in order to make the figure more readable. Inset F aims at summarizing 30 years evolution of the river in just one figure.

DIXON: Figure 7 – flow direction here I think would be mandatory, as it is not clear. I would recommend changing the red text to yellow to make it more colour blind/black & white friendly. It's pretty hard to read at the moment even with colour vision! I'm not sure about the colour ramp used for the inset meander history, at the moment the colours don't have any meaning as the colour ramp doesn't have a clear evolution. So I can look at it and see there has been lots of change, but I can't easily see if there are temporal patterns. Not sure if that is an objective of the figure, so if purpose is just to show its changed a lot then it's probably OK as is, but if it needs to show change at particularly times, or evolution of change then a graduated colour ramp (dark red to yellow for example) would be needed to show this.

REPLY: The following has been added to the figure caption: "The river flows from west to east." The colour of the text has been changed. A graduated colour ramp has been added.

DIXON: Figure 8 again flow direction and coordinates would help.

REPLY: The following has been added to the figure caption: "The river flows from southwest to northeast." The geographic location of all the studied rivers is shown in Figure 1.

DIXON: Figure 9 – hard to see the river flow arrow, maybe move it over the vegetation area and make it yellow or white?

REPLY: Changed as suggested

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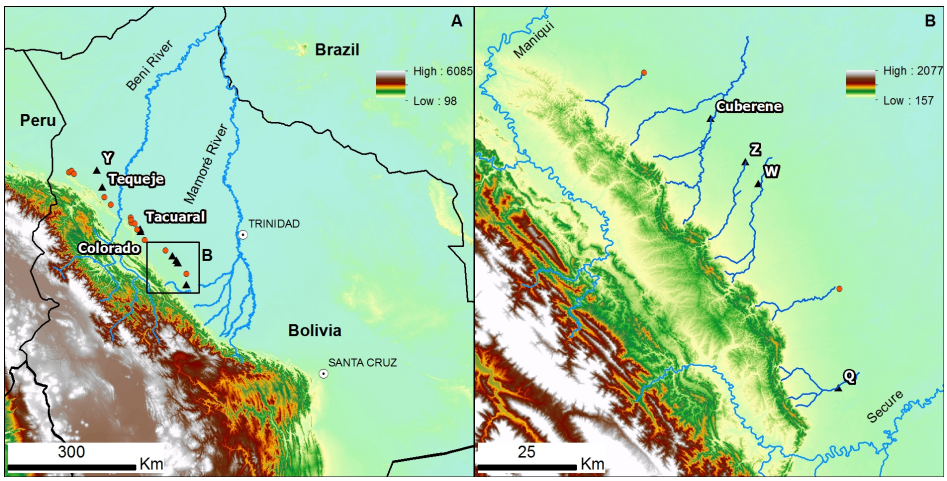

Fig. 1.

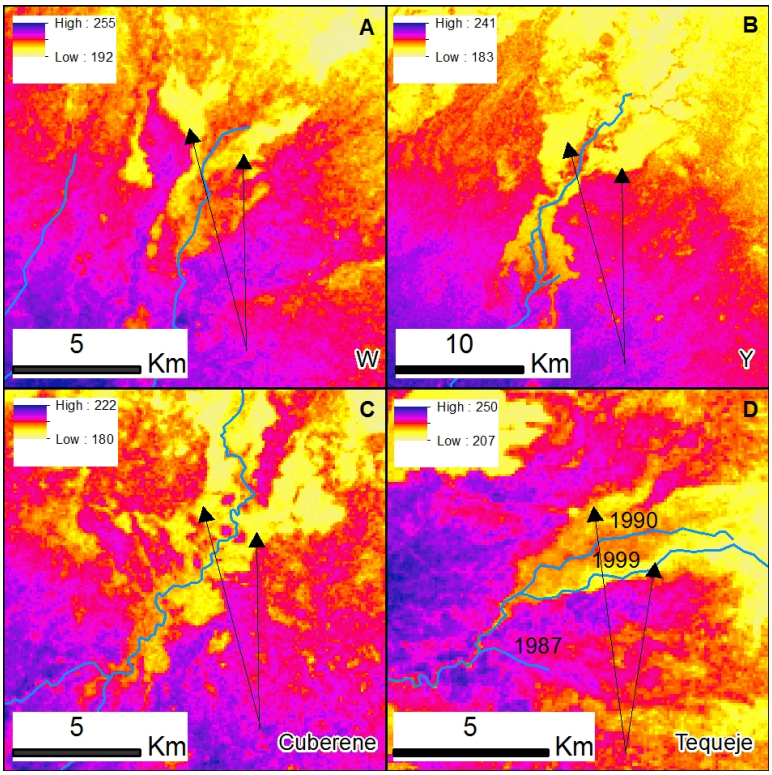
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Fig. 2.

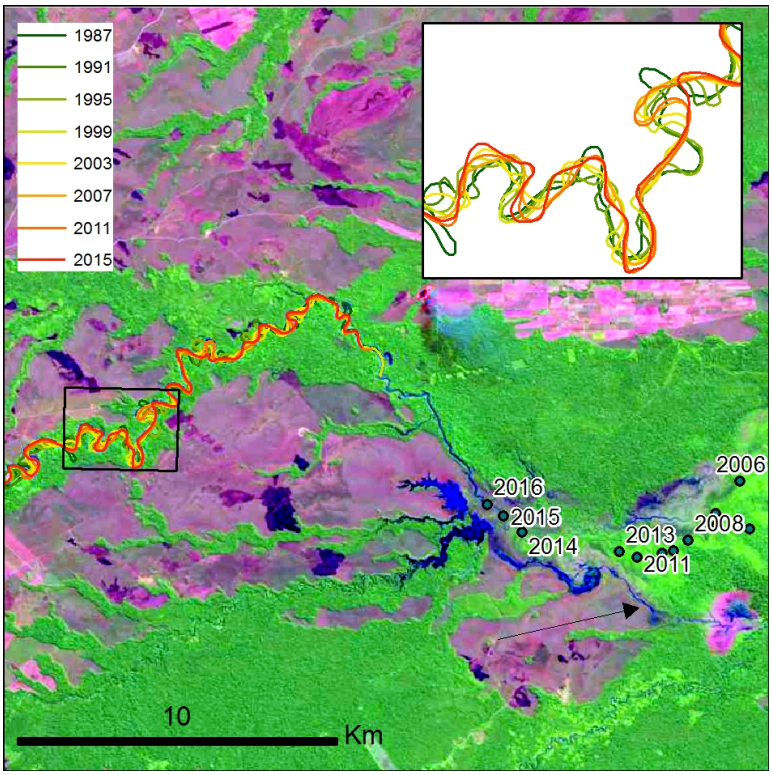
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Fig. 3.

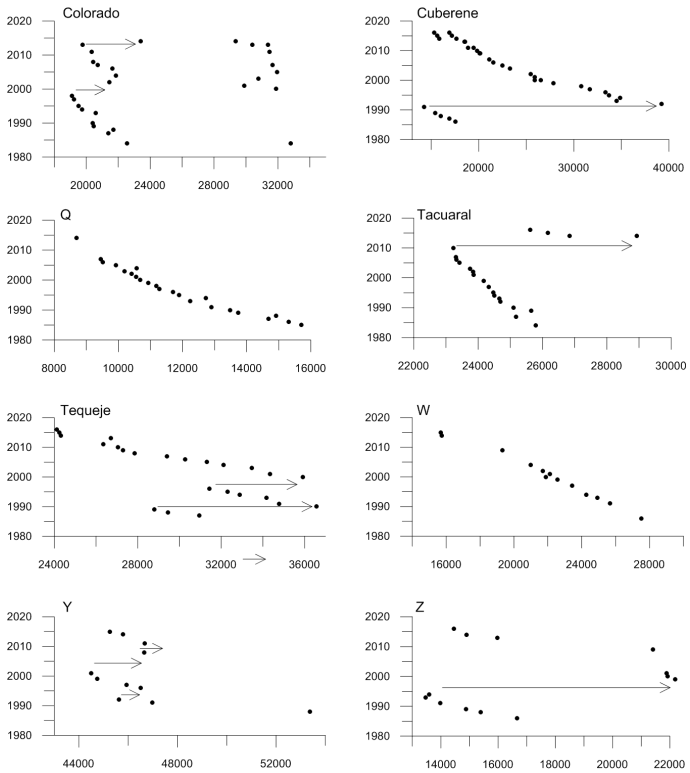
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Fig. 4.