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Interactive Comment

Interactive comment on "Alluvial plain dynamics in the southern Amazonian foreland basin" *by* U. Lombardo

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R-The authors, however, include inferences regarding spatial and temporal changes in sediment load, bed elevation, stream discharges, and floodplain deposition (specifically changes in floodplain elevation) that are not directly observed, but are rather interpretations based on indirect evidence. It might be best to remove most of these from the results section of the paper, and rather present this more interpretative aspect of their work in the discussion, where a conceptual model for the occurrence and progression of these changes (i.e., the crevassing and avulsions and their consequences) can be outlined clearly, and the data supporting them can be clearly outlined.

UL - The reviewer suggests that interpretations should be moved from "results" to the

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"discussion" section. I would like to highlight that presenting interpretations together with results is a conscious choice I made in order to improve the readability of the manuscript. This is why the section where results are presented is actually called "results and interpretation". Here, results and interpretation are provided for each river. The section "discussion" provides a more general interpretation of alluvial plain dynamics in the basin as a whole, without entering into the specific details of each river. I think that following the classical results/discussion structure would make the "results" section a very tedious list of river characteristics and the "discussion" section too long and complex. Having mixed the "results and interpretation" or "results and discussion" sections is nowadays common practice, see for example: Quaternary Science Reviews, Volume 132, 15 January 2016, Pages 114–128 or Earth Syst. Dynam., 6, 789-800, 2015. But see answer to comment 16. Reviewer (R): 1. Page 2064, line 11. "the" is unnecessary.

UL - Ok.

R: 2. Page 2064, lines 13-15. This sentence is awkward, and should be rewritten. Also, the author should clarify the nature of this conclusion, as this type of thinking is prevalent throughout the manuscript. No date on sediment loads or sedimentation rates is available; the basic data simply consists of aerial imagery. Conclusions regarding sediment loads such as this are inferences, and are not supported by direct observations. There is nothing wrong with making these inferences, but it should be clearly noted that the data do not directly demonstrate this. "I found", as written here, is a mis-statement of the nature of the data. "The data suggests " is a clearer way to present this (other options also might be considered). But please revise to remove "I found" here and elsewhere to clearly indicate to the reader that conclusions like these are indirect inferences, and are not supported by gaging or other direct measurements.

UL - "I found" has been changed for "the data suggests" throughout the manuscript. The following sentence has been added in line 13 pg 2066 "...it is now possible to document river spatial and temporal changes and make inferences regarding large-scale

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changes in hydrology, sedimentation patterns and river sedimentary loads (Buehler et al., 2011; Peixoto et al., 2009; Constantine et al., 2014).“ Also, the following has been added at the end of the introduction: “Although the analysis of optical remote sensing imagery here presented does not provide quantitative data on sedimentary processes, it does allow for a qualitative assessments of them and for a re-interpretation of already published quantitative data.” Data on sediment loads is published in Guyot et al 1994, 1996 and cited accordingly later on in the manuscript. The fact that most of the sediments are trapped in the floodplains before reaching the Mamoré is one of the main conclusions of the manuscript and is based not only on the observation of satellite imagery but, as explained in the discussion, is supported also by data of discharge and sedimentary load of the rivers Mamoré and Beni (Guyot et al., 1996; do Nascimento Jr. et al., 2015).

R: 3. Page 2064, line 24. Please explain what RAMSAR is.

UL - An explanation of what a RAMSAR site is has been added to the section “Study area”, line 1, pg 2068

R: Page 2065, line 15. “depend”, not “dependent”.

UL - Ok.

R: 5. Page 2065, line 19. “couple of” is rather informal, how about “few”?

UL - Ok.

R: 6. Page 2068, line 7. “All the tributaries. . .”. Please provide a number.

UL - It now reads “All twelve tributaries. . .”

7. Page 2068, lines 12-13. Please indicate how many rivers and the time periods for which high resolution data are available. This general statement is not very useful. Perhaps a table indicating the locations and years of data availability should be added.

UL - A table (Table 1) with locations and years of data unavailability (years of availability

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are too many to fit into a table) has been added.

8. Page 2070, line 22. “Alluvium”, rather than “alluvia”, is the more common term. I actually had to look the latter up, as I was not familiar with it.

UL - The term “alluvia” has been changed for “alluvium” throughout the manuscript.

9. Page 2072, lines 17-18. Since gaging station data are not available, what specifically is the evidence for the interpretation of “decreasing discharge down-flow”? Please present the observational evidence that supports this conclusion, and explain your interpretation, so the reader can understand who this inference is supported (or not supported) by data.

UL - This is just an introductory sentence that summarizes the main findings. Evidence supporting that discharge decreases down-flow is presented later on in the text, namely the reduction in river width and the reduction in meandering.

10. Page 2073, lines 17-18. “sharp drop in river discharge..”. See comment 9.

UL - Line 16, after “San Borja.” The following has been added “This suggests that river discharge decreases along this 40 km stretch”. See also answer to point 9. The word “sharp” has been deleted.

11. Page 2073, lines 19-21. “seasonally perched”. Please explain this term – it is not commonly used in fluvial geomorphology, and its meaning will not be obvious to most readers. Also, make it clear that the infilling of the channel and its consequences is an interpretation not supported by observation here – it is really just inferred as a necessary step leading to crevassing and avulsion, but there is really no direct evidence that this is happening.

UL - The new text reads: “The drop in river discharge and frequency of the avulsions suggest that the channel becomes perched during the dry season. Therefore, It can be inferred that while the infilling of the channel progresses, the point of the next siltation/logjam formation moves upstream and so does the location of the next crevasse.”

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12. Page 2073, line 20. “upwards”? Does this really refer to “upstream”? Please clarify.

UL - See answer to comment 11

13. Page 2074, line 1. “from the point: : :”. Can this location be more clearly specified? Does this mean “downstream of” this “point”?

UL - The sentence now reads: “located between 50 and 110 km downstream of the point in which the Piraí enters the alluvial plain.”

14. Page 2074, lines 24-25. Clause stating the annual TSS load is repeated below, and it is therefore not needed here.

UL - The repeated sentence has been deleted

15. Page 2075, lines 5-30. More this highly interpretive material to the discussion. It is inappropriate for the results section, which should be limited to presentation of data.

UL - See answer to reviewer’s general comment. This is not a “results” section but a “results and interpretation” section.

16. Page 2076, lines 1-6. Is the “water table” the correct term here? Should the reference be to the water depth? I don’t understand this at all. Please clarify, and also move this rather speculative text to the Discussion, where it really belongs.

UL - The sentence has been moved to discussion and now reads: “The behaviour of the rivers Maniqui, Piraí and Grande seems to be controlled by the seasonal lowering of the water table, below stream level, during dry season. This causes the river to leak water from its channel into the ground beneath, causing a reduction in the rivers’ sediment transport capacity, increased channel infilling and likelihood of logjam formations. However, as described in the case of Río Pilcomayo in the Chaco plains, which shows a similar seasonal behaviour (Martín-Vide et al., 2014), increased sediment discharge due to modern land use changes in the Andes could also contribute to the channel infilling.” “Water table” is the correct term.

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17. Page 2076, line 22. “water table: : :”. See comment #16.

UL - See answer comment 16

18. Page 2076, line 23. “hydraulic head”. Please explain in greater detail. Where is the “head” high, and where is it low, and what then is the direction of the driving force? How is hydraulic head defined here? Is this term used as it is typically defined in hydrogeology (water surface elevation in a well in an aquifer?), or is the term used in a context borrowed from hydraulics (water surface elevation of a free surface + velocity head, etc.). The reader needs a better explanation of this to understand the idea that the author is trying to convey.

UL - Lines 22-25 now reads: “Under these conditions, the formation of crevasses becomes more likely because the water level inside the river channel rises faster than the water level in the surrounding floodplain (Aalto et al. 2003).

19. Page 2077, lines 6-7. “play a dominant role: : :”. This is an overstatement. No comparative data for large rivers are provided. Please explain more clearly, and/or express more carefully.

UL - This statement is based not only on the findings of this paper (which do provide evidence of this), but is also consistent with the data provided in Guyot et al., 1996 and in do Nascimento Jr. et al., 2015. Moreover, as stated in the section “study area”: “Stratigraphic cores performed across the alluvial plain have shown that, since the mid Holocene, distributary fluvial systems formed by the Mamoré’s tributaries (Fig. 1) have deposited thick layers of sediments over the southern and central part of the LM (Lombardo, 2014; Plotzki et al., 2015).” During the Holocene, the Mamoré River has had only one avulsion, and the land covered with the paleo and modern meanderbelt of the Mamoré is a tiny fraction of the land covered by the deposits of its tributaries. This is why, in my opinion, “play a dominant role” is not an overstatement. The sentence now reads: “The results of this study, combined with other published data (Guyot et al., 1996 ; Lombardo, 2014; do Nascimento Jr. et al., 2015; Plotzki et al., 2015), suggest

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that these small rivers are highly active and play a dominant role in shaping the SAFB alluvial plains" Also the section about Río Grande has been partly re-written to make it clear that I used evidence from Landsat imagery to re-interpret the data published by Guyot et al. 1996 and to discuss previous estimates of TSS of the Grande-Mamoré system. The section now reads: "This data has been used by several authors to estimate the amount of sediment deposition along the Grande-Mamoré system. Charriere et al. (2004) have estimated that the Mamoré River deposits about 150 Mt yr-1 along the first 200 km of its course downstream of Puerto Villarroel (i.e. before reaching the PG gauging station); while Constantine et al. (2014) have estimated that Río Grande provides 84% of the TSS of the Mamoré at PG. These estimates implicitly assume that other tributaries of the Mamoré (several other rivers joining the Río Grande and the Mamoré between Abapo and Trinidad: the Ichilo, the Piraí, the Chimoré, the Chapare, the Sacta, the Isiboro and the Yapacaní) do not represent an important contribution to its TSS at the PG gauging station. On the contrary, the new data coming from the analysis of Landsat imagery suggests that most of the Mamoré's TSS at the station PG does not come from the Río Grande but from the other tributaries. The analysis of the meander migration rate of the Río Grande just before joining the Mamoré (Figure 11) suggests that, through the repeated formation of crevasses and avulsions, almost all of the Río Grande's TSS is deposited in the alluvial plains before it reaches the Mamoré, forming alluvial deposits and extensive dune fields (May, 2013; Latrubesse et al., 2012). Immediately before the Río Grande joins the Mamoré, it receives water from the Río Yapacaní. The average meander migration rates of the Río Grande before and after receiving water from the Yapacaní are 0.46 $\pm$ 0.4 m yr-1 and 3.53 $\pm$ 2.9 m yr-1 respectively. This shows that an important part of the sediments that the Río Grande brings to the Mamoré actually come from the Yapacaní. In addition, although data on the TSS of the rivers joining the Río Grande and the Mamoré between Abapo and Trinidad is very limited, these rivers cause an almost tenfold increase in river discharge from AP (330 m3s-1) to PG (2970 m3s-1). Therefore, several observations suggest that far more than the previously estimated 50% of the sediments that the Río

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Grande brings from the Andes are sequestered in the alluvial plains before reaching the Mamoré: i) the important contribution of the other tributaries to the Mamoré's discharge; ii) the high meandering rate of some of them; iii) the high number of crevasses and avulsions experienced by Río Grande; and iv) the changes in Río Grande's Mr in the proximity of its connection with the Yapacaní.

20. Page 2077, lines 10-13. "Most of the sediments: : :". No direct evidence for sediment loads etc. are provided, so this is inferred. Please explain the nature of the evidence for this, and present as the inference that it is (unsupported by direct observation). I don't argue with the conclusion, but please don't confuse the reader by claiming that your DATA demonstrate this. It is INFERRED from other data.

UL - I disagree with this observation. I do not have quantitative data and I am not giving numbers, but my data are sufficient to provide a qualitative assessment. My data demonstrate that several rivers (including Río Grande, which has by far the largest TSS, see data in Guyot et al 1996) form distributary systems. River courses disappear in crevasse splays in the case of the rivers Grande, Maniqui, Isiboro and Secúre. When the rivers reappear downstream of their distributary system, they are gathering runoff water, actually black water in the case of Maniqui (Hanagart and Sarmiento, 1990), and their meandering rate is significantly reduced (see for example Fig. 11). Under this setting, there is no way the bulk of the TSS that the rivers have at their exit from the Andes can reach the Mamoré; only a small fraction of their TSS would, during the rainy season, reach the Mamoré.

21. Page 2077, line 19. Is the figure given the annual average discharge? Please specify.

UL - Yes, the word "average" has been added.

22. Page 2077, line 29, page 2078, line 1. "annual to decadal" is better.

UL - "year" changed for "annual"

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23. Page 2077, line 2. “siltation”. What does this term mean here? Is the sediment silt? No grain size data are given in this paper? Does the author mean to refer to “bed aggradation”? Please clarify the meaning of this, and explain the evidence for it (if the author is referring to bed aggradation, it must be inferred as a necessary precursor to crevassing and avulsion, but there is no direct evidence available to suggest that it is occurring).

UL - I use “siltation” because the process I describe (see answer to comment 16) causes the deposition of silt within the channel (as also described by Martín-Vide et al., 2014). But to avoid confusions I have changed “siltation” for “bed aggradation”.

24. Page 2078, line 3. “perched river bed”. See previous comment about this term.

UL - Changed for “perched channel”, which is the term used by Jones, L.S., Schumm, S.A., (1999)

25. Page 2079, line 12. “WILL change their courses”

UL - “will” added

26. Page 2079, line 25. “works” is unnecessary.

UL - Deleted

27. Page 2080, lines 25-26. Delete “it is advisable that”, replace “is” with “should be”.

UL - Changed as suggested

28. Table 2. Please give the units of Mr.

UL - Added to the now table 3

29. Figure 6. I don’t understand the term “annexed” in the caption, or where this channel is on the figure. Please clarify. Perhaps the channel “annexed in 2000” can be specifically labeled as such in the figure, and the “crevasse initiated in 2002” can also be specifically labeled.

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UL - Annexed channel and crevasse have been labelled

30. Figure 7, caption. “new course lasted only until: : :.”. I don’t understand this. Is the large channel to the right in “d” temporary? Can this be explained and labeled more clearly?

UL - The blue area to the right of figure 7d is a depression that has been flooded because of the crevasse, it is not a channel. This has been added to the caption.

31. Where is the location illustrated in Figure 8? Please specify by including a “box” on another figure that illustrates this area in a larger context.

UL - Done, a box has been inserted in Fig 7

32. Figure 9. The labels “a”, “b”, and “c”, and some of the avulsion years are not clear. Put these in white boxes or something to improve readability?

UL - Done

Interactive comment on Earth Syst. Dynam. Discuss., 6, 2063, 2015.

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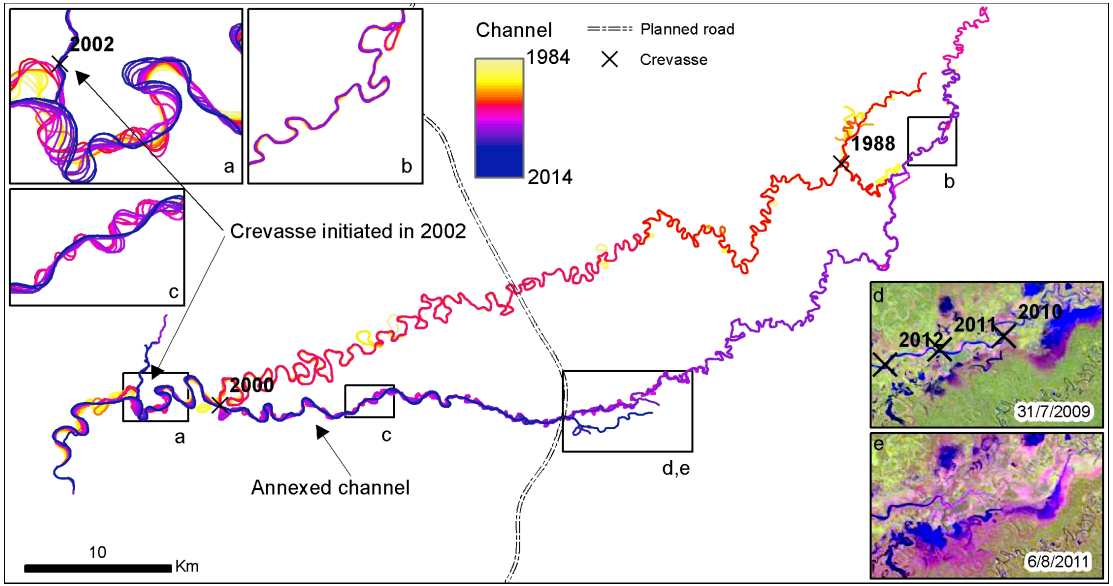

Fig. 1. Figure 6

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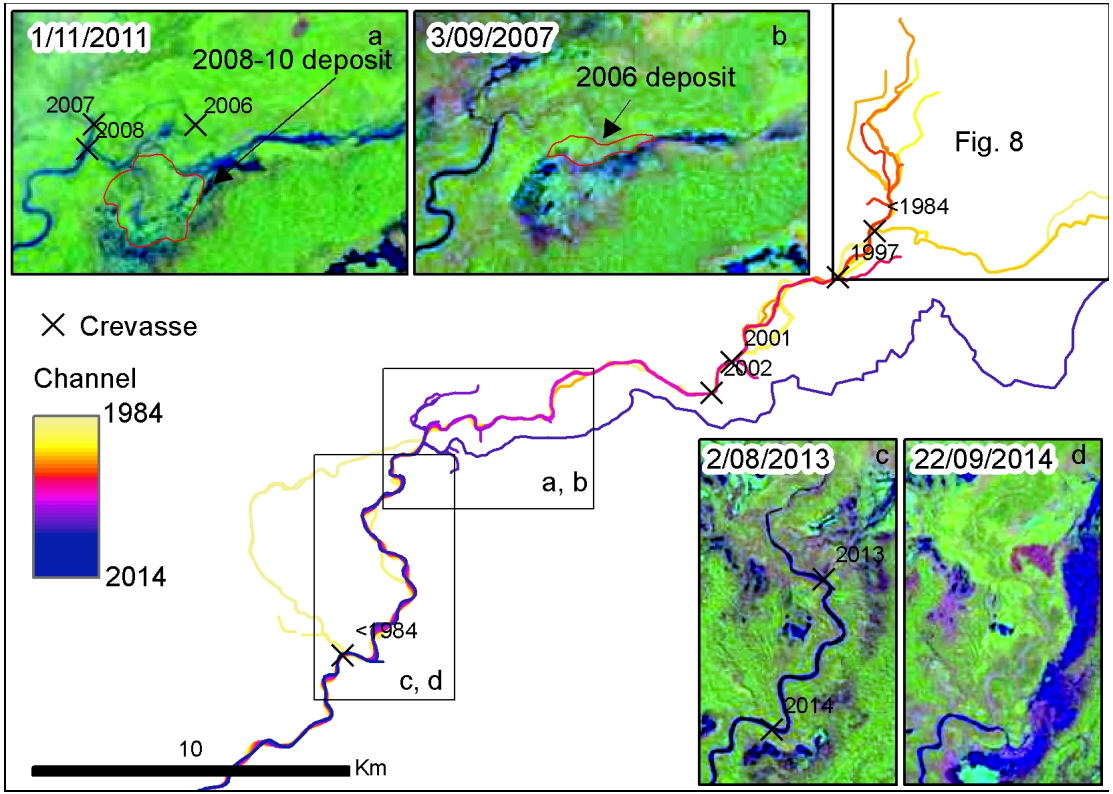

Fig. 2. Figure 7

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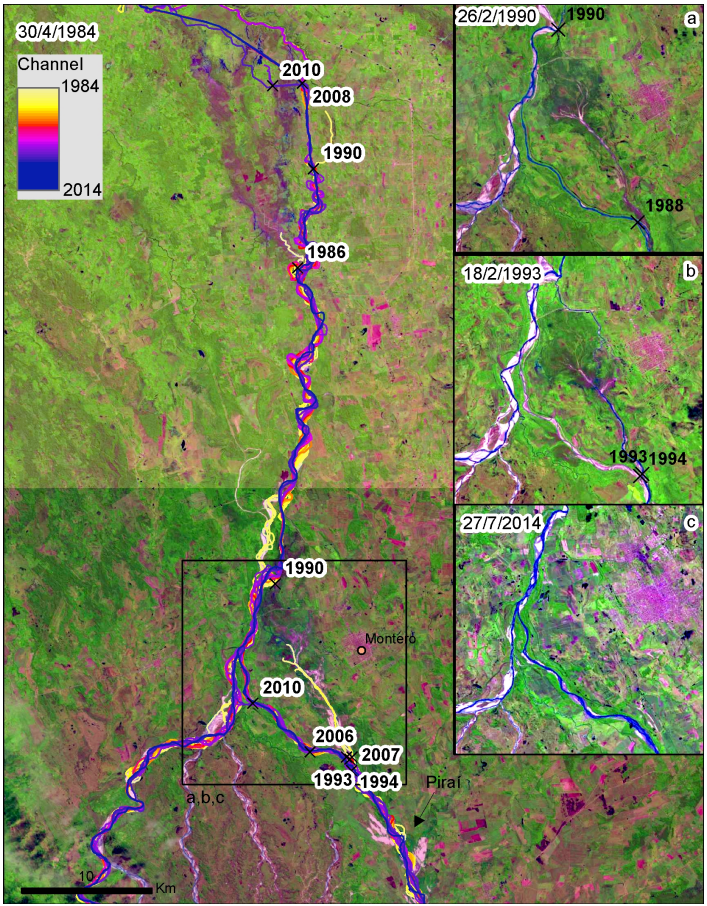

Fig. 3. Figure 9

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