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Hydrology and Earth System Sciences Discussions

# *Interactive comment on* "Creating a catchment perspective for river restoration" *by* L. Benda et al.

**Anonymous Referee #1**

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Comments on the paper "Creating a catchment perspective for river restoration", submitted by Benda, Miller & Barquín to Hydrol. Earth Syst. Sci. Discuss.

General River restoration is a highly important area, but one that is not always guided by sound science. Among the many uncertainties remaining, two are especially important: first, which are the "natural" characteristics we want to restore; and second, how to prioritize restoration sites, and how to do so in a landscape context. The first question has no obvious answer, at least in landscapes with a long history of human influence, and the second question is often answered from purely political grounds. Therefore, it is necessary to develop some scheme to apply sound scientific principles to guide river restoration, and it seems obvious that these principles should be based on fluvial geomorphology, at least in part.

The present paper tries to fill this gap, and does so by showing how satellite imagery



can be used to measure the extent of modification in fluvial landscapes, as well as to detect hotspots with the highest restoration potential. The paper is thus of interest for readers of Hydrol. Earth Syst. Sci. Furthermore, it is overall well written, and it makes an important contribution to the field of river restoration. On the weak side, its results are only as robust as the software used to do most of the analyses, and it remains unknown to which degree the predicted landscape features fit the reality in those parts less affected by human activities. Overall, the paper makes an important contribution, and thus, should be published with only minor changes in Hydrol. Earth Syst. Sci.

The title is far too general, as the paper does not create a catchment perspective; instead, it analyzes a catchment (the Pas river, in Spain), and shows where the present extension of the fluvial landscape is more reduced compared to the simulated (original). Furthermore, the title should give a hint to the methods used, as the paper is based on the use of novel methods.

I suggest deleting part 3 (The fluvial landscape and general principles of hydrogeomorphic processes). Although it makes an excellent introduction to the principles of fluvial geomorphology, most of it is already well known.

Also, authors should pay greater attention to the differences between results and discussion, which at the present state are mixed.

Specific comments

Page 2931, line 6. The authors state that the fluvial landscape includes features created by fluvial, terrestrial and ecological processes. I don't think fluvial and ecological, nor terrestrial and ecological processes are mutually exclusive. Otherwise, authors seem to refer to fluvial and terrestrial physical processes, plus to ecological processes in both realms.

Page 2931, line 10. Ward et al. 2002; Nakamura, 2006; Benda

Page 2932, line 10. Use catchment instead of watershed. For American both terms

are synonymes, but for Europeans they are not.

Page 2932, line 16. Have regulation and so eliminated evidence of the fluvial landscape, or have they eliminated the fluvial landscape itself?

Page 2933, line 5. In the Pas basin, as in the rest of Spain, land development goes back to times much older than the 17th century. Forest clearing was very important for Neolithic times, some 4000 y ago.

Page 2933, lines 8-13. Move paragraph into Method section.

Page 2933, line 20. Please, define landscape hotspot.

Page 2934, line 12. Mean annual MINIMUM flow is 1.6, I guess?

Page 2934, lines 14-19. Write species names in singular (ash, lime, and so on).

Page 2934, line 17. Correct spelling: Q. petraea.

Page 2934, line 22. Use heath instead of shrubs?

Page 2934, line 23. is dominated by black alder (Alnus glutinosa).

Page 2934, line 24. Willow (Salix atrocinerea) replace alder...

Page 2934, line 25. What does it mean willow to replace alder when it deteriorates? Better: in frequently disturbed stands, willow replaces alder.

Page 2934, line 26-27. ...alder is replaced by ash of by hazelnut.

Page 2934, line 27. What is a controlled river environment? Explain, please. What are areas impacted by human activities? Do you mean bramble, rose and hawthorn are common in abandoned pastureland?

Page 2935, line 1. Human settlement in the Pas valley probably began much earlier than 40000 y ago, although the first evidence comes from the upper Paleolithic.

Page 2935, line 6. During this period deforestation was used to create pasture land?



This is a weird sentence. Alternative: during this period forests were cleared for pasture.

Page 2935, line 6. Better than iron industry, for the smelting industry.

Page 2935, lines 8-11. Rephrase. Describe separately activities in the catchment (plantations) and activities in the channel and riparian areas (bridges, urban development...).

Page 2935, line 12-19. It is not clear why the authors describe in detail the fish communities, but do not mention water quality or inverts. Write the common names in lower case (brown trout, not Brown Trout).

Page 2935, line 15. Barbo di Graells seems a weird English name. Barbel?

Page 2935. Some important information which is missing from this section is how many people live in the catchment, which are the main economic activities, and where are the main towns located. It would also be interesting to comment whether water abstraction is only for local use, or it is piped away.

Page 2935, line 20 and following. As mentioned above, I suggest deleting the entire section of the fluvial landscape, as these principles are general and pretty well known.

Page 2935, line 22. It is no clear what the author mean by low terraces. Are they zones in the floodplain with a higher elevation, or are they not inundated periodically?

Page 2936, line 4. Valley geometry is neither a principle nor a process.

Page 2936, line 7. Same goes for fluvial environment.

Page 2936, line 13. It is no clear what is the upstream transition from uncostrained to constrained valley segment. Does it mean that upstream from these transition there is a bottleneck?

Page 2936, line 18. Same thing. Downstream from the transition, sediment deposition

increases.

Page 2939, line 25. Please, explain in greater detail what is this "attributed and routed stream layer". What attributes does it have?

Page 2940, line 6. On what is based the prediction of a tributary to influence channel ecologically? Please, explain in greater detail.

Page 2940, line 8. What is this topographic index of erosion based on?

Page 2940, lines 20-24. Were the regressions between channel dimensions and drainage area based on data from human-impacted rivers? I guess so, because these regressions seem go be derived from regional data. If so, how can this affect to the attempt to model the theoretical channel?

Page 2941, lines 4-9. By definition, floodplains are areas just above bankfull stage, as this is the highest stage that is still contained in the channel. It seems sound to define zones of frequent inundation as those within 1-3 bankfull depths. Nevertheless, because the deepest pools in the Pas are ca. 2 m deep, bankfull depth should be somewhere between 1 and 2 m, and thus, floodable areas those between ca. 2-5 m in elevation, which are hardly detectable with a 5-m DEM. What is the confidence of authors in these maps to chart floodplains? Please, discuss.

Page 2942, line 16. I see no clear why using an approximate erosion rate of 100 tkm-2y-1 is enough. Absolute erosion rates are important, not only relative ones.

Page 2943 and following. The results are sometimes hard to follow, because of a lack of clear definition of terms as fluvial landscape and floodplain. As far as I understand, areas inundated at bankfull are river channels, areas inundated at 1-3 bankfulls are floodplains, and the sum of channel + floodplain is the fluvial landscape. This should be clearly stated somewhere, and the results written consistently.

Page 2943 and following. Again, results are hard to follow because the river is described from mouth to source, in a way that is counterintuitive for river scientists. In



some parts this gets especially hard. For instance, in page 2947, lines 5 and following, the authors describe a wide river section between RK 5-12, and then state that "The East Fork then enters a narrow canyon to the south", when it is the contrary, the river flows downstream through a narrow canyon, AND THEN crosses the wide valley.

Page 2943, line 12. Bankfull widths predicted from what? Are data obtained from catchments without human intervention? If not (as I guess), how confident can we be these are the "natural" channel dimensions?

Page 2943, line 13. Same question applies for predicted channel gradient.

Page 2943, line 19. It is not clear what is the fluvial landscape. The floodable areas below 3 bankfull depths?

Page 2944, lines 8-10. Move to discussion.

Page 2946, lines 1-5. Again, move to discussion. Do not cite other works in your results.

Page 2946, lines 15-23. It is no clear which are the consequences of higher or lower effectivity in routing materials to the main stem. Please, make clear.

Page 2948, lines 5-8. Move to discussion.

Page 2948, lines 19-22. I suggest writing it more clearly: Mapped channels occupy 44% to 78% of the channel surface (bankfull depth) inferred from DEM, and the floodplains (1-3 bankfull depths) 6 to 19%.

Page 2948, lines 23-26. Move to discussion.

Page 2949, line 8 and following. Avoid mentioning figure numbers in the Discussion.

Page 2951, lines 8-9. The opening sentence of this paragraph is hard to follow. The widest and most complex fluvial landscape among which? Please, make clear.

Page 2952, lines 9-18. This paragraph seems to follow an ad hoc logic. Instead of

arguing which are the most interesting reaches according to the results, the authors should give in the Methods section a list of characteristics that would make a reach interesting for restoration, and if possible, a numerical way to measure this interest. Then, in the discussion, it is enough to describe which reaches are the best according to these criteria.

Page 2955. The last section of the discussion should make a critical analysis of two points: 1. How does this work change the information provided by previous analyses of restoration potential in the Pas? and 2. What about feasibility of restoration programs, i.e., human settlements and other activities in the former floodplain?

Page 2956. Conclusions are not conclusions at all. Instead of a generic sort of sentences on the interest of a catchment perspective for restoration, show the specific conclusions of your work.

Page 2956. References. There is a strong emphasis on references of river geomorphology. Some more linked to river ecology would be worth, to point the reader the relevant literature. For instance, cite some of the following:

Beisel, Usseglio-Polatera & Moreteau, 2000. The spatial heterogeneity of a river bottom: a key factor determining macroinvertebrate communities. Hydrobiologia.

Corenblit, Tabacchi, Steiger & Gurnell, 2007. Reciprocal interactions and adjustments between ïňĆuvial landforms and vegetation dynamics in river corridors: a review of complementary approaches. Earth-Science Reviews.

Elosegi, Díez & Mutz, 2010. Effects of hydromorphological integrity on biodiversity and functioning of river ecosystems. Hydrobiologia.

Fisher, Heffernan, Sponseller Welter, 2007. Functional ecomorphology: feedbacks between form and function in ïňĆuvial landscape ecosystems. Geomorphology.

Harvey, Clifford & Gurnell, 2008. Towards and ecologically meaningful classiïňĄcation of the ïňĆow biotope for river inventory, rehabilitation, design and appraisal purposes.



Journal of Environmental Management.

Kail & Hering, 2009. The inïňĆuence of adjacent stream reaches on the local ecological status of Central European mountain streams. River Research and Applications.

Thoms & Parsons, 2002. Ecogeomorphology: an interdisciplinary approach to river science. International Association of Hydrological Sciences.

Thorp, Thoms & Delong, 2006. The riverine ecosystem synthesis: biocomplexity in river networks across space and time. River Research and Applications.

Page 2962. Again, something is missing in the definitions provided in the text. The active channel is usually defined as the area fringed by banks. Therefore, the area of active channel should equal that inundated at bankfull. In table 1 there is another puzzling thing: haw can area be reduced 1600%? A reduction of 100% suggests nothing has been left, and greater reductions are hard to imagine. Please, make clear.

Page 2964. Delete figure 2. It is redundant with fig. 4.

Page 2965. Correct figure foot. It is not the predicted fluvial landscape in the west Fork, it is the predicted fluvial landscape in the main stem and in the west fork.

Page 2968. It is puzzling why do the authors depict more channels in the general map than in the detailed portion. Please, make both maps identical.

Page 2972 and 2973. Figures 10 and 11 are the direct result of the present work. They should be described in the Results section, not left for the Discussion.

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