

Interactive comment on “Toward a conceptual framework of hyporheic exchange across spatial scales” by Chiara Magliozzi et al.

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Dear Referee,

Thank you for reviewing the manuscript and providing your detailed feedback. We are glad that you recognize its relevance to hyporheic research and applications, and its suitability for HESS journal. We agree with the suggested revisions and recognise that clarifications in the selected sections would help to improve the message and the quality of our manuscript. Please find below point-to-point responses to your main points.

Specific comments 1. There are a range of typos, incorrect forms of grammar. I marked some of them in the technical corrections section, but please take care to read through

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the manuscript carefully. 2. Some of the explanations are not clear. More descriptive terminology would help with this. I provided some examples of where terminology is not clear, but I encourage the authors to read closely through the manuscript to address all confusing terminology.

Yes, we will read carefully through the manuscript and correct typos, grammatical forms and address where terminology is not clear.

Title for Section 3.2 is confusing – in a large scale what? Also, what does “large” refer to? Perhaps catchment scale would be more descriptive? Though, after reading this section, it seems this section is encouraging researchers to take the context of the landscape into consideration for reach-scale research. Thus a more suitable title may be something like: “Reach scale HEF in the context of the larger landscape”

Yes, we agree. We will change the title with “Reach scale HEF in the context of the larger landscape”

P 8 L1: The language in this sentence is a little unclear. Please clarify what “water table is continuous on the bedrock” means.

The sentence “For example, HEF transport is expected to be more uniform when the water table is continuous on the bedrock than when the water table falls and interacts directly with bedrock topography (Ward et al., 2012)” will be modified in : “For example, HEF transport is expected to be more uniform in lowland rivers, where the flat land surface and shallow aquifers with low transmissivity favour a topographically-controlled water table, than in upland environments where bedrock outcrops may confine HEF and influence cross-valley hydraulic gradients (Ward et al., 2012)”

P8 L 22: This sentence is confusing - As valley confinement what? Perhaps the authors meant “As similar to valley confinement,”. Please clarify language.

Yes, we will modify with “As with valley confinement”.

3. Section 4.2 L 22-24: Quite a bit of field research has been conducted around par-

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tially submerged bedforms from the Lautz research group, specific to investigating HEF around restoration structures that mimic natural bedforms. See Gordon et al. 2013, Lautz and Fanelli, 2008, Zimmer and Lautz, 2014 for examples.

Yes, we acknowledge that and we will modify Section 4.2 Lines 22-24. “Current knowledge of hyporheic fluxes and their spatio-temporal variability in submerged bedforms has been obtained from simulations (Boano et al., 2014; Irvine et al., 2014; Trauth et al., 2014; Stonedahl et al., 2013; Janssen et al., 2012; Cardenas and Wilson, 2007; Elliott and Brooks, 1997), laboratory (Fox et al., 2014; Tonina and Buffington, 2007) and field experiments (Zimmer and Lautz, 2014; Gordon et al. 2013; Lautz and Fanelli, 2008).”

4. Is there a citation that can back up the P 12 L 6-7 statement?

Yes, there are citations to support the statement. For example Kunz et al. (2017), Sun et al. (2015), and Gooseff et al. (2007).

The following references will be added to the reference list:

Gooseff, M. N., Hall, R. O., and Tank, J. L.: Relating transient storage to channel complexity in streams of varying land use in Jackson Hole, Wyoming, *Water Resources Research*, 43, 2007.

Sun, N., Yearsley, J., Voisin, N., & Lettenmaier, D. P.: A spatially distributed model for the assessment of land use impacts on stream temperature in small urban watersheds, *Hydrological Processes*, 29(10), 2331-2345, 2015.

Kunz, J. V., Annable, M. D., Rao, S., Rode, M., & Borchardt, D.: Hyporheic passive flux meters reveal inverse vertical zonation and high seasonality of nitrogen processing in an anthropogenically modified stream (Holtemme, Germany), *Water Resources Research*, 53(12), 10155-10172, 2017.

5. Section 7.2: It should be noted that dams (and many of the anthropogenic changes) can occur on small (Fanelli and Lautz, 2008) and much larger sized (Fritz and Arntzen,

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2007) rivers. It would be interesting to explore the relative control of dams on such different sized systems, relative to channel slope, etc.

Yes, we agree. This is an interesting point to develop and we will add the following paragraph:

P15, L19: after "...occur." "As a consequence, the effects of dams on HEF vary with channel planform and streambed topography. For example, in river systems characterized by large alluvial channels and unconfined aquifers, the relationship between dam-induced changes in river stage and HEF is characterized by hysteresis (Fritz and Arntzen, 2007). Therefore, HEF is not only dependent on changes in river stage but also on the difference between river and aquifer elevations (Fritz and Arntzen, 2007). As river stage varies, there is a fast response of hyporheic flows which rapidly change with the head difference within the HZ, and a slower response of HEF with changes in elevation head of the near aquifer (Fritz and Arntzen, 2007). Additionally, the lower hydraulic conductivity near the surface of the HZ, caused by accumulation of sediment in the alluvial matrix and often characterizing alluvial channels (Section 5.2), might restrict the changes in hydraulic pressure over the first cm of river sediment (Fritz and Arntzen, 2007). In river systems characterized by small channel sizes and complex streambed morphology, differences of HEF within the subsurface upstream and downstream of dams have been attributed to the overall hydraulic behaviour around the dam and to the changes in topography induced by the dam (Hester et al., 2009; Fanelli and Lautz, 2008). Studies using thermal sensors have reported that upstream and downstream pools created by ponding and channel degradation, respectively, have the potential to drive bedform-scale exchange flow. Temperature results suggest that the highest hyporheic exchange rates occur downstream of dams, while HEF is limited in upstream pools where fine sediment deposits yield low hydraulic conductivities (Fanelli and Lautz, 2008)."

Technical corrections

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P 2 L 2: remove first “and” Yes, “and” will be removed

P 2 L 3: Replace “HEF but less” to “HEF, but are less” Yes, will add “,” after “HEF”

P 2 L 18: Add “the” before “catchment scale” Yes, will add “the”

P 3 L 25 – Change reach scale to “the reach scale” or “reach scales”. There are several instances like this throughout the manuscript, please address them all. Yes, we will change “the reach scale” accordingly throughout the manuscript.

E.g. P 3 L 28: change “HZ” to “the HZ”. Yes, we will change “HZ” to “the HZ”.

P4 L 21 – Missing a word after “at a larger” Yes, we will add “at a larger scale (i.e. catchment)”.

P 5 L 21 – change “though” to “through” Yes, we will change “though” with “through”

P 7 L 21: change “his study” to “this study” or “their study”. Yes, we will change “his study” with “their study”

In addition to the typos and grammatical errors already identified, we will:

P2, L2: change “turbulence” in “turbulence”. Remove “and”. P2, L4: change “floodplain” in “floodplain”. P2, L7: correct “vertically and laterally (i.e. flood spates, overbank flows, etc.; (Minshall et al., 1985; Newbold et al., 1982, 1981)” with “vertically and laterally i.e., flood spates, overbank flows, etc. (Minshall et al., 1985; Newbold et al., 1982, 1981)” P3, L25: change “at reach scale” with “at the reach scale” P4, L5: change “the HZ was found” with “the HZ has been found” P4, L10: invert “affect significantly” with “significantly affect” P5, L4: invert “have usually” with “usually have” P5, L31: change “into” with “in” P6, L14: remove “s” in “times” P6, L18: add “the” before “longitudinal” P6, L28: add “the” before “riffle-pool” P9, L 22: remove “forefront” with “priority” P9, L 23: add “the” before “stream” P9, L 27: add “a” before “result” P12, L21: remove “Certainly” and capitalize “In-channel”. Remove “the” in front of “create” P15, L21: change “create” with “created” P16, L17: removed “that” that is typed twice

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P16, L23: replace “Because of” with “Given” Subheading 4.2: correct "an in-channel bedforms", with "in-channel bedforms"

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