Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-288-RC1, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "How does daily groundwater table drawdown affect the diel rhythm of hyporheic exchange?" *by* Liwen Wu et al.

Anonymous Referee #1

Received and published: 30 August 2020

Wu et al, 2020 Review

How does daily groundwater table drawdown affect the diel rhythm of hyporheic exchange? Initial Comments The authors of this paper use USGS gauge data with diel fluctuations in discharge and river temperature to model hyporheic exchange rates in order to better understand how daily groundwater table fluctuations change hyporheic exchange rates in gaining, losing, or neutral streams. The authors use complex modeling to show how in-phase or out-of-phase daily groundwater table drawdown can influence hyporheic exchange rates. The model created for this paper makes hard assumptions about river morphology, network position, and sediment characteristics to step back and look at daily groundwater table dynamics conceptually. While much of the paper is modeling hyporheic exchange the authors also ask how diel ground-

Printer-friendly version

Discussion paper

water table fluctuations and river temperature impact residence time for denitrification potential and thermal refugia for aquatic species. The authors conclude that groundwater table dynamics modulate hyporheic exchange process differently than diel river temperature. When diel groundwater table drawdown is out-of-phase with river temperature hyporheic exchange is greater than when in-phase. Under gaining conditions upwelling groundwater buffers diel river temperature and increases hyporheic exchange rates. Under losing conditions surface water temperature penetrates deeper into the hyporheic zone and decreases hyporheic exchange rates. The authors do a good job in the modeling and data analysis sections of this research yet need to make the objectives of this paper clearer to support findings of this paper.

Specific Comments 1. The objective statement of this paper is not well defined. After a good introduction, the last paragraph is lacking in clarity as to what this paper is about. Suggestion for the authors to use language like: “In the present study, we aim to quantify the impact of groundwater withdrawal on hyporheic exchange processes at the daily scale as well as better understand impacts on potential denitrification and thermal buffering”. Then move on to how this paper accomplished the objectives. “To investigate these objectives, we built a complex model that. . ..” This will also help guide the reader towards the start of the methods section. 2. The connection from the modeling to RSF and thermal refugia for aquatic species is weak. It feels like the nutrient processing and ecosystem services provided by hyporheic exchange are tossed into this paper to try to broaden the scope of the paper. I suggest that the authors leave nutrient processing to the discussion section rather than a main objective of this paper. Much of the paper does good modeling of hyporheic exchange rates and that should be the focus. There is also some confusion in if this paper wants to just focus on denitrification or RSF and this distinction needs to be clear to the audience. The authors also provide no hard numbers as to how RSF was applied to their model. The Gomes-Velez (2016) paper provides a range of RSF for stream orders 1-12 and how RSF varies throughout stream orders. The authors fail to mention what RSF values were chosen amongst that range. While the result of the RSF analysis is interesting, the explanation as to what

this mean ecologically is missing. 3. Hyporheic connectivity is not discussed or mentioned in this paper. How does connectivity change during these diel fluctuations or during storms? How connected the hyporheic zone is could impact the thermal buffering capacity. A short paragraph on this topic should be added. 4. The is also confusion as to what a groundwater table drawdown means. The diel groundwater fluctuations presented here are due to plant uptake, yet the authors also mention groundwater pumping. The introduction paragraph (Lines 64-70) sets up the pumping problem well but does not mention plants. The discussion section does not discuss the pumping problem well enough to support the management implications in the conclusion. The implications for poorly designed pumping schedules are huge given your data during the flood event! 5. The conclusion is also weak and does not drive home the answers found from the objective statement. The closing sentence is subjective and needs to be reworded: “Our data show that hyporheic exchange rates in a gaining river increase significantly during storm events. When combined with an in-phase diel groundwater table fluctuation, hyporheic exchange rates are higher than an out-of-phase fluctuation (Fig 3f storm vs. Fig 5f storm). Anthropogenic aquifer pumping schedules should be out of phase with diel river temperature to ensure minimal contaminant uptake”. RSF or denitrification also needs to me worded stronger here. 6. Transitional sentences between paragraphs and sections need to be stronger making it hard for the reader to follow

Technical Comments âĂć Abstract ok o The phrasing of groundwater withdrawal makes it sound like there is anthropogenic influence. You do not specifically look at this so I would keep it to the discussion section âĂć Line 14, I would turn this first sentence in a strict definition of the hyporheic zones o Something like hyporheic zones are transitional areas between surface water and groundwater environments that often exhibit marked physical, chemical, and biological gradients that drive the exchanges of water flow, energy, solute and microorganisms between surface and subsurface regions. o This will help focus the readers the research in this paper âĂć Line 18, what makes researching spatiotemporal variability of hyporheic exchange key to water

resources management? Provide a reference âĂć Line 19, what and how is it key to ecosystem restoration âĂć Line 23, change to factors influencing the hydraulic. . .. âĂć Line 26, change language. Make this more clear âĂć Entire second paragraph needs to be worded better âĂć Line 43 – Good sentence here âĂć Figure 1 o Groundwater table A and B separation is confusing to the eye o Do these relate to either the gaining or losing condition o Suggestion to color the lines differently o Remove the tree image or add more. Suggestion to use a tree silhouette. âĂć Line 45, reference needed for 1st sentence âĂć Line 58, Wu et al. observed. . .. âĂć Line 71, This entire paragraph needs to be stronger âĂć Transition from objective statements to modeling section is poor o Ideas for objective statements ïĆğ Stronger, need to be more focused. This paragraph is short and weak when it should be the strongest hit of the paper âĂć In the present study, we aim to quantify the impact of groundwater withdrawal on hyporheic exchange processes at the daily scale as well as better understanding river temperature impacts on potential denitrification and thermal buffering. o Modeling transition ïĆğ Use the last paragraph to transition to the modeling âĂć This is poor âĂć Line 80, need a transition sentence to connect to the aims âĂć Line 84, need reference for COMSOL method and mesh-independent. âĂć Figure 2 o Good conceptual figure âĂć Figure 3 o Say that discharge is not to scale, rather than not labeled. Or that you are using it for visual aid and not to scale âĂć Line 214, you say only in-phase results are shown but Figures 3 and 5 show out of phase results âĂć Figure 4 o I don't like the positioning of Figure 4 but don't know if you have control over this or the journal does. It looks odd to have a figure showing gaining conditions in the 3.1.2 under Losing Conditions section of the paper âĂć Figure 5 o Caption says discharge is not labeled when it is in Fig 5c and Fig 5d o I think you may mean that discharge is not to scale in 5e and 5f âĂć Line 260, please state the values you used for you models or at least a range of values âĂć Figure 6 o I'm not sure how necessary figure 6 is in this paper. While I like the figure, I believe you could and do explain this information in the text. o This could help you shorten the paper o You could slow spice this up by clipping a few of these snapshots together and then playing them in a .gif over

the course of a storm so you could see the variations in the losing condition sections of the figure o âĂć Figure 7 o Same weird out of place figure placement o I like this figure. It tells me clearly that gaining in-phase hyporheic zones have less variable temperature from the constant upwelling of groundwater o Get rid of the underscore in gaining in-phase, keep it consistent with the figures above. Same goes for the color scheme if possible âĂć Line 260 o Gomez-velez et al 2015 reports RSF over entire river networks. How you are you implementing these findings into this new model? The also include river bedform information and this paper assumes uniform sediment. So please list what metrics you are using from this Gomez-velez paper. What are the quantiles??? âĂć Figure 8 o Under loosing conditions reaction significance time is 3 orders of magnitude less than gaining conditions o This figure indicate that the RSF can vary by $\sim$1 order of magnitude over the course of the day. While the difference between gaining and loosing conditions is and interesting result. How do you justify this with the range of stream orders, sediment size, and hydraulic conductivity show in the Gomez-Veles papers? o Are you using the stream order of the USGS gauge you gather the data from? If so report these information and explain this process in the text âĂć Discussion âĂć Line 267, Water table drawdowns coupled with hydraulic gradient changes through temperature contribute to enhanced diel fluctuations of exfiltrating hyporheic fluxes âĂć Line 269, Under the neutral condition âĂć Line 272, 269 – o You only reference figure 3 here which is the gaining condition, should you also mention figure 5 the loosing condition? o Or be more specific in the text âĂć Paragraph on Line 285 o I agree with what you are saying o Don't pump an aquifer during a storm because the drawdown could pull pollutants into the hyporheic zone o Could you provide an example of a usgs site that has daily drawdowns from groundwater pumping like the ones shown in this paper from the plants? o This may be a hard reach but could have important management implications âĂć Line 307, could you use your data (from figure 6 maybe) to show this? o Upwelling keeps warm surface water from connecting to HZ âĂć Therefore, in summer when river temperature is relatively high, the hydraulic conductivity is enhanced and becomes the main modulator for

hyporheic exchange rate under losing condition. o Change the therefore language. The authors use this word a lot âĂć Combine the paragraphs between Lines 310 and 320 âĂć Line 343, Therefore, hyporheic zones have a larger cooling effect during high river temperature under out-of-phase gaining conditions than under in-phase conditions (under gaining conditions) âĂć Too many conditions maybe think of different wording for in-phase and out-of-phase (conditions) âĂć Loosing conditions speeds up residence time (RSF = reaction scale factor) âĂć Gaining conditions slows down residence time and allows mixing of GW and SW âĂć In conclusion, the timing 365 of groundwater table drawdown is more important under gaining conditions than under losing conditions for denitrification reactions. âĂć Line 668 – could you mention this fact earlier in the paper, so the reader is not thinking about denitrification the entire time? âĂć Study limitations? o What about connectivity? A reference to some of this great work would be nice to see in this paper âĂć Conclusion o Not strong enough or long enough o Need more space and references to specific aquatic community impacts and groundwater table diel drawdown.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-288/hess-2020-288-RC1-supplement.pdf

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-288, 2020.

Printer-friendly version

Discussion paper