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Hydrology and Earth System Sciences Discussions

Interactive comment on "Investigation of groundwater-surface water interaction using hydrochemical sampling with high temporal resolution, Mangatarere catchment, New Zealand" *by* M. R. Guggenmos et al.

Anonymous Referee #2

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Overview

This paper uses stream and groundwater data from the upstream and downstream ends of a reach to quantify groundwater/surface water interactions. The data consists of several months of stream and groundwater stage and temperature data, and uses major ion and nutrient chemistry to support interpretation of the data. Chemistry is also used to create a mass balance. The authors need to provide more information to support some assumptions, most notably ignoring evapotranspiration and surface water/throughflow inputs to the stream. Including an analysis of the potential error in gw/sw interaction calculations would also benefit the story.

Major Comments

1) Evapotranspiration (ET): ET is often a significant fraction of stream water balances. The authors claim that it is unimportant over 10 km of stream reach, but do not provide evidence to support this claim. This seems unlikely, especially if there is a riparian corridor (also no mentioned). Also, given significant discussion by the authors of how water from smaller precipitation events does not contribute to groundwater recharge but is instead stored in soils, it seems likely that bank storage could also be an important mechanism of stream discharge loss. These mechanisms need to be considered, or a stronger argument needs to be made that they are unimportant. This assumption affects both water and solute mass balances, and thus has implications for the calculations B1 and B2, as well as the data presented in Figures 7 and 8.

2) In this paper, groundwater/ surface water (gw/sw) interactions are inferred from differences in stage, chemistry, and discharge between the upstream and downstream gages. It is difficult to make a strong argument given the paucity of the data. Multiple studies exist that show the dangers of relying on total discharge to infer these processes (see K. Bencala et al. 2011 and R. Payn et al. 2009 both in Water Resources Research). More rigorous methods for considering gw/sw interactions, such as stream tracer additions or installation of shallow subsurface wells in the streambed along the 10 km study reach could provide useful data to support the author's claims. As is, the data is equivocal and the interpretation is generally speculative. It is very likely that there is both upwelling and downwelling within the study reach. It's quite possible that the two active faults that cross the stream have an effect on both subsurface flow and chemistry (and thus the mass balances). Consideration of these faults and their effects could have implications for the results and interpretation.

3) Groundwater/surface water interactions inferred from groundwater temperature. The

apparent temperature increase does correspond to the two largest periods of precipitation, but I'm surprised that there is not a lag between the maximum daily air and groundwater temperatures. Is the difference in water levels so small that the lack of lag is reasonable? Such a fast response might be expected from water short-circuiting the porous media and flowing along the well casing. It would be useful to see this period of Figure 5 in a larger size to better analyze this. Also, the major period of groundwater warming corresponds closely to periods where the groundwater stage appears erroneous. Is this just coincidence?

4) Catchment Hydrology Results: I'm confused by the y-axis in Figure 3. Where is the datum for water stage? It appears that the upstream groundwater has a head that is approx. 2.5 m above the surface water. This implies an upward gradient, and would seem to preclude infiltration/recharge from the stream to the subsurface. I'm also surprised that there is almost no stage difference between the upstream and downstream surface water gage. I'm guessing that these three lines have different datum. Also, in the text at 10237-11, "...downstream stage generally 10 cm higher". Since water flows from high head to low, this suggests water is flowing upstream. Please clarify.

Specific Comments

Abstract and Introduction: I agree that short timescales are important for considering gw/sw interactions, but I don't think it's fair to say that short (< weekly) timescales have not been studied. There are many examples of rigorous studies, either through modeling or tracer-based methods that focus on high spatial and temporal components.

Field Site: Given the high winter temperatures (up to 24C) and the dry fohn winds, it seems like evapotranspiration (ET) could result in a significant loss of water from this stream. The authors need to at least mention ET, and indicate if it might be a substantial fraction of the stream water budget.

Field Methods: Were the absolute pressure transducers corrected for barometric pressure fluctuations? This is not mentioned.

10237-10-15: For the comparison of the upstream and downstream flows, it would be better to quantify discharge instead of inferring discharge from stage. Larger catchment area and greater distance downstream are not always good reasons to expect higher discharge at the downstream gage.

10238-0-2: Higher EC does not necessarily signal stream recharge, and could also indicate evaporation between the upstream and downstream gages, or small high-concentration inputs from the fault zone.

10238-4-5: How is runoff generated from groundwater?

10244: It seems like several of the downstream surface water attributes including higher EC, elevated TDS, nitrate, ammonium, and P could have originated from agricultural runoff. How do you know that their presence is related to gw/sw interactions? The authors mention (line23) that these could come from tributary streams, and I think this sounds more likely.

10245 and Figure 5: The buffered temperatures in the downstream sw are attributed to recharge from cooler groundwaters. However, while the temperature range is certainly smaller, it doesn't look like the average daily downstream sw temperature is significantly lower than the upstream sw temperature. Could this buffering be related instead to a more established riparian corridor shading or greater soil moisture and associated thermal buffering?

10246: Unless the entire stream discharge is moving through a flume or weir, linear interpolation between each rating point would likely produce a more realistic and accurate rating curve than relying on a single equation.

Figure7 & 8: Error bars on the discharge calculations would be useful... can you accurately quantify groundwater inputs via this method? ie. by subtracting one large number (downstream discharge) from another large number (upstream discharge) to get a small number (recharge) likely results in large errors.

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10247: Ignoring evapotranspiration could lead to significant errors in the % mass balance calculation. Tracer dilution in the reach of expected groundwater recharge would provide another, more accurate method of quantifying inflows to the stream.

10253: In the mass balance at B2, there should be a negative sign before the upstream component (ie. US + groundwater = DS).

10254-1: I have a hard time believing that the rating from the Gorge can effectively estimate discharge at the upstream gage! I think you need to provide channel cross sections, slopes, and roughness values to support your claim that this rating can be transferred from one location to another. Better yet, develop a rating curve for the upstream gage.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 10225, 2011.