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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assessing land–ocean connectivity via Submarine Groundwater Discharge (SGD) in the Ria Formosa Lagoon (Portugal): combining radon measurements and stable isotope hydrology" *by* C. Rocha et al.

Anonymous Referee #2

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Assessing land–ocean connectivity via Submarine Groundwater Discharge (SGD) in the Ria Formosa Lagoon (Portugal): combining radon measurements and stable isotope hydrology Rocha et al. Hydrol. Earth Syst. Sci. Discuss., 12, 12433–12482, 2015 This study attempts to quantify submarine groundwater discharge and its likely source in Portugal using a range of natural tracers. The natural tracer radon (222Rn) has been widely used to estimate the cumulative SGD of both fresh groundwater and recirculated seawater, however determining the actual contribution of each of these sources can be problematic. Both the scale of the project and the combination of trac-

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ers used, represents a novel approach and as such represents a worthy addition to the literature. My major concern with the study is the seemingly ad hoc sampling design. The authors state for example that “Samples for stable isotope analysis of water were collected in triplicate from all possible water sources to the lagoon on various occasions between 2007 and 2013.” (P12446 L1); and “Quasi-synoptic distributions of 18O and 2H in water at different tidal stages were obtained for the lagoon in the winter of 2009.” (P12446 L15). With so much temporal variation in all of the tracers, drawing conclusions from multiple sampling campaigns under differing conditions can be problematic to say the least. This is of particular concern with the natural tracers used as concentrations and fluxes of the tracers would very much be affected by rainfall, tide heights etc. While comparing the results of different campaigns can be done, to do so, it would be necessary to demonstrate that the system was operating under similar hydrological conditions during each of the campaigns. To do this, a reporting differences in rainfall (both long and short term), temperature, groundwater water levels, groundwater concentrations/signatures and tide heights would be necessary. Another concern is with the selection of an endmember for seawater recirculation. The authors concluded that most of the SGD is comprised of recirculated seawater, but does the beach groundwater endmember represent fully equilibrated recirculated seawater or new seawater with a very low residence time that has yet to fully equilibrate. The authors assume it is fully equilibrated, but it needs to be discussed why they believe this is so.

Specific comments are listed below: P12435 L1. I find the first and second sentences contain too many distinct points and both can be written more clearly with shorter sentences. P12435 L19. This is confusing, I suggest something like “SGD can be separated into fresh groundwater inputs and recirculate lagoon waters” to make it a bit clearer. P12435 L21. I believe “permanent” is the wrong word here as it implies long, multi temporal sampling. Perhaps “dominant” is a better word. P12435 L26 Remove “so more difficult to predict”. P12436 L9. Suggest including a more recent estimate such as: Kwon, E. Y., G. Kim, F. Primeau, W. S. Moore, H. M. Cho, T. DeVries, J. L. Sarmiento, M. A. Charette, and Y. K. Cho (2014), Global estimate of submarine

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groundwater discharge based on an observationally constrained radium isotope model, Geophysical Research Letters, 41(23), 8438-8444. P12437 Radium is normally absent in “fresh” groundwater. P12438 L9 Sentence is unclear. P12438 L13 Remove “so far to progress beyond our ability”. P12438 L13. I believe this can be expanded upon. The endmember is usually the greatest uncertainty in any tracer mass balance. With most studies using a range of endmembers across the catchment/aquifer/study site, determining the endmember concentration in the area of the likely source of groundwater would very much lead to much less uncertainty in SGD estimates. P12438 L19. I believe a separate paragraph (of which some of the information occurs in the last paragraph of the introduction) on how O18 and 2H can be used and where they have been used to quantify SGD sources. P12438 L15. There quantification of N inputs into the lagoon has not been set up in the introduction but is mentioned in the abstract, methods etc. P12444 L22. Unclear why this input is not included. Is it are large potential source, small one, what is the discharge? Rivers of course can be large sources of tracer and nutrient inputs particularly in times of flood. This should be acknowledged, shown on figure 1 & 2 and addressed as a limitation if no data is available. P12446 L1 As discussed above in the general comments, you need to provide specific information on when the sample collection took place and how comparable the different campaigns are. To do this, a minimum of reporting differences in rainfall (both long and short term), groundwater water levels, temperature, groundwater concentrations/signatures and tide heights would be necessary. P12447 L19. A better explanation of the exclusion of winter data should be given. If higher evasion rates were likely during winter than why were Rn concentrations and distribution similar. This points to very different drivers of SGD temporally and as the comments above suggest, that comparing tracer concentrations over multiple campaigns in problematic. P12448 L26. Detailing the water balance in the lagoon would be helpful ie. The amount of water coming in and the amount of water going out. If the water balance is not equal over the particular tidal cycle where the Rn was measured, this can have significant impacts on the mass balance and should be accounted for. P12450 L1. Throughout the Stable Isotope Hydrology

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section, it needs to be clear which samples were collected during the 222Rn surveys and timeseries and if the collection times were different how applicable is it to compare signatures at the different times and how the signatures compare to the 222Rn concentrations/export/import/mass balance. P124550 L14 Please define the acronyms used in figure 4 and 5 in the caption ie.WMMWL P12455 L5. Change “discriminate between potential source functions of SGD.” To “discriminate between potential sources of SGD.” P12455 L9. Change “potential source functions” to “potential sources” P12455 L9. As per the general comments, clarification on the recirculation endmember needs to be addressed. Does the beach groundwater endmember represent fully equilibrated recirculated seawater or new seawater with a very low residence time that has yet to fully equilibrate. The authors assume it is fully equilibrated, but it needs to be discussed why they believe this is so. P12455 L15. Add in “The corresponding volumetric discharges, if each of these potential sources is considered in turn to be the only source of SGD to the lagoon are..” P12455 L25. Again this highlights the temporally dynamic nature of the lagoon and comparison of parameters across different campaigns must be discussed. P12456 L2. Please describe this mechanism (with references) in more detail as I find this explanation highly unlikely. As 222Rn is essentially sourced from sediments and porewater 222Rn is regularly many magnitudes higher in porewater than surface water, surface water contributing 222Rn to the porewater is not feasible. At a guess I would say that wind and current evasion is likely underestimated. Providing more detailed explanation of the terms used in evasion calculations and uncertainties around those estimates may help determine if this is the case. P12456 L22 Would “is” be a better choice of words here than “could”? P12456 L20 Again the “two different periods” are not clearly defined previously in the manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 12433, 2015.