

## ***Interactive comment on “Combining resistivity and frequency domain electromagnetic methods to investigate submarine groundwater discharge (SGD) in the littoral zone” by Marieke Paepen et al.***

### **Anonymous Referee #2**

Received and published: 12 February 2020

Review Manuscript Number: hess-2019-540 Title: Combining resistivity and frequency domain electromagnetic methods to investigate submarine groundwater discharge (SGD) in the littoral zone Article Type: Research paper

The manuscript by Paepen, et al. addresses an important issue when it comes to SGD: the view across compartments. Traditional work mostly focuses either on marine or terrestrial compartments. Only a few studies, such as the present one, consider both compartments and see SGD as a continuum and across-compartment process. As such it is of utmost importance to include geophysical approaches that to date are still underrepresented despite its promising results (see works of Swarzenski et al., Cross

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et al., Virtasalo et al.). Despite the importance the manuscript contains drawbacks both in the way it is presented and concerning content-wise aspects. I addressed both in the attached \*.pdf and partly in the questionnaire, I was asked to answer (see below).

Questionnaire:

Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Hydrology and Earth System Sciences (substantial new concepts, ideas, methods, or data)? Fair

Scientific quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)? Fair

Presentation quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)? Fair

1. Does the paper address relevant scientific questions within the scope of HESS? The manuscript by Paepen et al. addresses an important issue when it comes to SGD, the view across compartments. Traditional work mostly focuses either on marine or terrestrial compartments. Only a few studies, such as the present one, consider both compartments and see SGD as a continuum and across-compartment process. As such it is of utmost importance to include geophysical approaches that to date are still underrepresented despite its promising results (see works of Swarzenski et al., Cross et al., Virtasalo et al.). Concluding, yes it addresses a very relevant scientific question.

2. Does the paper present novel concepts, ideas, tools, or data? According to the authors, only the combination of the three applied geophysical methods allow to “to fully characterize the discharge zone in the target area (Pg4 L4)”. The authors mention the combination of methods to be used for the first time in the context of SGD, which makes it novel.

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3. Are substantial conclusions reached? This question is difficult to answer from my perspective. Presented results show the same pattern of either resistivity or conductivity signals. Following the authors narrative and conclusion it seems as if substantial conclusion are reached. Yet, as a non-geophysicist it is very often difficult to follow the narrative as the authors refer to likeliness of fresh/brackish discharge but show resistivity or conductivity values. Besides, results are obtained without validating them. Even the inversion was based on geophysical data only although the authors themselves state "Due to measurement errors, resolution and inversion constraints it is impossible to deduce the true total dissolved solids (TDS) without a specific calibration of geophysical measurements based on ground truth data. (Pg8 L10f)". The statement is addressed to the deduction of TDS but given the measurement uncertainties and natural heterogeneities along with small variances between brackish, fresh water along with its effects on resistivity or conductivity signals, the above question cannot be properly answered. However, I must emphasize, this is from the perspective of a non-geophysicist. I certainly feel not qualified to evaluate the methods in general and leave this part to more qualified colleagues. Instead, I concentrated on the general picture and the benefit for SGD investigations.

4. Are the scientific methods and assumptions valid and clearly outlined? As written before, I am not qualified to properly answer the question concerning the methodical part. In parts, the paper reads too technical and is hard to understand. I added comments in the \*.pdf. From my limited understanding, and also the authors themselves mention it several times throughout the manuscript, I would like to see the pros/cons of each method (vertical resolution, max. vertical range, uncertainties etc.) to be in the position to better judge.

5. Are the results sufficient to support the interpretations and conclusions? The combination of the three methods, as always when it comes to combine different methods in order to reduce uncertainties of single methods, the interpretations are supported by the results. Certain conclusion on fluxes should be avoided (Pg10 L16 // Pg 12 L8).

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This would mean to include a time-dimension which the mono-temporal data do not allow. Moreover, what would certainly improve the narrative and alleviate the understanding would be figures that i) include a scale showing the likeliness of SGD, ii) have information in the graphics concerning important features (salt water lens, freshwater, clay lens etc.) and iii) even a continuous spatial scale beneath Figs. 4,5,6 to be able to follow the distances given in the text. I wished the authors had added some in-situ data on e.g. pore water chemistry, drilling etc. to prove the results with an independent data set which would elevate the manuscript to a higher level.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? I would leave this question to colleagues with a profound understanding/knowledge of the methods. Used software was mentioned, likewise were applied thresholds.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes.

8. Does the title clearly reflect the contents of the paper? Yes.

9. Does the abstract provide a concise and complete summary? Yes and no. Complete yes, concise partly. Parts of the abstract between L18-24 could be reduced/deleted as it unnecessarily lengthens the abstract. I leave it the authors to decide.

10. Is the overall presentation well structured and clear? Yes. However, I would encourage the authors to add a subsection in which they outline which of the results can be stated with certainty given all uncertainties and relative terms/subjectivity, and which of the results must be proven as they are highly uncertain. I added comments at the respective parts of the manuscript in the \*.pdf

11. Is the language fluent and precise? Yes, it is well written.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Not applicable.

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13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? Yes, I added suggestions in the \*.pdf

14. Are the number and quality of references appropriate? Yes.

15. Is the amount and quality of supplementary material appropriate? Not applicable.

Please also note the supplement to this comment:

<https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-540/hess-2019-540-RC2-supplement.pdf>

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