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Hydrology and Earth System Sciences Discussions

Interactive comment on "Quantifying freshwater resource in coastal barriers: the joint use of transient electromagnetic and magnetic resonance soundings" *by* J.-M. Vouillamoz et al.

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-General comments:

I find this article very interesting and relevant especially because of the applied focus presenting a ready-to-use methodology. It is relatively easy accessible to the wide audience without excessive theoretical details.

The article presents a good example of not only combining two supplementary geophysical methods, but also combining these with hydrological measurements and knowledge. The hydrological interpretation of geophysical data is challenged fre-

quently. Too often hydrological conclusions are drawn based purely on for example electrical resistivity data which would be excellent if possible, but the reality is more complicated. Therefore examples like this of sensible joint use of geophysics and hydrology are appreciated. The article presents a wise level of how to apply geophysics within it's capabilities and respecting the limits.

I have only some suggestions to minor technical corrections and a few comments/questions. I recommend this article for publishing with only minor corrections.

-Specific individual scientific questions/issues/comments:

P5262, L11-17, I completely understand the arguments that drilling and hydraulic testing is not always possible, but was any performed to check the results achieved from applying the suggested methodology in the current survey?

P5264, L10, "..to estimate the properties in 1-D of coastal aquifers in Myanmar but it was applied in confined aquifer conditions." This "but" indicates that the aquifer in this survey is unconfined, and I don't know if it should be obvious, but mentioning it explicit earlier could help the reader.

P5265, L28, "In this paper, we compare Sy measured on sand samples with θMRS". This is indeed very interesting and relevant. The results are described on P5274 from L7, where the resulting sample porosity is mentioned and compared to the MRS water content. If any additional information of this comparison exists (for example uncertainties, sample variations, illustrations etc), it could be very relevant to expand this section.

P5269, L14, What is saturated geometry? Water saturated layers?

P5272, L15, I agree that the first layer cannot be resolved by TEM, but what about the second layer that is less than 5 m thick, isn't this also problematic to resolve?

P5272, L20-23, Description of the fourth layer is missing, the other 4 layers are described. And just a question; can the third and fourth layer really be distinguished from

each other with the resistivities being quite similar? Maybe they can because of the low resistivities at relatively low depth.

P5273, section 1, the procedure in this section is a little unclear. In L19 "..the water EC is linearly increasing with depth", and the arguments for this simplification is information from the monitoring wells, but mentioned is only one ECpiezometer value. Can it be mentioned what the uncertainty of this assumption is and what uncertainty it causes on the resulting aquifer thickness? When first reading I did not have figure 5c because it disappeared when printing, which may have caused my confusion.

P5275, section 3, Is the estimated KMRS and TMRS used in the conclusive estimation of the fresh water thickness and volume?

P5275, L16, It would be interesting to see the parameter uncertainty of the depth to the salt water for the TEM interpretations. Is it less than 1 m in order to resolve the variations illustrated in fig. 7?

P5276, L7, if the MRS boundary uncertainty is +/- 8 cm, wouldn't you have expected to observe the variations with MRS to some extend since the variations interpreted with TEM is 10-15 cm if I understood right?

P5277, L21-p5279, L2, the description of less successful attempts with different geophysical methods are very relevant and valuable, so thank you for including these descriptions.

-Technical comments:

I am not either native English speaking, but I did my best to give suggestions to corrections. A native English proofreading would undoubtedly give a better result than I am able to.

Generally: Shouldn't it be either "The Archie equation" or "Archie's equation" instead of "Archie equation", ex. P5267, L1, L6, L9, L19, L25, L26 etc.

Suggestions to change sentences to:

P5262, L5, "Spatial knowledge of the aquifer properties and creation of a groundwater model are required for achieving a sustainable management of the resource."

P5262, L11, "..allows mapping of the fresh water lens and estimation of the specific yield, the hydraulic conductivity, the water salinity and the water table recharge."

P5262, L14, "..of surface area depending on the location and season."

P5262, L16, "..the recharge after a rainy event to pose close to 100% of the rain, and the net recharge at the end of the monsoon to pose less than 10% of the rain

P5263, L19, "..can be very useful if they succeed to provide accurate estimates.." P5264, L1, "..(Legchenko and Valla, 2002) and the resulting MRS parameters are the distribution of groundwater content.." P5264, L10, "..to estimate the 1D-properties of coastal aquifers in Myanmar but it was applied in confined aquifer conditions."

P5264, L19, "This proposed methodology is applied for estimating the groundwater resource.."

P5264, L25, "During measurements, the nuclei of the hydrogen atoms of.."

P5265, L3, "..surface in average conditions, but in salty water context.."

P5265, L11, "..the MRS result is the depth related distribution of groundwater content θMRS and pore-size related parameters."

P5266, L2, "Based on hydrogeological equations linking aquifer grain size and hydraulic conductivity (Hazen and Kozeny-Carman)..". The reference Hazen and Kozeny-Carman is not found in the reference list.

P5266, L11, "For sandy conditions CT.."

P5266, L14, "Geophysical methods that give access to information about the electrical resistivity.."

P5266, L16, "..expressed by the (delete: so-named) first Archie equation.."

P5266, L23, "Moreover, as mentioned by Archie (1942), the value of m depends on aquifer rock type and ranges between 1.8 and 2 for consolidated sandstone with a value of approximately 1.3 for unconsolidated sand. Archie's equation has been empirically confirmed by numerous filed experiments and is often reports as.."

P5267, L9, "..the only remaining unknown parameter of Archie's equation is the porosity that hence can be calculated for the sea water layer. Assuming the porosity to be the same for the entire saturated thickness, the calculated porosity value can be used to solve Archie's equation.."

P5267, L20, "We include measurements of not only electrical resistivity but of a complementary.."

P5267, L27, "..water EC were still needed."

P5268, L21, "..geological assumptions presented in Fig. 1."

P5269, L3, "On (delete: the) one hand, numerical modeling conducted with TEM alone shows. . . On the other hand. . ."

P5269, L21, "..and the brackish water layer boundaries with an accuracy of.."

P5269, L24, "..respectively if the layer is (delete: of) 10 m thick."

P5270, L2, "WTFM is based on the assumption that a rise in the groundwater level is due to.."

P5271, L2, "The thickness of the sand deposit is unknown. The highest elevation of the barrier.."

P5271, L19, "..measuring 25 m (delete: long) per side was used (except at one location where a 50 m (delete: long) side loop was used)."

P5271, L26, "square shape and 25 m (delete: long) per side.."

P5272, L15, "..a 5 layered resistivity model (Fig. 4b). Note that the resistivity of the first layer is not known because (1) the TEM measurement has poor resolution from ground surface.."

P5272, L19, "..from ground surface and down, we interpret a dry sand layer.."

P5274, L2, "..(instead of "one can") this criteria is used to estimate the thickness of the fresh water lens."

P5274, L12, "Total porosity excluding bound water is named.."

P5274, L17+18, I think it should be "sand" or "sand samples" instead of "sands", since sand is both singular and plural.

P5275, L15, "..different periods of time."

P5275, L16, The reference El-Kaliouby et al. is listed 2007 in the reference list and not 2005.

P5276, L6, "..carried out at the same dates as the TEM.."

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