

Interactive comment on “Identifying recharge under subtle ephemeral features in flat-lying semi-arid region using a combined geophysical approach” by Brady A. Flinchum et al.

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General Comments

This is an interesting paper which applies several near surface geophysical techniques to show that recharge is occurring from a subtle ephemeral feature in Australia. Although arguably a case study, the combination of geophysical methods used and the narrow focus on a very small feature make it of interest to a wide audience researching dryland hydrology. I would recommend publication, however the paper would benefit from revisions to improve its clarity and impact.

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General Comments (expanded in the Specific comments below): 1. Discuss and frame with the Poisson's ratio (rather than P and S Waves) – particularly in abstract, and results. Too much time is spend on individual interpretation of P and S wave data 2. More explanation is required for the difference between the in situ data (gravitation water content, soil water conductivity) and the geophysical data. 3. Delete the section on the use of Archie's equation which is unreliable in this context. 4. The wider context and implications are overplayed. Although the paper identifies recharge occurring, it does not indicate its significance to the overall system, and similarly they have not identified a new conceptual model for groundwater recharge. 5. Language and diagrams need some improvement. Particularly the overuse of the word "unique" and some colloquial language throughout the text. 6. The authors also provide a tantalizing glimpse of wider data from 47 research boreholes not included in this study. Are they being interpreted elsewhere? Or could they be used to upscale their results?

Specific comments:

Abstract – mention the Poisson's ratio – delete references to unique. Line 18. Your results show that localised recharge is occurring, not that all recharge is localised. Also you don't know how significant this is to the broader system – so change to may play and important role in gw recharge in dryland areas

Line 35 – you've missed out Water level fluctuation method. Probably one of the most common on semi arid areas. You could quote the recent Cuthbert et al 2019 Nature paper

Paragraph at Line 55 – Not sure you can say that ephemeral stream recharge processes are usually undertaken by time lapse and that there is not a one-off survey method that exists. For example many people have used groundwater chemistry and environmental tracers (using existing boreholes) to identify that groundwater recharge is occurring. Also people have used ERT to show fresh water over saline.

Paragraph line 66 – Not really a unique combination. Just say a combination. Would

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strengthen the paper if you discuss and frame with using Poisson's ratio rather than independent S and P wave

Site description section. Much of what is here is wider context and immaterial. Please reduce this section to just describe the site and local hydrogeology of relevance. Also please mention the vegetation. The 47 boreholes also confused me. Is there a separate paper using these data? I was hoping the paper was going to upscale the results using these boreholes. It also raises the question that most of the information reported in the paper could have been gained from rapidly drilling 10 shallow piezometers across the site to 8 m.

Line 300 Soil Sample results. These need much more explanation and are skipped over in the paper. Why are the gravitational water content and conductivity data so different from the geophysical data? Looking at the plots they could be from a different borehole in another location.

Results: Line 265. Both the P and S wave interpretation show very little evidence of a "clear and observable feature" showing the recharge from the water table under the ephemeral stream. Would be much stronger if you report the Poisson's ratio in the results. Its an established technique – so doesn't need to go in the discussion. Much less emphasis on P and S Wave interpretation (unless to show that they are much inferior) and report the Poisson's ratio – which is good.

Line 309 – you discuss no changes in lithology – however above you discuss clay below the water table – please clarify

Line 335 and following. This paragraph needs to be changed. You can't say "different physics" and "gravitate towards". Just say the second interpretation is more likely due to the NMR data.

Line 360 and following – first sentence you need to mention the observations from cores and piezometer. Also please revisit line 34 – Nano TEM identified low conductiv-

ity area – not an increase in saturation.

Line 375 an following. The use of Archie's equation here is questionable and weakens the paper. Youi have already mentioned very high and variable water conductivity and the presence of clays – both of which make applying Archie's equation unreliable. This detracts from the paper and I would delete this whole section

Line 410 and following Hydrogeological interpretations. One question here that is not answered is whether this water helps sustain an aquatic ecosystem, or vegetation, or is it "lost" to a saline groundwater system.

line 441 and following, "impossible to know ahead of time"? Delete this. The geophysical survey particularly Poisson's ration and nanoTEM has helped confirm recharge occurring and therefore guide the siting of more detailed drilling.

Line 454 – New conceptual model of groundwater recharge in semi arid areas? Unless I missed something I don't think you have done this Many have discussed recharge from ephemeral streams of all sizes – you have confirmed recharge has occurred from a very small "0" order tributary using a sensible and well applied combination of geophysical methods and ground truthed with a piezometer.

Conclusions: please name check the Poisson's ratio – which proved useful Line 490 – Do they play a vital role in recharge to the NAP? I don't think you can conclude this, you can say that you have confirmed that ephemeral recharge occurs – but not how important or significant it is to the overall water balance.

Diagrams Overall could do with improving the quality. Figure 1 is really difficult to follow. I don't think we need all the panels. A location map (that's easy to follow – currently couldn't tell land from sea) than panel C which is the main information. A cross section may also be useful if you want to keep in the wider context Figure 2, 3 – combine and add in the poisson's ratio. Add in the location of the piezometer an ephemeral feature to all diagrams Figure 4 – need more information on how to interpret the residuals. I

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don't know whether its good or bad. Figure 5 – you need to explain the discrepancy between the geophysical data and the in situ data Figure 6 – delete the line for the water table – and add in the piezometer and point observation Figure 7 – Delete along with the section on Archie's law

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