

Interactive comment on “The importance of small artificial water bodies as sources of methane emissions in Queensland, Australia” by Alistair Grinham et al.

Anonymous Referee #2

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The importance of small artificial water bodies as sources of methane emissions in Queensland, Australia 1. Does the paper address relevant scientific questions within the scope of HESS? Yes 2. Does the paper present novel concepts, ideas, tools, or data? Yes 3. Are substantial conclusions reached? Yes 4. Are the scientific methods and assumptions valid and clearly outlined? No 5. Are the results sufficient to support the interpretations and conclusions? Yes 6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? No, more details are needed on the chamber method. 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

C1

paper? Yes 9. Does the abstract provide a concise and complete summary? Yes 10. Is the overall presentation well structured and clear? Could use some improvement. 11. Is the language fluent and precise? Yes, with a few exceptions in the discussion and conclusions. 12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes, with the one exception of units for CH₄ flux which needs clarification. 13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? The methods need some clarification; the conclusions need to be distilled. 14. Are the number and quality of references appropriate? Yes 15. Is the amount and quality of supplementary material appropriate? Yes

Summary: The global importance of GHG emissions from small ponds is not well understood due to a lack of knowledge of both their 1) GHG emission rates and 2) cumulative spatial extent. This study quantifies both for the state of Queensland, Australia, and the authors also propose two upscaling approaches. In addition, the study investigates spatial (both intra- and inter-pond), temporal variability in emissions, and the impact of variable inundation status on emissions. The study found that including small ponds in the calculation of total surface area of artificial water bodies increased the cumulative total surface area by 24%. Spatial variability within ponds was found to be much greater than temporal variability.

Overarching comments: This study is an important contribution to the literature on methane emissions from inland waters, and well executed. My main comment is that the manuscript could benefit from some clarification and reorganization. There are several additions needed in the methods, several items stated in results that should be included in the methods, several items that belong in the results that are in the discussion (see specific comments, below), and more attention to study components 2-4 (laid out in the introduction) in the discussion. Methods: Several sections in the methods could be clearer if the intention was stated in a topic sentence leading each paragraph. For example, in section 2.2 the onus is put on the reader to figure

C2

out what parts are for the purpose of determining individual water body sizes, what parts are for determining the cumulative area of small ponds, and what parts are for determining the size distribution. In section 2.4, the total number of sample ponds should be stated, as should the method for choosing the subset that purportedly represents the wide spectrum of ponds. More detail on the chamber method should be included. Concerns about the methodology that need to be addressed include:

- o Biases in the emission measurement due to diffusive uptake of methane from the chamber headspace to the water under conditions of high methane partial pressure in the chamber headspace

Discussion:

- o The introduction lays out four components of the study, but the discussion is heavily weighted to component 1: “Quantify the area of ponds, relative to regional assessments of larger artificial water bodies”, and to unstated components/objectives of scaling. Either:
 - o the introduction should be revised to reflect the structure of the discussion, e.g. state more clearly how components 2-4 support upscaling of inland water emission estimates, why determining the pathway is important or
 - o the discussion should be revised to address components 2-4

Specific Comments:

- o Page 2 lines 2-3 introduce the concept of uncertainty in surface area and classes of artificial water bodies. It is unclear what the authors mean by this – differences in how water bodies are classified? Different classification schemes? This sentence cites:
 - o Surface area: Chumchal et al., 2016 Abundance and size distribution of permanent and temporary farm ponds in the southeastern Great Plains, *Inland Waters*
 - o Classes: Panneer Selvam et al., 2014 Methane and carbon dioxide emissions from inland waters in India—implications for large scale greenhouse gas balances
- o Page 2 line 15: correct typo “the creation of water small artificial water bodies”
- o Page 2 line 18: “these can be considered anthropogenic in origin” the use of “can” makes this statement sound like it is optional or up to someone’s discretion to categorize emissions from flooded lands as anthropogenic or natural. Clarify this sentence by restating as “these emissions are considered anthropogenic in origin according to [IPCC guidelines], and should therefore be. . .”
- o Page 2, lines 26-28: the parenthetical statement is distracting. It seems the authors wrote it this way because

C3

the goal “to determine the factors that account for spatial and temporal variability in the flux” is a sub-goal of obtaining CH₄ flux measurements from a broader range of sites. I recommend moving the parenthetical statement to a sentence following this one: “An important part of the value of building a dataset of CH₄ flux estimates from a broad range of sites is determining factors that account for spatial and temporal variability in the flux.”

- o Page 3, line 6: this is the first mention of inundation level influencing emission rates. This idea should be introduced in the introduction; the intro as it is currently just deals with the difficulty of estimating total surface area due to changing surface areas
- o Page 3, line 9: change “having” to “has”
- o Page 3, line 10 – 11: stating that 80% of the land is used for agriculture could be supported by figure 2, as could the statement about rainfall gradients on lines 14-15.
- o Figure A1: where are the two ponds in panel a)? Could they be pointed to with arrows, for example?
- o Page 4, line 8-9: How was the mean surface area used to calculate the total surface area? Please provide an equation, or at least spell it out with more clarity. Scaled simply as mean size per pond * total number of ponds? Any size binning or other weighting? It is unclear if the sentences following are clarifications on the surface area determination methodology, or are background information for the two upscaling approaches
- o Figure 2: add the Category titles to the legend in panel a). For b) and c), increase the font size. Is it possible to indicate the location of the 22 study lakes on this map?
- o Page 4, line 25: please clarify if several emission measurements were taken over 24-hour periods, or if the chamber incubation period was 24 hours. How many headspace gas samples were taken per emission measurement? Also, what time frame were these measurements made over?
- o Page 5, line 4: mention the number of ponds monitored, i.e. change to “The variability in surface area of each of the 22 ponds monitored in the emissions surveys was analyzed. . .”
- o Page 6, line 16: is it possible to provide more quantitative evidence than “clearly” for the lognormal fit? In the Figure caption, a p-value is mentioned, but not in the text.
- o Page 6, line 28: what additional datasets?
- o Page 6, line 35-36: Your first research objective was to quantify the area of ponds relative to regional assessments of larger artificial water

C4

bodies – how does the 1,000 km² compare to the total artificial water body surface area in Queensland? – Page 7, line 3: change mg m⁻² d⁻¹ to mg CH₄ m⁻² d⁻¹ or mg CH₄-C m⁻² d⁻¹ depending on which you mean. I’m guessing the former, but the latter is also sometimes used. – Page 8, line 13: remove “clearly” – Page 8, line 14-15, 19-20: these results should be moved to section 3.1; however, the discussion of their importance is appropriate to have here – Page 8, line 20-22: how do these emissions compare to mean annual CH₄ emissions from larger inland waters in the state? – Page 9, line 36: what do you mean by “available for emissions”? This phrasing is unclear. Consider changing to “as this will greatly improve the surface area estimate of flooded lands used for upscaling greenhouse gas emissions.”

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