

Reply to “Comment on essd-2022-448” by Gillian R. Foulger (Referee)
Referee comment on "Global physics-based database of injection-induced seismicity" by Kivi et al., Earth Syst. Sci. Data, 2023

The paper by Kivi et al. introduces a global physics-based database of injection-induced seismicity. I recommend acceptance with the option of making the following very small number of minor tweaks.

The authors provide a publicly available database which is very positive and will without doubt be welcomed by diverse stakeholders and researchers. Providing information to fill in critical gaps in the HiQuake database for well-documented cases is a very positive step.

The early part of the paper provides a good concise review of the subject. The paper continues on to explain the rationale of the database and details of its contents. The work was clearly thought through very carefully and reasons for decisions are given.

The paper is authoritatively written and the relevant descriptions of data categories thorough. The database accords with official international standards. The illustrations and tables are elegant and clear.

The English is excellent throughout the main body of the paper.

Authors' response: We thank the reviewer for her careful consideration and positive assessment of the paper. We have tried to carefully address the reviewer's comments in the paper.

I noticed a small number of awkward/wrong expressions in the Abstract that would benefit from a light editing: 1) “if intensely shaking the ground” should be reworded, 2) “these data are hardly gathered” would be better “these data are challenging to gather”, 3) “data aims” should be “data aim”, 4) “Conclusively” could be deleted.

Authors' response: The suggested corrections have been implemented in the Abstract.

Line 125: It is not clear what is meant by “We rely on HiQuake in the consensus that anthropogenic activities induced all reported earthquakes.” Please rephrase this. HiQuake lists all earthquakes proposed, on the basis of scientific arguments, to have been human-induced. Simple inclusion in HiQuake says nothing about the likelihood that the proposals are true, and cases vary from highly unlikely to virtually certain to be human induced. It would be very helpful if this critical but widely unappreciated feature of HiQuake could be made clear here in the text.

Authors' response: Following the reviewer's comment, we have modified our explanation of the natural or induced origin of the earthquakes included in the database.

Changes in the manuscript:

Page 6, lines 128-134: We have deleted the sentence “We rely on HiQuake in the consensus that anthropogenic activities induced all reported earthquakes”. We have added “We build our database mainly upon HiQuake, the holistic and invaluable compilation of earthquakes proposed, on scientific grounds, to be induced by human activities. However, Wilson et al. (2017) and Foulger et al. (2018) point to varying degrees of certainty, from strongly unlikely to virtually certain, that the reported earthquakes in HiQuake have been anthropogenically induced”.

Line 186: Foulger et al. (2018) mention three CCS projects that are thought to be seismogenic.

Authors' response: We have reworded the sentence for clarification. We have already mentioned in the first paragraph of Section 3.2 the three seismogenic CCS projects reported in HiQuake.

Changes in the manuscript:

Page 9, line 196: "Megatonne geologic carbon storage projects have been accompanied by low seismic activity" instead of "Arguably, megatonne geologic carbon storage projects have remained seismically quiescent".

Section 2.2.6: It would be useful to cite errors in the b -values mentioned as the errors in b are frequently larger than the differences between the b -values under discussion. It is thus common to read interpretations of variations in b that are not statistically significant. The text at line 548 onwards also needs attention in this respect.

Authors' response: We agree with the reviewer and have adapted the text accordingly.

Changes in the manuscript:

Corrections have been made to the manuscript to highlight the point raised by the reviewer:

Page 14, lines 341-343: "For instance, the b -value has shown meaningful reductions from 1.58 ± 0.05 to 1.15 ± 0.07 in Basel, Switzerland (Bachmann et al., 2011), deep geothermal project, and from 2.0 ± 0.3 to 1.1 ± 0.1 in Castor, Spain (Ruiz-Barajas et al., 2017), underground gas storage project between co- and post-injection seismicity".

Page 23, lines 567-570: "Nevertheless, evaluations of the b -value are commonly accompanied by large errors that challenge the treatment of the variations in the b -value as statistically meaningful. Hence, conclusive statements on the differences between induced seismicity patterns solely based on this parameter should be avoided (Shi and Bolt, 1982)".