

[Comment] This study tries to map the global distribution of farm size using data harmonization approach. This is an interesting topic, but there are a few major issues that need to be solved.

[Response] Thank you for your comments. These comments enable us to improve our manuscript. We appreciate the time and effort you spent on reviewing. Below are our responses and how we will address them in the next revision.

[Comment] First, there is a large gap in China, causing an unpleasant blank area in the entire East Asia. I believe China's data can be easily obtained from the annual yearbook or other statistical records, and I would suggest the authors fill this gap.

[Response] The inclusion of China is our ambition since designing the research, however, data access remains unsolved so far. To include any extra country or region, we need farm-size specific and crop-specific data at the regional level from statistical records. This information for China is not publicly available, which is confirmed by the *Statistics Information Service* from the *National Bureau of Statistics of China* after consulting. According to our best knowledge, two databases may provide such data: the microdata of the *Third National Agricultural Census in China* (NBS, 2022) and the *China Rural Household Panel Survey* (CRHPS) (SSECZU, 2019). We submitted our data request and discussed with the database manager of the two databases in August 2021 and February 2022 respectively, however, we could not be granted access according to the corresponding current data policy. The data policy might change in the future, and we are prepared to include more countries including China once additional data is available. We would also like to invite scholars, users, and policymakers to update our database together in the future.

[Comment] Second, I have concerns about the validation in Lines 220-224. The comparisons are actually a compromise of data inconsistency. What if a different threshold value was used? Do the conclusions change if a different threshold was used? A sensitivity analysis maybe helpful here.

[Response] We agree that a sensitivity analysis would be helpful to understand the comparison here. Besides the current threshold of 25 ha, we also tried 10 ha and 50 ha as thresholds and conducted the same comparison with observations from satellite images. We found the conclusions in Section 3.3 are not sensitive to the choice of threshold. We will add the sensitivity analysis in the next revision.

[Comment] Third, language editing is also needed.

[Response] The next revision will receive proofreading from a native speaker.

Other minor suggestions:

[Comment] 1. Line 119, an extra "and"?

[Response] Yes, this word is redundant and will be removed in the next revision.

[Comment] 2. The claims in Lines 263-264 were actually not supported by the figure. There is a large drop in the >1000 category in Fig. 3a for the orange and red lines. Please also explain.

[Response] Thanks for pointing it out; we agree that more precise formulation is due. The more appropriate claim will be that large farms irrigate to a larger extent than small farms when water is scarce.

The reason for the drop is that the water scarce area of the >1000 ha farm size is mainly contributed by limited crops from a few regions, at least in our dataset. In this case, the characteristics of these crops and regions have more impact on the overall relationship between water scarcity and irrigation. For example, one of the main contributors to the significant and severe water scarce area of >1000 ha farm size (the orange and red lines) is sugarcane from São Paulo in Brazil. Brazil is the world's largest sugarcane producer and São Paulo account for around 60% of sugarcane production in Brazil (Bordonal et al., 2018; Palludeto et al., 2018). Sugarcane in this area is dominated by >1000 ha farm size (Ricciardi et al., 2018), mainly rainfed (OECD-FAO, 2015; Yu et al., 2020), and under water scarcity (Mekonnen and Hoekstra, 2016). However, water scarcity is not present all year round. The level of water scarcity is low from January to June, which is the tillering phase for sugarcane. During the dry season, sugarcane is usually harvested, during which moisture in sugarcane is relatively low and the sugar is highly concentrated (Kavats et al., 2020). This may help to explain why the large farms in this area are rainfed even though under a certain level of water scarcity.

In Fig. 3, we do not aim to draw conclusions on irrigation levels for specific farm sizes in absence of further investigation on influencing factors and uncertainties. The reason we have Fig. 3 is to compare it with previous observations. Ricciardi et al. (2020) show that large farms irrigate to a larger extent than small farms when water is scarce. In their study, farms are divided into either small or large farms without further classification, and the status of water scarcity is only classified as the water is scarce (moderate, significant, and severe) or not (low). Plausible thresholds to differentiate small and large farms could be country specific, and range from 1-42 ha for most countries (FAO, 2017, 2019; Khalil et al., 2017). With any threshold within this range, our dataset supports previous observations given that the farm size >1000 ha only contributes to less than 4.5% of water scarce area of large farms, so specific observations for the largest farm size may be spurious and are not emphasized in the paper.

In the next revision, we will improve the claim, clarify the intention of this analysis, and explain Fig. 3 with more details based on the above response.

[Comment] 3. In line273, I don't know why the author made this claim: "This means the spatial distributions of oil palm production in our downscaled maps and Descals et al. (2020) are similar." The comparisons were about the harvested area, and why and how did the production involved here?

[Response] Thanks for pointing it out. The statement indeed is about the harvested area instead of production. We will formulate it unambiguously in the next revision.

[Comment] 4. Line 328, separately?

[Response] Yes, this word will be corrected in the next revision.

Reference

- Bordonal RO, Carvalho JLN, Lal R, de Figueiredo EB, de Oliveira BG, La Scala N (2018) Sustainability of sugarcane production in Brazil. A review. *Agronomy for Sustainable Development* 38. doi:10.1007/s13593-018-0490-x
- FAO (2017) Small family farms data portrait. Basic information document. Methodology and data description. Food and Agriculture Organization of the United Nations, Rome
- FAO (2019) Methodology for computing and monitoring the Sustainable Development Goal indicators 2.3.1 and 2.3.2. FAO Statistics Working Paper Series 18-14. Food and Agriculture Organization of the United Nations, Rome
- Kavats O, Khramov D, Sergieieva K, Vasyliov V (2020) Monitoring of sugarcane harvest in Brazil based on optical and SAR data. *Remote Sensing* 12:1-26. doi:10.3390/rs12244080
- Khalil CA, Conforti P, Ergin I, Gennari P (2017) Defining small scale food producers to monitor target 2.3 of the 2030 Agenda for Sustainable Development. FAO, Rome
- Mekonnen MM, Hoekstra AY (2016) Four billion people facing severe water scarcity. *Science Advances* 2. doi:10.1126/sciadv.1500323
- NBS (2022) Micro data, National Bureau of Statistics. <https://microdata.stats.gov.cn/> (in Chinese) Accessed 20-April-2022
- OECD-FAO (2015) OECD-FAO Agricultural Outlook 2015-2024. Organisation for Economic Co-operation Development, Food and Agriculture Organization of the United Nations
- Palludeto AWA, Telles TS, Souza RF, de Moura FR (2018) Sugarcane expansion and farmland prices in São Paulo State, Brazil. *Agriculture and Food Security* 7. doi:10.1186/s40066-017-0141-5
- Ricciardi V, Ramankutty N, Mehrabi Z, Jarvis L, Chookolingo B (2018) An open-access dataset of crop production by farm size from agricultural censuses and surveys. *Data Brief* 19:1970-1988. doi:10.1016/j.dib.2018.06.057
- Ricciardi V, Wane A, Sidhu BS, Godde C, Solomon D, McCullough E, Diekmann F, Porciello J, Jain M, Randall N (2020) A scoping review of research funding for small-scale farmers in water scarce regions. *Nature Sustainability* 3:836-844.
- SSECZU (2019) Data access policy of the Chinese Family Database from Zhejiang University. <http://ssec.zju.edu.cn/sites/main/template/news.aspx?id=51027> (in Chinese) Accessed 20-April-2022
- Yu Q, You L, Wood-Sichra U, Ru Y, Joglekar AKB, Fritz S, Xiong W, Lu M, Wu W, Yang P (2020) A cultivated planet in 2010 – Part 2: The global gridded agricultural-production maps. *Earth System Science Data* 12:3545-3572. doi:10.5194/essd-12-3545-2020