

We are highly appreciated for your constructive comments and suggestions on our manuscript. Those comments and suggestions are valuable and helpful for revising and improving our article, as well as inspiring our research. We have carefully reviewed the comments and have revised the manuscript accordingly. Our responses are given in a point-by-point manner below and **BLUE** fonts. Please find our detailed responses in supplement to all these comments/suggestions and thank you again for everything you have contributed.

RC1

This article describes a dataset purporting to describe maximum irrigation extent and irrigation type with global scope at a 100-metre resolution. This dataset would have broad applicability for agricultural, economic and other analyses at global and more localised levels.

The authors make an attempt at providing this dataset at such a refined resolution, however there are some fundamental issues that need to be addressed before it could actually deliver what the authors promise in the article. I believe currently the authors give a flawed sense of accuracy in their estimates of irrigated and non-irrigated land. In its current form I do not recommend this manuscript/dataset be accepted for publication in ESSD.

1. Areas and cropland definition: This dataset/manuscript needs better clarification of what areas of irrigated and non-irrigated land are included. For instance the title suggests the dataset is global, implying all irrigated and non-irrigated land are included. In the abstract they state ‘In our study, we present a robust methodology that leverages irrigation performance during drought stress as an indicator of crop productivity and water consumption to identify global irrigated cropland.’ The latter implies it includes only cropland. Cropland has different definitions to different authors (see Tubiello et al 2023: <https://www.nature.com/articles/s43016-022-00667-9>) and can be very tricky to differentiate properly. In section 2.3 the authors state they use the JECAM definition of cropland which includes land used for seasonal crops (sowed/planted and harvested at least once within the 12 months) such as cereals, root and tuber crops, oil crops as well as economically significant crops like sugar, vegetables, and cotton. Additionally land occupied by greenhouses was considered as cropland. Greenhouses in cropland is a strange inclusion and needs explaining.

Response: Thanks for your comments. According to different definition, greenhouses belong to different class. But greenhouse is often considered part of arable land, especially in facility agriculture. They provide a controlled environment for growing a wide range of crops, thus extending the functions of traditional arable land. Greenhouses allow farmers to grow crops in areas or seasons that may not be suitable for open-air cultivation, optimizing crop growth by controlling conditions such as temperature, humidity and light. In the classification system of ChinaCover and Globalland 30, Green house was included in Cropland.

Because we used Synthesized cropland mask from ChinaCover in China, so the greenhouse was recognized as cropland in this research.

2. The authors then go on to say they used “The cropland mask at 30- meter resolution could be obtained from International Research Center of Big Data for Sustainable Development goals via https://data.casearth.cn/thematic/cbas_2022/158”. They state the overall accuracy of this dataset is 89.4%, but when I look at maps from these data it appears as though they include a lot of non-cropland area esp. pasture and meadow land (see Fig 1 below). I therefore do not have confidence that this dataset is suitable for supporting the authors assertion that their dataset has 100 metre resolution.

Response: Thanks for your comments. The data was at 30 meter resolution. You could view it online via http://desp.casearth.cn/data-preview/?id=GCL30_2020&lang=en or download it via <https://data.casearth.cn/en/sdo/detail/62ff50e208415d271ab1b84a>.

We are sure that the accuracy of this basically acceptable. Because this data integrated 10 existing land cover maps or cropland datasets to delimit the global cropland extent while masking out irrelevant non-cropland pixels for the period of 2016–2018 (Figure 1). More detailed information on these land cover and cropland layer products as well as their classes used in the integration refer to (Zhang et al., 2021). Although variations in classification systems among different products exist, a subset of classes of those land cover and cropland layer products were selected to best fit into the cropland definition. Spatially, FROM-GLC was selected for Europe, Africa, New Zealand, the majority of Asia, and part of Latin America. GFSAD30 was selected for tropical Asian islands, including Indonesia, Malaysia, and the Philippines. In addition to these two global-coverage cropland extent products, several national or regional datasets, including ChinaCover, CDL, AAFC ACI, NLCD, MapBiomass, CLUM, SERVIR, and INTA, were used because they have been extensively validated by local experts and hence exhibited high accuracies of cropland mapping.

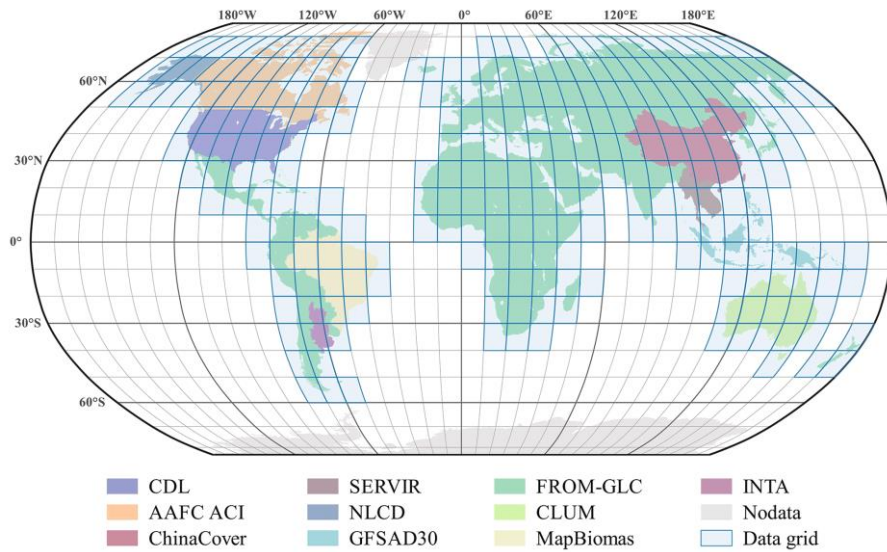


Figure 1 Spatial distribution of the land cover/cropland layer products used for the global 30-m cropland (Zhang et.al 2021 ESSD)

Zhang, M., Wu, B., Zeng, H., He, G., Liu, C., Tao, S., Zhang, Q., Nabil, M., Tian, F., Bofana, J., Beyene, A. N., Elnashar, A., Yan, N., Wang, Z., and Liu, Y.: GCI30: a global dataset of 30;m cropping intensity using multisource remote sensing imagery, *Earth Syst. Sci. Data*, 13, 4799-4817, 10.5194/essd-13-4799-2021, 2021.



Figure 1: Screenshot of casearth.cn dataset.

- Furthermore, the title of this manuscript implies this dataset is for ‘maximum irrigation extent’ i.e. all irrigation. They assess centre pivot irrigation, but it is not clear if the authors include lateral irrigators which is much the same technology as centre pivot, only it could be harder to distinguish lateral irrigation due to the patterns of NDVI (see figure 12).

Response: We didn’t include lateral irrigation. The identification was rely on the circle shape in the satellite data. But the lateral irrigation didn’t show this feature. But in the

maximum irrigation extent we include all the irrigation types that could mitigate water stress.

4. Finally, as per section 2.1 the research relied on evapotranspiration data at a 500 m resolution. Shouldn't the authors state that the resolution of their irrigation dataset is equivalent to the lowest resolution of their input data? Otherwise you are giving a false sense of accuracy.

Response: Thanks for your comments. The evapotranspiration, precipitation product with 500 meter resolution was used to determine the driest months within each IMZ. And the time period was used to detect irrigation performance and detect irrigated cropland. In each IMZ, 30meter NDVI data was used as major input. Then to avoid effect fallow land and crop rotation, we calculate the irrigation proportion within 100meters.

5. Given the above uncertainties in cropland categorisation I suggest the authors use a definition of cropland that aligns to something like that used by the FAO. This will improve the applicability of the dataset.

Response: Thanks for your valuable comments. The crop land definition from FAO was "Cropland is land used for the cultivation of crops, both temporary (annuals) and permanent (perennials), and may include areas periodically left fallow or used as temporary pasture." Actually, we just focus temporary cropland because this was food producing crop type. The permanent crops were usually for fruit trees, nut trees, coffee, tea, and some types of vines, which is recognized as shrub or tree in most landcover system such as ESRI, FROM-GLC, GLAD-Map, GLC-FCS30 and WORDCOER. On the contrary, harvest crops, maize, soybean, wheat, and rice was most important feeding crops. So, we choose this definition to distinguish irrigated and rainfed cropland.

CROPLAND MAP	MAPPED CATEGORY AND OPERATIONAL DEFINITIONS
ESRI ²	Crops. Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.
FROM-GLC ³	Croplands. Land that has clear traits of intensive human activity. It varies a lot from bare field, seeding, crop growing to harvesting. It includes arable and tillage land with herbaceous/shrub crops and land with plastic foam or grass roof protection with distinguishing spectral properties. Fruit trees are classified into forests.
GLAD_Map ¹	Cropland. Land used for annual and perennial herbaceous crops for human consumption, forage (including hay) and biofuel. Perennial woody crops, permanent pastures and shifting cultivation are excluded.
GLC-FCS30 ⁴	Cropland. Rainfed and irrigated cropland. Detailed (Level 2) data on herbaceous cover. In this analysis, we excluded detailed data on Tree or shrub cover for better comparison with other layers.
GLOBELAND30 ⁵	Cropland. Category includes paddy fields, irrigated dry land, rain-fed dry land, vegetable land, pasture planting land, greenhouse land, land mainly for planting crops with fruit trees and other economic trees, as well as tea gardens, coffee gardens and other shrubs.
WORLDCOVER ⁶	Cropland. Land covered with annual cropland that is sowed/planted and harvestable at least once within the 12 months after the sowing/planting date. The annual cropland produces an herbaceous cover and is sometimes combined with some tree or woody vegetation. Note that perennial woody crops will be classified as the appropriate tree cover or shrub land cover type. Greenhouses are considered as built-up.

Figure 2 Definition of Cropland in mainstream landcover according to Tubiello et.al 2023

Tubiello F N, Conchedda G, Casse L, et al. Measuring the world’s cropland area[J]. Nature Food, 2023, 4(1): 30-32.

- This manuscript needs to be edited heavily before it is resubmitted. I made a note of some of these edits in minor comments in the first few pages. Note, the list I provide is not exhaustive as there were many other changes to make.

Response: Thanks for your valuable comments. We have carefully checked and polished our MS and the certification is shown as below:



Editing Certificate

This document certifies that the manuscript

GMIE-100: A global maximum irrigation extent and irrigation type dataset derived via irrigation performance during drought stress and machine learning methods

prepared by the authors

Fuyou Tian, Bingfang Wu, Hongwei Zeng, Miao Zhang, Weiwei Zhu, Nana Yan, Yuming Lu Yifan Li

was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified native English speaking editors at AJE.

This certificate was issued on **March 20, 2024** and may be verified on the [AJE website](#) using the verification code **43DF-D3A8-CFB3-00BF-59DP**.



Neither the research content nor the authors' intentions were altered in any way during the editing process. Documents receiving this certification should be English-ready for publication; however, the author has the ability to accept or reject our suggestions and changes. To verify the final AJE edited version, please visit our verification page at [aje.com/certificate](#). If you have any questions or concerns about this edited document, please contact AJE at support@aje.com.

AJE provides a range of editing, translation, and manuscript services for researchers and publishers around the world. For more information about our company, services, and partner discounts, please visit [aje.com](#).

7. Lines 134-140. A better plain language description of how irrigated and non-irrigated land was categorised is needed.

Response: Thanks for your valuable comments. Inspired from purpose of irrigation, what is to mitigate the effect of water stress. Basically, we assume that water stress can be regular or irregular. If there is crops during dry season, the irrigation should occurs regular. Otherwise, irrigation is just complementary to rainfall in extremely dry year, which means irrigation is irregular. For regular irrigation, we could detect vegetation signal in the dry season (DM-NDVI) when precipitation couldn't meet water demand for crops. For irregular irrigation, we compare the NDVI in extremely dry year with 10-year average level and calculate the deviation($NDVI_{dev}$) to determine whether it is irrigated or not. To determine whether, it is region with regular or irregular irrigation, we used both of these two indicators and choose the method get higher accuracy.

We have change the explanation in the body text.

8. Section 3.4. The uncertainty in estimates of cropland used in the authors models needs to be better explained. Differences in classification of 'cropland' for instance can contribute to variation in estimates in irrigated cropland mentioned in section 3.1.

Response: Thanks for your valuable comments. We have include this uncertainty in the discussion part.

“The crop land definition from FAO was “Cropland is land used for the cultivation of

crops, both temporary (annuals) and permanent (perennials), and may include areas periodically left fallow or used as temporary pasture.” Actually, we just focus temporary cropland because this was food producing crop type. The permanent crops were usually for fruit trees, nut trees, coffee, tea, and some types of vines, which is recognized as shrub or tree in most landcover system such as ChinaCover. On the contrary, harvest crops, maize, soybean, wheat, and rice was most important feeding crops. These may lead to uncertainty for some extent”

Also, we add uncertainty assessment of irrigated cropland area estimation. We change the absolute value to confidence level of 403.17 ± 9.82 Mha

Minor comments

1. Abstract 1st line 11. “primary sector of human water...”; Use other word than sector such as form.

Response: Thanks for your valuable comments, we changed the sentence to *“Irrigation accounts for the major form of human water consumption and plays a pivotal role in enhancing crop yields and mitigating drought effects.”*

2. Line 26: What is the DL method? Define when you first use an abbreviation.

Response: Thanks for your detail comments, DL means deep learning method, we change this sentence to “Furthermore, with the help of the deep learning (DL) method, the global central pivot irrigation system (CPIS) was identified using Pivot-Net”

3. Line 27: What is Pivot-Net?

Response: Thanks for your detail comments, It means a novel convolutional neural network based on U-net. We added it in the text.

4. Line 29: “The GMIE-100 dataset containing both or irrigated extent...”. What does the both relate to?

Response: Thanks for your detail comments. It should be “The GMIE-100 dataset containing both the irrigated extent and CPIS distribution”

5. Line 40 use reference to back up claim that highest resolution maps are 500m to 10km.

Response: Thanks for your detail comments, we have add three reference for this sentence.

6. Line 60 use space between croplands and (Thenkabail et al 2009)

Response: Thanks for your detail comments. We have change it accordingly.

7. Line 106. Use reference to back up claim of 80% efficiency.

Response: Thanks for your detail comments, We have added the citation.

8. Throughout references and tables, make sure abbreviations are defined esp in title of Figure 1 and 2.

Response: Thanks for your detail comments. We have added all the abbreviation in the tile.

9. Line 175. What is GVG?

Response: Thanks for your detail comments. GVG (GPS, Video, GIS) application serves as a comprehensive field data collection system that integrates GPS for precise positioning, a video for capturing geo-tagged photographs, and a GIS system for managing geographic information. You could download it via <https://gvgserver.cropwatch.com.cn/download> . We added this information in the body text.

10. Line 251. Spelling mistakes in Nirrgated and Nnon-irrgated.

Response: Thanks for your detail comments, we have corrected it.

11. Line 268. Spelling mistake exemple.

Response: Thanks for your detail comments, we have corrected it.

12. Line 377: belt_Mexican coastal plain. Error.

Response: Thanks for your detail comments, we have corrected it.

13. Line 469-471: How does looking at if an area of land has been cultivated during the driest month over a span of three year help determine if it is irrigated land? What if the cultivation occurs in one of the regular wet seasons of the year but irrigated is still needed thereafter?

Response: Thanks for your comments. In the first case it should be irrigated. As for the second case, if the cultivation occurs in one of the regular wet seasons of the year but irrigated is still needed thereafter, we need to see whether water could meet crop requirement in another growing season. If there is a regular water stress in thereafter growing season, it is region with regular irrigation. Otherwise, it is region needs irrigation occasionally.