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.

Response: Thanks for your overall comments. As we all know, irrigation is important for food producing and water resource management. But the updated and high-resolution irrigation dataset is still rare. We believe this dataset will promote the understanding of global irrigation distribution and support the related application.

The most concerned points, as you mentioned, was the cropland extent. Actually, we already used almost the state-of-art landcover for each region to synthesized a global cropland mask. **These data have been utilized for their extensive validation by local experts, usually leading to their high precision in mapping cropland.** The cropland mask used in this research integrated more than 10 cropland dataset including global cropland product: FROM-GLC, GFSAD30 as well as National and regional data sets, such as ChinaCover (Wu et al., 2017; Wu et al., 2024), Cropland Data Layers (Boryan et al., 2011), Agriculture and Agri-Food Canada Annual Crop Inventory (Fisette et al., 2013; Mcnairn et al., 2009), MapBiomass (Do Canto et al., 2020) et.al. Please see the detail reply below.

Q1. 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. 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.

We agree with you that the cropland mask have crucial effect for the final result. Due to lack of high-resolution and consistent cropland data layer, we used synthesized data layer to depict the cropland extent. This data integrated more than 10 cropland dataset including global cropland product: FROM-GLC, GFSAD30 as well as National and regional data sets, such as ChinaCover (Wu et al., 2024; Wu et al., 2017), Cropland Data Layers (Boryan, Yang, Mueller, & Craig, 2011), Agriculture and Agri-Food Canada Annual Crop Inventory (Fisette et al., 2013; McNairn, Champagne, Shang, Holmstrom, & Reichert, 2009), MapBiomass (do Canto et al., 2020) et.al for the period of 2016–2018. **These data have been utilized for their extensive validation by local experts, usually leading to a high precision in mapping cropland (Wu et al., 2023).**

The detail information for the source of cropland mask was listed in Table S1 and Figure S1. 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 (Figure S1). 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.

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 (Table S1).

The data was at 30 meter resolution, which can be viewed online via http://desp.casearth.cn/data-preview/?id=GCL30_2020&lang=en or downloaded via https://data.casearth.cn/en/sdo/detail/62ff50e208415d271ab1b84a.This data was present to United Nations on behalf of the Chinese government by Wang Yi, Foreign Minister of China (https://www.mfa.gov.cn/eng/zxxx_662805/202209/t20220922_10769737.html). We are sure that the accuracy of this synthesized cropland mask was basically acceptable. This data was used for supporting crop intensity mapping (Zhang et al., 2021).

According to different classification system, greenhouses belong to different class. But greenhouse is often considered part of arable land, especially in facility agriculture. 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 (Wu et al., 2024; Wu et al., 2017) and Globalland 30 (Chen et al., 2015), 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.

The following text has been added:

Line 258-234:

This data integrated more than 10 cropland dataset including global cropland product: FROM-GLC, GFSAD30 as well as National and regional data sets, such as ChinaCover (Wu et al., 2017; Wu et al., 2024), Cropland Data Layers (Boryan et al., 2011), Agriculture and Agri-Food Canada Annual Crop Inventory (Fisette et al., 2013; Mcnairn et al., 2009), MapBiomass (Do Canto et al., 2020) et.al. More information about this cropland mask can be found in supplementary. These data have been utilized for their extensive validation by local experts, leading to their high precision in mapping cropland (Wu et al., 2023a)

Line 550-557:

Actually, we just focus on seasonal cropland, because 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 (Karra et al., 2021), FROM-GLC (Yu et al., 2013), GLAD_Map (Potapov et al., 2022), GLC-FCS30 (Zhang et al., 2021b) and WORDCOER (Zanaga et al., 2022). On the contrary, harvest crops, maize, soybean, wheat, and rice was most important for food security. So, we choose this definition to distinguish irrigated and rainfed cropland, rather than the definition from FAO's. Different definition of crop as input data may produce varied irrigated cropland area, which will definitely introduce uncertainty in the final result. A consistent, high resolution cropland mask with high accuracy is urgently needed to solve this problem.

We provided this explanation in the supplementary materials to clarify the reliability of this cropland Mask.

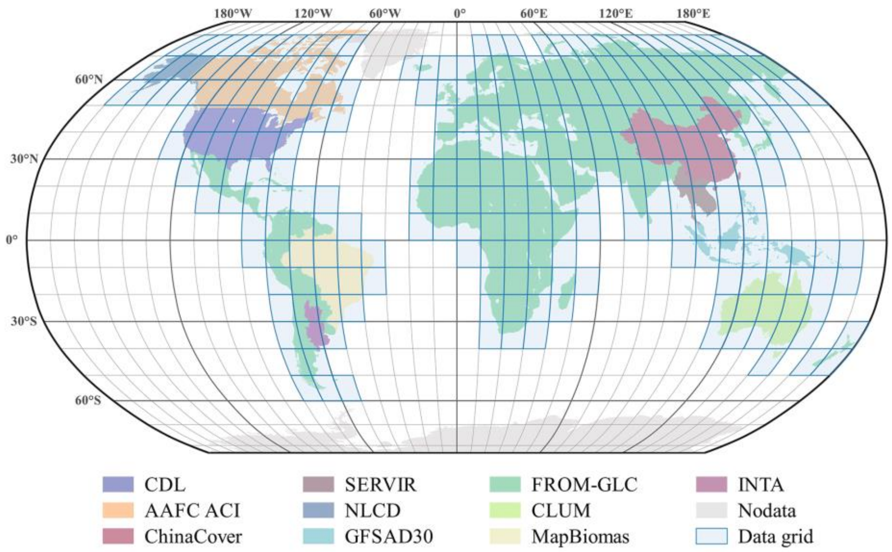


Figure S1 Spatial distribution of the land cover/cropland layer products used for the global 30-m cropland (Zhang et.al 2021 ESSD)

Table S1. Cropland and land cover datasets used for the study

Region	Dataset name	Year	Selected classes	Resolution	Accuracy	Reference
Argentina	Crop type map	2018-19		30	81%	Abelleyra et al, 2019(de Abelleyra Diego, 2019)
Australia	Catchment Scale Land Use of Australia	2018	Cropping, Seasonal horticulture, Irrigated cropping, and Irrigated seasonal horticulture	50	0.92%	ABARES, 2016
Brazil	MapBiomas			30		Project MapBiomas, 2019*
Bhutan	Land cover data of Bhutan	2010	Agriculture	30		ICIMOD, 2011
Canada	Canada AAFC Annual Crop Inventory data	2009	Seasonal crops and greenhouse	30	85%	(McNairn, H,2009) (McNairn et al., 2009)
China	ChinaCover	2015	Upland and rice field	30	86%	Wu et al., 2017
Mozambique	ChinaCover	2018		10	85%	Bofana et al., 2020
Nepal	National landcover for Nepal	2010	Agriculture area	30		Uddin et al., 2015(Uddin et al., 2015)
New Zealand	New Zealand Land Cover	2012	Short-rotation cropland	30		NZLRI, 2015
United States	CDL	2009	Class 1~56 and Class 225~254	30	85%-95%	Boryan, C.,et al. 2011
Zambia	ChinaCover	2018		10	0.87	Bofana et al., 2020
Zimbabwe	ChinaCover	2018		10	0.86	Bofana et al., 2020
Europe	CORINE land cover	2018				Büttner, et al., 2017(Büttner, Kosztra, Soukup, Sousa, & Langanke, 2017)
Central Asia	CA Landcover	2015		30		CASEarth
Africa	FROM-GLC-Africa30	2015				Feng et al., 2018
Lower Mekong	SERVIR-Mekong Land Cover	2018	Cropland and Rice	30	0.94	Saah et al., 2020(Saah et al., 2020)
Global	FORM-GLC 2015	2015		30		**
Global	GFSAD30	2015		30		***
*	https://plataforma.mapbiomas.org/map#coverage					

**	http://www.chinageoss.org/tansat/pdf/FROM-GLC.pdf
***	https://lpdaac.usgs.gov/news/release-of-gfsad-30-meter-cropland-extent-products/

Boryan, C., Yang, Z., Mueller, R., & Craig, M. (2011). Monitoring US agriculture: the US department of agriculture, national agricultural statistics service, cropland data layer program. *Geocarto International, 26*(5), 341-358.

Büttner, G., Kosztra, B., Soukup, T., Sousa, A., & Langanke, T. (2017). CLC2018 technical guidelines. *European Environment Agency, Wien*.

Chen, J., Chen, J., Liao, A., Cao, X., Chen, L., Chen, X., . . . Lu, M. (2015). Global land cover mapping at 30 m resolution: A POK-based operational approach. *ISPRS Journal of Photogrammetry and Remote Sensing, 103*, 7-27.

de Abelleyra Diego, B. S., Verón Santiago, Mosciaro Jesús, Volante José,. (2019). Mapa Nacional de Cultivos campaña 2018/2019. Retrieved from https://inta.gob.ar/sites/default/files/mapa_nacional_de_cultivos_campana_2018_2019.pdf

do Canto, A. C. B., Marques, R., Leite, F. F. G. D., da SILVEIRA, J., DONAGEMMA, G., & RODRIGUES, R. (2020). *Land use and cover maps for Mato Grosso from 1985 to 2019*.

Fisette, T., Rollin, P., Aly, Z., Campbell, L., Daneshfar, B., Filyer, P., . . . Jarvis, I. (2013). *AAFC annual crop inventory.* Paper presented at the 2013 Second International Conference on Agro-Geoinformatics (Agro-Geoinformatics).

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-Scale Geospatial Analysis for Everyone. *Remote Sensing of Environment, 202*, 18-27.

McNairn, H., Champagne, C., Shang, J., Holmstrom, D., & Reichert, G. (2009). Integration of optical and Synthetic Aperture Radar (SAR) imagery for delivering operational annual crop inventories. *ISPRS Journal of Photogrammetry and Remote Sensing, 64*(5), 434-449. doi:10.1016/j.isprsjprs.2008.07.006

Saah, D., Tenneson, K., Poortinga, A., Nguyen, Q., Chishtie, F., San Aung, K., . . . Cutter, P. (2020). Primitives as building blocks for constructing land cover maps. *International Journal of Applied Earth Observation and Geoinformation, 85*, 101979.

Tubiello, F. N., Conchedda, G., Casse, L., Pengyu, H., Zhongxin, C., De Santis, G., . . . Muchoney, D. (2023). Measuring the world's cropland area. *Nature Food, 4*(1), 30-32.

Uddin, K., Shrestha, H. L., Murthy, M., Bajracharya, B., Shrestha, B., Gilani, H., . . . Dangol, B. (2015). Development of 2010 national land cover database for the Nepal. *Journal of Environmental Management, 148*, 82-90.

Wu, B., Fu, Z., Fu, B., Yan, C., Zeng, H., & Zhao, W. (2024). Dynamics of land cover changes and driving forces in China's drylands since the 1970 s. *Land Use Policy,*

140, 107097. doi:10.1016/j.landusepol.2024.107097
Wu, B., Qian, J., Zeng, Y., Zhang, L., Yan, C., Wang, Z., . . . Huang, J. (2017). Land Cover Atlas of the People's Republic of China (1: 1 000 000). *Science Bulletin, 65*, 1125-1136.
Wu, B., Tian, F., Nabil, M., Bofana, J., Lu, Y., Elnashar, A., . . . Zhu, W. (2023). Mapping global maximum irrigation extent at 30m resolution using the irrigation performances under drought stress. *Global Environmental Change, 79*, 102652. doi:10.1016/j.gloenvcha.2023.102652
Zhang, M., Wu, B., Zeng, H., He, G., Liu, C., Tao, S., . . . Liu, Y. (2021). GCI30: a global dataset of 30 m cropping intensity using multisource remote sensing imagery. *Earth Syst. Sci. Data, 13*(10), 4799-4817. doi:10.5194/essd-13-4799-2021

Q2. 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: The identification was relied on the circle shape in the satellite data. So, we didn't include lateral irrigation. 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.

The following text has been added:

Line 522-524:
However, this study didn't include the lateral irrigation, because the identification of irrigation method was relied on the circle shape in the satellite data and the lateral irrigation didn't show this feature. In the maximum irrigation extent, we include all the irrigation types that could mitigate water stress.

Q3. 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 100 meters.

The following text has been added:

Line 500-503:
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, 30-meter NDVI data was used as major input. Then to avoid effect fallow land and crop rotation, we calculate the irrigation proportion within 100 meters.

Q4. 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. As mentioned by Francesco et.al in *Measuring Measuring the world’s cropland area* (Tubiello et al., 2023), the cropland mask in most remote sensing products were more closer to the definition of ***arable cropland*** from FAO. He also recommended to use the correct FAO terminology to avoid confusion. The permanent crops are a FAO sub-category that is likely to be classified as grassland, rather than cropland, in most remote sensing products.

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.

The following text has been added:

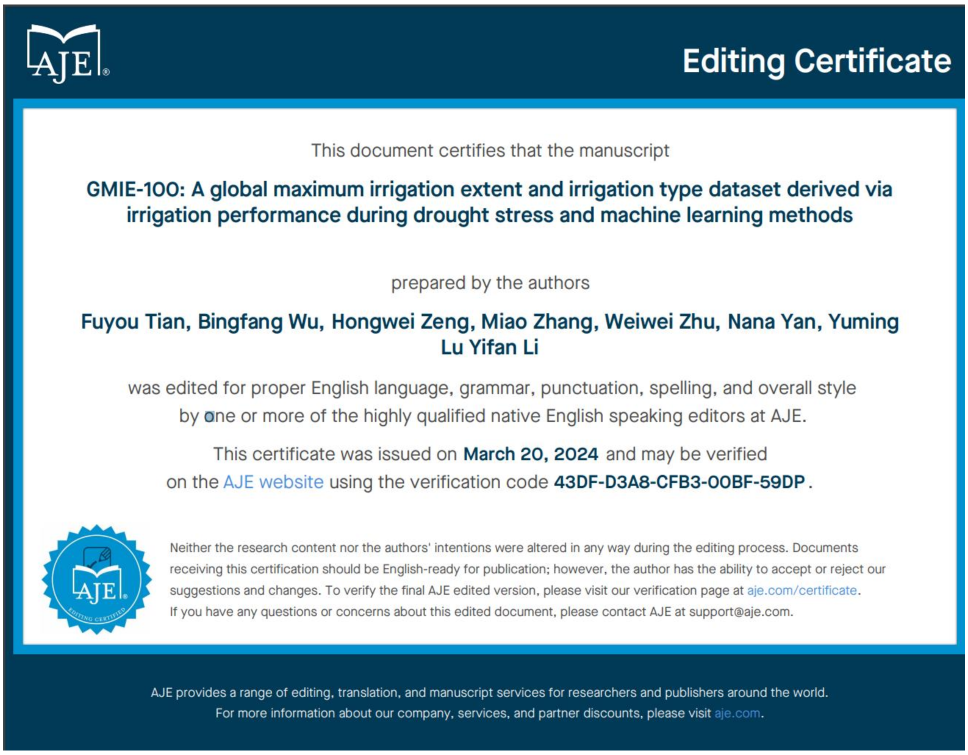
Line 550-557：

Actually, we just focus on seasonal cropland, because 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 (Karra et al., 2021), FROM-GLC (Yu et al., 2013), GLAD_Map (Potapov et al., 2022), GLC-FCS30 (Zhang et al., 2021b) and WORDCOER (Zanaga et al., 2022). On the contrary, harvest crops, maize, soybean, wheat, and rice was most important for food security. So, we choose this definition to distinguish irrigated and rainfed cropland, rather than the definition from FAO's. Different definition of crop as input data may produce varied irrigated cropland area, which will definitely introduce uncertainty in the final result. A consistent, high resolution cropland mask with high accuracy is urgently needed to solve this problem.*

Q5. 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. The polish certification from AJE 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.

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Q6. 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 are crops during dry season, the irrigation should occur 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.

The following text has been added:

Lin 134-140:

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 are crops during dry season, the irrigation should occur 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.

Q7. 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.

The cropland masks had the greatest influence on the GMIE-100 dataset. Different definition of crop as input data may produce varied irrigated cropland area, which will definitely introduce uncertainty in the final result. A consistent, high resolution cropland mask with high accuracy is urgently needed to solve this problem."

The following text has been added:

Line 542-557:

"*The cropland masks had the greatest influence on the GMIE-100 dataset (Salmon et al., 2015; Meier et al., 2018), despite the selection of 16 distinct cropland datasets derived from country- and region-level sources as high-priority inputs. These datasets often exhibit disparities in estimating the distribution of cropland, particularly in African countries, due to the complex landscape, frequent cloud cover, and the presence of small agricultural fields (Nabil et al., 2020). Consequently, inaccuracies within the cropland datasets were transposed onto the GMIE-100 dataset. Nevertheless, importantly, these datasets remain the primary sources of cost-effective and up-to-date information covering vast geographical areas. Actually, we just focus on seasonal cropland, because 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 (Karra et al., 2021), FROM-GLC (Yu et al., 2013), GLAD_Map (Potapov et al., 2022), GLC-FCS30 (Zhang et al., 2021b) and WORDCOER (Zanaga et al., 2022). On the contrary, harvest crops, maize, soybean, wheat, and rice was most important for food security. So, we choose this definition to distinguish irrigated and rainfed cropland, rather than the definition from FAO's. Different definition of crop as input data may produce varied irrigated cropland area, which will definitely introduce uncertainty in the final result. A consistent, high resolution cropland mask with high accuracy is urgently needed to solve this problem.*"

We also evaluate the uncertainty of total area estimation. The total area of GMIE is estimated as 403.17±9.82Mha, accounting for 23.4%±0.6% of the global cropland. We change all the statement across the whole text.

Minor comments

Q1. 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 in line 11-12:

"Irrigation accounts for the major form of human water consumption and plays a pivotal role in enhancing crop yields and mitigating drought effects.".

Q2. 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 in Lin 25-26:

"*Furthermore, with the help of the deep learning (DL) method, the global central pivot irrigation system (CPIS) was identified using Pivot-Net, a novel convolutional neural network based on U-net.*"

Q3. 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 in Lin 25-27:

"*Furthermore, with the help of the deep learning (DL) method, the global central pivot irrigation system (CPIS) was identified using Pivot-Net, a novel convolutional neural network based on U-net.*"

Q4. Line 29: "The GMIE-100 dataset containing both or irrigated extent…". What does the both relate to?

Response: Thanks for your detail comments.

We have corrected it in Line 30:

"*The GMIE-100 dataset containing both the irrigated extent and CPIS distribution*"

Q5. Line 40 use reference to back up claim that highest resolution maps are 500m to 10km.

Response: Thanks for your detail comments, we have added three references for this sentence.

Line 38-40:

However, the highest available resolution for existing irrigation maps remains within a range of 500 metres to 10 kilometres (Nagaraj, Proust, Todeschini, Rulli, & D'Odorico, 2021; Siebert et al., 2005; Siebert, Henrich, Frenken, & Burke, 2013).

Q6. Line 60 use space between croplands and (Thenkabail et al 2009)

Response: Thanks for your detail comments. We have change it accordingly and check all this kind of error through the whole MS.

Q7. Line 106. Use reference to back up claim of 80% efficiency.

Response: Thanks for your detail comments.

We have added the citation in Line 107:

Furthermore, considerable variations in irrigation efficiency are apparent among different irrigation types, with central pivot irrigation systems (CPISs), which have an efficiency rate exceeding 80%, emerging as the predominant global sprinkler irrigation method (Tian et al., 2023)

Q8. Throughout references and tables, make sure abbreviations are defined in title of Figure 1 and 2.

Response: Thanks for your detail comments.

We have added all the abbreviation in the tile.

Line 130:

Figure 1 Samples of irrigated, rainfed and central pivot irrigation system (CPIS) from multiple sources and mapping units for irrigation mapping and CPIS identification. GVG means GPS, Video, GIS system for collecting field data. VHR means very high resolution. IMZs means Irrigation mapping zones.

Line 146:

Figure 2 Flow chart of GMIE-100 with a typical irrigation type of CPIS. GVG means GPS, Video, GIS system for collecting field data. VHR means very high resolution. IMZs means Irrigation mapping zones. NDVIdev : NDVI deviation in extremely dry year with 10-year average level. DM-NDVI: NDVI in the dry season.

Line 430:

Figure 12 Accuracy for countries with GVG (GPS, Video, GIS) irrigation validation points

Q9. 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 more explain in Line 181-184:

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.

Q10. Line 251. Spelling mistakes in Nirrgated and Nnon-irrgated.

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

Q11. Line 268. Spelling mistake exemple.

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

Q12. Line 377: belt_Mexican coastal plain. Error.

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

Q13. 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.

RC2

This study demonstrated a global irrigation dataset with 100 meters using irrigation performance during drought stress, which is a brand-new way to detect irrigated and non-irrigated cropland. Furthermore, this MS finishes mapping the global central pivot irrigation system using the Deep Learning method. Also, it is interesting to detect special irrigation methods using deep learning methods. Overall, the MS was well-written and designed for readers. But there were still some concerns before this MS was accepted:

Response: Thanks for your positive comments.

Major concerns:

Q1. About the resolution: In section 2.1 some coarse data was described as input data, but the final resolution of the irrigation map is 100 meters, so this will mislead some readers on how to produce a 100-meter irrigation map using 500-meter data.

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, 30-meter NDVI data was used as major input. Then to avoid effect fallow land and crop rotation, we calculate the irrigation proportion within 100 meters.

We also added this statement in the body text.

Line 500-503:

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, 30-meter NDVI data was used as major input. Then to avoid effect fallow land and crop rotation, we calculate the irrigation proportion within 100 meters.

Q2. About the IMZs: You mention that "65 MRUS in Cropwatch served as the basis for further division of global cropland into 110 irrigation mapping zones (IMZs)", what is the principle for further dividing these zones? Are these zones available or not?

Response: Thanks for your comments.

We further divided 65 zones into 110 based on arid indices, water availability, soil types, and landforms. This data is publicly available on the CropWatch website or you can contact us via email. We added it in available data source.

Line 597:

The irrigation unit zone can be downloaded from http://cloud.cropwatch.com.cn/

Q3. About accuracy assessment: you collect many field points using the GVG app. How to distinguish irrigation field points during the field survey?

Response: Thanks for your constructive suggestions.

Although it is not easy to identify irrigated cropland on satellite data, irrigation cropland could be identified accurate in field according to irrigation infrastructure, crop type and crop health condition. Even you cannot distinguish them following above characteristics, you could ask local farmer, who will answer this question with hesitate.

- Irrigation infrastructure, some obvious feature was easy to identify, such as canner, irrigation plump and central pivot irrigation system. We display serval photos for this case as below:

	
Irrigation cannel in Xinjiang	Drip irrigation in Hebei province
	
Irrigation pump	Central pivot irrigation system

- Usually, irrigated was applied for certain crop types, such as winter wheat in North China Plain, Cotton in Xinjiang and vegetable and tomatoes in most province, et.al.
- Last but not least, irrigated crops usually appear greener and lush compared with near crops.

We added this in the GVG data description in Line 186-189:

Also, irrigated was applied for certain crop types, such as winter wheat in North China Plain, Cotton in Xinjiang and vegetable and tomatoes in most province, et.al. Meanwhile, irrigated crops usually appear greener and lush compared with near crops. Even it cannot be distinguished following above characteristics, the injury of local farmer could give the answer.

We also include above information in the supplementary materials.

Q4. The irrigation map and GCPIS were identified using two ways (irrigation performance and DL), but some figures make me confused to display these two results.

Response: Thanks for your valuable comments.

The irrigation map was identified using irrigation performance while the irrigation method, specifically for central pivot irrigation system, was identified using DL method. As for the figures we have changed the display manner in the MS for Figure1, 6, 16.

Please see the following response in detail.

Minor revision:

Q1. The preprocess of NDVI data in Line 160 should be further explained.

Response: Thanks for your suggestion.

We added more explanations in the text to describe the preprocessing to NDVI data.

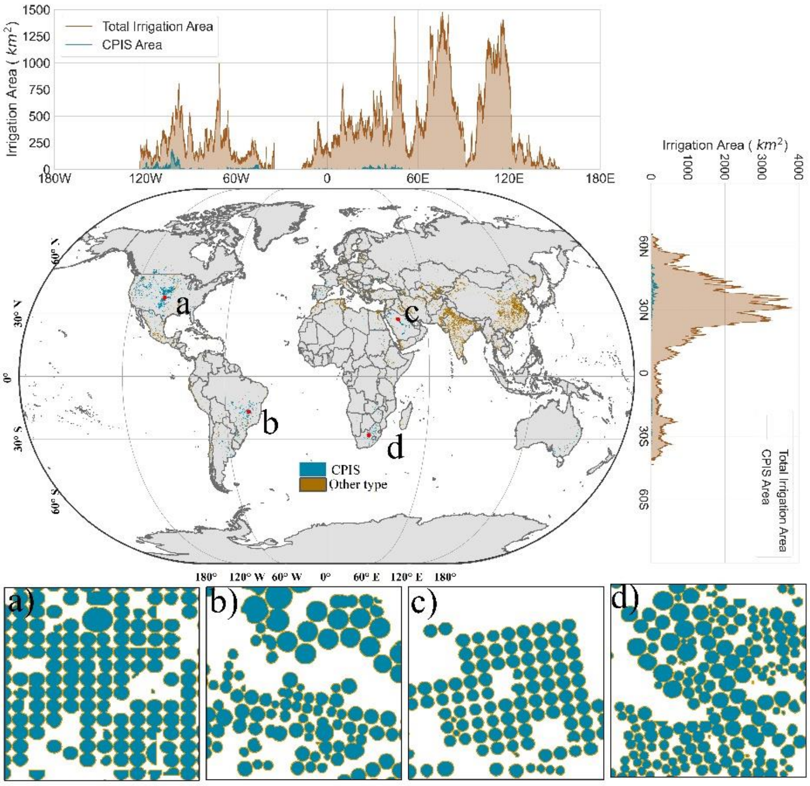
Line 165-166:

The 30-metre spatial resolution NDVI data from the Landsat sensors Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Thermal Infrared Sensor (OLI-TIRS) onboard Landsat-5, Landsat-7, and Landsat-8, respectively, were utilized in Google Earth Engine (GEE) (Gorelick et al., 2017) to differentiate irrigated and nonirrigated areas across various IMZs during a specific period. The NDVI data was masked using the cloud and water mask in the flag file and rescaled into the same range between -1 and 1.

Q2. You could list some detailed maps of global CPIS in Figure 6 to make the global CPIS map clearer.

Response: Thanks for your suggestion.

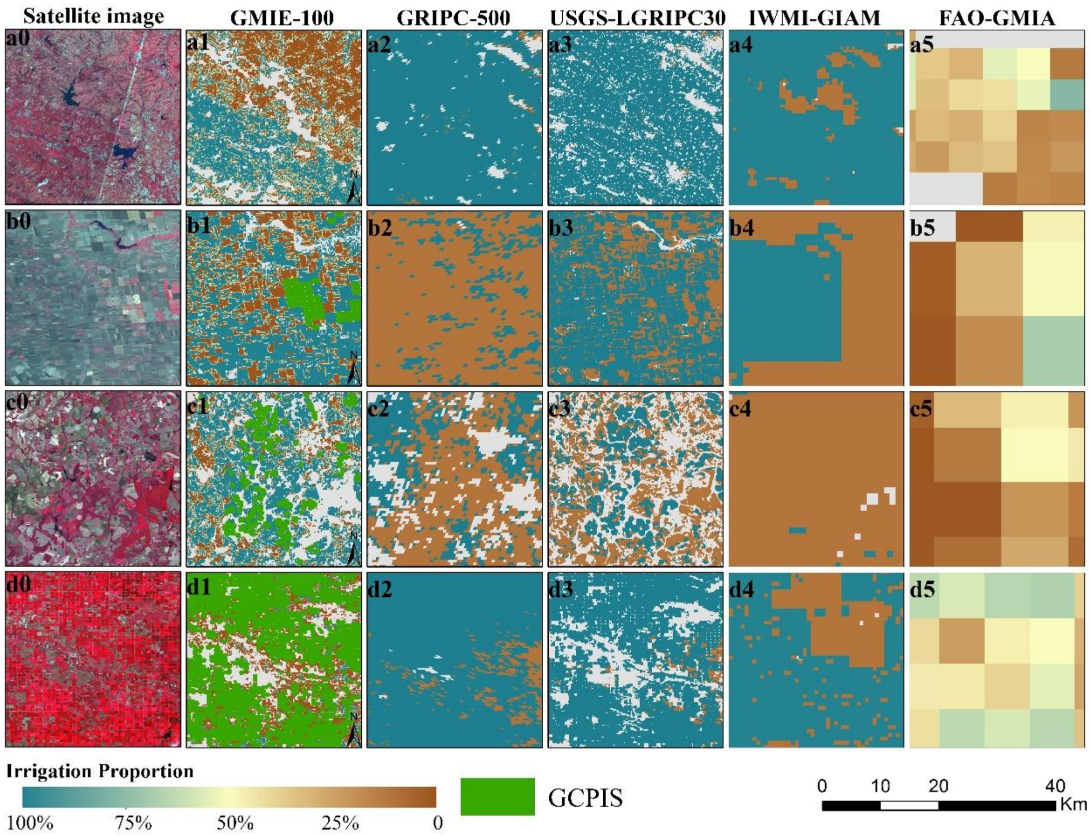
We added the detail map of CPIS in Figure6. Figure b-d are the detail map of CPIS. The location of each sub figure was labelled in the main global map.



Q3. In Figure 16 it will be significant if the satellite images were added to give the reader a basis for their judgment.

Response: Thanks for your suggestion.

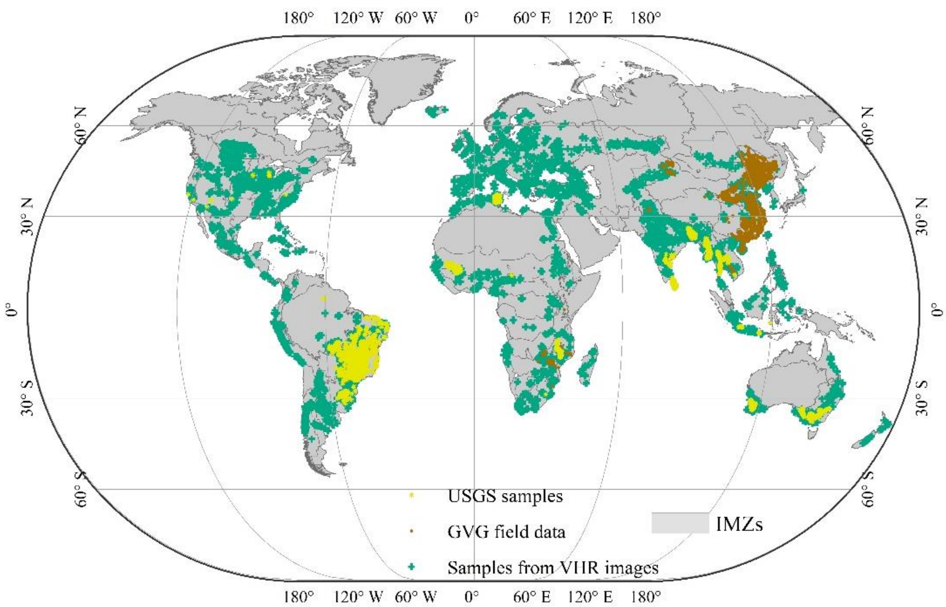
We have revised the figure accordingly.

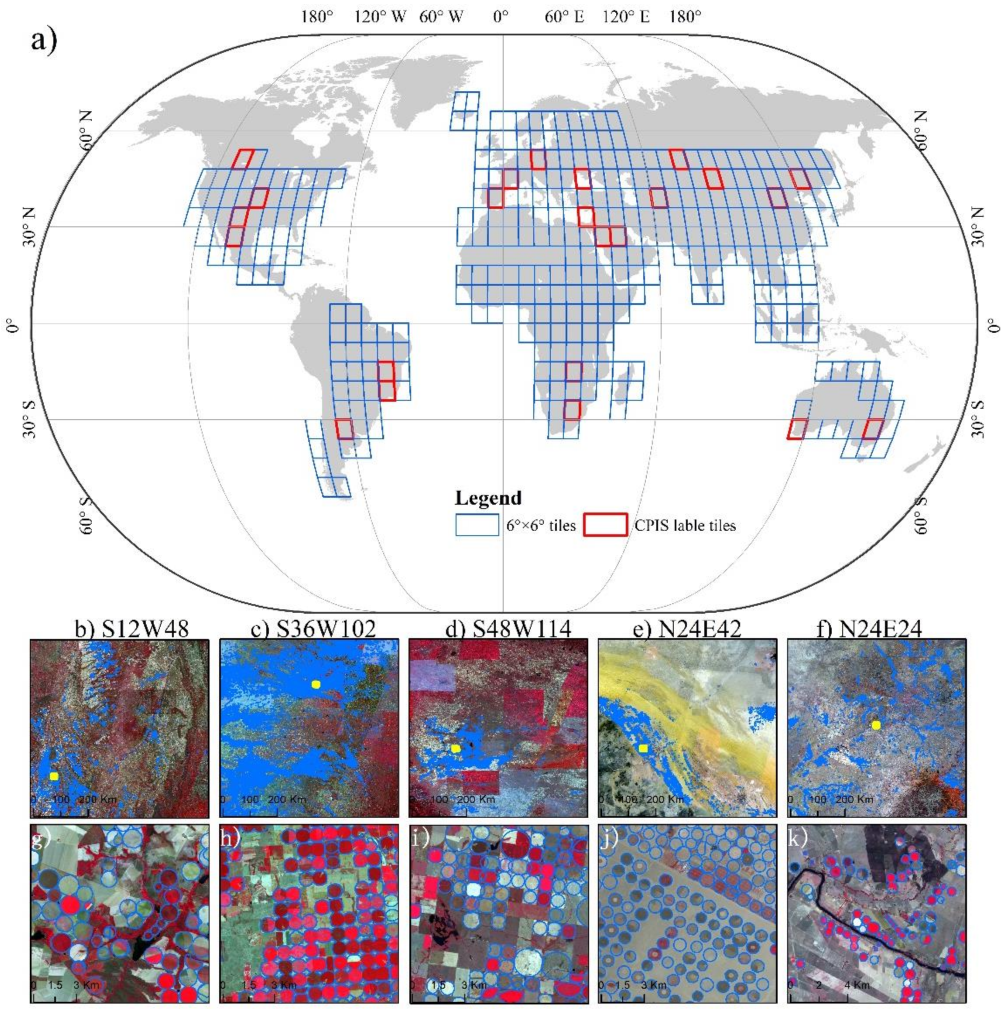


Q4. IMZ was not so readable in Figure 1.

Response: Thanks for your comment.

We have separate figure one as two to make the element such as IMZ boundary clearer.

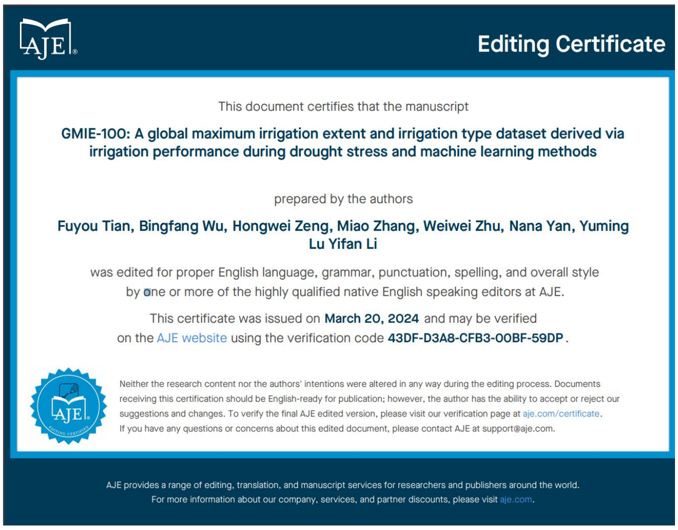




Q5. The English should be further polished and improved.

Response: Thanks for your suggestion.

we have polished our MS and the certification is shown as below.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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

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RC3

This manuscript introduced the GMIE-100 dataset, which identifies global irrigated cropland using drought stress performance and machine learning. This is a valuable dataset that could benefit various fields, including agriculture, environmental science, and water resource management. However, I have some major concerns about this MS that need the authors to clarify before it is further processed.

Q1. The title of the manuscript indicates that the dataset represents the largest irrigated area. How does the author interpret this "largest area"? This requires the author to provide explicit clarification within the text. Additionally, how does the author consider the possibility of overestimation of this largest area relative to the actual distribution, given that our focus is on the actual distribution range?

Response: Thanks for your valuable suggestion comments.

The largest area should be understood separately for region with regular irrigation (RIR)and region with irregular irrigation (RIO). For RIR, the largest area means the cropland area irrigated one time at least for last three years (2017-2019). Because we detect irrigation every year for this region. To avoid missing fallow land, we identify the largest extent for last three years (2017-2019).

For RIO, it means the cropland area irrigated one time at least for last ten years (2010-2019). For RIO, irrigation occurs occasionally. We detect whether the cropland is irrigated in the driest year. But in the normal year, the irrigation maybe not necessary in this area. So, this means the largest extent area for last ten years (2010-2019).

We add this explanation in the conclusion and discussion part.

Line 504-511:

As for the maximum extent should be understood separately for RIR and RIO. For RIR, the largest area means the cropland area irrigated one time at least for last three years (2017-2019). Because we detect irrigation every year for this region. To avoid missing fallow land, we identify the largest extent for last three years (2017-2019). For RIO, it means the cropland area irrigated one time at least for last ten years (2010-2019). For RIO, irrigation occurs occasionally. We detect weather the cropland is irrigated in the driest year. But in the normal year, the irrigation maybe not necessary in this area. So, this means the largest extent area for last ten years (2010-2019). On the other hand, when we compare our result with nation census data, the result shows high consistent. Compared with USGS-LGRIP30 and GRIPC-500, our result didn't show much overestimation.

Q2. The samples are derived from different collection methods. It is crucial for the author to clarify whether samples collected through different methods exhibit consistent representation and describe irrigated land in the same manner. If their collection standards vary, the author needs to explicitly discuss the impact on the results.

Response: Thanks for your valuable suggestion.

The representation of samples was extremely important for the final accuracy. Nevertheless, it is hard to collect the irrigation field point globally, even crop types samples. So, we fused three independent sources, the GVG field data, USGS-samples and visual interpenetration data. You can see the distribution of samples from three sources in the following figures and a specific number for each country.

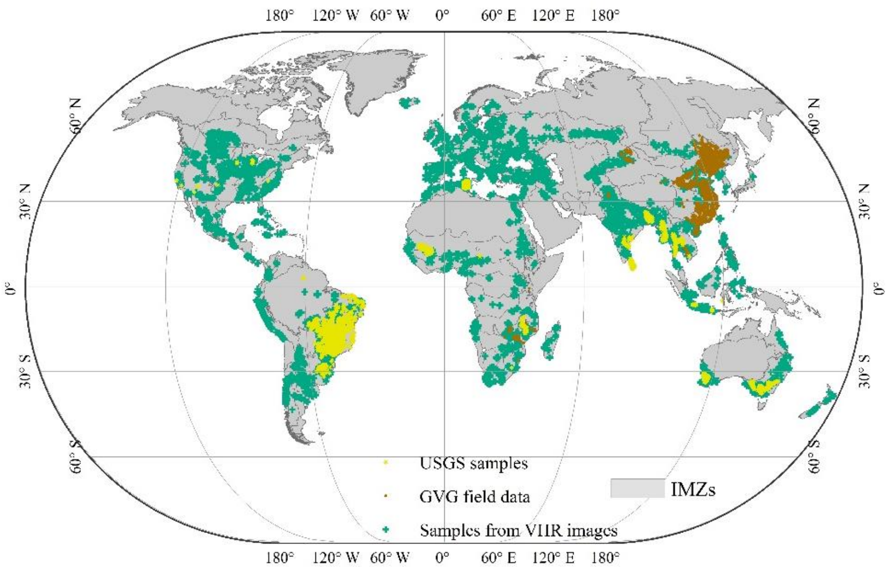


Table S3 Number of samples in different countries and sources

Sources	Number	Distributed country
GVG field data	78,338	China(72,224) \Cambodia\Ethiopia\Zambia\ Zimbabwe
USGS-samples	17,076	Brazil (13,368), Australia (2,192), Thailand (393), and Tunisia (389)
VHR-interpratation	19,965	Rest Countries
total	115,379	

From different country, there is varied dominant samples source. Such as in China, most of samples was obtained from GVG field survey. While in Brazil, major samples were from USGS samples. Except country with GVG and USGS-samples, the visual interpretation data was dominant sources of samples. This also ensure the represented manner of irrigated cropland.

This could definitely introduce some uncertainty in terms of samples representatives. This effect should be acceptable in arid and semi-arid regions because the irrigation performance is relatively easy to identify. However, the uncertainty maybe enlarged in wet region due to complex manner of irrigated cropland.

We add this uncertainty of representations in the discussion part

Line 558-567:

"Thirdly, it is hard to collect the filed samples globally, we fused three sources of samples. From different country, there is varied dominant samples source. Such as in China, most of samples was obtained from GVG field survey. While in Brazil, major samples were from USGS samples. Except country with GVG and USGS-samples, the visual interpretation data was dominant sources of samples. This also ensure the represented manner of irrigated cropland. Overall, the number of samples was very large. Basically, this irrigated and rain-fed samples database could meet the globally irrigated cropland mapping compared with global cropland expansion mapping research (Potapov et al., 2022), which achieved cropland mapping globally with thousands of samples. Meanwhile, this fused samples maybe introduce some uncertainty in terms of representation. This effect should be acceptable in arid and semi-arid regions because the irrigation performance is relatively easy to identify. However, the uncertainty maybe enlarged in wet region due to complex manner of irrigated cropland. "

Q3. In terms of accuracy assessment, merely providing overall accuracy is insufficient. Please refer to best practices for reporting accuracy as outlined in papers such as Olofsson et al. 2014 [1]. Moreover, I have not observed quantification of uncertainty, which necessitates further work from the author.

Olofsson P, Foody GM, Herold M, Stehman SV, Woodcock CE, Wulder MA. Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment 2014; 148:42–57. https://doi.org/10.1016/j.rse.2014.02.015.

Response: Thanks for your valuable comments.

We changed all the accuracy assessment following the commended practice and evaluate the uncertainty of total area estimation.

Briefly, the overall accuracy of GIME-100 was 83.6%±0.6% with producer accuracy of 86.1%±0.7% and UA of 82.20%±0.8%. And the total area of GMIE is estimated as 403.17±9.82Mha, accounting for 23.4%±0.6% of the global cropland.

For the GCPIS data, the overall Accuracy was 97.87%±0.1% with producer accuracy of 81.75%±0.2% and UA of 92.68%±0.1%. And the total area of GCPIS is estimated as 11.5±0.01Mha.

We have changed the statement of accuracy assessment and area estimation in the body text.

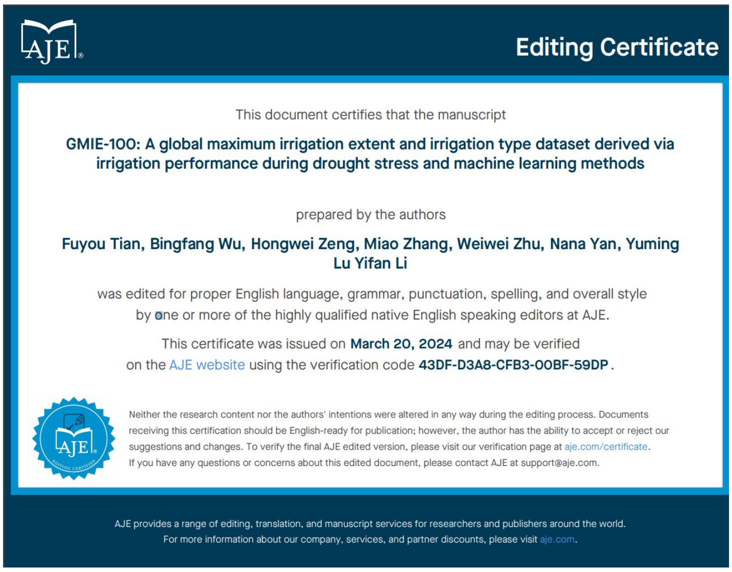
Q4. The results and discussion sections lack necessary citations. Many explanations proposed by the author lack corresponding literature support, which makes it difficult for me to be convinced of the correctness of your interpretations. Please see the annotations I've made in the manuscript.

Response: Thanks for your specific comments. We add necessary citation in the revised version.

Q5. I have made several annotations in the manuscript indicating areas that need revision. It is advised that the author make corresponding modifications and carefully review the entire document to rectify similar errors.

Response: Thanks for your nice suggestion.

Firstly, AJE have re-polished this MS for us, and the certification is show as below. Also, we carefully check the whole MS again and revised the similar errors.



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