

## Responses to the comments of Referee #1

**Article ID:** essd-2024-2

**Title:** CIrrMap250: Annual maps of China's irrigated cropland from 2000 to 2020 developed through multisource data integration

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Dear Reviewer,

Thank you very much for the great efforts on our manuscript. Inspired by your valuable comments, we have made a major revision to our manuscript. The key revisions include:

- (1) The data description has been carefully rewritten to avoid any potential misinterpretations by users.
- (2) Additional experiments have been conducted to provide further explanation of our methodology.
- (3) Additional information and discussion regarding our results have been incorporated.
- (4) Many paragraphs, sentences, and figures have been revised to improve readability, conciseness, and clarity.

The detailed point-to-point responses are as follows. **Texts in red** are the reviewer's comments; **those in black** are our responses to the reviewer's comments; and *those in blue and italics* are the revised texts appeared in the revised manuscript.

We will finalize the revised manuscript once we have received comments from the second reviewer. At that stage, we will attach a clean version (essd-2024-2\_Manuscript\_Clean\_Version.docx) as well as a tracking enabled version (essd-2024-2\_Manuscript\_Marked\_Version.docx) with editing marks for your reference.

The manuscript “CIrrMap250: Annual maps of China’s irrigated cropland from 2000 to 2020 developed through multisource data integration” applies a random forest algorithm to classify and produce a new irrigation map product (CIrrMap250) over China at 250m resolution. The authors evaluate the new maps quantitatively and qualitatively (using reference data, withdrawal data and other existing irrigation products) over the 2000-2020 period. Generally, the paper is properly structured. It is well suited for this journal. However, the manuscript and supporting document appear rushed with several inconsistencies and mistakes. Some remarks:

- Check (and re-check) all the reported details. I.e., the performance metrics and other variables in the figures, tables and elsewhere in the manuscript (and the supplementary document). Please correct all inconsistencies. More below.

**Response:** Thanks for your detailed and valuable comments. We sincerely apologize for the mistakes we made in the original manuscript. We have thus carefully read through the revised manuscript and supplementary file, including figures, equations, tables, and text. please refer to our point-by-point response below for further details.

- What is the definition of ‘irrigated cropland’ as used in this study? At first I was rather intrigued when the authors mentioned in the initial sections that their product gives the irrigated cropland (which I interpreted as the fraction of vegetation cover that is actually irrigated). On further reading, however, it seemed the authors were only labeling the pixels as either irrigated [1] or not [0] and then presenting the total fraction vegetation cover (FVC) of [1] as the ‘irrigated cropland’ ...is my understanding correct? If this is the case, what differentiates this product from a binary [1,0] irrigation map that is combined with the many (readily available) FVC products. Actually, one would argue that the latter method is better as it is not prone to misinterpretation by the user. Users are likely to misinterpret the produced CIrrMap250 irrigation maps to mean the ACTUAL irrigated pixel proportion and not the total vegetation cover. Also, how do you address pixels that have possibly been assigned an FVC of ~0 (e.g. at early growth stages) but have an [actual] irrigated area/extent larger than 0?

**Response:** Thanks for the valuable comments. Your understanding is correct. In this study, each 250-meter pixel was categorized as either irrigated or non-irrigated. No further classification was conducted to distinguish between irrigated and non-irrigated cropland at the subpixel level. Therefore, if a pixel was classified as “irrigated”, it was assumed that all cropland within that pixel was irrigated.

The binary irrigation maps were spatially filtered and finally multiplied by the corresponding cropland mask layers to produce the annual maps of irrigated cropland in China (i.e., CIrrMap250). As a result, the pixel value of our product indicates the

percentage of a 250-meter resolution pixel covered by irrigated croplands (i.e., irrigated area / pixel area  $\times 100$ ). This post-processing step was implemented to consider the fractional coverage of croplands within moderate-resolution pixels, thereby enhancing the accuracy of irrigated area estimates in China where farms are typically small and fragmented. For instance, in a binary irrigation map, if 10 grids in a county are classified as “irrigated”, the calculated irrigated area would be  $250 \times 250 \times 10 = 625,000 \text{ m}^2$  without considering fractional coverage of cropland. However, if the cropland coverage within each grid in the county is only 50%, then the actual irrigated area should be halved, amounting to  $312,500 \text{ m}^2$ .

To mitigate any misinterpretations, we have explicitly clarified our product in the introduction and methodology sections. Additionally, we have removed phrases such as “irrigation cropland proportion”, “fraction coverage of irrigated cropland”, and “the mixed pixel issue” from our dataset descriptions.

*The newly developed irrigated cropland maps (CIrrMap250) feature a spatial resolution of 250 meters and an annual temporal resolution, spanning the period from 2000 to 2020. These maps show the percentage of each 250 m by 250 m pixel that is covered by irrigated cropland (i.e., irrigated area / pixel area  $\times 100$ ).*

*Finally, the binary, spatially filtered irrigation maps were multiplied by the corresponding cropland mask layers to produce the annual maps of irrigated cropland in China (i.e., CIrrMap250). As a result, the pixel value of our product indicates the percentage of a 250-meter resolution pixel covered by irrigated croplands (i.e., irrigated area / pixel area  $\times 100$ ). This post-processing step was implemented to consider the fractional coverage of croplands within moderate-resolution pixels, thereby enhancing the accuracy of irrigated area estimates in China where farms are typically small and fragmented.*

Consistent with prior researches (Zhu et al., 2014; Meier et al., 2018; Zhang et al., 2022a; Wu et al., 2023), irrigated cropland in our study is defined as cropland that is subject to irrigation. Consequently, a crucial step of mapping irrigated cropland involved selecting or generating suitable cropland mask layers. The classification of irrigated and non-irrigated cropland was exclusively conducted at the cropland grids (i.e., irrigated cropland was restricted to cropland areas). Thus, each irrigation map corresponds to a specific cropland mask. For example, CIrrMap250 utilized the cropland mask from the high-resolution (30-meter) hybrid cropland product (CCropLand30) (Zhang et al., 2024), while IrriMap\_CN employed the cropland mask from the National Land Cover Dataset (NLCD) (Zhang et al., 2022a). Consequently, binary irrigation maps cannot be merged with other cropland masks due to significant disparities in cropland identification by different cropland datasets. For instance, a pixel classified as irrigated cropland in the irrigation map based on cropland mask A may

become non-irrigated if merged with another cropland mask B, as it may be classified as non-cropland in cropland mask B.

The Fraction of Vegetation Cover (FVC) typically represents the percentage of ground covered by green vegetation, ranging from 0% to 100%. However, in our study, fraction coverage of cropland denotes the proportion of cropland area within the 250-meter grids, which was derived from our high-resolution hybrid cropland product. For example, a pixel value of 0.2 in the cropland mask layer indicates that 20% of the 250-meter grid is covered by cropland. The classification of irrigated and non-irrigated cropland was exclusively performed on the cropland grids identified by cropland masks. Cropland proportion in each pixel was assumed to remain unchanged throughout the year in our study and other similar studies (Zhu et al., 2014; Meier et al., 2018; Zhang et al., 2022a; Wu et al., 2023).

- The CIrrMap250 product is limited to China. Have the authors considered applying a similar methodology to other regions, e.g. extend it globally? Obviously, training and test datasets from other global sites would be required, but would it be viable to apply your RF classifier/model (as-is) to other regions beyond China? What would be the limitations?

**Response:** In this study, we developed CIrrMap250 by integrating multisource data through a semi-automatic training approach (Zhang et al., 2022d; Xie et al., 2019). While our irrigation mapping method is applicable to other regions worldwide, we acknowledge that its effectiveness largely depends on the availability and reliability of multisource datasets, particularly those related to irrigation area statistics and surveys. This dependency stems from our methodology's framework, which uses a threshold-calibration method to generate training samples for each county in China based on remote sensing data, irrigation area statistics/surveys, and irrigation suitability maps. Consequently, the random forest models trained in this study were customized for China and may not be directly transferable to other regions due to significant variations in irrigation practices, and geographical and climatic characteristics (Salmon et al., 2015; Zhang et al., 2022d).

**Specific comments :**

L16: "... and considered the fraction coverage of irrigated cropland (i.e., the mixed pixel issue). In this study, we addressed these important gaps ..." - This is somewhat misleading as the mixed pixel issue is not addressed in this manuscript. I was expecting that the authors were referring to 'mixed pixel' in terms of irrigation, i.e. proportion of

the fraction vegetation cover (FVC) that is irrigated or not. If not mistaken, the only consideration here is the total FVC, which is provided within most RS products anyway, and can thus be similarly combined (rather straightforwardly) with any available binary/boolean [1,0] irrigation maps. Also see your comment in L495 : “CIrrMap250 cannot differentiate irrigated and rain-fed croplands at the subpixel scales. There are many small and fragmented croplands in ... with complex terrain and diverse vegetation types. CIrrMap250 should be used with caution in these regions due to the wide existence of the mixed pixels”

**Response:** Yes, we agree that this is confusing as the issue of mixed pixels has not been explicitly addressed in our work. We have revised the sentence to mitigate any confusion.

*Accurate maps of irrigation extent and dynamics are important to study food security and its far-reaching impacts on Earth systems and the environment. While several efforts have been made to map irrigated areas in China, few of them have provided multi-year maps, incorporated national land surveys, addressed data discrepancies, or considered the fractional coverage of cropland within moderate-resolution pixels.*

Actually, here, we intend to highlight a gap in previous studies, wherein binary cropland masks were utilized for irrigation mapping. In such masks, each pixel is classified either as cropland or non-cropland, disregarding the fractional coverage of cropland within the moderate-resolution pixels. This may lead to overestimations or underestimations of the extent of irrigated cropland due to the following two reasons. First, many studies generated the cropland mask layers by resampling the original 30-meter cropland data to moderate resolution (e.g., 1 km or 500 m). This resampling process could overlook cropland that covers a relatively small proportion of the moderate-resolution grid, while overestimating cropland in grids that are not totally covered by cropland. Secondly, the threshold-splitting method used in this study was commonly used in conjunction with irrigated area statistics to depict the spatial distribution of irrigated cropland; and this method relies on the assumption that the spatially allocated irrigated area should be equal to the statistics. If it is assumed that each grid cell is fully covered by cropland, the extent of irrigated cropland may be significantly underestimated. For instance, if the statistical irrigated area of a county is 625,000 m<sup>2</sup>, and 10 grids (pixel area: 250×250 = 62,500 m<sup>2</sup>) would be classified as irrigated cropland in a binary cropland mask. However, if the cropland proportion within each grid in the county is only 50%, then in reality, 20 grids should be classified as irrigated cropland.

L17: "... named as CIrrMap250 ..." – consider describing all abbreviations such as CIrr before use.

**Response:** The abbreviation "CIrrMap250" has been explained.

*In this study, we addressed these important gaps and developed new annual maps of China's irrigated cropland from 2000 to 2020, named as CIrrMap250 (China's irrigation map, with a spatial resolution of 250 m).*

L23: "... accuracy of 0.79-0.88 for years 2000, 2010, and 2020, respectively" - only for years 2000, 2010, 2020? What about the other years in between? Is it because the evaluation data were only available for those 3 years? If so, make it a bit clear here.

**Response:** Yes, the evaluation was conducted only for years 2000, 2010, and 2020, because the reference data were only available for the 3 years.

*Our evaluation results showed that CIrrMap250 agreed well with the available reference points for the years 2000, 2010, and 2020, attaining an overall accuracy of 0.79-0.88.*

L42: its' >> its

**Response:** Sorry for our carelessness. It has been revised.

*Given the vital importance of irrigation, it is essential to know its precise location and dynamics.*

L45-46: "While numerous land use/cover and thematic cropland products have been made available to the public, they often lack information on irrigation status ..." - Why would it be important to provide land use land cover (LULC) maps with irrigation status information? Should rain/precipitation or evapotranspiration information be provided within LULC maps/products as well?

**Response:** We agree with you. This sentence has been removed in the revised manuscript.

L51: "...normalized difference water index (NDWI)..." - Note that there is another index that goes by the same name but used to detect floods/open water bodies (NDWI, McFeeters (1996)) – so it could ideally be used to map areas that employ flood irrigation

(rice paddies, for example).

**Response:** Thank you for this reminder. The Normalized Difference Water Index (NDWI) proposed by Gao (1996) is known for its sensitivity to both soil and plant water content, making it a valuable tool for monitoring rice paddy fields (Dong et al., 2016; Singha et al., 2019). Consequently, it was utilized in this study as well as many other studies (Deines et al., 2017; Deines et al., 2019; Xiang et al., 2020; Zhang et al., 2022), for mapping irrigated areas. Regarding the NDWI proposed by McFeeters (1996), we acknowledge its potential utility for mapping areas employing flood irrigation, such as rice paddies. We have incorporated this reference into the revised manuscript.

L57: "...been applied to detected irrigate areas..." >> ...to detect irrigated areas

**Response:** Sorry for our carelessness. It has been revised.

*Moreover, remotely sensed soil moisture from microwave and optical sensors has also been applied to detect irrigated areas by using threshold splitting methods (Yao et al., 2022), supervised/unsupervised classification algorithms (Dari et al., 2021; Gao et al., 2018), and remote sensing-modelling comparison approaches (Zohaib and Choi, 2020; Zaussinger et al., 2019)*

L74: "China is a big agricultural country with the \*largest irrigated area in the world ..." – any reference for this?

**Response:** Yes, we have added the reference.

*China is a big agricultural country with the largest irrigated area in the world (International Commission on Irrigation and Drainage, 2018)*

*International Commission on Irrigation and Drainage: World Irrigated Area-2018, <https://www.icid.org/world-irrigated-area.pdf>, 1-6, 2018.*

L85: "... in paces ..." – do you mean places?

**Response:** Yes, it's a type error. It has been revised.

*As a result, it remains unclear where the expansion of irrigated area is water-sustainable (i.e., irrigated area expanded in places without experiencing water stress) (Mehta et al., 2024).*

L97: “many other studies “ – which studies? Add some reference[s] here

**Response:** We have added the related references.

*Finally, it is worth noting that, apart from the study by Zhang et al. (2022a), many other studies assessed their irrigation maps with a relatively limited number of reference samples, potentially compromising the reliability of their evaluation results (Zhu et al., 2014; Zhang et al., 2022d; Xiang et al., 2020; Bai et al., 2022).*

L104-105: “CIrrMap250) have a spatial resolution of 250 meters and describe irrigated cropland distribution through fractional coverage” – what of the temporal resolution? Also, as already mentioned above, this statement is misleading as one could assume you are providing the fraction of total FVC that is under irrigation.

**Response:** The newly developed irrigated cropland maps (CIrrMap250) have an annual temporal resolution. The phrase “describe irrigated cropland distribution through fractional coverage” has been removed to prevent potential confusion. We have rewritten the data descriptions in the introduction and methodology sections. Please refer to our response to your first comment.

*The newly developed irrigated cropland maps (CIrrMap250) feature a spatial resolution of 250 meters and an annual temporal resolution, spanning the period from 2000 to 2020. These maps show the percentage of each 250 m by 250 m pixel that is covered by irrigated cropland (i.e., irrigated area / pixel area ×100).*

*Finally, the binary, spatially filtered irrigation maps were multiplied by the corresponding cropland mask layers to produce the annual maps of irrigated cropland in China (i.e., CIrrMap250). As a result, the pixel value of our product indicates the percentage of a 250-meter resolution pixel covered by irrigated croplands (i.e., irrigated area / pixel area ×100). This post-processing step was implemented to consider the fractional coverage of croplands within moderate-resolution pixels, thereby enhancing the accuracy of irrigated area estimates in China where farms are typically small and fragmented.*

L113-116: “These indices were generated every 16 days with a spatial resolution of 250 meters...” – to be consistent with other descriptions in the section, provide the product number of the vegetation indices product; is it MOD13Q1? “ ...band 4 ...band1” – consider adding the spectral ranges here as well

**Response:** Yes, the product number is MOD13Q1. We have added the product number



as well as the spectral ranges for the bands.

*We collected the Terra Moderate Resolution Imaging Spectroradiometer (MODIS) vegetation indices, i.e., NDVI and Enhanced Vegetation Index (EVI) (Huete et al., 1997), from the NASA's Earth Science Data Systems (<https://www.earthdata.nasa.gov/>). These vegetation indices (MOD13Q1) were generated every 16 days with a spatial resolution of 250 meters. Meanwhile, the surface spectral reflectance of MODIS band 4 (545-565 nm) from the MOD09A1 product was resampled from the original 500 meters to 250 meters using simple nearest-neighbor interpolation (Debeurs and Townsend, 2008). These resampled data were used alongside with the 250-meter and 8-day surface reflectance of band 1 (620-670 nm) from the MOD09Q1 product to derive the Greenness Index (GI) (Supplementary Table S1).*

L119: “Greenness Index (GI) (Supplementary Table S1)” – in Table.S1 (supplementary document) under GI, you write the ‘formula’ as  $GI = NIR / green$ , and ‘MODIS bands’ as ‘Bands 01, 04’. The sub-caption however reads: ‘Red: band 01’ and ‘Green: band 04’ ...which is which? Please correct.

**Response:** Apologies for our carelessness. In calculating the GI index, we utilized ‘Bands 02, 04’ instead of ‘Bands 01, 04’. We have revised the table accordingly, as listed below for your reference.

*Table S1. Summary of the MODIS-derived vegetation indices used in this study*

<i>Vegetation indices</i>	<i>Formula</i>	<i>MODIS bands</i>	<i>Resolution</i>
<i>NDVI</i>	$(NIR - Red) / (NIR + Red)$	<i>Band 01 (Red)</i> <i>Band 02 (NIR)</i>	<i>250 m/16 day</i>
<i>EVI</i>	$2.5 * (NIR - Red) / (NIR + 6 * Red - 7.5 * Blue + 1)$	<i>Band 01 (Red)</i> <i>Band 02 (NIR)</i> <i>Band 03 (Blue)</i>	<i>250 m/16 day</i>
<i>GI</i>	$NIR / Green$	<i>Band 02 (NIR)</i> <i>Band 04 (Green)</i>	<i>250 m/8 day</i>

*where NIR is the near-infrared band (841-876 nm), and Red (620 – 670 nm), Blue (459-479 nm) and Green (545-565 nm) are the are the visible red band, visible blue band, and visible green band, respectively.*

L121: "... The data for unreliable pixels were reconstructed using a straightforward nearest neighbor interpolation method..." - is this the right way to go about it? For example, for an overcast pixel (which is maybe vegetated), why would you take the remotely sensed spectral signal of the next/closest cloud-free pixel (which is maybe urban/built-up)? Meaning you may end up missing vegetated pixels under irrigation or vice versa. Why not just drop such pixels from your analysis (i.e. at that particular time)?

**Response:** We completely understand your concern. Indeed, directly applying the interpolation method to all MODIS data in China could significantly impact the results. As you pointed out, if the neighboring pixel with reliable data is located in an urban or built-up area, the reconstructed pixel is likely to be erroneously excluded from irrigated cropland due to the low value of vegetation index. However, in this study, we actually extracted MODIS data only for cropland pixels in China. For cropland pixels with unreliable data, their values were interpolated from the nearest neighboring cropland pixels with reliable data. This approach helps to avoid interpolating data for cropland pixels from areas covered by other land use types, such as urban and forest. We have provided a more detailed explanation in the revised manuscript.

*We extracted MODIS data for all cropland pixels in China. In cases where cropland pixels had unreliable data, their values were interpolated from the nearest neighboring cropland pixels with reliable data.*

We chose not to exclude pixels with unreliable data at a particular time from our analysis because our mapping process relies heavily on the peak values of MODIS vegetation indices during the growth period. Omitting pixels with unreliable data for a specific time could potentially result in unreliable peak values of vegetation indices, thereby affecting our mapping results.

L157-159: "In years lacking survey data, the harmonized irrigated area was determined using Eq. 2, assuming that the relative changes in statistical irrigated area are reliable" - could you explain the rationale behind Equation (2)? How to interpret it? to me it appears that a year without survey data could end up having a lower assigned/harmonized irrigated area despite having a larger irrigated [statistical] area without land survey ( $A_{\text{statt2}}$ ). For instance, if we assume:  $A_{\text{harmt2}}=20$ ,  $A_{\text{statt2}}=20$ ,  $A_{\text{statt2}}=30$ ,  $C_{\text{asurvt2}}=40$ ; then  $A_{\text{harmt2}}$  becomes  $\min(20*(30-20)/20,40)=10$   
...the harmonized value ( $A_{\text{harmt2}}$ ) even becomes negative if we consider  $A_{\text{statt2}}$  to be less than  $A_{\text{statt2}}$ . What am I missing? Please clarify.

**Response:** We apologize for the typographical error in Equation 2, where the relative changes of the statistical irrigated area should plus one before being multiplied with

$A_{harm}^{ts}$ . The correct equation should be:

$$A_{harm}^{t2} = \min \left( A_{harm}^{ts} \times \left( 1 + \frac{A_{stat}^{t2} - A_{stat}^{ts}}{A_{stat}^{ts}} \right), CA_{surv}^{ts} \right) \quad (2)$$

For your example,  $A_{harm}^{ts}=20$ ,  $A_{stat}^{ts}=20$ ,  $A_{stat}^{t2}=30$ ,  $CA_{surv}^{ts}=40$ ; then  $A_{harm}^{t2}$  becomes  $\min (20*(1+(30-20)/20),40) =30$ . In this case, the relative change of the statistical irrigated area is  $(30-20)/20*100=50\%$ . Consequently, the harmonized data in the survey year should be adjusted by increasing 50%, i.e.,  $20*(1+0.5) =30$ . This ensures that the relative changes between  $A_{harm}^{ts}$  and  $A_{harm}^{t2}$ , and between  $A_{stat}^{ts}$  and  $A_{stat}^{t2}$  remain consistent. This process preserves the interannual changes observed in the statistical irrigated area while enhancing data consistency across years. For instance, in a span of five years lacking survey data, the recorded statistical irrigated areas are 11, 12, 13, 14, and 15 hectares respectively, whereas the reconciled irrigated areas in adjacent years with survey data might amount to 101, 102, 103, 104, and 105 hectares. Without the aforementioned adjustment, notable data inconsistencies would arise. In the revised manuscript, we corrected Equation 2, and meanwhile, double-checked all other equations to ensure their correct formulation.

*In years lacking survey data, the irrigated area was determined by adjusting the harmonized data in adjacent survey year using relative change information derived from irrigated area statistics (Eq. 2). This method preserved the interannual changes observed in statistical irrigated area while enhancing data consistency across years.*

$$A_{harm}^{t2} = \min \left( A_{harm}^{ts} \times \left( 1 + \frac{A_{stat}^{t2} - A_{stat}^{ts}}{A_{stat}^{ts}} \right), CA_{surv}^{ts} \right) \quad (2)$$

*where  $A_{harm}$ ,  $A_{stat}$  and  $A_{surv}$  represent harmonized, statistical and surveyed areas of irrigated cropland, respectively;  $CA$  is surveyed area of cropland; and  $ts$  and  $t2$  indicate the year with and without land surveys, respectively.*

L189: "... used in combination with the MCD43A3 albedo product" - this is a daily product. Did the authors calculate the daily PET? how did you reconcile this with the other 8/16-day products?

**Response:** Yes, the MCD43A3 albedo is a daily product, so we computed the daily PET accordingly. These daily PET values were summed to annual values spanning from 2000 to 2020. In the revised manuscript, we have clarified this point.

*These datasets were combined with the MCD43A3 albedo product to compute daily potential evapotranspiration (PET) using the Priestley-Taylor method (Priestley and Taylor, 1972). The daily PET values were summed to obtain annual values for the period from 2000 to 2020. These annual PET values were then used to derive the aridity index,*

*defined as the ratio of precipitation to PET.*

In terms of the other 8/16-day products, such as NDVI, EVI, and GI, we utilized their annual peak values during the growth period in this study, rather than directly employing their original values. Consequently, both the estimated PET and other MODIS products were utilized at annual scales.

L211: "... were then then" >> were then

**Response:** Revised.

*The mapping outcomes were then mosaicked and post-processed to obtain annual maps of irrigated cropland in China, denoted as CIrrMap250.*

L222: "\*A static irrigation suitability map \*were constructed based on ..., and aridity index of cropland" - was this one map or several ('\*A static' then '\*were'). If one, why was the temporal variation of the aridity index not considered?

**Response:** In this study, we utilized a single and static irrigation suitability map. The concept of integrating irrigation suitability into the mapping process was inspired by previous researches assessing land potential for irrigation (Worqlul et al., 2015; Worqlul et al., 2017; Li and Chen, 2020; Zhang et al., 2022b). The aridity index served as a metric reflecting climate suitability for irrigation, where lower values indicate a higher deficit of available water for crops, thereby suggesting a greater need for irrigation. However, aridity is typically measured by comparing long-term average water supply (precipitation) to long-term average water demand (evapotranspiration) (Zomer et al., 2022), rather than through the lens of a single year's data. Consequently, in our study, we utilized a 21-year average aridity index (covering the period 2000-2020) in conjunction with elevation and slope data to produce a static irrigation map for China.

Regarding your concerns, we conducted an additional experiment to evaluate the influence of temporal variations in the aridity index on irrigation mapping results. Specifically, we computed the aridity index for each year and applied it to derive annual irrigation suitability maps spanning from 2000 to 2020. The resulting 21 suitability maps were then applied to each corresponding year to generate irrigated cropland maps using the methodology outlined in our study. We kept other factors the same to ensure that any disparities in the mapping results from our original ones are solely attributed to the use of annual irrigation suitability maps. As shown in Figure R1, the incorporation of annual irrigation suitability maps has a negligible impact on the accuracy of irrigation maps.

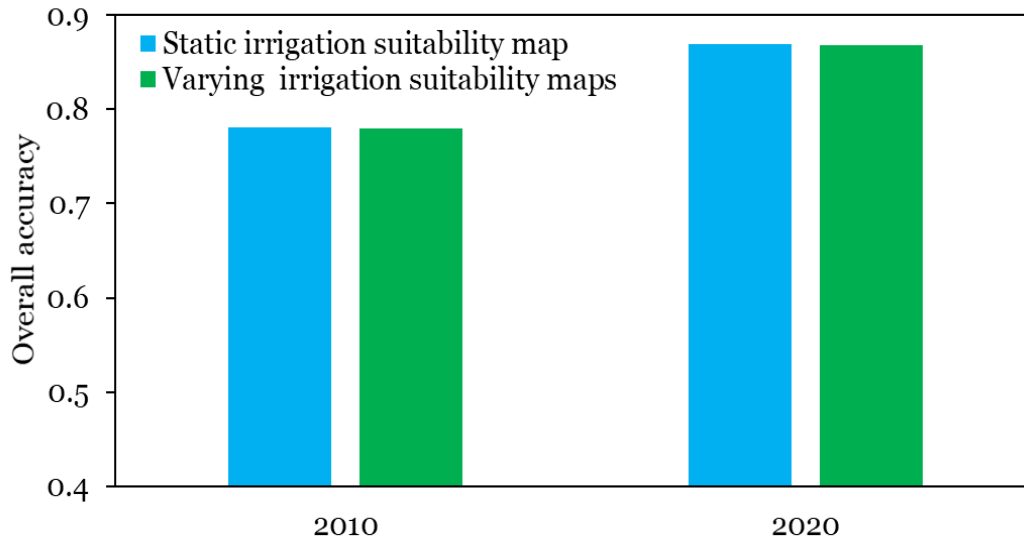


Figure R1. Accuracy of irrigation maps derived from the experiments with static and varying irrigation suitability maps, respectively. The static irrigation map was derived from elevation, slope, and the 21-year (i.e., 2000-2020) averaged aridity index, while the varying irrigation suitability maps from elevation, slope, and annual aridity index.

L230: "... (Supplementary Table S2)" – in Table S2 (supplementary document), why do you have the same ‘Suitability value’ for the lowest suitability classes S3 and S4. I.e., for the ‘elevation’ and ‘slope’ irrigation suitability factors, S3=2 and S4=2.

**Response:** It appears to be an unintentional error in the original table. For the irrigation suitability factors ‘elevation’ and ‘slope’, the correct values should be S3=2 and S4=1. The suitability values for each factor should follow a monotonic pattern, with higher values indicating greater suitability for irrigation. We have corrected this unintentional error and have also double-checked all the other tables in our manuscript to avoid similar typo errors.

Table S2. Suitability values for the influencing factors of irrigation suitability

<i>Influencing factors</i>	<i>Reclassification</i>	<i>Suitability value</i>
<i>elevation</i>	<i>S1: &lt; min+100</i>	<i>S1=4</i>
	<i>S2: [min+100, min+300]</i>	<i>S2=3</i>
	<i>S3: [min+300, min+500]</i>	<i>S3=2</i>
	<i>S4: &gt; min+500</i>	<i>S4=1</i>
<i>slope</i>	<i>S1: &lt;2%</i>	<i>S1=4</i>
	<i>S2: [2%, 4%]</i>	<i>S2=3</i>
	<i>S3: [4%, 8%]</i>	<i>S3=2</i>
	<i>S4: &gt; 8%</i>	<i>S4=1</i>
<i>aridity index</i>	<i>S1: &lt;0.1</i>	<i>S1=10</i>
	<i>S2: [0.1, 0.2]</i>	<i>S2=9</i>

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<i>S3: [0.2, 0.3]</i>	<i>S3=8</i>
<i>S4: [0.3, 0.4]</i>	<i>S4=7</i>
<i>S5: [0.4, 0.5]</i>	<i>S5=6</i>
<i>S6: [0.5, 0.6]</i>	<i>S6=5</i>
<i>S7: [0.6, 0.7]</i>	<i>S7=4</i>
<i>S8: [0.7, 0.8]</i>	<i>S8=3</i>
<i>S9: [0.8, 0.9]</i>	<i>S9=2</i>
<i>S10: &gt;0.9</i>	<i>S10=1</i>

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*Note: min is minimum elevation of the mapping unit*

L258: “and time-invariant environmental variables (i.e., latitude, longitude, crop intensity” – why is the crop intensity considered time-invariant?”

**Response:** In this study, we utilized a time-invariant crop intensity dataset (Xu, 2017) due to the lack of publicly available annual crop intensity dataset when our work was conducted. While an annual dynamic global cropping intensity dataset is available for the years covering 2001-2019 (Liu et al., 2021), employing this dynamic dataset did not yield improvements in mapping accuracy; in fact, it resulted in a slightly decreased accuracy, potentially attributable to its relatively lower precision in China. The test results, as depicted in Figure R2, are provided for your reference. Consequently, we opted to utilize the available time-invariant crop intensity data for this study.

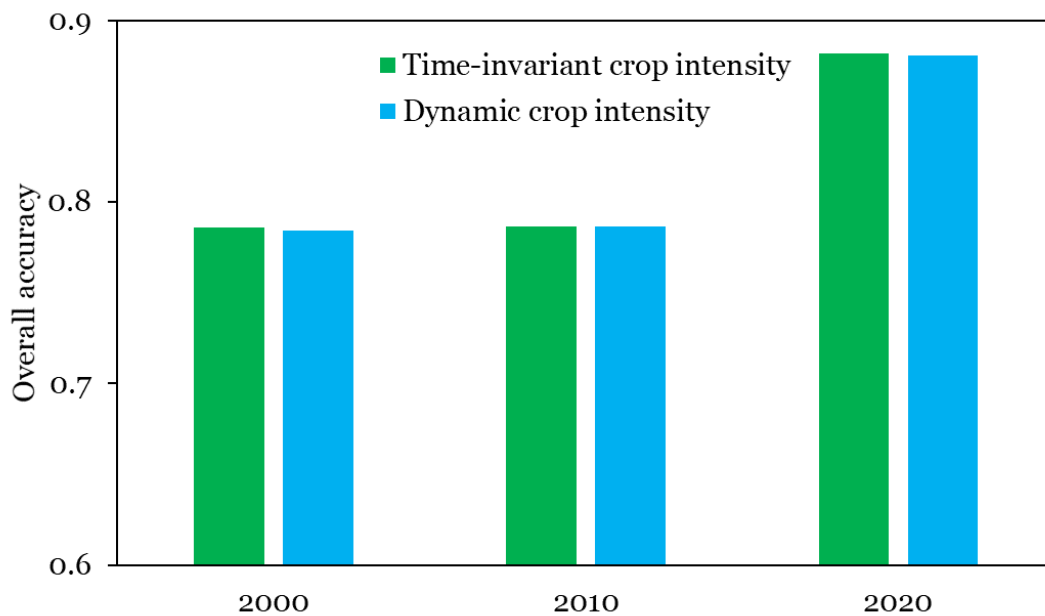


Figure R2. Comparison of irrigation mapping accuracy for the year 2000, 2010, and 2020 in the experiments of using time-invariant and dynamic crop intensity datasets, respectively.

L261: “To enhance the accuracy of these maps, a spatial filter (a 7x7 window)...” - clarify what you mean by this. Why 7x7? ...‘constituting <5% of the window area’ is ambiguous. Is the 250 m resolution retained after this?

**Response:** After classification, we merged the annual, county-level mapping results to generate preliminary maps of irrigated cropland in China. Finally, a spatial filtering was applied to improve the accuracy of these maps. Specifically, for each target irrigated pixel, we calculated the ratio of the number of irrigation grids to the total number of grids within a moving window. If the calculated ratio fell below 5%, we assigned all cropland grids within the moving window as “non-irrigated”. Conversely, if the ratio exceeded 95%, we assumed all cropland grids (i.e., cropland proportion > 0) within the moving window to be irrigated. This post-processing step preserved the original spatial resolution of the maps (250 meters), removed isolated irrigation pixels, and also identified potentially omitted irrigated croplands. The size of the moving window was determined to be 7×7 pixels through a trial-and-error process. We tested three different window sizes (5×5, 7×7, and 9×9) in the post-processing step and found that the 7×7 window size yielded the highest mapping accuracy.

In the revised manuscript, we have clarified the spatial filtering process.

*A spatial filtering technique was then employed to enhance the accuracy of these maps. Specifically, for each target irrigated pixel, we calculated the ratio of the number of irrigation grids to the total number of grids within a moving window. The size of the moving window was determined to be 7×7 pixels through a trial-and-error process. If the calculated ratio fell below 5%, we then assigned all cropland grids (i.e., cropland proportion>0) within the moving window as “non-irrigated”. Conversely, if the ratio exceeded 95%, we assumed all cropland grids within the moving window to be irrigated. The spatial filtering operation preserved the original spatial resolution of the maps (250 m) and removed isolated irrigation pixels, while also identifying potentially omitted irrigated croplands.*

L276: “were acquire from ...” >> were acquired

**Response:** Revised.

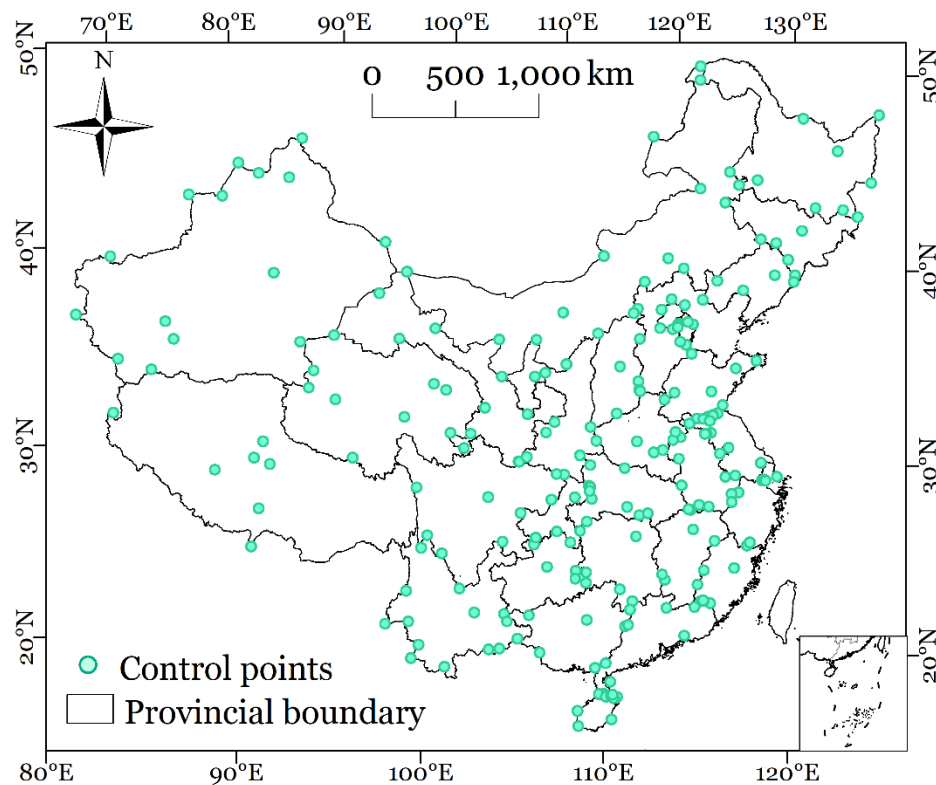
*The validation samples for the year 2020 were acquired from Chen et al. (2023), who mapped the center pivot irrigation systems (CPIS) in global arid regions.*

L282-: “Due to the lack of georeferencing information, we georeferenced these land use maps using the georeferencing tool in ArcGIS in conjunction with high-resolution

images “ – the authors do not talk about the data that were used to serve as ground control points for the georeferencing (e.g. How many GCPs, their spatial distribution, ...?)

**Response:** In total, we selected 234 control points nationwide, primarily distributed along provincial boundaries. In the revised manuscript, we added the information on the georeferencing points, and provided the spatial distribution map of these points (see below) in the supplementary file.

*Due to the lack of georeferencing information, we georeferenced these land use maps using the georeferencing tool in ArcGIS in conjunction with high-resolution images. A total of 234 control points were selected nationwide (Supplementary Figure S1), primarily situated along provincial boundaries, to facilitate the georeferencing process. The irrigated samples were taken from the patches of irrigated lands and paddy fields in the georeferenced land-use maps, while non-irrigated samples were taken from dryland patches.*



*Figure S1. Spatial distribution of the identified reference points used for georeferencing the provincial land-use maps of the second National Land Survey in China*

L294-: “It’s noteworthy that this percentage represents the proportion of cropland within the 250 ..., not the proportion of irrigated cropland to total cropland” ; L362: “irrigated cropland in CIrrMap250”. As already mentioned, giving the irrigated cropland as a percentage is very likely to mislead users into assuming that your



irrigation product provides the proportion of the total fraction of vegetation cover (FVC/cropland) that is irrigated. If feasible, wouldn't it be more useful to have both products, i.e. the total fraction cover product and the proportion of that that is deemed irrigated? The authors also acknowledge in L492 that "...cirrmap250 has a relatively coarse resolution". You may still argue that at the relatively higher spatial resolution of 250m, one could assume the whole cropland (total FVC) to be equivalent to the irrigated area. This might be true but still needs validation to avoid being misleading.

**Response:** To prevent misinterpretation, we have clarified our product in in the introduction and methodology sections.

*The newly developed irrigated cropland maps (CIrrMap250) feature a spatial resolution of 250 meters and an annual temporal resolution, spanning the period from 2000 to 2020. These maps show the percentage of each 250 m by 250 m pixel that is covered by irrigated cropland (i.e., irrigated area / pixel area ×100).*

*Finally, the binary, spatially filtered irrigation maps were multiplied by the corresponding cropland mask layers to produce the annual maps of irrigated cropland in China (i.e., CIrrMap250). As a result, the pixel value of our product indicates the percentage of a 250-meter resolution pixel covered by irrigated croplands (i.e., irrigated area / pixel area ×100). This post-processing step was implemented to consider the fractional coverage of croplands within moderate-resolution pixels, thereby enhancing the accuracy of irrigated area estimates in China where farms are typically small and fragmented.*

As you pointed out, one potential approach to avoid the misinterpretation is to provide both binary irrigated cropland maps and cropland mask layers (representing fractional coverage of cropland) to users. While we acknowledge the merits of this method, we opted not to implement it for the following reasons. Firstly, data users may misinterpret that pixels with value equals to 1 are fully irrigated, and may directly utilize the binary irrigation maps for their research, such as estimating irrigation water use or assessing the hydroclimatic impact of irrigation. However, relying solely on these maps could bring significant biases into their results. Secondly, users would need to combine the binary irrigation maps with the cropland mask layers, a process that may introduce errors and increase the risk of generating irrigation maps divergent from those we have released. Lastly, providing only irrigation maps, instead of both binary irrigation maps and cropland mask layers, aligns with the practices of other similar studies (Zhu et al., 2014; Meier et al., 2018; Xie and Lark, 2021; Zhang et al., 2022a; Wu et al., 2023).

L340: "... under severe to extreme..." - In the previous sentence (L339), only low, moderate, high and severe WSI ranges are described. What is the extreme WSI range? Is extreme synonymous to severe here?

**Response:** The levels of water stress should be categorized as: low ( $WSI \leq 0.2$ ), moderate ( $0.2 < WSI \leq 0.4$ ), severe ( $0.4 < WSI \leq 1.0$ ), and extreme ( $WSI > 1$ ), in line with our previous study (Zhang et al., 2023). It has been revised in the new manuscript.

*The WSI denotes the fraction of available water resources appropriated by humans and is employed to categorize water stress into four levels: low ( $WSI \leq 0.2$ ), moderate ( $0.2 < WSI \leq 0.4$ ), severe ( $0.4 < WSI \leq 1.0$ ), and extreme ( $WSI > 1$ ) (Zhang et al., 2023b). Expansions of irrigated areas under severe to extreme water stress were designated as “unsustainable” due to their potential to exacerbate the depletion of surface water and groundwater resources (Mehta et al., 2024). Conversely, expansions of irrigated areas under low to moderate water stress or reductions in irrigated areas under severe to extreme stress were deemed “sustainable”.*

L352: “CIrrMap250 and IrriMap\_CN performs similarly in user’s accuracy...” – TableS5 (supplementary document) shows a user accuracy (UA) of 1 (error of commission=0). Can this perfect UA be explained? From Fig3c/TableS2 (year 2020), IrriMap\_CN has a producer accuracy (PA) of 0.2, why this huge discrepancy between the [perfect] irrigated.UA (1) and the [rather poor] irrigated.PA (0.2)?

**Response:** In 2010, the reference points were extracted from the Center Pivot Irrigation Systems (CPIS) map developed by Chen et al. (2023). All of these reference points represent irrigated samples, as shown in the newly added confusion matrix (see below). Consequently, both CIrrMap250 and IrriMap\_CN achieved a perfect user’s accuracy. However, IrriMap\_CN exhibited a low producer’s accuracy of 0.2, as only 20% of the irrigated samples were correctly identified. We have clarified it in the revised manuscript.

*For the year 2020, CIrrMap250 detects 88% of the fields with center pivot irrigation systems, while IrriMap\_CN identifies only 20% (Figure 3c and Supplementary Figure S2). Note that both CIrrMap250 and IrriMap\_CN achieves a perfect user’s accuracy in this year mainly because all the reference points are irrigated samples (Section 3.31 and Supplementary Table S6).*

Since you use ~20,000 samples in your classification exercise (into irrigated and non-irrigated), could you provide (in supplementary doc) the CIrrMap/IrriMap confusion matrices for 2000, 2010, 2020 to aid with interpretation (i.e. how many of the reference samples are irrigated or not? How do you split these into training and test sets? ...more details on how the RF classifier used in CIrrMap250 performs, ...)

**Response:** Thanks for your suggestion. As per your advice, we have incorporated the Confusion Matrix for CIrrMap250 and the existing maps (IrriMap\_CN, IAAA, GFSAD) in 2000, 2010, and 2020, respectively. The Confusion Matrix presents the numbers of correctly and erroneously classified irrigated and non-irrigated samples by different products, thereby facilitating a more comprehensive understanding of our results. It's important to note that, in this study, the training samples were generated using a threshold-calibration method (refer to Section 3.1), rather than obtained from the reference points. All reference samples were independent of the training data and were utilized for the performance evaluation of irrigation maps.

*Table S6. Confusion matrix for CIrrMap250 and the existing maps (IrriMap\_CN, IAAA, GFSAD) in 2000, 2010, and 2020, respectively*

	<i>Products</i>	<i>Classified</i>	<i>Reference</i>		
			<i>Irrigated</i>	<i>Non-irrigated</i>	
2000	<i>CIrrMap250</i>	<i>Irrigated</i>	271	75	
		<i>Non-irrigated</i>	66	246	
	<i>IrriMap_CN</i>	<i>Irrigated</i>	172	43	
		<i>Non-irrigated</i>	165	278	
	<i>IAAA</i>	<i>Irrigated</i>	221	177	
		<i>Non-irrigated</i>	116	144	
2010	<i>CIrrMap250</i>	<i>Irrigated</i>	6818	1385	
		<i>Non-irrigated</i>	1365	3325	
	<i>IrriMap_CN</i>	<i>Irrigated</i>	5003	1167	
		<i>Non-irrigated</i>	3180	3543	
	<i>IAAA</i>	<i>Irrigated</i>	5274	2183	
		<i>Non-irrigated</i>	2909	2527	
	<i>GFSAD</i>	<i>Irrigated</i>	4939	1995	
		<i>Non-irrigated</i>	3244	2715	
	2020	<i>CIrrMap250</i>	<i>Irrigated</i>	6340	0
			<i>Non-irrigated</i>	849	0
<i>IrriMap_CN</i>		<i>Irrigated</i>	1426	0	
		<i>Non-irrigated</i>	5763	0	

L366-367: “CIrrMap250 yields irrigation ratios (i.e., the ratio of irrigated area to the total cropland area) of...” – this sentence contradicts L294 (i.e., “... this percentage represents the proportion of cropland within the 250 ..., not the proportion of irrigated cropland to total cropland”), and many other statements in this report (e.g. L495 “cirrmap250 cannot differentiate irrigated and rainfed croplads at the subpixel scales”). Such inconsistencies make it somewhat difficult to follow and interpret your results/analyses.

**Response:** In this stud, we classified each 250-meter grid cell as either irrigated or non-irrigated. The binary irrigation maps were finally multiplied by the corresponding cropland mask layers to produce the annual maps of irrigated cropland in China (i.e., CIrrMap250). As a result, the pixel value of our product indicates the percentage of a 250-meter resolution pixel covered by irrigated croplands (i.e., irrigated area / pixel area ×100). While our product does not provide the proportion of irrigated cropland area to total cropland area at the pixel scale, it can be utilized to determine irrigation ratio at the regional scale. Specifically, for a target region, we first calculate the irrigated cropland area and the total cropland area, respectively. Then, the area of irrigated cropland is divided by the total area of cropland to estimate the irrigation ratio for this region. We have revised the related sentence in the new manuscript.

*IrriMap\_CN estimates the irrigation ratios (i.e., the ratio of irrigated cropland area to total cropland area) to be 0.47, 0.37, and 0.61, respectively, for China, Northern China, and Xinjiang Uygur Autonomous Region (Supplementary Figure S4). In comparison, the values derived from CIrrMap250 are 0.58, 0.70, and 0.96, respectively, which align more closely with reality and official reports (<https://gtdc.mnr.gov.cn/>).*

L370-374: “However, CirrMap250 tends ... southern part of South China (SC)” – why? Could you discuss this section a little bit more. Readers may not go back to the literature on the other products to find out by themselves. Also, what does ‘\*southern part of \*South China’ mean?

**Response:** Thanks for the suggestion. We have provided more explanation and discussion on those results. Additionally, we have revised the phrase “south part of South China” to simply “South China” to prevent any potential confusion.

*Nevertheless, CIrrMap250 tends to yield lower estimates of irrigation area in Northeast China (NEC) when compared to IrriMap\_CN, possibly due to inaccurate statistical and survey data in this region. In contrast to CIrrMap250 and IrriMap\_CN, IAAA notably underestimates irrigated croplands in Northwest China (NWC) and North China (NC), but overestimates them in NEC and Southwest China (SWC). This could*

*be explained by the fact that IAAA was developed using an unsupervised classification algorithm based mainly on vegetation dynamics (Siddiqui et al., 2016), limiting its ability to accurately depict the extent and spatial heterogeneity of irrigation in China (Tian et al., 2024). GFSAD shows overestimations of irrigated area in the Dujiangyan district and the North China Plain, but exhibits evident omission errors in sparsely distributed irrigation regions like NWC and South China (SC). The large bias of GFSAD is understandable, as it is not an irrigation-specific product and only considers five major crop types (Xie et al., 2021; Thenkabail et al., 2016).*

**L388: Fig5 – This figure needs improvement. How come no irrigated pixels in zone B are detected by the 1Km GFSAD product?**

**Response:** In the revised manuscript, we have improved the figure by thickening the borders of the subplots. Meanwhile, we have provided the legend for different products (as shown below). Regarding your comment on lacking irrigated pixels of GFSAD in Zone B, we have carefully reviewed the map and indeed found that it did not identify any irrigated cropland. This is because GFSAD notably underestimates irrigated cropland in Zone B and its surrounding regions. Furthermore, we cross-checked the comparison results of the irrigated cropland map with GFSAD in the study by Zhang et al. (2022a), they also reported significant underestimation of irrigated cropland by GFSAD, particularly in Southern China. The underestimation of irrigated cropland by GFSAD may be attributed to the fact that it is not an irrigation-specific product and only considers five major crop types (Thenkabail et al., 2016; Xie et al., 2021).

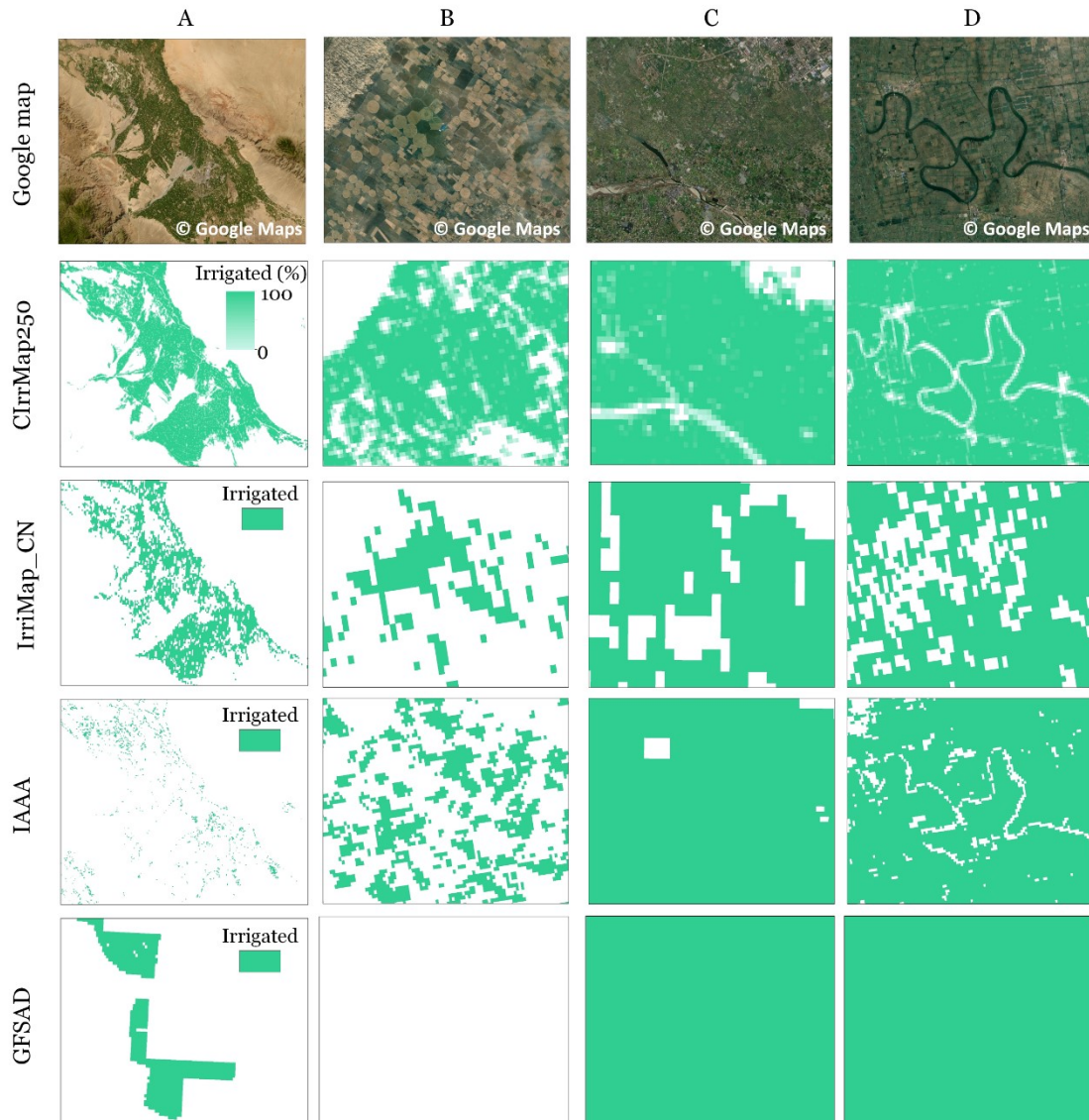


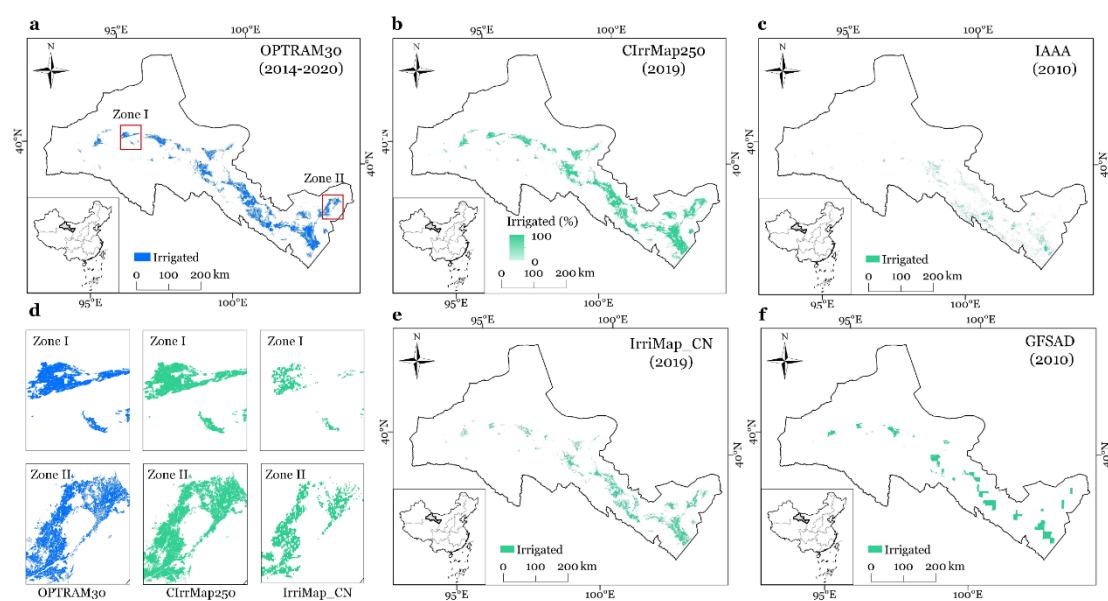
Figure 5. Visual comparison of CIrrMap250 with the existing maps. The five rows from top to bottom correspond to the Google map, CIrrMap250, IrriMap\_CN, IAAA and GFSAD, respectively. Locations of the four selected zones are presented in Figure 4a.

L391: “Figure 6 ...CIrrMap250 exhibits a robust agreement with OPTRAM3” - This is not clear from the figure. Qualitatively, Figure 6a may even be interpreted differently unless the authors have overlain CIrrMap250 over OPTRAM30. If that is the case, please find a better way to illustrate/present the map inter-comparisons.

**Response:** Thanks for the comment. In the previous version, Figure 6a presented overlays of CIrrMap250 on the OPTRAM30 map. We agree it is not easy to interpret. We have thus revised the figure. Specifically, we have depicted the irrigated cropland distribution in CIrrMap250, IAAA, IrriMap\_CN, GFSAD, and OPTRAM30, respectively. Additionally, we have further compared CIrrMap250 and IrriMap\_CN

with OPTRAM30 in two local zones to better illustrate the differences between ClrrMap250 and IrriMap\_CN. We present the revised figure alongside the related descriptions below for your reference.

*Figure 6 provides an additional comparison of the aforementioned large-scale irrigation maps with the field-scale remote sensing irrigation map (OPTRAM30) in the Hexi Corridor of Northwest China. ClrrMap250 exhibits a robust agreement with OPTRAM30 in the distribution of irrigated cropland. While IrriMap\_CN captures the general pattern of irrigated croplands in this region, it tends to underestimate irrigation extent, as demonstrated evidently in the two selected local zones (Figure 6d). The IAAA product struggles to identify irrigated cropland in this area, displaying significant omission and commission errors. Similarly, GFSAD has a limited ability to accurately depict irrigated areas in the Hexi Corridor.*



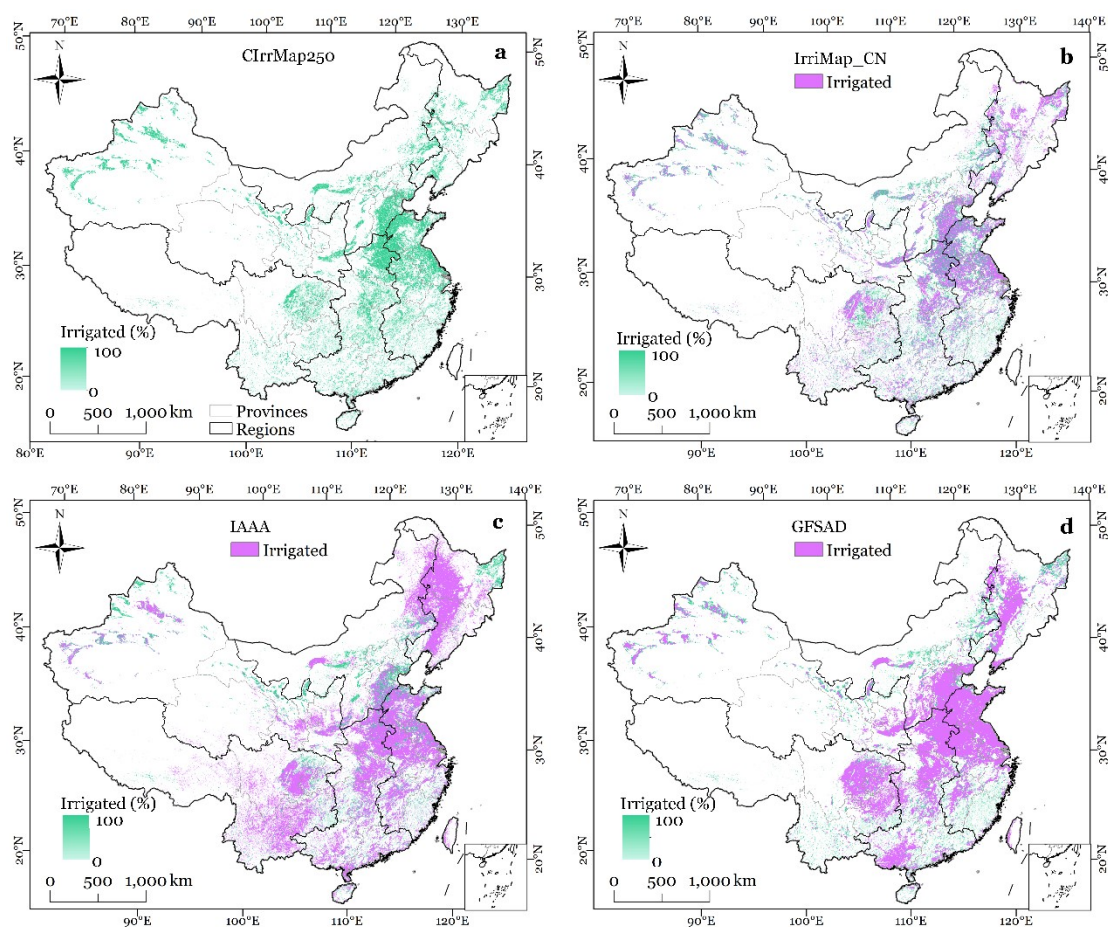
*Figure 6. Comparison of large-scale irrigation maps with the field-scale remote sensing irrigation map (OPTRAM30) in the Hexi Corridor of Northwest China. Panels a, b, c, e, and f depict the distribution of irrigated cropland in OPTRAM30, ClrrMap250, IAAA, IrriMap\_CN, and GFSAD, respectively. Panel d presents the comparisons of ClrrMap250 and IrriMap\_CN with OPTRAM30 in two local zones.*

Figure6 – the [0-100] color scale as provided in Figure4 is missing. In supplementary, Figure S2 (b, c, d) – the magenta color scale (for IrriMap, IAAA, GFSAD) is missing. Additionally, why was year 2019 selected in Figure6a,b (ClrrMap250/IrriMap\_CN) for the comparisons with the 2014-2020 OPTRAM30 product?

**Response:** The color scale has been provided in the revised figure 6 (see above). The OPTRAM30 product was derived by counting the detected irrigation events over an

extended period (2014-2020) to complement for any missed detections. We opted to compare CIrrMap250 and IrriMap\_CN with OPTRAM30 using data from the year 2019 for two reasons. Firstly, the authors of OPTRAM30 have utilized images from 2019 and 2020 to assess the spatial pattern of their irrigation maps. Second, IrriMap\_CN covers the period from 2000 to 2019, while our product CIrrMap250 spans from 2000 to 2020. To maintain consistency between IrriMap\_CN and CIrrMap250, we selected the year 2019 for data comparison.

Figure S2 becomes Figure S3 now, and it has been replotted in the new manuscript. We presented it here for your reference.



*Figure S3. Comparison of the distributions of irrigated cropland in CIrrMap250 with the existing products (IrriMap\_CN, IAAA, GFSAD). Panel a displays the distribution of irrigated cropland in CIrrMap250, while panels b, c, and d overlay the irrigation maps IrriMap\_CN, IAAA, and GFSAD on CIrrMap250, respectively.*

L406-407: “..., namely 2010 and 2020. The estimates of irrigated areas from the other two maps, namely IAAA and GFSAD, are able to explain only a small proportion of the variances in irrigation water withdrawals (i.e., 0.12 and 0.20) ...” – Please clarify. According to Figure 7c,e, these (IAAS and GFSAD) metrics only apply to year 2010 NOT 2020.



**Response:** Yes, these metrics of IAAA and GFSAD only apply to the year 2010. We have clarified it in the revised manuscript.

*As shown in Figures 7c and f, the irrigated area estimates from the other two maps (i.e., IAAA and GFSAD) demonstrate limited explanatory power, explaining only 12% and 20% of the variation in irrigation withdrawals for the year 2010.*

L410: "...irrigated area estimates against irrigation water withdrawals..." – maybe you mean ‘irrigated water withdrawals against irrigation area estimates...’? Y against X.

**Response:** We agree, and it has been revised.

*Figure 7. Scatterplots of irrigation water withdrawals against irrigated area estimates from different products for the years circa 2010 and 2020. The data are presented in logarithmic units to reflect both small and large values.*

L426: "As shown in Figure 9, all subregions exhibit an increasing trend in irrigated area from 2000 to 2020" - is this conclusion based on CIrrMap250 or some other [reference] data?

**Response:** Yes, the conclusion is based on CIrrMap250. We have revised the sentence.

*As shown in Figure 9, our annual irrigation maps (i.e., CIrrMap250) indicated that all subregions exhibited an increasing trend in irrigated area from 2000 to 2020, with NEC expanding significantly faster than the other subregions.*

L435-: Figure 9d - some of the percentage entries in the concentric pie charts are likely incorrect. I.e. percentages for years 2000 and 2020 add up to 101% (11+7+17+30+24+12) and 98% (11+11+16+26+22+12), respectively.

**Response:** Thanks for the reminder. We have checked the results carefully and revised the figure accordingly. We present the revised figure here for your reference.

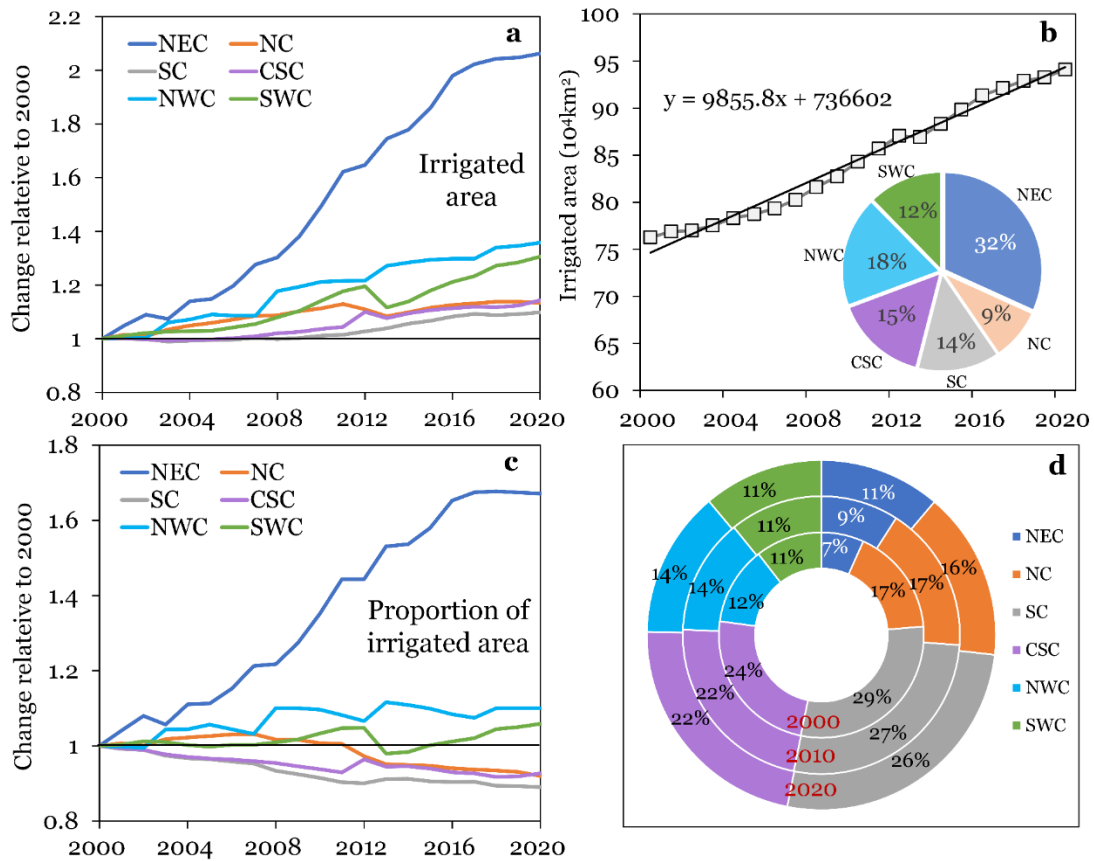


Figure 9. Changes in irrigated area across the six subregions of China during 2000-2020. a, Relative changes in irrigated area. b, Changes in China's total irrigated area, with the contribution of different subregions depicted in the inserted pie chart. c, Relative changes in the proportion of irrigated area. d, Proportion of irrigated area for the years 2000, 2010 and 2020.

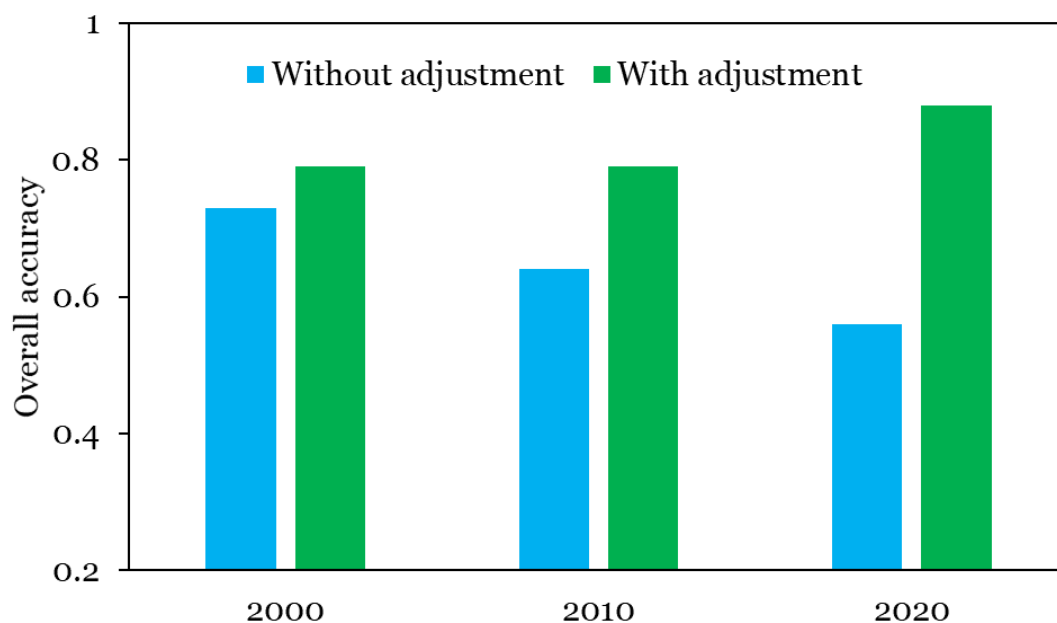
L445: "... The net expansion of irrigated area is about 180,000 ..." but L427 reads "The irrigated area of China increases from 750,000 to 950,000...", which is ~200,000. Both for the 2000-2020 period. Please be consistent with the presented numbers.

**Response:** Thank you for the comment. We have double-checked our results and have confirmed that the irrigated area of China has increased from about 760,000 to 940,000 km<sup>2</sup> over 2000-2020, with a net increase of about 180,000 km<sup>2</sup>. We have revised this sentence.

*The irrigated area of China increased from about 760,000 to 940,000 km<sup>2</sup> at the rate of about 10,000 km<sup>2</sup>/year (or 1.29%/year).*

L465: "...leading to a decrease in irrigation mapping accuracy by 8%-26% (Supplementary Figure S4)." – do these numbers refer to supplementary Figures S3? They do not appear in Figure S4.

**Response:** Apologies for our carelessness. We have placed the figure in the wrong place. This sentence should be referred to Figure S5 in the revised manuscript. We present the figure below for your reference. Furthermore, we have carefully reviewed the figures in Supplementary file to avoid similar mistakes.

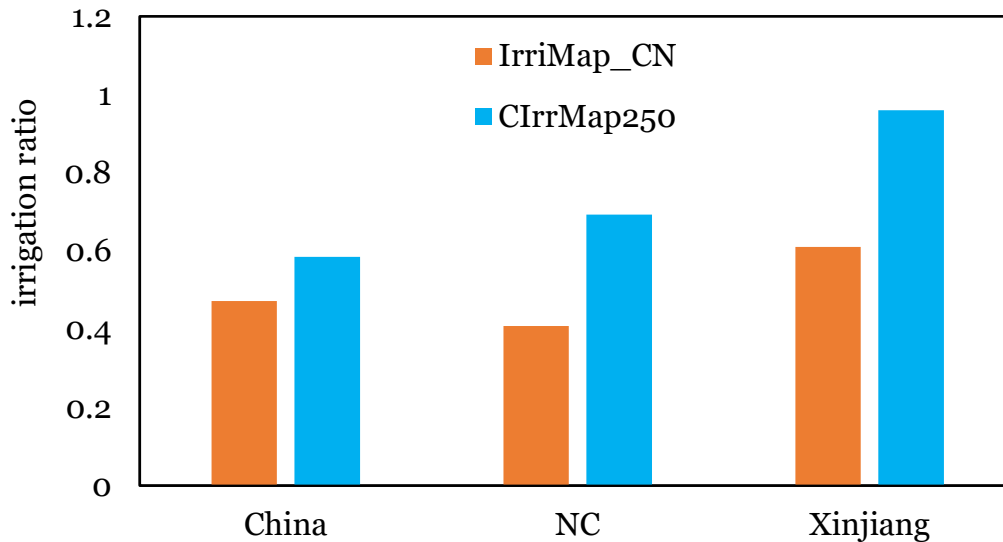


*Figure S5. Comparison of the performance of irrigated cropland maps constrained by different irrigated area data. “without adjustment” means the use of the original irrigated area statistics, while “with adjustment” indicates the use of the harmonized and reconciled irrigated areas (this study).*

The caption of Figure S3 reads “Comparison of irrigated ratio estimates of CIrrMap250 and IrrMap\_CN in China, Northern China, Xinjiang Uygur Autonomous Region” ... does this mean that this conclusion only applies to that specific part of China?

**Response:** Figure S3 has been erroneously presented in the original manuscript. We present the correct figure below for your reference. The sentence in the main texts that refers to the figure are as follows (see Section 4.1.2):

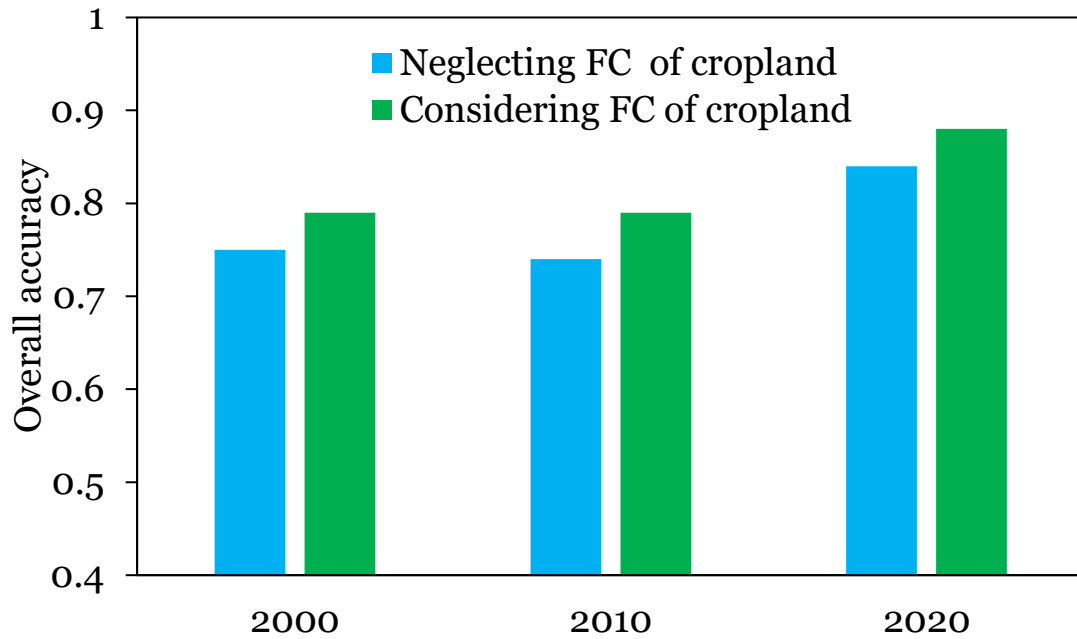
*IrrMap\_CN estimates the irrigation ratios (i.e., the ratio of irrigated cropland area to total cropland area) for China, Northern China, and Xinjiang Uygur Autonomous Region as only 0.47, 0.37, and 0.61, respectively (Supplementary Figure S4). In comparison, the values derived from CIrrMap250 are 0.58, 0.70, and 0.96, respectively, which align more closely with reality and official reports (<https://gtdc.mnr.gov.cn/>).*



*Figure S4. Comparison of irrigated ratio estimates of CIrrMap250 and IrriMap\_CN in China, Northern China, Xinjiang Uygur Autonomous Region*

L474-475: “... The accuracy of the irrigated cropland map would decrease by approximately 5%-6% (Supplementary Figure S6) “ - Figure S6 (in the supplementary document) contradicts this statement. From the figure, it appears that “considering FC of cropland” (blue bars according to the plot legend, and “this study” according to the caption) yields worse overall accuracies (OA) than “Neglecting FC of cropland” (green bars). This is the case for all three (2000, 2010, 2020) years. Is the plot legend correct?

**Response:** Thanks for the kind reminder. We have mistakenly presented the legend of the figure. As depicted in the revised figure (see below), the accuracy of the irrigated cropland map would decrease by approximately 5%-6% if we disregard the fractional coverage of cropland. Yes, this decrease in mapping accuracy can be observed across the three years (i.e., 2000, 2010, and 2020).



*Figure S7. Comparison of performance of irrigated area maps in the scenarios of considering fractional coverage (FC) of irrigated cropland (this study) and neglecting FC of irrigated cropland*

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