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

Overall, this will be a useful work to publish. However, there are, currently, numerous highly significant issues that needs to be addressed and re-reviewed before further consideration.

1. Very poor reference to literature

I have marked at number of places where existing Landsat-derived rainfed and irrigated area product @ 30 m (LGRIP30) is completely overlooked. Authors claim other existing products are coarse but fail to mention at number of places LGRIP30 which is a 30 m global irrigated and rainfed cropland product exists.

Apart from that reference to literature pertaining to previous irrigated and rainfed areas is poor. I definitely like to see upfront reporting of this keeping in view highest scientific ethics.

Response:

Thanks for your useful comments we included the Landsat-derived rainfed and irrigated area product at 30 meters (LGRIP30) in the list of existing products. We acknowledge the oversight in our initial submission and have now added a detailed description of LGRIP30 within the text.

We would like to clarify that our product GMIE, was published in March 2023, coinciding with the release of LGRIP-30. This timing may have contributed to the initial lack of a comprehensive description of LGRIP-30 in our introduction. However, we have since rectified this by including a thorough introduction to LGRIP-30, recognizing its importance as a high-resolution irrigated land product. We have also taken the opportunity to compare our GMIE with LGRIP-30, highlighting the similarities and differences in methodology, application, and results. This comparison is aimed at providing a clearer understanding of the contributions our work makes to the field of high-resolution agricultural land classification using remote sensing.

We appreciate the reviewer's guidance in maintaining the highest scientific standards and ethics in our work. We believe that the revisions made will strengthen the manuscript and ensure that it acknowledges and builds upon the existing body of research in a respectful and scholarly manner.

Line 92-98:

Among these data, the Landsat-derived Global Rainfed and Irrigated-area Product (LGRIP30) is a high-resolution irrigated cropland with an overall accuracy of 86.5% using advanced machine learning algorithms, which is released on Feb 2023 and available through NASA's Land Processes Distributed Active Archive Center (LP DAAC)(Teluguntla et al., 2023). The LGRIP30 data indicates a total global net irrigated area (TGNIA) of 0.71 billion hectares among all cropland area of 1.80 billion hectares of croplands, ie the irrigation proportion was about 39.44% , suggesting a notably *high proportion compared with exiting result (Thenkabail et al., 2009; Siebert et al., 2015).*

2. Methods

Authors divide the world into 110 zones and use very simplistic NDVI approach to determining where are the irrigated and rainfed croplands. This approach when applied within each zone like those in Indus or Ganges will provide reasonable results in separating irrigation from rainfed. But in numerous other zones where there is minor ground water irrigation or in humid areas will have huge uncertainties.

Why is such a simplified approach adopted for such a complex problem of separating irrigated from rainfed. Please refer to algorithm theoretical basis document (ATBD) of LGRIP30:
https://lpdaac.usgs.gov/products/lgrip30v001/

I understand that such a simplified approach is easy to code in GEE. But, uncertainties of the outputs will be huge.

Response:

Thank you for your valuable comment. We acknowledge that decision tree methods are indeed beneficial for information mining and can handle complex datasets to extract useful insights. Nevertheless, In developing our method, we have retraced the essence of irrigation to identify key time windows that require irrigation. We use these time windows along with vegetation indices to differentiate between irrigated and rainfed croplands. While the final thresholding approach is relatively straightforward to implement in Google Earth Engine (GEE), the selection of appropriate time windows, preparation of multi-year remote sensing data, and accurate zoning processes are crucial.

As you pointed out, the accuracy of our method does indeed vary across different regions. This is due to the variability in climate, soil types, crop species, and irrigation practices among different areas. According to the accuracy reports for each irrigation mapping zone, there is cropland in 105 zones of total 110 irrigation mapping zones,whilw 96 of them have an accuracy greater than 70%. There are just 9 divisions with accuracy less than 70%, most of which are located in the Southeast Asian Island countries, regions like Thailand, Myanmar, Laos, and the tropical rainforest areas of South America (Amazon), which are humid regions.

Furthermore, our method has been published in the journal *Global Environmental Change (GEC)*, where the article provides a detailed description of our approach and implementation process. The current paper is a description of the dataset generated by that method. Our goal is to provide a reliable dataset for researchers and policymakers to better understand and manage irrigated croplands.

We recognized that there is huge uncertainty in the above-mentioned regions, but the irrigation proportion in this region is usually not that much compared with arid and semi-arid regions. Meanwhile, the identification of irrigation in these regions using the machine leaning methods is also challenging task and not easy to fully distinguish irrigated and rainfed cropland without proper feature inputs.

We understand and agree with your concerns about the uncertainties that may arise for humid regions. Therefore, we have also discussed these potential uncertainties in the paper and suggested possible directions for improvement in future research. We believe that the combination of irrigation performance assessment to choose optimal time windows and powerful machine learning methods could be potential way to handle this problem for humid regions.

Line 563-573:

The accuracy of our method indeed varies across different regions due to the variability in climate, soil types, crop species, and irrigation practices among different areas. According to the accuracy reports for each irrigation mapping zone, cropland is present in 105 out of the total 110 irrigation mapping zones, with 96 of them exhibiting an accuracy greater than 70%. There are only 9 divisions with accuracy less than 70%, most of which are situated in the Southeast Asian island countries, regions such as Thailand, Myanmar, Laos, and the tropical rainforest areas of South America, notably the Amazon, which are characterized by their humid conditions. We acknowledge that there is significant uncertainty in these aforementioned regions; however, the proportion of irrigation in these areas is typically not as substantial compared to arid and semi-arid regions. The task of identifying irrigation in these regions using machine learning methods is also challenging, as it is not straightforward to fully distinguish between irrigated and rainfed cropland without accurate phenological inputs. A potential solution for improving accuracy in humid regions could involve the integration of irrigation performance assessments to select optimal time windows, coupled with advanced machine learning techniques.

4. Accuracy assessments

Each of the 110 zones much have accuracy error matrices.

Response:

Thank you for your comment regarding the accuracy assessments for each of the 110 zones in our study. We understand the importance of providing detailed accuracy error matrices for each zone to ensure the credibility and robustness of our findings.

In response to your request, we have prepared and included detailed accuracy reports for each zone as supplementary material. These reports contain point number used for validation and overall accuracy for each zone, which are useful for understanding the reliability of the data.

We appreciate your comments and look forward to your further feedback on our revised manuscript and provided supplementary materials.

Line 434:

The specific accuracy for each IMZ could refer to Table S1

Region code	Region name	Cropland Sources &year	Crop Types	Climate Zone	Driest Year	Dry Months	P	P/PET	P-PET	Threshold		NDVI difference (average Irrigated - average rainfed)	Overall accuracy	Point number used for validataion
										NDVI at Dry season	NDVI deviation at Extreme events			
C01_1	Equatorial central Africa_zone1 (Cameron, Central African Republic, and South Sudan)	GFSAD30AFC	Cassava, rice and banana	Tropical savanna	2014	April-July	104.3	0.90	-11.6		-1.2%		77.60%	18
C01_2	Equatorial central Africa_zone2 (North DRC, Equatorial Guinea, Uganda, Republic of Co	GFSAD30AFC	Cassava, rice and banana	Tropical monsoon & Tropical rainforest	2014	April-July	90.5	0.85	-15.8		-1.0%		70.50%	18
C01_3	Equatorial central Africa_zone3 (South DRC, Rwanda, Burundi, Gabon)	GFSAD30AFC	Cassava, rice and banana	Tropical savanna	2014	April-July	94.6	0.89	-11.2		-1.0%		88.90%	29
C01_4	Equatorial central Africa_zone4 (Angola, Zambia, and Malawi)	GFSAD30AFC	Cassava, rice and banana	Temperate, dry winter, hot summer	2013	July-August	23.0	0.78	-6.5	0.49		0.40	92.90%	53
C02	East African highlands	FORM-GLC30	Cassava, rice and banana	Temperate	2015	January - March	26.2	0.92	-2.4	0.68		0.34	100.00%	37
C03_1	Gulf of Guinea zone1 (Nigeria, Benin, Togo, Ghana, Cote d'Ivoire, Guinea, and Guinea-B	FORM-GLC30	rice and maize	Tropical savanna	2015	January - March	42.9	0.21	-163.3	0.42		0.34	98.10%	31
C03_2	Gulf of Guinea zone2 (South Nigeria, Liberia, Sierra Leone, south Ghana, south Cote d'Iv	FORM-GLC31	rice and maize	Tropical mansoon	2015	March-May	88.7	0.95	-4.5		-10.0%		90.90%	23
C04	Horn of Africa	FORM-GLC30	Wheat, maize, sorghum and soybean	arid, sub-arid, warm humid and sub humid	2017	September-November	67.0	0.32	-143.8	0.71		0.17	98.00%	36
C05	Madagascar(main)	FORM-GLC30	Rice, maize, beans and peanuts	subtropical	2016	September	10.3	0.16	-50.8	0.55		0.25	99.00%	32
C06	SW Madagascar	FORM-GLC30	rice and maize	sub arid tropical climate	2016	September	4.9	0.09	-47.1	0.55		0.39	91.00%	20
C07	North Africa Mediterranean	FORM-GLC30	Wheat, Rice, Barley, Soybeans, Maize	Arid & Temprate climate	2017	July	3.6	0.01	-257.5	0.24		0.36	94.40%	244
C08	Sahel	FORM-GLC30	apple , vegetable	Tropical savannah	2017	Oct. - December	17.0	0.07	-233.4	0.45		0.40	99.50%	79
C09_1	Southern Africa_zone1 (West Angolan coast)	GFSAD30AFC	cotton, maize	Arid, steppe, hot	2017	March-May	26.5	0.17	-133.8		-10.0%		85.20%	9
C09_2	Southern Africa_zone2 (southeastern Kenya, East Tanzania, and Mozambique)	GFSAD30AFC	wheat, maize	Tropical savannah	2015	September-October	19.2	0.72	-7.5	0.60		0.39	97.00%	43
C09_3	Southern Africa_zone3 (South Zambia)	GFSAD30AFC	wheat, maize	Temperate, dry winter, hot summer	2015	September-October	7.8	0.03	-248.4	0.51		0.39	99.00%	62
C09_4	Southern Africa_zone4 (Zimbabwe)	GFSAD30AFC	wheat, maize	Temperate, dry winter, warm summer	2015	September-October	13.0	0.05	-244.9	0.53		0.44	93.00%	93
C09_5	Southern Africa_zone5 (Northeast of Namibia, Botswana, and south Zimbabwe a	GFSAD30AFC	wheat, maize	Arid, steppe, hot	2015	August - October	11.0	0.04	-256.2	0.51		0.33	91.00%	94
C09_6	Southern Africa_zone6 (West Namibia coast)	GFSAD30AFC	wheat, maize	Arid, desert, hot	2018	July-December	14.3	0.06	-218.9	0.32		0.25	92.00%	31
C09_7	Southern Africa_zone7 (Southeast Namibia, Southwest Botswana, and northeast of Sout	GFSAD30AFC	wheat, maize	Arid, desert, hot	2015	July-December	16.0	0.06	-247.8	0.34		0.52	88.00%	72
C09_8	Southern Africa_zone8 (South Africa and southwest Namibia)	GFSAD30AFC	wheat, maize	Arid, desert, cold	2018	May-June	16.0	0.12	-122.7	0.39		0.41	93.00%	49
C09_9	Southern Africa_zone9 (western part of South Africa, Lesotho, and Eswatini)	GFSAD30AFC	wheat, maize	Temperate, dry winter, warm summer	2015	May-December	27.6	0.26	-79.4	0.68		0.42	88.00%	83
C09_10	Southern Africa_zone10 (Middle part of South Africa)	GFSAD30AFC	wheat, maize	Arid, steppe, cold	2015	June-October	40.8	0.21	-154.8	0.70		0.41	89.00%	89
C10	S. Africa Western Cape	FORM-GLC30	wheat, maize	temperate climate	2017	Nov-Dec.	2.1	0.07	-25.7	0.45		0.45	98.00%	81
C11	British Columbia To Colorado	CDL&AAFC	wheat	Cold, no dry season, cold summer	2013	May-August	49.5	0.20	-139.4	0.74		0.28	80.00%	139
C12_1	America northern great plains_canada	CDL&AAFC	winter wheat, spring wheat	Cold, no dry season, warm summer	2012	July-August	28.0	0.16	-144.0		-10.0%		88.00%	83
C12_2	America northeastern great plains	CDL&AAFC	winter wheat, spring wheat	Cold, no dry season, warm summer	2012	May-June	62.0	0.27	-152.2		-10.0%		84.00%	77
C12_3	America northwestern great plains	CDL&AAFC	winter wheat, spring wheat	Cold, no dry season, warm summer	2012	May-June	32.0	0.16	-169.0		-10.0%		92.00%	64
C12_4	Nnorth of high plain	CDL&AAFC	winter wheat, spring wheat	Cold, no dry season, warm summer	2012	June-July	29.0	0.12	-204.0	0.52		0.53	97.00%	72
C13	America corn belt	CDL	Corn, soybean	Cold, no dry season, warm summer	2012	June-July	80.8	0.37	-135.2		-10.0%		91.00%	67
C14_1	America cotton belt-Mexican coastal plain	CDL	cotton	Temperate, no dry season, hot summer	2011	July-August	30.3	0.11	-232.6	0.37		0.21	76.00%	144
C14_2	America cotton belt-lower Mississippi	CDL	cotton	Temperate, no dry season, hot summer	2010	July-August	111.2	0.49	-117.0	0.70		0.45	96.00%	101
C14_3	America cotton belt-high plain	CDL	cotton	Temperate, no dry season, hot summer	2010	July	108.8	0.45	-131.5		-15.0%		85.00%	66
C15	Sub-boreal North America	AAFC	winter wheat, spring wheat	Cold, no dry season	2010	April-June	76.3	0.42	-72.4		-17.0%		95.00%	76
C16	America West Coast	CDL&AAFC	wheat, maize	Temperate, dry summer, warm summer	2013	May-July	38.7	0.10	-200.7	0.64		0.25	78.00%	70
C17	Sierra Madre	FORM-GLC30	Soybean, Maize, Wheat, Sorghum and Rice	Tropical, dry and tempered	2012	March-May	28.0	0.11	-221.5		-20.0%		73.00%	75
C18	SW Mexico and N. Mexico highlands	CDL	maize, wheat	Arid, desert	2011	June-July	30.1	0.08	-242.6	0.52		0.54	95.00%	83
C19	Northern South and Central America	FORM-GLC30	Rice, Maize and Sorghum	Tropical temperate, Arid	2015	February	55.5	0.28	-139.7		-10.0%		42.00%	46
C20	Caribbean	FORM-GLC30	Rice, Maize and Sorghum	Tropical warm	2015	March	35.3	0.16	-184.2		-8.0%		49.00%	64
C21_1	Central-Northern Andes	FORM-GLC30	Soybean, Barley, Wheat, Sorghum and Rice	Arid	2010	March-December	25.8	0.13	-170.5	0.10		0.74		0
C21_2	Central-Northern Andes	FORM-GLC30	Soybean, Barley, Wheat, Sorghum and Rice	Polar, tundra & Arid, steppe, cold	2016	August	49.6	0.32	-104.5	0.47		0.40	92.10%	60
C22	Brazil Nordeste	MapBiomas &FORM-GLC30	Barley, Maize, Rice, Cotton and Wheat	Tropic, Semi-arid	2012	August-October	12.7	0.07	-178.0	0.42		0.40	89.20%	335
C23	Central-Eastern Brazil	MapBiomas & FORM-GLC30	Barley, Maize, Rice, Cotton and Wheat	Tropical temperate	2015	August	11.3	0.06	-193.2	0.60		0.56	96.70%	1930
C24	Amazon	MapBiomas & FORM-GLC30	Barley, Maize, Rice, Cotton and Wheat	Rainforest climate	2015	September	70.9	0.37	-121.3		-1.0%		31.00%	59
C25	Central-North Argentina	FORM-GLC30 & INTA	Maize, Barley, Wheat, Sorghum and Rice	Temperate, dry summer	2013	July-September	9.3	0.05	-194.1	0.57		0.34	94.20%	75
C26	SE Brazil-Concepcion-Bahia Blanca	MapBiomas, FORM-GLC30 & INTA	Soybean, Maize, Wheat, Sorghum and Rice	Tropical rainforest	2008	July	49.9	0.71	-20.6		-13.0%		89.00%	400
C27	SW Southern Cone	FORM-GLC30	Barley, Maize, Rice and Wheat	Semi-arid	2016	January-March	34.6	0.17	-164.7	0.44		0.49	96.90%	62
C28	Semi-arid Southern Cone	FORM-GLC30	Maize, Barley, Wheat, Sorghum and Rice	Arid	2009	January-December	24.8	0.23	-81.1	0.57		0.27	84.53%	13
C29	Caucasus	FORM-GLC30	Wheat, Barley, Corn, Rice, Soybeans	Cold	2017	June & July	48.9	0.01	-228.0		-10.0%		86.47%	19
C30	Central Asia Pamir mountains	FORM-GLC30	Maize	Cold, dry summer	2016	July	40.5	0.17	-195.0		-20.0%		86.00%	82
C31-1	Western Asia	FORM-GLC30	maize	Arid	2017	July- September	6.1	0.69	-3.0	0.26		0.44	99.00%	51
C31-2	Western Asia1	FORM-GLC30	corn(maize)	Semi-arid	2017	July- September	7.3	0.81	-1.6	0.31		0.61	100.00%	58
C32	China Gansu-Xinjiang	China_Cover	Wheat,Maize	Temperate continental climate	2017	Jan. - Dec.	25.1	0.09	-122.2	0.12		0.65	100.00%	155
C33	China Hainan	China_Cover	Rice	Tropical monsoon climate	2015	May	69.5	0.34	-136.0		-12.0%		99.00%	75
C34	China Huang Huaihai	China_Cover	Wheat,Maize	Temperate monsoon climate	2014	March - May	41.8	0.19	-135.7	0.36		0.23	81.00%	1368
C35	China Inner Mongolia	China_Cover	Wheat,Maize	Temperate continental climate	2017	June - August	117.0	0.41	-114.0		-16.0%		84.00%	1120
C36	China Loess region	China_Cover	Millet,Wheat,Maize	Temperate monsoon climate	2015	July	49.1	0.25	-150.6		-20.0%		99.00%	1246
C37	China Lower Yangtze	China_Cover	Wheat,Maize	Subtropical monsoon climate	2011	April	60.0	0.39	-93.3		-20.0%		72.00%	4600
C38	North East China	China_Cover	Wheat,Maize	Temperate monsoon climate	2011	April-June	90.0	0.43	-83.7		-10.0%		74.00%	7000
C39	China Qinghai-Tibet	China_Cover	Wheat,Barley	Plateau mountain climate	2015	July	67.3	0.35	-127.6		-15.0%		91.00%	51
C40	Southern China	China_Cover	Early_Rice	Subtropical monsoon climate	2011	April	53.8	0.37	-91.5		-12.0%		76.00%	330
C41	South-West China	China_Cover	Rice,Wheat,Maize	Subtropical monsoon climate	2011	April	38.6	0.25	-118.6		-20.0%		94.00%	48
C42	Taiwan	China_Cover	Rice,Wheat,Maize	Tropical monsoon climate/Subtropical monsoon climate	2014	April	56.6	0.37	-97.5		-25.0%		99.00%	48
C43	East Asia	GFSAD30AFC	Rice,Maize	Temperate monsoon climate	2008	June	83.5	0.45	-101.4		-30.0%		100.00%	49
C44-111	Southern Himalayas_zone111 (Vietnam, Laos, Myanmar)	SERVIR-Mekong Land Cover	Rice, Maize, Wheat	Temperate, dry winter, hot summer/Tropical, savannah	2016	November	98.2	0.75	-33.2	0.52		0.22	66.00%	12
C44-112	Southern Himalayas_zone112 (Myanmar)	SERVIR-Mekong Land Cover	Rice, Maize, Wheat	Temperate, dry winter, hot summer	2014	December	3.1	0.03	-120.8		-0.3%		77.00%	6
C44-113	Southern Himalayas_zone113 (India, Myanmar, Bangladesh)	SERVIR-Mekong Land Cover&GFSAD30AFC	Rice, Wheat	Temperate, dry winter, hot summer/Tropical, savannah	2014	January	2.7	0.02	-121.4	0.50		0.26	82.00%	9
C44-12	Southern Himalayas_zone12 (Bhutan)	Land cover data of Bhutan	Rice, Maize, Wheat	Temperate, dry winter, hot&warm summer	2016	December	1.0	0.01	-97.0		-0.6%		78.00%	10
C44-211	Southern Himalayas_zone211 (India)	GFSAD30AFC	Corn, Millet, Rice, Wheat	Temperate, dry winter, hot&warm summer	2016	May	53.8	0.21	-203.0	0.51		0.32	97.00%	43
C44-212	Southern Himalayas_zone222 (Nepal, India)	National landcover database for Nepal&GFSAD30AFC	Corn, Millet, Rice, Wheat	Temperate, dry winter, hot&warm summer	2017	October	6.9	0.03	-266.6	0.62		0.04	65.00%	36
C44-221	Southern Himalayas_zone221 (India)	GFSAD30AFC	Rice, Maize, Wheat, Soybean	Arid, steppe, hot/Arid, desert, hot	2017	March	13.9	0.09	-140.0	0.30		0.40	94.00%	15
C44-222	Southern Himalayas_zone222 (India)	GFSAD30AFC	Rice, Maize, Wheat, Soybean	Tropical, savannah	2017	March	3.4	0.03	-111.0	0.31		0.31	98.00%	14
C44-223	Southern Himalayas_zone223 (India)	GFSAD30AFC	Rice, Maize, Wheat, Soybean	Temperate, dry winter, hot summer	2017	February	3.0	0.02	-184.5	0.44		0.32	90.00%	9
C45	Southern Asia	FORM-GLC30	rice	Tropical, savannah	2017	Jan.-Feb.	9.6	0.04	-182.2	0.45		0.28	86.00%	87
C46	Southern Japan and Korea	GFSAD30AFC	Rice	Temperate maritime monsoon climate	2013	May	79.6	0.44	-101.4		-30.0%		100.00%	48
C47	Mongolia region (Western of Mongolia)	Mongolia Land Cover	Wheat, Barley, Potatoes, and vegetables	Arid, steppe, cold / Arid, desert, cold						0.10		0.74		
C48	S. Asia Punjab to Gujarat	FORM-GLC30	rice	Arid, desert, hot	2017	Jan-Feb	4.4	0.02	-175.9	0.44		0.34	92.00%	58
C49-1	SE Asia islands_zone1 (Indonesia, Malaysia)	GFSAD30AFC	Maize, Rice	Tropical rainforest & savannah	2014	July	130.8	0.89	-15.6		-5.0%		54.00%	31
C49-2	SE Asia islands_zone2 (Indonesia, Malaysia)	GFSAD30AFC	Maize, Rice	Tropical rainforest	2015	October	169.4	1.21	29.6		-2.5%		58.00%	25
C49-3	SE Asia islands_zone3 (Indonesia, Papua New Guinea)	GFSAD30AFC	Maize, Rice/ sweet potatoes, sugar cane, copra, coffee, cocoa, rubber	Tropical rainforest	2015	November	160.2	1.02	3.0		-2.5%		47.00%	56
C50-1	SE Asia mainland_zone1 (Myanmar, Bangladesh)	SERVIR-Mekong Land Cover&GFSAD30AFC	Rice, Wheat	Tropical, savannah/Arid, steppe, hot	2016	February	4.3	0.02	-181.2		-10.0%		94.00%	54
C50-2	SE Asia mainland_zone2 (Thailand, Myanmar, Laos)	SERVIR-Mekong Land Cover	Maize, Rice, Wheat	Tropical, savannah/Tropical, monsoon	2015	February	10.9	0.05	-188.3		-5.0%		48.00%	25
C50-3	SE Asia mainland_zone3 (Cambodia, Vietnam, Thailand, Laos)	SERVIR-Mekong Land Cover	Rice, Maize	Tropical, savannah/Tropical, monsoon	2015	January	5.0	0.03	-193.0		-1.3%		98.00%	15
C51	Eastern Siberia		no crop	Tundra										
C52	Eastern Central Asia (Eastern of Mongolia)	Mongolia Land Cover	Wheat, Barley, Potatoes, and vegetables	Arid, steppe, cold / Arid, desert, cold	2016	September	16.5	1.07	1.1	0.50		0.41	78.00%	18
C53-1	North Australia_zone1 (Timor-Leste, Indonesia, Papua New Guinea)	GFSAD30AFC	Maize, Rice	Tropical ravannah&monsoon	2015	July	32.3	0.19	-138.0		-1.3%		100.00%	19
C53-2	North Australia_zone2 (Northern Australia)	Catchment Scale Land Use of Australia	Wheat, Barley, Corn, Sorghum, Peanuts Oats, Millet, Cotton	Tropical Savanna/Arid, steppe, hot	2014	June	25.8	0.05	-105.8		-5.0%		100.00%	38
C54-1	Australia Queensland to Victoria _zone1 (Southeast Australia-coast)	Catchment Scale Land Use of Australia	Wheat, Barley, Corn, Sorghum, Rice, Oats, Millet, Cotton	Temperate, no dry season, warm & hot summer	2014	November	40.6	0.18	-187.9		-10.0%		100.00%	12
C54-21	Australia Queensland to Victoria _zone21 (Southeast Australia Marrin Darling)	Catchment Scale Land Use of Australia	Wheat, Barley, Oats	Arid, steppe, cold&hot/Arid, desert, hot	2015	October	20.5	0.10	-186.5		-15.0%		99.00%	32
C54-22	Australia Queensland to Victoria _zone22 (Southeast Australia Adeleid)	Catchment Scale Land Use of Australia	Wheat, Barley, Corn, Sorghum, Rice, Oats, Millet, Cotton	Temperate, dry summer, warm summer	2015	February	8.5	0.04	-190.1	0.37		0.42	100.00%	32
C55-1	Australia Nullarbor-Darling_zone1 (Southwest Australia)	Catchment Scale Land Use of Australia	Wheat, Barley, Oats	Arid, steppe, cold&hot	2014	October	44.5	0.23	-50.3		-15.0%		90.00%	24
C55-2	Australia Nullarbor-Darling_zone2 (Southwest Australia)	Catchment Scale Land Use of Australia	Wheat, Barley, Oats	Temperate, dry summer, hot&warm summer	2015	November	13.0	0.06	-215.3		-10.0%		92.00%	30
C56	New Zealand	New Zealand Land Cover Database	Cereal, vegetables, and fruits	Temperate,no dry season, warm summer	2015	October	68.0	2.76	59.9		-5.0%		95.00%	12
C57	Boreal Eurasia	Corine2018 & FORM-GLC30	Wheat, Corn, Rice, Barley, Soybeans	Cold & Polar	2011	July & Aug.	36.8	0.32	-76.7		-20.0%		75.00%	13
C58	Ukraine to URAL Mountains	Corine2018 & FORM-GLC30	Wheat, Barley, Corn, Rice, Soybeans, Rice, Cotton, Orchards	Cold	2011	August	31.0	0.44	-39.8		-12.0%		79.00%	22
C59	Mediterranean Europe and Turkey	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Arid & Temperate	2017	June & July	33.8	0.14	-205.5	0.40		0.45	84.34%	16
C60-1	W. Europe _zone1 (Germany, Poland, Switzerland, Czechia, Hungary, Austria,	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Cold	2011	May, June & July	58.8	0.32	-123.5		-20.0%		76.30%	34
C60-2	W. Europe_zone2 (Southeastern of Romania, Moldova, and southwestern Ura	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Arid	2011	June	92.6	0.45	-114.2		-20.0%		76.10%	21
C60-3	W. Europe__zone3 (Ebro River, Zaragoza, Spain)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Arid	2017	June & July	31.3	0.03	-215.0	0.25		0.49	99.50%	57
C60-4	W. Europe_zone4 (Northeastern of Italy and southwestern coast of France)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Temperate	2017	August	19.8	0.10	-172.2	0.33		0.39	93.20%	35
C60-5	W. Europe_zone5 (North Italy)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Temperate	2015	July	35.0	0.15	-193.0		-20.0%		84.70%	39
C60-6	W. Europe_zone6 (Switzerland, North Italy and west Austria)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Polar	2015	June & July	68.5	0.23	-148.0	0.25		0.47	85.30%	10
C60-7	W. Europe_zone7 (Ireland, United Kingdom, France, Belgium, Netherland)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Temperate	2015	May, June & July	28.0	0.08	-166.0		-20.0%		71.00%	43
C60-8	W. Europe_zone8 (Northwest of turkey and northeast of Greece)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Temperate	2017	July	19.1	0.08	-216.9		-20.0%		100.00%	50
C60-9	W. Europe_zone9 (North Greece and North Macedonia)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Cold & Arid	2011	August	27.0	0.01	-250.0		-25.0%		100.00%	33
C60-10	W. Europe_ zone10 (Northwestern Greece and southwestern of Albania)	Corine2018	Wheat, Barley, Corn, Rice, Soybeans, Cotton, Orchards	Temperate	2011	August	9.0	0.04	-216.0		-37.0%		100.00%	43
C61	Boreal North America	FORM-GLC30		Cold, no dry season, cold summer										
C62	URAL to Altai Mountains	FORM-GLC30	apring wheat	Cold, no dry season, warm summer	2012	April-July	38.5	0.15	-152.4		-20.0%		93.00%	81
C63	Australian Desert (Central Australia)	Catchment Scale Land Use of Australia	Wheat, Barley, Corn, Sorghum, Cotton	Arid, desert, hot	2014	June	23.8	0.18	-110.5	0.30		0.52	74.00%	10
C64	Old World Deserts	FORM-GLC30		Hyber-Arid						0.10		0.72		
C65	Sub Arctic America (IceLand)	Corine2018	Vegetables	Polar, tundra	2015	June	45.5	0.37	-75.9	0.52		0.46	100.00%	12

5. cropland mask

Also refer to this important work on global cropland mask:

https://lpdaac.usgs.gov/news/release-of-gfsad-30-meter-cropland-extent-products/

Response:

Thank you for drawing our attention to the important work on global cropland mask released by the Land Processes Distributed Active Archive Center (LP DAAC). We appreciate your suggestion to incorporate this valuable resource into our study.

The Global Food Security-support Analysis Data (GFSAD30) offers invaluable high-resolution data on cropland extent worldwide, which is essential for informed decision-making in areas such as water sustainability and food security. Actually, we have already integrated GFSAD30 data into our synthesized cropland mask for Southeast Asia. However, due to varying definitions of what constitutes cropland, we have not applied this data in other regions. Our focus has been primarily on seasonal croplands, as permanent crops—such as fruit and nut trees, as well as coffee, tea, and certain vines—are often classified as shrubland or tree cover in most land cover classification systems. Nevertheless, it's important to note that the GFSAD30 includes these continuous plantations within its cropland data. (Phalke, Özdoğan et al. 2020).

We will ensure that the GFSAD30 data is properly cited in our manuscript. Thank you once again for your valuable feedback, which undoubtedly enhances the quality and integrity of our work.

Line 241:

Thenkabail, P.S., Teluguntla, P.G., Xiong, J., Oliphant, A., Congalton, R.G., Ozdogan, M., Gumma,

M.K., Tilton, J.C., Giri, C., Milesi, C., Phalke, A., Massey, R., Yadav, K., Sankey, T., Zhong, Y., Aneece, I., and Foley, D., 2021, Global Cropland-Extent Product at 30-m Resolution (GCEP30) Derived from Landsat Satellite Time-Series Data for the Year 2015 Using Multiple Machine-Learning Algorithms on Google Earth Engine Cloud: U.S. Geological Survey Professional Paper 1868, 63 p., https://doi.org/10.3133/pp1868.

6. Definitions

What is irrigated areas?. Do you consider an area as irrigated if it gets water once in growing season or is the area irrigated if it is irrigated during one season and not the other. Definitions are key to mapping. But, clarity is lacking.

Response:

Thank you for your inquiry about the definition of irrigated areas within our study. Your point about the importance of clear definitions for accurate mapping is well-taken.

Irrigated cropland is characterized as agricultural land that benefits from human interventions and equipped with irrigation infrastructure, including facilities like canals and central pivot systems. In our study, an irrigated area is defined as a land area where water is artificially supplied to the crops at least once during the growing season to supplement natural rainfall. This definition includes areas that receive irrigation at any time during the season, regardless of whether they are irrigated in every season or not.

Therefore, we have revised our manuscript to include a more explicit definition of irrigated areas. This definition will be clearly stated in the methods section to ensure that there is no ambiguity for readers and users of our data. We appreciate your feedback and the opportunity to clarify our methodology. We believe that these revisions will enhance the quality and precision of our research.

Line 133-136:

So, the Irrigated cropland is characterized as agricultural land that benefits from human interventions and is outfitted with irrigation infrastructure, including facilities like canals and central pivot systems(Salmon et al., 2015; Meier et al., 2018). This definition includes areas that receive irrigation at any time during the season, regardless of whether they are irrigated in every season or not.

7. area calculations

Only net irrigated areas are calculated. What about gross irrigated areas? In same piece of land crops are grown one, two, or three times in some areas. How do you distinguish that.

Response:

Thank you for your insightful question regarding the calculation of irrigated areas, specifically the distinction between net and gross irrigated areas and the management of multiple cropping cycles within the same piece of land.

We have concentrated on the net irrigated area, which represents the actual land area equipped and utilized for crop irrigation. This approach is commonly used to assess the land area that requires water resources for irrigation purposes. However, gross irrigated cropland area encompasses all the land that could be irrigated during a crop's growing season, regardless of whether it is continuously irrigated throughout the season. For instance, if a plot of land is planted and irrigated twice in one growing season, that land would be counted twice, reflecting in the gross irrigated cropland area. Therefore, the gross irrigated area may exceed the net irrigated area because it accounts for instances of multiple plantings and irrigations. This distinction is vital for accurately assessing the use of water resources and planning agricultural production.

In our research, we estimate maximum irrigation extent under the assumption that irrigation equipment is primarily deployed to mitigate the most water-stressed conditions (such as the dry season in the RIR and extreme drought events within ten years for the RIO). Regarding multiple cropping cycles, our methodology identifies an area as irrigated if irrigation occurs at least once within a crop season. For the regions need regular irrigation (RIR), we choose only the dry season & growing season that experiences the greatest water stress for every year to estimate the net irrigation in that growing. Similarly, for the region needs irrigation only occasionally for some years (RIO), we evaluate net irrigation area based on a single growing season that has undergone an extreme drought event in the last decade. After all, we didn't consider the multiple cropping with in one-piece land. So, we just estimate the net irrigation area for selected growing season, whose value should be largest during that decades or three years.

We have expanded our discussion in the manuscript to include a more comprehensive analysis of both net and gross irrigated cropland, as well as future perspectives on this topic.

Line 525-536:

When discussing irrigation extents, it is crucial to differentiate between "net irrigated area" and "gross irrigated cropland area." The net irrigated area refers to the actual land area equipped with irrigation facilities and receiving irrigation, while the gross irrigated cropland area encompasses all the land that could be irrigated during a crop's growing season, regardless of whether it is continuously irrigated throughout the season. For instance, if a plot of land is planted and irrigated twice in one growing season, that land would be counted twice, reflecting in the gross irrigated cropland area. Therefore, the gross irrigated area may exceed the net irrigated area because it accounts for instances of multiple plantings and irrigations. This distinction is vital for accurately assessing the use of water resources and planning agricultural production. In our research, we estimate maximum irrigation extent under the assumption that irrigation equipment is primarily deployed to mitigate the most water-stressed conditions. So, we just estimate the net irrigation area for selected growing season, whose value should be largest during that decades or three years. For RIR, we estimate the net irrigation in the dry season & growing season that experiences the greatest water stress for every year. Similarly, for RIO, we evaluate net irrigation area based on a single growing season that has undergone an extreme drought event in the last decade.

8. Uncertainties in irrigated area map and area calculations

So, if the proportion of a pixel irrigated is say 10%., so you then only calculate fraction of the pixel area as irrigated or is it full pixel area. This is unclear.

Response:

Thank you for addressing the uncertainties in our irrigated area map and the calculations therein. We appreciate your emphasis on the necessity for precise definitions to ensure the accuracy of our mapping efforts.

In our methodology, a parcel of land is designated as irrigated if it receives any supplemental artificial water supply to support crop cultivation at least once during the growing season. The Global Maximum Irrigated Extent (GMIE) dataset, initially developed at a 30-meter resolution, categorizes each pixel as either irrigated or rainfed cropland. Thus, if a pixel contains at least 10% irrigated cropland, it is classified as an irrigated pixel within that 30×30 meter area. We recognize that the actual extent of irrigation at 30m resolution can fluctuate due to factors such as crop rotation and the presence of fallow land, which are clearly discernible at the 30-meter resolution and can influence the overall measurement of irrigated cropland. To mitigate these variations and enhance the accuracy of our data, we have calculated the proportion of irrigated cropland within a larger 100 m × 100 m grid.

As the result, there may be a tendency towards overestimation due to the mixed pixels at the 30-meter resolution, particularly in regions with smaller fields such as Southern China, Southeast Asia, and parts of Africa. However, the relatively high resolution of the pixels helps to mitigate this uncertainty to a certain extent.

We added more discussion regarding to this uncertainty of overestimation.

Line 600-607:

Also, a parcel of land is designated as irrigated if it receives any supplemental artificial water supply to support crop cultivation at least once during the growing season. The Global Maximum Irrigated Extent (GMIE) dataset, initially developed at a 30-meter resolution, categorizes each pixel as either irrigated or rainfed cropland. Thus, even if a pixel contains less than 100% irrigated cropland, it is classified as an irrigated pixel within that 30×30-meter area. As the result, there may be a tendency towards overestimation due to the mixed pixels at the 30-meter resolution, particularly in regions with smaller fields such as Southern China, Southeast Asia, and parts of Africa. However, the relatively high resolution of the pixels helps to mitigate this uncertainty to a certain extent.

9. Irrigation Method

There are numerous types of irrigation. Centre Pivot irrigation is well mapped. However, rest are all totally unclear. I suggest this aspect is completely removed from the manuscript and the manuscript is limited to irrigated and rainfed.

Response:

Thank you for your insightful comments and suggestions regarding the manuscript. We have given careful consideration to your recommendation to remove the sections discussing various types of irrigation systems that are not well-documented or clear, and to focus the manuscript on irrigated and rainfed systems.

After thorough evaluation, we have decided to retain the section on Centre Pivot irrigation. Our rationale for this decision is based on the fact that Centre Pivot irrigation is one of the most efficient and widely used systems globally. Moreover, we have identified a significant gap in the global mapping of CPIS, although there is some research mapping the CPIS for the dryland (Chen, Zhao et al. 2023). In light of this, we propose to maintain the current scope of the manuscript, which includes the part and description of global Centre Pivot irrigation, and to emphasize the importance of further research and data collection on other types of irrigation systems.

In another hand, we changed the title to “GMIE-100: A global maximum irrigation extent and central pivot irrigation system dataset derived via irrigation performance during drought stress and machine learning methods” to deal with the problem that other irrigation type is not well documented. Also, in the discussion part, we put these points in Limitation and outlook the identification of other irrigation types in the future with the help of big-geo data, which is important for water use estimations.

Line547-550:

However, this study didn’t include the lateral other irrigation types, because the identification of irrigation CPIS method was relied on the circle shape in the satellite data and other irrigation typesthe lateral irrigation didn’t show this distinguish feature. The identification of other irrigation types in the future is definitely important for water use estimations (Boutsioukis and Arias-Moliz, 2022), maybe with the help of big-geo data.

1) Chen, F., H. Zhao, D. Roberts, T. Van de Voorde, O. Batelaan, T. Fan and W. Xu (2023). "Mapping center pivot irrigation systems in global arid regions using instance segmentation and analyzing their spatial relationship with freshwater resources." Remote Sensing of Environment 297: 113760.
2) Phalke, A. R., M. Özdoğan, P. S. Thenkabail, T. Erickson, N. Gorelick, K. Yadav and R. G. Congalton (2020). "Mapping croplands of Europe, Middle East, Russia, and Central Asia using Landsat, Random Forest, and Google Earth Engine." ISPRS Journal of Photogrammetry and Remote Sensing 167: 104-122.