

Supplementary Materials

GlobalWheatYield4km: a global wheat yield dataset at 4-km resolution during 1982-2020 based on deep learning approaches

Yuchuan Luo¹, Zhao Zhang¹, Juan Cao¹, Liangliang Zhang¹, Jing Zhang¹, Jichong Han¹, Huimin Zhuang¹, Fei Cheng¹, Jialu Xu¹, Fulu Tao^{2, 3, 4}

¹Academy of Disaster Reduction and Emergency Management Minsitry of Emergency Management & Ministry of Education, School of National Safety and Emergency Management, Beijing Normal University, Beijing 100875, China

²Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

³College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China

⁴Natural Resources Institute Finland (Luke), FI-00790, Helsinki, Finland

Correspondence to: Zhao Zhang (zhangzhao@bnu.edu.cn)

Tel./Fax: 86-10-58800409

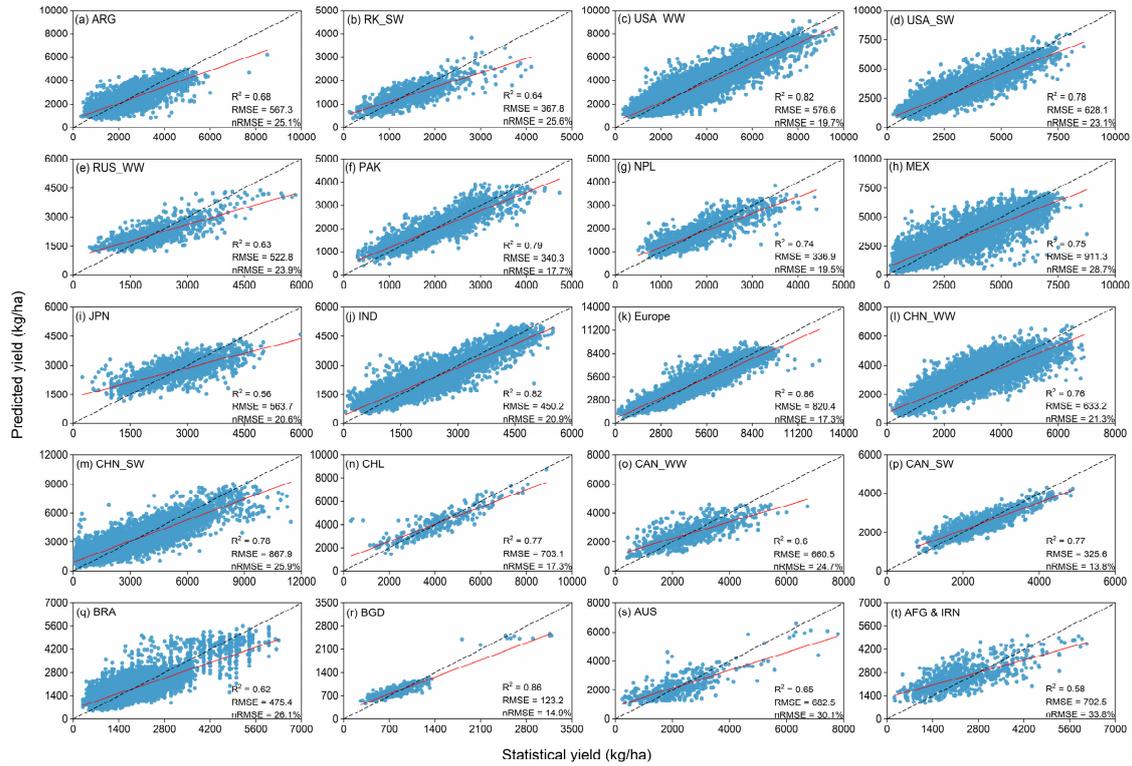


Figure S1: Comparisons between the predicted yields of GlobalWheatYield4km and statistics. RK_SW: spring wheat in RUS and KAZ; USA_WW: winter wheat in USA; USA_SW: spring wheat in USA; RUS_WW: winter wheat in RUS; CHN_WW: winter wheat in China; CHN_SW: spring wheat in China; CAN_WW: winter wheat in Canada; CAN_SW: spring wheat in Canada;

Table S1: Summarization for information on each country across the study area.

Country	Wheat type	Political unit of statistical data (Number)	Time frame	Source
Afghanistan	Winter wheat	ADM1 (34)	2011-2017	http://afghanistan.countrystat.org/
Albania	Winter wheat	ADM0 (1)	1987-2017	https://ec.europa.eu/eurostat/web/main
Argentina	Winter wheat	ADM2 (503)	1981-2019	http://www.siiia.gov.ar/
Australia	Winter wheat	Natural Resource Management Region (50) + ADM1 (9)	2005-2018 1981-2018	http://www.abs.gov.au/
Austria	Winter wheat	ADM1 (9)	1981-2018	https://ec.europa.eu/eurostat/web/main
Azerbaijan	Winter wheat	ADM2 (79)	2000-2018	https://www.fao.org/in-action/countrystat/national-countrystat-sites/en/
Bangladesh	Winter wheat	ADM2 (65)	1981-2014	https://bbs.portal.gov.bd http://www.brri.gov.bd
Belgium	Winter wheat	ADM1 (11)	1981-2017	https://ec.europa.eu/eurostat/web/main
Bolivia	Winter wheat	ADM1 (9)	1984-2019	https://www.ine.gob.bo/
Brazil	Winter wheat	ADM2 (5504)	1981-2017	www.conab.gov.br/index.php
Bulgaria	Winter wheat	ADM1 (6)	1985-2018	https://ec.europa.eu/eurostat/web/main
Canada	Winter wheat Spring wheat	ADM2 (82)	1981-2019	https://www.statcan.gc.ca/eng/start
Chile	Winter wheat	ADM1 (13)	1981-2019	https://www.odepa.gob.cl/
China	Winter wheat Spring wheat	County (2008)	1981-2015	http://www.stats.gov.cn
Croatia	Winter wheat	ADM0 (1)	2006-2018	https://ec.europa.eu/eurostat/web/main
Czechia	Winter wheat	ADM1 (8)	1981-2017	https://ec.europa.eu/eurostat/web/main
Denmark	Winter wheat Spring wheat	ADM1 (5)	1981-2018	https://ec.europa.eu/eurostat/web/main
Estonia	Winter wheat Spring wheat	ADM0 (1)	1987-2018	https://ec.europa.eu/eurostat/web/main
Finland	Spring wheat	ADM1 (5)	1981-2018	https://ec.europa.eu/eurostat/web/main
France	Winter wheat	ADM1 (27)	1981-2018	https://ec.europa.eu/eurostat/web/main
Germany	Winter wheat	ADM1 (38)	1981-2018	https://ec.europa.eu/eurostat/web/main
Greece	Winter wheat	ADM1 (13)	1981-2018	https://ec.europa.eu/eurostat/web/main
Hungary	Winter wheat	ADM1 (19)	1981-2017	https://ec.europa.eu/eurostat/web/main
India	Winter wheat	ADM2 (506)	1997-2015	https://data.gov.in/
Iran	Winter wheat	ADM1 (31)	2004-2020	www.maj.ir
Ireland	Winter wheat	ADM1 (3)	2017-2018	https://ec.europa.eu/eurostat/web/main
Italy	Winter wheat	ADM1 (21)	1981-2018	https://ec.europa.eu/eurostat/web/main
Japan	Winter wheat	ADM1 (47)	1981-2018	https://www.e-stat.go.jp/
Kazakhstan	Spring wheat Winter wheat	ADM1 (14)	2014-2020	https://stat.gov.kz/
Latvia	Winter wheat Spring wheat	ADM0 (1)	1987-2018	https://ec.europa.eu/eurostat/web/main
Lithuania	Winter wheat Spring wheat	ADM1 (2)	2017-2018	https://ec.europa.eu/eurostat/web/main
Luxembourg	Winter wheat	ADM0 (1)	1981-2018	https://ec.europa.eu/eurostat/web/main

Macedonia	Winter wheat	ADM0 (1)	2005-2018	https://ec.europa.eu/eurostat/web/main
Mexico	Winter wheat	ADM2 (2442)	2003-2018	https://www.gob.mx/ http://infosiap.siap.gob.mx/
Nepal	Winter wheat	ADM2 (75)	1981-2018	https://nepalindata.com/
Netherlands	Winter wheat	ADM1 (12)	1981-2018	https://ec.europa.eu/eurostat/web/main
Norway	Spring wheat	ADM1 (7)	2015-2017	https://ec.europa.eu/eurostat/web/main
Pakistan	Winter wheat	ADM3 (113)	1981-2014	http://www.amis.pk/
Peru	Winter wheat	ADM1 (26)	1981-2018	https://www.gob.pe/
Poland	Winter wheat	ADM1 (17)	1995-2016	https://ec.europa.eu/eurostat/web/main
Portugal	Winter wheat	ADM1 (7)	1999-2015	https://ec.europa.eu/eurostat/web/main
Republic of Moldova	Winter wheat	ADM1 (37)	2007-2018	https://statbank.statistica.md/PxWeb/pxweb/en/
Romania	Winter wheat	ADM1 (7)	1995-2017	https://ec.europa.eu/eurostat/web/main
Russia Federation	Winter wheat Spring wheat	ADM1 (62)	1990-2016	https://data.gov.ru/?language=en
Slovakia	Winter wheat	ADM1 (4)	1995-2017	https://ec.europa.eu/eurostat/web/main
Slovenia	Winter wheat	ADM1 (2)	2007-2017	https://ec.europa.eu/eurostat/web/main
Spain	Winter wheat	ADM1 (18)	1981-2018	https://ec.europa.eu/eurostat/web/main
Sweden	Spring wheat	ADM1 (8)	1992-2018	https://ec.europa.eu/eurostat/web/main
Turkey	Winter wheat	ADM1 (26)	1995-2016	https://ec.europa.eu/eurostat/web/main
Ukraine	Winter wheat	ADM1 (27)	2004-2017	https://ec.europa.eu/eurostat/web/main
United Kingdom	Winter wheat	ADM1 (40)	1987-2018	https://ec.europa.eu/eurostat/web/main
United States	Winter wheat Spring wheat	ADM2 (2846)	1981-2016	https://quickstats.nass.usda.gov/

Table S2: Comparisons of harvested areas between the GWPMS-based estimates and subnational-level statistics.

Region/ Crop type	2006		2007		2008		2009		2010		2011		2012		2013		2014	
	R ²	RMSE (Kha)																
SEA	0.81	38.1	0.76	41.9	0.8	38.1	0.85	21.3	0.78	26.3	0.82	18.3	0.83	20.4	0.81	21.9	0.77	23.7
CA	0.82	100.3	0.77	157.7	0.71	117.6	0.85	113.8	0.69	134.7	0.83	94.1	0.84	68.2	0.75	91.9	0.8	69.9
Europe	0.78	57.2	0.81	49.3	0.86	53.7	0.77	61.6	0.78	60.4	0.83	66.3	0.81	64.5	0.8	61.6	0.82	72.3
RK_SW	0.85	198.1	0.84	247.5	0.82	197.4	0.8	202.2	0.84	230.8	0.81	204.2	0.79	200.3	0.86	151.7	0.76	287.8
RUS_WW	0.75	235.8	0.82	175.9	0.86	166.6	0.79	212.9	0.77	355.6	0.81	206.1	0.83	221.9	0.78	264.9	0.84	224.1
AUS	0.87	229.9	0.84	217.2	0.88	215.3	0.86	227.8	0.89	273.5	0.88	224.4	0.86	242.5	0.82	204.7	0.87	214.2
SA	0.75	7.2	0.8	6.8	0.82	5.9	0.77	5.9	0.72	8.6	0.79	6.2	0.76	5.9	0.65	8.7	0.74	7.3
NA_SW	0.79	17.4	0.85	11.5	0.82	11.3	0.84	12.9	0.82	15.6	0.87	12.3	0.8	12.5	0.75	17.2	0.76	15.6
NA_WW	0.78	8.2	0.84	7.2	0.81	7.1	0.85	6.6	0.84	6.9	0.85	6.4	0.77	8.7	0.79	7.6	0.8	7.7

Note: SEA, South and East Asia; CA, Central Asia; RK_SW, spring wheat in Russian Federation and Kazakhstan; RUS_WW: winter wheat in Russian Federation; SA, South America; NA_SW, spring wheat in North America; NA_WW, winter wheat in North America.

Table S3: Comparisons of yields between the GlobalWheatYield4km- or SPAM-based estimates and statistics.

Country/ Crop type	2000				2005				2010			
	Our dataset		SPAM		Our dataset		SPAM		Our dataset		SPAM	
	R ²	RMSE (kg/ha)										
ARG	0.65	424.5	0.02	875.6	0.74	497.3	0.66	578.5	0.72	748.7	0.71	751.2
AUS					0.7	480.2	0.29	1118.1	0.65	522	0.14	920.7
BGD	0.73	99.8	0.18	972.1	0.77	146.5	0.42	933.9	0.74	141.2	0.15	1380.1
BOL	0.41	144.7	0.01	197.4	0.66	373.2	0.54	348.7	0.78	365	0.92	204.5
BRA	0.49	479.8	0.03	566.7	0.6	479	0.65	531	0.62	480.2	0.52	633.8
CAN	0.64	324.3	0.57	485.7	0.8	522.8	0.31	790.6	0.66	487.4	0.16	761.9
CHL	0.65	621.2	0.4	991.2	0.74	434	0.09	1525.5	0.89	509	0.6	1918.7
CHN_WW	0.79	718.6	0.55	1059.3	0.84	684.1	0.85	720	0.84	742.9	0.8	975.2
CHN_SW	0.81	983	0.5	1435	0.7	1097.6	0.6	1412.5	0.77	990.2	0.73	1123.5
Europe	0.86	834.9	0.81	973.4	0.91	703.1	0.93	636	0.88	671.1	0.79	941.9
CHN_WW	0.79	718.6	0.55	1059.3	0.84	684.1	0.85	720	0.84	742.9	0.8	975.2
CHN_SW	0.81	983	0.5	1435	0.7	1097.6	0.6	1412.5	0.77	990.2	0.73	1123.5
IND	0.83	448.2	0.49	841.8	0.87	396.2	0.7	613.2	0.83	461.7	0.8	588.1
IRN					0.75	547.9	0.37	1076.7	0.74	553	0.7	695.9
JPN	0.71	617	0.01	1192.9	0.68	558.7	0.66	531.1	0.66	412.1	0.7	365.9
MEX					0.82	800.1	0.63	1280	0.7	1033.4	0.67	1331.1
NPL	0.4	263.6	0.09	378.8	0.57	314.1	0.05	786.1	0.72	395.5	0.01	974.3
PAK	0.77	447.7	0.04	1052.4	0.84	278.3	0.32	885.1	0.81	388.9	0.63	737.3
RUS	0.69	366	0.03	680.4	0.73	416.5	0.94	209.1	0.79	460.5	0.72	613
UKR					0.4	316	0.02	464.4	0.55	437.9	0.25	582.5
USA_WW	0.86	555.8	0.77	657.9	0.77	693.2	0.55	1075.9	0.8	579.1	0.58	871.9
USA_SW	0.77	645.9	0.74	1202.5	0.7	725.4	0.63	1340.1	0.82	512.1	0.74	807.9
Mean	0.7	537.6	0.35	892.1	0.73	556.6	0.53	863.1	0.75	573.9	0.58	876.3