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Global Food-Security-Support-Analysis Data at 30-m Resolution (GFSAD30) Cropland-Extent Products—Download Analysis

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U.S. Department of the Interior
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By Adam Oliphant, Prasad Thenkabail, and Pardhasaradhi Teluguntla

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
meter (m)	1.094	yard (yd)
	Area	
hectare (ha)	2.471	acre
hectare (ha)	0.003861	square mile (mi^2)

Abbreviations

AEZ	agroecological zones
AFCE	Africa cropland-extent product [abbreviated name]
ATBD	algorithm theoretical basis document
AUNZCNMO	Australia, New Zealand, China, and Mongolia cropland-extent product [abbreviated name]
AVHRR	Advanced Very High-Resolution Radiometer
ETM	Enhanced Thematic Mapper
EUCEARUME	Europe, Central Asia, Russia, and Middle East cropland-extent product [abbreviated name]
FAO	United Nations Food and Agriculture Organization
GB	gigabyte
GEE	Google Earth Engine
GFSAD1KCD	1-km-resolution multisensor-derived crop dominance subproduct
GFSAD1KCM	1-km-resolution multisensor-derived crop mask subproduct
GFSAD30	global food-security-support-analysis data at 30-m resolution
GFSAD30AFCE	Africa cropland-extent product
GFSAD30AUNZCNMOCE	Australia, New Zealand, China, and Mongolia cropland-extent product
GFSAD30EUCEARUMECE	Europe, Central Asia, Russia, and Middle East cropland-extent product
GFSAD30NACE	North America cropland-extent product
GFSAD30SAAFGIRCE	South Asia, Afghanistan, and Iran cropland-extent product
GFSAD30SACE	South America cropland-extent product
GFSAD30SEACE	South East Asia cropland-extent product
GFSAD30VAL	global accuracy validation subproduct
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
LP DAAC	Land Processes Distributed Active Archive Center
MODIS	Moderate-Resolution Imaging Spectroradiometer
NACE	North America cropland-extent product [abbreviated name]
NASA	National Aeronautics and Space Administration

OLI	Operational Land Imager
OMB	Office of Management and Budget
SAAFGIR	South Asia, Afghanistan, and Iran cropland-extent product [abbreviated name]
SACE	South America cropland-extent product [abbreviated name]
SEACE	South East Asia cropland-extent product [abbreviated name]
TOA	Top of Atmosphere
USGS	U.S. Geological Survey
VHRI	very high resolution imagery

Global Food-Security-Support-Analysis Data at 30-m Resolution (GFSAD30) Cropland-Extent Products—Download Analysis

By Adam Oliphant, Prasad Thenkabail, and Pardhasaradhi Teluguntla

Introduction

The global food-security-support-analysis data at 30-meter (m) resolution (GFSAD30) cropland-extent product is a project funded by the U.S. Geological Survey (USGS) and National Aeronautics and Space Administration (NASA) to provide high-resolution global cropland-extent data relating to water use. This project contributes knowledge toward global food security in the 21st century. It is the first global-land-cover map focusing exclusively on agriculture with a 30-m spatial resolution (1 pixel=0.09 hectares). The overarching goal of the GFSAD30 project is to produce consistent and unbiased estimates of global agricultural cropland products such as the following:

1. Cropland extent;
2. Cropland types, with a focus on the eight crops that occupy 70 percent of the global cropland areas;
3. Irrigated versus rainfed cropland;
4. Cropping intensities (single, double, triple, or continuous cropping); and
5. Spatial and temporal (from 2000 to 2017) changes in cropland extent.

Mapping cropland extent with a 30-m resolution is important to determine the spatial extent of agricultural land cover. Unlike tabular cropland area, acreages derived from 30-m-resolution products can be used to determine cropland extent at any spatial resolution (for example, from town to nation). This is particularly useful for estimating the effect on agricultural production owing to flooding, wildfire, political conflict, or development (Thenkabail and others, 2011). It is an advancement over existing global cropland-extent products created at a 250-m to 1-kilometer (km) resolution using Moderate-Resolution Imaging Spectroradiometer (MODIS) or Advanced Very High-Resolution Radiometer (AVHRR) data (Pittman and others, 2010; Portmann and others, 2010).

During November 2017, the GFSAD30 project publicly released the world's highest resolution Landsat-derived global 30-m-resolution cropland-extent product (available at www.croplands.org) through USGS'–NASA's joint Land Processes Distributed Active Archive Center (LP DAAC). The globe was partitioned into seven regions that were mapped separately: (1) North America, Central America, and the Caribbean; (2) South America; (3) Africa; (4) Europe, Russia, and the Middle East; (5) South and Central Asia; (6) Southeast and Northeast Asia; and (7) China, Australia, New Zealand, and Mongolia. This release included data (listed in appendix 1), associated documents such as a user guide and algorithm theoretical basis documents (ATBDs) (listed in appendix 2), and associated program codes. These are made available for each continent or major world regions at LP DAAC (https://lpdaac.usgs.gov/news/release-of-gfsad-30-meter-cropland-extent-products). The products are also viewable at full resolution through an interactive web map (www.croplands.org), an overview of which is shown in figure 1.

Purpose and Scope

The goal of this report is to assess and discuss the usage of the global food-security-support-analysis data at 30-m-resolution (GFSAD30) project's (www.usgs.gov/wgsc/gfsad30) Landsat-derived cropland-extent product (www.croplands.org). This is the highest known resolution global cropland-extent product, and it was released in November 2017. These data are available for download at LP DAAC (https://lpdaac.usgs.gov/news/release-of-gfsad-30-meter-cropland-extent-products), on a continent-by-continent basis. An overview of the entire set of GFSAD30 cropland-extent products is available as a USGS professional paper (Thenkabail and others, 2021).

Since the release of GFSAD30, LP DAAC has tracked the number of files downloaded, the total size of files downloaded, the country from which the GFSAD30 data were downloaded, and the user's field of study. This report presents a monthly assessment of the usage of GFSAD30 from November 2017 through December 2019, which is available in an accompanying data release (Oliphant and others, 2022).

There were a sustained number of users of this global data every month from November 2017 through December 2019. During this period, about 1,900 gigabytes (GB) of data and about 225,000 files were downloaded; users in more than 100 countries downloaded and used the data. The United States and China are the main users of the data, followed by European countries and other large nations.

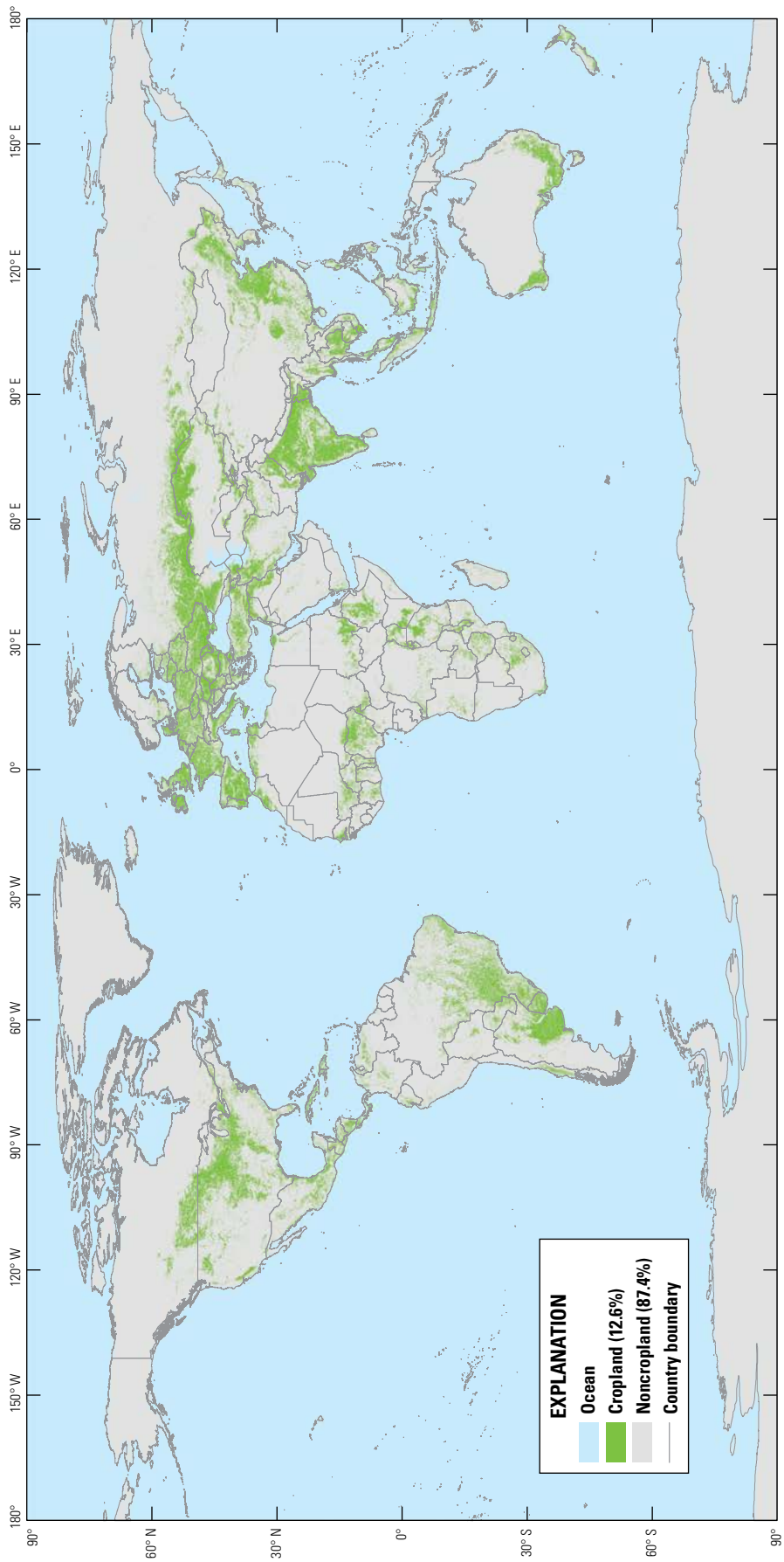

Figure 1. Global map classification of croplands and noncroplands using global food-security-support-analysis data at 30-meter resolution (GFSAD30). Also shown are percentages (in parentheses) of cropland and noncropland out of total global cropland area. Country boundaries from Food and Agricultural Organization of the United Nations (2015).

In addition to summarizing the download statistics of the data and files from LP DAAC, this report includes how GFSAD30 has been cited in media, scientific journals, and other data products. The release of data was widely covered by the national and international press (see appendix 4). Furthermore, GFSAD30 products have been cited more than 200 times in scientific journals and have been used in multiple innovative global land-cover products. It also composes one of the main layers in the Geofolio global product (available at https://geofolio.org).

The GFSAD30 project continues to be supported by scientists and researchers who help support global food and water security analysis and management. These Landsat- and (or) Sentinel-derived nominal 30-m or higher resolution products include irrigated versus rainfed cropland, cropping intensities, cropland fallows, and crop types. Given the usage of the GFSAD30 cropland-extent product, the demand for related products is expected to be equal or higher.

Methodology

In this section we provide a brief description of the processes used to create the seven GFSAD30 products; a detailed methodology of how the seven products were created can be found in the sources listed in appendixes 1 and 2.

The base imagery used was from Top of Atmosphere (TOA) Landsat 8 Operational Land Imager (OLI) data, whereas Landsat 5 Enhanced Thematic Mapper (ETM), Landsat 7 ETM+, and Sentinel 2 were used as supplementary imagery in some regions. Google Earth Engine (GEE) was used to create time-period composites of Landsat imagery. Cropland and noncropland training samples were generated from a combination of ground collection, visual interpretation from very high resolution imagery (VHRI) (at resolutions of less than a meter to 5 m), collaborators, and previous studies. GEE was also used to create and execute a supervised random forest classification.

Product Definitions

The GFSAD30 product, which consists of seven products covering different regions of the globe (table 1; see also, appendixes 1, 2), maps cropland extent at a 30-m resolution. Table 1 also contains some introductory statistics on total land area and total cropland-extent for each product provided by the United Nations (UN) global administrative unit layer (GAUL) (available at https://data.apps.fao.org/map/catalog/srv/eng/catalog.search?id=12691#/metadata/9c35ba10-5649-41c8-bdfc-eb78e9e65654). Cropland extent is defined as the sum of all agricultural lands that can be classified within

Table 1. Names, geographic areas, and attributes of products that compose the global food-security-support-assessment data at 30-m resolution cropland-extent (GFSAD30CE) product.

[Abbreviated names: AFCE, Africa cropland-extent product; AUNZCNMO, Australia, New Zealand, China, and Mongolia cropland-extent product; EUCEARUME, Europe, Central Asia, Russia, and Middle East cropland-extent product; NACE, North America cropland-extent product; SAAFGIR, South Asia, Afghanistan, and Iran cropland-extent product; SACE, South America cropland-extent product; SEACE, South East Asia cropland-extent product. Other abbreviations: Mha, million hectares; %, percent]

Product name	Abbreviated name	Region	Land area (Mha)	Cropland extent (Mha)	Percentage of cropland in region (%)	Percentage of global cropland extent (%)
GFSAD30NACE	NACE	North America, Hawaii, Central America, and the Caribbean	2,095.45	275.18	12.84	14.70
GFSAD30SACE	SACE	South America	1,746.83	152.00	8.70	8.12
GFSAD30AFCE	AFCE	Africa and nearby islands	2,988.87	313.10	10.48	16.73
GFSAD30EUCEARUMECE	EUCEARUME	Europe, Central Asia, Russia, and Middle East	3,066.05	545.68	17.80	29.15
GFSAD30SAAFGIRCE	SAAFGIR	South Asia (India, Pakistan, and Himalaya area) Afghanistan, and Iran	640.10	255.62	39.93	13.66
GFSAD30SEACE	SEACE	Southeast Asia, Japan, Korea, and Pacific Islands	490.86	126.57	25.79	6.76
GFSAD30AUNZCNMOCE	AUNZCNMO	Australia, New Zealand, China, and Mongolia	1,883.47	203.80	10.82	10.89
Total area			12,911.63	1,875.20		100

one or more of the following conditions: (1) land cultivated and harvested for food, feed, and fiber once or more during a 12-month period; (2) land left fallow, when equipped for agriculture; (3) or land permanently cropped with plantations (for example, orchards, vineyards, and coffee, tea, or rubber plantations). The products (in 10°×10° tiles) are available for download at LP DAAC (https://lpdaac.usgs.gov/news/release-of-gfsad-30-meter-cropland-extent-products).

Product Usage Statistics

The number of downloads of GFSAD30 through LP DAAC is tracked to assess the effect and use of the GFSAD30 products. This section summarizes the tracking of monthly downloads of GFSAD30 data using various metrics and following the citations and selected products that use GFSAD30 data.

Downloads by Month

Downloads of GFSAD30 from LP DAAC were steady following its release in November 2017. Downloads averaged about 9,000 files per month, and the average download volume was 80 GB (fig. 2). The data used to generate figures 2 through 5 are available in an accompanying data release (Oliphant and others, 2022).

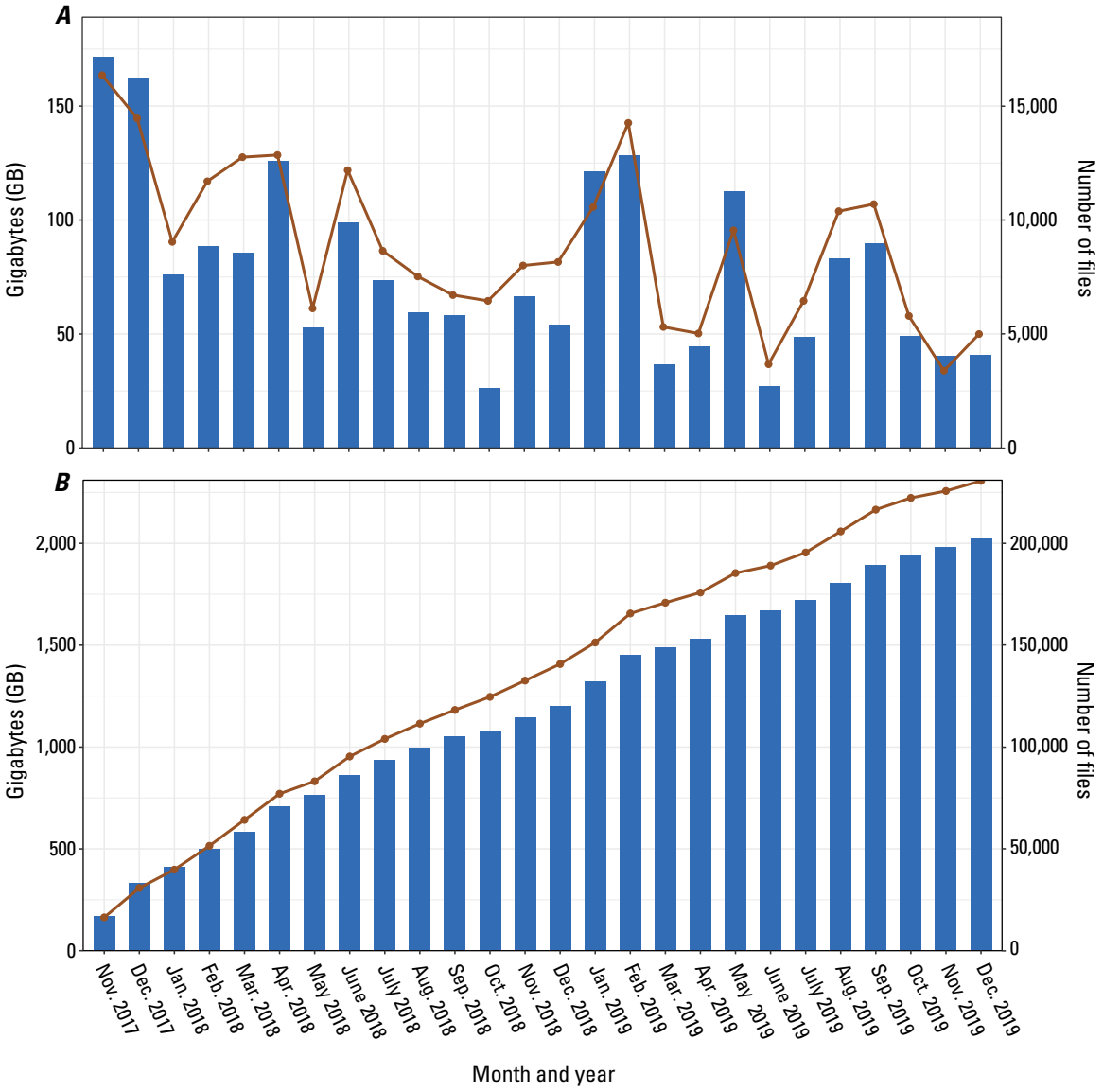

Figure 2. Graphs showing data volume (blue bars), in gigabytes (GB), and number of files downloaded (brown line) of global food-security-support-analysis data at 30-m resolution (GFSAD30) per month between November 2017 and December 2019. *A*, Monthly metrics. *B*, Cumulative metrics over the entire November 2017 to December 2019 time period.

Downloads by Country

The GFSAD30 products were downloaded and used by many users from the United States and around the world (figs. 3*A*, 3*B*). Users in the United States downloaded over 40 percent of the data (700 GB), with the remainder of data being downloaded by other countries.

Downloads by Field of Study

All users who download GFSAD30 data are required to register at either USGS Earth Explorer or NASA Earthdata. User information requested upon registering for Earthdata are name, country, email, affiliation (choices include government, commercial, educational/university, nonprofit, or other), field

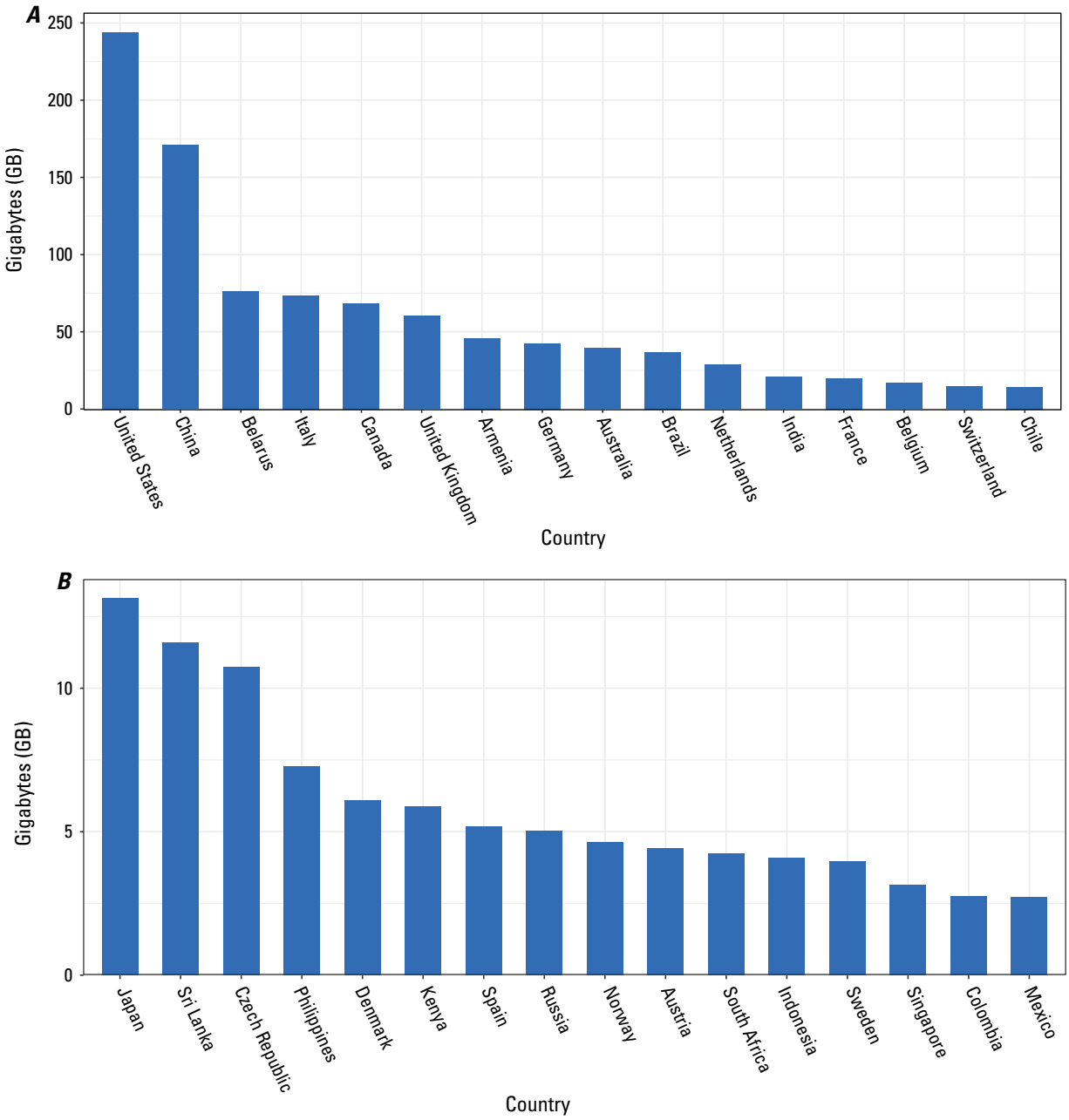

Figure 3. Graphs showing data volume (blue bars), in gigabytes (GB), of global food-security-support-analysis data at 30-m resolution (GFSAD30) by each country between November 2017 and December 2019. *A*, Metrics by country of 16 highest volume countries, shown in descending order. *B*, Metrics by country of next 16 highest volume countries, shown in descending order. Note differences in vertical scale between *A* and *B*.

of study (fig. 4), and organization. Data collection supporting this study was consistent and compliant with the Paperwork Reduction Act under NASA (OMB control number 1090-007). After the personally identifiable information (name, email, and organization) is removed, the usage of GFSAD30 can be tracked and analyzed.

The fields of study of users and their numbers of downloaded files are presented in figure 4*A*. "Land processes" had the largest number of downloads, followed by "other," "hydrologic cycle," "human dimensions of global change," "global biosphere," and so on. It is notable that the category of "other" was second on the list, indicating a wider variety of uses (as represented by their numbers of downloads) than were represented by these options. Also notable is that neither agriculture or food security were available as a usage option; therefore, it is possible that some users who selected "other" or "land processes" may have had an agricultural focus.

Additionally, users' affiliations are presented in figure 4*B*. Approximately 60 percent of users are university affiliated, with approximately equal amounts of government, nonprofit, other, and commercial users.

Downloads by Product

The GFSAD30 is composed of several products and subproducts that cover seven geographic areas. Figure 5*A* shows the file sizes and number of files downloaded for the various GFSAD30 products. Additionally, figure 5*B* shows the download rates of three additional GFSAD30 subproducts: GFSAD30VAL (GFSAD30 validation dataset; Congalton and

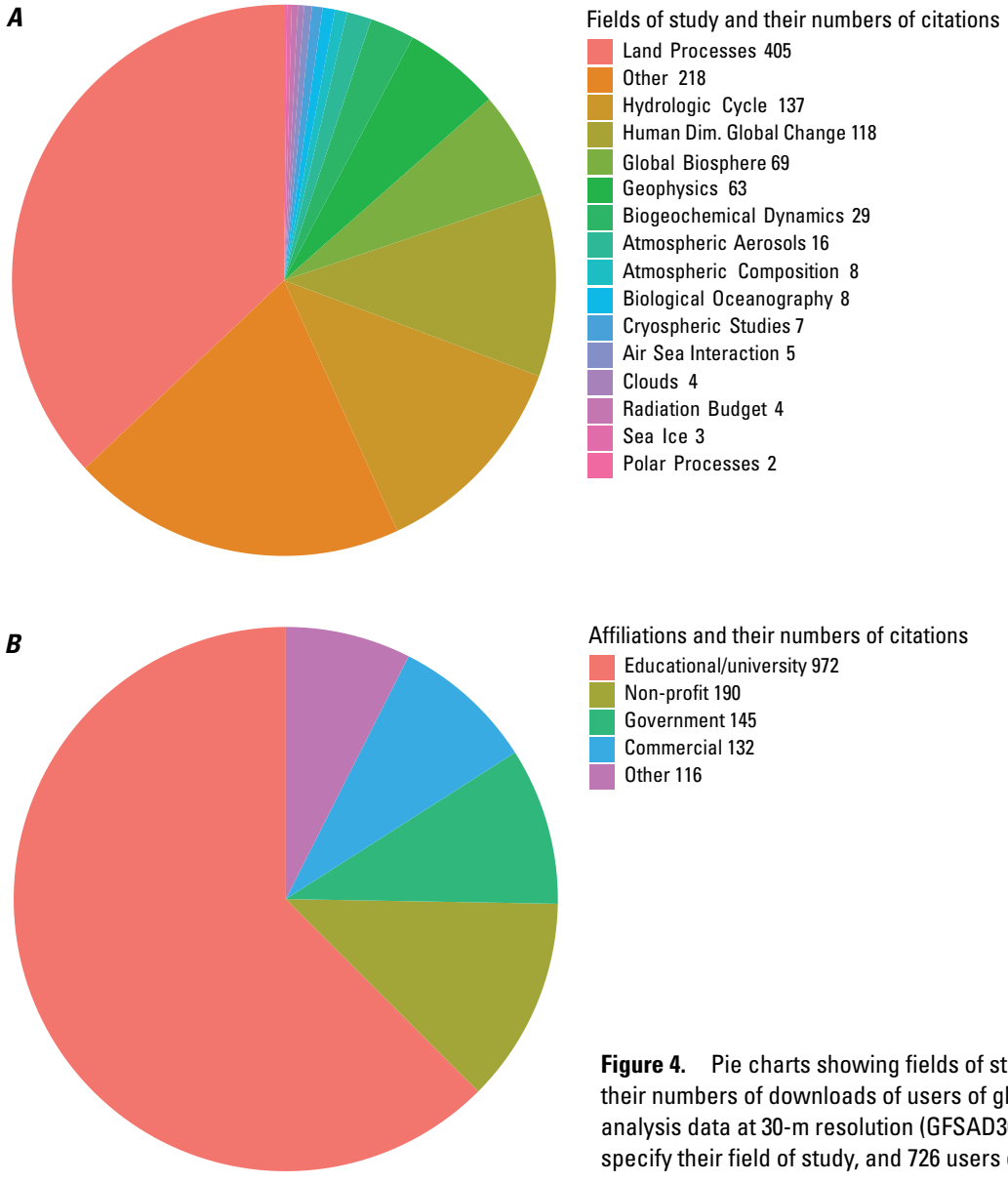

Figure 4. Pie charts showing fields of study (*A*) and affiliations (*B*) and their numbers of downloads of users of global food-security-support-analysis data at 30-m resolution (GFSAD30). Note that 1,185 users did not specify their field of study, and 726 users did not specify their affiliation.

others, 2017a), GFSAD1KCD (GFSAD30 crop dominance; Thenkabail and others, 2016a), and GFSAD1KCM (GFSAD30 crop mask; Teluguntla and others, 2016). Some geographic areas have been downloaded more than others: figure 5*A* shows that the most downloaded product was EUCEARUME (Europe, Central Asia, Russia, and Middle East cropland-extent product). Note that figures 5*A* and 5*B* are split owing to their large differences in vertical scale caused by the much smaller file sizes and number of files downloaded of the GFSAD30VAL, GFSAD1KCD, and GFSAD1KCM subproducts.

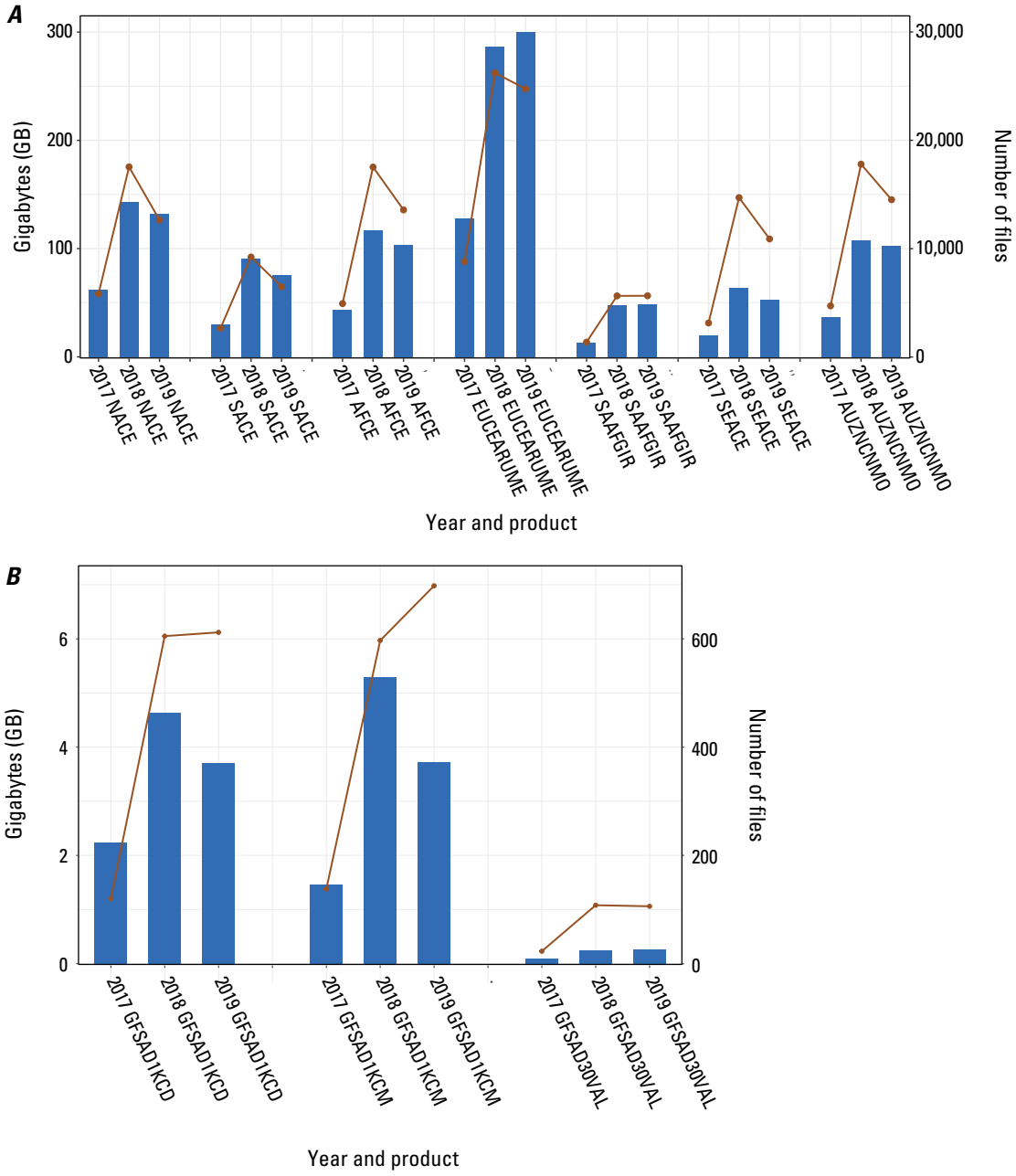

Figure 5. Graphs showing data volume (blue bars), in gigabytes (GB), and number of files downloaded (brown lines) for the different global food-security-support-analysis data at 30-m resolution (GFSAD30) cropland-extent products (*A*) and their accuracy subproducts (*B*) in years 2017, 2018, and 2019. Note the differences in scale between *A* and *B*. Cropland-extent product abbreviations: AFCE, Africa; AUNZCNMO, Australia, New Zealand, China, and Mongolia; EUCEARUME, Europe, Central Asia, Russia, and Middle East; NACE, North America; SAAFGIR, South Asia, Afghanistan, and Iran; SACE, South America; SEACE, South East Asia (see also, table 1). GFSAD30 subproduct abbreviations: GFSAD1KCD, crop dominance; GFSAD1KCM, crop mask; GFSAD30VAL, accuracy validation.

Usage of Global Food-Security-Support-Analysis Data at 30-m Resolution (GFSAD30)

Citations of GFSAD30 Publications

Currently (2020), seven peer-reviewed articles that describe the methods used to produce the GFSAD30 cropland-extent products have been published in various remote-sensing journals (Xiong and others, 2017c; Massey and others, 2018; Teluguntla and others, 2018; Yadav and Congalton, 2018a, b; Gumma and others, 2019; Oliphant and others, 2019), and these publications have been widely cited. The full citations of the journal articles are provided in appendix 3, and the number of times they have been cited in peer-reviewed publications as of this writing (2020) are provided in table 2.

Seven GFSAD30 products, one GFSAD30 accuracy report, and two 1-km-resolution subproducts are available for download from LP DAAC. The data are accompanied by algorithm theoretical basis documents (ATBD) and user guides. The citations for these products are listed in appendix 2. Five of the seven GFSAD30 products have published peer-reviewed journal articles associated with them. As of April 16, 2020, these five articles were cited 200 times in academic journal articles, conference proceedings, and theses and dissertations (table 2). The article describing the methodology used to map Africa has been cited 123 times, the most of any of the GFSAD30 articles (table 2). GFSAD30 publications have been cited in over 60 scientific journals and 11 different publishers (calculated using Publish or Perish software [Harzing, 2007] and the Google Scholar database).

Media Reporting of GFSAD30

The release of GFSAD30 in November 2017 was reported in several media outlets. Appendix 4 lists 20 media articles that featured GFSAD30.

Use of GFSAD30 Products

Many products and publications have used GFSAD30 products as critical inputs for further studies. Some examples include Geofolio (https://geofolio.org/), Resource Watch (https://resourcewatch.org/data/explore/Global-Croplands), and Open Development Mekong (https://data.opendevelopmentmekong.net/dataset?res_format=GeoTIFF&taxonomy=Agriculture).

Conclusions

In addition to summarizing the download statistics from the Land Processes Distributed Active Archive Center (LP DAAC), this report includes information on how the global food-security-support-analysis data at 30-m resolution (GFSAD30) products were cited in media, scientific journals, and other data products. The release of the data in 2017 was extensively covered by the national and international press (see appendix 4). GFSAD30 products have been cited more than 200 times in scientific journals and have been used in multiple innovative global land-cover products. It also forms one of the main layers in the Geofolio global product (https://geofolio.org).

The GFSAD30 project continues to be supported by the geoscience community, which helps support global food and water security analysis and management. These Landsat- and (or) Sentinel-derived nominal 30-meter or higher resolution products include maps of irrigated versus rainfed cropland, cropping intensities, cropland fallows, and crop types. Given the effect of the GFSAD30 cropland-extent product, the demand for other related products is expected to increase.

Table 2. Number of citations of articles on the global food-security-support-analysis data at 30-m resolution (GFSAD30) cropland-extent products by product location.

[Numbers calculated using Publish or Perish software (Harzing, 2007) and Google Scholar database. See appendix 3 for full citations of GFSAD30 cropland-extent products]

Location of associated GFSAD30 cropland-extent product[1]	Number of citations[2]
Africa	123
China and Australia	46
North America	16
Southeast Asia	13
South Asia	2
Total	200

[1]Note that only five of seven GFSAD30 products have had associated peer-reviewed journal articles published.

[2]If an article cites more than one GFSAD30 product, each citation is counted individually.

References Cited

Agri-View, 2017, World cropland mapped—Results surprising: Agri-View, November 15, 2017, https://www.agupdate.com/agriview/markets/crop/world-cropland-mapped-results-surprising/article_570bf535-2077-517e-9288-7b52f1b60d1a.html.

Balpataky, K., 2017, Global agriculture intensity detailed in interactive map: Water Canada, November 14, 2017, https://www.watercanada.net/global-agriculture-intensity-detailed-in-interactive-map/.

Chaturvedi, A., 2017, USGS releases interactive map of croplands in the world: Geospatial World, November 22, 2017, https://www.geospatialworld.net/blogs/usgs-croplands-interactive-map/.

Congalton, R., Yadav, K., McDonnell, K., Poehnelt, J., Stevens, B., Gumma, M., Teluguntla, P., and Thenkabail, P., 2017a, GFSAD30VAL v001—Global food security-support analysis data (GFSAD) cropland extent 2015 validation 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30VAL.001.

Congalton, R.G., Yadav, K., McDonnell, K., Poehnelt, J., Stevens, B., Gumma, M.K., Teluguntla, P., and Thenkabail, P.S., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) 30-m cropland extent validation (GFSAD30VAL)—User's guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/171/GFSAD30VAL_User_Guide_V1.pdf.

Deb, P., 2017, India beats US and China on farmland—Report: International Business Times, November 15, 2017, https://www.ibtimes.co.in/india-beats-us-china-farmland-report-749512.

Durisin, M., 2017, There's more farmland in the world than was previously thought: Bloomberg, November 15, 2017, https://www.bloombergquint.com/global-economics/2017/11/14/there-s-more-farmland-in-the-world-than-was-previously-thought.

European Seed, 2017, New map of worldwide croplands supports food and water security: europeanseed, November 17, 2017, https://european-seed.com/2017/11/new-map-worldwide-croplands-supports-food-water-security/.

Farm and Dairy, 2017, Cropland map supports food, water security—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: Farm and Dairy, November 18, 2017, https://www.farmanddairy.com/news/cropland-map-supports-food-water-security/456694.html.

Feed&Grain, 2017, New map of worldwide croplands—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: Feed&Grain, November 14, 2017, https://www.feedandgrain.com/news/new-map-of-worldwide-croplands.

Food and Agricultural Organization of the United Nations, 2015, Global administrative unit layers (GAUL): Food and Agricultural Organization of the United Nations, FAO Map Catalog, available at https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/9c35ba10-5649-41c8-bdfc-eb78e9e65654.

GISUSER, 2017, New map of worldwide croplands supports food and water security: GISuser Beyond the Map, December 30, 2017, https://gisuser.com/2017/12/new-map-of-worldwide-croplands-supports-food-and-water-security-2/.

Gumma, M., Thenkabail, P., Teluguntla, P., Oliphant, A., Xiong, J., Congalton, R., Yadav, K., Phalke, A., and Smith, C., 2017a, GFSAD30SAAFGIRCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 South Asia, Afghanistan, Iran 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SAAFGIRCE.001.

Gumma, M.K., Thenkabail, P.S., Teluguntla, P., Oliphant, A.J., Xiong, J., Congalton, R.G., Yadav, K., Phalke, A., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for South Asia, Afghanistan and Iran—Cropland extent product (GFSAD30SAAFGIRCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 14 p., https://lpdaac.usgs.gov/documents/162/GFSAD30SAAFGIRCE_User_Guide_V1.pdf.

Gumma, M.K., Thenkabail, P.S., Teluguntla, P.G., Oliphant, A.J., Xiong, J., Giri, C., Pyla, V., Dixit, S., and Whitbread, A.M., 2019, Agricultural cropland extent and areas of South Asia derived using Landsat satellite 30-m time-series big-data using random forest machine learning algorithms on the Google Earth Engine cloud: GIScience & Remote Sensing, v. 57, no. 3, p. 302–322, https://doi.org/10.1080/15481603.2019.1690780.

Haire, B., 2017, This map clearly shows individual farm fields anywhere in the world: Southeast FarmPress, November 14, 2017, https://www.farmprogress.com/crops/map-clearly-shows-individual-farm-fields-anywhere-world.

Harzing, A.-W., 2007, Publish or Perish, v. 2: Harzing.com software release, https://harzing.com/resources/publish-or-perish.

Henderson, G., 2017, New interactive maps of global cropland: AG Web Farm Journal – Harvest, November 14, 2017, https://www.agweb.com/news/crops/harvest-news/crops/planting/new-interactive-maps-global-cropland.

Ho., S., and Thenkabail, P., 2017, New USGS map of global croplands will provide data for food, water security: USDA Radio, November 15, 2017, https://www.usda.gov/media/radio/daily-newsline/2017-11-15/new-usgs-map-global-croplands-will-provide-data-food-water.

Massey, R., Sankey, T., Yadav, K., Congalton, R., Tilton, J., and Thenkabail, P., 2017a, GFSAD30NACE v001—Global food security-support analysis data (GFSAD) cropland extent 2010 North America 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30NACE.001.

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., and Tilton, J.C., 2018, Integrating cloud-based workflows in continental-scale cropland extent classification: Remote Sensing of Environment, v. 219, p. 162–179, https://doi.org/10.1016/j.rse.2018.10.013.

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., Tilton, J.C., and Thenkabail, P.S., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for North America—Cropland extent product (GFSAD30NACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/159/GFSAD30NACE_User_Guide_V1.pdf.

Mertes, C., 2017, Mapping the land from space (in the Cloud): Medium, May 1, 2017, https://medium.com/@carly_mertes/mapping-the-land-from-space-in-the-cloud-e86c73fd3282.

Morning Ag Clips, 2017, New map of worldwide croplands released—South Asia and Europe are considered agricultural capitals of the world: Morning Ag Clips, November 14, 2017, https://www.morningagclips.com/new-map-of-worldwide-croplands-released/.

Ohio's Country Journal, 2017, New map of worldwide croplands supports food and water security: Ohio's Country Journal, November 16, 2017, https://www.ocj.com/2017/11/67028/.

Oliphant, A., Thenkabail, P., Teluguntla, P., Xiong, J., Congalton, R., Yadav, K., Massey, R., Gumma, M., and Smith, C., 2017a, GFSAD30SEACE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Southeast and Northeast Asia 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SEACE.001.

Oliphant, A.J., Thenkabail, P.S., and Teluguntla, P., 2022, Download rates of the global food-security-support-analysis data at 30-m resolution (GFSAD30) cropland-extent products: U.S. Geological Survey data release, https://doi.org/10.5066/P9HOIB7S.

Oliphant, A.J., Thenkabail, P.S., Teluguntla, P., Xiong, J., Congalton, R.G., Yadav, K., Massey, R., Gumma, M.K., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Southeast and Northeast Asia cropland extent-product (GFSAD30SEACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 12 p., https://lpdaac.usgs.gov/documents/168/GFSAD30SEACE_User_Guide_V1.pdf.

Oliphant, A.J., Thenkabail, P.S., Teluguntla, P., Xiong, J., Gumma, M.K., Congalton, R.G., and Yadav, K., 2019, Mapping cropland extent of Southeast and Northeast Asia using multi-year time-series Landsat 30-m data using a random forest classifier on the Google Earth Engine Cloud: International Journal of Applied Earth Observation and Geoinformation, v. 81, p. 110–124, https://doi.org/10.1016/j.jag.2018.11.014.

Phalke, A., Ozdogan, M., Thenkabail, P., Congalton, R., Yadav, K., Massey, R., Teluguntla, P., Poehnelt, J., and Smith, C., 2017a, GFSAD30EUCEARUMECE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Europe, Central Asia, Russia, Middle East 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30EUCEARUMECE.001.

Phalke, A., Ozdogan, M., Thenkabail, P.S., Congalton, R.G., Yadav, K., Massey, R., Teluguntla, P., Poehnelt, J., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Europe, Middle-east, Russia and Central Asia—Cropland extent product (GFSAD30EUCEARUMECE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/156/GFSAD30EUCEARUMECE_User_Guide_V1.pdf.

Pittman, K., Hansen, M.C., Becker-Reshef, I., Potapov, P.V., and Justice, C.O., 2010, Estimating global cropland extent with multi-year MODIS data: Remote Sensing, v. 2, no. 7, p. 1844–1863, https://doi.org/10.3390/rs2071844.

Portmann, F.T., Siebert, S., and Döll, P., 2010, MIRCA2000—Global monthly irrigated and rainfed crop areas around the year 2000—A new high-resolution data set for agricultural and hydrological modeling: Global Biogeochemical Cycles, v. 24, no. 1, 24 p., https://doi.org/10.1029/2008GB003435.

Quarterman, J.S., 2017, Global croplands, Suwannee River Basin: WWALS Watershed Coalition (WWALS) is Suwannee RIVERKEEPER, December 8, 2017, https://www.wwals.net/2017/12/08/global-croplands-suwannee-river-basin/.

Saunders, F., 2018, Croplands up close—A highly detailed map of the world's productive areas for crops corrects some misconceptions about how much is being grown and where: American Scientist, v. 106, no. 1, p. 6, https://www.americanscientist.org/article/croplands-up-close.

SeedQuest, 2017, New map of worldwide croplands supports food and water security—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: SeedQuest, November 14, 2017, https://www.seedquest.com/news.php?type=news&id_article=93387&id_region=&id_category=&id_crop=.

TABLE, 2017, New interactive maps of global cropland now available online: TABLE, December 12, 2017, accessed October 22, 2019, at https://www.tabledebates.org/research-library/new-interactive-maps-global-cropland-now-available-online.

Teluguntla, P., Thenkabail, P., Xiong, J., Gumma, M., Congalton, R., Oliphant, A., Sankey, T., Poehnelt, J., Yadav, K., Massey, R., Phalke, A., and Smith, C., 2017a, GFSAD30AUNZCNMOCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Australia, New Zealand, China, Mongolia 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30AUNZCNMOCE.001.

Teluguntla, P., Thenkabail, P., Xiong, J., Gumma, M., Giri, C., Milesi, C., Ozdogan, M., Congalton, R., Tilton, J., Sankey, T., Massey, R., Phalke, A., and Yadav, K., 2016, GFSAD1KCM v001—Global food security support analysis data (GFSAD) crop mask 2010 global 1 km: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD1KCM.001.

Teluguntla, P., Thenkabail, P.S., Oliphant, A., Xiong, J., Gumma, M.K., Congalton, R.G., Yadav, K., and Huete, A., 2018, A 30-m landsat-derived cropland extent product of Australia and China using random forest machine learning algorithm on Google Earth Engine cloud computing platform: ISPRS Journal of Photogrammetry and Remote Sensing, v. 144, p. 325–340, https://doi.org/10.1016/j.isprsjprs.2018.07.017.

Teluguntla, P., Thenkabail, P.S., Xiong, J., Gumma, M.K., Congalton, R.G., Oliphant, A.J., Sankey, T., Poehnelt, J., Yadav, K., Massey, R., Phalke, A., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m of Australia, New Zealand, China, and Mongolia—Cropland extent-product (GFSAD30AUNZCNMOCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 15 p., https://lpdaac.usgs.gov/documents/147/GFSAD30AUNZCNMOCE_User_Guide_V1.pdf.

Tenenbaum, D., 2017, Mapping cropland—UW-Madison plays critical role in worldwide map: University of Wisconsin–Madison News, November 17, 2017, https://news.wisc.edu/mapping-cropland-uw-madison-plays-critical-role-in-best-ever-map/.

Thenkabail, P., Knox, J., Ozdogan, M., Gumma, M., Congalton, R., Wu, Z., Milesi, C., Finkral, A., Marshall, M., Mariotto, I., You, S., Giri, C., and Nagler, P., 2016a, GFSAD1KCD v001—Global food security support analysis data (GFSAD) crop dominance 2010 global 1 km: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD1KCD.001.

Thenkabail, P., Teluguntla, P., Xiong, J., Oliphant, A., and Massey, R., 2016b, NASA making Earth system data records for use in research environments (MEaSUREs) global food-security support analysis data (GFSAD) 1 km datasets—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 15 p., https://lpdaac.usgs.gov/documents/172/GFSAD1K_User_Guide_V1.pdf.

Thenkabail, P.S., Hanjra, M.A., Dheeravath, V., and Gumma, M.K., 2011, Global croplands and their water use from remote sensing and nonremote sensing perspectives, *in* Weng, Q., ed., Advances in environmental remote sensing—Sensors, algorithms, and applications: Boca Raton, Fla., Taylor & Francis, p. 383–419, https://doi.org/10.1201/b10599-20.

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, M., 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.

Xiong, J., Thenkabail, P., Tilton, J., Gumma, M., Teluguntla, P., Congalton, R., Yadav, K., Dungan, J., Oliphant, A., Poehnelt, J., Smith, C., and Massey, R., 2017a, GFSAD30AFCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Africa 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30AFCE.001.

Xiong, J., Thenkabail, P.S., Tilton, J.C., Gumma, M.K., Teluguntla, P., Congalton, R.G., Yadav, K., Dungan, J., Oliphant, A.J., Poehnelt, J., Smith, C., and Massey, R., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Africa—Cropland extent-product (GFSAD30AFCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 14 p., https://lpdaac.usgs.gov/documents/152/GFSAD30AFCE_User_Guide_V1.pdf.

Xiong, J., Thenkabail, P.S., Tilton, J.C., Gumma, M.K., Teluguntla, P., Oliphant, A., Congalton, R.G., Yadav, K., and Gorelick, N., 2017c, Nominal 30-m cropland extent map of continental Africa by integrating pixel-based and object-based algorithms using Sentinel-2 and Landsat-8 data on Google Earth Engine: Remote Sensing, v. 9, no. 10, 27 p., https://doi.org/10.3390/rs9101065.

Yadav, K., and Congalton, R.G., 2018a, Accuracy assessment of global food security-support analysis data (GFSAD) cropland extent maps produced at three different spatial resolutions: Remote Sensing, v. 10, no. 11, 30 p., https://doi.org/10.3390/rs10111800.

Yadav, K., and Congalton, R.G., 2018b, Issues with large area thematic accuracy assessment for mapping cropland extent—A tale of three continents: Remote Sensing, v. 10, no. 1, 27 p., https://doi.org/10.3390/rs10010053.

Zhong, Y., Giri, C., Thenkabail, P., Teluguntla, P., Congalton, R., Yadav, K., Oliphant, A., Xiong, J., Poehnelt, J., and Smith, C., 2017a, GFSAD30SACE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 South America 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SACE.001.

Zhong, Y., Giri, C., Thenkabail, P.S., Teluguntla, P., Congalton, R.G., Yadav, K., Oliphant, A.J., Xiong, J., Poehnelt, J., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for South America—Cropland extent product (GFSAD30SACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/165/GFSAD30SACE_User_Guide_V1.pdf.

Appendixes 1—4

Appendix 1. References for GFSAD30 Products

GFSAD30AFCE (Africa)

Xiong, J., Thenkabail, P., Tilton, J., Gumma, M., Teluguntla, P., Congalton, R., Yadav, K., Dungan, J., Oliphant, A., Poehnelt, J., Smith, C., and Massey, R., 2017a, GFSAD30AFCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Africa 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30AFCE.001.

GFSAD30AUNZCNMOCE (Australia, New Zealand, China, and Mongolia)

Teluguntla, P., Thenkabail, P., Xiong, J., Gumma, M., Congalton, R., Oliphant, A., Sankey, T., Poehnelt, J., Yadav, K., Massey, R., Phalke, A., and Smith, C., 2017a, GFSAD30AUNZCNMOCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Australia, New Zealand, China, Mongolia 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30AUNZCNMOCE.001.

GFSAD30EUCEARUMECE (Europe, Middle East, Russia, and Central Asia)

Phalke, A., Ozdogan, M., Thenkabail, P., Congalton, R., Yadav, K., Massey, R., Teluguntla, P., Poehnelt, J., and Smith, C., 2017a, GFSAD30EUCEARUMECE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Europe, Central Asia, Russia, Middle East 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30EUCEARUMECE.001.

GFSAD30NACE (North America)

Massey, R., Sankey, T., Yadav, K., Congalton, R., Tilton, J., and Thenkabail, P., 2017a, GFSAD30NACE v001—Global food security-support analysis data (GFSAD) cropland extent 2010 North America 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30NACE.001.

GFSAD30SACE (South America)

Zhong, Y., Giri, C., Thenkabail, P., Teluguntla, P., Congalton, R., Yadav, K., Oliphant, A., Xiong, J., Poehnelt, J., and Smith, C., 2017a, GFSAD30SACE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 South America 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SACE.001.

GFSAD30SEACE (Southeast and Northeast Asia)

Oliphant, A., Thenkabail, P., Teluguntla, P., Xiong, J., Congalton, R., Yadav, K., Massey, R., Gumma, M., and Smith, C., 2017a, GFSAD30SEACE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 Southeast and Northeast Asia 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SEACE.001.

GFSAD30SAAFGIRCE (South Asia, Afghanistan, and Iran)

Gumma, M., Thenkabail, P., Teluguntla, P., Oliphant, A., Xiong, J., Congalton, R., Yadav, K., Phalke, A., and Smith, C., 2017a, GFSAD30SAAFGIRCE v001—Global food security-support analysis data (GFSAD) cropland extent 2015 South Asia, Afghanistan, Iran 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30SAAFGIRCE.001.

GFSAD30VAL (Global Validation)

Congalton, R., Yadav, K., McDonnell, K., Poehnelt, J., Stevens, B., Gumma, M., Teluguntla, P., and Thenkabail, P., 2017a, GFSAD30VAL v001—Global food security-support analysis data (GFSAD) cropland extent 2015 validation 30 m: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD30VAL.001.

GFSAD1KCD (1-km-Resolution Multisensor Derived Crop Dominance)

Thenkabail, P., Knox, J., Ozdogan, M., Gumma, M., Congalton, R., Wu, Z., Milesi, C., Finkral, A., Marshall, M., Mariotto, I., You, S., Giri, C., and Nagler, P., 2016a, GFSAD1KCD v001—Global food security support analysis data (GFSAD) crop dominance 2010 global 1 km: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD1KCD.001.

GFSAD1KCM (1-km-Resolution Multisensor-Derived Crop Mask)

Teluguntla, P., Thenkabail, P., Xiong, J., Gumma, M., Giri, C., Milesi, C., Ozdogan, M., Congalton, R., Tilton, J., Sankey, T., Massey, R., Phalke, A., and Yadav, K., 2016a, GFSAD1KCM v001—Global food security support analysis data (GFSAD) crop mask 2010 global 1 km: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center website, https://doi.org/10.5067/MEaSUREs/GFSAD/GFSAD1KCM.001.

Appendix 2. References for GFSAD30 Product Documentation

GFSAD30AFCE (Africa)

Xiong, J., Thenkabail, P.S., Tilton, J.C., Gumma, M.K., Teluguntla, P., Congalton, R.G., Yadav, K., Dungan, J., Oliphant, A.J., Poehnelt, J., Smith, C., and Massey, R., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Africa—Cropland extent-product (GFSAD30AFCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 14 p., https://lpdaac.usgs.gov/documents/152/GFSAD30AFCE_User_Guide_V1.pdf.

GFSAD30AUNZCNMOCE (Australia, New Zealand, China, and Mongolia)

Teluguntla, P., Thenkabail, P.S., Xiong, J., Gumma, M.K., Congalton, R.G., Oliphant, A.J., Sankey, T., Poehnelt, J., Yadav, K., Massey, R., Phalke, A., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m of Australia, New Zealand, China, and Mongolia—Cropland extent-product (GFSAD30AUNZCNMOCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 15 p., https://lpdaac.usgs.gov/documents/147/GFSAD30AUNZCNMOCE_User_Guide_V1.pdf.

GFSAD30SEACE (Southeast and Northeast Asia)

Oliphant, A.J., Thenkabail, P.S., Teluguntla, P., Xiong, J., Congalton, R.G., Yadav, K., Massey, R., Gumma, M.K., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Southeast and Northeast Asia cropland extent-product (GFSAD30SEACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 12 p., https://lpdaac.usgs.gov/documents/168/GFSAD30SEACE_User_Guide_V1.pdf.

GFSAD30SAAFGIRCE (South Asia, Afghanistan, and Iran)

Gumma, M.K., Thenkabail, P.S., Teluguntla, P., Oliphant, A.J., Xiong, J., Congalton, R.G., Yadav, K., Phalke, A., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for South Asia, Afghanistan and Iran—Cropland extent product (GFSAD30SAAFGIRCE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 14 p., https://lpdaac.usgs.gov/documents/162/GFSAD30SAAFGIRCE_User_Guide_V1.pdf.

GFSAD30EUCEARUMECE (Europe, Middle East, Russia and Central Asia)

Phalke, A., Ozdogan, M., Thenkabail, P.S., Congalton, R.G., Yadav, K., Massey, R., Teluguntla, P., Poehnelt, J., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for Europe, Middle-east, Russia and Central Asia—Cropland extent product (GFSAD30EUCEARUMECE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/156/GFSAD30EUCEARUMECE_User_Guide_V1.pdf.

GFSAD30NACE (North America)

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., Tilton, J.C., and Thenkabail, P.S., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for North America—Cropland extent product (GFSAD30NACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/159/GFSAD30NACE_User_Guide_V1.pdf.

GFSAD30SACE (South America)

Zhong, Y., Giri, C., Thenkabail, P.S., Teluguntla, P., Congalton, R.G., Yadav, K., Oliphant, A.J., Xiong, J., Poehnelt, J., and Smith, C., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) @ 30-m for South America—Cropland extent product (GFSAD30SACE)—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/165/GFSAD30SACE_User_Guide_V1.pdf.

GFSAD30VAL (Global Validation)

Congalton, R.G., Yadav, K., McDonnell, K., Poehnelt, J., Stevens, B., Gumma, M.K., Teluguntla, P., and Thenkabail, P.S., 2017b, NASA making Earth system data records for use in research environments (MEaSUREs) global food security-support analysis data (GFSAD) 30-m cropland extent validation (GFSAD30VAL)—User's guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 13 p., https://lpdaac.usgs.gov/documents/171/GFSAD30VAL_User_Guide_V1.pdf.

GFSAD1KCD (1-km-Resolution Multisensor-Derived Crop Dominance)

Thenkabail, P., Teluguntla, P., Xiong, J., Oliphant, A., and Massey, R., 2016b, NASA making Earth system data records for use in research environments (MEaSUREs) global food-security support analysis data (GFSAD) 1 km datasets—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 15 p., https://lpdaac.usgs.gov/documents/172/GFSAD1K_User_Guide_V1.pdf.

GFSAD1KCM (1-km-Resolution Multisensor-Derived Crop Mask)

Thenkabail, P., Teluguntla, P., Xiong, J., Oliphant, A., and Massey, R., 2016b, NASA making Earth system data records for use in research environments (MEaSUREs) global food-security support analysis data (GFSAD) 1 km datasets—User guide: U.S. Geological Survey–National Aeronautics and Space Administration Land Processes Distributed Active Archive Center, 15 p., https://lpdaac.usgs.gov/documents/172/GFSAD1K_User_Guide_V1.pdf.

Appendix 3. References for Peer-Reviewed Scientific Journal Publications Associated with GFSAD30

Accuracy Assessment

Yadav, K., and Congalton, R.G., 2018a, Accuracy assessment of global food security-support analysis data (GFSAD) cropland extent maps produced at three different spatial resolutions: Remote Sensing, v. 10, no. 11, 30 p., https://doi.org/10.3390/rs10111800.

Yadav, K., and Congalton, R.G., 2018b, Issues with large area thematic accuracy assessment for mapping cropland extent—A tale of three continents: Remote Sensing, v. 10, no. 1, 27 p., https://doi.org/10.3390/rs10010053.

Africa

Xiong, J., Thenkabail, P.S., Tilton, J.C., Gumma, M.K., Teluguntla, P., Oliphant, A., Congalton, R.G., Yadav, K., and Gorelick, N., 2017c, Nominal 30-m cropland extent map of continental Africa by integrating pixel-based and object-based algorithms using Sentinel-2 and Landsat-8 data on Google Earth Engine: Remote Sensing, v. 9, no. 10, 27 p., https://doi.org/10.3390/rs9101065.

Australia

Teluguntla, P., Thenkabail, P.S., Oliphant, A., Xiong, J., Gumma, M.K., Congalton, R.G., Yadav, K., and Huete, A., 2018, A 30-m landsat-derived cropland extent product of Australia and China using random forest machine learning algorithm on Google Earth Engine cloud computing platform: ISPRS Journal of Photogrammetry and Remote Sensing, v. 144, p. 325–340, https://doi.org/10.1016/j.isprsjprs.2018.07.017.

North America

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., and Tilton, J.C., 2018, Integrating cloud-based workflows in continental-scale cropland extent classification: Remote Sensing of Environment, v. 219, p. 162–179, https://doi.org/10.1016/j.rse.2018.10.013.

Southeast Asia

Oliphant, A.J., Thenkabail, P.S., Teluguntla, P., Xiong, J., Gumma, M.K., Congalton, R.G., and Yadav, K., 2019, Mapping cropland extent of Southeast and Northeast Asia using multi-year time-series Landsat 30-m data using a random forest classifier on the Google Earth Engine Cloud: International Journal of Applied Earth Observation and Geoinformation, v. 81, p. 110–124, https://doi.org/10.1016/j.jag.2018.11.014.

South Asia

Gumma, M.K., Thenkabail, P.S., Teluguntla, P.G., Oliphant, A., Xiong, J., Giri, C., Pyla, V., Dixit, S., and Whitbread, A.M., 2019, Agricultural cropland extent and areas of South Asia derived using Landsat satellite 30-m time-series big-data using random forest machine learning algorithms on the Google Earth Engine cloud: GIScience & Remote Sensing, v. 57, no. 3, p. 302–322, https://doi.org/10.1080/15481603.2019.1690780.

Appendix 4. References for Other Online Sources that Mention GFSAD30

Agri-View, 2017, World cropland mapped—Results surprising: Agri-View, November 15, 2017, https://www.agupdate.com/agriview/markets/crop/world-cropland-mapped-results-surprising/article_570bf535-2077-517e-9288-7b52f1b60d1a.html.

Balpataky, K., 2017, Global agriculture intensity detailed in interactive map: Water Canada, November 14, 2017, https://www.watercanada.net/global-agriculture-intensity-detailed-in-interactive-map/.

Chaturvedi, A., 2017, USGS releases interactive map of croplands in the world: Geospatial World, November 22, 2017, https://www.geospatialworld.net/blogs/usgs-croplands-interactive-map/.

Deb, P., 2017, India beats US and China on farmland—Report: International Business Times, November 15, 2017, https://www.ibtimes.co.in/india-beats-us-china-farmland-report-749512.

Durisin, M., 2017, There's more farmland in the world than was previously thought: Bloomberg, November 15, 2017, https://www.bloombergquint.com/global-economics/2017/11/14/there-s-more-farmland-in-the-world-than-was-previously-thought.

European Seed, 2017, New map of worldwide croplands supports food and water security: europeanseed, November 17, 2017, https://european-seed.com/2017/11/new-map-worldwide-croplands-supports-food-water-security/.

Farm and Dairy, 2017, Cropland map supports food, water security—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: Farm and Dairy, November 18, 2017, https://www.farmanddairy.com/news/cropland-map-supports-food-water-security/456694.html.

Feed&Grain, 2017, New map of worldwide croplands—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: Feed&Grain, November 14, 2017, https://www.feedandgrain.com/news/new-map-of-worldwide-croplands.

GISUSER, 2017, New map of worldwide croplands supports food and water security: GISuser Beyond the Map, December 30, 2017, https://gisuser.com/2017/12/new-map-of-worldwide-croplands-supports-food-and-water-security-2/.

Haire, B., 2017, This map clearly shows individual farm fields anywhere in the world: Southeast FarmPress, November 14, 2017, https://www.farmprogress.com/crops/map-clearly-shows-individual-farm-fields-anywhere-world.

Henderson, G., 2017, New interactive maps of global cropland: AG Web Farm Journal – Harvest, November 14, 2017, https://www.agweb.com/news/crops/harvest-news/crops/planting/new-interactive-maps-global-cropland.

Ho., S., and Thenkabail, P., 2017, New USGS map of global croplands will provide data for food, water security: USDA Radio, November 15, 2017, https://www.usda.gov/media/radio/daily-newsline/2017-11-15/new-usgs-map-global-croplands-will-provide-data-food-water.

Mertes, C., 2017, Mapping the land from space (in the Cloud): Medium, May 1, 2017, https://medium.com/@carly_mertes/mapping-the-land-from-space-in-the-cloud-e86c73fd3282.

Morning Ag Clips, 2017, New map of worldwide croplands released—South Asia and Europe are considered agricultural capitals of the world: Morning Ag Clips, November 14, 2017, https://www.morningagclips.com/new-map-of-worldwide-croplands-released/.

Ohio's Country Journal, 2017, New map of worldwide croplands supports food and water security: Ohio's Country Journal, November 16, 2017, https://www.ocj.com/2017/11/67028/.

Quarterman, J.S., 2017, Global croplands, Suwannee River Basin: WWALS Watershed Coalition (WWALS) is Suwannee RIVERKEEPER, December 8, 2017, https://www.wwals.net/2017/12/08/global-croplands-suwannee-river-basin/.

Saunders, F., 2018, Croplands up close—A highly detailed map of the world's productive areas for crops corrects some misconceptions about how much is being grown and where: American Scientist, v. 106, no. 1, p. 6, https://www.americanscientist.org/article/croplands-up-close.

SeedQuest, 2017, New map of worldwide croplands supports food and water security—India has the highest net cropland area while South Asia and Europe are considered agricultural capitals of the world: SeedQuest, November 14, 2017, https://www.seedquest.com/news.php?type=news&id_article=93387&id_region=&id_category=&id_crop=.

TABLE, 2017, New interactive maps of global cropland now available online: TABLE, December 12, 2017, accessed October 22, 2019, at https://www.tabledebates.org/research-library/new-interactive-maps-global-cropland-now-available-online.

Tenenbaum, D., 2017, Mapping cropland—UW-Madison plays critical role in worldwide map: University of Wisconsin–Madison News, November 17, 2017, https://news.wisc.edu/mapping-cropland-uw-madison-plays-critical-role-in-best-ever-map/.

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