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Remote Sensing Image Based Dataset of Chengdu Facility Agriculture Spatial Distribution (2010, 2020)

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Abstract: The rapid development of facility agriculture, primarily greenhouse farming in Chengdu city has been driven by urbanization. Using high-resolution imagery data from Google Earth, the author conducted visual interpretation and geostatistical methods to obtain spatial distribution data for facility agriculture in 15 districts and counties of Chengdu city in 2010 and 2020. Statistical analysis was also conducted to determinethe land area occupied by facility agriculture in each district and county, resulting in the creation of the Chengdu facility agriculture spatial distribution dataset (2010, 2020). The findings reveal that from 2010 to 2020, the area of facility agriculture in Chengdu city increased by 45.30 km^2 and expanded continuously from the southern to the northern regions of Chengdu. The dataset comprises two main components: (1) spatial distribution data for facility agriculture in 2010 and 2020, and (2) statistical data on the land area of facility agriculture in each district and county for 2010 and 2020. The dataset is available in .gdb and .xlsx formats, consisting of 53 data files with data size of 6.63 MB (compressed into one file, 3.36 MB).

Keywords: Facility agriculture; Chengdu city; Google Earth; Geostatistics

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Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2022.03.02.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2022.03.02.V1.

1 Introduction

Facility agriculture, a cutting-edge agricultural model, employs a artificial means to regulate

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[2] Liu, Q., Shu, X. Y., Hu, Y. F., *et al*. Facility agriculture dataset in Chengdu of China (2010, 2020) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2022. https://doi.org/10.3974/geodb.2022.03.02.V1. https://cstr.escience.org.cn/CSTR:20146.11.2022.03.02.V1.

and control the growth environment of plants. By optimizing growth factors, it aims to achieve the maximum potential yield and efficiency of crops. Utilizing existing facilities, this approach gradually liberates traditional agriculture from the constraints of natural conditions. Facility agriculture belongs to the high-tech, high-input, and high-output industry, playing a significant role in the advancement of modern agriculture[1, 2]. The advent and progression of facility agriculture have facilitated the intensive and efficient utilization of land, leading to improved land productivity and better alignment with market demands. Agricultural greenhouses, as a prominent form of facility agriculture, encompass a total area of 4.6 million hectares worldwide, according to the 2017 survey data. Notably, they are primarily concentrated in China, South Korea, and Japan. Among these, the plastic greenhouse type accounts for approximately 28.3%, with a total area of about 1.3 million hectares. They are widely used in Jiangsu, Liaoning, Shandong, and other provinces in China[3], providing conditions for intensive production and regional industrial chain construction. As a major agricultural country in the world, China has rapidly developed facility agriculture and has the largest area in the world[4], but started relatively late. In Sichuan province, facility agriculture has entered a phase of rapid development after several years of progress. Nonetheless, challenges persist, such as the uneven regional distribution of facility agriculture and outdated operational models. These issues necessitate appropriate allocation and management in future rural infrastructure development efforts.

Traditional methods, such as sampling surveys and statistical reporting, are commonly employed to gather relevant information on agricultural greenhouses, including their regions, locations, quantities, spatial distributions, and economic benefits. However, these methods are complex, generate large size of data, are challenging to organize, and may result in reduced accuracy and timeliness. In contrast, remote sensing offers significant advantages due to its dynamic nature and rapid data acquisition speed. It enables large-scale, synchronized observation and is particularly suitable for extracting information about agricultural greenhouses. Visual interpretation of remote sensing images involves directly observing ground objects or utilizing reading instruments on remote sensing images to obtain specific target information[5]. By leveraging information-rich, high-resolution images, agricultural greenhouses can be swiftly and accurately identified. Moreover, the precise and real-time monitoring of the temporal and spatial development trends of agricultural greenhouses becomes achievable. This approach essentially provides a reflection of the land use situation in rural areas, offering a valuable foundation for future regional development and planning, rural revitalization, and industrial advancement.

This study aims to investigate the spatial distribution pattern and change characteristics of facility agriculture in Chengdu over the past 10 years. Using Google Earth high-resolution satellite imagery as the basic data, a combination of visual interpretation, basic mathematical statistics, ArcGIS 10.6 grid statistics, and Excel analysis was used to obtain and compile the distribution of facility agriculture and typical spatial distribution data in Chengdu from 2010 to 2020.

2 Metadata of the Dataset

Metadata of the Spatial dataset of facility agriculture in Chengdu city (2010, 2020)[6] are shown in Table 1.

Table 1 Metadata summary of the Facility agriculture dataset in Chengdu of China (2010, 2020)

Items	Description
Dataset full name	Facility agriculture dataset in Chengdu of China (2010, 2020)
Dataset short name	FacilityAgriChengdu
Authors	Liu, Q., Sichuan Agricultural University, 15884321475@163.com Shu, X.Y., Sichuan Agricultural University, 18202809282@163.com Hu, Y. F., Sichuan Agricultural University Li, J., Sichuan Agricultural University Zhang, J. Y., Sichuan Agricultural University Du, S. Q., Sichuan Agricultural University Huang, H., Xinjiang Agricultural University Zhang, X. G., Chengdu Agricultural Exchange Longquanyi Rural Equity Exchange Co., Ltd.
Geographical region	Chengdu city
Year	2010, 2020
Temporal resolution	1 m
Dataset format	.shp, .kmz
Data size	6.63 MB
Data files	Including the spatial data of agricultural greenhouses in 15 counties and cities of Chengdu in 2010 and 2020, and the spatial data of typical agricultural greenhouse areas in four counties and cities in 2010 and 2020
Foundations	Sichuan Province (2020JDRC0074, 2021JDRC0082)
Computing environment	ArcGIS campus license of College of Recourse, Sichuan Agricultural University
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data* & *Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[7]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

3 Study Area

As the center city of the Southwest region, Chengdu is located on the Chengdu Plain and has superior geographic location, transportation conditions, and economic development advantages. The annual average temperature in Chengdu is 16.8 ℃, with an annual sunshine duration of 804.2 h and annual precipitation of 1,068.5 mm. It is an area with excellent production conditions and abundant agricultural resources in Sichuan province and has become one of China's nine major commodity grain bases, gradually achieving coordinated development with surrounding areas[8]. In recent years, due to the development of the secondary and tertiary industries and the increase in population pressure, the demand for urban residential land, infrastructure land, and industrial land for increasing employment will also increase. The agricultural land structure and industrial system in rural areas on the outskirts of the city have undergone significant changes and presented a diversified development trend[9]. According to the functional zoning of land use and modern agricultural development, the characteristics of land use changes are obvious[10]. The management of facility agriculture has been further improved, and the trend of large-scale and clustered agricultural production has been strengthened. Among them, a large number of facility greenhouse lands have appeared in the agricultural land of Pingba district, used for growing vegetables with scale advantages.

The agricultural greenhouses in Chengdu are mainly intelligent greenhouses, standard greenhouses, and simple greenhouses. There are significant differences in the technical content of greenhouses, and their operational conditions and adaptability differ. Although the total area of greenhouses is relatively large, the structure of the number of greenhouses of each type is unreasonable due to traditional statistical data, and the operating modes in different regions have shifted from sporadic dispersed management to centralized and large-scale management[11,12]. As time and seasons change, there may be differences in the area of existing greenhouses. From the perspective of greenhouse materials, plastic film is commonly used, while glass/PC board is used for covering. There is also a significant difference in the supporting facilities of the greenhouse. From the perspective of greenhouse technology, greenhouses in the area are mainly used for the production of vegetables and fruits. The site selection, management, cultivation, and output of greenhouses are gradually upgrading, but the overall level is still weak[13].

4 Data Sources and Methods

This study mainly used high-resolution Google Earth satellite images with resolutions ranging from 0.24 m (level 19) to 0.51 m (level 18), following the method of Wei *et al*.[14]. First, taking the vector map of the Chengdu area in Sichuan province as the boundary, with the geographic coordinate system of GCS_WGS_1984 and the projected coordinate system of WGS_1984_UTM_Zone_47N, the agricultural greenhouse land in the Chengdu area over the past 10 years was obtained through visual interpretation of satellite images mainly from 2010 and 2020. The area of the agricultural greenhouse land interpreted from the satellite images during this period accounted for 80.79% of the total number of agricultural greenhouse land in Chengdu. Among this part, 84.53% of the facility agriculture land was obtained from satellite images from January to April 2020. The remaining 7.18% and 12.03% of agricultural greenhouses were obtained using Google Earth high-resolution satellite images from 2018 and 2019, respectively, due to missing data in the latest image data.

Therefore, the high-resolution imagery from January 2018 to September 2020 was extracted using Google Earth software and archived as .kml files, which were then converted to .shp files using the conversion tool in 91ditu and ArcGIS 10.6. Given the large amount of visual interpretation data obtained and the fact that agricultural greenhouses are mostly distributed around major towns, with few in the central urban areas or remote mountainous regions, this study selected Google Earth high-resolution imagery (with a resolution of 0.24–0.51 m and taken between January 2010 and September 2020) from several districts and counties in Chengdu city, including Xinjin, Pengzhou, Chongzhou, Dayi county, Qingbaijiang, Wenjiang, Shuangliu, Pidu, Qionglai, Xindu, Jianyang, Dujiangyan, Jintang, Pujiang, and Longquanyi. However, recent data is missing for some regions in several counties and cities, including Jintang, Jianyang, Dujiangyan, Dayi, Chongzhou, and some areas in Shuangliu in 2018, as well as some areas in Jianyang, Dujiangyan, Pidu, Shuangliu, Pengzhou, and Longquanyi in 2019. Agricultural greenhouse data was obtained through visual interpretation. To better and more accurately understand the spatial distribution pattern and development trend of greenhouses during this period, the grid statistics function available in ArcGIS 10.6 was used to convert independent spatial-temporal data into high-resolution basic geographic units, and the greenhouse data was correlated on the spatial scale,

which is also often used to reflect the land use status and concentration in the region [15,16].

5 Data Results

5.1 Data Products

The facility agriculture dataset in Chengdu of China consists of four parts, including two spatial datasets for agricultural greenhouses in 15 counties and cities in Chengdu city for the years 2010 and 2020. The counties and cities included are Xinjin county, Pengzhou city, Chongzhou city, Dayi county, Qingbaijiang district, Wenjiang district, Shuangliu district, Pixian district, Qionglai county, Xindu district, Jianyang city, Dujiangyan city, Jintang county, Pujiang county, and Longquanyi district. Additionally, there are two spatial datasets for the spatial distribution of agricultural greenhouses in four typical counties in Chengdu city, namely Xinjin county, Dayi county, Chongzhou city, and Shuangliu county, for the years 2010 and 2020. The study area and agricultural greenhouses can be seen in Figure 1 and Figure 2, respectively.

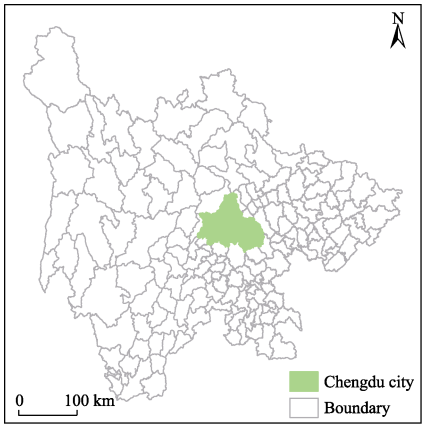

Figure 1 Geo-location of Chengdu city

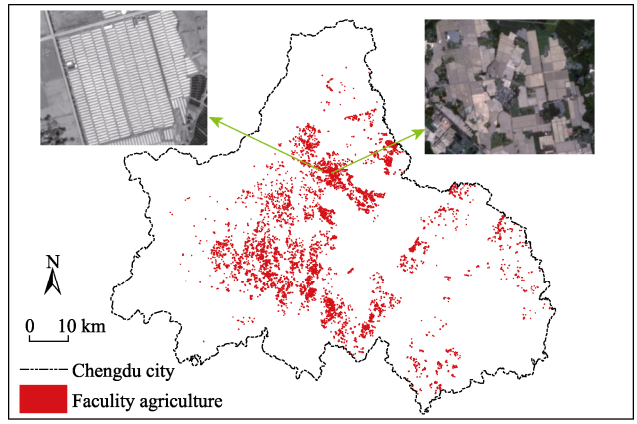

Figure 2 Agricultural greenhouses distribution in Chengdu city

5.2 Data Results

5.2.1 Analysis of Spatio-temporal Changes in Facility Agriculture in Chengdu

In 2010, the area of facility agriculture in Chengdu city was 15.63 km^2, primarily concentrated in Dayi, Shuangliu, Chongzhou, and Xinjin (Figure 3). The area of facility agriculture in each district and county is presented in Table 2.

China is the country with the largest area of facility cultivation, with three main types: plastic greenhouses, sunlight greenhouses, and multi-span greenhouses. In the Chengdu Plain area, most of the greenhouses are plastic greenhouses, distributed on both sides of the Longquan Mountains. Greenhouse cultivation mainly focuses on vegetables and fruits. By 2020, the area of facility agriculture in Chengdu city had expanded to 60.93 km^2, primarily distributed in Dayi, Shuangliu, Chongzhou, Xinjin, Wenjiang, and Pixian districts (Figure 4). Over the span of ten years, the area of facility agriculture in Chengdu city increased by 45.30 km^2, representing a growth rate of 290%. The expansion of facility agriculture occurred from the southern to the northern parts of Chengdu, resulting in significant changes in the north-south

pattern of facility agriculture land. Regarding the uneven or sparse distribution of agricultural greenhouses in Wenjiang district and Pujiang county, it is mainly due to changes in the local industrial system. The area has transitioned to the flower and horticultural industry, including citrus fruits and kiwifruits[17, 18]. The shift in dominant industries has led to differences in the demand for agricultural greenhouses compared to regular agricultural land, thus affecting the development of agricultural greenhouses in the area.

In 2010, Dujiangyan, Jianyang, Jintang, and Pujiang county had relatively less facility agriculture. However, by 2020, all districts and counties in Chengdu experienced an increase in facility agriculture. Among them, Dayi saw the largest increase in facility agriculture area, reaching 10.80 km^2, accounting for 17.72% of the total. Pujiang county had the least distribution of facility agriculture, with only 0.09 km^2, accounting for 0.16% of the total.

Table 2 Agricultural facility area in each district and county of Chengdu city from 2010 to 2020

County	2010			2020		
	Area (km^2)	Proportion (%)	Ranking	Area (km^2)	Proportion (%)	Ranking
Chongzhou	1.10	7.04	6	9.12	14.64	3
Dayi	3.27	20.93	2	10.92	17.55	1
Dujiangyan	0	0.00	12	3.06	4.92	8
Jianyang	0	0.00	12	1.18	1.90	13
Jintang	0	0.00	12	2.94	4.72	9
Longquanyi	0.11	0.71	10	1.52	2.45	12
Pengzhou	0.06	0.39	11	3.19	5.13	7
Pidu	0.61	3.89	8	4.60	7.38	5
Pujiang	0	0.00	12	0.09	0.15	15
Qingbaijiang	0.57	3.66	9	0.38	0.62	14
Qionglai	2.79	17.84	3	3.69	5.92	6
Shuangliu	1.25	7.98	5	9.21	14.79	2
Wenjiang	0.71	4.57	7	2.31	3.70	11
Xindu	1.71	10.95	4	2.51	4.03	10
Xinjin	3.44	22.02	1	7.53	12.10	4

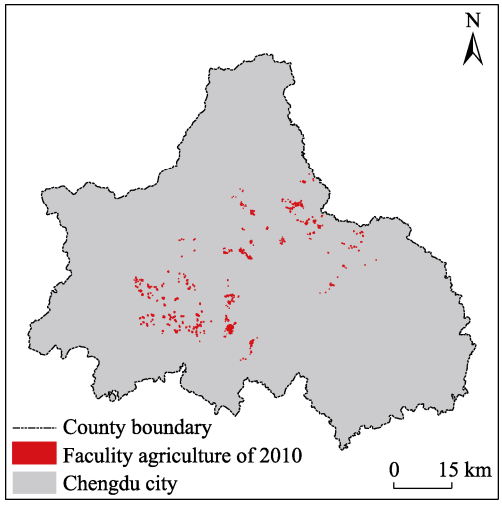

Figure 3 Map of spatial distribution of facility agriculture in Chengdu city in 2010

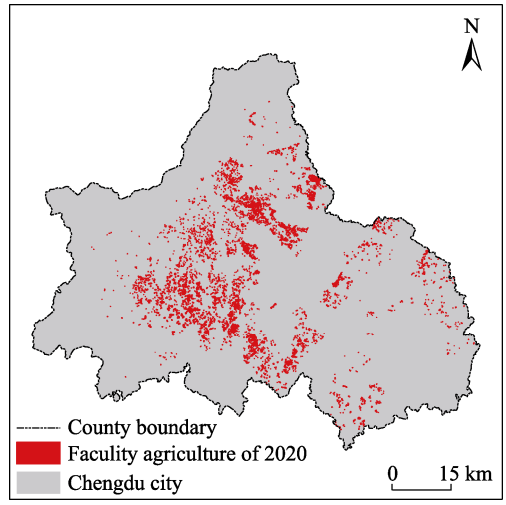

Figure 4 Map of spatial distribution of facility agriculture in Chengdu city in 2020

5.2.2 Analysis of Spatio-temporal Changes in Facility Agriculture in Typical Regions

This dataset selected several districts and counties with larger areas of facility agriculture, including Dayi, Chongzhou, Xinjin, and Wenjiang, to form a typical area (Figure 5, 6). The area statistics for the typical region are shown in Table 3. In 2010, the area of facility agriculture in the typical region was 9.06 km^2, and by 2020, it had increased to 36.43 km^2, an increase of 27.36 km^2 and a growth rate of 302%. Among them, Chongzhou city had the fastest growth rate, increasing from 1.10 km^2 in 2010 to 9.12 km^2 in 2020.

Table 3 The area of facility agriculture land in typical areas from 2010 to 2020

County	2010			2020		
	Area (km^2)	Proportion (%)	Ranking	Area (km^2)	Proportion (%)	Ranking
Chongzhou	1.10	12.14	4	9.12	24.79	3
Dayi	3.27	36.11	2	10.92	29.70	1
Shuangliu	1.25	13.77	3	9.21	25.04	2
Xinjin	3.44	37.98	1	7.53	20.48	4

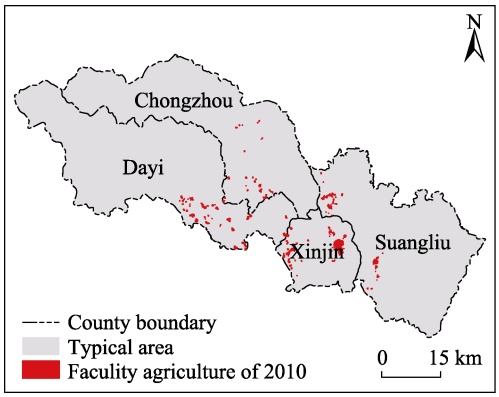

Figure 5 Map of spatial distribution of facility agriculture in typical areas in Chengdu city in 2010

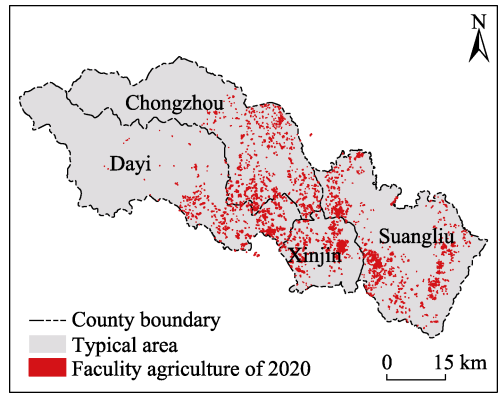

Figure 6 Map of spatial distribution of in facility agriculture in typical areas in Chengdu city in 2020

6 Discussion and Conclusion

This study is based on a dataset of facility agriculture land in Chengdu city, constructed using Google Earth imagery. It reveals the spatial distribution of facility agriculture in Chengdu from 2010 to 2020, making it the first dataset specifically focused on the spatial distribution of facility agriculture in Chengdu. It provides data support for understanding the current status and changing characteristics of facility agriculture land in Chengdu. Our results found that the area of facility agriculture in Chengdu was 15.63 km^2 in 2010 and increased to 60.93 km^2 in 2020. During the period from 2010 to 2020, the area of facility agriculture in Chengdu expanded by 45.30 km^2, representing a growth rate of 290%. In terms of distribution, facility agriculture in Chengdu is primarily concentrated in the districts of Dayi, Shuangliu, Chongzhou, Xinjin, Wenjiang, and Pixian. From 2010 to 2020, facility agriculture expanded from the southern part to the northern part of Chengdu. It should be noted that when using this research dataset, the Google Earth imagery should be adjusted to the corresponding year of the data to avoid inaccurate data correspondences.

Author Contributions

Shu, X. Y. and Ye, Q. X. proposed and promoted the development, design, and paper writing of the dataset. Liu, Q., and Liu, W. J. translated and obtained the data on facility agricultural land in Chengdu from 2010 to 2020. Wu, J. W. and Liu, Q. processed and compiled the dataset, and wrote the data paper. These individuals worked together to produce the dataset and wrote the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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