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Spatial Distribution Dataset for Facility Agriculture in the Tibetan Plateau and Two Typical Regions

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Abstract: During the past decade, facility agriculture has grown quickly in the Tibetan Plateau and has become a new highlight of the region's agricultural development. Identifying the distribution pattern and spatiotemporal change characteristics of facility agriculture in the Tibetan Plateau is helpful for understanding trends in its development and providing support for rational planning of its future development. Using high-resolution image data obtained from Google Earth in 2018 as the data source, this study first determined the area used for facility agriculture in the Tibetan Plateau by visual interpretation and mapped its spatial distribution with ArcGIS. Then, Xining and Lhasa were selected as two typical regions and the changes of the areas dedicated to facility agriculture between 2008 and 2018 were identified. The results showed that in 2018, the total area dedicated to facility agriculture in the Tibetan Plateau was 9,426.95 hm^2, which was mainly distributed in the major cities and their surrounding areas in southern Tibet autonomous region and eastern Qinghai province. Of the total land area dedicated to facility agriculture, about 65.53% was distributed in Qinghai and 29.96% in Tibet, respectively. In the past ten years, facility agriculture has developed rapidly in Xining and Lhasa, with the area increasing from 537.32 hm^2 and 616.12 hm^2 in 2008 to 2,231.68 hm^2 and 1,448.30 hm^2 in 2018, respectively. In both cities, facility agriculture land showed a spatial variation trend spreading from the urban area to the periphery, resulting in a great change in regional distribution. The research results related to the dataset were published in *Resources Science* (Vol. 41, No. 6, 2019).

Keywords: facility agriculture; the Tibetan Plateau; spatial distribution; high-resolution imagery; Resources Science

1 Introduction

Facility agriculture is an agricultural production method that uses artificial technologies to improve light and temperature conditions in order to realize efficient agricultural production[1–4]. China is the country with the largest area under facility cultivation in the world; the

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main types of facility agriculture are plastic greenhouses, solar greenhouses, and terraced greenhouses[4–5]. In the Tibetan Plateau, traditional alpine agriculture dominated by grassland animal husbandry and crop production is the main source of income for farmers and herdsmen and also determines the dietary structure, which is mainly composed of tsampa, dairy products, beef, and mutton[5–9]. With socioeconomic development, the diet has gradually changed and has promoted an increase in demand for vegetables and fruits. Therefore, traditional agriculture based on planting highland barley and wheat has been unable to meet the dietary needs, particularly with respect to vegetables. As greenhouses can overcome the limitations of low temperatures with respect to vegetable and fruit production, facility agriculture has emerged and developed rapidly on the Tibetan Plateau.

Detecting the spatial distribution of and recent changes in facility agriculture can provide support for the rational planning and adjustment of facility agriculture. Current studies of facility agriculture mainly focus on the aspects of engineering technologies[3,10–11], benefits[12–14], research methods[9,15], and environmental impacts[16–19], while no studies have addressed the issues of the spatial distribution of and temporal changes in facility agriculture[5], mainly due to the lack of spatial distribution data for facility agriculture. Therefore, we obtained and compiled the spatial distribution dataset of facility agriculture for the whole Tibetan Plateau in 2018 and two typical areas of Xining and Lhasa in 2008 and 2018, based on high-resolution Google Earth satellite images with a resolution of 0.24–0.48 m.

2 Metadata of Dataset

Metadata of "Spatial dataset of facility agriculture in Tibetan Plateau (2008, 2018)" [20] are shown in Table 1.

Table 1 Metadata Summary of "Spatial dataset of facility agriculture in Tibetan Plateau (2008, 2018)"

Items	Description
Dataset full name	Spatial dataset of facility agriculture in Tibetan Plateau (2008, 2018)
Dataset short name	FacilityAgri_TibetanPlateau
Authors	Wei, H. X-4306-2019, Institute of Geographic Sciences and Resources Research, Chinese Academy of Sciences, irene1993weihui@163.com Lv, C. H., Institute of Geographic Sciences and Resources Research, Chinese Academy of Sciences, luch@igsnrr.ac.cn Yang, K. J. AAH-6922-2019, Institute of Geographic Sciences and Resources Research, Chinese Academy of Sciences, kaijieyoung@163.com Liu, Y. Q. F-6616-2017, Institute of Geographic Sciences and Resources Research, Chinese Academy of Sciences, yaqun_liu@163.com
Geographical region	The Tibetan Plateau; Year: 2008, 2018; Temporal resolution: 1 year
Dataset format	.shp, .kmz; Data size: 3.08 MB; Spatial resolution: 1 m
Data files	Spatial distribution data for facility agriculture: data in the Tibetan Plateau in 2018; data in Xining in 2008; data in Xining in 2018; data in Lhasa in 2008; data in Lhasa in 2018
Foundation	Chinese Academy of Sciences (XDA20040301)
Computing environment	ArcGIS campus license of Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
Data Publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, 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 percent 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 [21]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS

3 Data Source and Methods

The data used in this study were high-resolution Google Earth satellite images with resolutions ranging from 0.24 m (level 19) to 0.48 m (level 18). First of all, we identified the areas dedicated to facility agriculture in the whole Tibetan Plateau in 2018 by visual interpretation. The Tibetan Plateau boundary was based on a vector diagram[22]; the geographic coordinate system was GCS_WGS_1984, and the projected coordinate was WGS_1984_UTM_Zone_47N. The data extraction was mainly based on November 2017 to November 2018 satellite images, from which 70.47% and 16.40% of the facility agriculture lands were acquired from the satellite images in 2018 and those from November to December 2017, respectively. The remaining 13.13% of facility agriculture land was scattered in the sparsely populated regions of northwest Tibet, northwest Qinghai, and Xinjiang. As no recent image data were available, the area was extracted from images from October 2010 to October 2017. The interpretation data obtained based on Google Earth were archived as a kml file and then transformed into a .shp file using the transformation tool of ArcGIS10.5.

Considering the difficulty in obtaining earlier high-resolution images of the whole Tibetan Plateau and as facility agriculture was mostly distributed in and around major cities, this study chose Xining and Lhasa as representative areas and identified the areas dedicated to facility agriculture in these two cities by visual interpretation to detect temporal changes, based on high-resolution images (0.24–0.48 m) from November 2007 to December 2008 and November 2017 to November 2018.

4 Results

4.1 Data Products

The dataset contains five .shp files, as presented in Table 1, including spatial distribution data for facility agriculture in the three different places.

4.2 Data Results

4.2.1 Distribution of Facility Agriculture in the Tibetan Plateau

In 2018, the total area of facility agriculture in the Tibetan Plateau was 9,426.95 hm^2, which was mainly distributed in the major cities and their surrounding areas in the southern Tibet autonomous region and eastern Qinghai province (Figure 1). Qinghai had an area of 6,177.48 hm^2 dedicated to facility agriculture, accounting for 65.53% of the total area. Tibet had an area of 2,826.61 hm^2 dedicated to facility agriculture, accounting for 29.96% of the total area. Gansu and Sichuan had areas of 228.01 hm^2 and 154.35 hm^2 dedicated to facility agriculture, accounting for 2.42% and 1.64% of the total area, respectively. Yunnan had the smallest area dedicated to facility agriculture: only 42.49 hm^2, accounting for 0.45% of the total area dedicated to facility agriculture.

4.2.2 Spatiotemporal Variation of Facility Agriculture in Lhasa and Xining

From 2008 to 2018, facility agriculture in Lhasa developed rapidly, with the land dedicated to facility agriculture increasing from 616.12 hm^2 to 1,448.30 hm^2 (Figure 2). In 2008, facility agriculture in Lhasa was mainly concentrated in the urban area, covering an area of 401.61 hm^2, accounting for 65.18%, and the rest was distributed in Qushui (27.72 hm^2,

4.50%), Dazi (10.86 hm^2, 1.76%), and Linzhou (3.99 hm^2, 0.65%). After 2008, facility agriculture in Lhasa spread outside the urban area. By 2018, the proportion of facility agriculture in the urban area had dropped to 29.82%, while it increased rapidly in Qushui and Dazi counties, reaching 27.01% and 22.49%, respectively. The area dedicated to facility agriculture in Linzhou County increased from 3.99 hm^2 to 24.85 hm^2, and in Mozhugongka and Nimu counties, the area was 20.99 hm^2 and 0.20 hm^2, respectively (Table 2).

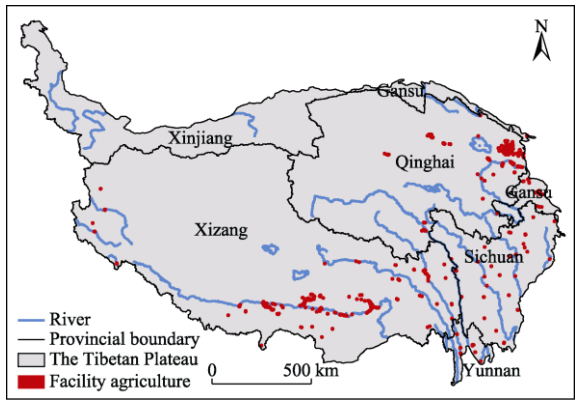

Figure 1 Spatial distribution of facility agriculture land in the Tibetan Plateau in 2018[22]

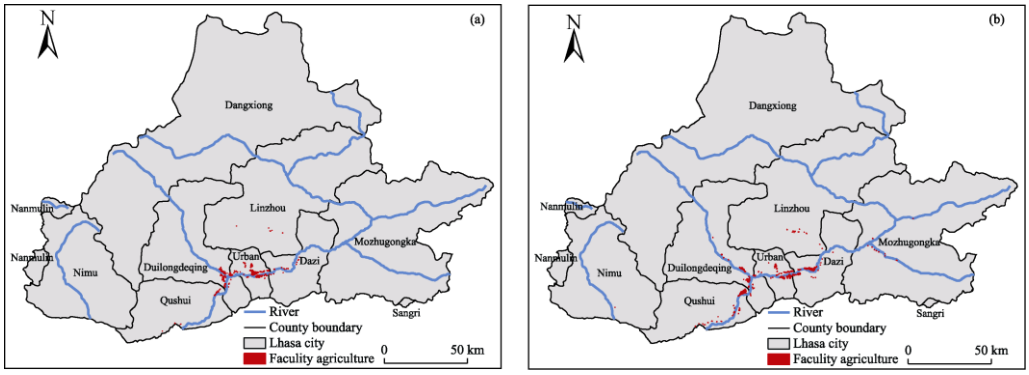

Figure 2 Spatial distribution of facility agriculture land in Lhasa in 2008 (a) and 2018 (b)

Table 2 The area of facility agriculture land in Lhasa in 2008 and 2018

County	2008			2018		
	Area (hm^2)	Proportion (%)	Ranking	Area (hm^2)	Proportion (%)	Ranking
Dazi	10.86	1.76	4	325.77	22.49	3
Duilongdeqing	171.95	27.91	2	253.42	17.50	4
Urban area	401.61	65.18	1	431.89	29.82	1
Linzhou	3.99	0.65	5	24.85	1.72	5
Qushui	27.72	4.50	3	391.19	27.01	2
Mozhugongka	0.00	0	6	20.99	1.45	6
Nimu	0.00	0	6	0.20	0.01	7

The area dedicated to facility agriculture in Xining increased from 537.32 hm^2 in 2008 to 2,231.68 hm^2 in 2018. Similar to the trend in the development of facility agriculture in Lhasa, facility agriculture also spread from the urban area to the periphery. The proportion of facility agriculture in the urban area decreased from 48.83% in 2008 to 16.07% in 2018, but the area increased from 251.61 hm^2 to 358.69 hm^2. The area dedicated to facility agriculture in Datong increased from 169.71 hm^2 in 2008 to 630.39 hm^2 in 2018, while the proportion decreased from 31.58% to 28.25%. Huangzhong showed the fastest development of facility agriculture, with the area increasing by 1,083.75 hm^2 (accounting for 63.96% of the newly increased area in the whole city) compared with 2008; it reached 1,183.75 hm^2 or 53.04% of

the total area in Xining. Due to the relatively long distance from the urban area, the proportion of facility agriculture in Huangyuan decreased from 2.98% in 2008 to 2.64% in 2018 (Table 3).

Table 3 The area of facility agriculture land in Xining in 2008 and 2018

County	2008			2018		
	Area (hm^2)	Proportion (%)	Ranking	Area (hm^2)	Proportion (%)	Ranking
Datong	169.71	31.58	2	630.39	28.25	2
Huangyuan	16.00	2.98	4	58.85	2.64	4
Huangzhong	100.00	18.61	3	1,183.75	53.04	1
Urban area	251.61	48.83	1	358.69	16.07	3

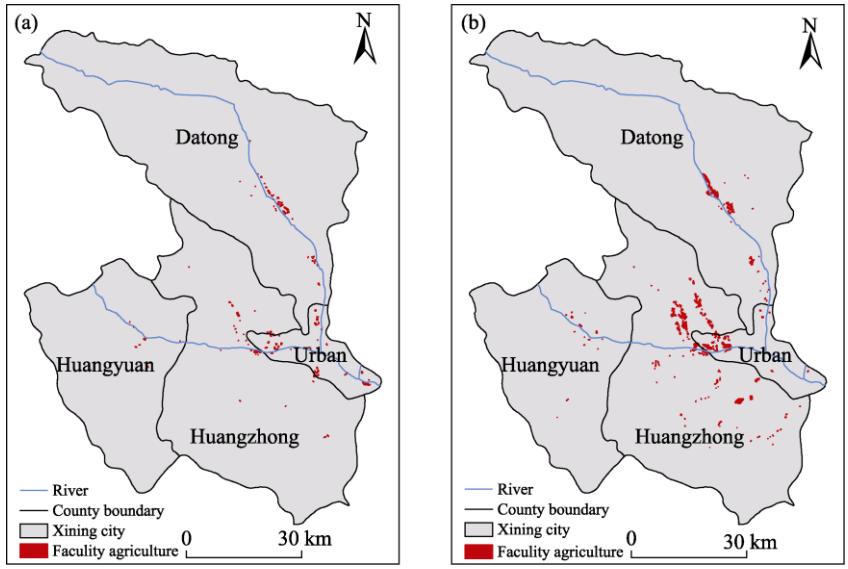

Figure 3 Spatial distribution of facility agriculture land in Xining in 2008 (a) and 2018 (b)

5 Discussion and Conclusion

The meter-resolution dataset for facility agriculture built in this study reveals the spatial distribution of facility agriculture in the Tibetan Plateau. It is the first high-resolution spatial dataset of facility agriculture and can be used to support the development of facility agriculture in the Tibetan Plateau. To use the dataset, the year of the Google Earth image should be adjusted to the year corresponding to the dataset so as to avoid inaccurate data correspondences. The spatiotemporal changes in facility agriculture and the causes were analyzed in detail in our paper[5] published in *Resources Science* in 2019, so no further analyses are given. It should be noted that in the process of data publishing, we have made further interpretations, and thus the data are modified and improved. Therefore, this dataset has some differences from the data published in the early paper[5]; we suggest using this dataset instead.

Author contributions

Lv, C. H. promoted this research, designed the structure of the dataset, and revised the data paper; We, H. interpreted the data for facility agriculture in the Tibetan Plateau in 2018 as well as in Xining and Lhasa in 2008, processed and compiled the dataset, and wrote the data

paper; Yang, K. J. interpreted the data for some facility agriculture in Tibet autonomous region in 2018; Liu, Y. Q. was involved in the data processing.

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