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GIES Case Dataset on Baoshan Arabica Coffee Dry-Hot Valley in Xinzhai Village, Yunnan Province of China

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Abstract: The Baoshan coffee Xinzhai village dry-hot valley case dataset on ecosystem protection and sustainable development is a joint effort product by contributors from university, company, government, research institutes and local stakeholder. There is a series of products from the case, including dataset, articles, education base, germplasm resources, etc. Xinzhai village of Baoshan city (prefecture) lies at the Yunnan province, and is characterized by its diverse dry-hot valley. Coffee came to Yunnan across China's southwest boundary around 1900s and mainly served missionaries or locals for personal consumption in following years. In early 1950s, coffee began to be planted in large scale in Lujiang town (a part of in Nujiang valley) of Baoshan prefecture. While Baoshan is not in the normally recognized World Coffee Belt (23.5°S–23.5°N), it managed to produce one of the best coffees in the world (partly thanks to dry-hot climate of Nujiang valley), and Baoshan Arabica coffee was included into First-batch China-EU Protected Geographical Indication List (100∶100). Xinzhai village in Lujiang town was identified as the case for Baoshan coffee terror, due to its coffee plantation scale and its vertical gradient along the slope from 760 to 1,640 m. The dataset consists of four parts: 1) boundary data; 2) physical geography data, including climate, elevation class, NDVI and soil chemical composition; 3) characteristics and distribution of coffee varieties; 4) coffee introduction and management specifications, etc. The dataset is archived in .shp, .tif, .xlsx and .jpg data formats, and consists of 95 data files with data size of 107 MB (compressed to one single file with 105 MB).

Keywords: Baoshan; Xinzhai village; Arabica coffee; dry-hot valley; geographical indication;

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[2] Duan, R. T., Liu, Y. T., Fu, C. L., *et al*. Baoshan coffee Xinzhai village dry-hot valley case dataset on ecosystem protection and sustainable development [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. https://doi.org/10.3974/geodb.2021.05.10.V1. https://cstr.escience.org.cn/CSTR:20146.11.2021.05.10.V1.

sustainability; GIES; case 2

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CSTR: https://cstr.escience.org.cn/CSTR:20146.14.2021.03.05

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.2021.05.10.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2021.05.10.V1.

1 Introduction

Coffee is a perennial evergreen shrub of *Coffea arabica* L. (Arabica coffee) of Rubiaceae. Among the 125 species of coffee, *Coffea arabica* and *Coffea canephora* (*Coffea robusta*) have been found to be of economic value. *Coffea arabica* was developed and utilized earlier, with stricter environmental requirements, lower yield but higher quality, accounting for 60% of the coffee area in the world. *Coffea robusta* was found late, with stronger resistance to diseases and pests, better adaptability to humid and hot environment, higher yield but slightly poor quality, accounting for about 40% of the coffee area in the world[1]. More varieties have been developed from *Coffea arabica* and *Coffea robusta*. Although coffee has been introduced into Yunnan from abroad in early 1900s, it was only sporadically distributed near churches, some foreigners' residential areas and some border areas during 1900–1950. It was not until 1952 that coffee was planted on a large scale in Lujiang town, Baoshan[2–4].

Baoshan is located at 25° north latitude, while it is not in the core area of the world coffee belt (between the tropic of cancer and capricorn, 23°26′S–23°26′N), it has managed to make "Baoshan Arabica" an staple local cash crop, thanks to the unique natural conditions of the dry and hot valley and the joint efforts of scientists, coffee farmers, governments and enterprises in Yunnan province. "Baoshan Arabica" has won a series of honors, including but not limited to: designated as China's geographical indication product[1] in 2010, Yunnan province established local standards for "Baoshan Arabica" protection[5] in 2012, and designated as the first batch of China-EU geographical indication product[2] in 2020.

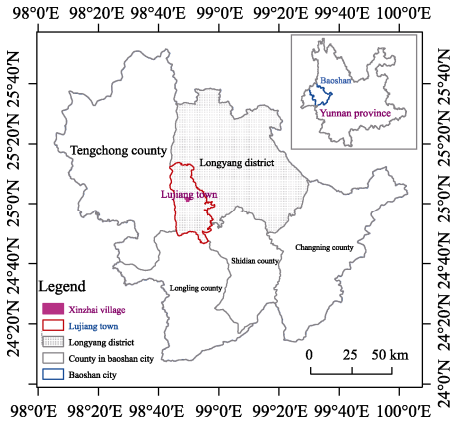


Figure 1 Location of Xinzhai village

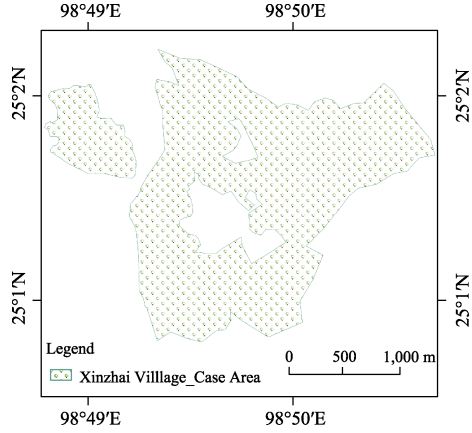


Figure 2 Boundary of Xinzhai village

Xinzhai village, the case area, is located at Lujiang town in Longyang district of Baoshan city, lies between Gaoligong mountain and the Nujiang river (Figure 1, Figure 2). It is east-facing sloping region with a DEM spanning 737–1,600 m. With an extreme temperature

[1] General Administration of Quality Supervision. Announcement on approving the protection of geographical indication products for Baoshan Arabica coffee (No. 2010–162)[OL]. https://dlbzsl.hizhuanli.cn:8888/Product/Detail/172.

[2] Xinhua News Agency. China and the EU officially signed the China-EU agreement on geographical indications [OL]. http://www.xinhuanet.com/2020-09/14/c_1126492774.htm.

of 0.2–40.4 °C, and an active accumulated temperature greater than 10 °C of 7,800 °C, the climate in Xinzhai village coffee plantation is nearly frost-free throughout the year. The cultivated land area of Xinzhai village is 13,632 mu (1 mu is about 1/15 hectare), of which 12,000 mu is coffee plantation and accounts for 95% of the total arable land. With a per capita coffee area up to 5.7 mu, Xinzhai is known as the "No. One Coffee Village in China".

2 Metadata of the Dataset

Metadata of the dataset[6] is summarized in Table 1.

Table 1 Metadata summary of Baoshan coffee Xinzhai village dry-hot valley case dataset on ecosystem protection and sustainability

Items	Description
Dataset full name	Baoshan coffee Xinzhai village dry-hot valley case dataset on ecosystem protection and sustainability
Dataset short name	BaoshanCoffeeCase02
Authors	Duan, R. T., Baoshan University, 269202376@qq.com Liu, Y. T., Baoshan University, 82156146@qq.com Fu, C. L., Baoshan University, 28106140@qq.com Hu, K., Baoshan University, hk19990904@qq.com Yang, Y. H., Meteorological Bureau of Longyang District, 406549773@qq.com Zi, X. M., Meteorological Bureau of Longyang District, 1551226758@qq.com Jia, H. S., Meteorological Bureau of Longyang District, 975833925@qq.com Liu, C., Baoshan Quality and Technical Supervision Comprehensive Testing Center, 357217069@qq.com Li, X. B., Baoshan Chunzheng Coffee Industry Development Co., Ltd., Coffee Association of Yunnan Province, 1292274500@qq.com Wang, Z. X. L-5255-2016, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, wangzx@igsnrr.ac.cn
Geographical regions	Xinzhai village of Lujiang town, Longyang district, Baoshan city 25°1′23″N–25°2′49″N, 98°49′1″E–98°51′0″E
Year	2020
Spatial resolution	10 m (Sentinel-2 NDVI), 30 m (DEM and slope)
Data format	.shp, .tif, .xslx, .doc
Data size	107 MB
Data files	Four major data classes are archived in 4 data folders: (1) physical geography data: boundary of case area, DEM, climate (monthly sunshine,monthly temperature, monthly precipitation), soil chemicals, NDVI, land use; (2) coffee botany and green coffee bean chemistry; (3) coffee production in Yunnan; (4) coffee history in Yunnan
Foundation	Chinese Academy of Sciences (XDA23100100, XDA19040501)
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 (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, arewelcome 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 Physical Geography and Habitat Conditions of the Case Area

3.1 Topography and Geomorphology

30-m DEM and slope data are used to characterize the topographic conditions of Xinzhai village and its impact on coffee production (Figure 3–6).

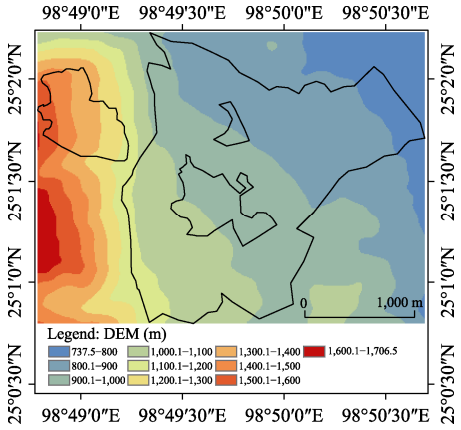


Figure 3 DEM spatial distribution

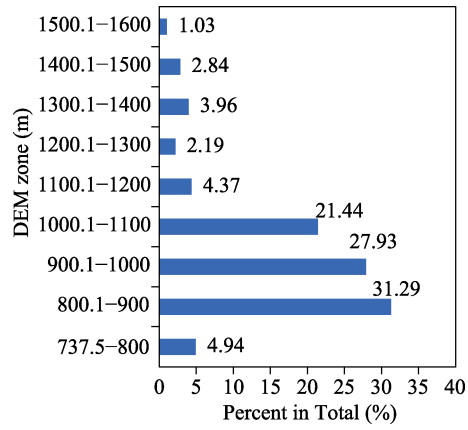


Figure 4 DEM zonal percentage

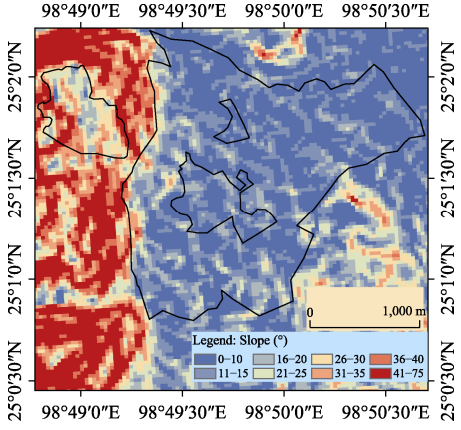


Figure 5 Slope spatial distribution

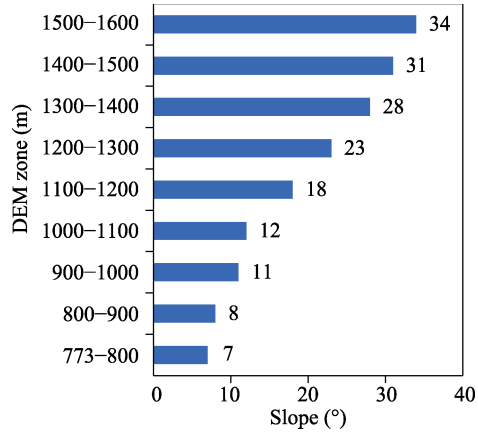


Figure 6 Slope averaged by DEM zone

3.1.1 The Effect of Altitude on Coffee Quality: General Law in Yunnan

Literatures show that most of the high-quality coffee comes from the tropical alpine regions of the world. In order to explore whether this conclusion remained hold in Yunnan, a team was formed to study the altitude (DEM) and coffee quality in the main coffee producing areas in Yunnan province from 2000 to 2001. Two basic conclusions were obtained. First, for the existing coffee area, there is generally a positive relationship between altitude and coffee quality[8], which is consistent with the conclusions in most parts of the world. Second, there is an exception in regions beyond the 24 degrees north latitude, where the relationship between altitude and coffee quality is mixed. In some cases, the coffee quality may decrease with the increase of altitude[9].

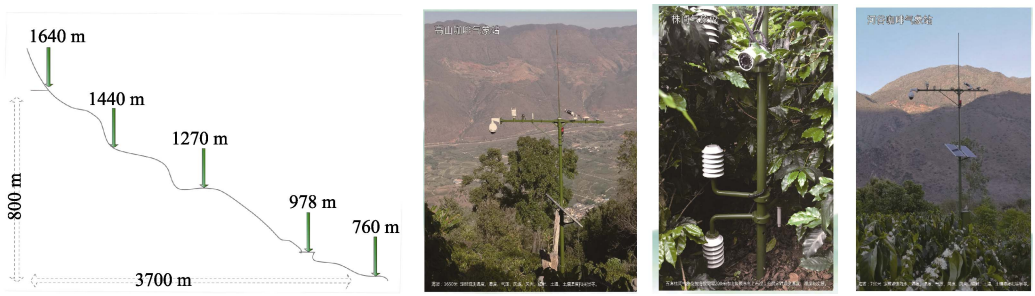
3.1.2 The Effect of DEM on Coffee Quality: Specific in Case Area (Xinzhai Village)

Since altitude plays a key role in coffee quality, the local standard of Yunnan province[5] stipulates that only coffee from the altitudes of 1,000–1,500 m can apply to use the GI mark of

"Baoshan Arabica coffee". Figure 4 shows the area of DEM ≥ 1,000 m accounts for 35.84% of the coffee area, while the area of DEM < 1,000 m accounts for 64.16%. The coffee plantation over 1,000 m is the main producing area of specialty coffee in the future. And the plantation below 1,000 m may be phased out and replaced with more competitive cash crops. For slope (Figure 5, 6), the area with over 25 degrees accounts for 7.6% of the total area, mainly distributed in areas above 1,000 m; while the area of below 25 degrees accounts for 92.4%, mainly in low altitude areas below 1,000 m.

3.2 Meteorological Condition

Meteorological data are important factors affecting coffee production. However, the traditional meteorological stations are mainly distributed at flat and low altitude. Therefore, the data from these stations generally cannot fully represent the meteorological characteristics of coffee plantations at higher altitude and with large variation. For example, Dai *et al*.[10] used the data from the traditional county meteorological station to study the low-temperature frost risk of coffee in Yunnan and found that coffee frost damages in Baoshan and Binchuan were obviously overestimated. Therefore, obtaining meteorological data at different altitudes has important scientific and production significance for better coffee management.



(1) Altitude distribution of 5 meteorological stations (2) Station at 1,640 m (3) Under-canopy stations at 978, 1,270, and 1,440 m (4) Station at 760 m

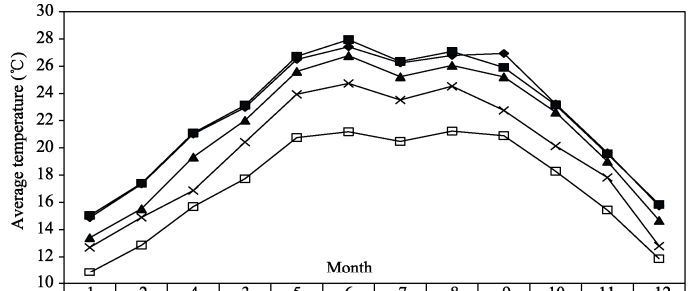
Figure 7 Meteorological system for monitoring coffee in Xinzhai village

In May 2018, a coffee gradient meteorological observation system was installed in Xinzhai village, which can provide 24-hour monitoring of coffee growth in the case area. The system consists of five stations, with an altitude range of 760–1,640 m (Figure 7). This case dataset uses the temperature and precipitation data from this system during 2019–2020.

3.2.1 Monthly Average Temperature from Coffee Weather Monitoring Stations, 2019–2020

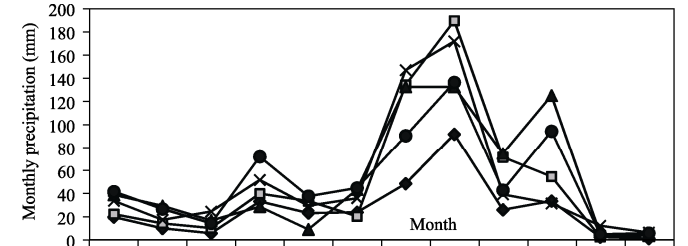
Figure 8 shows the monthly average temperature from five coffee weather stations in Xinzhai village from 2019 to 2020. The minimum monthly average temperature of five meteorological stations in Xinzhai village from 2019 to 2020 occurs in January (10.85–15.04 °C, average 13.38 °C), and the maximum occurs in June (21.19–27.95 °C, average 25.62 °C). The annual average temperature is 17.28–22.44 °C. From January to May, the monthly average temperature continued to rise, increased slightly from May to June, and reached the annual peak in June. It is stable from May to September. From September to December, a reverse trend to January to May occurred. It is generally believed that the temperature decreases with the increase of altitude. However, some data in this observation seem to have temperature inversion. From 760 to 978 m, the average annual temperature increases from 22.4 to 22.44 °C. Above 978 m, the temperature decreases gradually with the increase of altitude. The maximum drop is at 1,440–1,640 m: with an altitude increases of 200 m, the monthly average temperature decreases by 1.9–3.5 °C from May to September. If

978–1640 m is taken as the main producing area of specialty coffee, the monthly average temperature in this area will decrease by 5.01–6.76 °C from May to September with the increase of altitude, while the temperature in the coldest month from December to January will decrease by 3.99–4.19 °C with the increase of altitude.



	1	2	4	3	5	6	7	8	9	10	11	12
760 m	14.88	17.35	21.02	22.97	26.5	27.43	26.24	26.79	26.94	23.24	19.65	15.74
978 m	15.04	17.4	21.1	23.14	26.73	27.95	26.35	27.08	25.91	23.16	19.57	15.85
1270 m	13.41	15.54	19.33	22.03	25.62	26.78	25.23	26.06	25.22	22.63	19.02	14.68
1440 m	12.7	14.9	16.9	20.4	23.9	24.7	23.5	24.5	22.8	20.1	17.8	12.8
1640 m	10.85	12.86	15.69	17.74	20.76	21.19	20.48	21.24	20.9	18.29	15.44	11.86

Figure 8 Monthly average temperatures from 5 stations during 2019–2020



	1	2	3	4	5	6	7	8	9	10	11	12
760 m	20.2	10.4	6.2	33.6	23.6	24.2	48.9	92	26.4	33.9	2.9	1.7
978 m	22.7	14.7	10.7	40.3	33.9	20.8	134.7	189.8	71.9	55.1	3	4.3
1270 m	39.3	29.7	17.2	29.1	9.5	43.9	132.9	132.9	75.2	125.4	5.5	4.1
1440 m	34.1	17.8	24.9	52.1	29.9	36.4	147.3	172.1	39.7	31.9	12.7	6.8
1640 m	42	27.1	14.8	72.2	38.1	45.2	90.7	136.7	43.3	94.6	5.3	6.3

Figure 9 Monthly precipitations from five stations during 2019-2020

3.2.2 Monthly Precipitation from Coffee Weather Stations, 2019–2020

Figure 9 shows the monthly precipitation from five coffee weather stations in Xinzhai from 2019 to 2020. The minimum monthly precipitation occurs from November to December, and the monthly precipitation of each station is generally less than 10 mm. The maximum monthly precipitation occurs in August, and the precipitation of 5 stations is 92–189 mm. The minimum annual precipitation is 324 mm (at 760 m) and the maximum is 644.7 mm (at 1,270 m). The seasonality of precipitation in Xinzhai village is not as stable as the temperature, which is reflected in the large fluctuation of precipitation between months. Generally, the rainy season is from July to October, and the month with the highest precipitation (August) lags behind the month with the highest temperature (June) by 2 months. Although the temperatures at 760 m and 978 m are very close, the annual precipitation at 760 m is only 324 mm, showing typical dry and hot valley characteristics. Above 978 m, the annual precipitation of the four stations is 601.9–644.7 mm, which fluctuates in a relatively small range, and there is no obvious relationship between precipitation and altitude.

3.2.3 Effects of Temperature and Precipitation on Coffee in Xinzhai

The ideal coffee producing area is the high mountains in the tropics. This combination contains at least two conditions. First, the temperature in the coldest month should not be too low, to prevent coffee from frost damage[10]; meanwhile temperature in the hottest month should not be too hot. It is ideal to have cloud and fog weather to alleviate the damage of overheat to coffee, such as premature of coffee beans and decline in crown growth. Literatures also show that due to the global climate change, people pay more attention to the increase of coffee pests and diseases caused by rising temperature[11], and the measures to reduce heat damage by adding shade trees in coffee plantation[12–16].

The annual precipitation of the main Arabica coffee producing areas in the world is 1,200–2,200 mm[1], by contrast, the annual precipitation at Xinzhai from 2019 to 2020 is only 324–645 mm. Therefore, the main challenge in the future is to improve water infrastructure and address the water shortage problem. There may be some outliers: when the climate is abnormal, there is too much precipitation in the dry season, which will make the coffee beans unable to mature normally and yield poor coffee beans[17].

3.3 Soil Quality

Since coffee plantation in areas below 1,000 m may be phased out in the future, six soil samples were collected only at 1,000 m and 1,400 m altitudes. The metal elements of these six soil samples were analyzed by X-ray fluorescence method in the College of Resources and Environment, Baoshan University. The analysis results of soil chemical elements are shown in Table 2. Contrasting the soil chemical data with the national standard—soil environmental quality standard for soil pollution risk control of agricultural land (trial) (GB 15618—2018)[18], it is clear that the contents of 7 heavy metals in 6 soil samples meet the national standard. However, the content of individual heavy metals is a little bit high, which needs to be vigilant in the future.

Table 2 Soil chemicals of coffee plantation at Xinzhai village (mg/kg)

Element	Soil samples at 1,000 m			Soil samples at 1,400 m			GB 15618—2018[18]	
	1-1	1-2	1-3	2-1	2-2	2-3	Filter value	Control value
As	18	14.48	17	17	13	12	25	100
Cd	0	0.40	0	0	0	0	0.6	4
Cr	60	51	59	49	56	35	250	1,300
Pb	61	57.43	66	64	48	44	170	1,000
Ni	31	26.95	29	31	24	19	190	
Zn	95	88.35	106	82	127	52	300	
Cu	24	21.14	25	22	16	12	100	

3.4 NDVI Data

The NDVI data from of Sentinel-2 Satellite L2A was used to characterize land cover in Xinzhai village. The Sentinel 2 L1A data in September 2020 were from the ESA Copernicus Project website[3]. The NDVI with a spatial resolution of 10m is calculated from L1A by SNAP software, as shown in Figure 10. Due to the importance of altitude on coffee production and quality, the average NDVI was calculated by DEM zones (Figure 11). The data show that the mean NDVI below 1,000 m are relatively low, partly because of its small precipitation and larger parts of fallow land. In high areas above 1,000 m, the two peaks of mean NDVI appear in 1,100–1,200 m (0.85) and 1,500–1,600 m (0.835) respectively. This indicates that the vegetation in the high altitude is in good condition, and there is no obvious

[3] https://scihub.copernicus.eu/dhus/#/home.

water and soil loss due to the steeper slope. The still higher mountain area beyond the case area belongs to Gaoligong Mountain Nature Reserve, with even higher NDVI and better vegetation. This is not only an important ecological shelter for the case area, but also a valuable source of coffee pollinating insects.

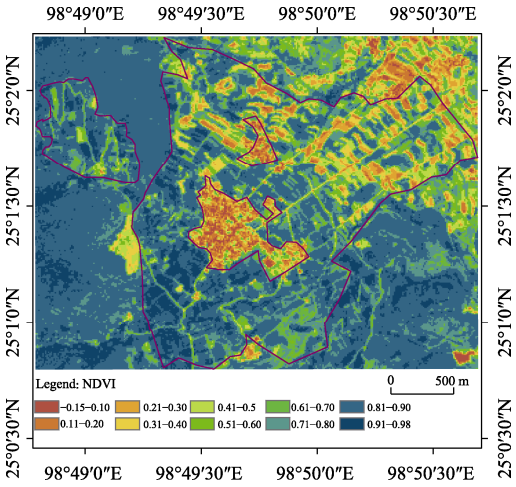


Figure 10 NDVI in Xinzhai village

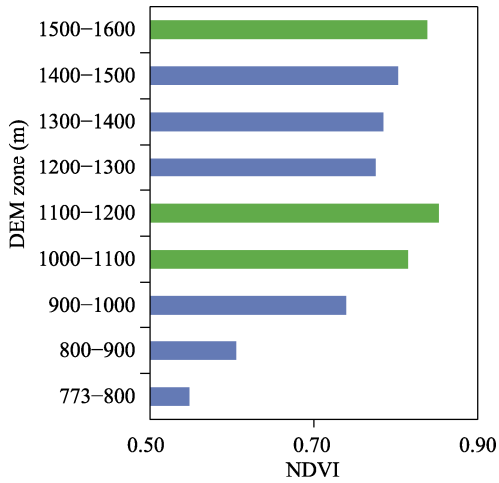


Figure 11 NDVI by DEM zones

4 Baoshan *Coffea arabica*: Cultivation and Chemical Property

4.1 Coffea Arabica

Coffee belongs to *C. Arabica* L. of *Rubiaceae*. There are 125 coffee species in *C. Arabica* L., of which there are two kinds of coffee species with important economic value: *Coffea arabica* and *Coffea canephora*. The plant of *Coffea arabica* is short, with a plant height of 4–5 m and branches of 0.7–0.85 m. The leaves of *Coffea arabica* are small and sharp, long oval, hard, leathery on the leaf surface, with fine and obvious ripple on the leaf edge. The top buds and leaves are green or bronze, so it is also called "green top coffee" and "red top coffee" in Yunnan. Under normal circumstances, the number of fruit per section of *Coffea arabica* is 12–20; Occasionally it could be as more as 25. The ratio of fresh bean to dry bean (fresh to dry ratio) of *Coffea arabica* is about 4.5–5.1 kg dry coffee beans are composed of 4,000–5,000 coffee beans. The general varieties of *Coffea arabica* are susceptible to leaf rust and are vulnerable to longicorn beetles. While the natural life span can reach 100 years, its economic life span is only about 25 years. The chromosome base of Coffea arabica is x=11, the chromosome is 4N = 44, self pollination, and the genetic character variation of the offspring is small, with about 5% natural variation, including purple leaf type, willow leaf type, thick leaf type, and high stem type. A number of coffee varieties have been cultivated from these two coffee species. Two varieties of *Coffea arabica* are mainly planted in this case area[19].

4.2 Two Coffee Varieties in Case Area: Catimor and Typica

Catimor series is bred by Portuguese Coffee Rust Research Center. It is crossed by Hibrido de Timor and Caturra, including T series, P series, red card, green card and other varieties. At present, the coffee variety with good performance is Catimor7963, which has the characteristics of short stem, high yield and rust resistance, accounting for about 70% of the

coffee area in Yunnan province. In Xinzhai village, Catimor7963 is mainly distributed in low areas under 1,000 m.

Typica has the characteristics of many fruits, large berries, early maturity, high yield and strong plants. The tree shape of adult plants is conical, its new leaves are bronze, the leaves are narrow, not resistant to strong sunshine, and is prone to branch blight. Typica coffee has good quality and high output. It is mainly in the high mountain area above 1,000 m.

4.3 Coffee Cultivation

In the case area, coffee needs an obvious dry season to bloom, and then coffee beans gradually grow during the rainy season. From October to next April, coffee beans gradually mature and can be harvested timely. *Coffea Arabica* propagates through seeds. The main stages of coffee cultivation are shown in Figure 12.

(1) Seedling stage (2) Flowering stage (3) Green fruit stage

(4) Gradual maturity: April–October (5) Full maturity: October–April (6) Degummed and dried coffee beans

Figure 12 Main periods of coffee cultivation in Xinzhai village

4.3 Chemical Compositions of Green Coffee Beans

The quality indexes of green coffee beans include physical indexes (appearance) and chemical indexes. Chemical indexes are used in this dataset. The chemical composition of green coffee bean samples is analyzed by Baoshan Quality Inspection Center. The analysis results are shown in Table 3. The chemical composition is mainly divided into "nutritional composition" and "hygienic composition (heavy metals)". The green coffee bean samples meet the health and nutritional standards, and the content of coffee flavor precursors such as crude fat is much higher than the local standard[5], indicating that the green coffee beans from Xinzhai village have great potential for later processing. Sun *et al.*[20] studied the chemical composition and coffee quality of 20 coffee samples from 500–1,480 m region in Baoshan. The results showed that some plantation at low altitudes can also produce high-quality coffee.

Table 3 Main chemical compositions of green coffee beans from Xinzhai village

No.	Chemicals	Unit	Coffee varieties		Reference standard[5]
			Catimor	Typica	Baoshan Arabica coffee
1	Water content	%	8.0–12.0	9.3, 8.1	≤12
2	Caffeine	%	0.9–1.2	1.17, 1.12	≥0.8
3	Protein	%	11.5–14.0	11.8, 11.7	≥11.5
4	Total sugar (sucrose)	%	10.80		≥9.0
5	Water extractables	%	28–34	–	≥22.0
6	Ash content	%	3.0–4.0	3.7, 3.8	≤5.5
7	Crude fat	%	10.0–15.0	–	≥5.5
8	Arsenic	mg/kg	＜0.1	＜0.1	0.5
9	Lead	mg/kg	＜0.1	＜0.1	0.5

5 Social and Economic Infrastructure for Coffee Production

5.1 Coffee Production at Yunnan Province, Baoshan Prefecture, and Longyang District Levels

The green coffee bean yield in Yunnan was about 50,000 tons before 2010, and developed rapidly since 2010. By 2016, the annual yield of coffee bean had reached 160,000 tons (Figure 13). According to the statistics in 2019, among the eight prefecture units in Yunnan, Pu'er has the largest coffee area, with a coffee area of 52,333 ha, accounting for 50% of the coffee area in Yunnan. In Lincang, coffee covers an area of 28,166 ha, accounting for 27% of Yunnan. In Baoshan, Dehong, and Xishuangbanna, coffee areas account for 6%–8.7% of total in Yunnan (Table 4).

Baoshan's coffee area was 9,066.67 ha in 2019, the green coffee beans yield was 20,300 tons, and the agricultural output was 1.053 billion Yuan. There are 78 coffee enterprises in Baoshan, of which 8 are provincial enterprises and 7 are municipal enterprises. Yunlu, Chunzheng and other 13 coffee enterprises have coffee export business in 20 countries and regions. Coffee is the major agricultural product with the largest export in Baoshan.

In 2010, Yunnan province issued the local standard—Baoshan Arabica coffee comprehensive standard[5]. Through a three-level extension system, this local standard is implemented in all levels of coffee production. Baoshan is also home to the Institute of Tropical and Subtropical Cash Crops (ITSCC), Yunnan Academy of Agricultural Sciences. ITSCC is the first institution in China to engage in the breeding of fine varieties of Coffea arabica. It is named the Transformation Center of Science and Technology of Coffea arabica by the Ministry of Science and Technology of China. Its coffee planting base is located in Lujiang town, which promotes new coffee varieties and technologies.

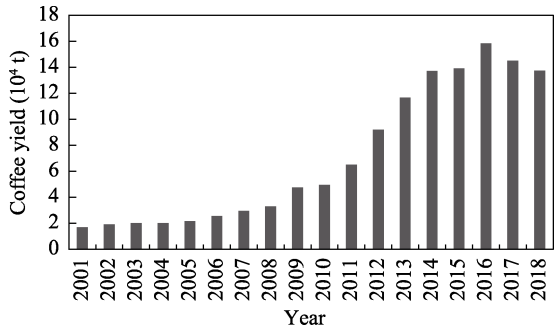


Figure 13 Coffee yield in Yunnan from 2001 to 2018

Table 4 Coffee area in Yunnan in 2019

Prefecture	Coffee area (ha)	% of Yunnan
Pu'er	52,333.34	50.1
Lincang	28,166.67	26.96
Baoshan	9,066.67	8.7
Dehong	7,533.34	7.2
Xishuangbanna	6,313.34	6.04
Nujiang	593.34	0.57
Dali	240	0.23
Wenshan	206.67	0.2

In 2019, Longyang district of Baoshan was awarded the provincial model county of "One County One Industry" for coffee. In order to cultivate coffee into a leading industry in Longyang and build a world-class organic coffee brand, Longyang has taken a series of measures in five fields, including coffee base, eco-friendly production, leading enterprises, coffee brand, and coffee market. Longyang has promoted the construction of large-scale agricultural demonstration park, strengthened publicity, perfected investment environment, held "Baoshan Coffee Culture Festival", and organized coffee enterprises to participate in agricultural Expos all over the country.

5.2 Coffee Production at Case Area: Xinzhai Village

(1) Business modal: company + base + professional cooperative + farmer
With the strong support of Baoshan government and the good business environment, five coffee enterprises have settled in Xinzhai village. They are: Baoshan Chunzheng Coffee Industry Development Co., Ltd., Yunnan Yunli Coffee Industry Co., Ltd., Baoshan Xinzhai Coffee Co., Ltd., Baoshan Hongku Coffee Co., Ltd. and Baoshan Ruixi Agricultural Development Co., Ltd. Of which, Baoshan Chunzheng Coffee Industry Development Co., Ltd. is a provincial agricultural leading enterprise and the president unit of Yunnan Coffee Industry Association. In terms of management, Xinzhai village adopts the mode of "company + base + professional cooperatives + farmers". This mode not only improves farmers' skills and improves the quality of coffee, but also reduces the operation cost and market risk, and increases the income of coffee farmers.
(2) Protect the primal environment
Good projects need to be based on good ideas. Coffee farmers and coffee enterprises in Xinzhai village follow the principle of "harmonious development of ecological protection and economic development". While developing the coffee industry, they pay great attention to the ecological and environmental protection of Gaoligong mountain area.
(3) Establish coffee traceability system
Coffee enterprises in Xinzhai village have joined the "Longyang district agricultural product traceability system", and also developed an independent coffee traceability system. In addition, coffee enterprises in Xinzhai established ISO22000 food safety management system. These measures guarantee the reputation and quality of coffee of origin in Xinzhai.
(4) Brand and integrity building
Baoshan coffee enterprises attach prioritizes brand construction of Baoshan Arabica coffee and take brand and quality as the core of competitiveness. The specific measures are as follows: build an organic coffee demonstration park, and train coffee enterprises and coffee farmers in the park by ISO standards. The training content covers varieties, planting, management, Harvesting and processing.
(5) A comprehensive business model integrating coffee production, sales, and tourism
The ecological coffee farm in Xinzhai village is composed of coffee processing, coffee culture exhibition, coffee tourism and coffee product sales. Among them, "coffee tourism" covers natural and cultural tourism (Gaoligong mountain natural scenery, multi-ethnic folk customs), coffee planting, coffee picking, coffee processing, and coffee tasting, which are deeply welcomed by tourists. In addition, Xinzhai village has also built a coffee auction center. Thus, a comprehensive system is formed covering coffee production, processing, sales, coffee culture and tourism, and promoted the innovative development of the whole industrial chain of Baoshan coffee.

6 A Brief History of Coffea Arabica in Yunnan

6.1 Entrance of Coffee into Yunnan

Coffee was introduced into Yunnan around 1900 by three routes (Figure 14).
(1) South (Mengzi Customs): In 1889, Mengzi Customs was opened. In 1904, with the

constructing of Yunnan-Vietnam railway, many westerners with coffee culture poured into Yunnan. In 1905, the first French cafe was opened—Yunnan-Vietnam Railway Bar in Mengzi. While the Yunnan-Vietnam Railway was completed in 1910, coffee began to be planted along the railway since 1912, and a small number of coffee trees are still preserved today.

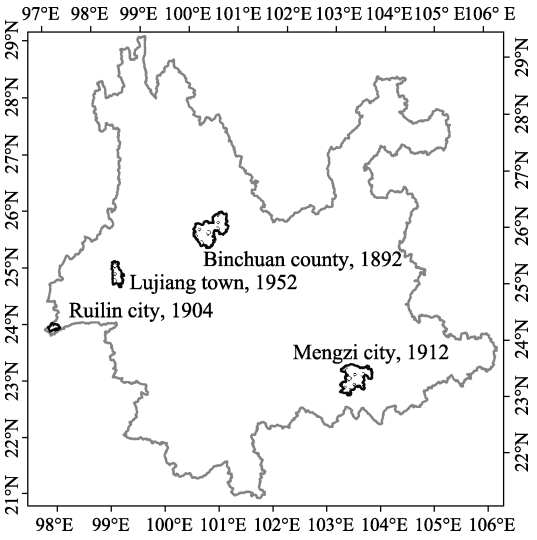


Figure 14 Entrance of coffee into Yunnan

(2) West (Ruili city): Owen Hanson, an American missionary born in Sweden, preached in the Jingpo nationality (Kachin nationality in Myanmar) community on the China-Myanmar border region from 1890 to 1893. On other Myanmar side, coffee was introduced in 1910. Hansen lived in the Kachin area for 38 years (1890–1928), and went deep into the Jingpo community in China. Due to the influence of missionaries, some locals began to grow coffee. Today, over 2,100 trees (including more than 20 old trees) still grow there. In 1904, the last Hill Officer of Jingpo nationality married, and his bride was Burmese. According to local customs, the bride's family needed to buy precious items as a dowry, and they chose fresh coffee beans[2]. These early coffee trees from these coffee beans still grow in Nongxian village, Ruili city (1,400 m a.s.l.).

(3) North (Dali city): In 1892, French missionary Tian de Neng went to Zhukula village, Binchuan county, Dali city and planted the first coffee bean. Today, 24 old coffee trees over 100 years still grow there[3]. In 2016, Zhukula coffee became a national geographical indication product. Although coffee was introduced into Yunnan in the early 1900s, it was only planted sporadically until the early 1950. Nevertheless, this early coffee history left behind the gene of coffee spreading in Yunnan. Therefore, when society gradually returned to stability in 1950, starting from Lujiang town, Baoshan city, Yunnan began the large-scale planting of Coffea arabica.

6.2 Large Scale Planting of Coffea Arabica in Yunnan

The large-scale cultivation of Coffea arabica in Yunnan began in 1952[4], and its market is mainly the former Soviet Union and Eastern Europe. At that time, the demand for coffee in China's domestic market was very small. Therefore, after the Soviet Union and Eastern European markets were closed to China, the development of coffee stagnated. With the reform and opening up since 1978, both domestic and foreign demand for coffee has increased rapidly. Yunnan coffee attracted several international coffee companies to settle in Yunnan in 1988. After Baoshan Arabica coffee entered the national geographical indication product list in 2010, the coffee area expanded rapidly. Baoshan Arabica coffee also entered the first batch of mutual protection list of geographical indication products in China and EU. Table 5 lists the main events of coffee development in Yunnan province.

7 Conclusion

The Baoshan coffee Xinzhai village dry-hot valley case dataset on ecosystem protection and sustainability includes four major categories of data (physical geography, social economy,

coffee management, and coffee history) and further classified into 8 minor categories: the geographical scope of the case area, topography (altitude and slope), meteorology, soil, land cover, coffee biology and chemistry, and the geography of coffee history in Yunnan. With reference to relevant national and local standards, the habitat conditions of the case area are preliminarily analyzed, and the conclusions are as follows.

Table 5 Major events of coffee planting in Yunnan

Year	Events
1952	Experts of Yunnan agricultural experimental field brought 70 kg fresh coffee berry from Nongxian village, Ruili city (1,100 m a.s.l.) to Lujiang town, Baoshan city for trial planting. These coffee plants had good adaptability and continued to grow since then. This marks the beginning of large-scale coffee planting in Yunnan[4]
1958	Baoshan Arabica coffee was rated as the first-class product in the London market and won the title of "Lujiang No. 1"
1978	From 1978 to 1988, some agricultural reclamation farms in Yunnan began to grow coffee, with mixed results
1980	Baoshan coffea arabica was awarded the "National Coffee Crown" by China Coffee Conference Baoshan was named as a national coffee production base by the South Subtropical Zone Office of the State Council
1984	Baoshan coffea arabica was praised as "Chinese coffee No. 1" by experts at the Beijing Fair
1988	Nestle settled in Yunnan. More multinational groups, including Maxwell and Starbucks, followed suit.
1992	Baoshan Arabica coffee won the silver award of China Agricultural Expo (no gold award was set up in this Expo)
1993	Baoshan Arabica coffee won the Eureka Gold Award at the world coffee competition in Brussels, Belgium
2002	Baoshan coffee chamber of commerce established. http://www.yn.xinhuanet.com/news/jj/j2022201.htm
2009	Coffee Association of Yunnan established. http://www.yunnancoffee.org/
2010	Baoshan Arabica coffee became a national geographical indication product
2012	The provincial standard "geographical indication product Baoshan Arabica coffee"(DB/T 3712012) was issued[5]
2020	Baoshan Arabica coffee entered the first batch of mutual protection list of geographical indication products in China and EU

(1) The coffee area over 1,000 m accounts for 35.84% of the total area of Xinzhai coffee plantation, which meets the altitude requirement of the national geographical indication product for "Baoshan Arabica coffee". According to the observation of meteorological stations at five altitudes from 2019 to 2020, the annual average temperature is 17.28–21.3 °C, and the annual precipitation is 605.7–644.7 mm. In September 2020, the NDVI is zoned on average according to the 100 m interval of DEM, and the NDVI in this high-altitude area is between 0.77–0.85, with good vegetation coverage. The analysis results of 6 soil samples at 1,000 and 1,400 m show that 7 heavy metal indexes meet national standards. The chemical analysis of green coffee beans shows that the coffee sample meet the hygienic and nutritional standard specified by the national and local standards of Yunnan province.

(2) The coffee area below 1,000 m accounts for 64.16% of total in Xinzhai village. Although this region does not fall into the altitude range of national geographical indication products, it is currently the main coffee area in Xinzhai village. According to the observation of five altitude meteorological stations from 2019 to 2020, the annual average temperature below 1,000 m is 22.4–22.44 °C, and the annual precipitation is 324–601.9 mm, indicating a typical dry-hot climate. The average NDVI in September 2020 under 1,000 m is between 0.54–0.74, poor than that above 1,000 m. In the long run, coffee plantations below 900 m may be phased out and replaced with more competitive crops. Before that, measures such as improving water conservancy and increasing shade tree species of tropical fruits should be taken to alleviate the premature caused by over heat climate.

(3) Since Baoshan Arabica coffee is already under the legal protection of geographical indication products in China and the EU, special attention should be paid to the habitat safety of Baoshan Arabica coffee in the future, so as to meet more stringent EU food standards and safeguard the hard won reputation of Baoshan Arabica coffee.

Author Contributions

Duan, R. T. designed dataset development; Yang, Y. H., Zi, X. M. and Jia, H. S. provided

meteorological data; Liu, C. analyzed the chemical compositions of green coffee beans; Li, X. B. collected coffee management information; Liu, Y. T., Fu, C. L. and Hu, K. processed the data; Duan, R. T. and Wang, Z. X. analyzed the data and wrote the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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