Preserving traditional systems: Identification of agricultural heritage areas based on agro-biodiversity

Moucheng Liu

2024..

Content

1. Research background

- Modern agriculture is overly dependent on high-yielding and genetically uniform varieties, whereas traditional agricultural systems contain a large number of genetically diverse landraces and the indigenous knowledge associated with them.
- We call traditional agricultural systems that survive to the present-day agricultural heritage systems (AHS).
- In 2002, FAO launched the Globally Important Agricultural Systems (GIAHS) project to preserve traditional sustainable agricultural systems;

1. Research background

- AHS can be broadly classified into two groups based on the core elements being conserved.

(1) Sustainable land use practices

(2) Agro-biodiversity in traditional systems

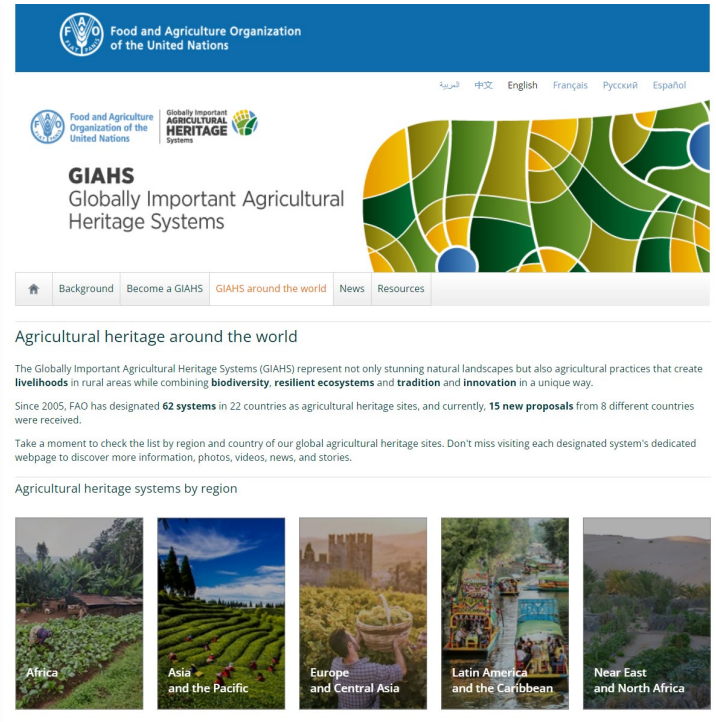
1. Research background

- However, these systems also face multiple threats, such as **climate change** and **increased competition for natural resources**. Under the impact of modernization, AHS are gradually disappearing.

VS

1. Research background

- As more of the valuable knowledge and germplasm resources inherent in traditional agriculture are lost, it is important for researchers to **identify** in a timely manner **where potential agricultural heritage areas are**, especially those with core germplasm resources.
- Identifying these systems is the first step towards conserving them.

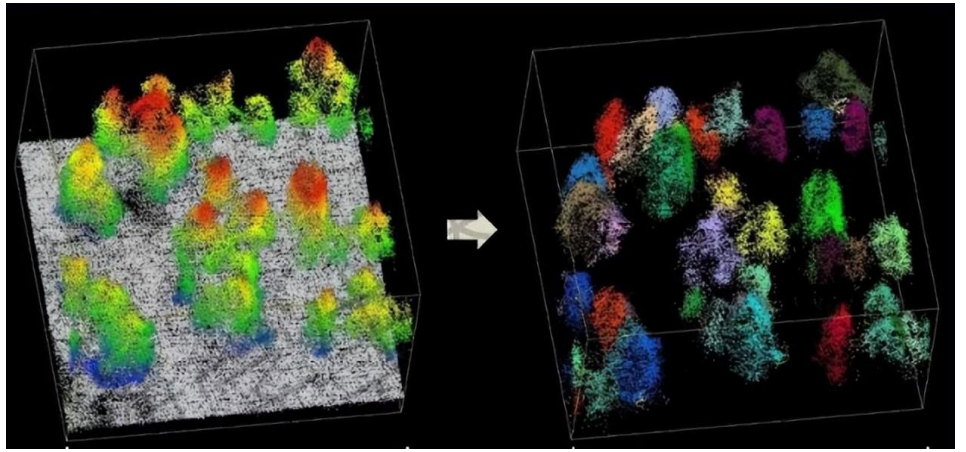


Content

2. Research ideas & methods

- Previously, field surveys was often used to investigating potential AHS.
- But on a large scale through field surveys is **labor intensive**, and relies heavily on **organizational efficiency, technical support capacity**.
- In contrast, **identifying potential areas through models** is a more practical assessment tool today.

VS



2. Research ideas & methods

【Object】

- Identifying potential areas of AHS with traditional germplasm resources at a large scale level

【Idea】

- **The distribution of traditional germplasm resources**, which is important for identifying areas of AHS based on agro-biodiversity, is often influenced by a variety of factors such as climate, soil, and topography, as well as more microscopic indicators within them.

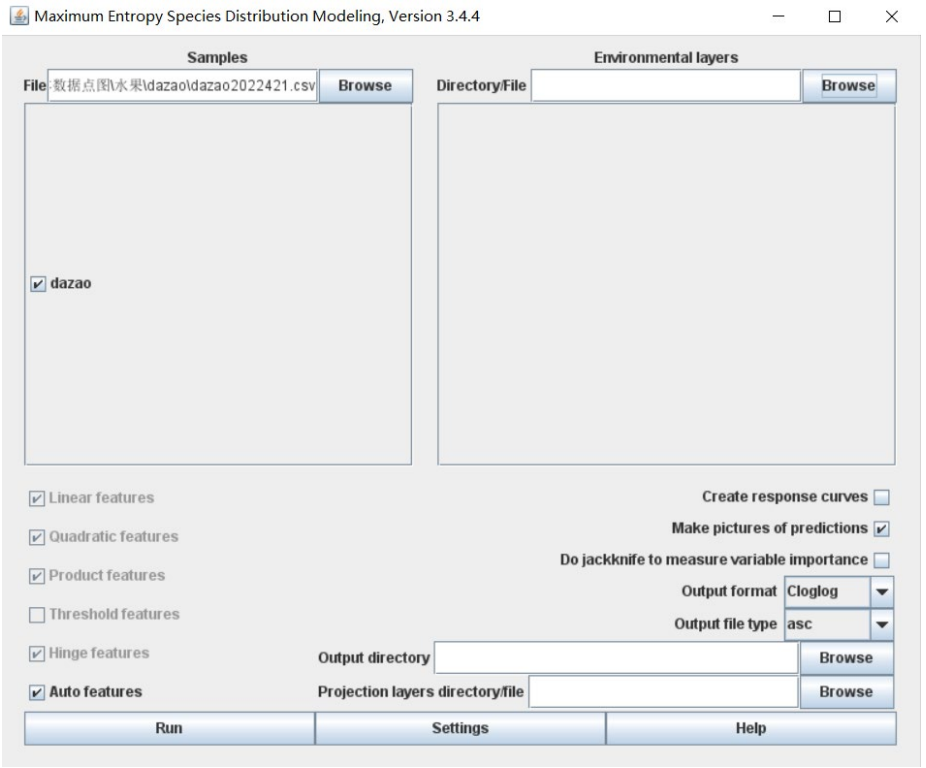
【Model】

- **Machine learning**
- The powerful data coverage and analysis capabilities

2. Research ideas & methods

【Software: Maxent】

- Maxent software uses **machine learning theory** as the underlying logic and the principle of **maximum entropy*** as a tool for statistical inference
- Maxent allows for the prediction of a species' potential range by selecting the maximum entropy of the species' distribution based on the close relationship between **the species' current incomplete distribution** and **environmental variables;**

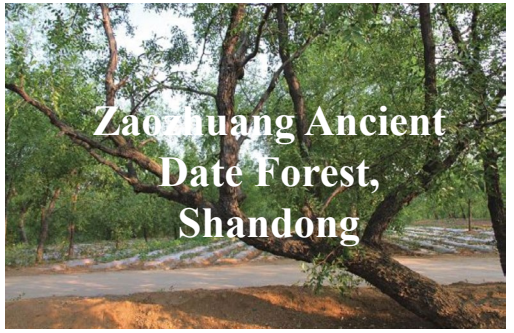


*When predicting the probability distribution of a random event, the maximum entropy model, with data (constraints) of $D=(X,Y)$, builds a classification model which satisfies both of the following two requirements in comparison to other classification models:- Satisfy all known constraints- No subjective assumptions are made about the unknown situation (highest uncertainty, highest information content, highest entropy)

Content

3. Case Study: Jujube-AHS

- Study Area: **China**
- Case traditional germplasm resources: **Jujube**
- -There are nearly 9,000 ancient jujube trees in China that are **more than 500 years old**;
- There are 7 out of xxx Chinese NIAHS with jujube as the core conservation objective



3. Case Study: Jujube-AHS

【Sample data】

- Obtained from the literature, local floras, the Global Biodiversity Information Facility (https://www.gbif.org/) and the China Crop Germplasm Resources Information Network (https://cgris.net/)

【Environment variable data】

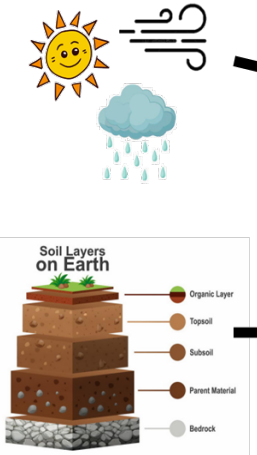


表 1 环境因子

Table 1 Environmental factors

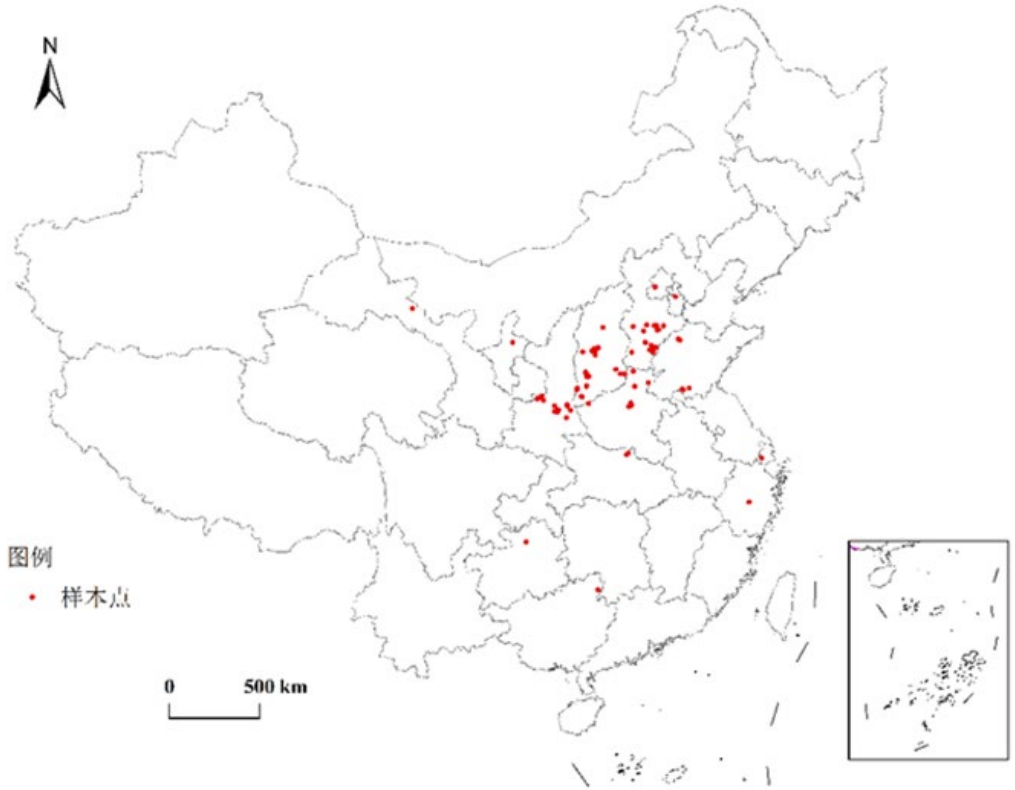
气候变量			
年均温 bio 1	最干季度平均温度 bio 9	最干季度降水量 bio 17	18 ℃积温持续天数 bi
昼夜温差日均值 bio 2	最暖季度平均温度 bio 10	最暖季度降水量 bio 18	无霜期 bio 26
等温性 bio 3	最冷季度平均温度 bio 11	最冷季度降水量 bio 19	湿润指数 bio 27
温度季节性变化的标准差 bio 4	年均降水量 bio 12	0 ℃积温 bio 20	年降水天数 bio 28
最暖月最高温 bio 5	最湿月降水量 bio 13	18 ℃积温 bio 21	干燥度 bio 29
最冷月最低温 bio 6	最干月降水量 bio 14	18 ℃积温 bio 22	年累计日照时数 bio 3(
年均温变化范围 bio 7	降水量变异系数 bio 15	0 ℃积温持续天数 bio 23	
最湿季度平均温度 bio 8	最湿季度降水量 bio 16	10 ℃积温持续天数 bio 24	
土壤变量			
土壤类型 bio 31	沙质土壤含量*bio 37/38	土壤容重* bio 47/48	碳酸盐含量* bio 57/58
土壤排水等级 bio 32	泥质土壤含量*bio 39/40	粘性层阳离子交换能力* bio 49/50	硫酸盐含量* bio 59/60
土壤参考深度 bio 33	砾质土壤含量*bio 41/42	土壤阳离子交换能力* bio 51/52	交换性钠盐百分比* 6
土壤有效蓄水量 bio 34	土壤 pH* bio 43/44	土壤盐基饱和度* bio 53/54	电导率* bio 63/64
土壤碎石含量*bio 35/36	土壤有机碳含量* bio 45/46—	交换性盐基* bio 55/56	
地形变量			
高程数据 dem bio 65	地貌类型数据 geomor bio 66	水距离 water_dis bio 67	

注：带*指标包含上层土壤（0— 0cm）和下层土壤（30— 100 cm）两个数据图层，例如 bio 46 代表上层土壤的有机碳含量，bio46 代表下层土壤的有机碳含量

Climate variables

Soil variables

Topographic variables



3. Case Study: Jujube-AHS

【Results】

- Four provinces, Hebei, Shanxi, Shaanxi and Henan, are the regions with a high concentration of high-potential distribution ($P \geq 0.75$) and medium-potential distribution ($0.5 \leq P < 0.75$), among which Hebei Province has a high-potential area of distribution, which is the first in the country;

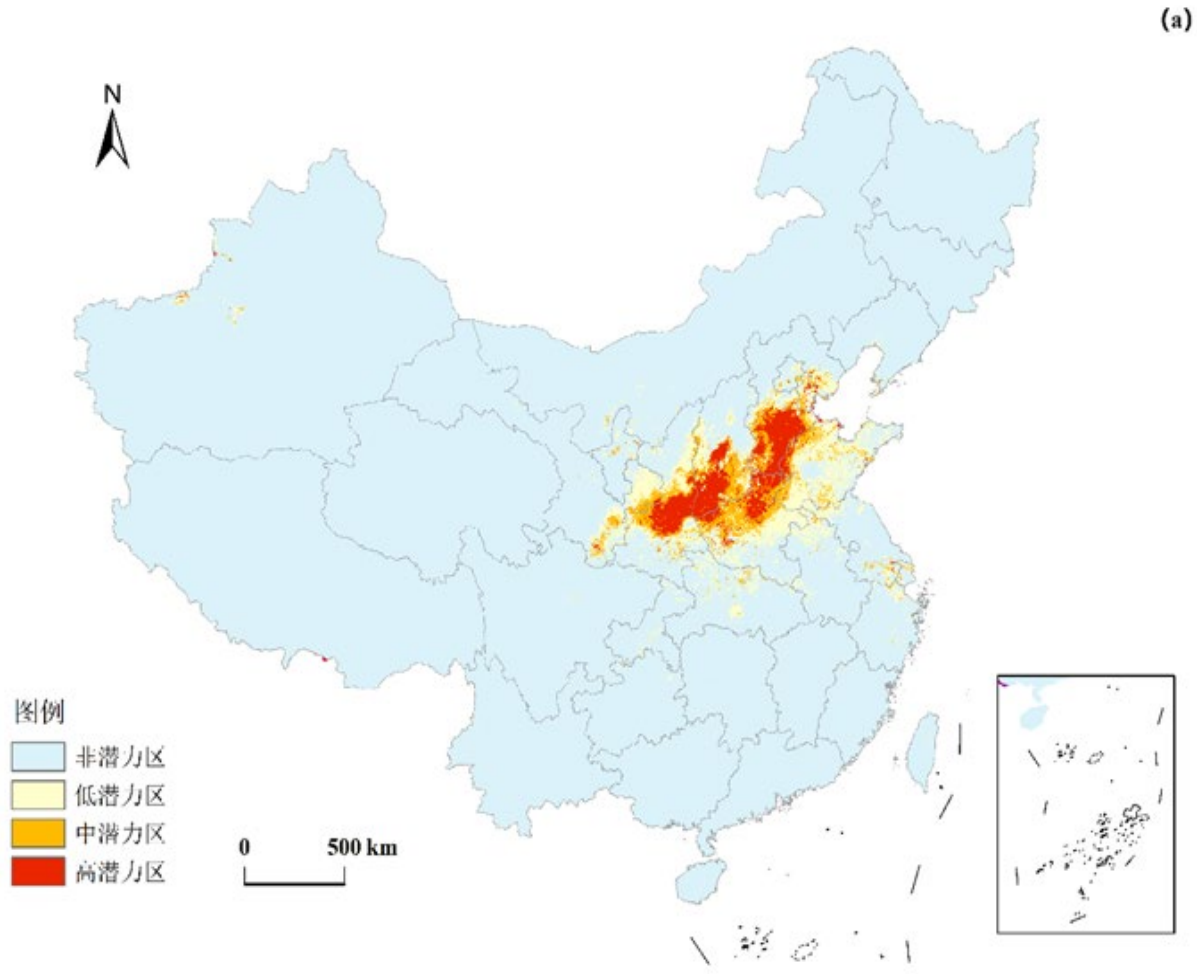


Figure: Potential distribution map of Jujube-AHS in China at the scale of 1km*1km

3. Case Study: Jujube-AHS

【Results】

- Using a probability density function calculation, we obtain a selection of counties that have a high probability of distribution but are not yet on the GIAHS and NIAHS lists.

表 3 传统红枣类重要农业文化遗产潜在热点区域

Table 3 The top twenty regions with the highest potential probability of agricultural cultural heritage construction

区域名	类型	所属省份	所属市区
大名县	县	河北省	邯郸市
巨鹿县	县	河北省	邢台市
广宗县	县	河北省	邢台市
威县	县	河北省	邢台市
南宫市	县级市	河北省	邢台市
献县	县	河北省	沧州市
河间市	县级市	河北省	沧州市
盐湖区	市辖区	山西省	运城市
夏县	县	山西省	运城市
尧都区	市辖区	山西省	临汾市
襄汾县	县	山西省	临汾市
莘县	县	山东省	聊城市
南乐县	县	河南省	濮阳市
无极县	县	河北省	石家庄市
河津市	县级市	山西省	运城市
孝义市	县级市	山西省	吕梁市
蒲城县	县	陕西省	渭南市
文水县	县	山西省	吕梁市
交城县	县	山西省	吕梁市
介休市	县级市	山西省	晋中市

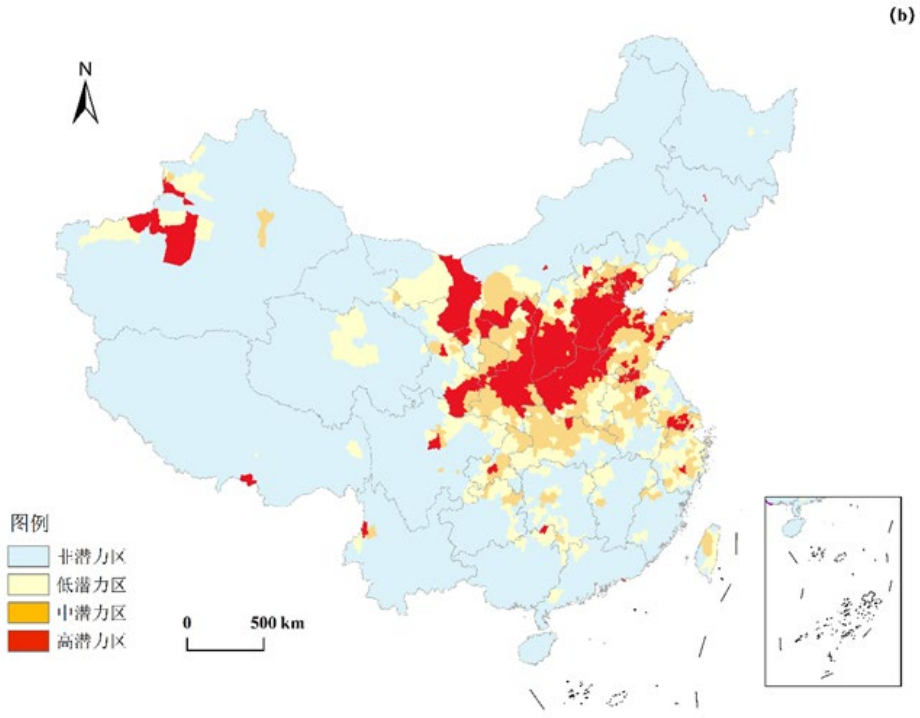


Figure: High potential areas at the county scale

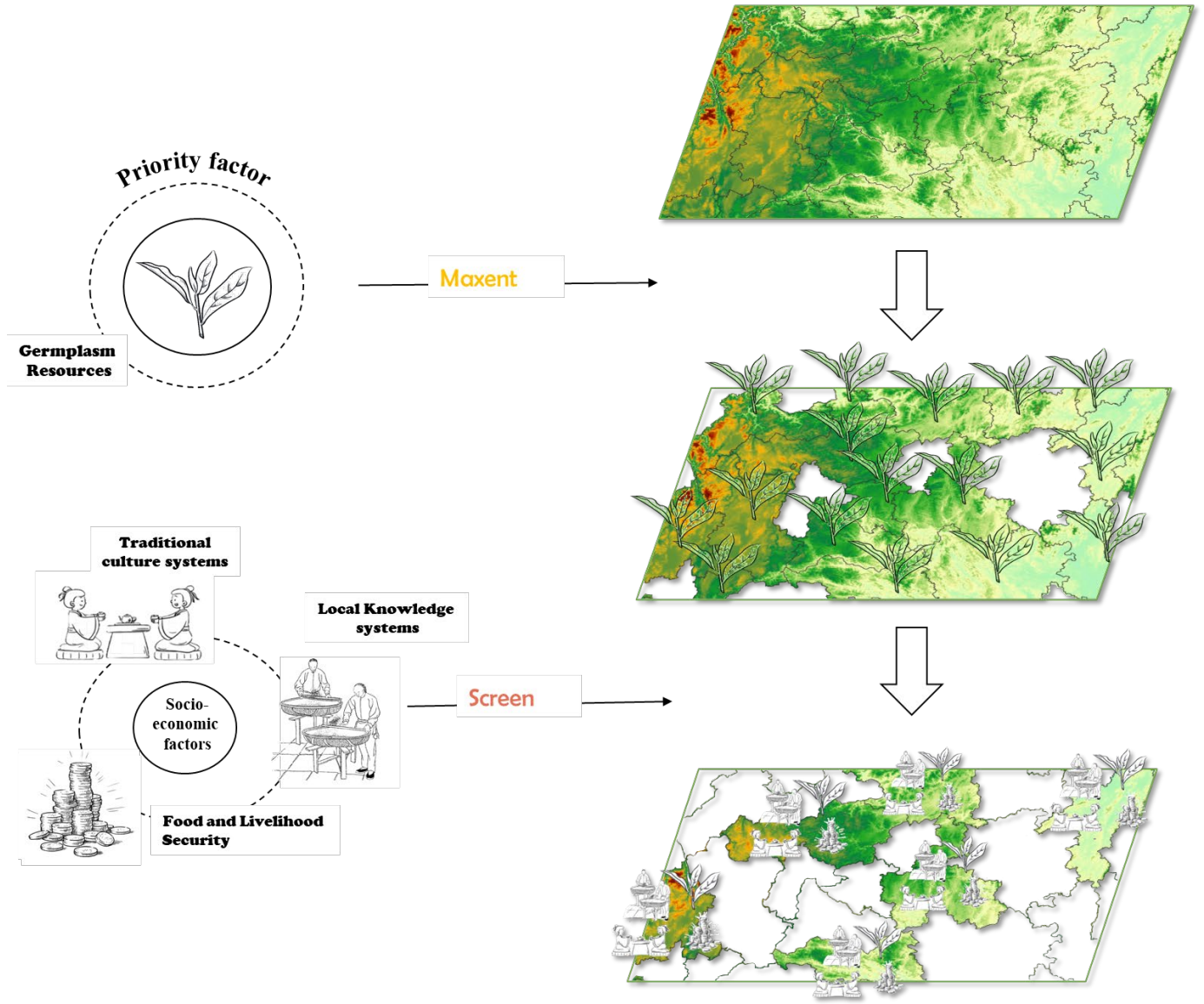
BAI Yunxiao, FENG Yuqing, LIU Moucheng. Identification of potential areas of agricultural heritage system:Take the traditional jujube germplasm resources as an example[J]. Resources Science,2023,45(2):441-449.

Content

4. Case Study: Tea-AHS

- For AHS, in addition to the core germplasm resources, the local smallholder livelihoods, traditional knowledge, and culture, which depend on germplasm resources, are also important features of AHS.

- Based on the Jujube-AHS case, we further improved the identification method.



4. Case Study: Tea-AHS

Table: Indicator system for identifying AHS based on germplasm diversity

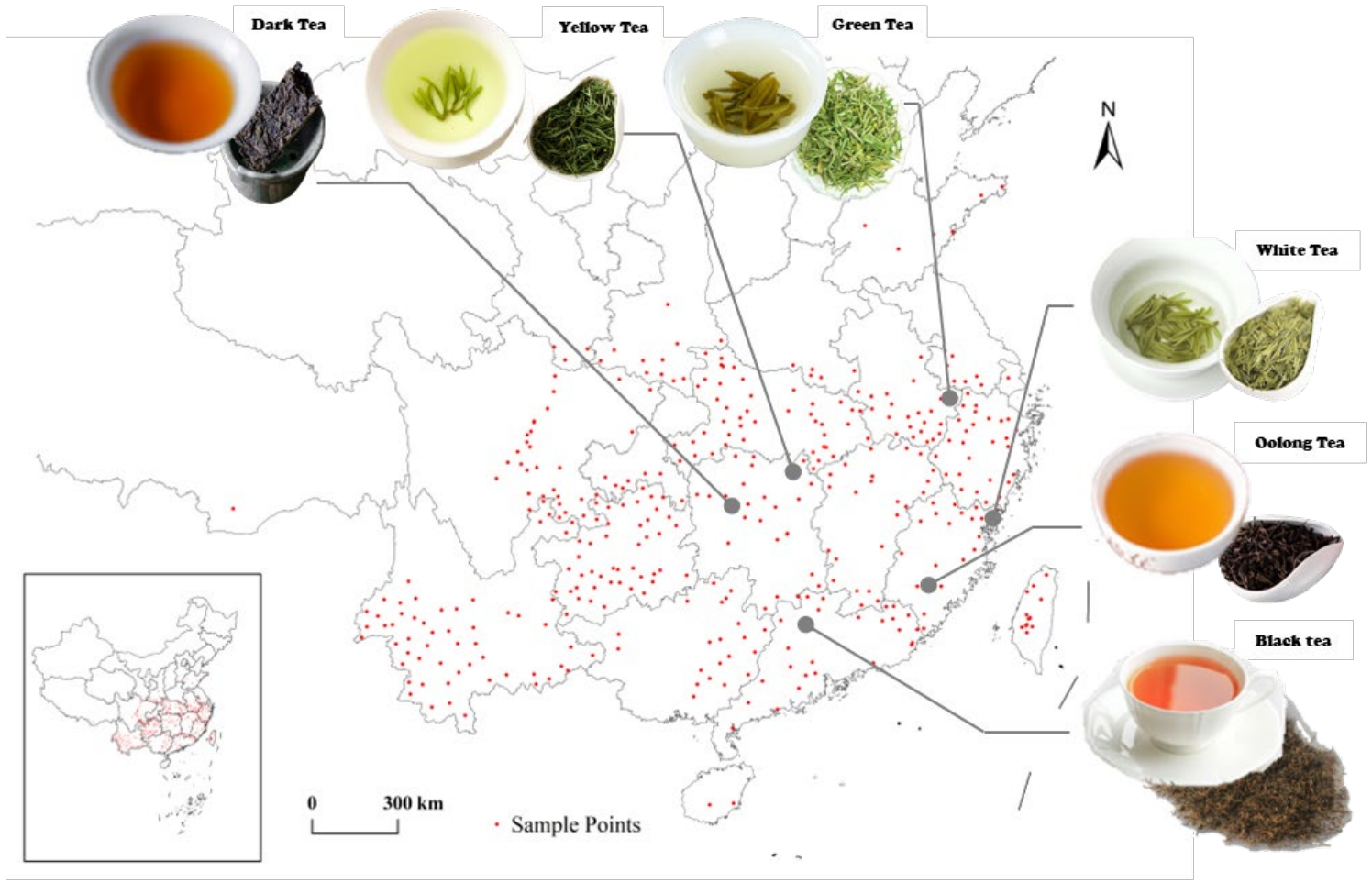
GIAHS features by FAO		Indicator	Role	Value
Priority factor 优先因素	Agro-biodiversity 农业生物多样性	Germplasm resources 种质资源	Germplasm resource is a core conservation element of AHS and a core component of what constitutes agro-biodiversity	Suitability score for the growth and distribution of the germplasm resource
Socio-economic factors 社会经济因素	Food and Livelihood Security 食物和生计安全	Agricultural production 农业生产	The core agricultural products of AHS are produced not only for the food security of farmers but also for their livelihood through market transactions	Yield or Output value; number of smallholders involved, etc.
	Local Knowledge Systems 传统知识与技术体系	Traditional knowledge知识	Describe the current status of invaluable local and traditional knowledge, ingenious adaptive technology, and management systems of natural resources, including biota, land, and water, which have supported agricultural, forestry and/or fishery activities	Variety selection, plantation cultivation, harvesting techniques, garden management, traditional medicine, or snacks associated with germplasm resources, etc.
		Ingenious adaptive technology 本土适应性技术		
		Management systems of natural resources自然资源管理		
	Traditional Culture Systems 文化价值体系和组织	Social organizations社会组织	Describe how the cultural identity and sense of place are embedded in and belong to the site of AHS.	Social organizations, folk literature, traditional music, traditional dance, traditional drama, opera, traditional sports, amusement and acrobatics, traditional art, folklore, or other culture forms associated with germplasm resources, etc.
		Value systems价值体系		
		Cultural practices文化实践		

4. Case Study: Tea-AHS

- Study Area: **China**
- Case traditional germplasm resources: **Tea**
- Tea is typical and representative of traditional agricultural systems in China, with 3 of the 5 Tea-GIAHS and 16 Tea-NIAHS of the xxx selected China-NIAHS.

Name	Location	NIAHS/GIAHS date
Jasmine and Tea Culture System of Fuzhou City	Fuzhou City, Fujian	2013/2014
Pu'er Traditional Tea Agrosystem	Pu'er City, Yunnan	2013/2012
Zhejiang Hangzhou West Lake Longjing Tea Culture System	Hangzhou City, Zhangjiang	2014/-
Anxi Tieguanyin Tea Culture System	Anxi City, Fujian	2014/2022
Hubei Chibi Yangloudong Brick Tea Cultural System	Chibi City, Hubei	2014/-
Guangdong Chaoan Phoenix Monocotyledon Tea Culture System	Chaoan District, Guangdong	2014/-
Hubei Enshi Yulu Tea Culture System	Enshi City, Hubei	2015/-
Ancient Tea Plantations and Tea Culture System in Mengku, Shuangjiang, Yunnan	Lahu-Va-Blang-Dai Autonomous County of Shuangjia, Yunan	2015/-
Guizhou Huaxi Ancient Tea Tree and Tea Culture System	Huaxi District, Guizhou	2015/-
Anhui Huangshan Taiping Monkey Kui Tea Culture System	Huangshan District, Anhui	2017/-
Fujian Fuding White Tea Cultural System	Fuding City, Fujian	2017/-
Sichuan Mingshan Mengdingshan Tea Culture System	Mingshan District, Sichuan	2017/-
Jiangsu Wuzhong Biluochun Tea and Fruit Complex System	Wuzhong District, Jiangsu	2019/-
Hunan Anhua Black Tea Cultural System	Anhua County, Hunan	2019/-
Ancient Tea Plantation and Tea Culture System at Jinjinzhai, Baojing, Hunan	Baojing County, Hunan	2019/-
Jiangxi Fuliang Tea Culture System	Fuliang County, Jiangxi	2021/-

4. Case Study: Tea-AHS

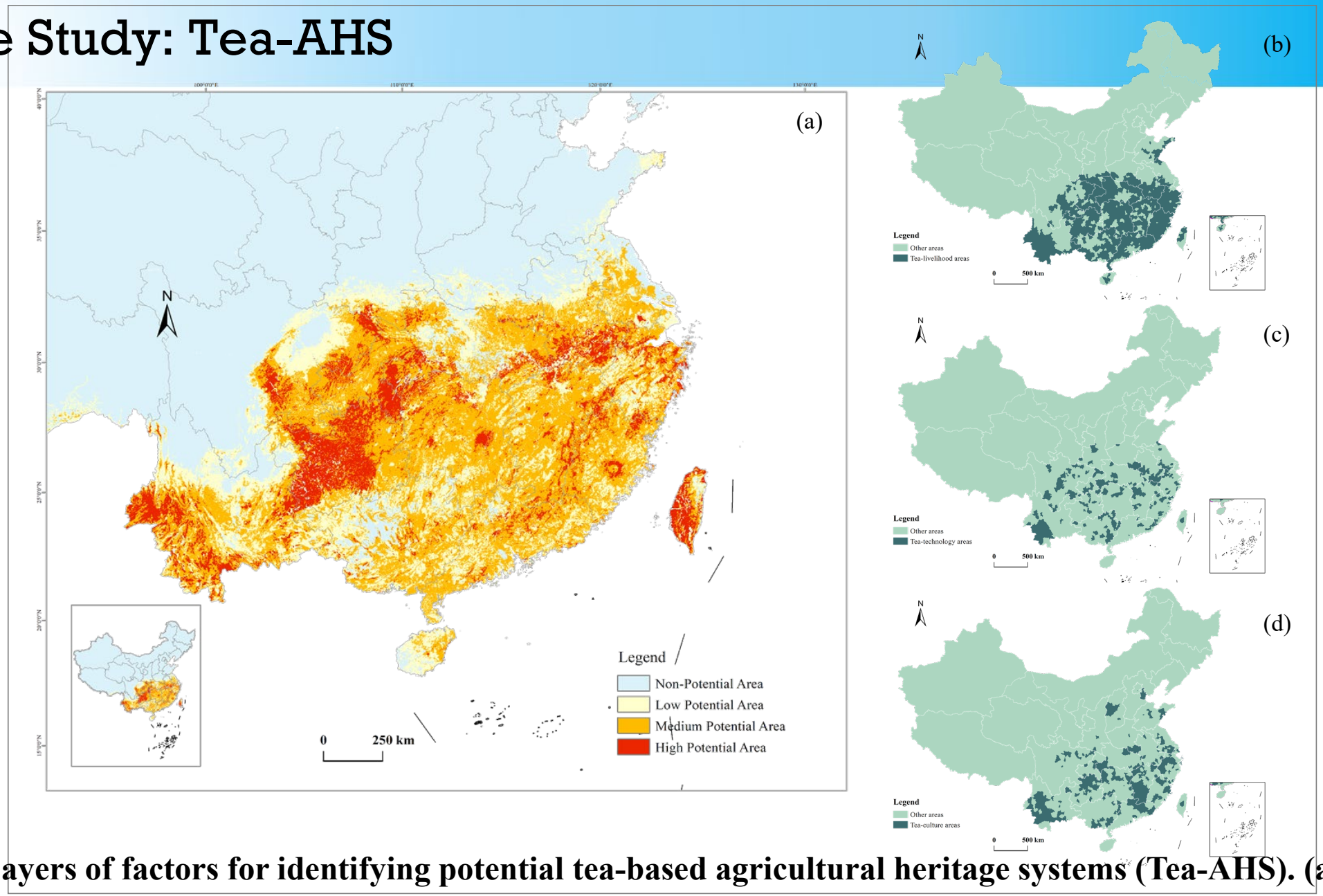


【Sample data】

- Obtained from the literature, local floras, the Global Biodiversity Information Facility (https://www.gbif.org/) and the China Crop Germplasm Resources Information Network (https://cgris.net/)

Distribution map of sample points (N = 489) of traditional tea origins in China. These sample points were used in Maxent to train the model to get the potential distribution areas of tea germplasm resources.

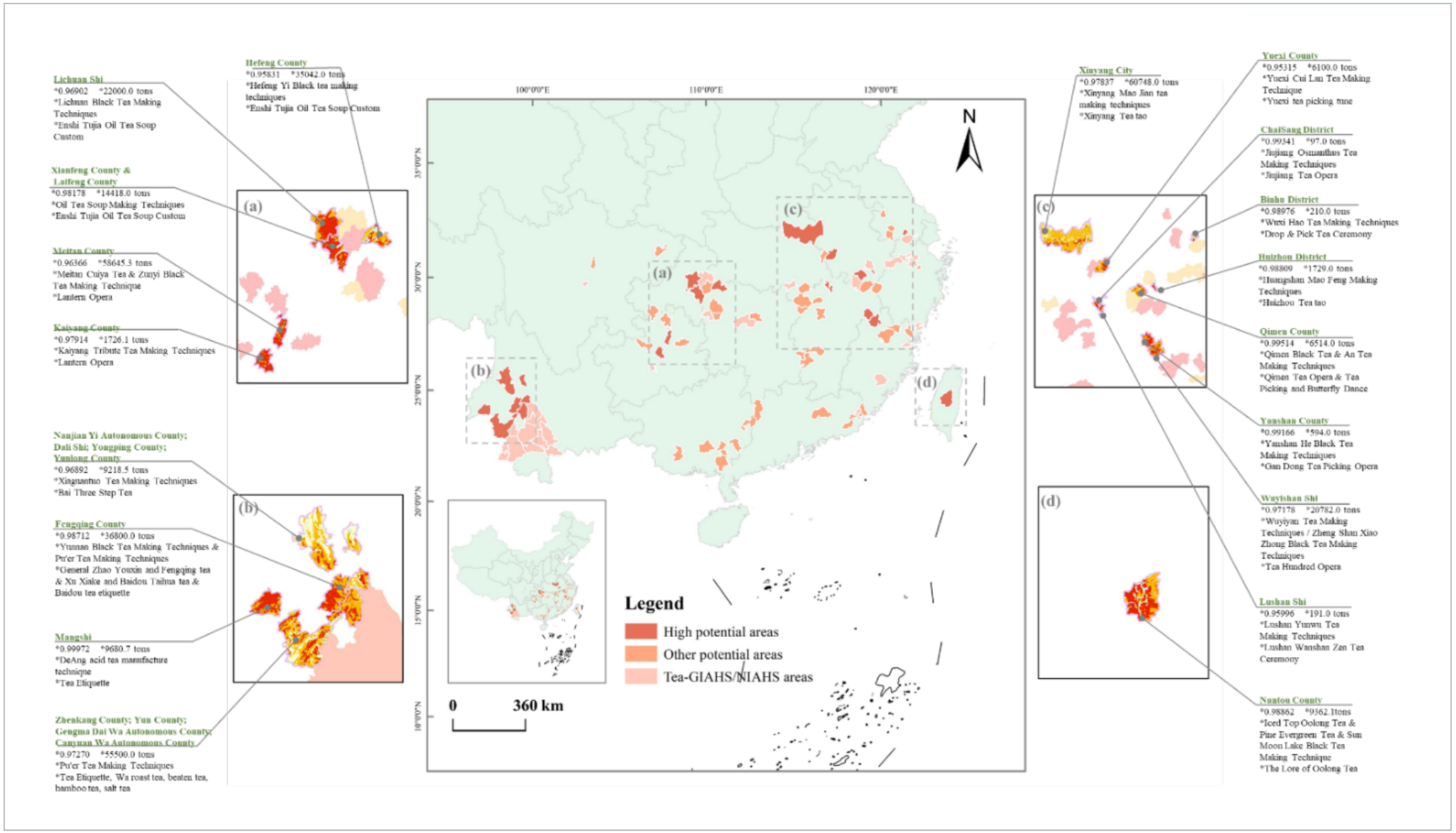
4. Case Study: Tea-AHS



Layers of factors for identifying potential tea-based agricultural heritage systems (Tea-AHS). (a) Potential distribution of traditional tea germplasm； (b) Food and livelihood security； (c) Local knowledge systems; (d) Traditional culture systems;

4. Case Study: Tea-AHS

Bai, Yunxiao, Li, Xiaoshuang, Feng, Yuqing, Liu, Moucheng, Chen, Cheng. (2024). Preserving traditional systems: Identification of agricultural heritage areas based on agro-biodiversity. Plants, People, Planet, 1–13.



Results of the identification of potential areas of Tea-AHS in China.

Thank you for listening