

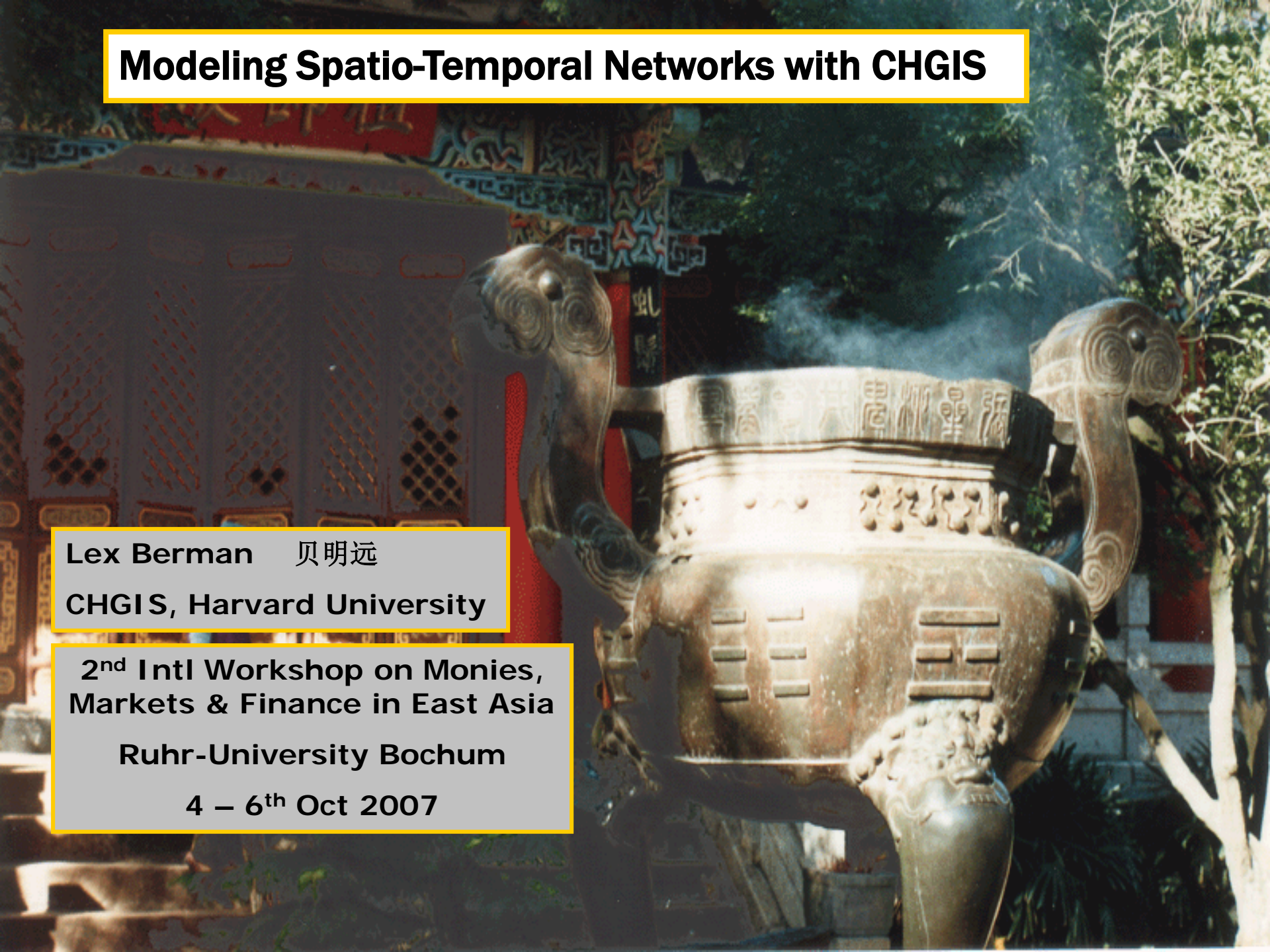
# Modeling Spatio-Temporal Networks with CHGIS

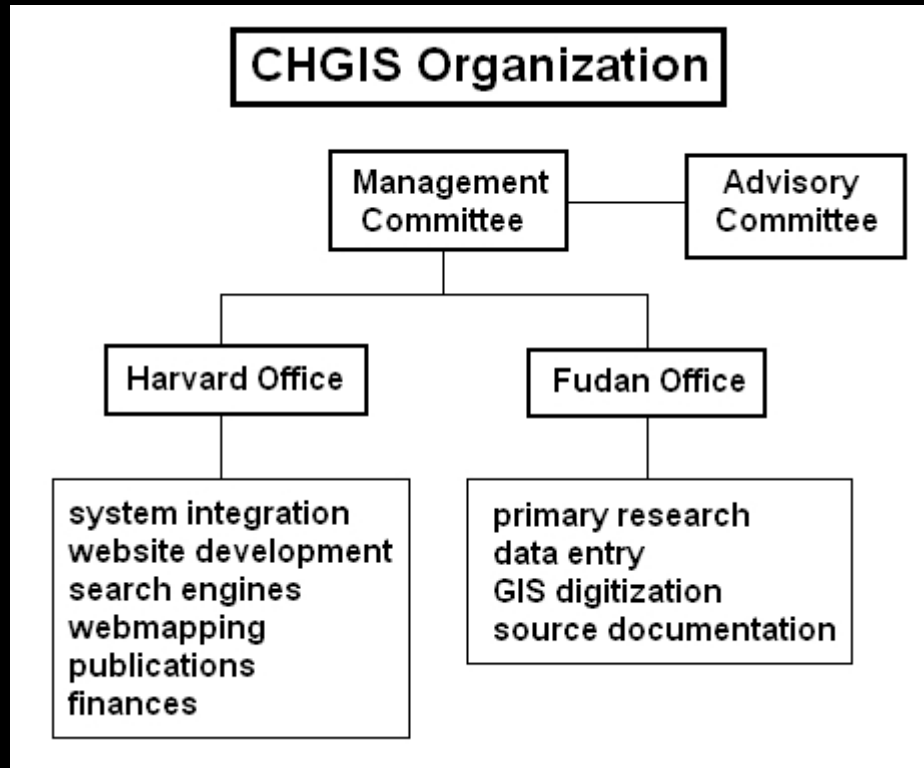
Lex Berman 贝明远  
CHGIS, Harvard University

2<sup>nd</sup> Intl Workshop on Monies,  
Markets & Finance in East Asia

Ruhr-University Bochum

4 – 6<sup>th</sup> Oct 2007





**Funded By:**

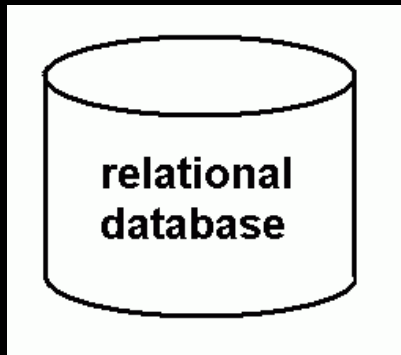
**Henry R. Luce Foundation (2001 – 2004)**

**National Endowment for the Humanities (2005 – present)**

<b>placename</b>	admin unit, populated place, natural feature, religious site, archaeological site, trade route, place where an event occurred, etc
<b>feature type</b>	city, village, mountain, temple, ruin, trade route, etc
<b>footprint</b>	latitude and longitude for each feature
<b>valid date</b>	date or range of time for which this record is valid
<b>source note</b>	citation of data source, commentary on feature

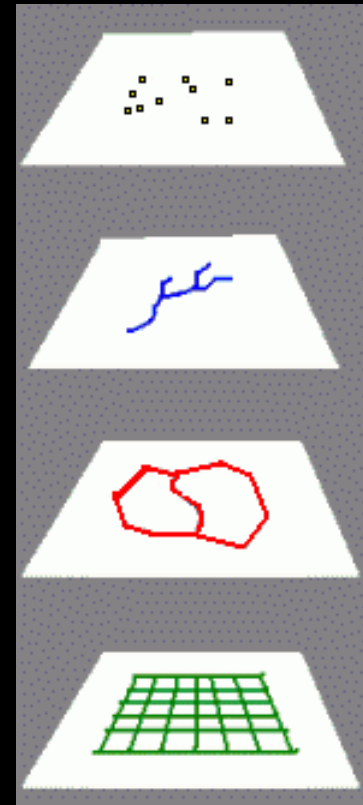
**core elements of a digital gazetteer**

## digital gazetteer



placename  
feature type  
coordinates  
valid date  
source note

## GIS layers



spatial objects

**CHGIS = gazetteer database + GIS layers**

秦始皇

222 BCE

清宣统

1911 CE



**POINT Features:**

- National Capitals
- Province Capitals
- Prefecture Capitals
- County Capitals
- Towns & Villages

**POLYGON Features:**

- National & Regime Boundaries
- Province Boundaries
- Prefecture Boundaries
- 1911 County Boundaries

**scope: a base GIS of Chinese admin divisions**

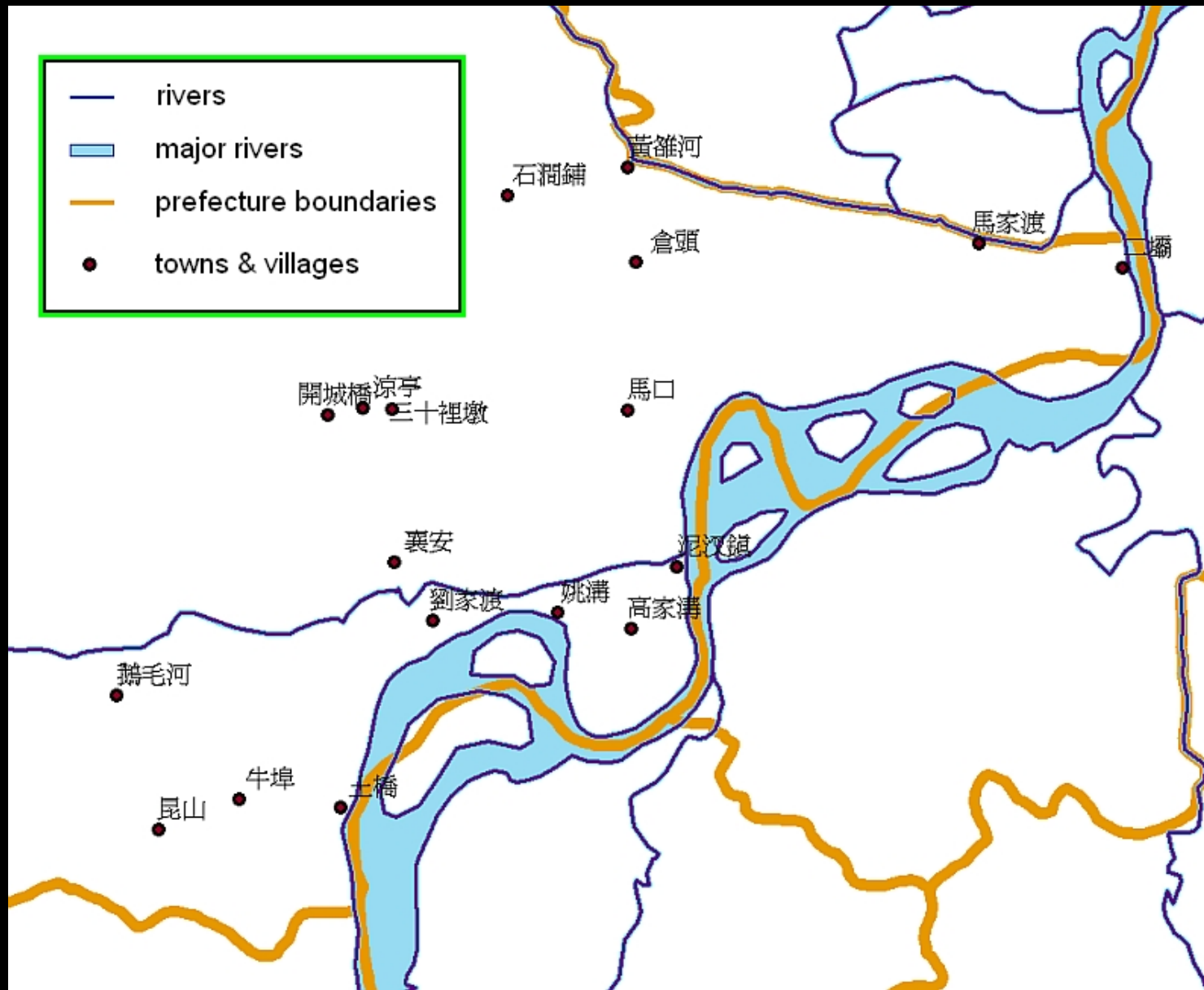


**Reference layer: 1820 Qing Dynasty**





Digitization process: maps scanned

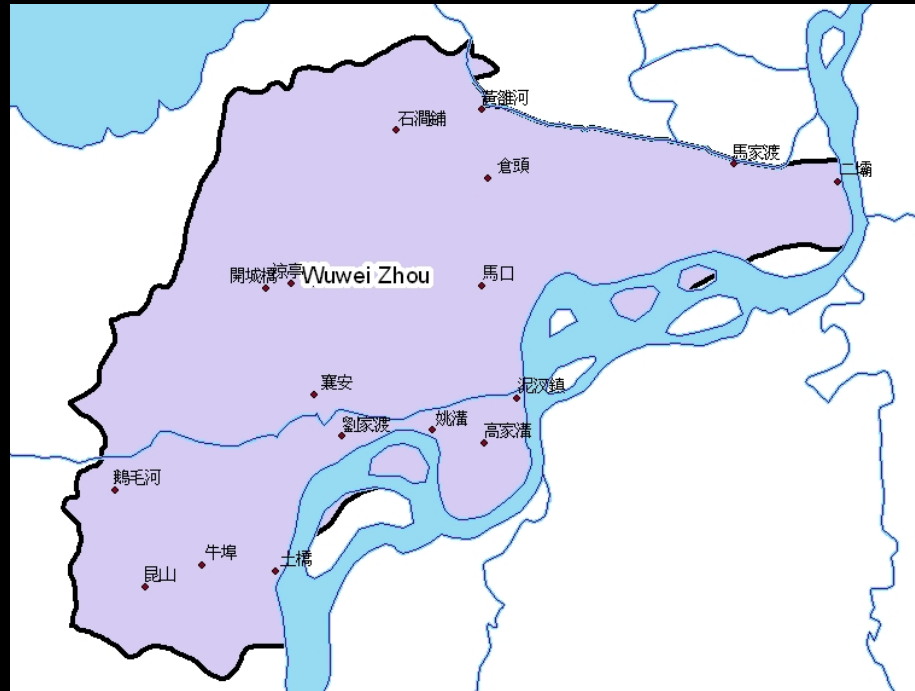


**Digitization process: town points entered**

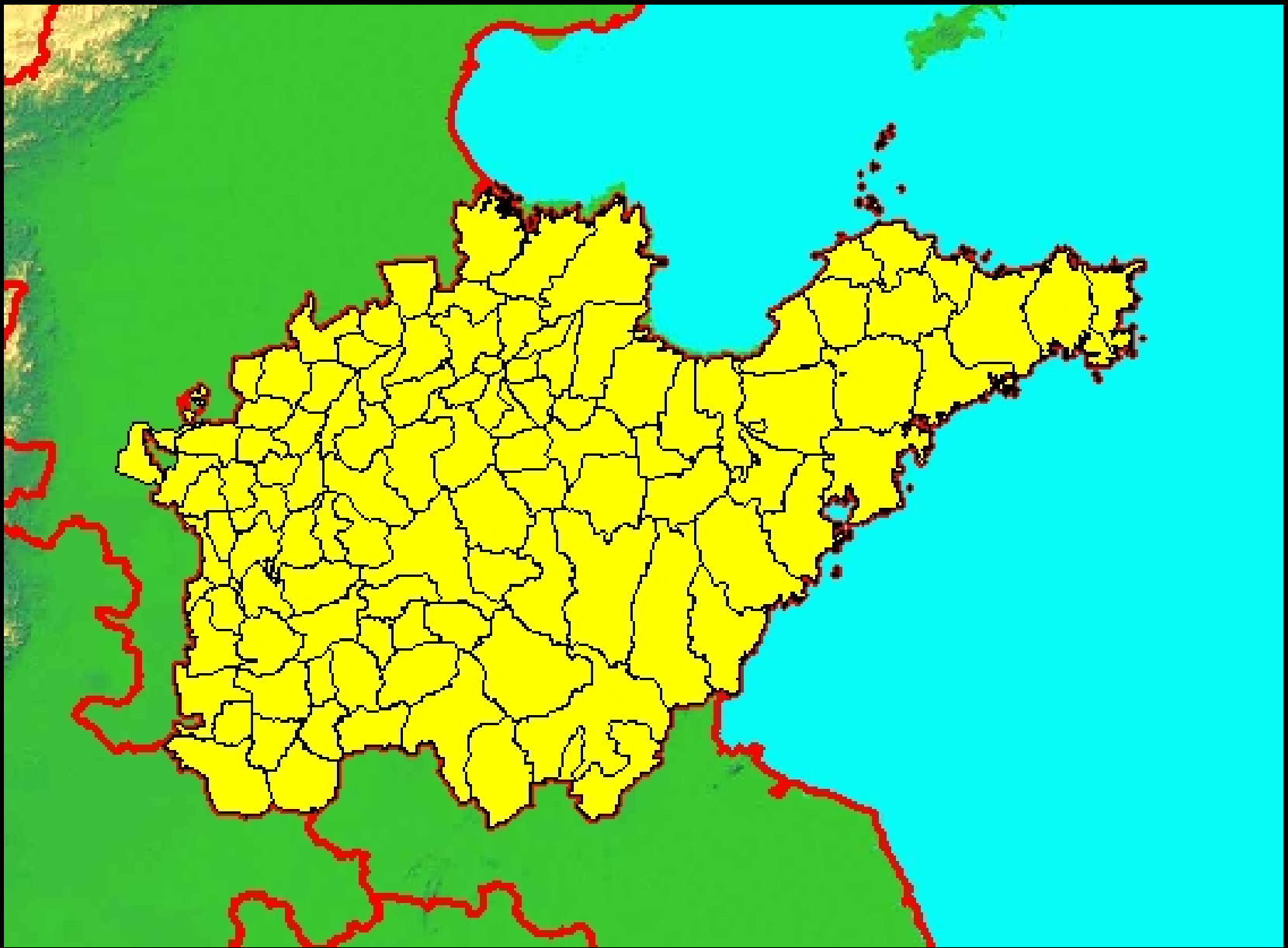




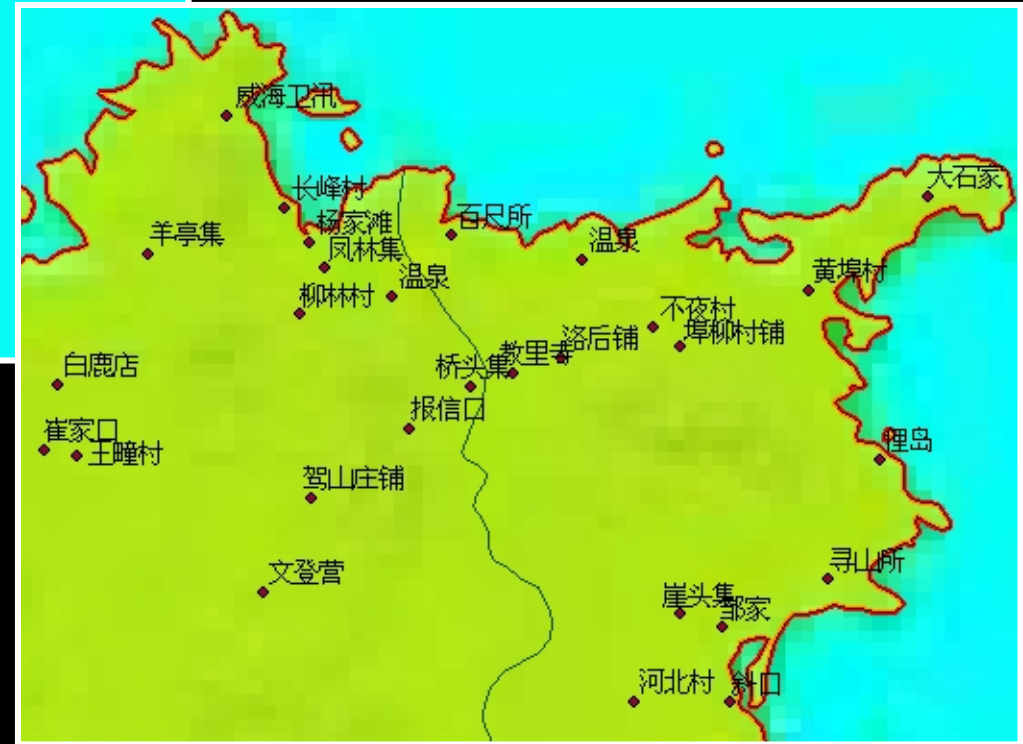
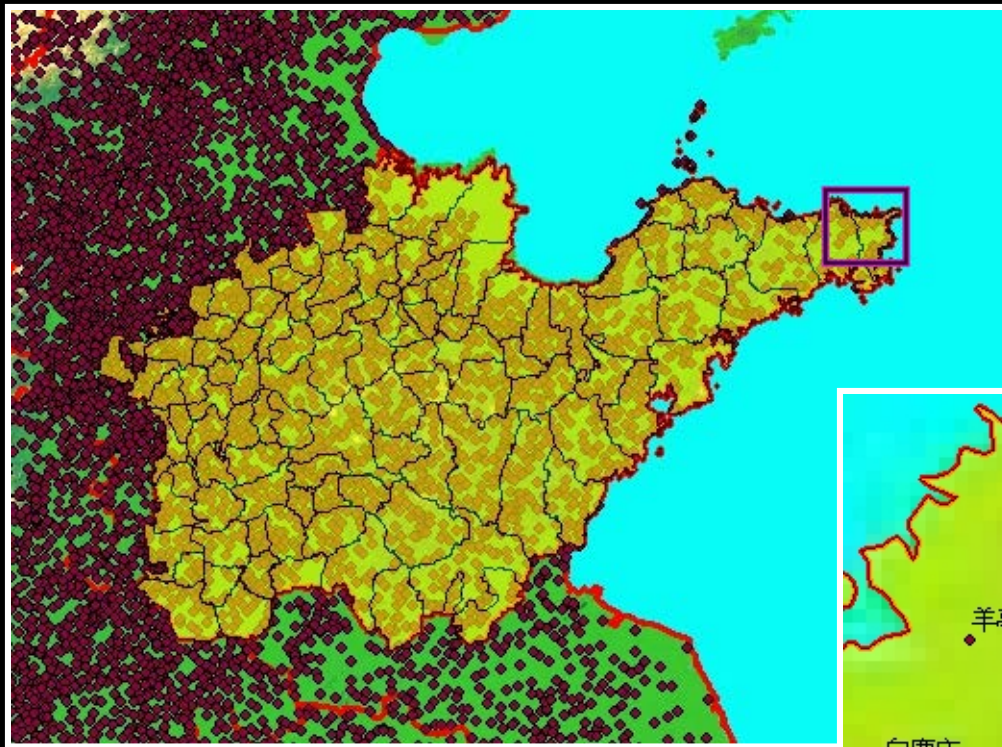
**Digitization process: boundary entered**



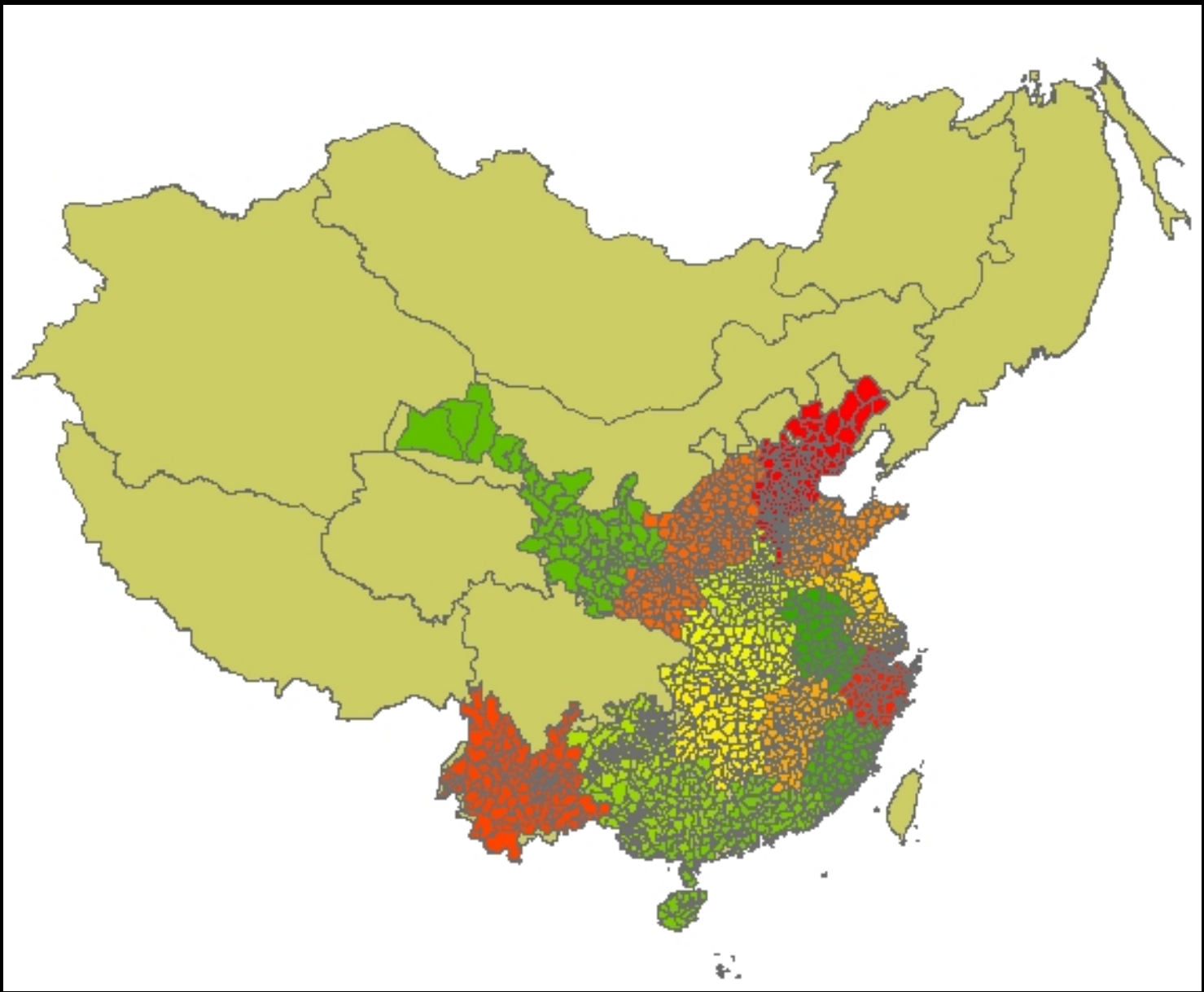
**Comparison of historic map with CHGIS data**



**Example: Shandong 1911 county boundaries**



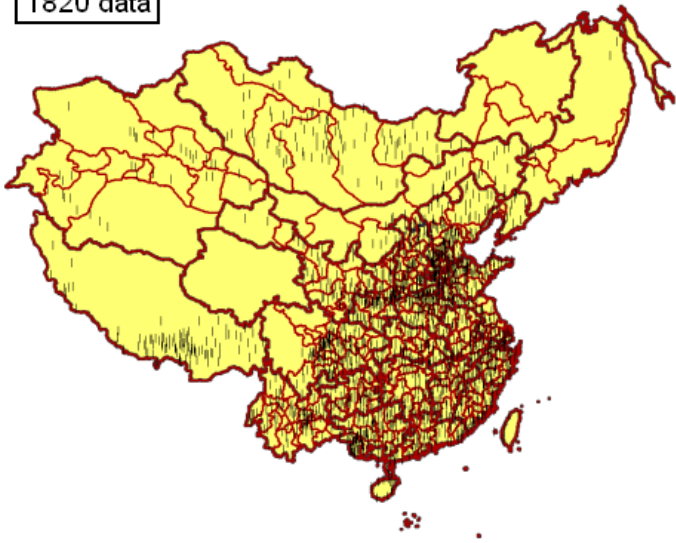
**Example: Shandong with Town points**



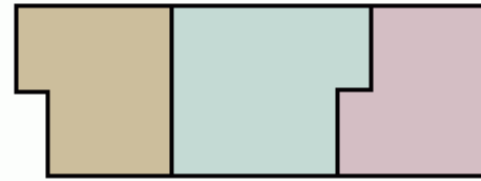
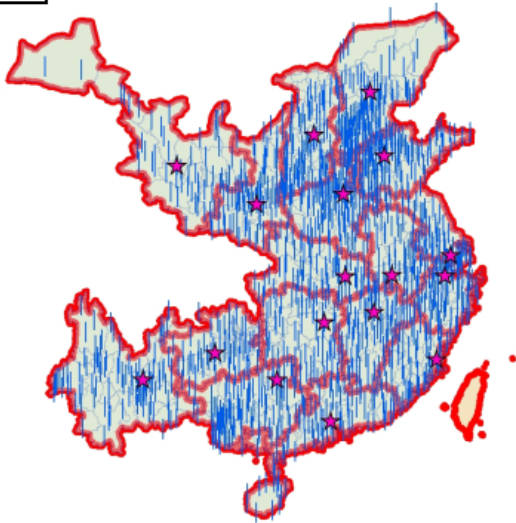
**Currently complete 1911 county boundaries**



1820 data



1911 data



time slice at time 16



time slice at time 11



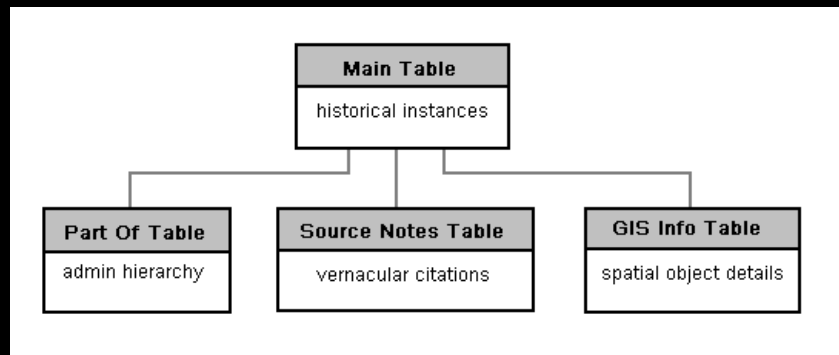
time slice at time 6



time slice at time 2

**Time Slice data = specific year of validity**

## Data Model



## Name Change

name_py	name_ft	beg_chg_type	end_chg_type	beg_yr	end_yr
Chongde Xian	崇德縣	更名	更名	1369	1661
Shimen Xian	石門縣	更名	数据下限	1662	1911

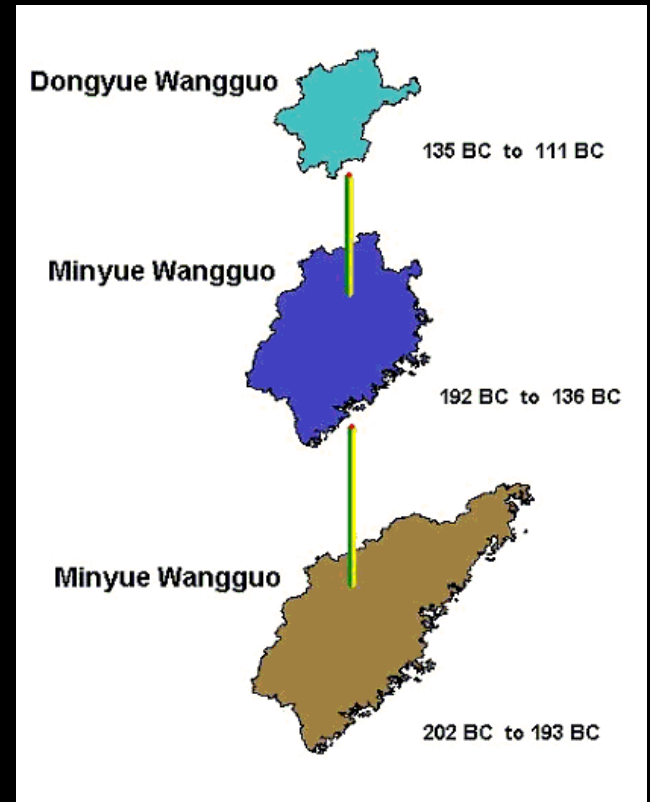
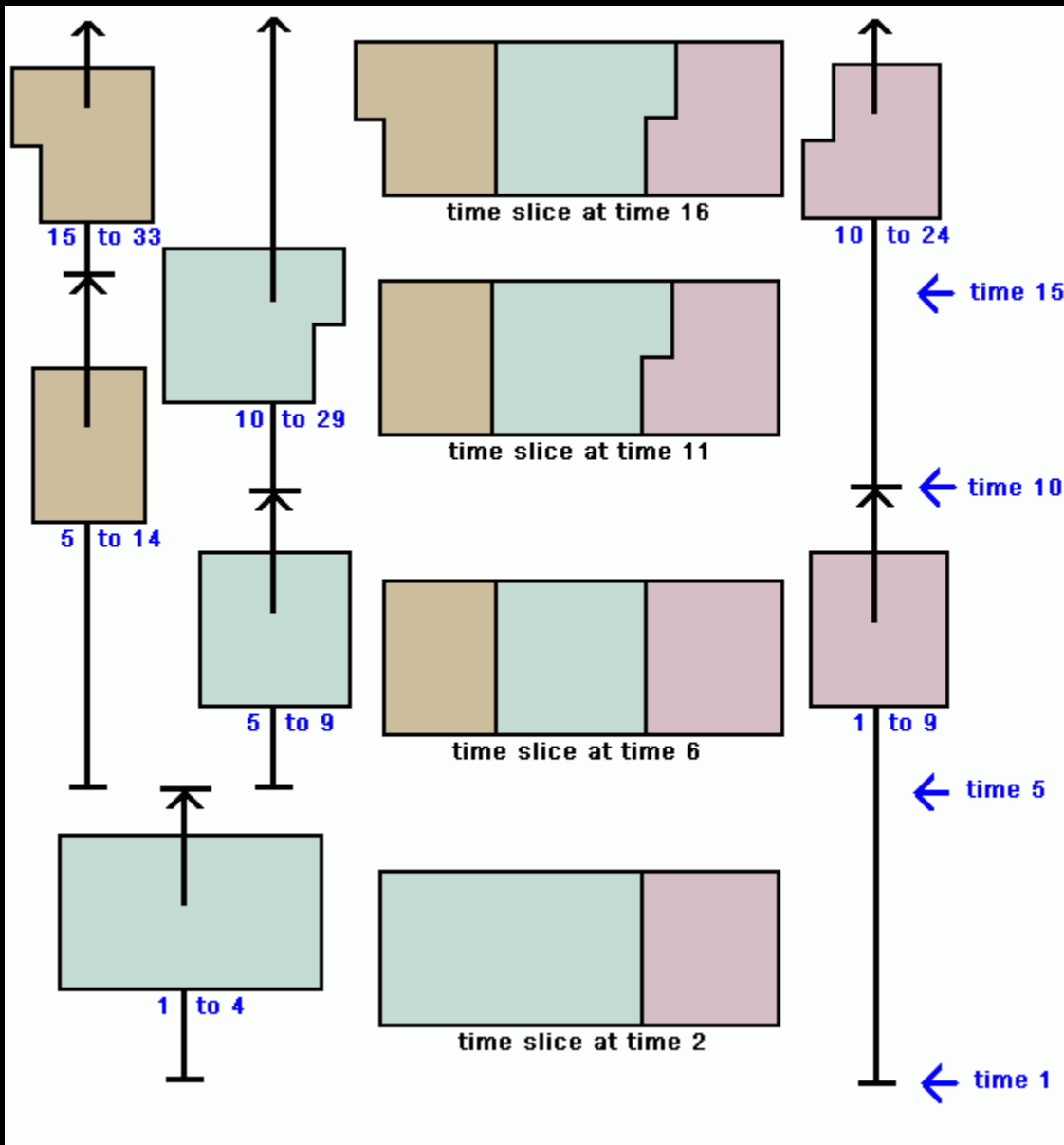
## Unit Change

name_py	name_ft	beg_chg_type	end_chg_type	beg_yr	end_yr
Chongde Xian	崇德縣	新建	更名	939	1294
Chongde Zhou	崇德州	更名	更名	1295	1368
Chongde Xian	崇德縣	更名	更名	1369	1661

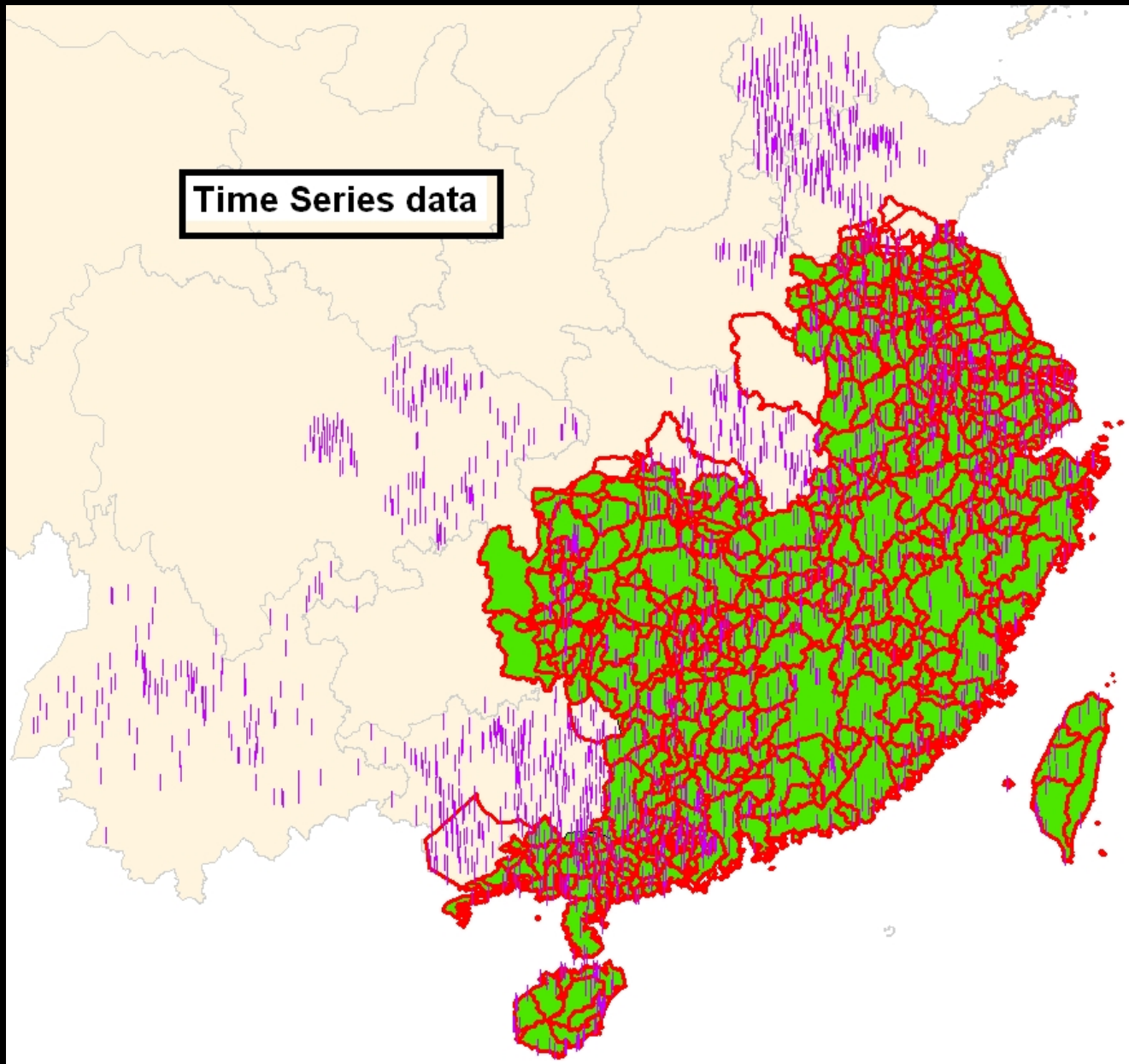
## Location Change

name_py	name_ft	beg_chg_type	end_chg_type	beg_yr	end_yr
Lin'an Xian	臨安縣	更名	迁移治所	978	1261
Lin'an Xian	臨安縣	迁移治所	数据下限	1262	1911

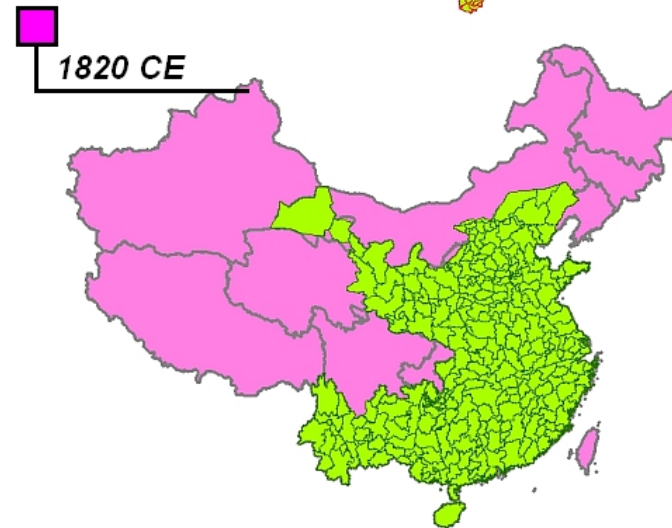
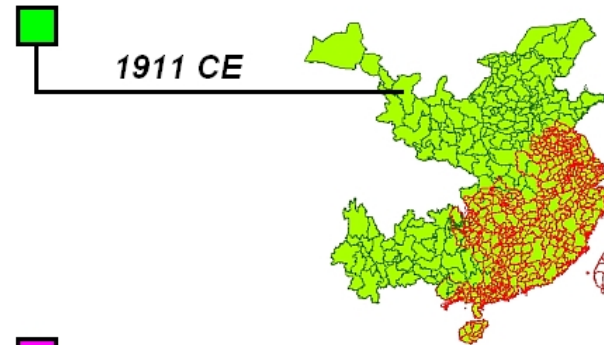
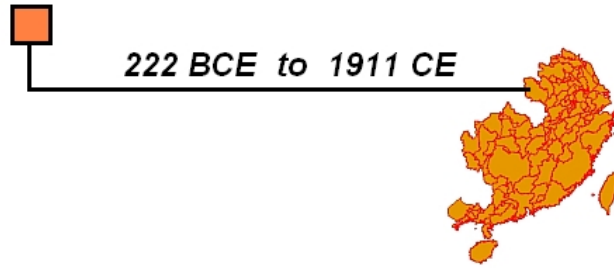
**Time Series = instances with ranges of time**



## Time Series in GIS layers



**Time Series current progress**



**CHGIS – Version 4 datasets**



大清一统志

*Da Qing yitongzhi.*

[Qing National Gazetteer]

中国の寺院

Yajima, Genryo. *Chugoku no ji'in.*

[Temples of China]

Tōhoku Daigaku Fuzoku Toshokan , 1966. [1941]

**Buddhist temple gazetteer sources**

# 崇聖寺

在太和縣西北蒼山十六峰  
 之下。寺有七樓八殿。三塔高  
 十餘丈。凡十六級。唐開元中  
 建。今名三塔寺。

餘 文 凡 十 六	峯 之 下 開 元 中 建 今 名 三 塔 寺	製 詩 十 八 章 賜 僧 無 極 碑 山 門 崇 聖 寺	由 天 竺 中 國 時 建 明 祖 有 御 時 摩 騰 竺 法 蘭	寺 觀 感 通 寺	昭 忠 祠	正 祠	田 廬	至 此	人 立	人 趙	認 建	和 縣	生 勸	通 兵	祠 祀	鮮 于
六 級	唐 開 元 中 建 今 名 三 塔 寺	峯 之 下 開 元 中 建 今 名 三 塔 寺	製 詩 十 八 章 賜 僧 無 極 碑 山 門 崇 聖 寺	寺 觀 感 通 寺	昭 忠 祠	正 祠	田 廬	至 此	人 立	人 趙	認 建	和 縣	生 勸	通 兵	祠 祀	鮮 于
六 級	唐 開 元 中 建 今 名 三 塔 寺	峯 之 下 開 元 中 建 今 名 三 塔 寺	製 詩 十 八 章 賜 僧 無 極 碑 山 門 崇 聖 寺	寺 觀 感 通 寺	昭 忠 祠	正 祠	田 廬	至 此	人 立	人 趙	認 建	和 縣	生 勸	通 兵	祠 祀	鮮 于
六 級	唐 開 元 中 建 今 名 三 塔 寺	峯 之 下 開 元 中 建 今 名 三 塔 寺	製 詩 十 八 章 賜 僧 無 極 碑 山 門 崇 聖 寺	寺 觀 感 通 寺	昭 忠 祠	正 祠	田 廬	至 此	人 立	人 趙	認 建	和 縣	生 勸	通 兵	祠 祀	鮮 于

page from Yitongzhi 24454

			崇聖寺
2220	267	295	285
224 大和 六峰	77 和泉の北郭外	23 昌邑果治末	69 嵯皇治末
唐、南元中	宋、熙寧中		宋、政和
今名、三塔寺。七樓八殿三塔あり	明、洪武合重建		

崇聖寺

2220

224  
大和、和泉  
六峰、倉山十

唐、南元中

今名、三塔寺。七樓八殿三塔あり

崇聖寺

在太和县西北蒼山十六峰  
之下。寺有七樓八殿。三塔高  
十餘丈。凡十六級。唐開元中  
建。今名三塔寺。

今名、三塔寺。七樓八殿三塔あり

2220

224

大、和県蒼山十六峰

唐、開元中

崇聖寺

Name:	崇聖寺
Temple ID:	2220
Site ID:	224
Location:	大和县蒼山十六峰
Established:	唐開元中
Notes:	今名三塔寺，七樓八殿三塔



229 麗江府 (2218) 州 (2053) 216 雲南府 (2184)  
 228 廣西府 (2257) 220 廣南府 (2210) 217 曲靖府 (2172)  
 227 廣西州 (2257) 224 大理府 (2219) 218 臨安府 (2180)  
 226 楚雄府 (2230) 221 開化府 (2173)  
 225 楚雄府 (2230) 222 昭通府 (2180)  
 224 大理府 (2219) 223 普洱府 (2178)  
 223 試定州 (2247) 224 永昌府 (2180)  
 222 昭通府 (2180)  
 221 永昌府 (2180)  
 220 昭通府 (2180)  
 219 元江州 (2247) 227 順寧府 (2181)  
 218 元江州 (2247) 227 順寧府 (2181)  
 217 元江州 (2247) 227 順寧府 (2181)  
 216 元江州 (2247) 227 順寧府 (2181)  
 215 元江州 (2247) 227 順寧府 (2181)  
 214 元江州 (2247) 227 順寧府 (2181)  
 213 元江州 (2247) 227 順寧府 (2181)  
 212 元江州 (2247) 227 順寧府 (2181)  
 211 元江州 (2247) 227 順寧府 (2181)  
 210 元江州 (2247) 227 順寧府 (2181)  
 209 元江州 (2247) 227 順寧府 (2181)  
 208 元江州 (2247) 227 順寧府 (2181)  
 207 元江州 (2247) 227 順寧府 (2181)  
 206 元江州 (2247) 227 順寧府 (2181)  
 205 元江州 (2247) 227 順寧府 (2181)  
 204 元江州 (2247) 227 順寧府 (2181)  
 203 元江州 (2247) 227 順寧府 (2181)  
 202 元江州 (2247) 227 順寧府 (2181)  
 201 元江州 (2247) 227 順寧府 (2181)

224  
 大理府  
 2219  
 2229

site_id	site_ch	site_alt	site_rom	chgis_id
217	曲靖府	曲靖府	Qujing Fu	9757
218	臨安府	臨安府	Linan Fu	9765
219	澄江府	澄江府	Chengjiang Fu	9760
220	廣南府	廣南府	Guangnan Fu	9762
221	開化府	開化府	Kaihua Fu	9766
222	昭通府	昭通府	Zhaotong Fu	9747
223	普洱府	普洱府	Puer Fu	9767
224	大理府	大理府	Dali Fu	9753
225	楚雄府	楚雄府	Chuxiong Fu	9754

<b>Name:</b>	崇聖寺
<b>Temple ID:</b>	2220
<b>Site ID:</b>	224
<b>Location:</b>	大和县蒼山十六峰
<b>Established:</b>	唐開元中
<b>Notes:</b>	今名三塔寺，七樓八殿三塔

georeferencing temple records, Yajima sites



child_id	child_rom	child_utf	child_utf	abeg_yr	end_yr	parent_utf	parent_rom	parent_id
1547	Langqiong Xian	浪穹县	浪穹縣	1820	1820	大理府	Dali Fu	9753
1553	Yunlong Zhou	云龙州	云龍州	1820	1820	大理府	Dali Fu	9753
1555	Yunnan Xian	云南县	云南縣	1820	1820	大理府	Dali Fu	9753
1556	Dengchuan Zhou	邓川州	鄧川州	1820	1820	大理府	Dali Fu	9753
1557	Binchuan Zhou	宾川州	賓川州	1820	1820	大理府	Dali Fu	9753
1558	Taihe Xian	太和县	太和縣	1820	1820	大理府	Dali Fu	9753
1623	Zhao Zhou	赵州	趙州	1820	1820	大理府	Dali Fu	9753
22347	Emaoding	鹅毛顶	鵝毛頂	1820	1820	大理府	Dali Fu	9753
22350	Shijing	师井	師井	1820	1820	大理府	Dali Fu	9753
22391	Liuku	六库	六庫	1820	1820	大理府	Dali Fu	9753
22408	Xiajiangzui	下江嘴	下江嘴	1820	1820	大理府	Dali Fu	9753
22409	Shangjiangzui	上江嘴	上江嘴	1820	1820	大理府	Dali Fu	9753
22411	Nuodengjing	诺邓井	諾鄧井	1820	1820	大理府	Dali Fu	9753
22412	Yunlongjiuzhou	云龙旧州	云龍舊州	1820	1820	大理府	Dali Fu	9753
22413	Fengyuxiang	凤羽乡	鳳羽鄉	1820	1820	大理府	Dali Fu	9753
22422	Caojian	曹涧	曹澗	1820	1820	大理府	Dali Fu	9753
22424	Shimenjing	石门井	石門井	1820	1820	大理府	Dali Fu	9753
22425	Laowo	老窝	老窩	1820	1820	大理府	Dali Fu	9753
22426	Jianganchang	箭杆场	箭桿場	1820	1820	大理府	Dali Fu	9753
22429	Xiaguan	下关	下關	1820	1820	大理府	Dali Fu	9753
22430	Shangguan	上关	上關	1820	1820	大理府	Dali Fu	9753
22431	Shi'erguansi	十二关司	十二關司	1820	1820	大理府	Dali Fu	9753
22433	Binjuzhai	宾居寨	賓居寨	1820	1820	大理府	Dali Fu	9753
22434	Midi	密滴	密滴	1820	1820	大理府	Dali Fu	9753
22435	Xizhou	喜洲	喜洲	1820	1820	大理府	Dali Fu	9753
22436	Midu	弥渡	彌渡	1820	1820	大理府	Dali Fu	9753
22437	Hongyan	红岩	紅巖	1820	1820	大理府	Dali Fu	9753
22440	Midian	米甸	米甸	1820	1820	大理府	Dali Fu	9753
22744	Shundangjing	顺荡井	順蕩井	1820	1820	大理府	Dali Fu	9753
22747	Dingxiling	定西岭	定西嶺	1820	1820	大理府	Dali Fu	9753

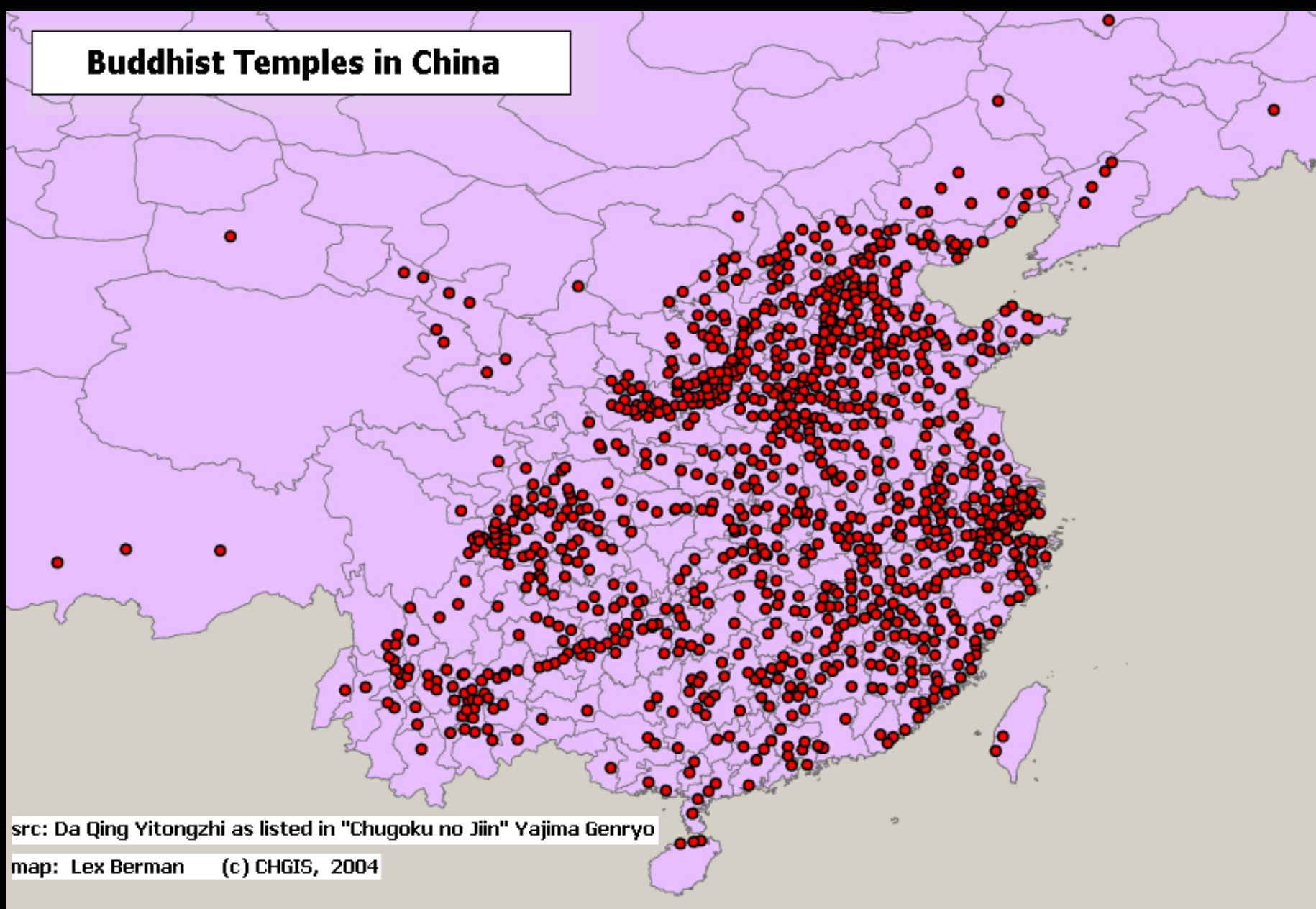
georeferencing temple records, CHGIS tables

<b>Name:</b>	崇圣寺
<b>Temple ID:</b>	2220
<b>Site ID:</b>	224
<b>Location:</b>	大和县苍山十六峰
<b>Established:</b>	唐开元中
<b>Notes:</b>	今名三塔寺，七楼八殿三塔



georeferencing temple records, map view

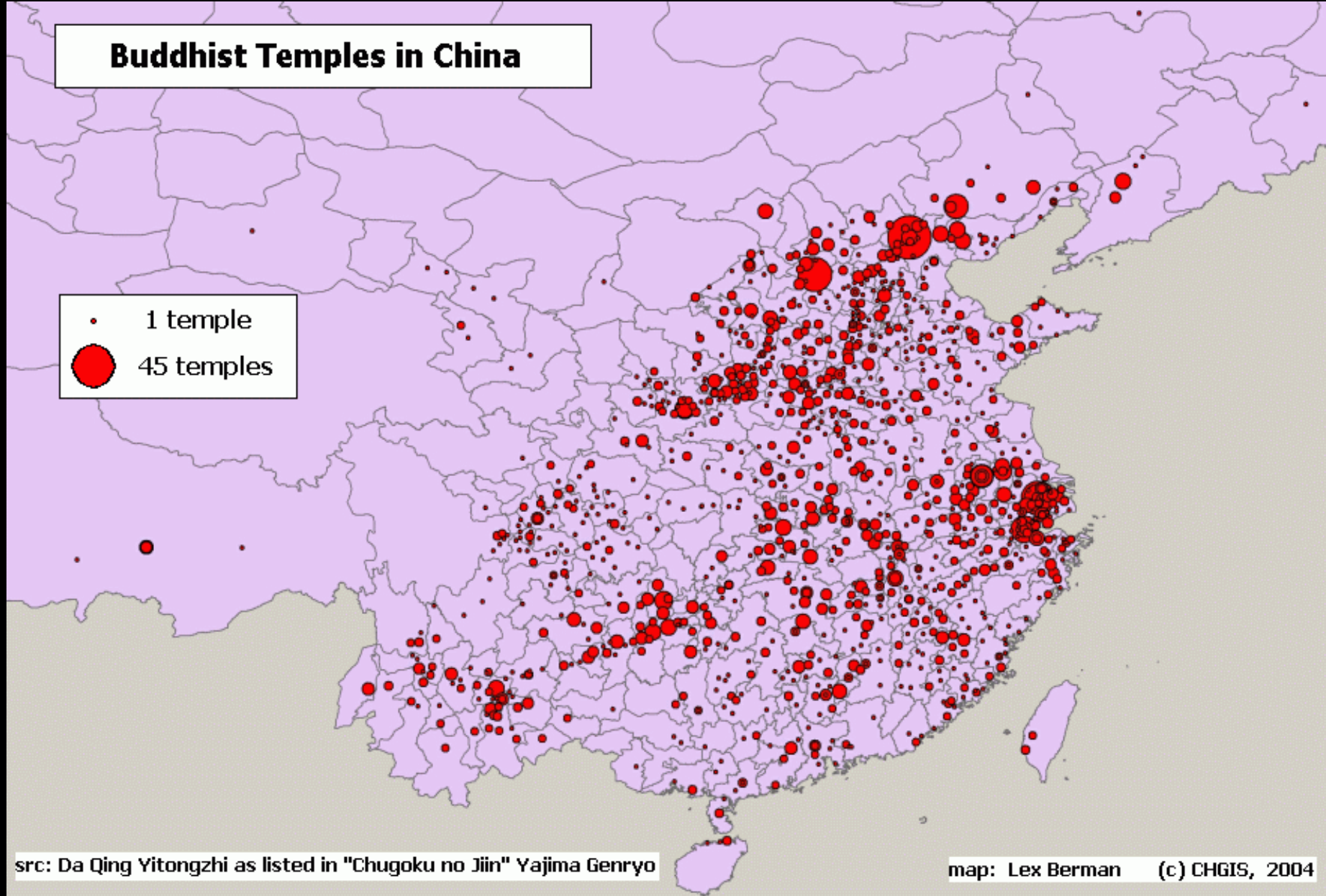
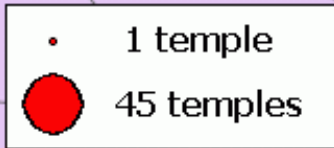
## Buddhist Temples in China



**overview of temple locations**



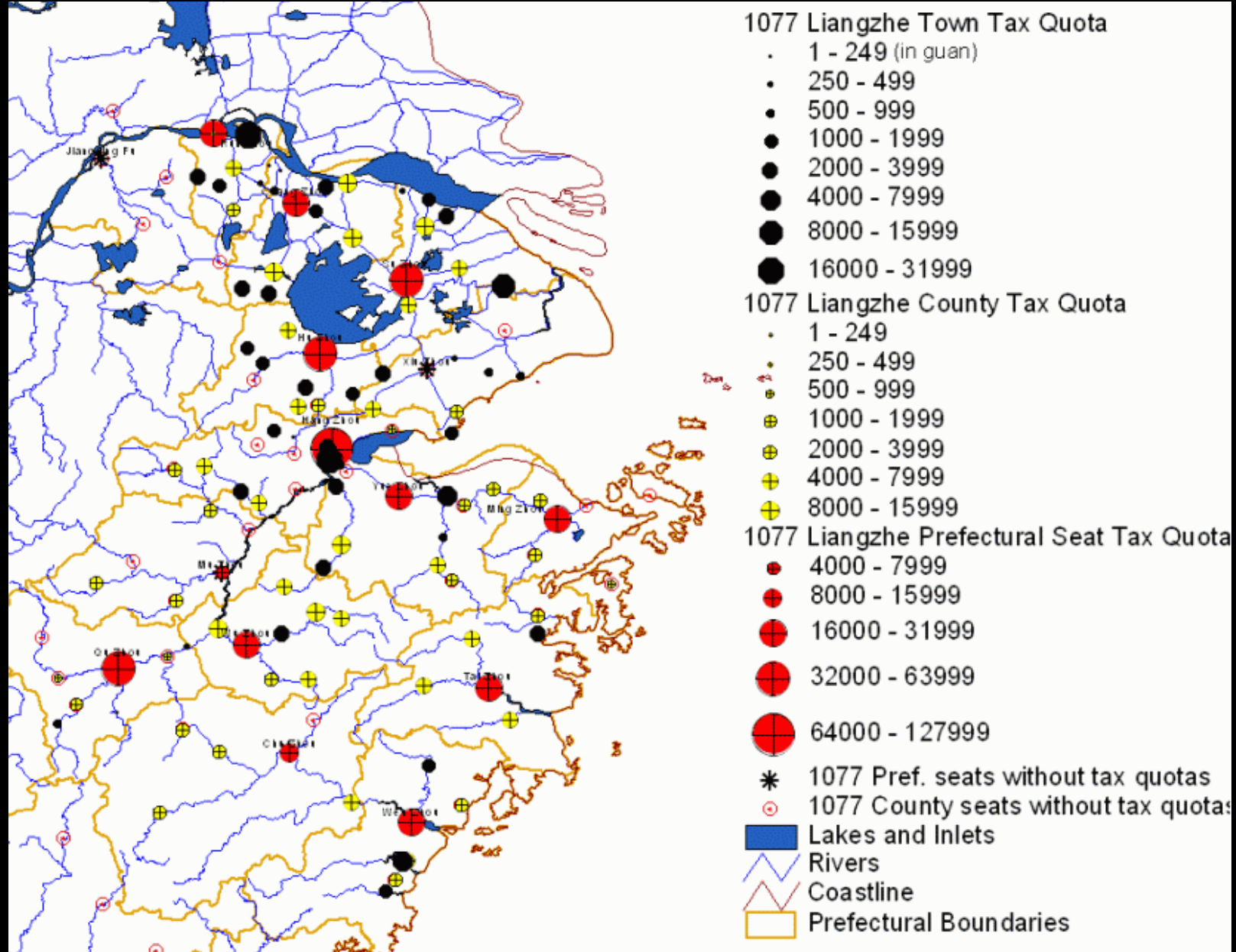
# Buddhist Temples in China



src: Da Qing Yitongzhi as listed in "Chugoku no Jiin" Yajima Genryo

map: Lex Berman (c) CHGIS, 2004

**density of temples at each location**



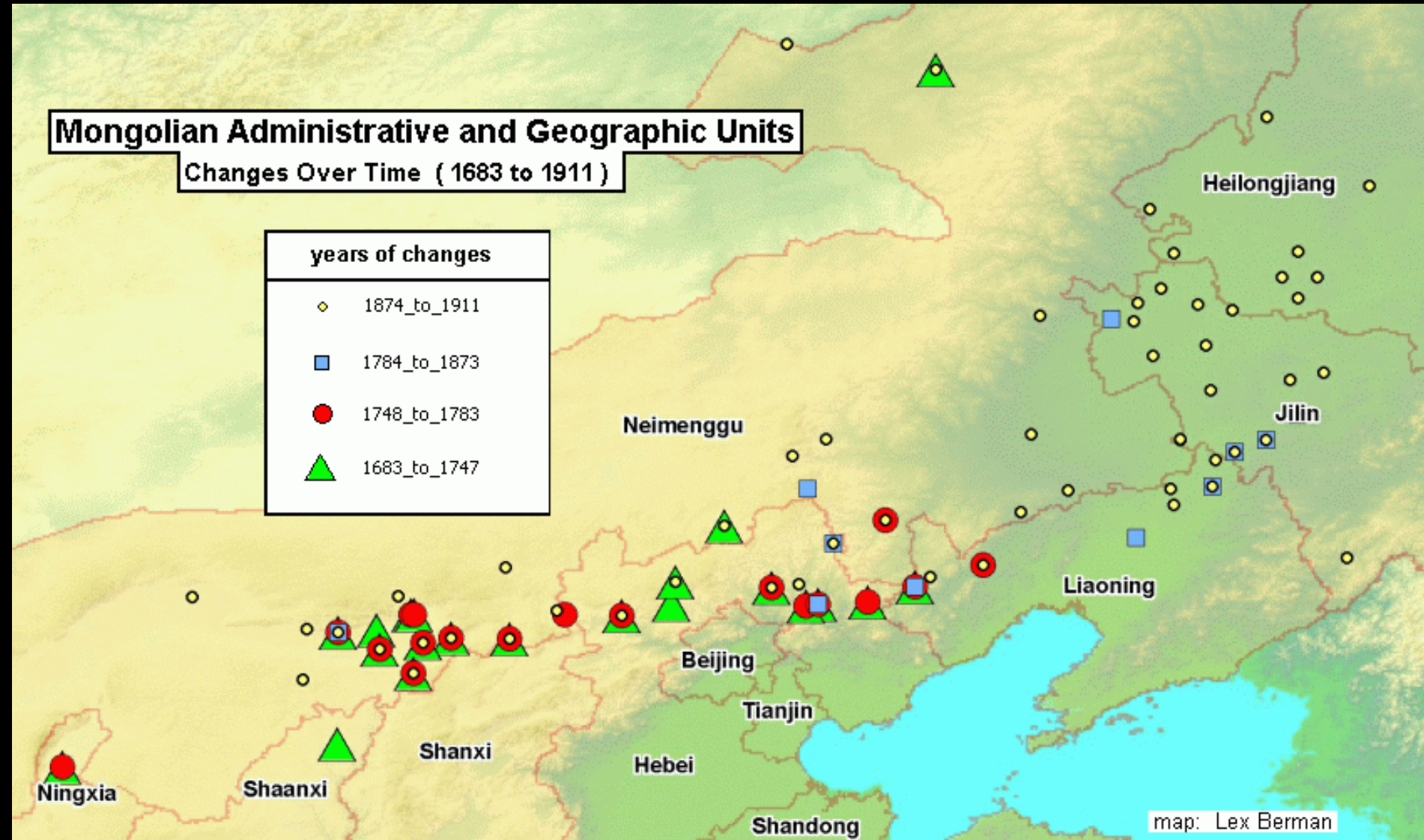
**Example: Song tax statistics**



# Mongolian Administrative and Geographic Units

Changes Over Time ( 1683 to 1911 )

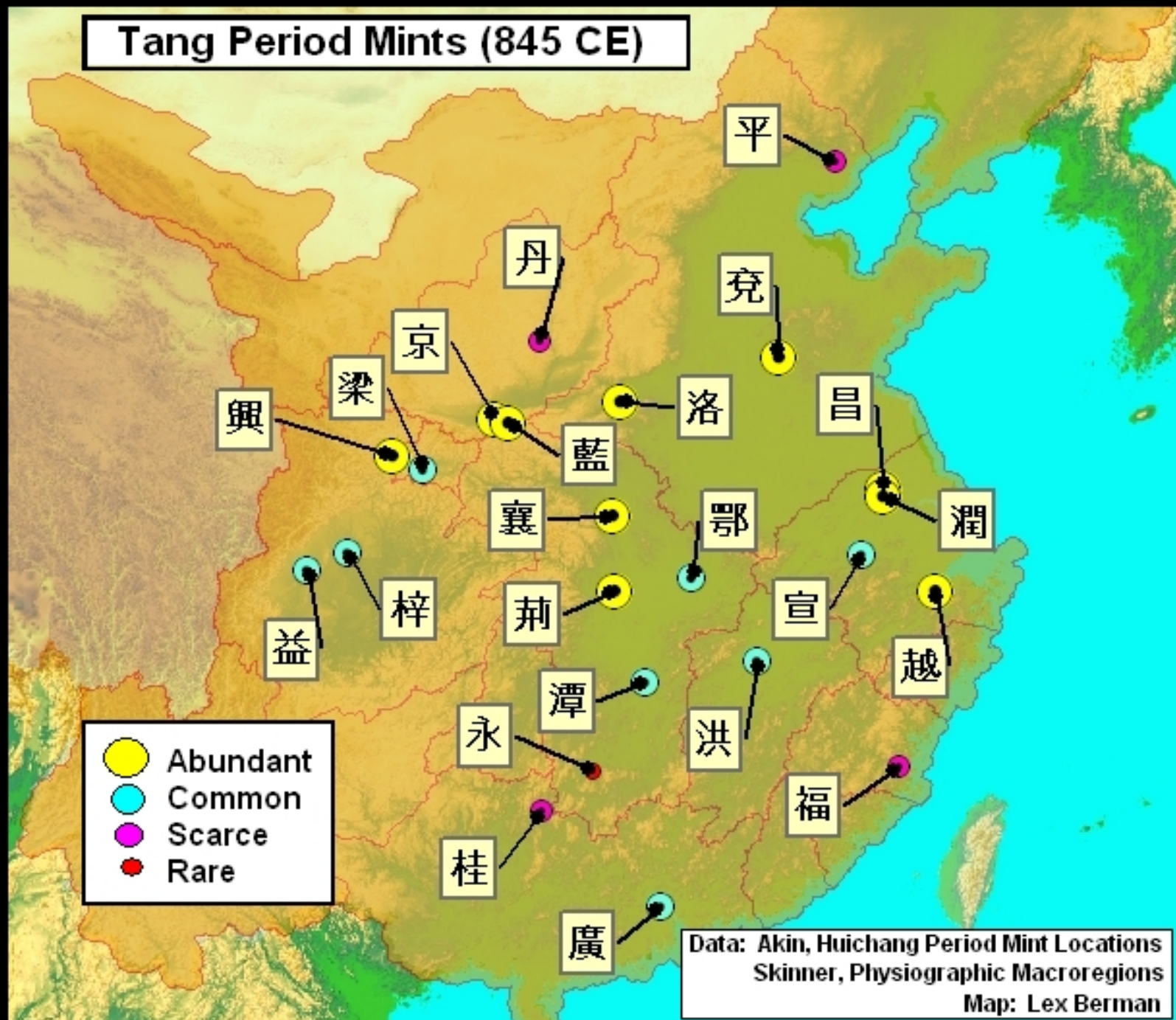
years of changes	
○	1874_to_1911
□	1784_to_1873
●	1748_to_1783
▲	1683_to_1747



map: Lex Berman

**Example: Mongolian Administration over time**

# Tang Period Mints (845 CE)

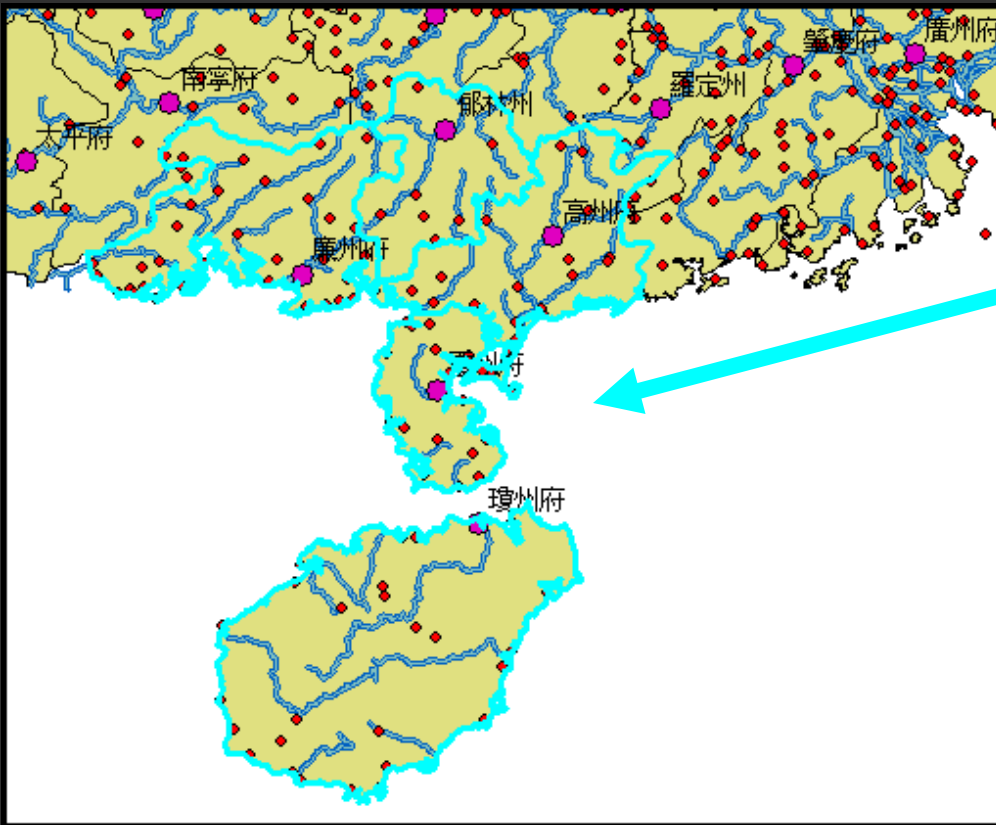


Data: Akin, Huichang Period Mint Locations  
Skinner, Physiographic Macroregions  
Map: Lex Berman



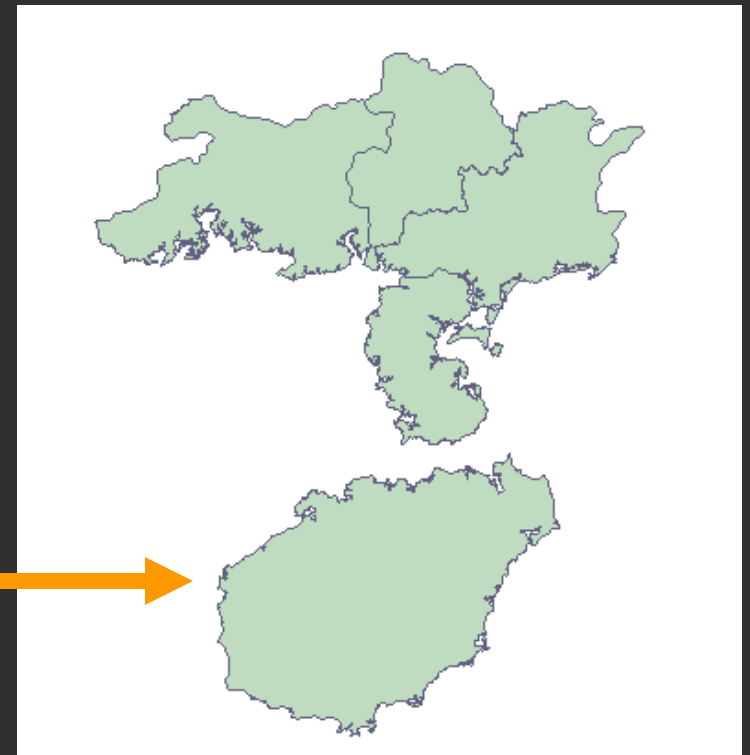


**Example: distribution of ceramic kilns**

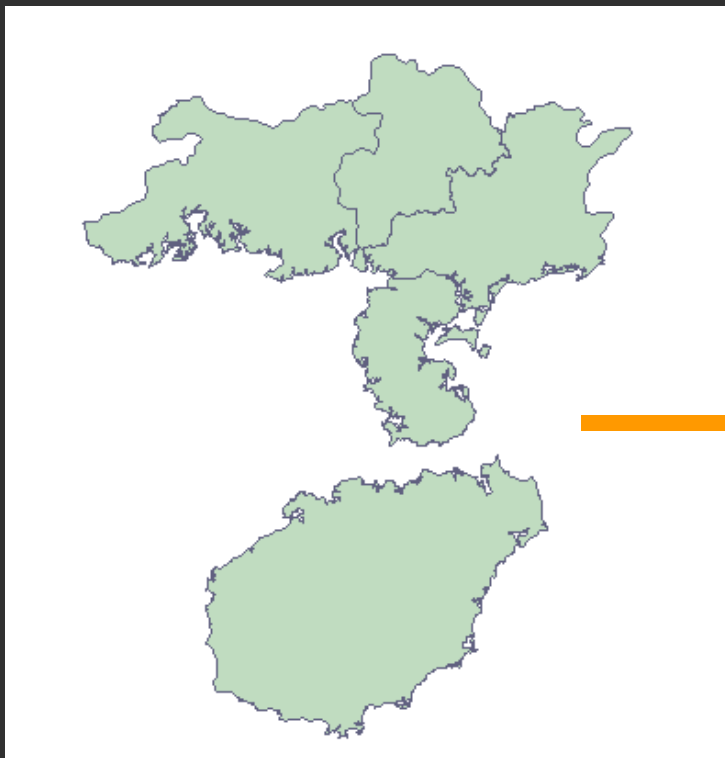


select area of interest

convert to "shapefile"



**Associating data values with polygon features**



export attribute data for focus area to TEXT file

Character_	Pinyin_nam	Prov_ch	Prov_py_na	System_id
郁林州	Yulin Zhou	廣西	Guangxi	1923
高州府	Gaozhou Fu	廣東	Guangdong	2047
雷州府	Leizhou Fu	廣東	Guangdong	2050
廉州府	Lianzhou Fu	廣東	Guangdong	2058
瓊州府	Qiongzhou Fu	廣東	Guangdong	2060

add a new column to the TEXT file

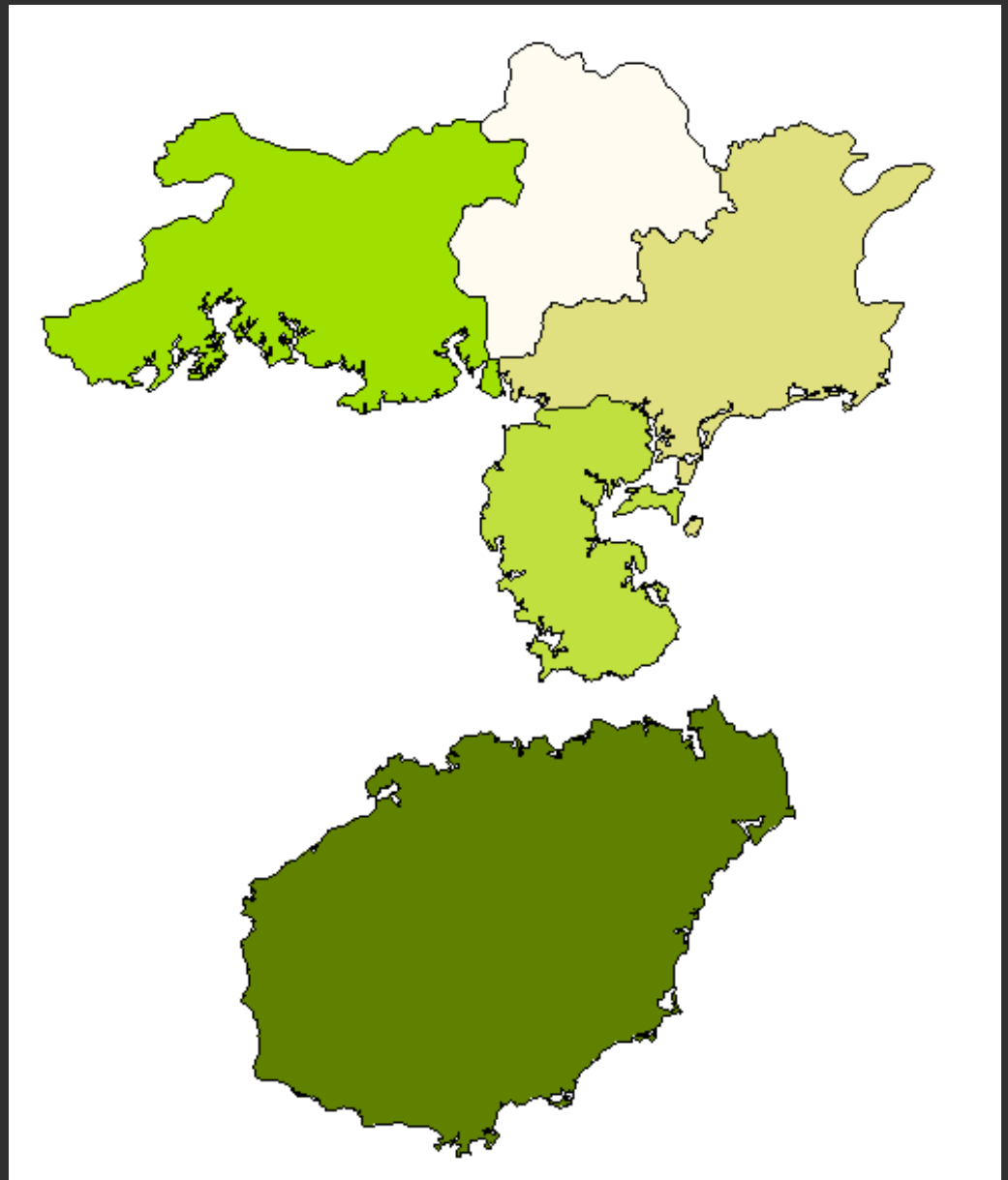
Character_	Pinyin_nam	Prov_ch	Prov_py_na	System_id	NEW
郁林州	Yulin Zhou	廣西	Guangxi	1923	
高州府	Gaozhou Fu	廣東	Guangdong	2047	
雷州府	Leizhou Fu	廣東	Guangdong	2050	
廉州府	Lianzhou Fu	廣東	Guangdong	2058	
瓊州府	Qiongzhou Fu	廣東	Guangdong	2060	

enter new values in the new column, then REJOIN to original GIS focus area shapefile

**join new data values to GIS attribute table**

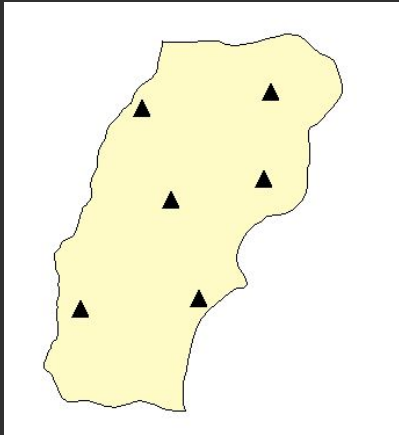


create choropleth  
map based on your  
data

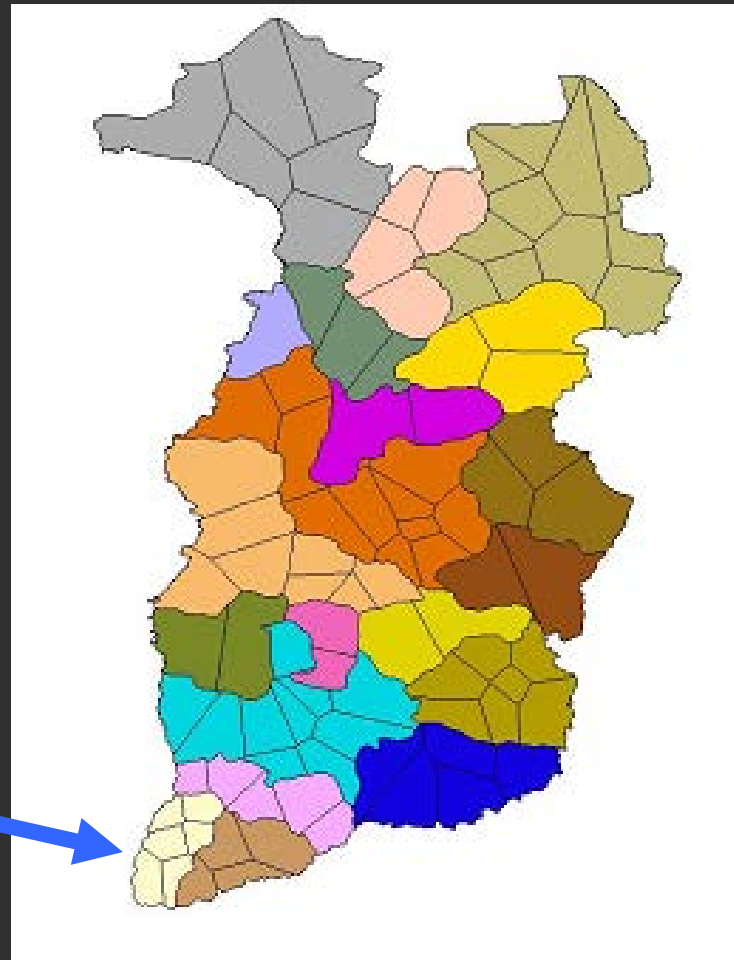


**Thematic map based on new data values**

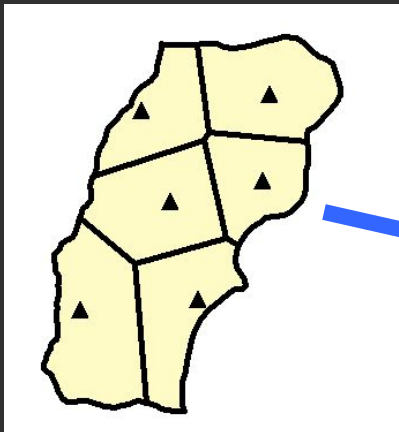
center points + outer boundary



aggregation of Thiessen boundaries

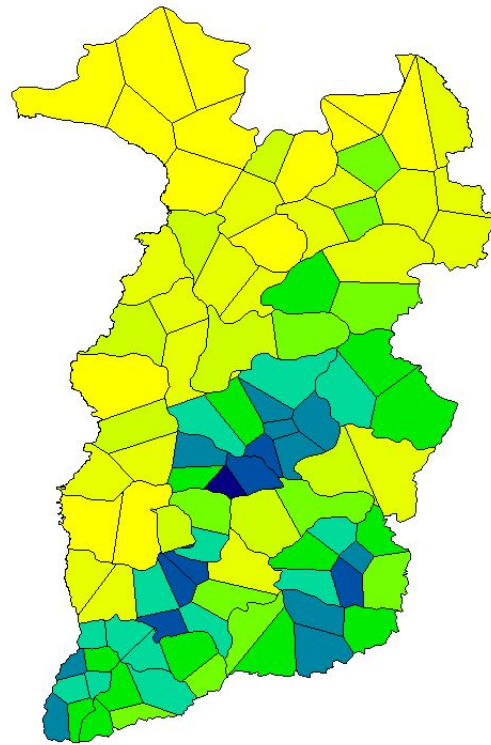


Thiessen Polygons based on points

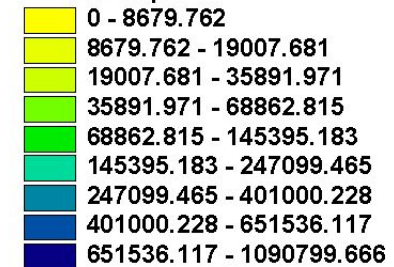


**Thiessen polygons generated from points**

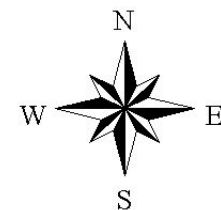
# Ding Population (1820) normalized by area



Theme1.shp

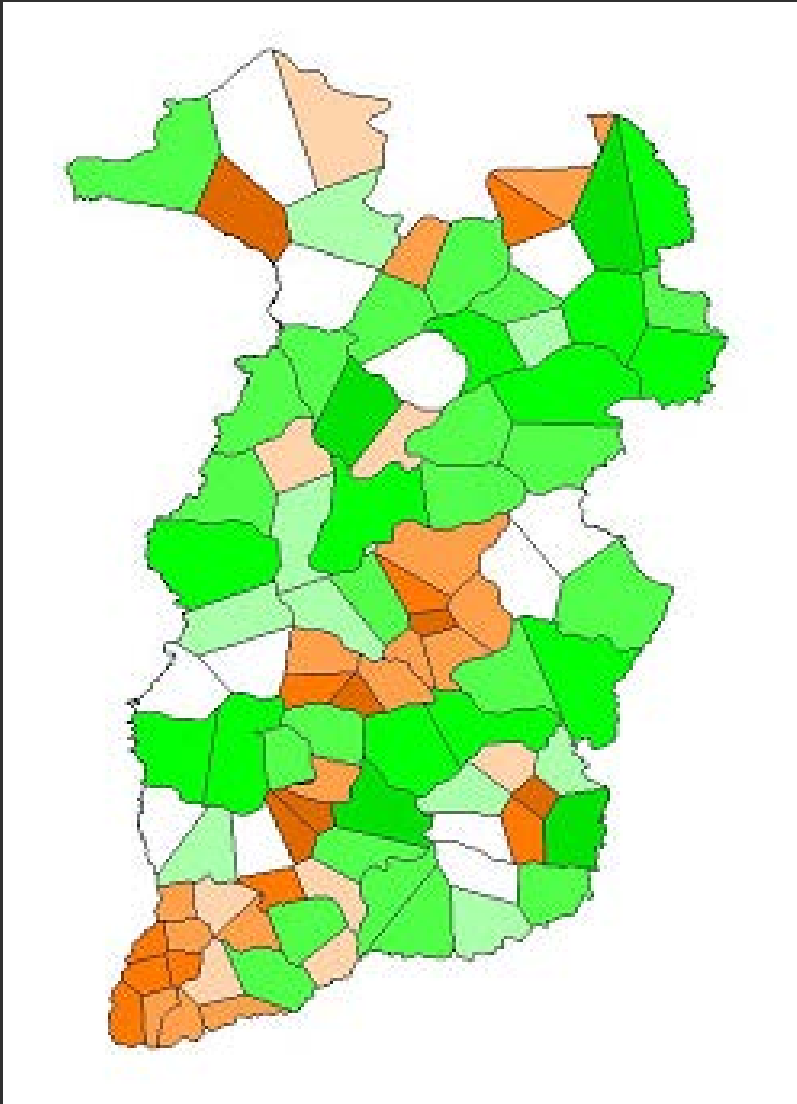


100 0 100 200 Miles

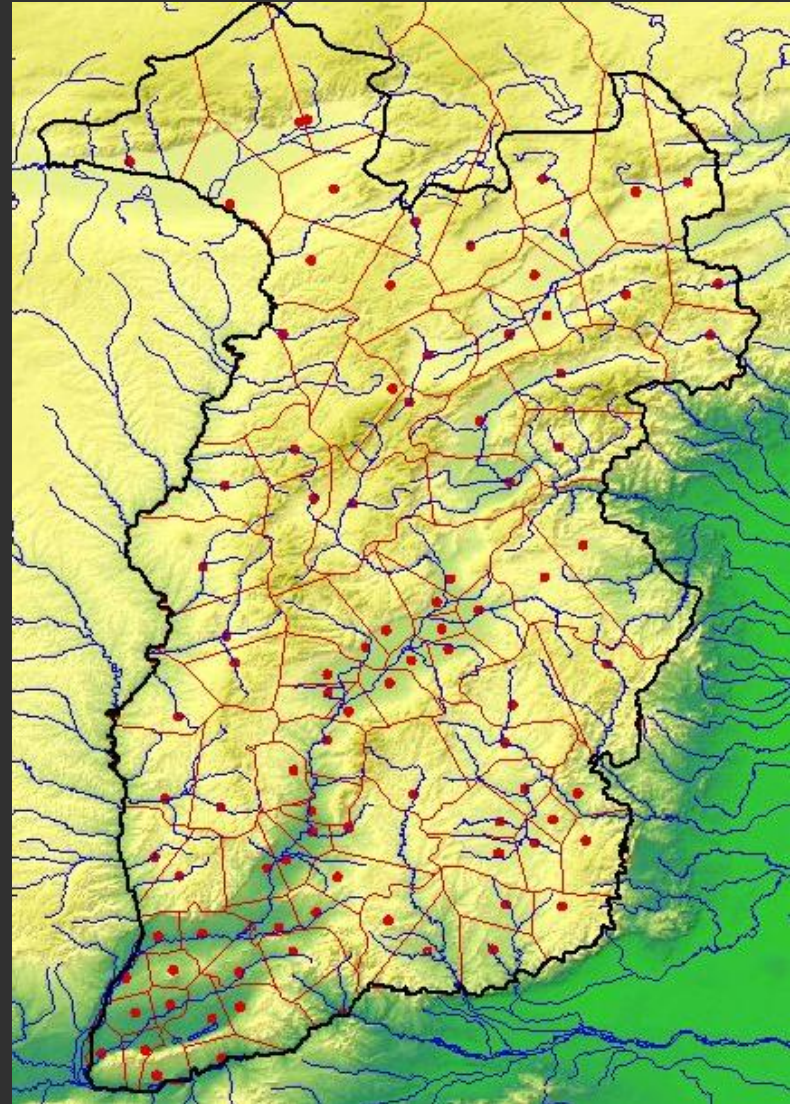


**population distribution – normalized by area**

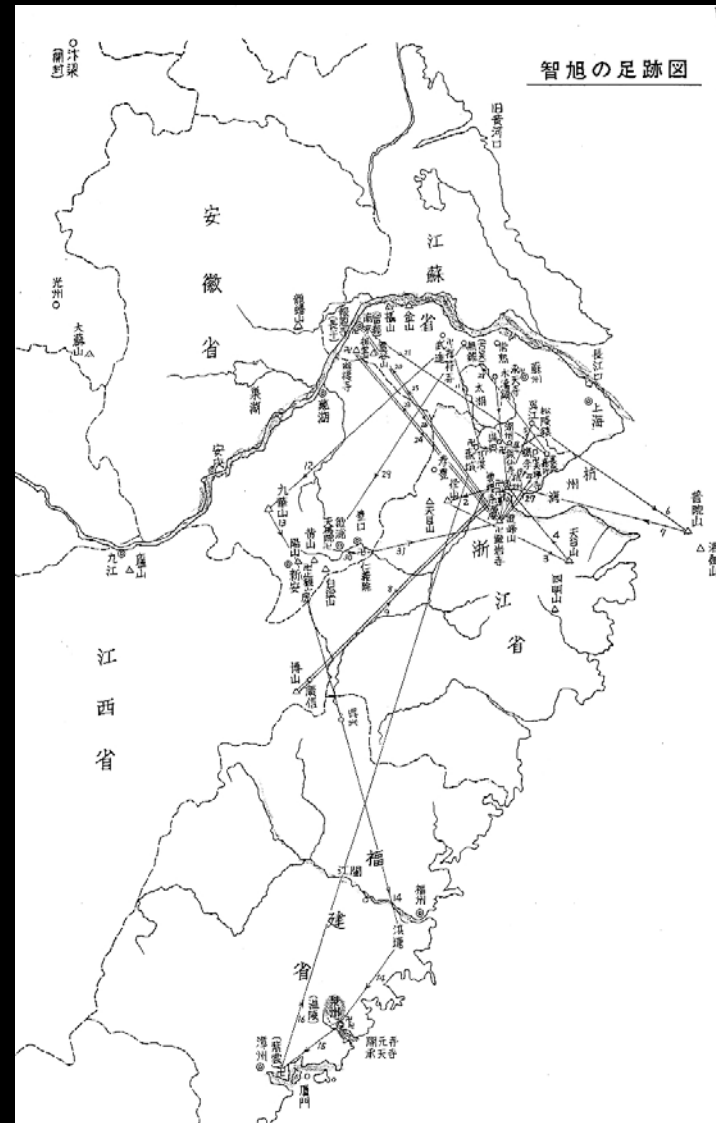
Male Population (1820) normalized by area



DEM background



Thiessen polygons compared with natural features



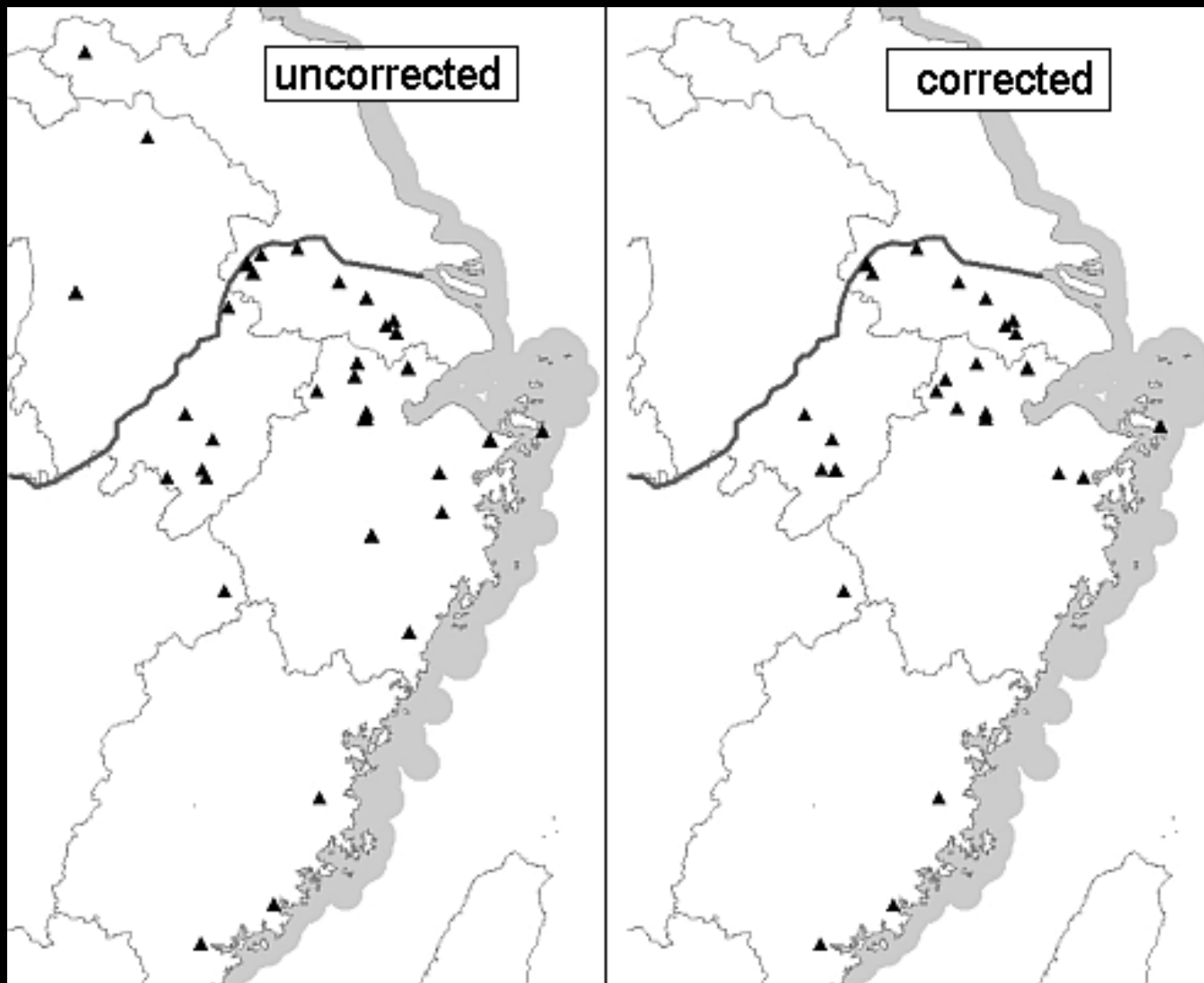
Mapping and animation of locations over time - Life of Ouyi Zhixu



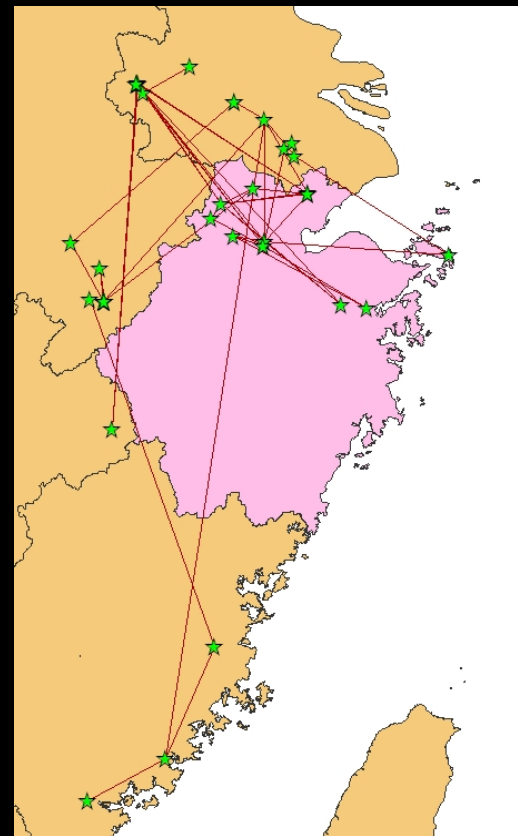
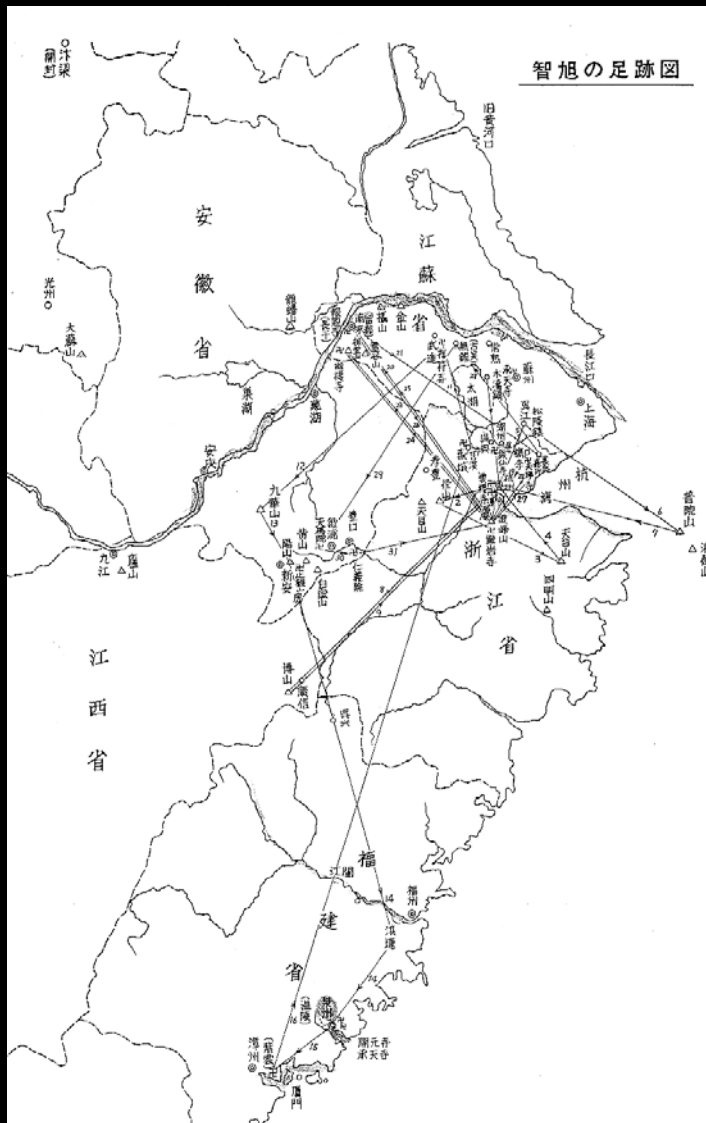
place_id	year	season	sequence	source	type_id	type_description	chrono_events_notes
ouyi_1	1599		1	autobio	1	birth	
ouyi_3	1622	summer	2	ZL.8.2.1-8, autobio	10	Yogacara (唯識論)	
ouyi_3	1622	summer	3	ZL.8.2.1-8, autobio	9	received teachings	
ouyi_2	1622	late fall	4	autobio	4	engaged in meditation	
ouyi_6	1622		5	ZL 8.2.1	25	other	first met Xinyi Dazhen 新
ouyi_6	1623		6	選佛譜序	18	divination game	傳燈[選佛圖]隨喜
ouyi_4	1623	spring	7		25	other	謁幽溪傳燈 - pay respe
ouyi_4	1623	fall	8		4	engaged in meditation	

point_id	name	name_ch	province	xian	geo_src_file	cgis_sys_id	x	y	ouyi_copy_notes
ouyi_1	Mu Duzhen	木渚鎮	Jiangsu	Wuxian	v4_1911_twn_pts	138990	120.51	31.253	birthplace
ouyi_2	Jingshan; Qi	徑山	Zhejiang	Xinchang	NIMA	nma_1922389	119.8	30.25	part of Lin'an Xian 临安
ouyi_3	Yunqi si	雲棲寺	Zhejiang	Hangzhou	v4_1911_pref_pts	120998	120.168	30.294	part of Qiantang Xian 乾
ouyi_4	Tiantai shan	天台山	Zhejiang	Tiantai	v4_nima_mtns_pts	nima_31788	121.333	29.5	

**table of events with known dates & table of locations**



**checking and correction of possible locations**



**Addition of paths of movement between locations for each event**

The screenshot displays the TimeMap software interface. At the top left is the TimeMap logo with the tagline "time-based interactive mapping". To the right of the logo are navigation icons: zoom in (+), zoom out (-), pan (crosshair), and a pointer. Further right are icons for layers, copyright, and a clock. The text "Layer Opacity" is visible on the far right.

Below the logo, there are controls for "Startup extent" (a dropdown menu) and "Theme" (set to "unnamed"). A list of layers is shown on the left:

- ▶ Ouyi Moves
- ▶ Ouyi Trail
- ▶ Ouyi Points
- ▶ 1820 Provinces

The main map area shows a map of Europe with three cyan square markers and thick black lines connecting them, representing movement paths. The text "TimeMap v2.2.48" is in the bottom right corner of the map.

Below the map is a scale bar from 0 to 500 km. A "LOG" button is on the left. The text "Map Extent is bounds" is displayed in blue. On the right, it says "Zoom: 555 km".

At the bottom is the "timebar tool", which includes a "Y, E, A, R, S" label and a slider. A box labeled "timebar tool" has an arrow pointing to the slider.

**Animation of points for each event, and paths of movement**



[www.fas.harvard.edu/~chgis](http://www.fas.harvard.edu/~chgis)



photo: Heilongtan, Kunming, Yunnan