

# Chapter 11

## The HGIS Experience of Drawing Sub-county Unit Boundaries in the Jiangnan Region of Late Imperial China

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### 11.1 Introduction

During the late imperial period (1100–1911), the Chinese documented local information on almost every part of the imperial realm into generations of local gazetteers (difangzhi 地方志 or fangzhi 方志). “Local gazetteers are chronicles of the history, present conditions, and noted people of local areas, arranged by topic (Brook 1988: 49–72).” In addition to the detailed accounts of taxation and population records, local customs, governmental policies, biographies of native notables and local historical events, these gazetteers also include primitive maps of towns and other local landmarks. However, there are two obvious limitations to consulting these highly specialized sources when performing geographical and historical research. First, the primitive maps and diagrams of these gazetteers provide insufficient coordination for modern cartography, and give few hints related to spatial analysis (Fig. 11.1). In other words, it would not be worthwhile to handle them directly as secondary sources to be converted into Geographical Information System (GIS) raster data by computer scanning. Second, although much of the information provided by the gazetteers is extremely precise in spatial terms, without a reliable unit platform for sub-county divisions and landscape structures, they can only be analyzed verbally at the county (xian 縣), prefectural (fu 府) and even provincial levels. It used to be almost impossible to conduct a meso-level analysis of the individual households and the county, i.e., the basic units of Chinese imperial control.

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Fig. 11.1 A typical abstract map of traditional Chinese local gazetteers

In preparing the “Geographical Information System Database of Cotton Textile Industry of the Greater Songjiang Region from the Late Ming to the Mid-Qing (<http://www.iseis.cuhk.edu.hk/songjiang/>),” we used high scale digital maps of modern Shanghai as our base maps and GIS technologies to partially overcome the aforementioned shortcomings of the local gazetteers. We transformed the verbal information and primitive maps of these traditional sources into agreeable forms of modern cartography that were ready for spatial analysis.

In short, after plotting the exact locations of hundreds of towns, temples, rivers and other landmarks, we were then able to draw the boundaries of sub-county units or townships (*du* 都 or *bao* 保) beneath the county or prefectural levels. In many Jiangnan counties, these units nearly went unchanged during the 600 years of Ming-Qing rule, and thus they provide a perfect platform for conducting a meso-spatial analysis that would be far more precise than that restricted at the original county or prefectural levels.

In this study, the structure and characteristics of the Chinese local gazetteers are first introduced and practical hints are offered on how information related to the building of GIS is derived from the various categories of these specialized historical sources. This is followed by a step-by-step demonstration of our experiences in building a historical GIS for the Ming-Qing Songjiang region (modern Shanghai). The study concludes with a discussion on the use of sub-county polygons in historical and geographical research.

## 11.2 Traditional Chinese Local Gazetteers

No fewer than 8,000 sets of local gazetteers compiled prior to the People's Republic of China (1949) still exist today, and various levels of modern China's local governments continue the tradition by establishing local history offices to compile current gazetteers. They are by far the largest component of the history category (shibu 史部) of works in traditional Chinese bibliographies, and thus offer an indispensable collection of sources for spatial analyses of various parts of China, past and present, that are not found elsewhere.

Since the beginning of the Qing period (1644–1911), to avoid the restrictions imposed by the Manchu government on compiling general political histories of the Ming and earlier periods, some experienced historians shifted their concerns and participated in the compilation of these local histories. Among these historians was Zhang Xuecheng 章學誠 (1738–1801), who first suggested that a standard format of local gazetteers based on the many earlier works of its kind should be established for all future compilation projects to guarantee the quality of local history records all over the Qing realm (Fang 2011: 190–196). In other words, learning the ideas and characteristics of the standard format is the key to understanding the characteristics and therefore the use of the great literature of China's local gazetteers.

Zhang's structure includes up to 25 local gazetteer content categories, each of which can be further divided into some chapters (Wilkinson 2000: 154–158). All local gazetteers open with (1) the front matter, i.e., some prefaces and the general rules (fanli 凡例) of the compilers. The background and editorial concerns of the work are explained in this section. The front matter is followed by (2) the maps of the locality (yutu 輿圖), including the maps and diagrams of the county's boundaries, its water and irrigation systems, its towns and military garrison points, its tourist scenes, the city plan of the county capital and other important towns and so on. Various types of geographical information related to the county are then provided, sometimes in the form of map commentaries. These include (3) the county's transforming borders (jiangyu 疆域) and changing administration units (perhaps in table form) (yan'ge 沿革); (4) topographical features such as rivers and mountains (shanchuan 山川); (5) famous scenes (mingsheng 名勝), gardens (yuanlin 園林) and ruins (guji 古蹟); (6) official buildings (gongshu 公署), city walls and moats (chengchi 城池) and public works (jianzhi 建置); (7) passes, fords and bridges (guanjin qiaoliang 關津橋樑); and (8) water conservancy (hefang 河防), canals and rivers, hydraulics (hequ 河渠) and irrigation works (shuili 水利). The information provided by these sections is directly relevant to the respective study topics on the locality. Moreover, gazetteers usually supply the exact directions and distance counts in steps (bu 步, equivalent to a meter) of landmarks measured from the gates of the county capital or the front door of the magistrate hall, thus presenting some accurate coordination of the county's geographical features.

The information on county landmarks is followed by local history categories, including (9) a chronicle of natural and human disasters or omens (zaiyi 災異, xiangyi 祥異 or bing 兵) such as floods, droughts, hail, snow, locusts, uprisings,

civil wars, high prices and other strange events. The educational and religious institutions of the locality are then presented, including (10) academics (private Confucian institutes or shuyuan 書院), (11) government schools (xuexiao 學校) and (12) Buddhist and Daoist temples (siguan 寺觀). In many cases, the exact coordinates of these schools and temples are included alongside other historical details.

Institutional information about the county is then offered, including information on its (13) officeholders or official posts (zhiguan 職官), (14) examinations and lists of successful candidates (xuangu 選舉) and (15) military institutions and men. These are followed by practical information categories such as (16) fiscal information related to household and head counts (hukou 戶口), land and other taxes (fushui 賦稅, tianfu 田賦); (17) granary reserves (cangchu 倉儲); (18) market towns, tolls and barriers (shizhen 市鎮) (in some gazetteers, the nature and specialties of these towns are mentioned along with their exact coordinates relative to the county capital); (19) products, produce and crops (wuchan 物產); and (20) customs and festivals (fengsu 風俗), including detailed accounts of the county's local cults and religious practices.

After these general institutional information categories, various types of notable native biographies are presented, including (21) biographies of upright officials, dignitaries and chaste women and (22) biographies of technicians such as doctors (fangji 方技) and Buddhist and Daoist monks (shilao 釋老).

The end of a local gazetteer sometimes includes up to three additional categories including (23) inscriptions and tombs (jinshi 金石), (24) bibliographies and selected excerpts of good essays from native writers (yimen 藝文) and (25) miscellaneous topics and records (zalu 雜錄), a section in which strange stories about ghosts and animals are occasionally recorded. These stories are very helpful for biographical research, as they may contain information about local figures not found elsewhere.

### 11.3 Historical GIS for the Songjiang Region During the Ming-Qing Periods

During the Ming and Qing periods (1368–1911), the region of Songjiang 松江 prefecture (which was established around 1277 during the Yuan period) and some adjacent counties, namely, Jiading 嘉定, Kunshan 崑山 and the Taicang 太倉 sub-prefecture of the Suzhou 蘇州 prefecture, as well as Jiashan 嘉善 and Pinghu 平湖 of the Jiaxing 嘉興 prefecture (i.e. the Greater Songjiang region of our HGIS), was the center of the Chinese cotton textile industry. In modern times, the Songjiang prefecture and Jiading county are incorporated into Shanghai Municipality (So and Tam 2011). From 1500–1800, it was one of the most densely populated areas in the world, with intervals appearing only during the catastrophic Ming-Qing transition (So and Tam 2011: 45–54). The local gazetteer of Songjiang prefecture published during Chongzhen's reign (1628–1644) at the end of the Ming Dynasty states that Su-Song-Jia-Hu (i.e., the four prefectures of Suzhou, Songjiang, Jiaxing and Huzhou 湖州) were “the most prominent prefectures in Southeast

China.” In fact, the cotton-producing Songjiang, together with the nearby silk-textile center of Suzhou, constituted the core of the booming Jiangnan market economy in the late Ming and high Qing periods.

Chinese historical geography once applied only a qualitative method when reconstructing a historical horizontal cross-section to examine related sectional issues (So and Tam 2012). This method is inadequate in analyzing transitions via synchronic and diachronic comparisons (Li 2000). The increasing application of GISs in recent decades has had an impressive effect on the approaches of historical geographers, as it is now possible to analyze the spatial changes of geography over time using a computer (Zhang 2006). The combination of GISs and historical geography (i.e., historical GISs) has become an increasingly attractive research direction. Several historical GISs were prepared recently to provide a good deal of historical geography information (Lin et al. 2006). For example, Harvard University and Fudan University co-developed a Chinese historical GIS to establish a database of populated places and historical administrative units over the course of Chinese history from 222 B.C. to 1911. Moreover, the “Chinese civilization in time and space” set up by the Academia Sinica of Taiwan constructed a GIS application infrastructure for China across a timeframe of several thousand years (Zhang et al. 2007). These are important attempts to establish China’s historical GISs at the national level. However, because they were created by scanning the secondary source of the Chinese historical maps prepared by Tan Qixiang 譚其驤 (originally done from base maps with 1:4,000,000 scales; Tan 1980) and provide only prefecture boundaries (Fig. 11.2), they can only create polygons at the prefectural level.

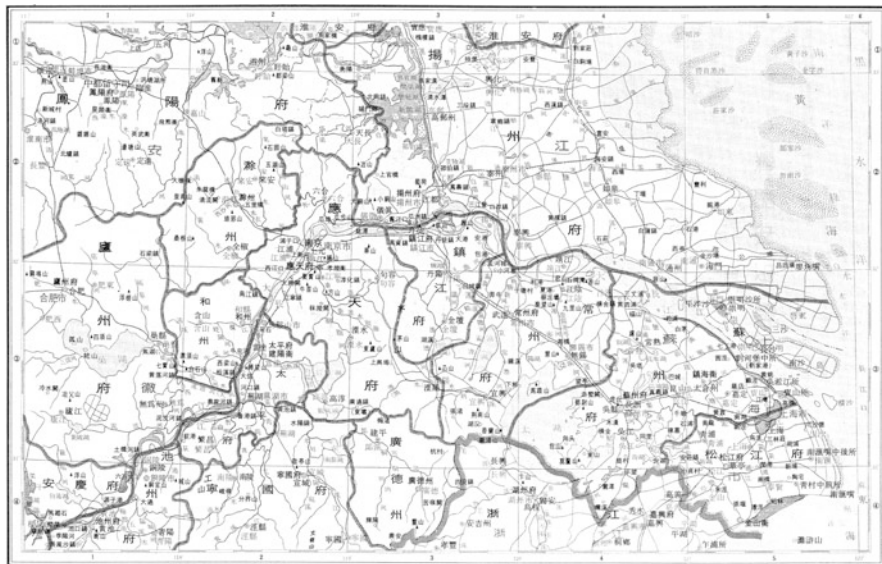


Fig. 11.2 A sample of the historical maps prepared by Tan Qixiang

Against this background, we designed our Hong Kong-based “Geographical Information System Database of Cotton Textile Industry of the Greater Songjiang Region from the Late Ming to the Mid Qing” as a GIS platform that uses quantitative and spatial methods to analyze the successful experiences of this cotton-textile production region over the last few centuries. To facilitate a precise intra-regional analysis within the Greater Songjiang region, this historical GIS identifies town and city locations and then draws the sub-county division boundaries (i.e., *bao* or *du*) in reference to the location data of temples and schools, trade routes, topology and so on. This is all executed according to information derived from the different categories of several generations of local gazetteers from the Greater Songjiang region.

To build a meaningful GIS that is appropriate for spatial analysis, it is critical to create spatial units at the highest resolutions possible so that the advantages of the computer system’s calculation and display can be fully exploited. In a GIS, maps are normally converted into raster data by scanning (Gregory and Ell 2007: 43). We are well aware of the limitations in using Tan Qixiang’s historical maps. Therefore, our first step was to lay our foundation on a modern Shanghai area map at a much higher resolution. We selected the digital version of the 1:150,000 map of Shanghai Municipality circa 1999 prepared by the Shanghai Institute of Surveying and Cartography ([www.shsmi.cn](http://www.shsmi.cn)) as our base map, with reference to historical maps collected from the *Shanghai lishi dituji* 上海歷史地圖集 (1999) and modern maps of nearby counties with scales of about 1:200,000.

Because the target of our research is a relatively small region the size of one or two prefectures (comprising seven to nine counties), drawing the administrative unit boundaries small enough to suit our meso-level research purpose required drawing the township boundaries, i.e. the *bao* of the Songjiang prefecture and the *du* of other counties in the Jiangnan region. The role of these micro divisions in traditional Chinese administrative systems can be considered as follows. Under a prefecture, there are counties; under the counties, there are *xiang* 鄉 units and under the *xiang* units are the *bao* or *du*. From the early Ming Dynasty to the Republican period, a varied number of taxation and administrative units of 110 households, i.e., *tu* 圖 or *li* 里, were assigned to each *bao* or *du*. In the traditional Chinese administrative systems, the townships were the principal units by which a county magistrate organized tax administration and were usually identified by a numbering system. The Ming Dynasty Founding Emperor Zhu Yuanzhang 朱元璋 (1368–1398) saw the townships in some regions as suitable units for setting up community granaries. He also ordered every unit to construct altars for conducting state-cult sacrifices. These units were also used to coordinate water control (Brook 2005). Although many new counties in the region were created over the course of the Ming-Qing periods by re-organizing the original county borders, the basic *bao* and *du* units remained basically unchanged until the end of the Qing Dynasty. As we used very similar measures to deal with the region’s distinct parts, we now take the Songjiang prefecture as an example to explain our methods and procedures for drawing the sub-county unit boundaries.

Indeed, from the early Ming to the late Qing periods, generations of local gazetteers from the Songjiang prefecture, or the Songjiang fuji 松江府志 ([Chongzhen] Songjiang fuji (崇禎) 松江府志 1991; [Jiaqing] Songjiang fuji (嘉慶) 松江府志 1991; [Kangxi] Songjiang fuji (康熙) 松江府志 and [Zhengde] Songjiang fuji (正德) 松江府志 1990), all recorded information about market towns in category (18) (i.e., market towns) along with their locations in each *bao* unit, their coordinates relative to the county seat and their commerce and industry specialties. When grouping the towns of each *bao* together, it is clear that usually more than one town falls into the area of each division. In total, more than 160 towns with clear *bao* identities appear in different versions of the Songjiang prefecture's local gazetteers. In short, these market town points should be located within the boundaries of the relevant *bao* so that if the points of the towns in each division are plotted on our high resolution base map it would be possible to draft the rough borders of the *bao* that encircles those points.

The plotting of the Ming-Qing towns onto the base map began by discovering the modern residential points of towns with the same or very similar names. We also tried to compare the modern location of the towns against their locations on the Ming, Qing and high resolution Republican historical maps of the *Shanghai lishi ditu*. If any differences in location were found, we plotted both places, but tried to follow the earlier-period maps to mark the boundaries of the *bao*. In the due course of searching for the Ming-Qing town locations, we realized that some of them no longer exist in modern times, and we could only plot them with reference to the coordinates given by the local gazetteers and the aforementioned historical maps. The "Market Town" chapter of the *Songjiang fuji*, therefore, provides the coordinates of towns in the form of their relative directions and distances measured in Chinese li 里, equal to 460 m. After putting those towns on the base map, we then cross-checked their locations with the coordinate data by using the ArcGIS software measurement function. It is crucial to point out that our plotted points generally agreed with the coordination data of the local gazetteers.

The next procedure involved drawing the *bao* boundary lines around the market town points. In the GIS field, it is desirable to convert point data to polygons using the Thessian polygon (also known as the Voronoi polygon) method. These polygons are created from a point layer by drawing boundaries that separate each point from its neighbors. The boundaries are located such that they are equidistant to the two points. Each polygon theoretically contains only one point. This method makes it possible to recreate boundaries that have never been mapped according to modern standards, such as the township boundaries of the Songjiang region. Its limitation, however, is very obvious: the polygons are triangulated into a triangulated irregular network. In his attempt to recreate the 1971 and 1981 English and Welsh Enumeration District units, Walford (2005) found Thessian polygons unsatisfactory due to their unnatural appearance, and that they were not suitable for spatial analysis due to their inaccuracy. He used the Thessian polygons only when no other hybrid approaches were appropriate (Gregory and Ell 2007: 68–70).

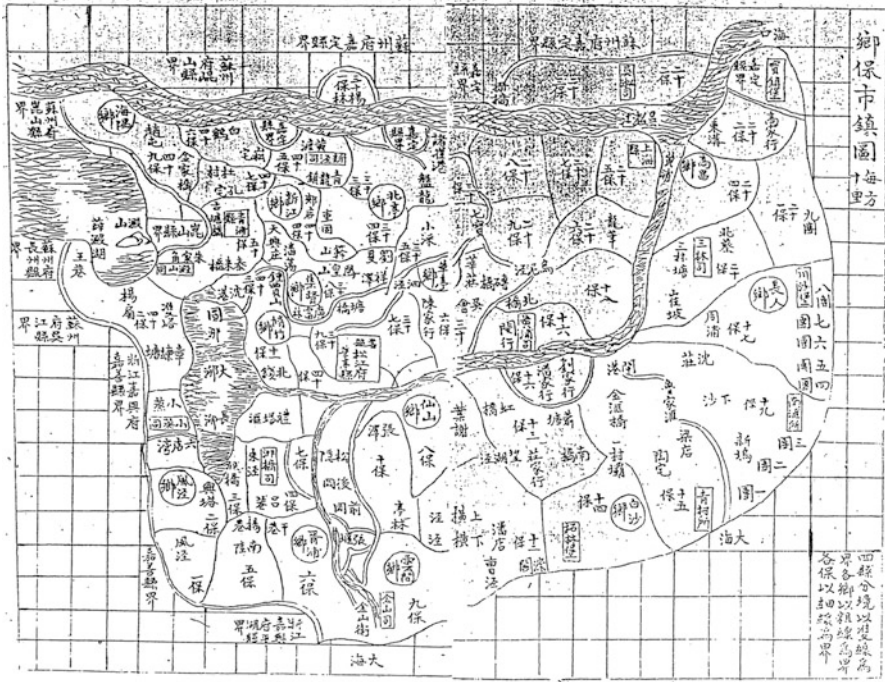


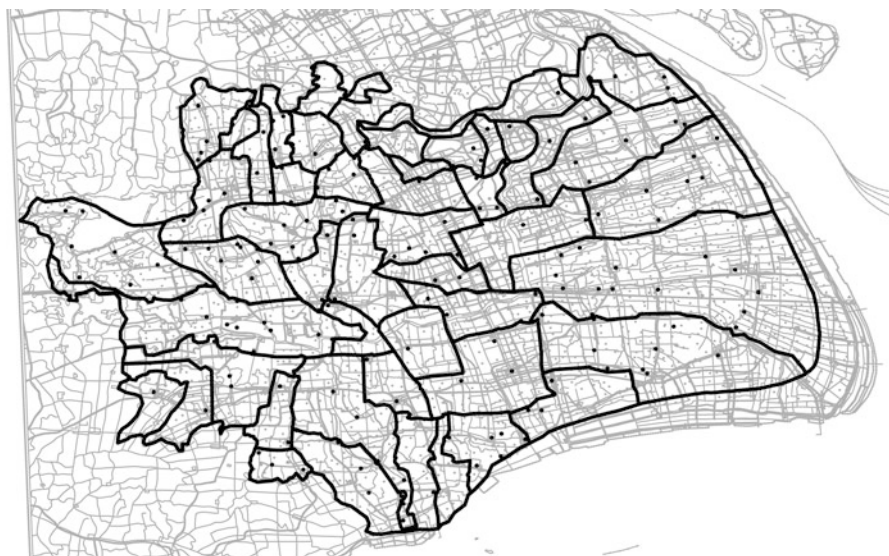
Fig. 11.3 The map of sub-county divisions and market towns of the Songjiang fuji

Nevertheless, there was more than one accurate town location alongside the other topological points and township boundary information in each of the *bao* units. As such, we abandoned the Thessian polygons and opted for recreating these boundaries according to our own method, which relied heavily on the information provided by the local gazetteers.

The abstract maps of the “Xiangbao shizhen tu 鄉保市鎮圖 (map of sub-county divisions and market towns)” found in category (2) of maps and diagrams of the *Songjiang fuji* published in the Jiaping reign (1792–1820) in the mid-Qing period) were our main references for determining the basic shape of the *bao* polygons (Fig. 11.3). However, because this map was not drawn according to modern cartography standards, further evidence was required to modify the drafted boundaries of the *bao*. Three more steps were therefore necessary to produce polygons that met our expectations.

First, we believe that when the *bao* was created, there were solid reasons for drawing their boundaries, and the best grounds for division were undoubtedly natural landmarks such as rivers and hills. Therefore, roughly following the shapes of the *bao* as shown in the local gazetteer maps, we moved their borders to nearby topological features shown on the base maps. Second, we modified the boundaries by consulting the waters displayed in the high resolution *Shanghai lishi dituji* maps and contemporary satellite photos of the Shanghai region.





**Fig. 11.4** The *bao* divisions of the Songjiang prefecture (The points representing the towns of the Songjiang prefecture)

Last but not least, we used hundreds of temple points to boost the accuracy of the *bao* boundaries. In category (12) Buddhist and Daoist temples of different generations of the *Songjiang fuji*, the coordinates and *bao* identities of about 500 temples of different religions are given in detail. We applied the same principles behind encircling the town points to drawing the *bao* boundaries to address the temples. Thus, we created about 50 polygons for the Songjiang prefecture sub-county division on a base of over 650 points (Fig. 11.4).

One possible contribution of this sub-county division boundary drawing, which is the first and only drawing of its kind in the Chinese history field, to historical geography is that the infrastructure of these accurately drawn polygons are measurable in the ArcGIS system. It is because the sizes of the respective areas are measurable, we could now calculate and display the population density and taxation levels of each micro-division when the relevant population and fiscal figures were taken from category (16) (i.e., fiscal matters) of the local gazetteers.

The local gazetteers of the Songjiang region do not directly give the population figure of each *bao*. Instead, they provide the *li* or ding 丁 (taxable male) figures of all of the townships. These figures were originally assigned according to the actual population of the *bao* in the early Ming and early Qing periods, respectively. We may estimate that they represent the approximate percentages of each township against the total of the Songjiang prefecture. Amongst the versions of the *Songjiang fuji*, the most comprehensive figures of the *li* and *ding* are given in the fiscal matters category of the early Qing version, which was compiled during Kangxi's reign (1677–1722). Table 11.1 shows the number of *li* and *ding* of each *bao* and their population percentages (4 sig. fig.) against the total of the Songjiang prefecture.

**Table 11.1** The number of *li* and *ding* of each *bao* and their population percentages against the total of the Songjiang prefecture

<i>Bao</i>	Number of <i>li</i>	Percentage (%)	Number of <i>ding</i>	Percentage (%)
1	26	1.935	4,041	1.942
2	12	0.893	1,167	0.561
3	29	2.158	3,987	1.916
4	32	2.381	2,838	1.364
5	25	1.860	2,423	1.164
6	22	1.637	3,092	1.486
7	41	3.051	5,191	2.494
8	22	1.637	2,785	1.338
9	14	1.042	2,087	1.003
10	15	1.116	2,557	1.229
11	15	1.116	2,553	1.227
12	30	2.232	5,268	2.531
13	38	2.827	5,961	2.864
14	41	3.051	6,656	3.198
15	63	4.688	10,747	5.164
16	30	2.232	4,633	2.226
17	34	2.530	10,196	4.899
18	43	3.199	5,323	2.558
19	89	6.622	19,325	9.285
20	27	2.009	6,360	3.056
21	25	1.860	4,874	2.342
22	43	3.199	7,952	3.821
23	15	1.116	2,714	1.304
24	41	3.051	6,506	3.126
25	12	0.893	1,137	0.546
26	14	1.042	2,853	1.371
27	11	0.819	1,907	0.916
28	17	1.265	3,428	1.647
29	6	0.446	2,026	0.973
30	11	0.819	2,423	1.164
31	8	0.595	647	0.311
33	7	0.521	503	0.242
34	12	0.893	1,057	0.508
35	32	2.381	4,697	2.257
36	53	3.944	6,453	3.100
37	31	2.307	2,867	1.378
38	47	3.497	5,837	2.804
39	20	1.488	2,184	1.049
40	25	1.860	3,000	1.441
41	68	5.060	10,872	5.224
42	47	3.497	7,516	3.611

(continued)

**Table 11.1** (continued)

<i>Bao</i>	Number of <i>li</i>	Percentage (%)	Number of <i>ding</i>	Percentage (%)
<b>43</b>	50	3.720	9,059	4.353
<b>44</b>	4	0.298	374	0.180
<b>45</b>	23	1.711	1,198	0.576
<b>46</b>	14	1.042	1,840	0.884
<b>47</b>	11	0.819	737	0.354
<b>49</b>	19	1.414	2,429	1.167
<b>50</b>	30	2.232	3,854	1.852
<b>Total</b>	<b>1,344</b>	<b>100</b>	<b>208,134</b>	<b>100</b>

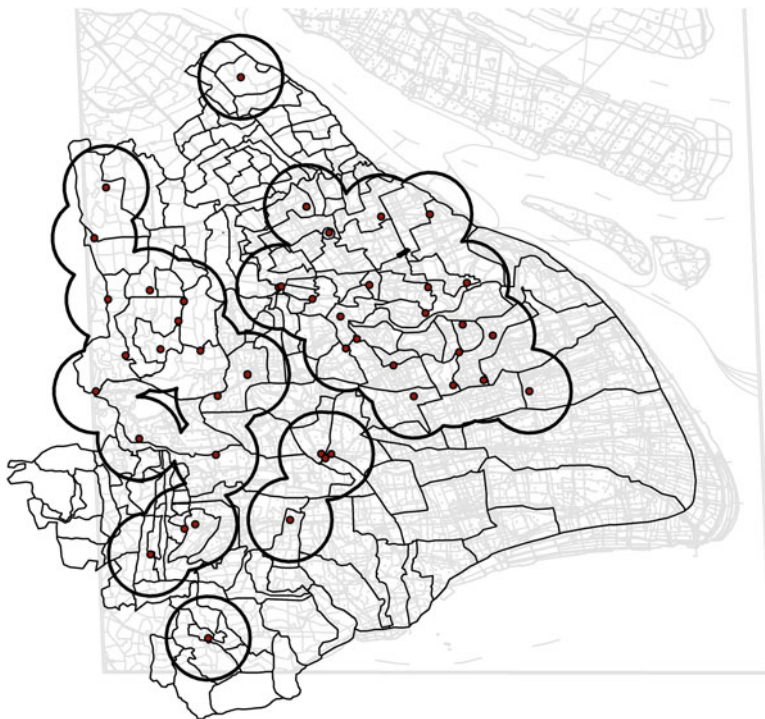


**Fig. 11.5** A demonstration of the display of population density in our HGIS (The darker color representing higher population density of the sub-county units)

Applying this list of population percentages to the township polygon infrastructure allowed us to calculate the population figures of each *bao*, and therefore enquire into the population density and taxation issues of these micro-divisions (Fig. 11.5).

### 11.4 Concluding Remarks: Potential of Sub-county Units in Historical and Geographical Research

The aforementioned methods of drawing the *bao* boundaries of the Songjiang prefecture circa the Ming-Qing periods are only a few of the ways in which the verbal and qualitative information collected by traditional local gazetteers has been



**Fig. 11.6** The 8 km buffer zone of the cotton cloth textile towns of the Greater Songjiang region during the Ming period (The points of the circle centers representing the cotton cloth textile towns)

transformed into electronic displays and quantitative data in a modern HGIS (Tam 2012). In theory, because the methods used to recreate the Songjiang region's township boundaries can be applied to every part of China when relevant local gazetteers are available, it is possible to build a GIS infrastructure for China's historical geography at a much higher resolution than the prefectural level presently used by most of the country's HGISs. Moreover, the nature of each local gazetteer category should be carefully explored to generate ideas and methods for possible new GIS applications. It is also important to be aware that some GIS applications are more related to the data collected from certain local gazetteer categories.

For example, because the mode of cotton cloth production in the Songjiang region involved weaving performed by households residing in the villages surrounding the cotton towns, it was sensible to use the "buffer area" function of the GIS to create zones around the relevant towns so that the actual area of cotton cloth production could be identified (Fig. 11.6). To recognize the cotton towns, we consulted category (18) (i.e., market towns) of the local gazetteers in which the nature and specialties of these towns are mentioned. However, we then faced the question of how long the length of the buffer zone area's radius should be. As a

general rule, the answers to similar economic and social questions are usually found in the last two categories of the gazetteers, namely, (19) products, produces and crops (wuchan 物產) and (20) customs and festivals (fengsu 風俗). In fact, the “fengsu” chapter of the late Qing version of the Jiading xianji 嘉定縣志 states that when carrying goods to trade in market towns, the villagers of the county shall not travel farther than 40 *li* so that they may return home within the same day (1991: 158b). In other words, a single trip should not exceed 20 *li* or 9.2 km, and thus it was safe to assume that the cotton-cloth-production buffer zone radius should be about 8–9 km. On the basis of the township unit boundaries, for instance, we could easily locate the *bao* in which cotton cloth production were concentrated in each stage of the Ming–Qing period, and cross-check whether their taxation responsibilities were changed accordingly.

Not all local gazetteers are compiled with all of the essential information prescribed in the perfect structure introduced by the Qing scholar Zhang Xuecheng. However, by incorporating the various kinds of available materials collected by these geographical sources into the historical GIS, we could create a much firmer ground on which to conduct multidisciplinary studies that combine socioeconomic history, local history, GISs, regional analysis and other social science methods to generate a new understanding of and new research strategies for the economic development of China’s regions, past and present.

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