Using LoGart to Uncover a New Spatiality of Science in China

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Abstract: LoGart, and especially its image search function Page with Image (PWI), allows for the use of local gazetteers to trace the development of new institutions and spaces for science in China in a geographically more diverse assortment of places than historians of science have hitherto examined. This essay looks at how results obtained by using LoGart help to map out a new spatiality of science in modern China.

The late nineteenth and early twentieth century was a period of tremendous turmoil in Chinese history, one that saw the collapse of the Qing dynasty (1644–1911) and the political splintering of the empire. At the same time, this political instability was accompanied by an intellectual openness to new ideas and practices from outside China. New names were given to these imported disciplines—chemistry (*huaxue* 化學), physics (*wuli* 物理), geology (*dizhi* 地質)—alongside the old designations of geography (*dili* 地理) and agricultural studies (*nongxue* 農學), now frequently used with "new" appended to indicate their scientific bona fides.[1] Works on "new" geography employed empirical study and statistical methods, in contrast to the kind of historical geography that literati with allegedly stultifying classical training had engaged in in previous eras. Localities acted with alacrity to open schools that taught science and attached agricultural experiment grounds. Yet, on closer examination, one can't help but notice the superficialities of these designations of newness. At the heart of the discussion is the issue of semantics—and the varying gray areas between classical Chinese, neologisms from Japan, and the various translations of ideas, from international law to the language of science, that so occupied missionaries, Chinese translators, and pioneering Chinese scientists alike in the late nineteenth and early twentieth

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[1] James Reardon-Anderson, "Chemical Industry in China, 1860–1949," *Osiris*, 1986, N.S., 2:177–224; Laurence Schneider, *Biology and Revolution in Twentieth-Century China* (Lanham, Md.: Rowman & Littlefield, 2003); Grace Yen Shen, *Unearthing the Nation: Modern Geology and Nationalism in Republican China* (Chicago: Univ. Chicago Press, 2014); Iwo Amelung, "Naming Physics: The Strife to Delineate a Field of Modern Science in Late Imperial China," in *Mapping Meanings: The Field of New Learning in Late Qing China*, ed. Michael Lackner and Natascha Vittinghoff (Leiden: Brill Academic, 2004), pp. 381–422; and Fa-ti Fan, "Redrawing the Map: Science in Twentieth-Century China," *Isis*, 2007, 98:524–538.

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century. LoGaRT allows us to map out how both linguistic change and institutional spaces for science spread throughout China by tracing their appearance in local gazetteers.

In the Republican period (1912–1949), geography, with a long and time-honored tradition as a field of study in China, splintered in several directions. Geologists dominated the subdisciplines of physical geography, which emphasized fieldwork and empirically based analysis. Under the heading of New Geography, advocates promoted geography as a science and advocated for its inclusion at the Academia Sinica, the national academy of sciences founded in 1928. Most members of this group actively distanced themselves from the humanistic tradition that dominated geographical study of the imperial period. This tradition included scholarship in *yange dili* 沿革地理, a term that loosely translates to "historical geography," which traces the evolution of place-names through the careful examination of historical records using local gazetteers. Yet despite the prominent advocacy of New Geography and calls to break with tradition in the Republican period, neither *yange dili* nor local gazetteers disappeared. In fact, both continued to flourish. Designations of "new" often belied the incorporation of older epistemologies.

In my initial use of the PWI function in LoGaRT, I focused on amassing and quickly scanning large numbers of images. By limiting my search to the late Qing and Republican periods, from roughly the mid-nineteenth century to 1949, I narrowed my search to within the ten-thousand-image limit of most of LoGaRT's GIS and statistical functions. Using the search functions does not preclude the need for the sort of visual analysis that most of us instinctually do when we see an image but that is still very difficult for computers and AI to replicate. Search tools require specificity, but narrowly defined searches of select keywords could overlook significant changes in the content and form of gazetteer maps. Quick scanning of these ten thousand maps showed the widespread adoption of new institutional forms of science and, in some instances, led me to further discussions in the text of schools and experimental fields.

A few examples of maps in local gazetteers demonstrate the flexibility of existing categories within the genre to adapt to new knowledge. The largest category of *tu* in local gazetteers falls under the umbrella term "maps" and usually appears either before the preface or in the geography section. The *Gansu Comprehensive Provincial Gazetteer* (*Gansu xin tong zhi* 甘肅新通志), which was updated in the late Qing, opened with a special *tu* section that included maps displaying the mineral resources in the province and marked with topographical lines. While maps were traditionally part of the *tu* component of local gazetteers, the geological and topographical content was new.[2] Other *tu* in the gazetteer illustrated a railway bridge. A few decades later, the *Tonghua County Gazetteer* (*Tonghua xianzhi* 通化縣志) from Jilin (1927) also featured a geological map, drawn and signed by a local high school student.[3] These examples from the late Qing and Republican periods show some of the ways that the category of maps in local gazetteers was modified to accommodate new content. These results would not have come to light without LoGaRT's PWI function, which pulled out images from thousands of gazetteers from across the country.

This initial broad sweep provided the foundation for more targeted work in the second stage of my research. I next turned to look at the term for a geographically delimited area known as the agricultural experiment station. *Shiyan* 試驗, the classical Chinese term for experiment, was already used in the Song dynasty (960–1279). A page text search for the term *shiyan* in LoGaRT shows two hits in the Song dynasty, two in the Yuan dynasty, 24 in the Ming, 205 in the Qing, and 1,567 in the Republican period in the twentieth century. By the late nineteenth century, however, the meaning of the term had changed considerably from its earlier usage, a transformation

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[2] LoGaRT shows the date of the gazetteer as 1875; but in fact, according to the preface, it was updated around the turn of the century. *Gansu xin tong zhi* 甘肅新通志, ed. An Weijun 安維峻 (1909), *tukao* 圖考.

[3] *Tonghua xian (Liaoning) zhi* 通化縣(遼寧)志, ed. Li Zhenhua 李鎮華 (1927), 1.115a.

that took place via Meiji-era Japan (1868–1889), which became a clearinghouse for the mixture of old and new, East and West.

Although the Tokugawa shogunate enacted the isolationist policy called *sakoku* in the seventeenth century, it continued to allow extensive trade with China through the port of Nagasaki on the western coast and with Europeans via the Dutch East India Company on the small island of Dejima. Western knowledge arrived through exchanges between those Europeans employed by the Dutch and a few interested Japanese scholars. This scientific, technical, and medical knowledge became known as *Rangaku* ("Dutch learning").[4] The first use of the term "experiment" 試驗 (Jp. *shiken*) in Japan appeared in the 1847 *Rangaku* work *Introduction to Chemistry* (*Seimi kaiso* 舎密開宗), by Udagawan Yōan (1798–1846). This work contained illustrations of various experiments, including a description of an electric battery.

Within a few decades, Japanese scholars coined a neologism, *shiyanchang* 試驗場 or 実験所 (Jp. shikenjō), by adding the locational character to create a new term for a laboratory or experimental zone.[5] Agriculture had long been an important part of statecraft in premodern China, which paved the way, as Peter Lavelle's essay in this Focus section shows, for agricultural science to grow rapidly from the late nineteenth century. With the dissemination of the neologism *shiyanchang*, however, the agricultural experiment station became a spatially distinct location for the cultivation of science.

The neologism *shiyanchang* 試驗場 circulated back to China from Japan, a route also taken by the neologisms for science, *kexue* 科學, and the concepts of public health and hygiene, or *weisheng* 衛生.[6] In the harsh climate of the remote corner between Korea and China, the first Meiji-era Japanese colonization efforts included the opening of agricultural experiment stations. The establishment of these stations took place in the vanguard of colonial administration, and particularly in contested zones, as models of modernization. The historian Nianshen Song, in his study of the northeastern borderlands at the intersection of Qing, Korean, and Japanese interests, described an experiment station established in advance of the expanding Japanese empire.

> In 1907 the Kanto Branch bought about 19,800 square meters of dry land behind its office and established an experimental farm. . . . Researchers cultivated various grains, vegetables, fruits, and flowers to test their adaptation to local conditions and compared the quality of seeds from both Japan and Korea. They applied cutting-edge cultivation techniques, especially winter-proofing technology. The branch also rented a paddy field in Longjing to test-plant rice. Finally the branch actively promoted education and hygienic projects.[7]

Note the multiple ways that the experiment station embodied the spirit of scientific modernization at a time and place of intense geopolitical tension. Neither the location of the experiment

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[4] Yulia Frumer, *Making Time: Astronomical Time Management in Tokugawa Japan* (Chicago: Univ. Chicago Press, 2018), p. 117; Maki Fukuoka, *The Premise of Fidelity: Science, Visuality, and Representing the Real in Nineteenth-Century Japan* (Stanford, Calif.: Stanford Univ. Press, 2012); and Federico Marcon, *The Knowledge of Nature and the Nature of Knowledge in Early Modern Japan* (Chicago: Univ. Chicago Press, 2015).

[5] Federico Masini, *The Formation of Modern Chinese Lexicon and Its Evolution Toward a National Language: The Period from 1840 to 1898* (Project on Linguistic Analysis, Univ. California, 1993), p. 197.

[6] Benjamin Elman, *On Their Own Terms: Science in China, 1550–1900* (Cambridge, Mass.: Harvard Univ. Press, 2005), pp. 414–417; and Ruth Rogaski, *Hygienic Modernity: Meanings of Health and Disease in Treaty-Port China* (Berkeley: Univ. California Press, 2004), p. 19.

[7] Nianshen Song, *Making Borders in Modern East Asia: The Tumen River Demarcation, 1881–1919* (Cambridge: Cambridge Univ. Press, 2018), p. 151.

station nor the timing of its construction is coincidental. Japan's astonishing victory in the Russo-Japanese War in 1905 reverberated around the world, giving hope to non-Western countries that modernization could lead to triumph over European colonial powers. The victory also allowed Japan to supplant Russian influence in Northeast China. In 1910 Japan formally announced the inclusion of Korea as part of its colonial orbit. The region became a hotly contested hub for competing powers.

Even before the Japanese empire opened its agricultural experiment station in the Kanto area, localities in the Qing empire had begun to open similar agricultural experiment stations or zones, agreeing with the Qing court on their importance as a means to modernization. Both use of the neologism and actual experiment stations spread rapidly in China. The circulation and dispersion of the term is particularly visible in local gazetteers because the genre traditionally included information on agriculture and products specific to the administrative area. A text search for the term "experiment station" (*shiyanchang* 試驗場) in the combined Erudition database and the Harvard-Yenching Library collection turns up results in 255 local gazetteers from across China. Most of the results come from the Republican era, although the 1900s, the last decade of the Qing dynasty, also saw a spike in mentions of the experimental zone. Forty-one mentions in the late Qing period balloon to 631 hits in the Republican period. In almost all cases the term was used in the agricultural context.

In all the provinces and across the borderlands, the agricultural experiment station became a favored tool of the state—both the Qing and its successors—to bring about modernization and development. It also enjoyed support from across the political spectrum. For reformers and modernizers, the experiment station represented science and progress. As part of a traditional field of knowledge and an arena for statecraft, agricultural experiment stations won the backing of conservatives as well. Discussions of the *shiyanchang* (some variations include the forestry experiment station, *nonglin shiyanchang* 農林試驗場, or the agronomic experimental area, *nongye shiyanchang* 農業試驗場) appear in different sections of local gazetteers, but frequently in the sections on "Schools" (*xuetang* 學堂), "Practical Learning" (*shixue* 實學), or "Products" (*wuchan* 物產). The term "practical learning" comes from a Neo-Confucian concept that by the nineteenth century accommodated imported knowledge from the West, including science and technology.[8] The "Products" section typically listed endemic species and local specialties in manufacturing, agriculture, and minerals. In the twentieth century, agriculture increasingly became part of a broader discussion of the economy of the region, included alongside information on industries, mineral deposits, forestry, and other natural resources within the jurisdiction.

In combination, the PWI and text search options in LoGaRT provide a database displaying the quick and remarkably broad spread of agricultural experiment stations in the nineteenth and twentieth centuries. The PWI function by itself returns only ten hits, clearly an undercount of the number of times agricultural experiment stations appear in maps and other images. These ten pages include photographs from gazetteers in the late Republican period. The list of 672 textual mentions of *shiyanchang* provides a better idea of the broad adoption of this new institution in localities. Closer examinations of the 255 gazetteers with mentions of *shiyanchang* also led to maps and other images in these works that are relevant to the term but didn't show up in the PWI search. The combined image and text search results challenge existing narratives about the spread of science and the importance of treaty ports as the primary location for the translation and dissemination of science. Most of the results show up in conjunction with discussions

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[8] Limin Bai, "*Gewu Zhizhi* and Curriculum Building," in *Re-Envisioning Chinese Education*, ed. Guoping Zhao and Zongyi Deng (London: Routledge, 2015), pp. 55–73, https://doi.org/10.4324/9781315745435.

about the establishment of New Schools, institutions that taught science and applied technologies rather than focusing solely on the Classics. These schools taught skills like the manufacturing of fertilizer or botanical grafting techniques and opened in coastal as well as interior and borderland provinces. In combination with the creation of experimental zones, they reveal a new spatiality of science in modern China.

LoGaRT's search functions pull out information from local gazetteers compiled across the country and allow for a chronological organization of the results. The downside of this digital humanities innovation, however, is the lack of the larger context afforded by reading specific gazetteers as a single work. The following discussion is largely chronologically based and covers materials pulled from local gazetteers from geographically dispersed regions of the country. Of the returns from the text search results, the *Linggui County Gazetteer* (*Linggui xian zhi* 臨桂縣志, 1905), from Guangxi Province in the Southwest, has the earliest mention of *shiyanchang*, included in a detailed history of the provincial university.[9] The editor of the 1905 *Linggui County Gazetteer*, Wu Zhengao 吳征鼇, was born in Fujian and received his *Jinshi* degree (the highest degree attainable under the imperial civil examination system, after which successful candidates were awarded highly esteemed positions in the civil bureaucracy) in 1874; he was subsequently posted to Guangxi Province. The compiler of the gazetteer, Huang Mi 黃沁, taught at the local school.

The discussion of the agricultural experiment station in Linggui County is included in the section on schools. According to the discussion in the text, the Guangxi Higher School was first opened at a location outside the city gates in the provincial capital of Guilin and housed in an old machine shop. In 1900, the governor-general Huang Huaisen 黃槐森 memorialized the throne, asking to open a technical school. Three years later, the new governor-general renamed the school Guangxi University. The school recruited students from impoverished backgrounds to study agricultural sciences, including Practical Learning (*shixue* 實學) disciplines like chemistry, which had direct applications for the manufacturing of fertilizer. Local officials, working with the school, dispatched subordinates to Japan to investigate the purchase of new agricultural machinery, cutting out intermediaries in treaty port cities like Shanghai, Guangzhou, or Tianjin. The gazetteer does not reveal local officials' connections to Japan or how these representatives went about purchasing machinery in a foreign country. One possibility is the presence of home-place associations and existing networks of Guangxi students in Japan. There was also interest in training students in grafting and other botanical techniques. To supplement training at the school, an agricultural experiment station was opened on the public lands (*guandi* 官地) attached to the school. As with the founding of land-grant universities in the United States, the *Linggui County Gazetteer* reveals the close relationship between public institutions of higher learning and the development of agricultural science.[10]

The *Jiande County Gazetteer* (*Jiande xian zhi* 建德縣志, 1910), in Anhui Province, close to the eastern coastline, retained a traditional format seen in gazetteers from earlier periods.[11] The discussion on schools, for example, focused on Confucian learning. Yet among the illustrations of temples and administrative maps there is a clearly labeled *tu* of the agricultural experiment station (*shiyanchang*). It is the only late Qing gazetteer in the database searchable by LoGaRT to devote a stand-alone illustration to the layout of an agricultural experiment station, although textual descriptions in other gazetteers suggest very similar layouts in locations in other parts of the

[9] *Linggui xian (Guangxi) zhi* 臨桂縣(廣西)志, ed. Wu Zheng'ao 吳征鼇 and Huang Mi 黃泌 (1905), 14.644.

[10] Michele Myatt Quinn and Robert B. Fairbanks, *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865–1930* (Tuscaloosa: Univ. Alabama Press, 2015).

[11] *Jiande xian zhi* 建德縣志, ed. Zhou Xueming 周學銘 (1910), 112–113.

country. Both the editor and the compiler came from scholar-official backgrounds. Zhou Xuemin 周學銘 was the late Qing official Zhou Fu's 周馥 younger son, born in the area and tasked by his father with compiling the gazetteer. The Zhou family's involvement in the compilation of the local gazetteer is representative of the role that prominent families played in the forming of agricultural societies, educational reforms, and the establishment of new local government institutions in the crucial transitional Qing–Republican period in the late nineteenth and early twentieth century.

In the 1911 *Dongguan County Gazetteer* (*Dongguan xian zhi* 東莞縣志), the administrative section discusses how an agricultural experimental zone was opened outside the southern city gates in the Guangxu era (1875–1908) in the late Qing.[12] The discussion includes information about the amount of fertilizer used, the selection of the most productive seed varieties, and the opening of a Nanyang Society (South Sea Society) in the last years of the Qing dynasty to solicit aid from overseas Chinese. The mention of a Nanyang Society suggests one way that the locality connected to diasporic populations in Southeast Asia. This group, in turn, became a conduit for ideas and technologies from overseas. According to the *Panyu County Gazetteer* (*Panyu xian zhi* 番禺縣志) (1911), the local agricultural experimental station also housed meteorological equipment for observations of weather conditions.[13] The gazetteer provides a history of the zone that indicated that the first agricultural science teacher at the local school had studied in the United States. The gazetteer includes extensive excerpts from reports on the results of the agricultural experimental grounds, the types of seeds and planting methods used, and comparisons of manual versus machine planting of rice.

The *Zhangwu County Gazetteer* (*Zhangwu xian zhi* 彰武縣志), published in 1911, begins by noting that European and American countries all have statistical bureaus.[14] The gazetteer compilers presented their own work as the Chinese counterpart to the statistical bureau. Local officials tasked the agricultural experiment station in the county with the improvement of agricultural implements. Nor did such experiment stations limit themselves to land-based farming. A 1911 Jilin gazetteer discussed fish farming, along with a broad range of household industries. Especially in the politically precarious borderland regions, agricultural experimental zones served multiple purposes. In Fengtian Province in the Northeast, the establishment of agricultural experiment stations was a direct reaction against similar efforts by the Japanese empire. Southern China experienced encroachment from the French empire. The map of Dali, Yunnan, in the Southeast, from the 1917 *Dali County Gazetteer* (*Dali xian zhi gao* 大理縣誌稿), clearly indicates an area for a forestry and agricultural experimental zone.[15] Both the compiler and the editor of the gazetteer had participated in the Xinhai revolution that led to the toppling of the Qing dynasty. The compiler, Zhou Zonglin, also served as the principal of the Dali teacher's college. In the 1920 *Gaiping County Local Gazetteer* (*Gaiping xian xiang tu zhi* 蓋平縣鄉土志), in Liaoning Province, the city map does not contain an experimental zone but shows the location of the agricultural society within the city walls.[16] The farmlands used as experimental fields would have lain outside the walls.

As is apparent from the broader context and geographical spread of these agricultural experiment stations, they were part of a constellation of new government institutions that appeared across China in the wake of political turmoil and the resulting major governmental reforms.

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[12] *Dongguan xian zhi* 東莞縣志, ed. Huang Shipei 黃時沛 (1911), 6.186, 15.433.

[13] *(Minguo) xu pan Yu Xian zhi* (民國)續番禺縣志, ed. Ling Heshu 凌鶴書 (1911), 12.645–649.

[14] *(Xuantong) Zhangwu Xian zhi* 宣統彰武縣志, ed. Zhao Bingshen 趙炳燊 (1911), 29, 64.

[15] *(Minguo) Dali Xian zhi gao* (民國)大理縣志稿, ed. Zhou Zonglin 周宗麟 and Zhang Peijue 張培爵 (1917), end of *juan* 1.

[16] *Gaiping Xian xiang tu zhi* 蓋平縣鄉土志, ed. Cui Zhengfeng 崔正峰 and Guo Chunzao 郭春藻 (1920), 94.

Such experiment stations were sometimes associated with new areas of study such as geology and meteorology. Historically, local gazetteers often contained information about climate, local products, and records of natural disasters; from the late nineteenth century, they directly connected this information with newly imported sciences. The agricultural experimental zone's association with schools gives us a sense of how scientific disciplines made their way across China. Such experimental zones appeared to be part of a larger series of late Qing efforts to encourage innovations in manufacturing and education and administrative reforms, including the establishment of police stations, hospitals, factories, and schools.[17] These institutions often survived the collapse of the Qing empire and in many cases continued operation in the Republican period with the same personnel. For example, one of the leading advocates of reform, the late Qing official Zhang Zhidong, in addition to establishing a number of industries and mines in Hubei Province also opened schools catering to new technical training related to railroads, agriculture, commerce, medicine, and industry. These enterprises and new institutions continued in the Republican period and later show up in discussions in the provincial gazetteers.[18]

The appearance of images depicting agricultural experiment stations in the local gazetteer is an important indication of their inclusion with other essential local government institutions. In the *Changtu Prefectural Gazetteer* (*Chantu fu zhi* 昌圖府志), from Liaoning Province in the Northeast, the discussion of the local agricultural experimental grounds is placed in the context of innovations such as the hospital, police, and other new administrative units.[19] The 1910 *Collected Records from Changbai* (*Changbai hui zheng lu* 長白彙徵錄), from the strategically vital Jilin Province in the Northeast, placed the experimental zone as part of the defense of the borderlands and migrant efforts to reclaim wastelands.[20] In addition to the official effort, a private reclamation company was also involved. A 300-*Mu* (1 *Mu* = ~0.165 acres) plot of land was set aside as an agricultural experimental zone. The graduates of the agricultural school conducted agricultural trials using both native and foreign methods.

The *Huaide County Gazetteer* (*Huaide xian zhi* 懷德縣誌) (1929–1934) features photographs of the compiler and local officials, a color map of the area, and schematics of government offices, the police department, the library affiliated with the Bureau of Education, the elementary school, and the normal school for girls.[21] A map of the county seat shows the major points of interest in the town, including the post office, schools, and police stations, and the agricultural experiment station on the outskirts of town. The 1917 *Kaiyuan County Gazetteer* (*Kaiyuan xian zhi* 開原縣志) contains a topographical map of its administrative territories.[22] A small inset map indicates an agricultural experimental zone outside the city walls. The gazetteer provides considerable detail about the history of the agricultural experiment station (see Figure 1). Kaiyuan originally opened an agricultural society in 1911. A few years later, in 1915, the society set up the experimental plot. The gazetteer lists the budget for the experiment station alongside that for the postal service, schools, and other administrative costs. The structure for the experiment station was repurposed from an old temple. However, the new occupants considered the old temple rooms too narrow and inappropriate for its present purposes. In May 1917 the government

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[17] See Albert Feuerwerker's classic economic histories of the late Qing period: Albert Feuerwerker, *China's Early Industrialization: Sheng Hsuan-Huai (1844–1916) and Mandarin Enterprise* (Cambridge, Mass.: Harvard Univ. Press, 1958); and Feuerwerker, *Studies in the Economic History of Late Imperial China* (Ann Arbor: Univ. Michigan, Center for Chinese Studies, 1995).

[18] See, e.g., *Hubei tong zhi* 湖北通志, ed. Yang Chengxi 楊承禧 and Zhang Zhongxin 張仲炘 (1921–1934).

[19] *Xuantong Changtu Fu zhi* 宣統昌圖府志, ed. Hong Ruchong 洪汝冲 (1910), 2.45.

[20] *Changbai hui zheng lu: Yuan ming Zheng cun lu* 長白彙徵錄：原名 徵存錄, ed. Zhang Fengtai 張鳳台 and Wang Youli 王有立 (1910), 7.297.

[21] *Huaide Xian zhi* 懷德縣志, ed. Sun Yunzhang 孫雲章 (1934), front matter.

[22] *Kaiyuan Xian zhi* 開原縣志, ed. Zhao Jiagan 趙家幹 (1917), 1.14.

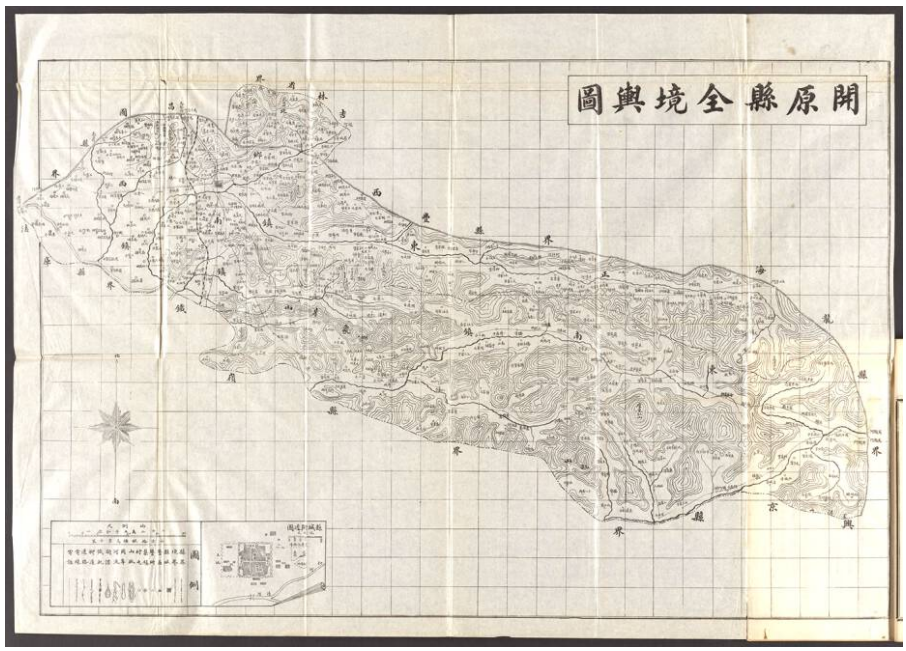

Figure 1. The 1917 *Kaiyuan County Gazetteer* 開原縣志 includes a topographical map of its administrative territories. From the late nineteenth century, gazetteer maps began to incorporate new types of knowledge, including geological and topographical information. A small inset map indicates an agricultural experimental zone outside the city walls. See *Kaiyuan Xian zhi*, ed. Zhao Jiagan, 6 *juan* (1917), after p. 11. Image from the open-access Harvard-Yenching Library online collection.

undertook the construction of a new brick building with five rooms, increasing available space for students.

The *Greater China Jilin Geography Gazetteer* (*Dazhonghua Jilin dili zhi* 大中華吉林地理志) from 1921 lists the experimental zone along with parks and zoos.[23] The *Hubei Provincial General Gazetteer* (*Hubei tong zhi* 湖北通志) explains that a forestry experimental zone was founded in 1901, along with a sericulture station. Wuchang City (present-day Wuhan), in Hubei, established an agricultural bureau in 1909, but the experiment station was founded earlier in an area outside the city walls. Taking up around 400 *Mu* of land, the station was intended as a place where students from the agricultural college could intern and receive practical training in veterinary and botanical studies. A second location, with over 700 *Mu*, was established a few years later.[24] The gazetteer also contains information on industries, including a textile factory, a silk workshop, and a hemp factory.

In the 1926 *Revised Nanchuan County Gazetteer* (*Chongxiu Nanchuan xian zhi* 重修南川縣志) the city maps have been replaced by photographs—of government buildings, the chamber of commerce, the police station, the department of education, and the entrance to the agricultural

[23] *Da Zhonghua Jilin di li zhi* 大中華吉林地理志, ed. Lin Chuanjia 林傳甲 (1921), 19.138.
[24] *Hubei tong zhi* 湖北通志 (cit. n. 18), 54.732–734.

experimental zone.[25] The 1931 *Tianjin Gazetteer* (*Tianjin zhi lue* 天津志略) doesn't discuss an agricultural experiment station but points to an aquatics products school. The principal of the school, Zhang Yuandi 張元第, was a thirty-four-year-old native of Tianjin. Zhang graduated from the Zhili provincial aquatics school in 1917 and went on to pursue graduate studies in the aquatic sciences in Nagasaki, Japan.[26] The 1935 *Zhangbei County Gazetteer* (*Zhangbei xian zhi* 張北縣志), from Zhangjiakou in Hebei Province, contained photographs of the front gate to the local agricultural experiment station.[27] A separate "Products" (*wuchan* 物產) section later in the gazetteer shows a floral display inside the station. One of the prefaces discusses the strategic importance of the region as the gateway to the Northwest. The gazetteer was produced at the height of the "Develop the Northwest" (*Kaifa xibei* 開發西北) movement in the 1930s, when growing nationalism led to various efforts to settle and reclaim "wastelands" on the frontier.

The political allegiance of the compilers of the *Zhangbei County Gazetteer* is made clear by the inclusion in its opening pages of photographs of the founding Nationalist Party leader Sun Yatsen and the contemporary Nationalist leader Chiang Kai-shek. In the gazetteer itself, the geography section traces the evolution of the jurisdictional territory in Hebei in the Northeast from ancient times to the present. The geography section includes a discussion of the topography and the mountain system in the region and various resources that could be found in the mountains, including valuable herbs and plants and mineral resources such as coal. The gazetteer also showcases photographs of women standing in front of Mongolian yurts to illustrate the ethnic minorities in the region, not unlike contemporary photo spreads in the American magazine *National Geographic*.

In the 1933 *Hunan Provincial Geographical Gazetteer* (*Hunan dili zhi* 湖南地理誌), agriculture is placed in the section on the economy, with specific discussions on local crops of rice, hemp, tea, cotton, and the tung oil tree (see Figure 2).[28] The provincial government oversaw experiment stations that carried out the testing of new ploughing methods and seed varieties. This research overlapped with similar efforts funded by the Rockefeller Foundation in North China from the 1920s. Clearly, agricultural science crossed national boundaries and the divide between state- and private or nongovernmental organization (NGO)–sponsored research. The textual discussions of agricultural experiment stations and zones, along with maps, schematics of buildings, charts, and statistical analyses of research, included in multiple gazetteers from across the country indicate overlapping networks that crossed from the late imperial scholar-officials and revolutionaries to Republican-era reformers and merchants; geographically, these changes took place across China, from Liaoning and Ningxia to Guangdong and Guangxi. They also indicate some potential areas for further research to connect agricultural science to global networks of science.

Gazetteers from contested borderlands, such as the Suiyuan region in the Northwest, as well as interior provinces like Hunan and Hubei reported the adoption of new technologies and scientific methods, be it the recording of meteorological measurements or experiments on crops like cotton and varieties of fruit trees. In many areas of the country, but particularly on the frontiers, the agricultural experiment station signified modernity and science. The research performed there extended the reach and spread of science in China, while the station itself served a national security function in the borderlands. According to the preface of the *Guisui County*

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[25] *(Minguo) chong xiu Nanchuan xian zhi* (民國)重修南川縣志, ed. Wei Linshu 韋麟書 and Liu Langsheng 柳琅聲 (1926), front matter.

[26] *Tianjin zhi lue* 天津志略, ed. Song Yunpu 宋蘊璞 (1931), 72.

[27] *Zhangbei xian zhi* 張北縣志, ed. Xu Wenshi 許聞詩 (1935), preface.

[28] *Hunan di li zhi* 湖南地理志, ed. Fu Jiaojin 傅角今 (1933), 154–155.

Figure 2. New types of *tu* like photographs started to appear in local gazetteers in the twentieth century. These images were part of a discussion of the efforts to improve agriculture in Hunan province. See *Hunan di li zhi*, ed. Fu Jiaojin (1933), pp. 154–155. Image from the open-access Harvard-Yenching Library online collection.

Gazetteer (*Guisui xian zhi* 歸綏縣志), the region was occupied by Mongolian nomads but had begun to recruit settlers in the Qing Daoguang reign (1820–1850).[29] The use of charts and detailed numbers indicates a new focus on numerical and statistical accuracy. The inclusion of various charts and graphs in the gazetteer highlights the differences between the Han Chinese compilers of the gazetteer and the nomadic and allegedly backward Mongols and other ethnic minorities in the borderlands, who were deemed to lack science and who failed to experiment with the most efficient farming technologies, to improve their livestock through systematic veterinary breeding programs, or to document changing weather patterns, rainfall, and other environmental conditions. These maps and images found through LoGaRT reveal a far wider spread of science and scientific institutions across China than the prevailing consensus on the late Qing and the Republican period had indicated. The geographical spread of agricultural experiment stations makes evident their centrality to an array of reforms and new forms of government institutions across the country.

CONCLUSION

These results produced using LoGaRT point to some important new questions for the study of science in modern China. From the late Qing period onward, maps and schematics of the agricultural experiment station could often be found in the same section as discussions about schools

[29] *Guisui xian zhi* 歸綏縣志, ed. Zheng Yufu 鄭裕孚 and Zheng Zhichang 鄭植昌 (1935), preface.

offering New Learning. Discussions about agricultural experiment stations also appear in gazetteer sections on Practical Learning (*shixue*). Both locations suggest a bottom-up approach to the study of science—in its practical applications at specific localities across the country. The profiles of the compilers changed from scholar-officials and scions of prominent lineages in the localities to revolutionaries and reformers. But along with these changes, there were clear continuities between the late Qing and Republican eras. Compilers and editors of local gazetteers, in their role as local elites, were also frequently active members or founders of schools. Agricultural experiment stations enjoyed close associations with local agricultural societies. Both drew interest from the same kind of people: local elites who were connected to the outside world because of their educational and social networks. These agricultural societies, schools, and experiment stations attest to considerable overlap in personnel between the late Qing and Republican periods. Before the professionalization of the field of agricultural science, many local gentry, notables, and teachers in schools participated in the adoption of new knowledge, an effort seen as an essential part of their historical role in governance and civic leadership rather than as acquiescence to a foreign import. This changes considerably how we view the adoption of science in China.

One argument put forth by Sinologists who study premodern uses of *tu* as graphic illustrations of specialized knowledge suggests that the failure to develop the specialized skills of technical drawing may have played a role in delaying the rise of modern science in China.[30] The discussion on *tu* usually overlooked local gazetteers because the images in this genre were of low quality and were frequently reused in multiple editions. Yet the flexible epistemological structure of local gazetteers easily allowed for the incorporation of new knowledge, particularly in areas like geography and agriculture. For the modern period, we can see how the ambiguity of *tu* in local gazetteers—in contrast to the clear connotations in English of "map," "illustration," or "image"—opens the door to a range of possibilities and is in fact an advantage in looking at the spread of science in China. The *tu* could be a city map, a chart, a photograph, an illustration, or a building schematic. In all these instances, the *tu* of the agricultural experiment station shows the widespread adoption of new agricultural practices and technologies, new varieties of crops, and new fish farming methods in both cities and small towns, in treaty ports and coastal areas, as well as in interior provinces and contested borderlands. It also shows how agricultural innovations were part and parcel of a broad range of industrial and technological adaptations, from sericulture, textile manufacturing, and veterinary sciences to light industries. The flexibility of the *tu* in many ways mirrors the flexibility of the gazetteer genre form: it could and did stretch to adapt to modern science. Like Peter Lavelle's and Jiajing Zhang's essays in this Focus section, my work demonstrates one way that LoGaRT allows for the mining of data from local gazetteers to reveal a new perspective on the spread of science in modern China.

[30] Francesca Bray, "The Power of *Tu*," in *Graphics and Text in the Production of Technical Knowledge in China: The Warp and the Weft*, ed. Bray, Vera Dorofeeva-Lichtmann, and Georges Métailie (Boston: Brill, 2007), pp. 1–79, esp. p. 26.