Focus: Using Chinese Local Gazetteers for the History of Science

Introduction: Redrawing the Map of Science in Modern China

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Abstract: This essay provides an overview of the Local Gazetteers Research Tools (LoGaRT) developed by the Max Planck Institute for the History of Science and examines the ways that LoGaRT could aid in redrawing the map of modern science in China.

In 2014, the Max Planck Institute for the History of Science (MPIWG) started a research project to study the nature of local knowledge and the role of local gazetteers in imperial China. The Local Gazetteers Research Tools—LoGaRT—were first developed in 2016 to apply computational methods to the large-scale search of digitized gazetteer collections.[1] In the years since, the MPIWG has organized several workshops for scholars from around the world to explore ways of using LoGaRT for research purposes, including a group on the use of images (*tu* 圖) in local gazetteers. The *Tu* work group was first organized in 2018, with Kenneth Hammond, Anne Gerritsen, Shellen Wu, and Jiajing Zhang as participants. These scholars worked with the team

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[1] Several published articles have come out of these workshops. See Alexis Lycas, Hasegawa Masato, and Chen Shih-Pei, "Local Uses of Geographical Knowledge in Imperial China: Introduction to Contributions to the International Workshop Held by the Max Planck Institute for the History of Science (MPIWG), Berlin, 29 June to 1 July 2020," *Monumenta Serica*, 2021, *69*:349–352; Nung-yao Lin, Chen, Sean Wang, and Calvin Yeh, "Displaying Spatial Epistemologies on Web GIS: Using Visual Materials from the Chinese Local Gazetteers as an Example," *International Journal of Humanities and Arts Computing*, 2020, *14*(1–2): 81–97; Dagmar Schäfer, Chen, and Qun Che, "What Is Local Knowledge? Digital Humanities and Yuan Dynasty Disasters in Imperial China's Local Gazetteers," *Journal of Chinese History*, 2020, *4*:391–429, doi:10.1017/jch.2020.31; and Chen, Kenneth J. Hammond, Anne Gerritsen, Shellen Wu, and Jiajing Zhang, "Local Gazetteers Research Tools: Overview and Research Application," *ibid.*, pp. 544–558, doi:10.1017/jch.2020.26. LoGaRT can be accessed at https://www.mpiwg-berlin.mpg.de/research/projects/logart-local-gazetteers-research-tools.

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Figure 1. LoGaRT provides statistical, mapping, and other analytical tools, in addition to text and image search capabilities. Here, for example, the results of text searches are layered on a map of China, with the circles indicating the location of gazetteers and the size of the circles correlating with the number of gazetteers. The pie charts break down the results by dynasty or administrative level.

at the MPIWG to develop a search function, Page with Image (PWI), specifically for pulling out images from local gazetteers; the effort has since expanded in a series of workshops with sixteen participants who have been incorporating the image search functions of LoGaRT in their research (see Figure 1). See the video in the supplemental material of the online edition for a demonstration of LoGaRT's various functions.[2] The three Focus pieces presented here developed from these meetings. I use LoGaRT to locate new institutional spaces for science from the nineteenth century; Peter Lavelle focuses on agricultural knowledge in local gazetteers to trace a new environmental history of China that is deeply embedded in localities; Jiajing Zhang argues that the combined use of longitude and latitude lines and the indigenous "grid of scales" on local gazetteer maps indicates an openness to new technologies from the West rather than a stubborn clinging to tradition. Each of us examines a different facet of how LoGaRT might be used for research in the history of science.

For the past thousand years, from approximately the tenth through the twentieth century, local officials and elites in China have produced gazetteers, which frequently contain copious information on local administration, economies, environment, flora and fauna, and cultural and

[2] See the demonstration video in the supplemental material to the online edition: https://doi/10.1086/722362.

religious practices. While the gazetteer has no exact counterpart in the West, in the wide variety of information on assorted topics they offer local gazetteers resemble encyclopedias. Local gazetteers primarily covered prefectural or county-level administrative units but also extended to the provincial level. The information in the gazetteers, from star charts to administrative maps to the cataloguing of local products, is part of a process of place-making, entering localities into the orbit of the imperial state and defining their administrative boundaries. As a genre, the gazetteers provided what geographers have termed "deep mapping" of a locality—a comprehensive and multilayered description of place.[3] Though not officially state sponsored, gazetteers provided an institutional infrastructure for knowledge collection. Yet despite their ubiquity and importance as a unique source of local knowledge, historians of science have paid scant attention to local gazetteers. This neglect is in part because, without a counterpart in the West, they do not figure into traditional narratives on the rise of science.

From the Ming dynasty (1368–1644), the numbers of gazetteers produced skyrocketed. By the Qing (1644–1911), the state was issuing guidance on and attempting to create and control a more uniform model for the organization and content of these repositories of knowledge for the benefit of the local officials and gentry who frequently undertook their compilation.[4] Over the course of the Qing, close to seven thousand titles were published in several waves of compilation. This golden age of the gazetteer coincided precisely with the period when, according to an earlier generation of history of science literature, Chinese innovation and developments in science and technology allegedly stalled and declined from previous heights in the premodern period.[5] Even as new media forms and genres emerged in the twentieth century, including a proliferation of atlases, textbooks, newspapers, and pictorial magazines, many localities continued to produce gazetteers.

Sinologists have long mined local gazetteers as important sources of information found nowhere else. Such research was limited by several factors. Only a small number of research libraries around the world have extensive collections of local gazetteers. The gazetteers themselves often run to tens of volumes. Some volumes contain thousands of pages, with long sections devoted to tax records and other information presented in dense blocks of text that make casual perusal difficult. Some localities produced multiple editions of their gazetteers, not all of which can be found today in the same library collection. LoGaRT considerably reduces the amount of time needed to do research, work that used to require days if not weeks, sometimes in more than one library.

With these advantages in mind, the new possibilities for research using tools like LoGaRT need to be placed in the context of the evolution of the genre, broader trends in Chinese history, and considerations about the limitations of digital humanities tools. The digitization of these gazetteers and the creation of various text and image search functions expand research possibilities but also de-territorialize a geographically specific genre of local knowledge by extracting information

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[3] Thanks to Ruth Mostern for pointing out gazetteers' role in bringing localities into the orbit of the imperial state in her presentation "Landscapes in Motion: Modeling Spatial Dynamics in Chinese and Global Digital History," University of Tennessee, Knoxville, 7 Mar. 2022. The idea of "deep mapping" in place-making is discussed in an essay by Kate McDonald and David Ambaras for their digital humanities project *Bodies and Structures*, https://scalar.chass.ncsu.edu/bodies-and-structures/what-were-doing (accessed 20 Mar. 2022). Gazetteers reflect Doreen Massey's definition of space as "the simultaneity of stories" in Doreen B. Massey, *For Space* (London: SAGE, 2005), p. 9; and David Turnbull's concept of "indexicality" in David Turnbull *et al.*, *Maps Are Territories, Science Is an Atlas: A Portfolio of Exhibits* (Chicago: Univ. Chicago Press, 1993).

[4] Pierre-Etienne Will, "Chinese Local Gazetteers: An Historical and Practical Introduction," *Notes de Recherche du Centre Chine*, 1992, no. 3.

[5] Joseph Needham, *Science and Civilisation in China*, Vol. 1: *Introductory Orientations* (Cambridge: Cambridge Univ. Press, 1954), pp. 3–4; Needham, *The Grand Titration: Science and Society in East and West* (Toronto: Univ. Toronto Press, 1969), p. 16; and Donald Lach, *Asia in the Making of Europe*, Vol. 2: *A Century of Wonder*, Bk. 3: *The Scholarly Disciplines* (Chicago: Univ. Chicago Press, 1977), p. 405.

without regard to its place-making context. Using LoGaRT, the Sinologist is no longer limited to examining various editions of the local gazetteer compiled for a particular city or region. Yet to contextualize and interpret the long list of results returned by LoGaRT's various statistical and graphing functions still requires prior training and knowledge of the genre and its customary organization (see Figure 2). Similar constraints apply to other databases and digital humanities projects: the technology can only be successfully used with an understanding of the way that functions like search terms and tags operate—and of their limitations.

Second, LoGaRT builds on existing databases of local gazetteers, primarily a commercial collection of more than two thousand gazetteers produced by the private Chinese company Erudition and an open-access collection of several hundred local gazetteers from the Harvard-Yenching Library. LoGaRT searches, therefore, access a significant but by no means comprehensive database out of an estimated eight thousand extant local gazetteers from the tenth to the twentieth century. For researchers interested in early dynasties before the Ming, LoGart provides limited benefits because so few extant copies of gazetteers exist. Scholars of later periods face the opposite problem. The early development of printing technology in China fostered a lively commercial publishing market.[6] By the late nineteenth century, the local gazetteer was only one of a wide range of publications that featured scientific content, including illustrated periodicals, textbooks, newspapers, and missionary journals and translations. Literati and official interest in specific subjects, such as agriculture, geography, and cartography, predates the arrival of Western science, and works on these topics circulated broadly outside of the local gazetteer framework.[7] While important, then, local gazetteers are not the only source for access to local knowledge, especially in the modern period.

Finally, like the translations from Japanese and other languages that often appeared in serial form in newspapers and other publications that featured science and technology in late nineteenth- and early twentieth-century China, the content of local gazetteers hints at the global circulation of knowledge; but, by definition, the genre remains narrowly focused on the adoption and impact of new ideas and practices in specific localities. Moreover, the content of local gazetteers favors the scholarly and administrative interests of the local elite who undertake their compilation, some of which were idiosyncratic rather than reflective of broader trends.

The most common category of images included in the local gazetteer is a variety of maps, but *tu* extends to a much broader group of nontextual elements that encompasses maps, diagrams, charts, and, in the twentieth century, photographs. In premodern Chinese usage, *tu* was a specialist term for images that encoded technical knowledge, not a stylistic but a functional category of graphic images.[8] The early innovation of woodblock printing in China in the ninth century made it far easier for printers to reuse existing images than to create new ones. The editors and compilers of local gazetteers in the Ming and Qing dynasties often turned to this practice for expediency, reusing maps from earlier editions rather than commissioning new ones. Some Sinologists, like Peter Golas, have argued that the development of technical drawing skills thus impeded Chinese

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[6] Cynthia Joanne Brokaw and Kai-wing Chow, *Printing and Book Culture in Late Imperial China* (Berkeley: Univ. California Press, 2005).

[7] For example, for a discussion of the popular pictorial *Dianshizhai Pictorial* (*Shanghai's Lens on the World*) (1884–1898), see Jeffrey Wasserstrom and Rebecca Nedostup, https://visualizingcultures.mit.edu/dianshizhai/dsz_essay01.html (accessed 21 Jan. 2022). For a discussion of the importation of agricultural technology in the nineteenth century see Peter B. Lavelle, "Tools for Overcoming Crisis: Agriculture, Scarcity, and Ideas of Rural Mechanization in Late Qing China," *Agricultural History*, 2020, 94:386–412, https://doi.org/10.3098/ah.2020.094.3.386.

[8] 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, on p. 2.

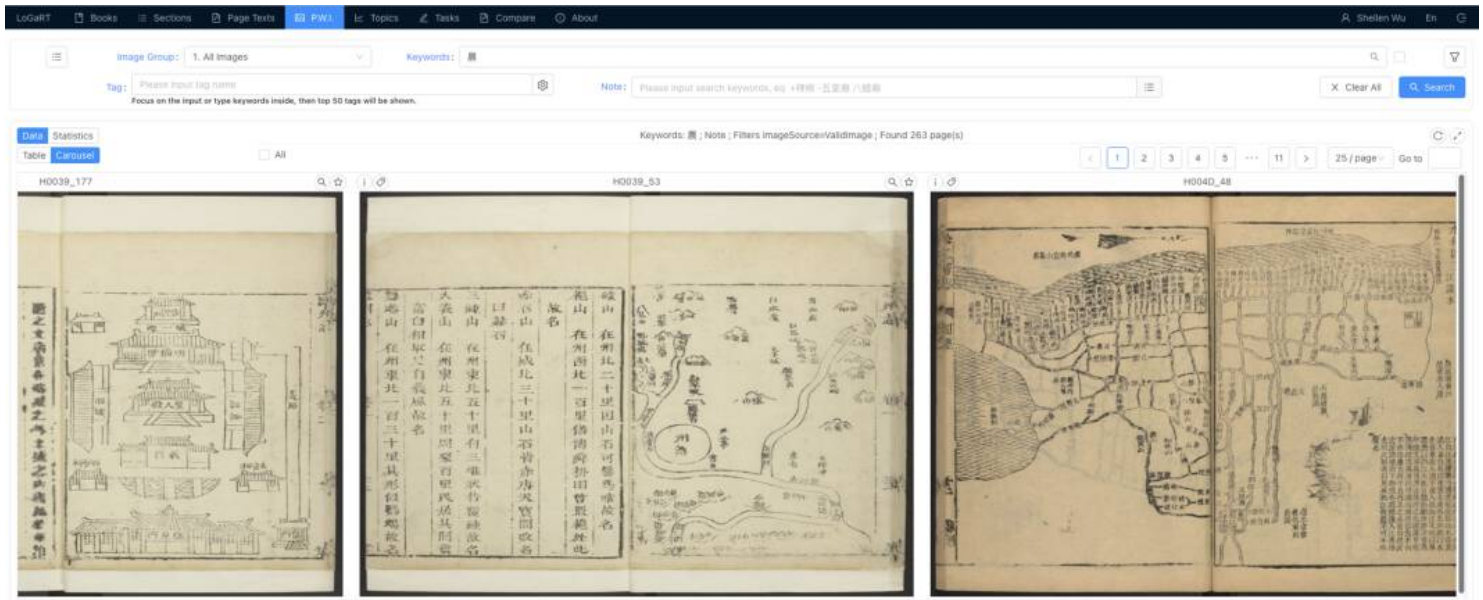

Figure 2. The LoGaRT team at the MPIWG developed the PWI (Page with Image) search tool to pull out images from local gazetteers. A keyword search will pull out all the images tagged with the term from the 4,400-plus gazetteers in the database. The carousel view allows for quick scanning of these images.

technological creativity.[9] The conceptual category of *tu*, like the local gazetteer, has no direct counterpart in the West. Several workshops dating from the late 1990s and 2000s addressed the role of *tu* in possibly delaying the turn to modern science. Yet, despite this earlier wave of interest, historians of science have paid scant attention to the flexible epistemological framework of the local gazetteer and its role in the dissemination of science in China, particularly the ways that *tu*, an essential element of the genre, changed in the nineteenth century and incorporated imported knowledge.

For these reasons, despite the caveats discussed above, LoGaRT presents an exciting opportunity to rethink the spread of science in China. The ubiquity of local gazetteers allows their study to take science out of treaty port cities like Shanghai, Guangzhou, and Beijing, where most scholarship in the last several decades has located efforts to translate and disseminate modern science in China.[10] Local gazetteers were never intended to be at the vanguard of knowledge creation. Compiled by local officials or notables, these gazetteers showcased points of local pride and provided helpful knowledge for newly assigned government officials unfamiliar with the region. In the nineteenth century, new features like agricultural experimental zones, new types of schools, including schools for girls, and new cartographic innovations imported from the West made their way into the content of these local gazetteers across the country—and often in places far from the coastal treaty port cities. Their presence in the local gazetteers indicates the widespread adoption of new institutions and venues for science as part of a cluster of reforms taking place across the country.

These reforms showed up in the text as well as in proliferating numbers of images (*tu*) in local gazetteers. These innovations in a traditional medium both showcase the flexibility of the genre and illustrate how existing networks of scholars and officials quickly adapted new knowledge. Lavelle argues in his essay that local elites who undertook the compilation of local gazetteers reused existing infrastructure like temples and their built-in audiences to disseminate new knowledge. Zhang also demonstrates the ways that cartographic innovations like longitude and latitude lines, even if incorrectly drawn, circulated widely in China through the local gazetteers. These changes recorded in local gazetteers carried over from the last decades of the Qing dynasty to the Republican period in the early twentieth century and the Communist era after 1949.

The inclusion of new knowledge in gazetteers forces us to rethink the accepted narratives about science in modern China; about what was in fact new and what modified and adapted from the imperial repertoire of statecraft and administration; and about the possibility that the epistemological revolution of the twentieth century was perhaps both less revolutionary and occurred earlier than Sinologists previously believed, building on the existing knowledge infrastructure of the local gazetteer. Of more immediate interest to historians of science, the image and text search functions of LoGaRT allow us to visualize a new atlas of modern science in China in the broader context of

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[9] *Ibid.*, p. 26. See Peter J. Golas, "The Emergence of Technical Drawing in China: The *Xin yi xiang fa yao* and Its Antecedents," *History of Technology*, 1999, 21:29–63; and Golas, "Technological Illustration in China: A Post-Needham Perspective," in *Science and Technology in East Asia: The Legacy of Joseph Needham*, ed. Alain Arrault and Catherine Jami (Turnhout: Brepols, 2001), pp. 43–58.

[10] David Wright, "Careers in Western Science in Nineteenth-Century China: Xu Shou and Xu Jianyin," *Journal of the Royal Asiatic Society*, 1995, 3rd Ser., 5:49–90; Wright, "The Translation of Modern Western Science in Nineteenth-Century China, 1840–1895," *Isis*, 1998, 89:653–673; Michael Lackner, Iwo Amelung, and Joachim Kurtz, eds., *New Terms for New Ideas: Western Knowledge and Lexical Change in Late Imperial China* (Leiden: Brill, 2001); James Reardon-Anderson, *The Study of Change: Chemistry in China, 1840–1949* (Cambridge: Cambridge Univ. Press, 1991); Reardon-Anderson, "Chemical Industry in China, 1860–1949," *Osiris*, 1986, N.S., 2:177–224; 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. Lackner and Natascha Vittinghoff (Leiden: Brill Academic, 2004), pp. 381–422; Fa-ti Fan, "Redrawing the Map: Science in Twentieth-Century China," *Isis*, 2007, 98:524–538; Shellen Wu, *Empires of Coal: Fueling China's Entry into the Modern World Order, 1860–1920* (Stanford, Calif.: Stanford Univ. Press, 2015); Benjamin Elman, *On Their Own Terms: Science in China, 1550–1900* (Cambridge, Mass.: Harvard Univ. Press, 2005); and Jing Tsu and Elman, eds., *Science and Technology in Modern China, 1880s–1940s* (Leiden: Brill, 2014).

political and educational changes sweeping across the country. Maps and images from local gazetteers demonstrate how agricultural experiment stations and new government institutions, such as new schools and hospitals—some based in repurposed temples, as Lavelle argues—spread throughout China in the late Qing and Republican periods and often appeared in clusters in the same places. By the late nineteenth and the early twentieth century, provincial gazetteers in densely populated coastal regions were as likely as those from far-flung borderlands to feature the latest mapping technologies and to contain information about potential mineral resources and infrastructure, as well as more traditional content concerning agricultural products and local religious practices.[11]

Officials and local gentry involved in these projects were often the first to adopt new agricultural technologies from abroad and to open schools that featured New Learning, including instruction in science and in applied fields. Sinologists have long focused on schools as sites of political contestation and local elite organization.[12] Far less attention has been paid to their role as local hubs in the dissemination of modern science. Local gazetteers traditionally featured both an editor, an honorary title that often went to a local official, and a compiler, usually a local notable familiar with the various sources of information specific to the area. Officials and notables from prominent local families dominated these roles in the late imperial period. Teachers in local schools often served as compilers and were the common denominator in the compilation of local gazetteers from the late Qing through the Republican period.[13] They too were frequently from prominent local families; some were educated overseas. They specialized in fertilizer production and taught chemistry, established meteorological stations, pioneered the statistical analysis of crop yields, and advocated for reforms in local government. These teachers would not fit into a narrowly defined category of the professional "scientist." Yet they served an essential role in local communities: to disseminate science and encourage the adoption of various scientific practices.

From the nineteenth century, disciplines like geography, cartography, engineering, agricultural science, economics, and medicine were linked in international professional and academic networks. Both in terms of content and in helping to delineate the overlap of personnel involved in creating local gazetteers and opening schools that taught science and applied sciences, the search functions in LoGaRT have produced results that point us away from the coastal entrepôts traditionally associated with the introduction of science in China. Agricultural experiment stations were typically affiliated with a school, provided apprenticeships for students, and in some instances were opened in conjunction with the local agricultural society. A number of gazetteers specify that a local agricultural school was opened first, with the joint support of local elites and officials, followed by the establishment of an agricultural experiment station.[14] When these locations were shown on city maps included in the local gazetteer, they joined the police station, schools (particularly girls'

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[11] See, e.g., *Menggu zhi* 蒙古志, ed. Yao Minghui 姚明煇 and Xiao Rizhan 夏日琖 (1907); and *Gansu xin tong zhi* 甘肅新通志, ed. An Weijun 安維峻 (1909).

[12] Much attention has focused on schools as the locus of political reform and local power. Civil examinations formally ended in 1905; both before and after this watershed, the issue of education reform was a politically charged matter that defined one's political stance. See Benjamin A. Elman, *Civil Examinations and Meritocracy in Late Imperial China* (Cambridge, Mass.: Harvard Univ. Press, 2013); Stephen C. Averill, "The Cultural Politics of Local Education in Early Twentieth-Century China," *Twentieth-Century China*, 2007, 32(2):4–32; Xiaoping Cong, *Teachers' Schools and the Making of the Modern Chinese Nation-State, 1897–1937* (Vancouver: UBC Press, 2007); and Robert Joseph Culp, *Articulating Citizenship: Civic Education and Student Politics in Southeastern China, 1912–1940* (Cambridge, Mass.: Harvard Univ. Asia Center, 2007).

[13] Teachers were also often prominent in local politics. See Federica Ferlanti, "Educators and Power Brokers: Political Mobilization and Violence in Wannian County, Jiangxi Province, 1926–1935," *Twent. Cent. China*, 2020, 45:227–246.

[14] Joseph Needham, *Science and Civilisation in China*, Vol. 6: *Biology and Biological Technology*, Pt. 2: *Agriculture*, ed. Francesca Bray (Cambridge: Cambridge Univ. Press, 1984); and William T. Rowe, *Saving the World: Chen Hongmou and Elite Consciousness in Eighteenth-Century China* (Stanford, Calif.: Stanford Univ. Press, 2001).

schools), and hospitals as markers of a locale's claims to modernity and progressive reforms. Similarly, the presence or absence of longitude and latitude lines and other Western cartographic innovations on gazetteer maps was visual evidence of the compiler's and editor's claims to modernity and openness to outside influence.

There is no question that the twentieth century and the modern period brought momentous change to China. Classical Chinese gave way to vernacular; the nation replaced empire; science became the savior of a nation in decline.[15] Yet some of these dynamics of radical change were also deceptive. The language changed, but the territorial expanse of empire mostly did not. In the late nineteenth and early twentieth centuries, influences from abroad, including the importation of scientific disciplines and ideas about race and nationalism, combined with long-running domestic concerns to form a potent new justification for territorial control over peripheral regions. LoGaRT allows us to map out some of the underlying continuities between a "traditional" Chinese form of knowledge compilation and twentieth-century developments.

[15] Zuoyue Wang, "Science and the State in Modern China," *Isis*, 2007, 98:558–570, https://doi.org/10.1086/521158.