Knowledgescapes

Geographical Information Systems and the History of Science

By Falk-Juri Knauft and Dagmar Schäfer

Where is knowledge formed? What kind of knowledge is reflected in scientific and technical relationships? The research group "Concepts and Modalities: Practical Knowledge Transmission in China" examines historical sources to enquire how the design and perception of space has changed historically and what impact this has had on scientific and technical thought. Researchers at the MPIWG have developed new methods to organize and analyze historical data, in particular the geographical analytical tool *map-Places-In-Time* (*mapPIT*) that enables the historian to map and compare diverse sources and archaeological findings in a spatial context with culturally and geographically relevant texts. Thus, changes in the social fabric of China described in fourteenth-century documentary sources and archeological evidence of a spatial (re)-organization in the then newly developing urban centers can be brought into the same context and analyzed.

Urbanization has always been a technical as well as a social challenge. Only an efficient infrastructure enables people to settle for any length of time in one place. This is particularly apparent in the regulation of water sourcing and disposal. Beijing, for example, has struggled since its inception with an insufficient supply of fresh water. Three of the five major water arteries that still serve the modern city are artificial feed lines, built between the four-

teenth and seventeenth centuries. Changes in the water flow and the influence this had on the landscape can still be partly traced in aerial photographs taken today. In the past Beijing suffered seasonally from a surfeit of water: again and again the Yongding River flooded its banks, shifted its course and cut new channels so that homes and workshops had to be moved or parts of the city had to be abandoned. Every impact on the geographical space advanced the skills and broadened the knowledge of man. He observed the constituents of soil and climate, measured distance and analyzed flora and fauna. In the process of building dikes, canals, houses and gardens and creating a new landscapes he also developed new knowledge about space and spatial relationships that he captured textually and visually. How do the ideas of space and spatial relationships expressed in these textual and visual documents relate to evidence gathered from archeological and material sources?

Place itself is assigned fundamental importance: because geographical location is a reliable indicator of knowledge, place becomes a descriptive factor in historiography. The spatial location of knowledge, in turn, manifests historically the concepts and methods that underlie and influence scientific and technical thinking and action.

The elements that characterize a city as a place of knowledge are themselves culturally specific. In classical Chinese political thought a city was a social-political structure ruled by administrative policies and ordered by ritual. As a general rule the historiography of the Chinese system allocates the seat of a county and district administration surrounded by a city wall the same status as a city. While the Yuan rulers used this system for administrative purposes few of these settlements were rewarded an independent status, similar to that of a modern city. In a document from 1265 they laid down three important criteria a settlement had to meet to be regarded as a city: (1) a long history, (2) a high population density, or (3) a strategically important location. A mapping of the data shows that the Yuan rulers accorded this status in particular to places in the north of the region of Jiangnan. Yet few of these cities were characterized by an unusually high population density.

Literary sources deal almost exclusively with the capital's urban life and, therefore always describe city growth as the result of conscious planning. Geomancy, i.e. the analysis of topography in relation to climate, played as important a role in city growth as strategic aspects or zoning and settlement structure. Ritual and cosmological discussions determined the philosophical writings and regional cartography of this period.

"Old City of Gaochang in China." Photograph: Anna Hagdorn (2009).

Tao 陶 宗仪 Zongyi (about 1315–1403) illustrated the Kaifeng Imperial Palace and analyzed the symbolism of imperial designs. In contrast to the European city, which is characterized by

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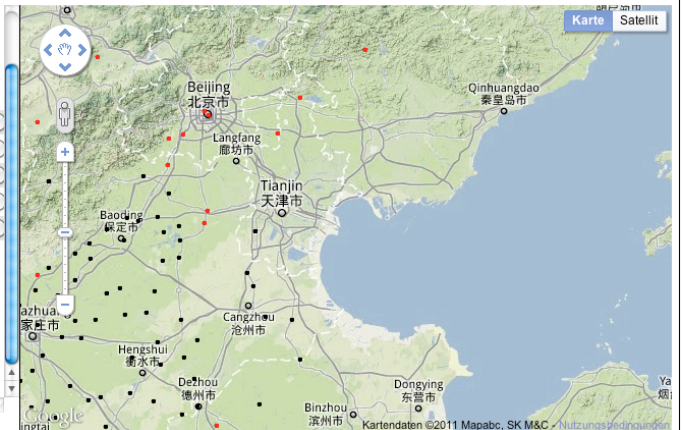
Map name yuan_city_map

Layers

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Screenshot of the web application *mapPIT*. MapPIT allows data to be mapped from tables, different sets can be layered. The red points on this map show places the Yuan rulers defined as independent cities. Black points show the prefecture seats of the Han-Chinese administrative system.

central buildings such as churches and city halls, the Chinese city is defined by the city wall; major imperial buildings like the Imperial Palace, the altar of agricultural offerings (grain and land) and also the ancestral temple were often originally built outside the city. Khublai Khan, for example, the founder of the Yuan Dynasty, conceived his government headquarters in the capital Dadu (Yuan-era designation of Beijing) as a resettlement next to the existing settlement of Beijing and not on its ruins. Elevating it to the capital and seat of the ruler, Khublai Khan created a divided city: on a previously uninhabited area of 60 square miles (50 square km) a new town was established north of the 97 li, ie 71.5 square km old town.

So the city grew spatially offset and did not expand concentrically. It appears that the settlement was concentrated in an area of five square kilometers in the New Town. The administrative files state that the number of officials in the city's registry office depended on the size of the population. On this basis, Dada would have had about 1.5 million inhabitants during the reign of Khubilai. While this intensive settlement structure is conceivable for the area, archaeological excavations suggest rather that the office was corrupt. A number of about 150,000 inhabitants seems more likely. For the purposes of comparison: twelfth-century Paris had 100,000 inhabitants; in the thirteenth century 240,000; and in the eighteenth century,

670,000. Moreover, large open spaces in Dadu imply the existence of parks and gardens, or possibly agricultural land within the city walls. For the compilation of this data and its analysis the Web interface *map-Places-In-Time* (*mapPIT*) was developed at the Max Planck Institute for the History of Science. This enables historians to integrate complex historical changes in the perception and design of space and spatial structures into the analysis of historical knowledge processes. In addition the interface also provides the opportunity to use space as an organizing principle for the merging of different data types. This also gives rise to new tools for historical research and the publication of research results.

Developed as part of the history of technology project "Concepts and Modalities: Practical Knowledge Transfer in China" in cooperation with the research group of Dagmar Schäfer, projects in Department I (Jürgen Renn), the library and the IT department of the Max Planck Institute of the History of Science as well as the Max Planck Digital Library a prototype with an intuitive user interface and maximum flexibility was developed. Online users can read, process and retrieve data in table structures in the system. Based on Google Maps service-level application, specific maps are generated, which can be combined and edited. Large amounts of data can easily be mapped, analyzed and published in conjunction with the digitized primary sources.

With the help of *mapPIT* historians can now merge different kinds of data, for example, to verify the relationship between the literary description of a local structure and archaeological findings. The cartographic reconstruction plots patterns and organizing principles. *mapPIT* allows historians to portray the dynamics of space and makes location available as a reference point for research in the humanities.

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