

Information Infrastructure of Beijing Historical Space – Using Google Earth and Complete Map of Peking, Qianlong Period

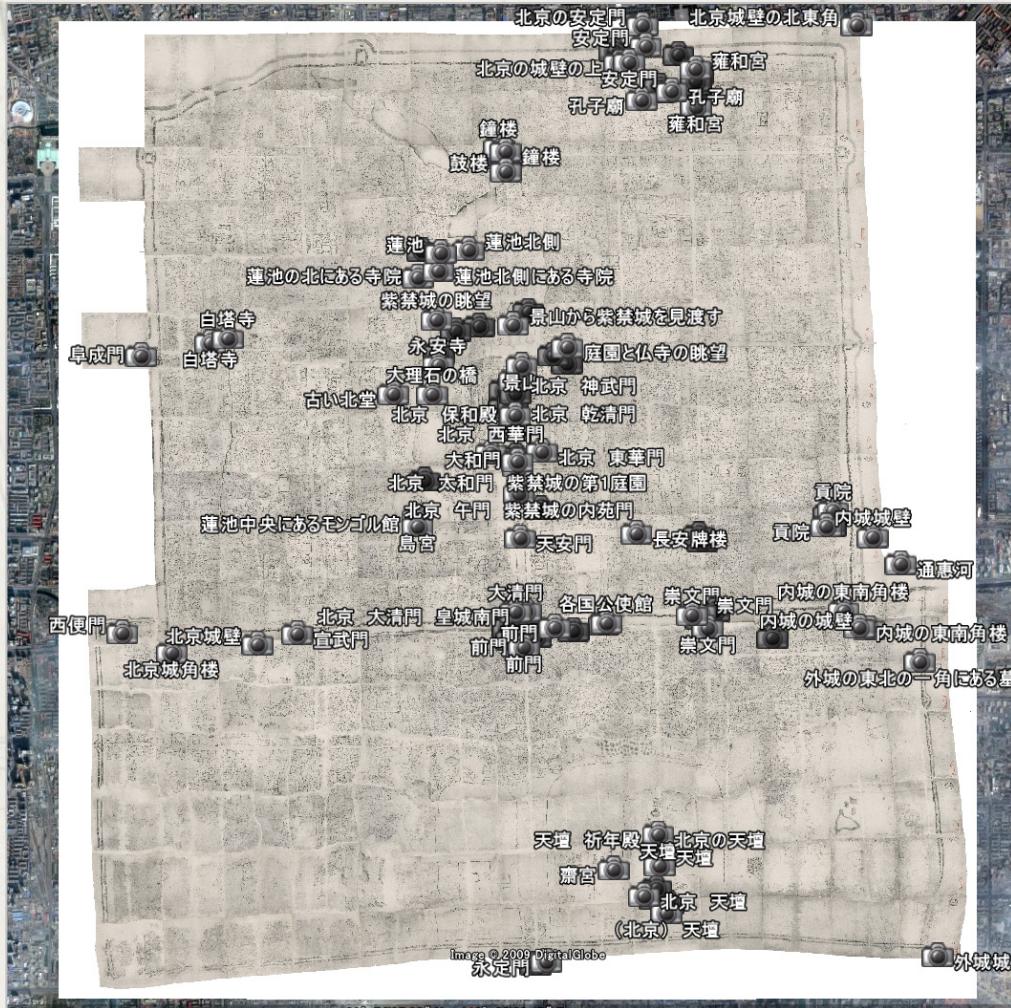
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<http://dsr.nii.ac.jp/>

Outline

<http://dsr.nii.ac.jp/beijing-maps/>

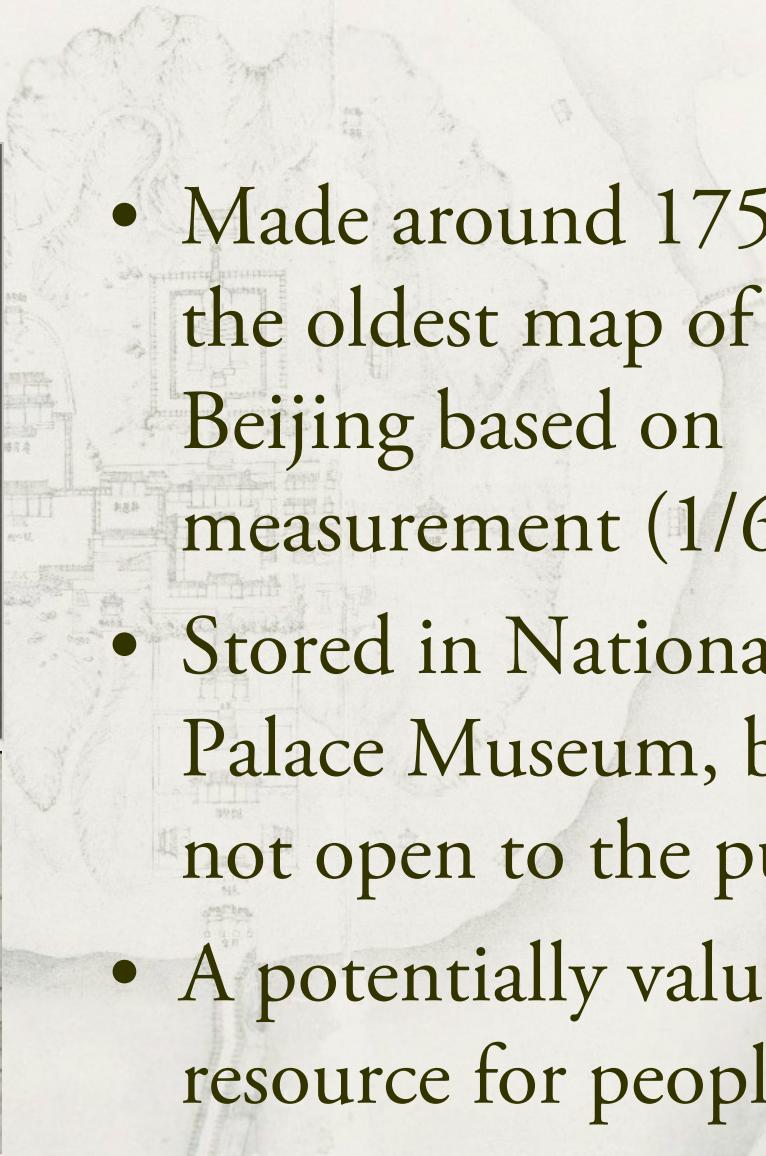
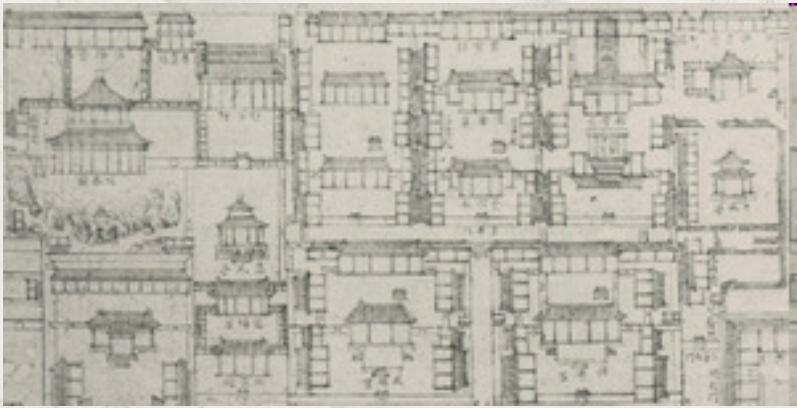


1. Challenges
2. Geometric correction
3. Rearrangement of maps
4. Spatial visual resources
5. Summary

Contributions

1. **A geometric correction method** for the old map of a city – preservation of linear features.
2. **Rearrangement of the map** – the discovery of mis-arrangement in the original map.
3. **Augmentation of the map** – a multilingual gazetteer and old photographs.
4. **Spatial visual resources** – the usage of Geo-browsers in data management and publishing.

Complete Map of Peking, Qianlong Period



- Made around 1750 – the oldest map of Beijing based on measurement (1/650).
- Stored in National Palace Museum, but not open to the public.
- A potentially valuable resource for people.

Problems and Challenges

Huge size = W 13 m x H 14 m

Many sheets = 203 sheets in total

- The survey of the whole map, in terms of e.g. accuracy, was not feasible.
- The map was not usable due to the difficulty of matching with the current (correct) map.

Solution and Requirement

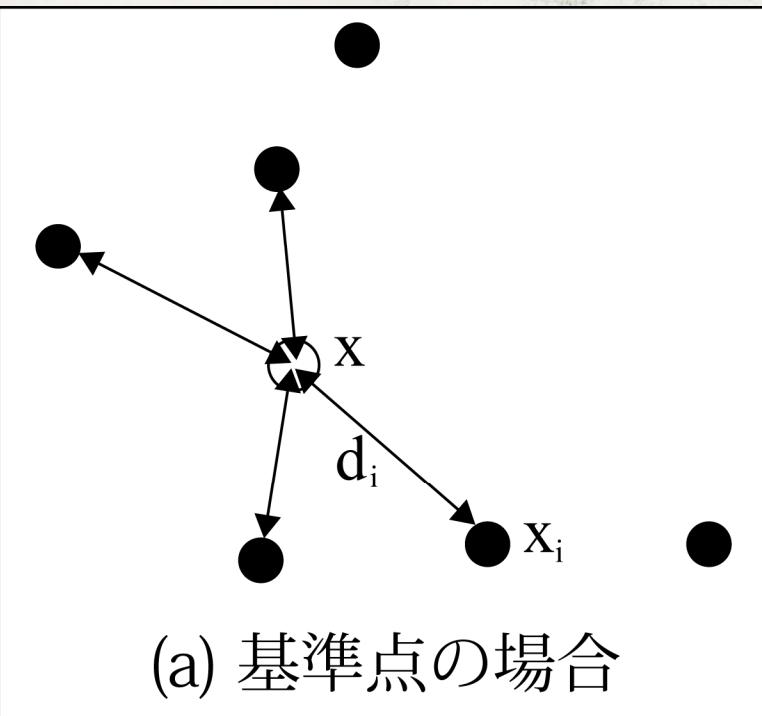
Propose a geometric correction method for geo-referencing the old map to the current satellite image.

1. The method must preserve **linear features** relevant in cities = Delaunay triangulation (typical method) is inappropriate.
2. The software must work for a **large scale problem** = traditional GIS software does not work with 29 billion pixels on 203 sheets.

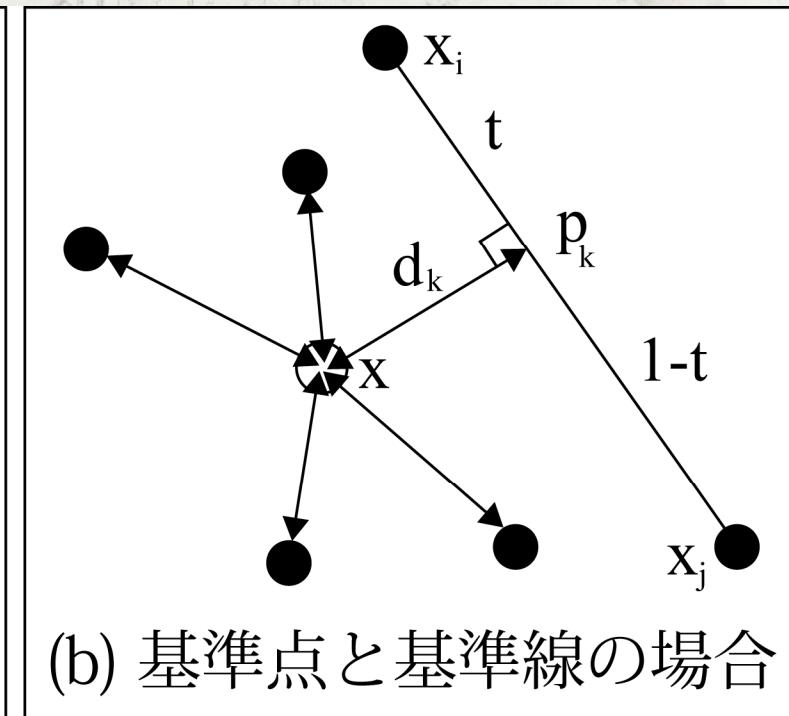
Line-Preserving Distance Weighting Method

A line is a set
of points

A “virtual” control
point on a control line



(a) 基準点の場合



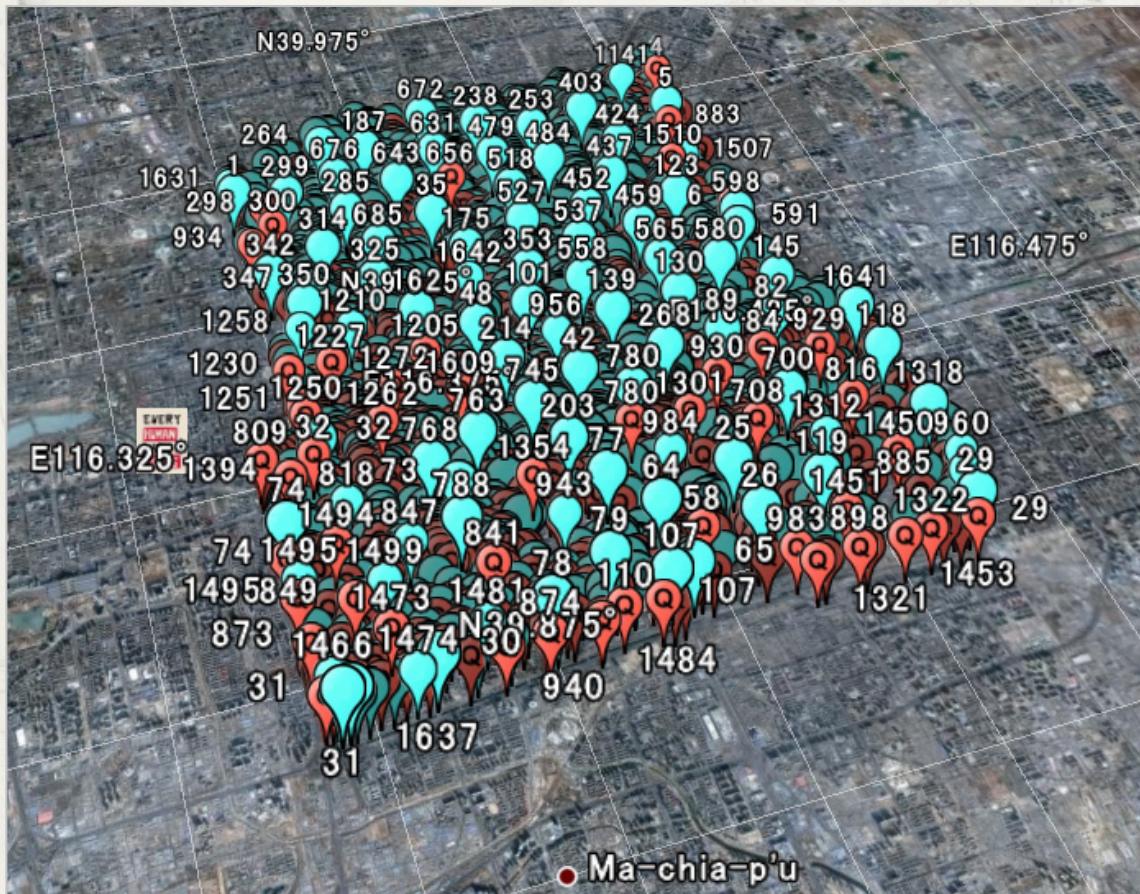
(b) 基準点と基準線の場合

$$z_p(x) = \sum_i w_i z_i / \sum_i w_i$$

$$z_l(x) = \sum_k w_k [(1-t)z_i + tz_j] / \sum_k w_k$$

Control Points

Palaces, intersections and hutongs present for 250 years.

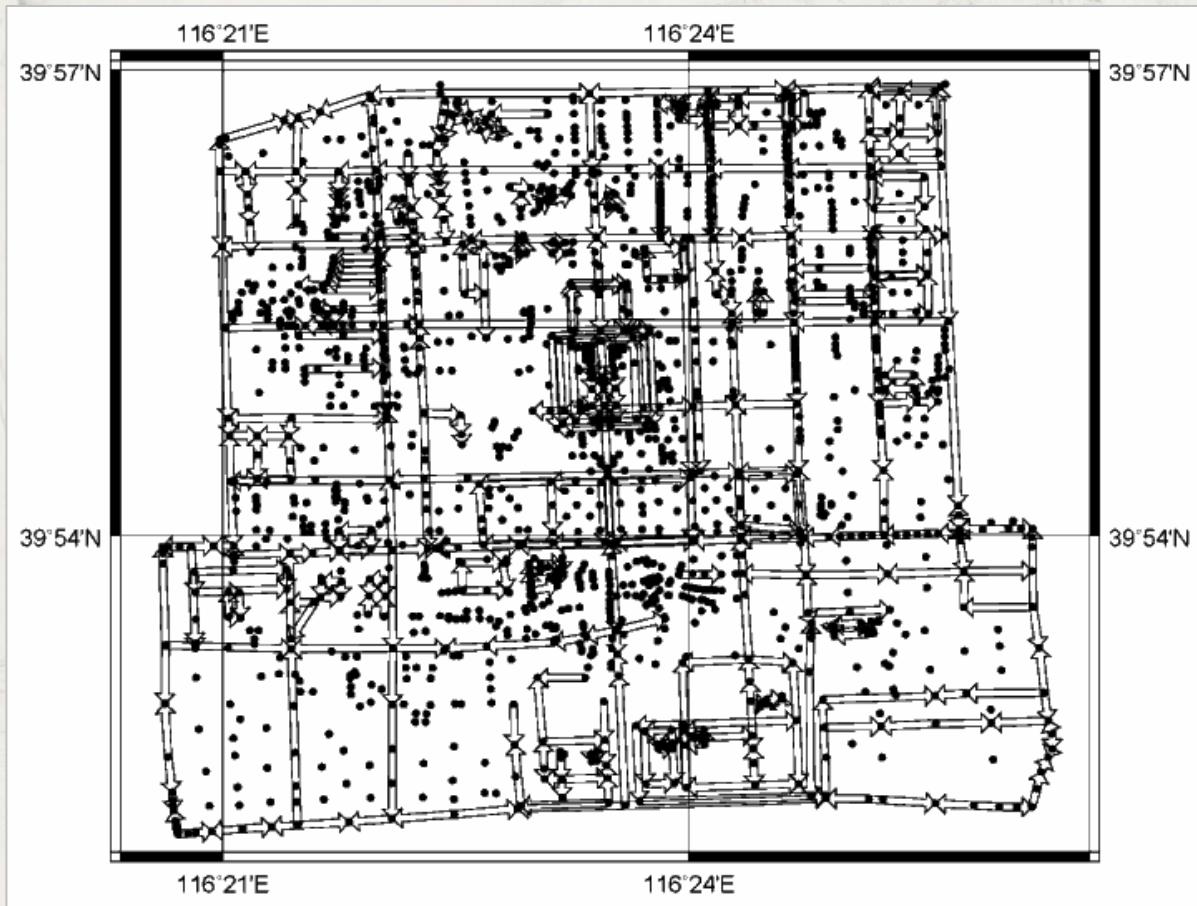


Red: old map; Cyan: current map

- About 1800 points are selected.
- Google Earth helps to find the current location of point features.

Control Lines

Streets present for 250 years + walls of inner and outer castle.



- About 500 lines are selected.
- Endpoints of control lines are selected from control points.

Result was Confusing...

203 sheets were seamlessly connected.

However, ...

1. Some parts are too different from the current map (especially in the west of outer castle).
2. Some regional features (such as temples) are not connected across neighboring sheets.
3. Some features that should be located at the current place are found in a wrong place.

Where is the error?

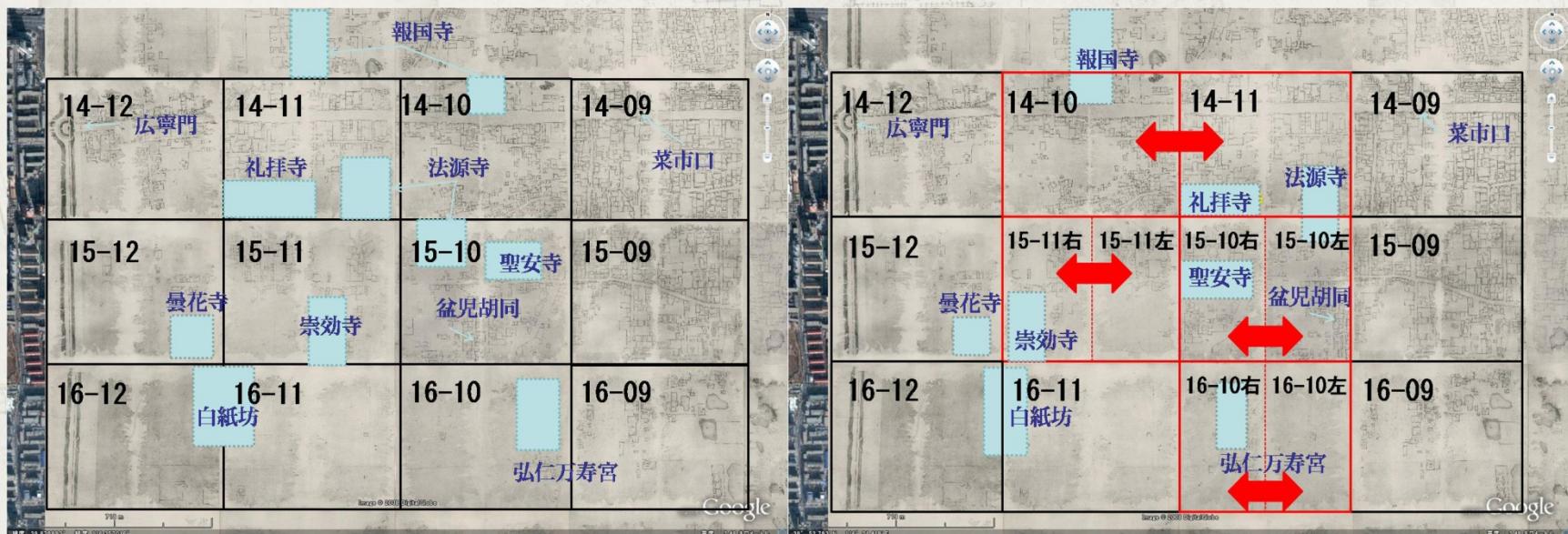
Past Work

- **Hou (1988)** – Errors in direction and scale are found in some areas.
- **Ihara (1997)** – Neighborhood of Fayuan si cannot be matched with the current map.
- **Li (2004)** – Mis-arrangement is present at pages 9,10,11 of line 14.

The presence of error was known, but the accuracy of the whole map was unknown.

Rearrangement of Sheets

Horizontal exchange of sheets between neighboring sheets and exchange of half-sheets within a sheet can solve all the inconsistencies.



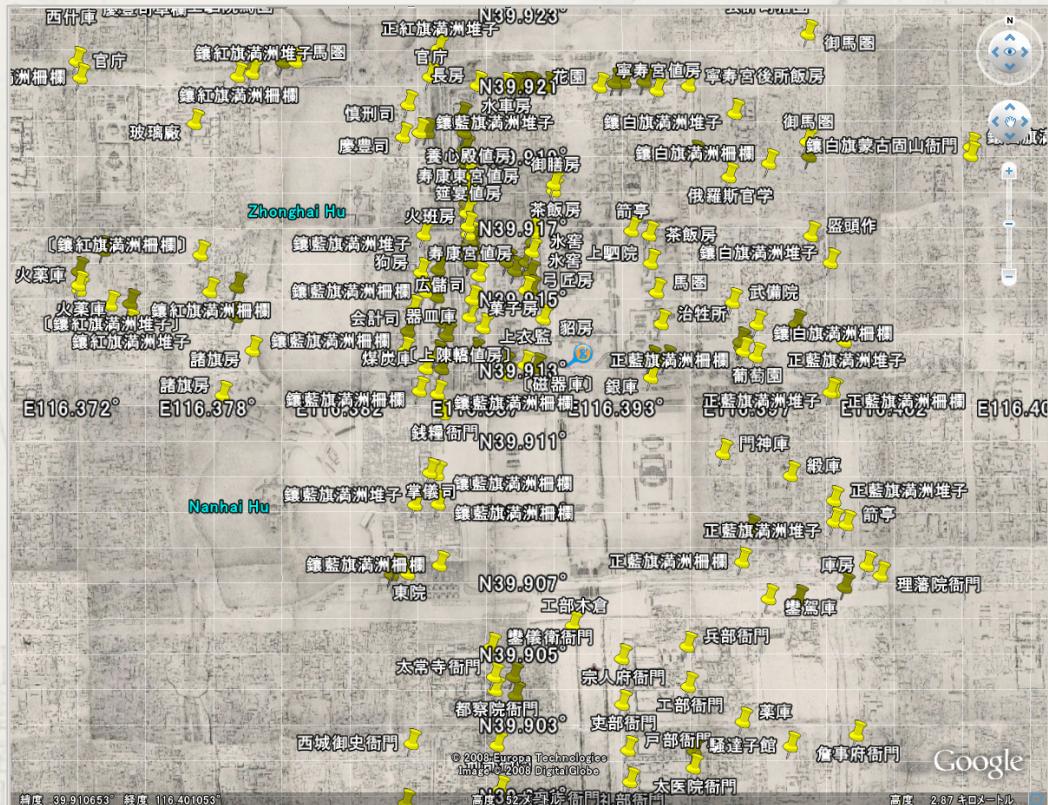
Mis-arrangement is present in 5 sheets.

Our Work

- Mis-arrangement is present not only in line 14, but also in line 15 and 16.
- The map is relatively accurate after correcting the mis-arrangement.

- How the mis-arrangement occurred?
- Probably due to the restoration of the map.
 - Mis-arrangement is found within a sheet.
 - Mis-arrangement is found on fragmented parts.

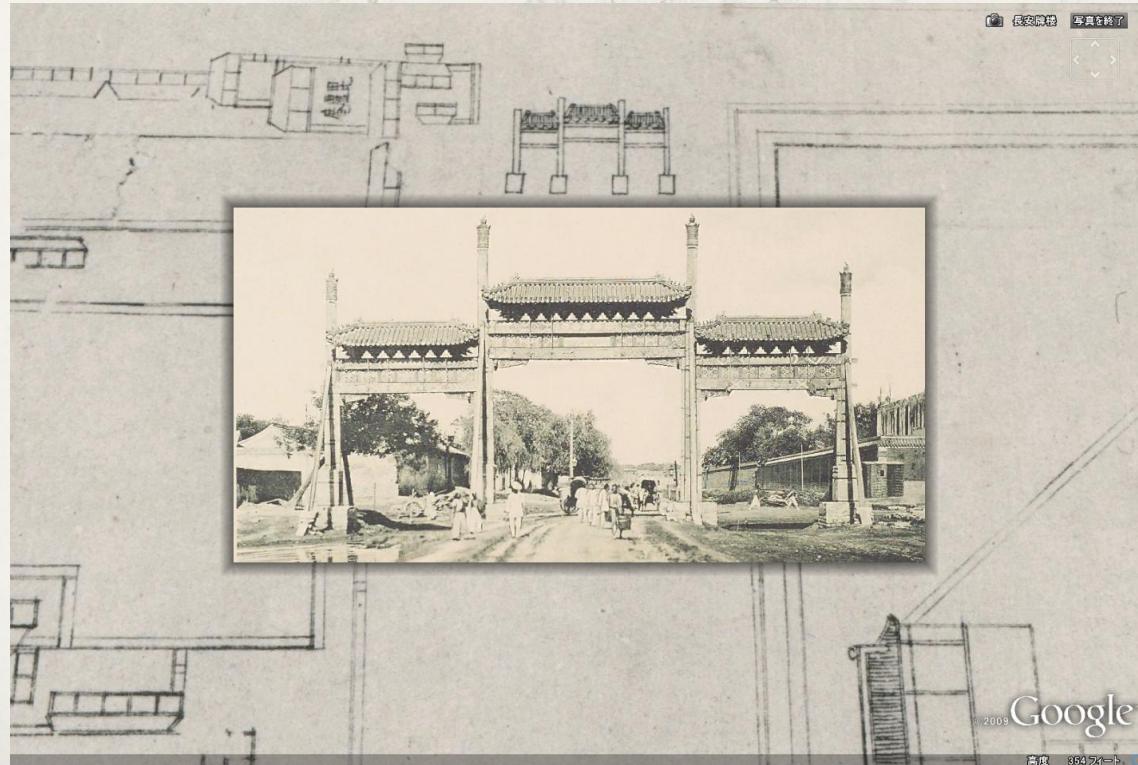
Multilingual Gazetteer



Of 3600 places, 800 had errors;
400 missing places were added.

- Digitize the original gazetteer in traditional Chinese.
 - Add Japanese, simplified Chinese and Pinyin for multilingual usage.
 - Geo-reference some place names.

Old Photographs on the Old Map



- Historical landscape of Beijing can be better studied by integrating many sources and analyze them together.

Spatial Visual Resources (SVR)

Spatial Resources

- Map
- Statistics
- Gazetteer

Visual Resources

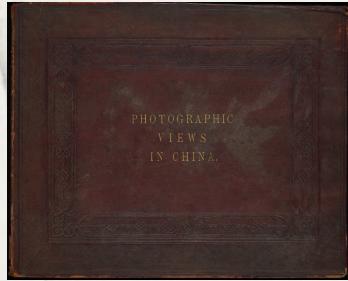
- Photograph
- Painting
- Drawing



Spatial Visual Resources

Maps + photographs = spatial info. is crucial.

Photo Albums of Beijing from Digital Archive of Toyo Bunko Rare Books

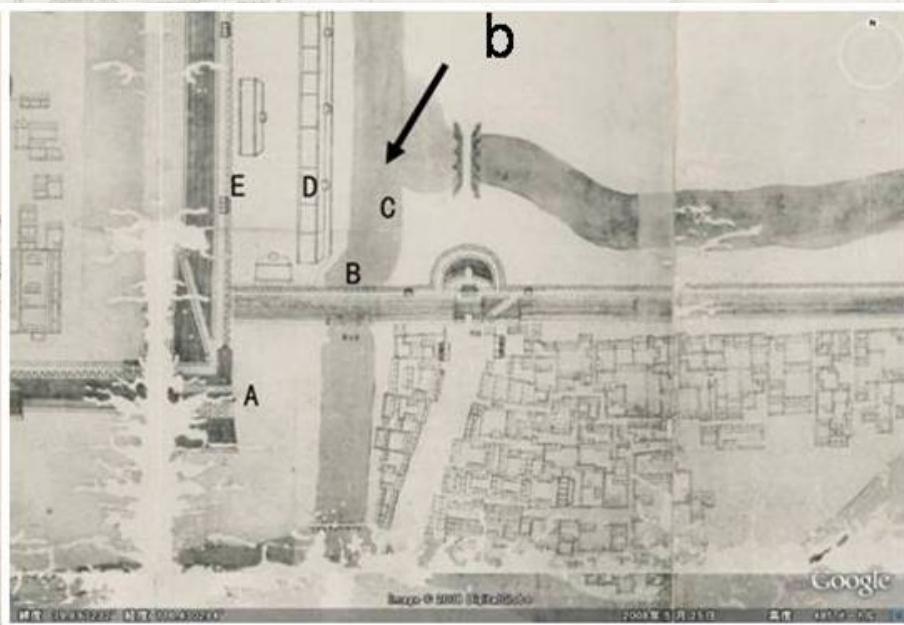
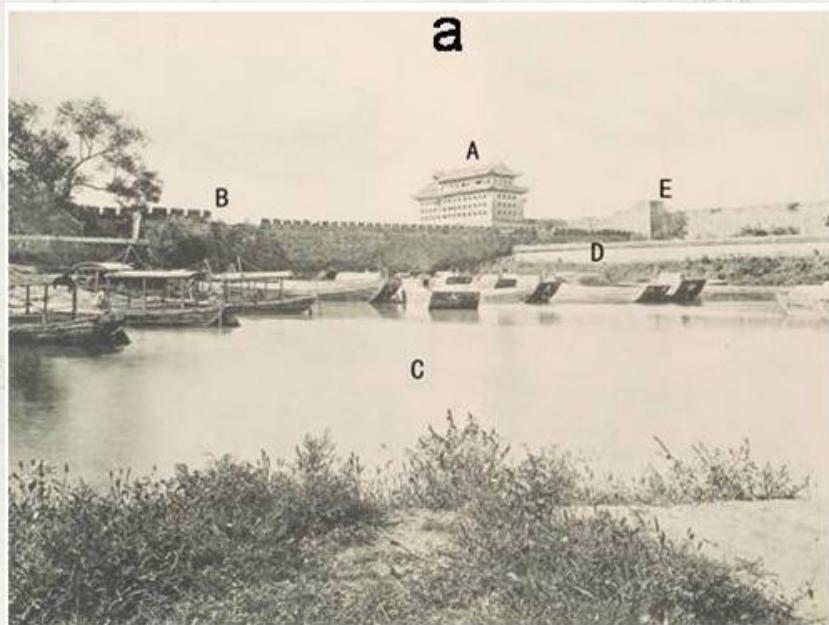


1. Felice Beato, *Album of Photographic Views in China*, 1860
2. Alfons von Mumm, *Ein Tagebuch in Bildern*, 1902
3. Sanshichiro Yamamoto, *Peking*, 1906
4. Sagimaro Kojima, *Views and Custom of North China*, 1909

Photographs of 100-150 years ago are especially valuable for studying landscape.

Geo-referencing Photographs

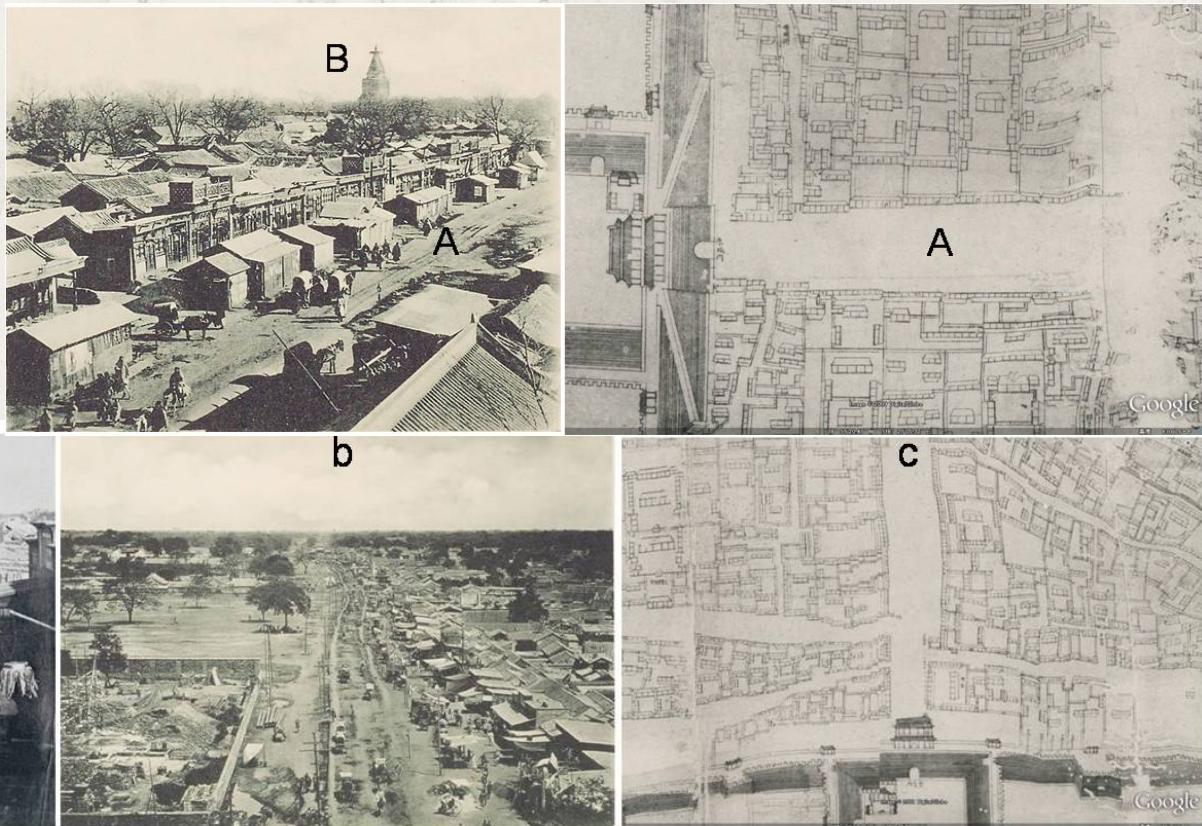
- Geo-reference by place names, by spatial arrangements, by unique features, etc.
- **Interpretation of photographs** is the key.



SVR is Worth 1000 Words

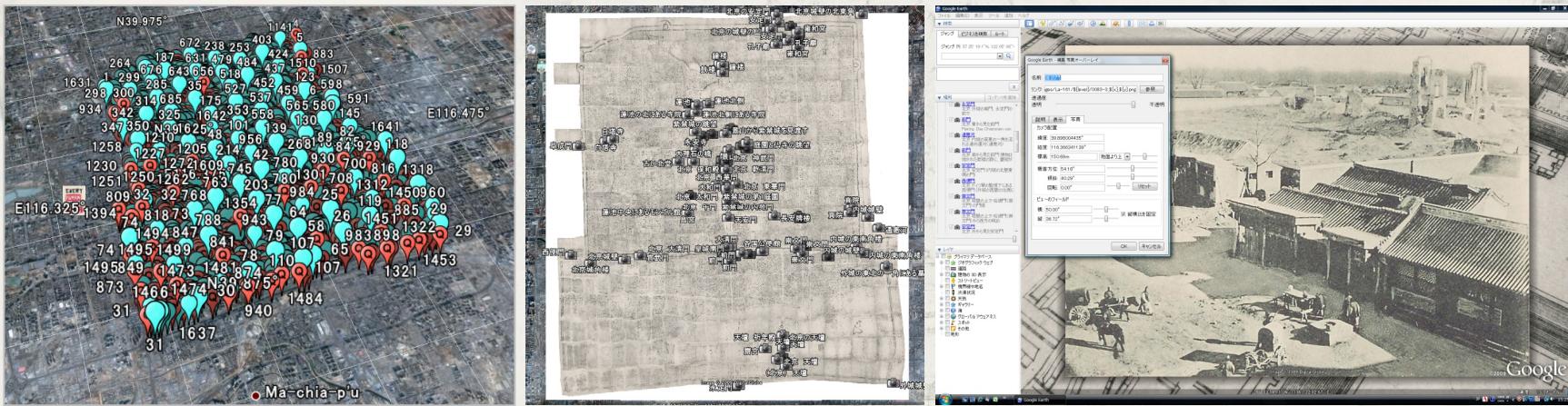
(Above)
Fucheng men

(Below) Chong
wen men



Houses and shops invaded into the street (侵街).
Text tells the concept; SVR reveals the real scene.

SVR and Historical GIS



- GIS software has been used for the old map; geometric correction and data management.
- Geo-browsers (e.g. Google Earth) are now emerging as alternative tools.

Historical GIS = the study of SVR?

Geo-Browser and GIS

Geo-Browser	(Traditional) GIS
Browse and annotate	Prepare and analyze
Free satellite images	More choices (for charge)
Internet-friendly, designed for sharing data.	Some are internet-friendly, but not the main feature.
Also good for qualitative data	Mainly for quantitative data

Combine both tools for their strengths toward a “wider” concept of historical GIS.

Summary

- A new geometric correction was proposed for the old map of cities to preserve linear features.
- Mis-arrangement of Qianlong Map was revealed after surveying inconsistencies in the old map.
- Multilingual gazetteer was created for easier access to place names.
- Photographs and maps were integrated under the concept of spatial visual resources (SVR).

Future Work

- Improve the accuracy of the map by adding more control points and lines.
- Improve the geometric correction algorithm for better usage of control points and lines.
- Integrate textual information from old books.
- Extend the system for a participatory infrastructure to collect various historical information from many experts across domains.

Thank you for your attention!

- <http://dsr.nii.ac.jp/beijing-maps/> -
Digital Maps of Old Beijing
- <http://dsr.nii.ac.jp/toyobunko/> - Digital
Archives of Toyo Bunko Rare Books
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