

# **HANOI URBAN TRANSFORMATION IN THE 19TH, 20TH, AND 21ST CENTURIES ON AREA INFORMATICS APPROACH - DISAPPEARANCE OF THE LAKES AND PONDS, AND TRANSITION OF VILLAGES -**

**Mamoru Shibayama<sup>1</sup>, Go Yonezawa<sup>2</sup> and Truong Xuan Luan<sup>3</sup>**

<sup>1</sup> Center for Southeast Asian Studies, Kyoto University  
46, Shimoadachi-Cho, Yoshida, Sakyo-Ku, Kyoto, 6068501, Japan  
Email: sibayama@cseas.kyoto-u.ac.jp

<sup>2</sup> Institute of Sustainability Science, Kyoto University  
46, Shimoadachi-Cho, Yoshida, Sakyo-Ku, Kyoto, 6068501, Japan  
Email: go-yone@cseas.kyoto-u.ac.jp

<sup>3</sup> Department of Geoinformatics, Hanoi University of Mining and Geology  
Dong Ngac, Tu Liem, Hanoi, Vietnam  
Email: txluan@yahoo.com

## **ABSTRACT**

*One of the core research topics for Area Informatics project is research into the process of urban formation in Hanoi in the 19th and 20th centuries. In this research, we aim to explain the history of urban development in Hanoi, which has been the capital of Vietnam for 1,000 years, and to digitize that research process and its results for publication. To explain the process of Hanoi's urban development and transformation, we created thematic maps of actual phenomena within 4-dimensional space, taking into account both spatial and temporal axes, and we conducted a spatial analysis of various data we gathered, including maps, satellite images, land registers and historic ruins, using GIS (Geographical Information Systems) and RS (Remote Sensing) technologies in order to further research into the process of Hanoi's urban development. In this paper, the analyses for urban transformation in the 19th and 20th centuries with emphasis on urbanized city, water area, and villages, mainly, have been discussed.*

### **1. Urban formation and transformation in Hanoi in the 19th and 20th centuries**

Sakurai[1] has generated the following hypotheses concerning the urbanization and transformation of Hanoi from the latter half of the 19th century through the beginning of the 20th century based on maps and other materials that were gathered.

*"Hanoi was positioned on a natural embankment in the center of the Red River Delta, and many lakes and ponds formed by the riverbed of the old Red River remained at the base of the natural embankment. Through the continual filling in of these lakes and ponds, Hanoi achieved significant urban development and transformation during the Nguyen Dynasty period (1802-1945)."*

To prove these hypotheses, the authors used spatial information technology from GIS and RS as well as informatics to analyze basic materials such as maps[1], satellite images, cadastral map[3] and illustrated village maps[3]. The specific methods and procedures for proving the hypotheses are as follows. First, we undertook a broad survey of urbanization and transformation from the latter half of the 19th century through the beginning of the 20th century, and then we investigated sites that we contended showed "significant urban development." To do this, we (1) first created a 1:2000 vector map (digital map that can be

handled in a GIS system) that would serve as the reference based on maps and satellite images, and then we used GIS technologies to create a comparison and analysis of features, such as buildings, levees and land cover, from the period of 1873 through 1936. In addition, (2) it was necessary to accurately grasp the administrative classifications that existed in the precolonial period in order to investigate urbanization and transformation from the French colonial period onward. To do this, we established the geographical positional relationships of the villages in 1873 based on the cadastral map[5] and then we tried to use an informatics approach, including GIS technology and graph theory, to restore the prefectures, districts and villages. Then, (3) we had to investigate the geographical and topographical environment and conditions required for a discussion of Hanoi's urban formation. For this purpose, we built a three-dimensional topographical model based on elevation data (DEM) obtained from maps, and we created a broad overview of the topographical changes in Hanoi from 1950 through the present.

## **2. Urban transformation during the French colonial period – spatial analysis based on map comparisons**

Using maps from 1873, 1885, 1890, 1898, 1902 and 1936, we were able to clarify the following features by roughly dividing the Hanoi area into three areas: (i) Thang Long citadel and surrounding area, (ii) old quarter on the east side of the citadel (Pho Co district), and (iii) third natural embankment positioned in the area from the west bank of the Red River to the area south of Thang Long citadel (Figure 1).

(1) Urban development planning progressed in the Thang Long citadel area and its surroundings during the French colonial period, and in the 1890s, the walls and moats around the citadel disappeared (Figure 2 and Figure 4). (2) Ponds and lakes that existed in the old quarter in the Pho Co district disappeared in the 1890s, and new streets and urban development emerged. This is because during this period, levee construction protected against catastrophic flooding, and the development of the old quarter proceeded at an accelerated rate. (3) During the approximately 10 years from 1890 (Figure 3) to 1900, urbanization rapidly proceeded westward from the west bank of the Red River to the south side of the Thang Long citadel. (4) The streets we currently see in Hanoi were created during the urban development from the French colonial period onward and were mostly complete by 1936 (Figure 5).

### **2.1 Overview of urban transformation during the French colonial period**

There is evidence that the urban development during the 10 years from 1890 indicated in (3) above was aborted in some places. In addition, the boundary between the old quarter on the east side of the citadel and the citadel itself was unclear, which caused some debate among historians, but it was possible to confirm and verify the border using spatial analysis of maps and satellite images superimposed in a GIS system (Figure 6). In addition, the following quantitative analyses and estimates were also possible: the land area of the Thang Long citadel and villages, the distances between the villages, the distribution, densities and positions of the villages based on an 1873 illustrated map, the differentiation between thatch or brick in home building materials in 1873, as well as a timeline of the construction of the levees and the disappearance of lakes and ponds.



Fig. 1 Three areas in central Hanoi

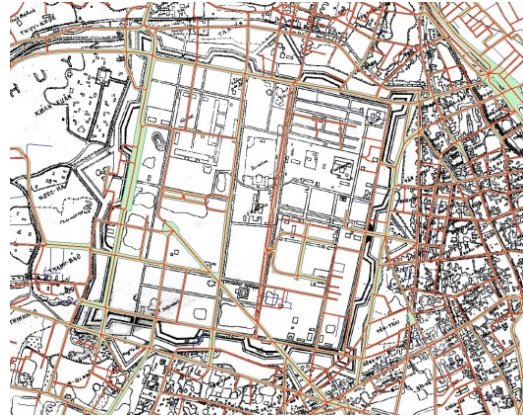


Fig. 2 Overlaying citadel in 1885 with current roads in 2005

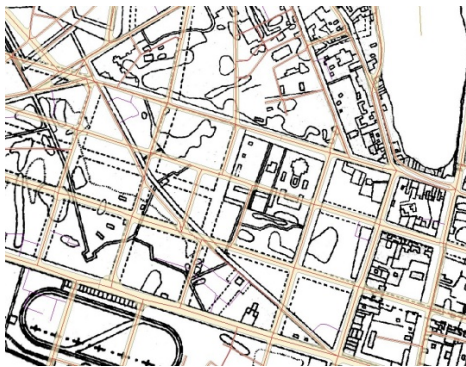


Fig. 3 Comparison for lakes and marshes between 1890 and 2005



Fig. 4 Comparison for streets between 1890 and 2005



Fig. 5 Current streets compared with 1936



Fig. 6(a) Overlaying map in 1885 with satellite image in 2005 (North)



Fig. 6(b) Range of houses on map (East)



Fig. 6(c) Houses view at a point 6(b):A

Table 1 Transition of water area

Variation in Lakes, Ponds, and Marshes (Total Area: 10.591Sq.Km)										
District	1885		1890		1898		1936		2005	
	N	Sq.	N	Sq.	N	Sq.	N	Sq.	N	Sq.
Ba Dinh*	37	0.706	47	0.588	21	0.355	3	0.261	4	0.223
Dong Da*	165	0.563	67	0.297	50	0.628	44	0.192	3	0.042
Hoan Kiem	159	0.576	97	0.819	45	0.242	1	0.117	1	0.105
Hai Ba Trung	244	0.908	55	0.749	88	0.763	106	0.648	3	0.257
Total	605	2.753	266	2.453	204	1.988	154	1.218	11	0.627
		100.0%		89.1%		72.2%		44.2%		22.8%
*: Partial Area									Unit.: Sq. Km	

## 2.2 Urban development under the French

A practical development plan spanning approximately 15 years from the start of the French colonial period can be understood by comparing the 1898 vector map and the 2005 digital map. In the 1898 map, the actual streets at that time and the planned streets are distinguished from each other and marked. Therefore, if you use GIS technologies to extract only the actual streets of that time and the planned routes, you can clearly extract the development plan of the period. If you compare that to 1890, the plan for street development on the south side of Thang Long citadel has changed, and you can see that some of the street plan from 1890 has disappeared by 1898. In addition, in the 1898 map, there was a plan for a straight street running diagonally from the west side of the citadel toward the south of Hoan Kiem Lake, but when it is superimposed with the 2005 digital map, it does not match the current streets. This could be another example of an aborted plan (Figure 4).

## 2.3 Disappearance of lakes, ponds, and marshes

We examined the transition of water area from 1885 to 2005 in central Hanoi based on extraction of lakes, ponds, and marshes using 1885, 1890, 1898, 1936, and 2005 maps. The calculation of basis is based on the 1885 map as shown in Figure 7(a). The outline of distribution of water area is shown in Figure 7(a)-(c). Table 1 and Figure 7(f) indicate the numerical change for the distribution. The water area was decreased 72.2%, 44.2%, and 22.8% in 1898, 1936, and 2005 respectively compared with 100% in 1885. Namely, 27.8% was decreased for 14 years from 1885 to 1898. Consequently, 28.0% was decreased for 38 years from 1899 to 1936. Eventually, 55.8% was filling in until 1936. As a result, filling in of lakes, ponds, and marshes between 1885 and 1898 was rapidly progressed compared with the beginning of the 20 century.

## 3. Positions of the old Hanoi villages – spatial estimates using GIS technology

### Estimated positions of old villages, prefectures and districts

To understand the significant transition to urbanization from the beginning of the French colonial period, it is necessary as a basic premise to accurately grasp the positions and distribution of the old villages and streets in the precolonial period. We conducted field research to obtain land registers from old precolonial villages in 1873 (data count: 168 villages). We used these land registers and the "Districts of Tho Xuong and Vinh Thuan" map to estimate the location of the individual villages onto a 2005 blank map. We used a Voronoi distribution analysis method to estimate the area of each of the villages. From these results it



was possible to estimate the land area of each of the villages and the adjacent relationships



Fig. 7(a) Target area

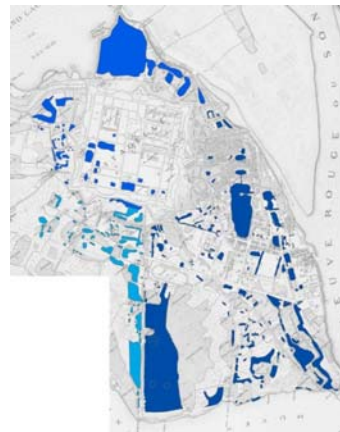


Fig. 7(b) 1885

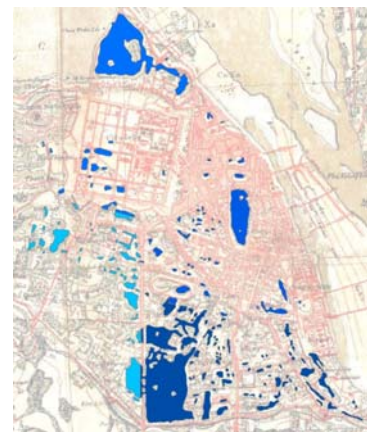


Fig. 7(c) 1890

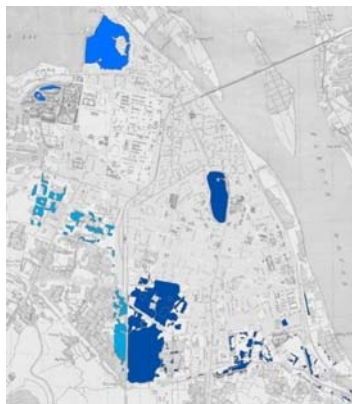


Fig. 7(d) 1898



Fig. 7(e) 1936

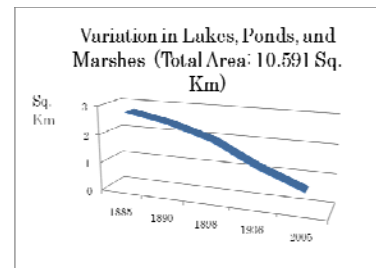


Fig. 7(f) 2005

among the villages, and it was an effective method for comparing the scale of the villages using land area. Then we combined this village mapping with the administrative classifications (prefectures, districts, villages) recorded in the land registers. These results made it possible to estimate the positions and sizes of the districts, which were a higher order spatial unit than the villages.

To accurately grasp the positional relationships between the 168 villages that were plotted, we tried to use an informatics approach to verify them. We focused on keywords for the neighboring, bordering and facing villages, streets and buildings indicated on the north, south, east and west lines in the land registers, and then we tried to infer the positional relationships between them. Based on the results of extracting the keywords, it was possible to use graph theory to visualize the adjacent relationships between the old villages. By comparing and examining these results superimposed with the Voronoi diagram, it became possible to more accurately estimate the positional relationships of the villages.

#### 4. Three-dimensional topographical landscape model

It is difficult to use two-dimensional spatial analysis to solve the problems of how so many lakes and ponds disappeared, or what were the processes by which the construction of the levees on the west bank of the Red River progressed, and how these affected all of the transformations of the urban environment during the urbanization from the latter half of the 19th century through the beginning of the 20th century. What can resolve these issues is analysis using three-dimensional modeling.



Fig. 8 Landscape in 2005



Fig. 9 Landscape in 1885

In the 2005 Hanoi map, the number of stories of the houses, which indicates their height, is listed for each block of houses. If you enter these blocks and the number of stories into a GIS system as three-dimensional data (features), it is possible to generate a three-dimensional urban landscape model. Yonezawa is currently entering approximately 700,000 data points. Expressing each feature using a timeline makes it possible to restore the urban landscape of that time. This includes the distribution of thatch and brick homes, as described above. In addition, it becomes possible to create an overview of how the current urbanization is advancing in the places where the lakes and ponds existed in the past. Figure 8 and 9 show the landscape using 3D modeling in 2005 and in 1885 respectively.

## 5. Conclusion – Area Informatics approach

In the research on the formation of the city of Hanoi described in the previous section, we superimposed eight maps from 1885 through 1936 with the base map, and we used spatial analysis to compare and examine urban transformation. Next, the accurate superimposition of the maps, accompanied by field research, yielded some conclusions regarding the history and location of the border between the old citadel and the old quarter, which were in dispute among historians. In addition, the following quantitative analyses and estimates were also possible: the land area of the Thang Long citadel and villages, the distances between the villages, the distribution, densities and positions of the villages based on an 1873 illustrated map, the differentiation between thatch or brick in home building materials in 1873, a timeline of the construction of the levees and the disappearance of lakes and ponds, as well as the distribution of ruins and historical sites and the distribution of historic relics and inscriptions. By building a three-dimensional topographical model, I was able to clearly see the landscape in some urban areas.

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