CONSTRUCTION OF URBAN 3-D MODEL OF HANOI, VIETNAM

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ABSTRACT

Analyzing the relief of terrain and micro-topography of Hanoi City plays an important role towards an explanation of urban transformation. It is necessary to generate the DEM (Digital Elevation Model) using the elevation data to analyze the geomorphic change. DEM is a digital representation of ground surface topography and the most important element of topographic analysis for urban transformation (i.e. evidence of existence such as old river, lake, fill and land subsidence). Consequently, we have generated the DEM of Hanoi City by the collected 8,000 points data. Based on the surface estimation method using Cubic B-Spline Function, it is generated at 2 meter resolution. Contour interval is 0.5 meter. The very subtle elevation gaps which can not be distinguished on the satellite image are significantly recognizable on this DEM. Meanwhile, the topographic map as a paper map was generated by French government in 1950 which belongs to French library. We also have generated this DEM at 2 meter resolution based on the DEM generation using the method of STRIPE. And it enables to show the difference between DEM (2005 and 1950). By comparing 2 patterns of DEM, the area of fills and lands subsidence are figured out. Moreover, the 3-D mode of buildings which we generated from house map in Hanoi City can be expressed visually.

1. INTRODUCTION

Hanoi City, the capital of Vietnam, is one of the fastest-growing cities in Southeast Asia. However, there were many lakes and ponds which were relict lake from old Red River (Sông Hồng) in Hanoi City before the 19th century. Early 20th century, they had disappeared almost completely on the map. The outline of this urban transition is explained by Sakurai et al. (2007). Practically, it is shown by Yonezawa et al. (2007) using GIS technology.

There are two important key points when we think this urban transformation in Hanoi City. One is that Vietnam was under French rule in the late 19th century. An urban planning of French government had a profound influence on an urban development of Hanoi City. The

other is geography of Hanoi City and natural environment around it. Hanoi City is located in a flood plain of the Red River, the average elevation being less than 10 meters. Therefore, it has been facing the repeated flood since a long time ago. According to the map which was drawn by French government, there was already a large-scale dike in the late 19th century.

In this study, we investigate an urban transformation of Hanoi City from topographic changes in the 19-20 centuries. To analyze the relief of terrain and micro-topography for such an urban transfiguration, we need to generate the DEM (Digital Elevation Model) using the elevation survey data. DEM is a digital representation of ground surface topography and the most important element of topographic analysis for urban transfiguration (i.e. evidence of old river, lake, fill and land subsidence). Consequently, we have generated two patterns of DEM of Hanoi City (2005 and 1950). By comparing them, the area of fills and lands subsidence are visually figured out. And, the three dimensional (3-D) mode of buildings which we generated from house map in Hanoi City can be also expressed apparently. It must be useful for an urban transformation because it is difficult to estimate how so many lakes and ponds disappeared by using two dimensional (2-D) spatial analysis only.

2. URBAN TRANSFORMATION OF HANOI

Figure 1 shows an urban transition of Hanoi City. The left image of Figure 1 is a historical map in 1873. We can find many lakes and ponds in Central Hanoi City. The right image of Figure 1 is a satellite (IKONOS) image in 2005. The lakes and ponds existed in 1873 disappeared. It means the apparent changes in recent 130 years are shown visually. Sakurai et al. (2007) showed from the historical materials (i.e. old map and literatures.) that obvious urban transformation of Hanoi City caused during the Nguyen Dynasty period (1802 ～1945). This change would be related to French government. Because Vietnam was under French rule from 1887 to 1954, French army headquarters were strategically placed in the Thang Long Citadel (central Hanoi City). At first, many military facilities of France were built in the citadel. The urban development which is centered in this citadel continued until the 1930s. It was developed by continuous land-filling of many lakes and ponds.

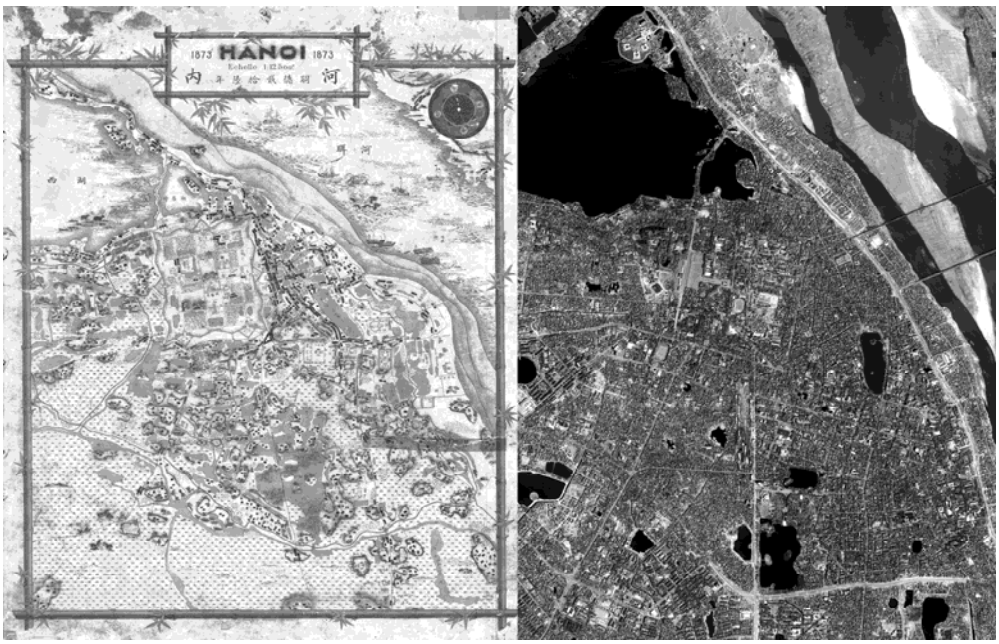

Figure 1. Urban transition of Hanoi City.

3. GENERATION OF HIGH RESOLUTION DEM

The SRTM (Shuttle Radar Topography Mission) is one of the most famous DEM which is covering the entire world. However, it is a low resolution for analyzing the urban transformation of Hanoi City, the resolution of SRTM-3 is about 90 m and SRTM-30 is about 900m. To analyze the urban transformation of Hanoi City, we need to generate much higher resolution.

Therefore, we generated the DEM (8km x 8km) of Hanoi City from approximately 24,000 points data collected in 2005. This survey data was provided by Hanoi University of Mining and Geology (HUMG). The all point data are shown in Figure 2. Based on the surface estimation method using Cubic B-Spline Function, we generated this DEM at 2 meters resolution (Nonogaki et al., 2008). The research area and generated DEM in whole area of Hanoi City are shown in Figure 3. Contour interval is 0.5 meters. The very subtle elevation gaps which can not be distinguished on the satellite image are significantly recognizable on it. The example of the visualization of 3-D DEM is shown in Figure 4 using the NVIZ of visualization tool in GRASS GIS software. It is

Figure 2. Point data of elevation survey.

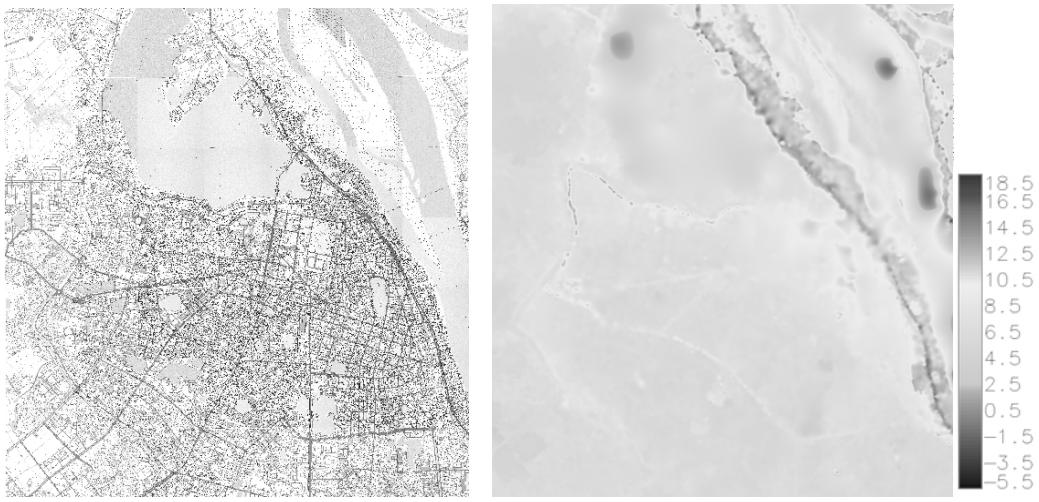

Figure 3. DEM of Hanoi City in 2005.

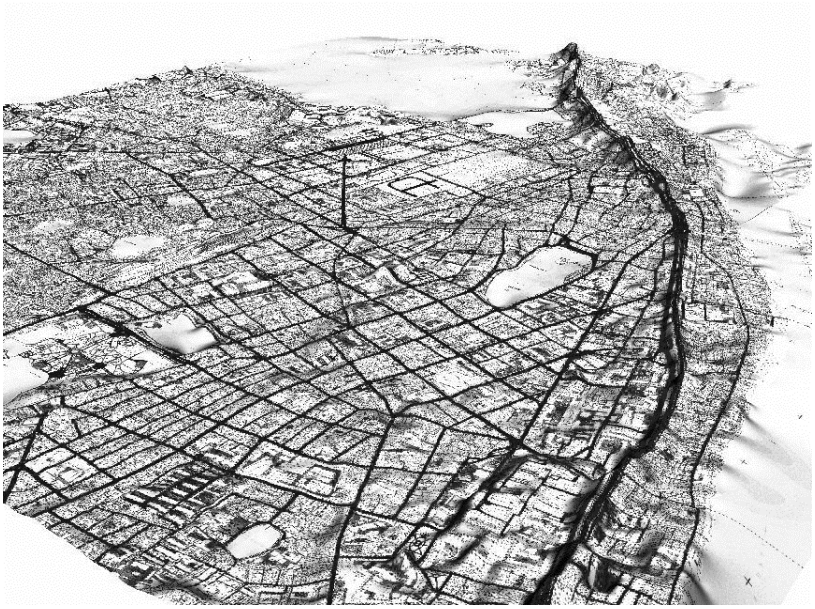

Figure 4. Example of the visualization of 3-D DEM.

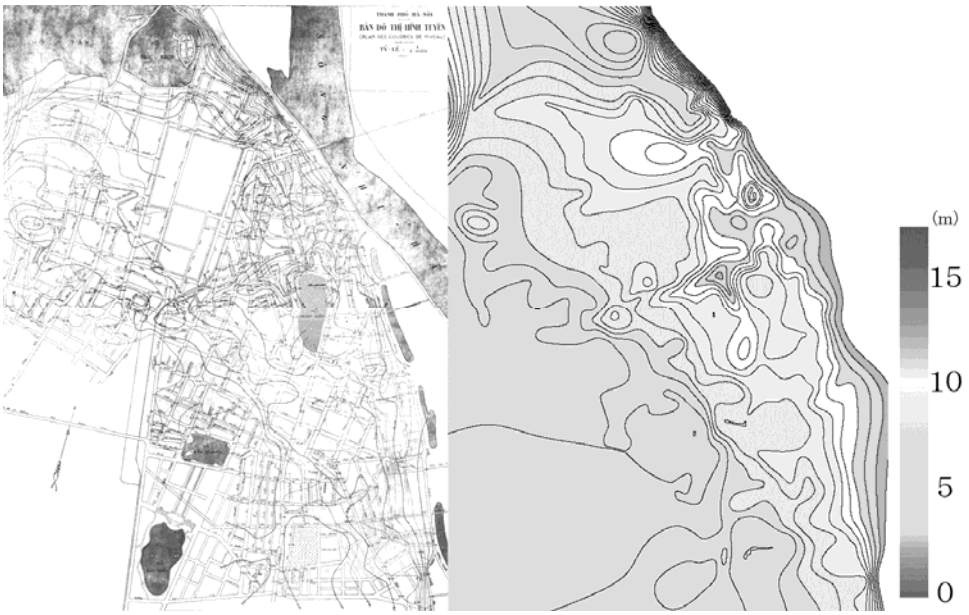

Figure 5. DEM of Hanoi City in 1950.

overlaid the Hanoi road map on the generated DEM.

Topographic map is generated by French government in 1950 comes from French library as paper map (the left image of Figure 5). We also generated this DEM at 2 meters resolution based on the DEM generation using the method of STRIPE (Noumi et al., 2003). This result is shown in the right image of Figure 5. Contour interval is 0.5 meter. We generated the difference of DEM by the comparing between 2005 and 1950. As a result of the comparing of both DEM, we found two remarkable points. One is the elevation of big dike which is about 2 meter higher than the 1950's elevation. The average height of dike in 2005 is about 12 meter, on the other hand in 1950 it was about 10 meter. This difference is shown that the dike is additionally constructed from 1950. Haruyama (2004) showed the height of dike in 1809 was 3.5 meter from historical materials. Therefore, the height of dike will be increasing year by year. The other is a land subsidence in Pho Co district. The average

Figure 6. 3-D modeling for building in Hanoi City (Pho Co district).

elevation of this area is about 9 meter in 2005. This is 0.5 meter lower than the elevation in 1950.

Unfortunately, the topographic map was not available excepting the survey data in 2005 and French topographic map in 1950. Therefore, by the comparing of both DEM, we think that it can be expected to show the urban transformation in Hanoi City from the topographic perspective.

5. 3-D MODELING OF BILDINGS

We generated the vector map of each block of houses in the Pho Co district in Hanoi City by using the house maps in 2005 which are provided by HUMG. It is consisted of 12,000 polygon data. These are converted the 3-D data (features) using the GIS software. It is shown in Figure 6 and termed the 3-D model for the building. This 3-D model is not only visualized the landscape in the Pho Co district accurately, but also reflected the elevation in this area. Thus, the 3-D features are built on DEM which is shown in Chapter 3. Therefore, we can create an overview of how the current urbanization is advancing in the area where the lakes and ponds existed in the past.

6. CONCLUSION

The generated DEMs give us not only the detail information of terrain of Hanoi City, but also the information of landform changes for approximately 50 years. There are two notable changes; (1) the additional construction by government, (2) the change of terrain around Pho Co district. Future work, we plan to study the relation between the flood and the construction of dike in Hanoi City. Hanoi City has been protected by this dike from the flood of Red River for a long time. We need to concern about the effects of dike of Red River on the urbanization and the life of residents. Additionally, we need to search the traces of an ancient river and the landfill area from the generated DEM. These signs can be an indicator of relation between the urban transformation and the topographic changes.

8. REFERENCES

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