APPLICABILITY OF 3D GIS TO THE VIEW PRESERVATION POLICY OF KYOTO CITY

T. Kirimura [a, *], K. Yano [a], H. Kawaguchi [b]

[a] Ritsumeikan University, 56-1 Tojiin-kitamachi, Kita-ku, Kyoto, 603-8577 - (lg004016@ed, yano@lt).ritsumei.ac.jp
[b] Kyoto City Office, 488, Teramachi-Oike, Nakagyo-ku, Kyoto, 604-8571 - kawcd706@city.kyoto.jp

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ABSTRACT:

This study demonstrates how 3D GIS is applicable for local administrative affairs. In order to preserve its urban landscapes, the Kyoto City Government enforced the ordinances in 2007. They tightly control the appearance and height of buildings in five aspects: the height regulation in the city center; view preservation from certain viewpoints; design restrictions of the buildings; regulation against outdoor advertisements; and preserving and improving the historical landscapes.
Among these five, we, some members of Ritsumeikan University and the Kyoto City Government, discuss here how to use 3D GIS for view preservation from certain viewpoints. For this purpose, what is helpful is Virtual Kyoto, a virtual time-space that we created on the computer in order to investigate the past, present and future of the historical city of Kyoto. The present Kyoto is represented, combining the 3D models and GIS databases. Using these digital data of the present Kyoto, we can simulate an urban landscape.
We had cooperated with the Kyoto City Office in the view preservation even before establishing the ordinances. Some of the simulations we made contributed to the committee's discussions on the ordinances. A case in point is a 3D model of the view of Mt. Daimonji, one of the five mountains where Gozan Fire Festival is held every August. The model simulates the view of the mountain from certain viewpoints, showing buildings to be targeted for the height regulation in terms of view preservation.
Since the ordinances took effect, we have been cooperating with the City Office, informing the public of height-regulated areas in terms of the view protection. Since the regulated heights differ from area to area, we built a viewing system of the height regulation using WebGIS to deal with this problem. This system is available at the City Office via the Internet.
This case study demonstrates that 3D GIS can be applicable as well as helpful for local administrative affairs at least in two ways. First, the use of 3D GIS is effective for the policy-making of height restrictions since it can illustrate persuasively their results. Furthermore, in the case of the complicated regulated areas, WebGIS and 3D GIS can help the public understand them easily, providing visualized and virtual information about them.

1. INTRODUCTION

1.1 Historical Landscape of Kyoto

Kyoto, one of the most historical cities in Japan, originates in Heian-kyo, an ancient capital founded in 794. The street system of the inner city takes a grid pattern, based on the urban plannings set in the eighteenth and the sixteenth centuries. The mountains surrounding the city are viewed from anywhere in the inner city because of the street system. In addition, there still remain a lot of historical buildings such as *machiya* (old wooden houses). For a long time, Kyoto residents have preserved this landscape with the mountain view and *machiyas* (Fig. 1).

The Kyoto City Government has helped preserving the landscape since 1930. Since developments of the mountains have been tightly regulated, green spaces surrounding the city have remained as they were. Recently, however, the number of *machiyas* in the inner city has been decreasing, and high-rise buildings are replacing them. The historical landscape of Kyoto is just being lost for this reason.

Figure 1. *Machiyas* and Mt. Daimonji

1.2 New Landscape Policy of Kyoto

In recent years, the city government has come to recognize its landscape as public assets that should be handed down to future generations. They also think that it is a duty and responsibility of the citizens. In September 2007, the city government started enforcing the ordinances for a new landscape policy under these

* Corresponding author.

Figure 2. 3D view of Kyoto

concepts, which are to control the landscape in the following five aspects (Kyoto City, 2009):

1. Building height - maximum heights are lowered over a wide range while segmenting height controls according to the areas' characteristics.
2. Design of buildings, etc. - regulation districts are more broadly expanded than before while fine-grained design standards are set in tune with regional characteristics.
3. Surrounding scenery and vistaed view - building height and designs are controlled at 38 locations selected by the committee for Forming Timeless and Radiant Kyoto Landscapes.
4. Outdoor advertisements - by regulating outdoor advertisements across the whole city, dignified beautiful scenery can be formed. In addition, the qualities of the advertisements are improved by advantages of high-grade advertisements.
5. Preserving and improving historical landscapes - since the *machiyas* convey traditional building styles and lifestyles, the government subsidizes their preservations, outer repairs and improvements.

Among these five, we, some members of Ritsumeikan University and the Kyoto City Office, here focus on the third point, discussing how to use 3D GIS for view preservation from certain viewpoints. Before the committee drew up the ordinances on the view preservation, we helped them by simulating various 3D scenes.

1.3 Virtual Kyoto Project

The Virtual Kyoto project has been a part of "Kyoto Art Entertainment Innovation Research (2002-2006)" at Ritsumeikan University driven by the 21st Century COE (Center of Excellence) Program funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and now handed over to the Global COE Program (2007-2011) entitled "Digital Humanities Center for Japanese Cultures and Arts." It aims at reconstruction and visualization of historical landscapes in Kyoto using 4D GIS, 3D GIS with a time dimension (Yano et al., 2009).

In this project, we mainly use MAP CUBE® data from INCREMENT P CORPORATION, CAD CENTER CORPORATION and PASCO CORPORATION. The data consists of prismatic 3D building block models based on building footprints and heights for the whole city of Kyoto (Fig. 2). Since 3D GIS allows us to conduct spatial analyses for heights, the project could help the Committee drawing up the ordinances on the view preservation.

This paper not only introduces some applications of the Virtual Kyoto project for the view preservation policy but also addresses some problems when applying 3D GIS for landscape policies. GIS was originally designed for urban planning, and 3D graphics is an information technology used to visually show complex phenomena (Hudson-Smith and Evans, 2003). With this case of Kyoto, we demonstrate how 3D GIS that combines 3D graphics and GIS can be useful to solve problems of urban landscapes.

Figure 3. "*Dai* (大)" character on Mt. Daimonji

No	*Type*	*Area*
1	Temple Views	14 World Heritage Sites, Kyoto Imperial Palace Park, Shugakuin Imperial Villa, Katsura Imperial Villa
2	Street Views	Oike St., Shijo St., Gojo St., Sanneizaka, etc.
3	Waterfront Views	Hori River, Uji River, Biwa Lake Sluice
4	Background Views of Gardens	Entsuji Temple, Shosei Garden
5	Mountain Views	Higashiyama and Kitayama from Kamo River, Nishiyama from Katsura River banks
6	Bonfire Characters Views	Gozan no Okuribi as seen from Kamo River, Kitayama St., Funaokayama, etc.
7	Lookout Views	Arashiyama range as seen from Togetsu Bridge downriver
8	Bird's eye Views	Cityscape seen from Daimonjiyama

Table 1. Types of vistaed views in Kyoto City

2. APPLICATIONS OF 3D GIS FOR VIEW PRESERVATIONS

2.1 View Preservation Policy

Kyoto's ordinances on the view preservation were the first to introduce the concept of vistaed view to urban planning in Japan. The city has many traditional vistaed views, one of which is Gozan Fire Festival. On August 16 every year, Chinese characters are lighted up on the five mountains, some of which continue the tradition for more than 200 years (Fig. 3). In order to preserve these vistaed views, the city needs to control the height of buildings that would cut across the views from certain viewpoints, as well as to regulate designs of buildings. Today, preserved are eight types, the total of thirty-eight vistaed views selected by the committee (Table 1).

The committee needed various kinds of information to select these thirty-eight, and 3D virtual views offered by Virtual Kyoto can constitute an important piece of the information. In the following section, we introduce one of such examples.

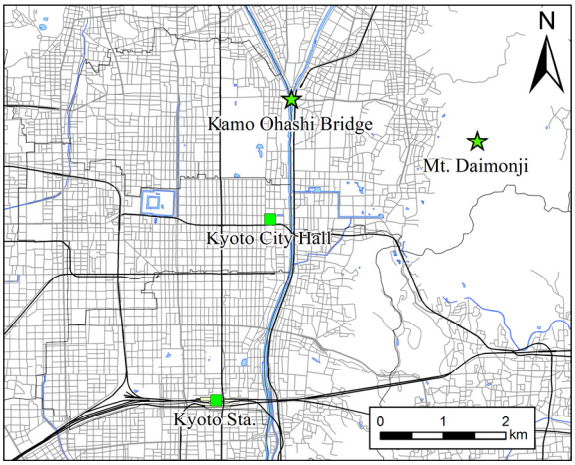

Figure 4. Locations of Mt. Daimonji and the Kamo Ohashi Bridge

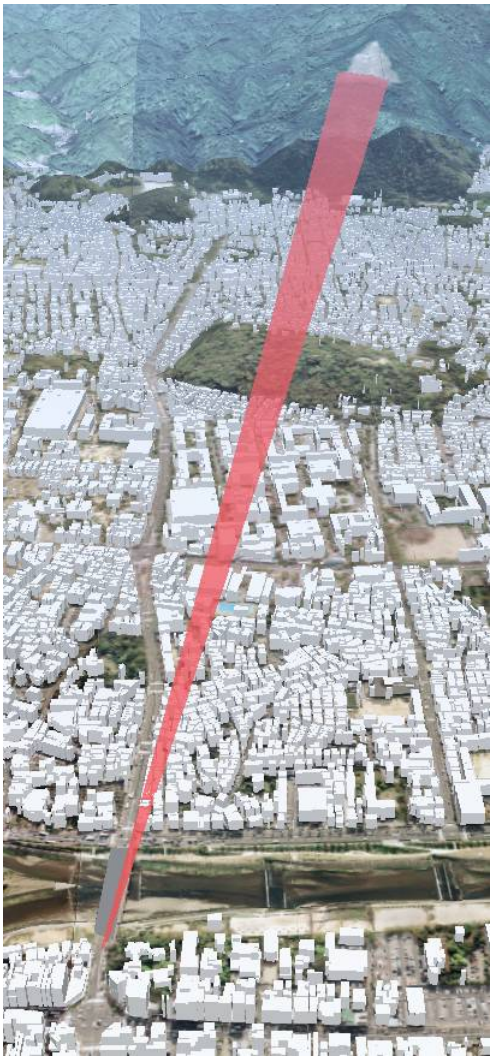
Figure 5. 3D-simulated view from a viewpoint near the Kamo Ohashi Bride to Mt. Daimonji

2.2 A Case of Vistaed View of Mt. Daimonji

One of the five mountains where Gozan Fire Festival is held, Mt. Daimonji lies in the east of Kyoto City (Fig. 4). The Kamo Ohashi Bridge over the Kamo River is considered one of the major spots to view Mt. Daimonji. Figure 5 shows a simulated


Figure 6. A Photo taken from the same viewpoint as Fig.5

view from a viewpoint near the Bridge. In this simulation, heights of buildings are to suggest maximum values in the previous ordinances. The red polygon indicates the view, and we can see some buildings stand to cut across the view to the bottom of the character. According to this 3D view, height control ought to be enforced actually in some areas near the river.

The implemented ordinances set Mt. Daimonji's viewpoints in a riverside park, located a little north of the Bridge. In the regulated area for this view, the maximum height at a certain point is approximately 61.8 meters high, and it is about 53.3 meters above sea level around the area. That means that, if a building is less than 8.5 meters high, its building permit will be granted.

A photo taken from the same viewpoint as the above-mentioned 3D view shows that some utility poles and electric cables cut cross the vistaed view (Fig.6). However, since these elements are not represented in Virtual Kyoto, we cannot simulate the 3D vistaed view in detail.

3. APPLICATIONS OF WEBGIS FOR SHOWING REGULATED AREAS

3.1 Regulations on Building Heights: Their Complexity

The regulated areas selected by the committee are complicated in three ways. Firstly, the value of regulation is different, depending upon locations. Only in the regulated area of the view for the Entsuji Temple's Garden, the height value is the same 110.2 meters, but in the other area, the closer the viewpoint is, the lower the value is. Secondly, the elevation varies depending upon locations, and so do the maximum heights of buildings. Finally, shapes of the regulated areas are very complicated.

As a result, the city government needs to provide citizen-friendly information about the regulated areas. For this purpose, we find WebGIS very useful. Google Maps API, one of free WebGIS, is easy to use and inexpensive. Moreover, it can also provide detail maps of individual buildings.

3.2 Viewing System of Regulations about View Preservation

We constructed the viewing system of the regulations about the view preservation with WebGIS (Fig. 7). In this system, Map Guide Open Source (MGOS), another free WebGIS, is used in addition to Google Maps API. In this system, MGOS works as a

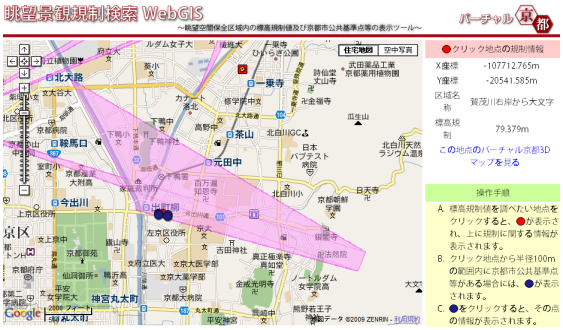

Figure 7. Viewing system of regulations about view preservation (http://www.geo.lt.ritsumei.ac.jp/keikan/)

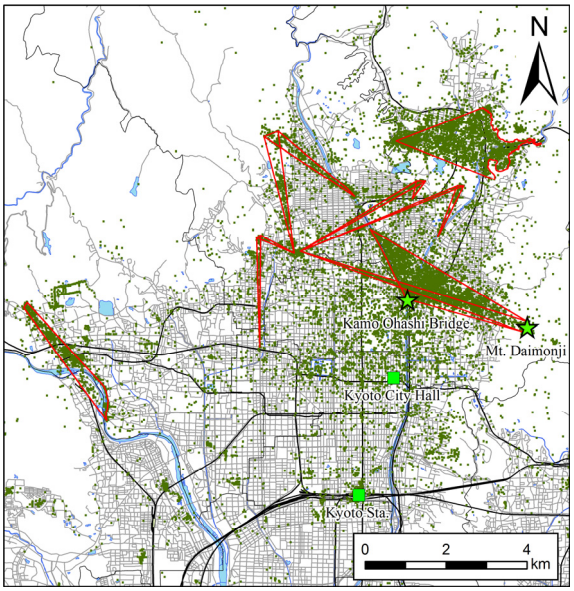

Figure 8. Regulated areas (bordered by red) and clicked points (in green) in the viewing system from Nov. 2007 to Aug. 2009

WMS (Web Mapping Service) server for delivering geographical information of the regulated areas.

If a user clicks a point on the map of this system, he or she can get the type of view preservation on the location, the value of regulation, and the elevation around there. The elevation that appears on this system is the value of an adjacent point, not the one of the clicked point exactly. This is because the value must be accurate. In order to get the elevation on an arbitrary point, we usually use interpolated elevation data by IDW or Kriging to get estimated values. However, since this regulation may touch upon delicate issues on property rights, this system should not provide inexact information such as estimated values. For the same reason, we set the limit to the maximum zoom level in this system, thus not as good as the one provided by Google Maps.

This system is a part of the website of Virtual Kyoto (http://www.geo.lt.ritsumei.ac.jp/) and linked to Virtual Kyoto 3D Map, a main content of Virtual Kyoto. The user of this system, therefore, can browse a 3D view by clicking the point.

3.3 Users' Trends

The WebGIS-based viewing system was released in August 2007, and since then, we have been logging users' accesses. In this section, we will refer to some trends of clicked points.

For about two years, 34,554 points have been clicked by 3,823 users. On an average day, 6 users click 9 points. In September and October 2007 right after the start of the ordinances, some users clicked hundreds of points. They might have been checking how accurate the information was. The users accessed from November 2007 to August 2009 clicked points in northern parts of Kyoto (Fig. 8). Most of them are found at the regulated areas for the view preservations. Since some point-concentrated areas are currently vacant lots or newly occupied, it is likely that the citizens are actually utilizing this viewing system.

4. CONCLUSIONS

In short, this paper explored how useful Virtual Kyoto can be as visual information for the committee. The regulated areas in the view preservation policy are complicated in many ways. Using 3D GIS for this case, however, one can clearly understand which building is subject to the regulations by the ordinances. In addition, the WebGIS-based viewing system can easily inform the public of the regulated areas, and the access log to this system demonstrates its high degree of usability.

Still, for the further applications of 3D GIS for view preservation policy, we must solve some problems. One of them is, of course, a financial one. The 3D GIS data such as MAP CUBE® are created only in big cities at the moments. When some other areas need this kind of data, they must create them by using high-priced cameras and airplanes. Another problem is data accuracy. For example, while utility poles do not show up in the 3D space of Virtual Kyoto, they could cut across the view in the real space. Using 3D models of several types of poles may solve this problem some degree, but by all means it is not a perfect solution. Moreover, for more effective applications for the urban planning, city governments need to secure 3D GIS specialists. In order to achieve this, essential is continual cooperation between universities and city governments.

ACKNOWLEDGEMENTS

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