

# GIS-Based Landscape Visualization and Visibility Analysis of the Mountain View in Heian-kyo, a Capital City of Ancient Japan

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Heian-Kyo, the capital city of Japan in the Heian Period (AD. 794–1192), was located in the northern part of the Kyoto basin. Heian-Kyo has been categorized as a grid city on the basis of its city plan. Some previous studies in the field of historical geography and urban history have noted that the city planning of Heian-Kyo was considered about the view of the surrounding mountains. In fact, there are mountain peaks on the north and the south of the north-south central axis of the Heian-Kyo grid-based city plan. However, to date, we have not been able to image the view of the mountainous landscape from the center of Heian-Kyo in 3D because at the current Heian-Kyo site, a number of high buildings block the view of the mountains from the city. Therefore, in order to carry out a visibility analysis of the Heian-Kyo site, it is necessary to restore the past landscape in 3D.

The aim of this study is to restore the landscape of Heian-Kyo by using 3D-GIS and 3D-CG technologies and simulate the visibility of mountains from the Heian-Kyo area by utilizing this 3D landscape visualization system. This system called “Virtual Heian-Kyo” is constructed using three types of data, namely topographical data, land use data, and buildings data, that are mainly acquired from archaeological excavation and historical documents. “Virtual Heian-Kyo” provides an interactive environment by using a 3D viewer in the GIS software in spite of the fact that more than 10,000 3D building models are arranged in the viewer as 3D map symbols.

As a result of the visibility analysis using “Virtual Heian-Kyo,” we could simulate the view of the surrounding mountains from the ground in the Heian-Kyo area, especially the relation between the buildings and the mountain peaks. In the landscape simulation from the “Daigoku-Den,” the Center Hall on the north-south central axis in the Heian Palace area, we could find mountain peaks in each of the four directions (north, south, east, and west). As it is already known that Mt. Funaoka is located along the northern extended line of the central axis

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and Mt. Kannabi is located along the southern extended line of the central axis, we can confirm, for the first time, that the peak of Mt. Daimonji is located in the eastern direction from “Daigoku-Den” and the peak of the Kamiyamada triangulation point is located in the western direction from “Daigoku-Den”.

Thus, 3D landscape visualization using information technologies, including GIS and 3D-CG, can provide new insights into various subject areas of the humanities such as landscape research in the fields of archaeology and geography. Although in this study, we have referred to geographical information as secondary source material archived from databases of early studies, in the future, it will be important to create a GIS database for geographical information on Heian-Kyo that is acquired directly from a large number of archaeological excavations and historical documents.

**Keywords: GIS, 3D, Visualization, Landscape Model, Kyoto**

DADH2010

# 以 GIS 為基礎的日本古都平安京之地景視覺化與可視性分析

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平安京為平安時代日本首都(AD. 794–1192)，坐落於京都盆地北部，其城市規畫為棋盤式。過去的歷史地理學與都市史研究指出，平安京的都市規劃亦將周邊山區地勢列入考量。事實上，在平安京棋盤式的城市平面圖上，南北中央軸線兩端各有山峰。然而，由於眾多高樓大廈阻擋，致使今日，我們無法從市區想像出週遭山勢的 3D 景象。因此，在分析可視性時，有必要重建以往地貌的 3D 模型。

本研究使用 3D-GIS 以及 3D-CG 科技來重建平安京的地貌與模擬，並搭配運用 3D 地景視覺化系統來模擬由平安京眺望週圍山區的可視性。這個名為「虛擬平安京」的 3D 地景視覺化系統，內含地形、土地使用與建築物等三種資料，分別來自考古採集與歷史文獻。此系統提供一個互動環境，藉由 GIS 軟體中的一個 3D 觀視器，將超過 10,000 筆的 3D 建物模型，建置在 3D 圖上，並一一顯示。

運用「虛擬京都」進行可視性分析，我們得以模擬平安京週圍的山區景象，特別是建築物與群峰間的關係。在模擬位於平安宮南北中央軸線正中的「大極殿」景觀時，可以清楚發現，東西南北四個方向皆有山峰，除了位於中央軸北方延伸線上的船崗山，與位於南方延伸線上的神奈備山，我們首次得以確認大文字山就在「大極殿」的東方，而上山田的三角測量點主峰就在「大極殿」的西方。

地景 3D 視覺化工具，運用了 GIS 與 3D-CG 兩項資訊科技，可以提供人文領域，如考古學與地理學，景觀研究新的見解。雖然本研究中使用的是二手地理資料，取自先前相關研究的資料庫，未來有必要利用大量考古資料與歷史文獻，將所蒐集的平安京地理資料建置一個專屬的 GIS 資料庫。

**關鍵字：**GIS、3D、視覺化、景觀模型、京都

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