UNFOLDING THE LANDSCAPE DRAWING METHOD OF *RAKUCHŪ RAKUGAI ZU* SCREEN PAINTINGS IN A GIS ENVIRONMENT

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Abstract *In this paper, I propose a new methodology for analysing landscape drawing methods using a GIS. The subject of my analysis is the genre of Japanese screen paintings known as* rakuchū rakugai zu*, created between the 16th and 18th centuries.* Rakuchū rakugai zu *provide bird's-eye views of the then-capital city of Kyoto, including buildings, natural features, and human activities. The methodology introduced here uses GIS spatial analysis functions to scan the painting surface onto a survey coordinate grid based on the relative positions of landmarks in the painting. The analytic sequence is as follows: (1) derive coordinate values for landmarks both on the painting and on a survey coordinate grid; (2) generate a link table from these two point-data sets; (3) use the projective transformation and rubber sheeting techniques to project the painting surface onto the survey coordinate grid; and (4) project the areas of the rubber sheet-derived polygons onto the painting. This process gives visual representation to differences between real space and the depicted space. Results show that* rakuchū rakugai zu *painted in the seventeenth century and later distorted real space more than those painted in the sixteenth century, indicating a decrease in adherence to conventional perspective-based painting.*

Keywords: Japanese Screen Paintings, Kyoto, Visualisation

INTRODUCTION

Recently, the use of Geographic Information Systems (GIS) to analyse historical space has attracted interest; this approach is known as Historical GIS (HGIS)[1].

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Most HGIS-related research to date has been limited in scope, relying primarily on the use of administrative boundary data and modern-style statistics[2]. In the interest of developing new areas of HGIS-based research, I propose a methodology for analysing landscape drawing using GIS. By applying this methodology to multiple landscape paintings, I aim to identify the characteristics of the methods employed to create these paintings and determine how these characteristics changed over time.

The subject of my study is a series of Japanese screen paintings known as *rakuchū rakugai zu*, created during the sixteenth to eighteenth centuries. *Rakuchū rakugai zu* – literally 'views inside and outside the capital' – provide contemporary bird's-eye views of the city and environs of Kyoto, Japan's capital at the time. The paintings include man-made structures such as the residences and palaces of prominent samurai and court nobles, temples and shrines; natural features such as hills and rivers; and festivals and other human activities. Nearly all of these works consist of a pair of folding screens of six panels each. At present, over 100 such sets are known to have survived.

Because the scenes of Kyoto depicted in *rakuchū rakugai zu* provide historical information not found in written texts, these paintings have attracted the interest of scholars in a variety of fields, including historians (Imatani,[3] Kuroda,[4] Okami and Satake,[5] Mizumoto,[6] Osawa and Kato[7]) and architectural historians (Naito,[8] Takahashi[9]) analysing specific regions, drawing ranges, and landmarks, as well as art historians (Takeda,[10] Tsuji,[11] Ozawa,[12]) seeking to identify the purposes, subjects, artists and commissioners of these works. Particularly noteworthy among these studies are the following three detailed analyses of the depiction of space in *rakuchū rakugai zu*.

First, Takeda[13] classifies *rakuchū rakugai zu* into three types according to era of creation and drawing method: (1) the 'standard' type, commonly known as the 'first generation', depicts scenes from the late sixteenth century, mainly views of the urban 'lower town' (*shimogyo*) and 'upper town' (*kamigyo*) districts with the surrounding hills as a backdrop; (2) the 'variant' type offers close-up depictions of specific subjects or districts; and (3) the 'developed' type, commonly known as the 'second generation', depicts scenes from the seventeenth century, particularly of Nijo Castle and downtown Kyoto, with hills in the background. Takeda argues that the change in drawing method between the first and second generations reflects a shift from seasonal nature paintings, employing elements of the 'famous views' painting tradition, to genre paintings reflecting trends of the times.

Second, to elucidate the characteristics of the spatial compositional method used in *rakuchū rakugai zu*, Naito[14] divided the Kyoto region into a grid of 24 (east-west) by 160 (north-south) cells, in which he positioned objects in the paintings and the boundaries of the panels. He found that in first-generation paintings blank areas appeared in the northeast and southwest sections of the

city, while in second-generation works the northeast section blanks had been eliminated providing a continuous panorama.

Thirdly, Mizumoto[15] further defines the three types of *rakuchū rakugai zu* according to configuration: (1) the first-generation symmetrically depicts features in the east and west of the city as viewed from a single point; (2) the variant type, which appeared briefly at the beginning of the early modern period, focuses on the central district and its periphery; and (3) the second-generation symmetrically depicts features in the east and west of the city as viewed from the centre line. Previous research has suggested that the north-south division of the first-generation paintings highlights the contrast between the northern half of the capital, where the Ashikaga (Muromachi) Shogunate had its palace, and the southern half, which was dominated by the *machiya* townhouses of the merchant class. Second-generation *rakuchū rakugai zu*, conversely, divide the capital east-west to contrast Nijo Castle on the west side, representing the Tokugawa (Edo) Shogunate, with the Great Buddha Hall of the Hokoji temple on the east side, representing the Toyotomi family, who held power before the Tokugawa.

The knowledge obtained from the aforementioned research concerning changes in the subject matter and geographic range of *rakuchū rakugai zu* is essential to our understanding of the composition of the paintings. However, this research does not shed light on how views of Kyoto were transferred to the restricted dimensions of the painting surface, nor on how real geographic data were manipulated in the process of making that transfer. This is because past analyses have relied solely on the simple mapping of landmarks. To analyse the compositional devices employed to paint these scenes, however, it is not enough simply to map landmarks; precisely which landmarks and districts were distorted – and how – must be determined. Here, I propose a new approach, HGIS, which offers an analytic methodology utilising GIS to measure distortions in the landscape space depicted in *rakuchū rakugai zu*. This methodology visualises distortions in drawn space by linking the positions of landmarks as they appear in the painting and on survey maps, and transforming the configuration of the painting accordingly. Combining the results obtained by this method with those of previous research should provide us with a more detailed and precise understanding of the drawn space depicted in *rakuchū rakugai zu*.

METHODOLOGY

Rakuchū rakugai zu *data*

As subjects for this study I selected examples of all three types of *rakuchū rakugai zu* defined by Takeda: first generation, second generation, and variant. For the first generation, I selected the oldest of the *rakuchū rakugai zu* paintings,

the National Museum of Japanese History 'A' screens (Rekihaku-A screens) and the most famous first-generation *rakuchū rakugai zu*, the Yonezawa City Uesugi Museum screens (Uesugi screens). For the second generation, I selected three works, each representing one of the three subclassifications of this type (according to landmark drawing style and geographic range of the drawn space) defined by Osawa and Kato[16]: the Hayashibara Museum of Art screens (Hayashibara screens), Shoko Temple screens (Shokoji screens), and Osaka Municipal Museum screens (Osaka screens). For the variant type I selected the Tokyo National Museum screens (Funaki screens), which rival the Uesugi screens in prominence. See Table 1 and Figure 1 for details about these works and an image of how to view screens.[17]

Regional settings

The geographic region depicted by *rakuchū rakugai zu* is equivalent to the city and surrounding environs of present-day Kyoto (Figure 2). Because many historical materials and famous temples and shrines survive in Kyoto today, it is a place that lends itself well to identifying the landmarks that appear in the paintings. As many landmarks have remained unchanged over the centuries, currently available digital or GIS data can be used to analyse past landmarks with minimal editing.

Data settings

In this study, I plotted landmarks as placed in the paintings as they appear on survey maps to visualise the discrepancies between real space and the painted scenes. To do this, I linked positional data on each landmark between the painting and the map and then projected the painting onto real space. Datasets were generated by the following procedure (Figure 3). Adobe Photoshop CS3 was used for image processing and ESRI ArcGIS 9.2 for GIS.

Step 1: Generating digital image data
Digital image data were generated by scanning images of *rakuchū rakugai zu* from a published book.[18]

Step 2: Generating the panel frames
Each *rakuchū rakugai zu* consists of a pair of folding screens with six panels each. Each panel was transformed into a grid of 10 (vertical) by 4 (horizontal) polygons. These grid polygons were joined together as a frame of twelve panels extending to the left and right, and this frame was overlaid with an image of the painting.

Step 3: Generating landmark point data
Using *Rakuchū rakugai zu Taikan*,[19] *Dai-ni-teikei Rakuchū rakugai zu Byōbu no Sogoteki Kenkyu*,[20] and Mizumoto[21] as references, point data

Table 1. Informations of selected representative screens.

Type	Name (also known as)	Production Period	Designated as	H × W (cm)	Collection
First Generation	Rekihaku-A Screens: Rakuchu Rakugai Zu Screens National Museum of Japanese History 'A' Version Screens	16th century	Important Cultural Asset	138×342.8	National Museum of Japanese History
	Uesugi Screens: Rakuchu Rakugai Zu Screens Yonezawa City Uesugi Museum Screens	16th century	National Treasure	160×364	Yonezawa City Uesugi Museum
Second Generation	Shokoji Screens: Rakuchu Rakugai Zu Screens Shokoji Temple Screens	17th century	Important Cultural Asset	155.4×351.5	Shoko Temple
	Osaka Screens: Rakuchu Rakugai Zu Screens Osaka Municipal Museum Screens	17th century		152.5×333	Osaka Municipal Museum of Art
	Hayashibara Screens: Rakuchu Rakugai Zu Screens Hayashibara Museum of Art Screens	17th century	Important Cultural Asset	159×363	Hayashibara Museum of Art
Variant	Funaki Screens: Rakuchu Rakugai Zu Screens Tokyo National Museum Screens	17th century	Important Cultural Asset	163×343	Tokyo National Museum

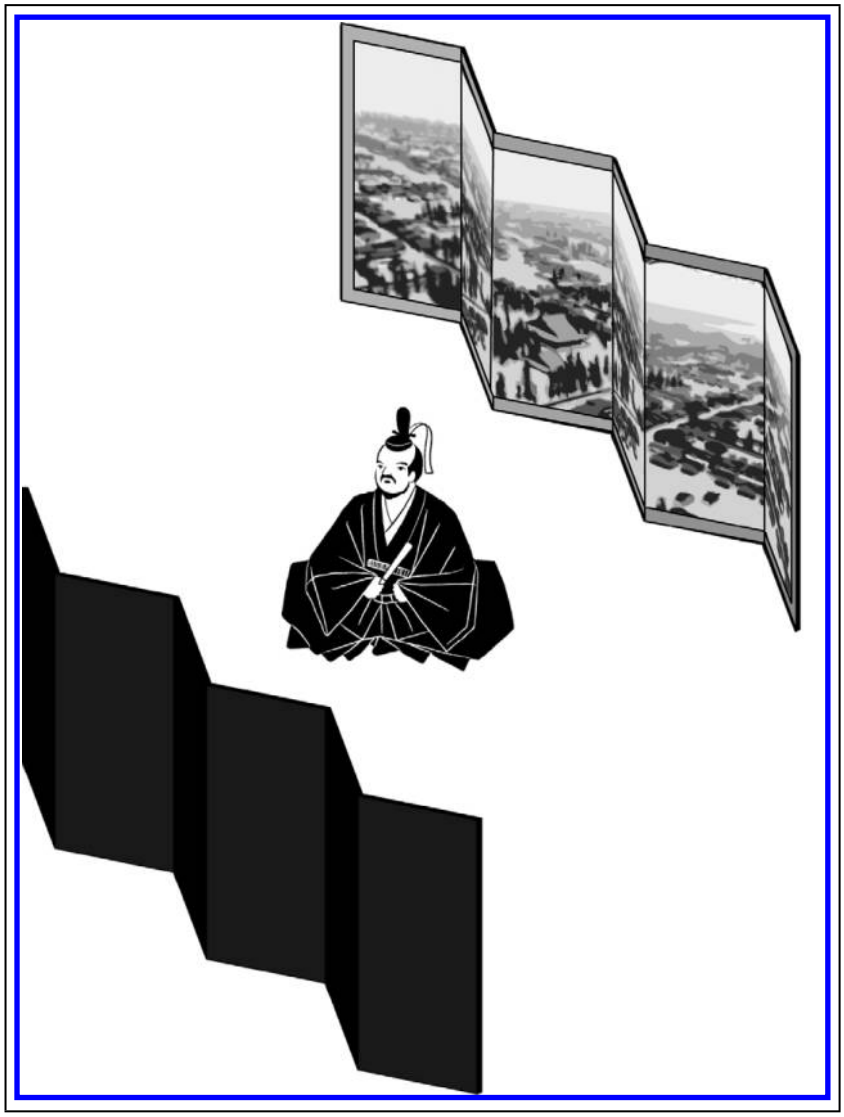

Figure 1. An image of how to view screens (A medieval warrior lord is viewing the rakuchū rakugai zu.)

were generated for landmarks appearing in the images overlaid with the grid polygons in the frame. Landmark point data were similarly generated from spatial coordinates on the survey map. Positions of landmarks that no longer exist were ascertained by referring to the Kyoto

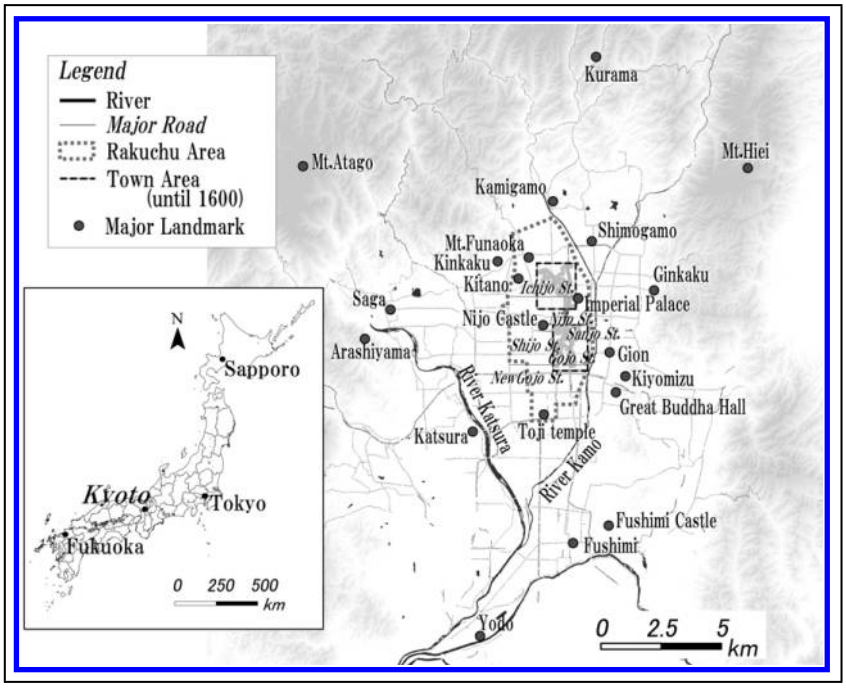

Figure 2. Study area.

City Historiographical Committee's *Kyoto no Rekishi*.[22] In this manner, the positions of landmarks in the paintings were converted to coordinate values in order to display them in a GIS.

DRAWN AREA

Polygon distortion

I created a link table based on the coordinates of various landmarks in the paintings and on the map and then performed a grid polygon transformation based on the link table data. There are two stages to the grid polygon transformation process: the first stage uses projective transformation, based on our perception that these landscape paintings were drawn from certain selected viewpoints according to established conventions similar to the rules of perspective; while the second stage uses the rubber sheeting technique,[23] according to which the screen surface is stretched or warped so as to align linked landmarks in the painting with those on the map. The resulting configuration

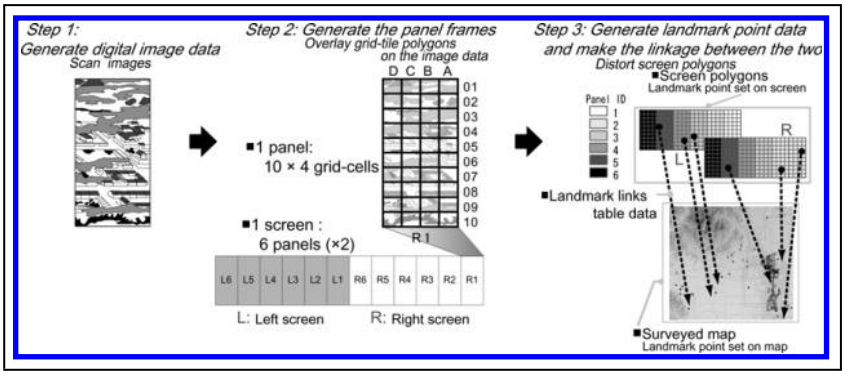

Figure 3. Procedures.

visually demonstrates the degree to which real space was distorted in the painting process. If, for example, a *rakuchū rakugai zu* were painted with the intention of accurately depicting real space, the grid polygons should transform into a configuration that exhibits a specific regularity.

First-generation type: drawn space on 16th-century rakuchū rakugai zu

The Rekihaku-A and Uesugi screens, selected as examples of first-generation *rakuchū rakugai zu*, have wide, fan-like configurations with relatively high degrees of regularity; in other words, the scenes depicted in these works are highly geographically accurate (Figure 4).

The Rekihaku-A screens are the oldest of the series, and also the most precisely rendered; however, landmarks were manipulated slightly to fit within the limited confines of the screens (Figure 4(a)), resulting in some degree of distortion.

In the left Uesugi screen (Figure 4(b)), the addition of landmarks on the north and west peripheries produces a broader panorama than that seen in the Rekihaku-A screens. The first panel of the left Uesugi screen in particular has an expansive north-facing view. In contrast, the right screen has a narrower view than its Rekihaku-A equivalent, with a lower northern limit. In the Rekihaku-A screens, the view of the city centre stops at Muromachi Street, while the first panel of the right Uesugi screen features greatly expanded views, including both upper and lower districts of the entire capital. Whereas the left Rekihaku-A screen captures a view from one point, both Uesugi screens also show both sides of the central capital (Rakuchū) from almost the same point, but captured views are turned slightly counterclockwise.

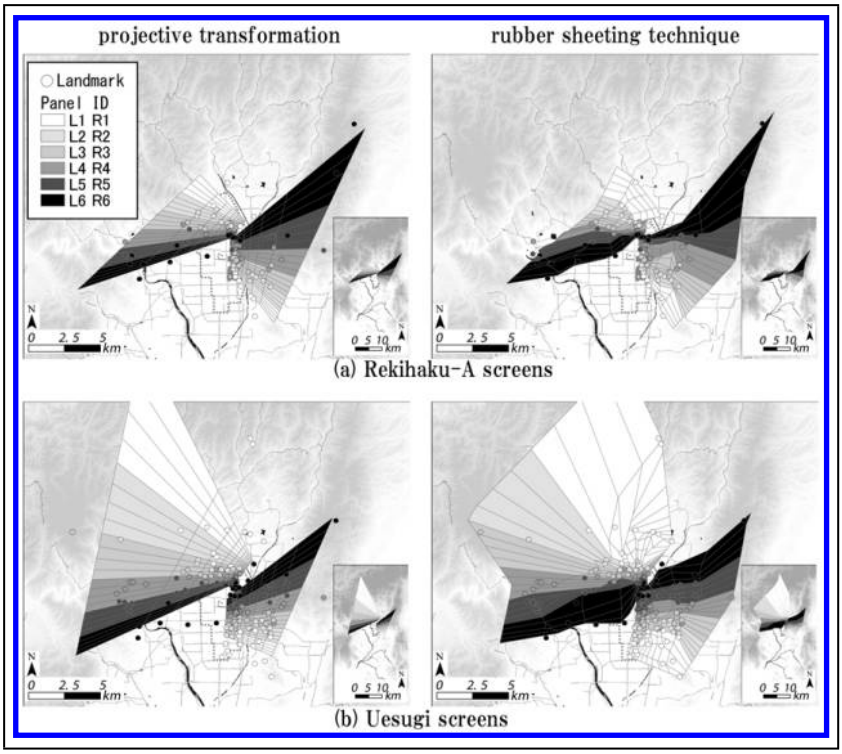

Figure 4. First generation type of drawn area.

Thus, while the drawing range varies among the first-generation paintings, the panel configurations are comparatively faithful to real positional coordinates.

Second-generation type: drawn space on seventeenth century and later rakuchū rakugai zu

As examples of second-generation *rakuchū rakugai zu*, I select three screens of the Shokoji, Osaka and Hayashibara (Figure 5).

After projective transformation of the Shokoji screens (Figure 5(a)), it is apparent that the angle of the left screen is widened to incorporate views of Kurama and Atago in the distance, and as a result the left screen overlaps with the fifth and sixth panels of the right screen. Moreover, the rubber-sheeted polygons assume distorted shapes even though a boundary line running north-south through Kyoto is still visible. The right screen features a relatively narrow

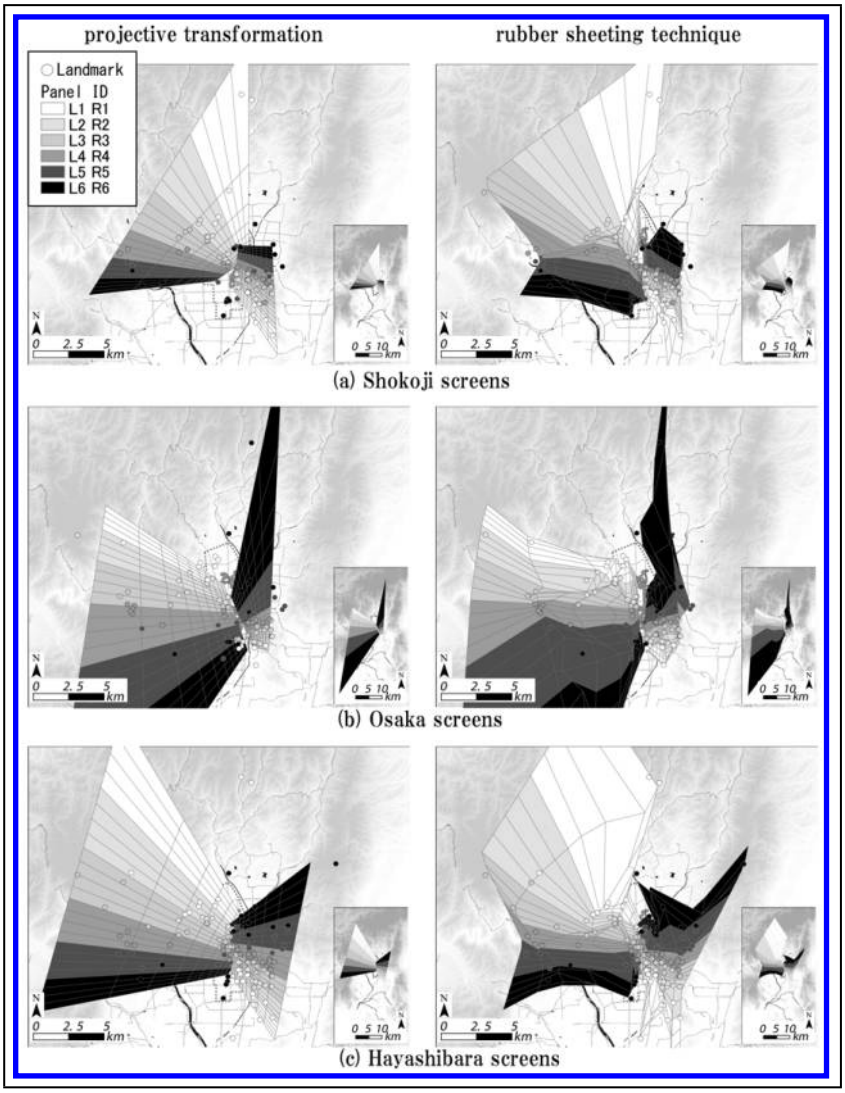

Figure 5. Second generation type of drawn area.

range of view that is nonetheless forced to include the Shimogamo Shrine at the northern limit and Fushimi Castle at the southern limit. Expansion of the distant view is pronounced in the left screen, which includes Kurama at its northern limit and Atago to the west.

The most salient aspect of the Osaka screens (Figure 5(b)) is the inclusion of the Yodo district at the southern limit of the left screen. Projective transformation reveals that the right screen has been stretched northward to include Kurama, which was omitted from the left screen in order to fit Yodo. The distribution of landmarks indicates that the left screen is oriented to the south and the right screen to the north. Here, the axis dividing the two screens is shifted in a counterclockwise direction, without any overlap of left and right screen views. This attribute becomes more obvious in the polygons derived by rubber-sheeting the Osaka screens. To fit Yodo at its southern limit, the left screen is given a northern limit ending at the Golden Pavilion, Mount Funaoka, and Atago. This requires that the Kurama Temple and the Kamigamo Shrine be incorporated into the right screen, producing a distorted configuration in the sixth panel. These adjustments may be due to the fact that the Saga, Katsura and Yodo districts portrayed in the left screen were undergoing dramatic development, which enhanced their importance during this period.

The Hayashibara screens (Figure 5(c)) are known for their precise rendering and the fact that they boast the most landmarks of any second-generation *rakuchū rakugai zu*. With projective transformation, the right screen and the bottom of the left screen overlap due to the forced inclusion of Kurama in the left screen. Even so, the size of each panel is about the same, without significant distortion. The right screen is deformed to a similar degree. In both screens, the influence of distant landmarks is minimal, which can be attributed to the relatively accurate positional relationship between the central city area and peripheral landmarks, and to the large number of city landmarks. Rubber sheeting further demonstrates that the configuration of the Hayashibara screens is more representative of the second-generation type than either the Shokoji or Osaka screens. However, even though Kurama and Atago are incorporated into the left screen, the Kamigamo Shrine is not. Thus, it is apparent that an effort was made to include distant landmarks at the far ends of the screen, resulting in a star-shaped warping of the configuration of the panels at the right and left ends of the right Hayashibara screen, even while the centre section was drawn with comparative precision.

Previous research has indicated that second-generation *rakuchū rakugai zu* generally divide Kyoto into east and west. However, the polygons derived from projective transformation are skewed to such an extent that the edges of the screens overlap. The orientation of the Shokoji and Hayashibara screens is towards the north, while that of the Osaka screens is towards the south. The rubber-sheeted polygons clearly indicate that the screens are divided east-west, but also that there is some forced incorporation of landmarks. These results show that peripheral landmarks were not always uniformly divided between east and west. It is this forced incorporation of certain landmarks that yielded drawings that ignore real-space geographic information.

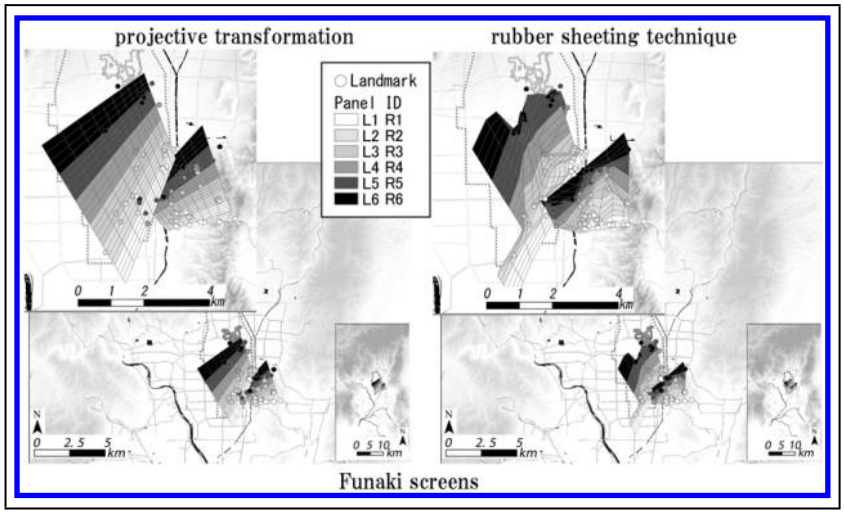

Figure 6. Variant type of drawn area.

Variant type: variant forms of rakuchū rakugai zu *depicting seventeenth-century Kyoto*

The Funaki screens (Figure 6) demonstrate the consequences of focusing on specific districts. The right and left screens are clearly divided into the east and west banks, respectively, of the River Kamo. They are arranged around political landmarks – the Great Buddha Hall representing the Toyotomi family on the one hand, Nijo Castle representing the Tokugawa family and the Imperial Palace representing the Emperor on the other. Major political landmarks are placed near the margins of the screens, with the space in between filled with landmarks mainly representing human activities, such as the Gion Festival and Kabuki Theater. The projective transformation-derived polygons are divided between left and right in a fairly regular fashion. However, the rubber-sheeted polygons show distortion in both screens. The right screen roughly describes a semicircle extending from south to north, a configuration necessitated by the extremely large depiction of the Great Buddha Hall. In the left screen, the first and second panels include the Toji temple, while Nijo Castle and the Imperial Palace are drawn large in the sixth panel. These elements produce the spatial distortion apparent in the configurations of these screens.

In the first-generation paintings, the projective transformation-derived polygons and rubber sheeting-derived polygons are similar in shape. The second-generation paintings, however, reveal a pronounced tendency to forcibly incorporate landmarks to the north and south of the city, resulting in various

expedient changes in the drawing area of the left screen and a progressive narrowing of the background scenery in the right screen. Finally, the variant-type paintings may be thought of as focusing on specific districts for which the forced inclusion of landmarks employed in second-generation paintings proved insufficient.

DRAWING REGULARITY

Area calculation

In this section, I shall attempt a more detailed elucidation of the landscape drawing method used in *rakuchū rakugai zu* by examining how real space was transferred to the paintings. To do this, I calculated the area of each rubber-sheeted polygon and then applied the results to the pre-transformation grid polygons. The shaded cells represent places in which polygons are twisted when transformed, and their areas are displayed as negative values. A negative-value cell indicates a location where a discrepancy has appeared in the positional relationship between landmarks. This enables us to identify districts and landmarks (i.e., cells) in which real space has been exaggerated or abbreviated.

First-generation: drawn space on 16th-century rakuchū rakugai zu

In the left Rekihaku-A screen (Figure 7(a)), the area value increases in an orderly fashion from the bottom to the top of the screen. At mid-level (close-range view) there are rows of samurai residences associated with the Muromachi Shogunate along Kokawa Street, while hills and temples appear at the top of the screen (distant view). The fact that the left screen depicts a smaller area than the right screen also demonstrates that the intended focus of the left screen is this district of samurai residences. The right screen is divided into several districts, with the left side focusing on the Imperial Palace, the centre section showing shrines, Buddhist temples and large residences, and the right side depicting city life along Shijo and Gojo Streets. Although the main subject of the right screen is the Imperial Palace in contraposition to the samurai residences on the left screen, the shrines and temples, as well as the street scenes of the lower town, are also prominent subjects. An examination of the distribution of variations in area shows that, whereas area values in the left screen increase above a transverse line, the right screen is laid out differently, being grouped into various districts. Thus, where the small-area samurai residence neighborhood is drawn continuously across the left screen, the right screen displays a series of different subjects, with the area ratio raised in the centre section in particular to

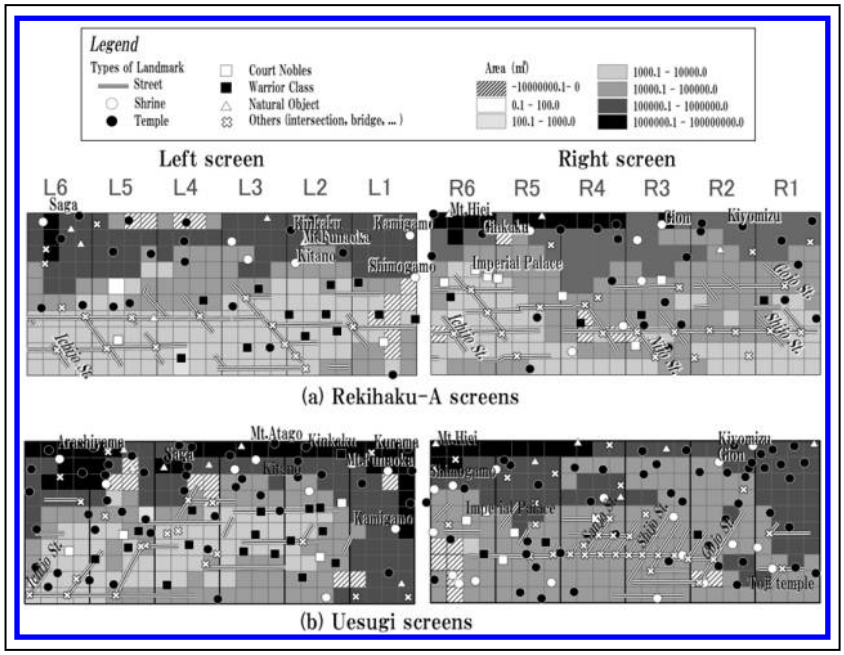

Figure 7. First generation type of drawing regularity.

accommodate a broader cityscape. Overall, the number of negative-value cells is relatively small.

In the left Uesugi screen (Figure 7(b)), area values rise in a concentric pattern outward from the group of samurai residences at the centre of the screen. The numerous landmarks scattered across the screen relate to the Muromachi Shogunate, which is the main subject of the screen. Like the Rekihaku-A screens, the Uesugi screens appear to have been drawn according to specific conventions. However, cells with negative values, indicating forced inclusion of landmarks, appear at the edges of the screen. Previous research has indicated that the Uesugi screens maintain relatively accurate positional relationships among landmarks by abbreviating space through the use of gold-leaf clouds throughout the screens. However, spatial discrepancies are visible in a few local areas.

The landscapes depicted in the first-generation paintings have relatively few spatial discrepancies, suggesting that certain basic drawing conventions were established at the time these works were created. The accuracy of the space drawn in these earliest *rakuchū rakugai zu* testifies to the sophisticated techniques possessed by the artists of the day.

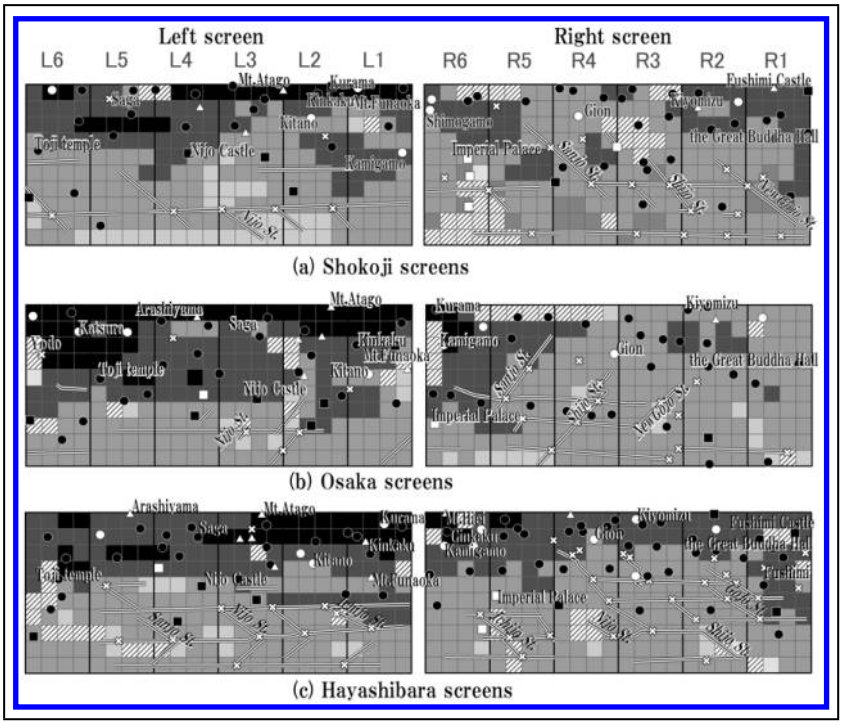

Figure 8. Second generation type of drawing regularity.

Second-generation: drawn space on seventeenth century and later
rakuchū rakugai zu

The Shokoji screens (Figure 8(a)) contain primarily low area values due to the prominent depiction of Nijo Castle at the centre of the left screen. Because Kitano Shrine is prominently drawn at the top of the left screen, the fifth highest value (10,000.1–100,000.0 m^2) cells extend to the second and third panels. The large size of Nijo Castle and the Kitano Shrine suggests that they were intended to be the primary subjects of the painting. The localised appearance of low-area values is due to the large-scale depiction of individual landmarks. However, because there are few such landmarks, their arrangement in the painting is relatively accurate. Although multiple grids categorised in the same colors are scattered throughout the Shokoji screens, spatial precision in the left screen is high because there are few landmarks. The right screen exhibits more spatial discrepancies, with local occurrences of negative-value cells and fluctuations in area.

In the Osaka screens (Figure 8(b)), the outlying Yodo district is depicted in the distance at the top of the left screen. The salient feature of the Osaka screens is the appearance of wide-area cells with 100,000.1–1,000,000.0 m^2 values at mid-level; this characteristic is caused by the omission of unimportant landmarks and the reduction of distances between remaining landmarks to make room for the Yodo district in the sixth panel of the left screen. The right screen is drawn in a spatially ambiguous manner from the fourth to sixth panels. The first to third panels contain many landmarks, but these are drawn at substantially the same area values up to the top of the screen, local variations in area notwithstanding. In the sixth panel of the right screen, Kurama and Kamigamo Shrines have been inserted at the top with the Imperial Palace at the bottom, producing an extremely forced composition.

Past research has called attention to the detail in the drawing of the Hayashibara screens (Figure 8(c)). However, spatial configuration in these screens is not as accurate as the first-generation paintings, revealing variations in area and the localised appearance of negative-value cells. Although the centre section of the left Hayashibara screen, showing Nijo Castle, does not contain negative-value cells, there are traces of spatial distortion at both ends of the screen. Forced inclusion of landmarks is particularly noticeable in the lower fifth panel and the sixth panel. Also, while area generally increases from the bottom to the top of the screen, the top tier of the view does not always have the highest area value. Discrepancies occur because the generally open spaces are abbreviated in certain localised areas. One salient feature of the Hayashibara screens is the fact that scenes of the city proper occupy over half of the space; this aspect is particularly evident in the right screen, where the central city is drawn at substantially the same magnification throughout. However, it is still by no means accurate, as the centre section of the painting and other local areas also contain forcibly incorporated landmarks.

Researchers studying second-generation *rakuchū rakugai zu* have explained that this spatial manipulation has its origins in the political environment, which became an increasingly significant factor as Japan entered the seventeenth century, resulting in paintings giving prominence to landmarks associated with the Tokugawa Shogunate.[24] It is certainly true that second-generation paintings display Nijo Castle, symbolising the Tokugawa family, in an exaggerated fashion. The importance of the mid-level placement of Nijo Castle is further evident from the placement at that level of the boundary between close-range and distant views. Meanwhile, unimportant landmarks are omitted even as certain other landmarks are given extra prominence. At the same time, the geographic range of the paintings expands to include outlying areas such as Kurama, Yodo and Fushimi. However, peripheral landmarks tend to be forcibly incorporated without regard for their real positional relationships. In short, second-generation

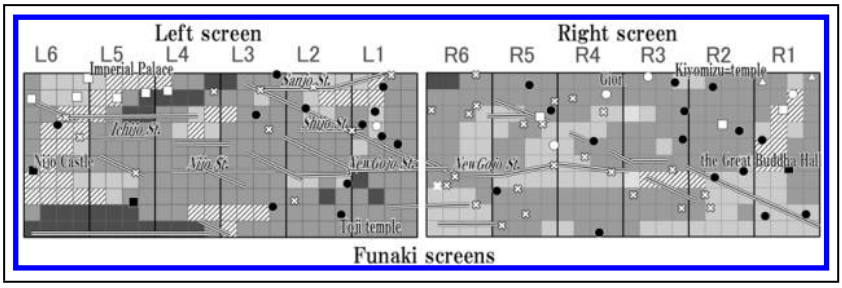

Figure 9. Variant type of drawing regularity.

rakuchū rakugai zu pay less heed to spatial regularity than first-generation works.

Variant type: drawn space on variant rakuchū rakugai zu *from the seventeenth century on*

The Funaki screens (Figure 9) epitomise the tendency to attach less importance to spatial regularity in the creation of *rakuchū rakugai zu*. The Funaki screens do not include the entire Kyoto region, but offer close-up views of the structures that are the primary subjects of other *rakuchū rakugai zu* paintings: the Imperial Palace, Nijo Castle, and the Great Buddha Hall. The Funaki screens were originally designed to be aligned alongside one another for viewing. The pairing of opposites is apparent in the arrangement of the primary landmarks: the Great Buddha Hall appears prominently at the right end of the right screen, while Nijo Castle and the Imperial Palace appear in the opposing panels at the left end of the left screen. The large scale at which these landmarks are drawn is responsible for the spatial discrepancies that occur in the first and second panels of the right screen and the fifth and sixth panels of the left screen. In a noteworthy discrepancy in the left screen, what was Shijo Street at mid-level in panels one through to three changes to Ichijo Street in panel five.

Besides the Funaki screens, there are other examples of variant *rakuchū rakugai zu*, though they do not share any common characteristics. Such works epitomise the fact that, during the seventeenth century, it became the norm for landscape paintings depicting city scenes to be relatively lacking in realistic spatial elements.

CONCLUSION: FROM REALISM TO DEFORMATION

In this study, I employed GIS functions to analyse drawn space in *rakuchū rakugai zu* paintings. This methodology enabled me to overlay the drawn space

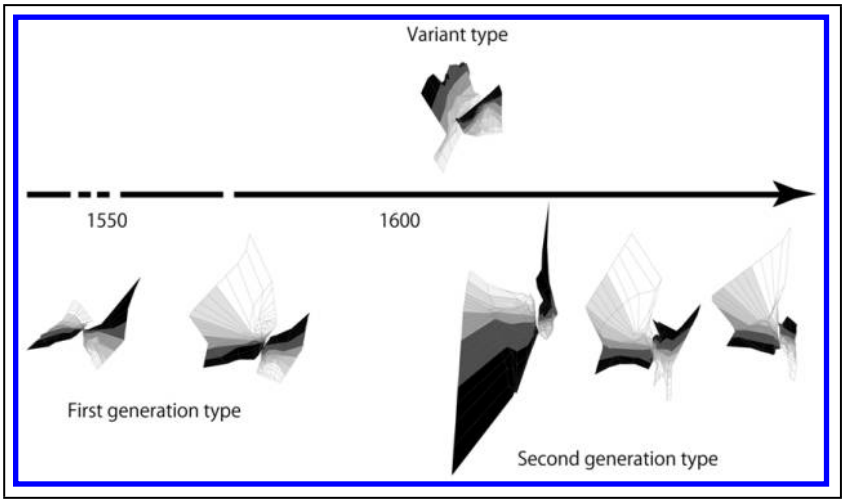

Figure 10. From realism to deformation.

onto survey maps and visualise how real space was transferred to the screen paintings.

First, I projected a virtual screen of polygons onto a survey map to determine the drawing area of each painting. When polygons from sixteenth-century, first-generation works were projected onto a map, it became apparent that these screens maintain a relatively accurate spatial configuration. In paintings from this period, the exaggeration of landmarks and manipulation of their positional relationships are minimal, reflecting a drawing method that faithfully transferred geographic information to the painting. However, works from the seventeenth century onward adopted extremely distorted configurations, even as they expanded the range of the drawn area. Second-generation and variant-type screens from this period include exaggerated close-up views of important structures, selective inclusion or omission of districts, and forced inclusion of distant landmarks. By the time these works were created, major distortions of space had become the norm in configuring the picture planes of *rakuchū rakugai zu* (Figure 10).

Next, I analysed the locations of spatial abbreviations and exaggerations in the paintings. First-generation paintings exhibited orderly increases in area value, suggesting that specific conventions similar to the rules of perspective were followed to achieve the precise geographic positioning of landmarks; the result is a realistic rendering of geographic space. In contrast, second-generation and variant-type works exhibited numerous instances of distorted space, and area value increases varied from locale to locale. This suggests that importance was

not attached to the actual positional relationships of landmarks in the drawing of these scenes. In terms of their rendering of real-space positional relationships, the first-generation paintings are superior to these later works.

Giving consideration to what has been discussed in conventional art history, changes in drawing method can be attributed to factors such as urbanisation, an expansion of public awareness of geography, and modification of subject matter in response to changes in political regime. Urbanisation and increased geographic awareness led to an expansion of the area depicted in the paintings. Political changes meant changes in the themes addressed by the paintings and the objects depicted at the centre of the works. Buildings associated with political entities (e.g., the Shogunate) represented at the centre of the paintings were also given exaggerated prominence relative to other landmarks. Clearly, the social environment of the time tended to attach value to grandiose depictions of landmarks with strong political associations. In turn, these localised exaggerations necessitated the omission of other landmarks or distorted positional relationships among different elements within the paintings. This trend also led to the emergence of the variant-type paintings, which focused only on specific districts.

As for deception of individual landmarks and their compositional relationships, from the seventeenth century on, as the prominent depiction of politically significant landmarks became the norm and took priority over the accurate rendering of geographic locations, landmarks took on the role of symbols, and the creators of *rakuchū rakugai zu* increasingly incorporated images of these symbolic landmarks into their works without regard to their actual positional relationships. While conventional art history has already pointed out increasing inclusion of politically significant landmarks, they have hardly addressed how accurate they are in terms of geographic information. In other words, conventional art history largely depends upon how individual researchers interpret and analyse political intentions and spatial compositional methods, drawn in paintings. Their typical research method is to choose and compare specific scenes or landmarks. Rather than this kind of subjective analysis, I argue, that using GIS that can quantitatively measure and visualise how real space is intentionally distorted onto the screen. Configuration, using spatial coordinates in real space as referential points, cannot only reexamine the conventional research subjects of artistic themes and image size, discussed from an objective points of view, but also visually demonstrates how geographic information came to be processed and represented on the screen surface.

As a result, my case study of *rakuchū rakugai zu* screens of the sixteenth and seventeenth centuries supports what conventional art history has argued but not from an objective point of view since using GIS can visualise drawn area and regularity in drawing exactly.

Until now, there has been little applied research utilising GIS to analyse landscape-drawing methods. As this study shows, such analysis is feasible when applied to paintings depicting aerial city views covering a wide area, such as *rakuchū rakugai zu*. The analytic methodology presented in this study involves not only mapping landmarks that appear in the paintings, but projecting a 'virtual screen' onto a survey map. I was able to implement this process for the first time using the adjust-area calculation, and table-join functions of GIS. The results obtained with this methodology offer geographic insights into the drawing and landmark positioning approaches taken in the creation of *rakuchū rakugai zu*.

For its analysis of landscape drawing methods, this study has taken as its subject *rakuchū rakugai zu* paintings from the sixteenth and seventeenth centuries. While this overview has provided a sense of the general trends in *rakuchū rakugai zu* painting over time, I hope to follow up with more detailed analysis of individual works in the context of the sociopolitical environments in which they were created.

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