

Keiji Yano*, Masanori Yamaji*, Satoshi Imamura*, Masao Kawashima*,
Kota Okukubo**, Tsuyoshi Nishiyama***

WebGIS-based application for comparing folding screens of *Rakuchū rakugai-zu* (Scenes in and around Kyoto) with maps

Keywords: Folding Screens of *Rakuchū rakugai-zu*, picture map, portal site, Web GIS, historical GIS, Kyoto

Summary: There is a genre of folding-screen paintings called *Rakuchū rakugai-zu* (Scenes in and around the Capital), which captures the early capital of Kyoto from a birds-eye view. These paintings, which usually come in the form of a pair of six-panel folding screens, capture in detail Kyoto's famous temples and shrines, the Imperial Palace, warrior residences, various shops as well as the townspeople (Kano, 1997). The collections of painted folding screens called *Rakuchū rakugai-zu* were made during the transition from the late Middle Ages (Muromachi period; 16th century) through the Modern Era (Edo period; 18th century). Currently, there are around 200 *Rakuchū rakugai-zu* folding screens both in Japan and abroad. High-resolution digital images of the folding screens have been recently made open to the public online and have promoted interdisciplinary research, serving as a good example for Digital Humanities research.

So far we have created GIS-based geo-spatial data including old topographic maps and picture maps of Kyoto. These old Kyoto maps could be used to compare with the *Rakuchū rakugai-zu* folding screens. Our WebGIS-based application allows more than browsing a folding screen; it allows the comparison of multiple folding screens, as well as between the folding screens and old picture maps, current maps and satellite images that corresponding to the folding screen. This was achieved by first creating a portal site of the folding screens, through which the folding screens can be easily searched and browsed using a web-based system. An application was then made to allow viewing of two windows at the same time, with functions for enlarging/reducing and zooming maps and the folding screens by using Google Maps API or GitHub libraries.

Introduction

Rakuchū rakugai-zu folding screens are folding screens that depict a birds-eye view of scenes and landscapes in and outside of Kyoto city during the Middle Ages and Pre-Modern Era of Japan. These folding screens show actual buildings and structures found in Kyoto in those times, as well as vividly depicting the life of the people back then. For this reason, researchers from various fields including history, art history, literature, history of architecture and anthropogeography have analyzed these folding screens from their perspectives to shed light on the culture, life and customs of Kyoto between the Middle Ages and the Pre-Modern Era (Kuroda 2003). On the other hand, these folding screens have been digitalized as part of the development of information technology and the images

* Art Research Center, Ritsumeikan University, Kyoto, Japan [yano@lt.ritsumei.ac.jp]

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*** The Museum of Kyoto

have been made available to direct public access — which was difficult in the past — in various ways.

As a result, the study of *Rakuchū rakugai-zu* has developed into an interdisciplinary field where researchers from different fields can participate and work together. The linking, fusing and unifying of different academic fields can open up anticipated possibilities for the creation of new knowledge (Kuroda 2005; Kuroda 2010; Sata 2011). In particular, the development in digital measurement technology in recent years has made it possible to take digital and infrared images at higher resolutions, while the acceleration of Internet connection now allows anyone to freely view these digital images wherever they can access the Internet ¹. In the case of humanities research whose subject is often delicate historical documents which, from the viewpoint of document preservation, are sometimes only available to certain people. However, developments in information technology can remedy this problem. The transformation in humanities research where researchers from various fields can work together by sharing such digital contents, known as Digital Humanities, has drawn much attention in recent years (Kawashima et al. 2009; Yano 2015). This is expected to further develop as technologies advance.

With such trends in mind, our current research aims to create a portal site on over 200 *Rakuchū rakugai-zu* folding screens known to exist in and outside of Japan with metadata attached. In addition, the project also aims to build a Web system that will allow viewing and comparing of images at high resolutions. However, in doing so we face two issues: the first one is the technical problem with the distribution of the information in the form of a map, where we must locate non-existing, illustrated geographic spaces on actual geographic locations; the second is the problem of requiring each individual owner to provide high-resolution digital images on the Internet.

First, in regard to the technical problem, it is ideal to have a system that allows the comparison of illustrated landscapes by overlapping various folding screens as maps using a geographic information system (GIS). For this Google Maps API is used to build a system for displaying *Rakuchū rakugai-zu* folding screens, illustrations, and up-to-date maps in several windows at the same time. In the case of a Web system using GIS, the subject locations must have coordinates that correspond to the actual longitude and latitude shown on an actual map. Geographical references can be placed over distorted maps such as old maps to ensure they match actual maps, but this is not realistic when it comes to illustrated spaces such as *Rakuchū rakugai-zu* folding screens that do not correspond to actual geographic spaces.

The current system used for this project divides the screen into two, one showing actual maps and the other displaying images of several *Rakuchū rakugai-zu* folding screens by first creating a drawing to line up past locations. Buildings depicted in all maps, drawn maps and *Rakuchū rakugai-zu* folding screens were prepared beforehand to allow users to click on them and display these at the same time in the two separate windows for comparison by enlarging or shrinking the scale. However, not all extant *Rakuchū rakugai-zu* folding screens have been digitally photographed, and only few have been digitally photographed at high resolutions recently. As the digitalizing process is still slow, only a small number of images are available for public, free viewing on the web.

These facts greatly affect the two issues we are facing in building an online viewing system that allows the comparison of *Rakuchū rakugai-zu* folding screens. And while high-resolution digital imag-

¹ Google Art Project. (<https://www.google.com/culturalinstitute/project/art-project>).

es are available for research, many people are reluctant to make such images available on public portal sites. For that reason, we have divided the content of our website to two types of access, one with contents for viewing by particular groups of registered people only, and the other with contents for general viewing.

***Rakuchū rakugai-zu* folding screens portal site**

For this project, we first added about 30 possible *Rakuchū rakugai-zu* folding screens² outside Japan to the list of 168 *Rakuchū rakugai-zu* folding screens in Japan was made by Ōtsuka (2015). Base on this we then made a comprehensive list of *Rakuchū rakugai-zu* folding screens that have been confirmed to exist in and outside of Japan. For this project we also plan to gradually add the many extant genre paintings related to Kyoto, such as ones depicting the Gion Festival and other ceremonial celebrations.

Each owner of *Rakuchū rakugai-zu* folding screens is requested to make or provide digital images of the folding screens at high resolutions. There are three main ways to obtain these images. The first is for the ARC to make its own high-resolution digital images of folding screen in the ARC's own collection or in the collection of other institutions and organization. The second is to add links to websites that have already made images of folding screens available for public viewing. The third is to request permission from owners of digital images already taken at relatively high resolutions but are not provided for general access for the use of their images.

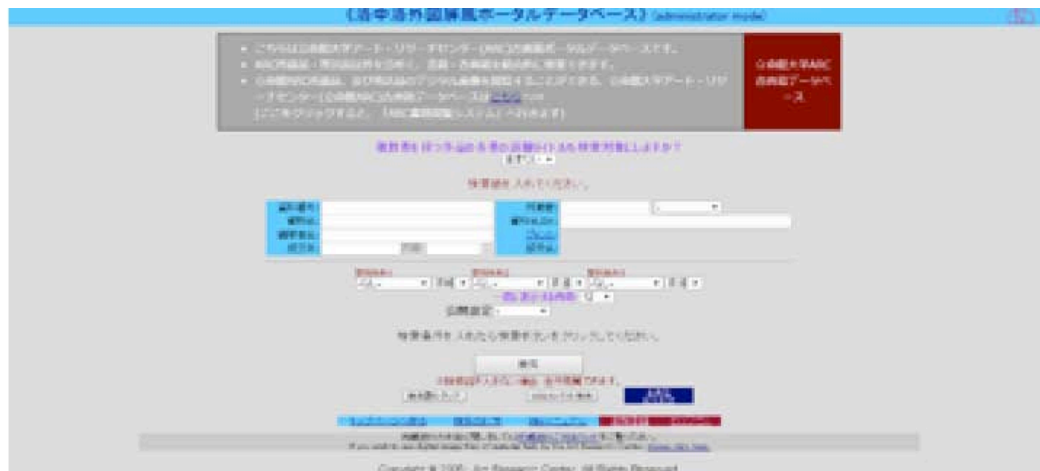
Following what Ōtsuka (2015) did, metadata of the images of *Rakuchū rakugai-zu* folding screens are added, including the era, school, format, height, drawing order (from upper right to lower left), label, owner, publication of images, painter, and so forth. In addition to these, digital image-related metadata such as resolution, image format, owner of the digital images, and date of creation are also tentatively created.

Figure 1 is a screenshot of the *Rakuchū rakugai-zu* folding screens portal site. The metadata are given in a table, following the File Number and the thumbnail on the left. As mentioned before, links to already publically available images are pasted in the table, while digital images we have the permission to use and images created at the ARC are displayed in the viewing system which will be discussed in the next section.

A search engine screen below is also added in to allow searching using meta data categories and keywords provided. In regard to high-resolution images of *Rakuchū rakugai-zu* folding screens available for access through this portal site that have been provided by owners of the images or created at the ARC, these are shown through the viewing system that allowing enlarging and shrinking of images to be discussed in the next section.

As mentioned earlier, we have made two types of contents available: contents available for general viewing by anyone and contents only available to registered researchers, both requiring access authentication.

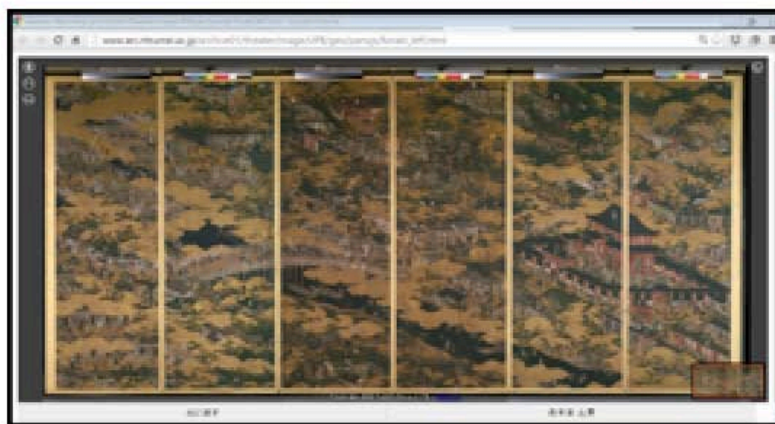
² Information courtesy of Professor Matthew McKelway, Columbia University (July 2015).



a)



b)



c)



d)

Figure 1: *Rakuchū rakugai-zu* folding screens portal site: a) Initial Screen; b) List of Folding Screens of *Rakuchū rakugai-zu*; c) Browsing screen (*Funaki* Screens); d) Meta data

System for viewing *Rakuchū rakugai-zu* folding screens

The high-resolution digital images owned by or provided to the ARC are made available for viewing using different types of free software such as Zoomify and PanoJS3 that allow basic zooming of the images, GIS software ArcGIS Online, and Google Maps API. From these we focused on using PanoJS3, Google Maps API, and ArcGIS Online to build our own viewing system, as these are compatible with the different types of browsers available.

Figure 2 shows the system for viewing “*Seigan-ji monzen-zu* Screens” in the collection of Kyoto Museum. The area being viewed is shown within the red frame at bottom right. This example shows the viewing system using PanoJS3 for viewing high-resolution digital visible and near-infrared images. The bottom below the window allows the viewer to switch between visible and near-infrared images. However, due to limitations of PanoJS3, it is difficult to show both visible and near-infrared images at the same time or synchronize them. Instead, ArcGIS Online is used to allow synchronization in two windows or overlapping the images (Figure 3). In addition, clickable explanation pins are added to buildings, human figures, and other elements depicted in *Rakuchū rakugai-zu* folding screens. The system also allows easy pasting of links on other websites.

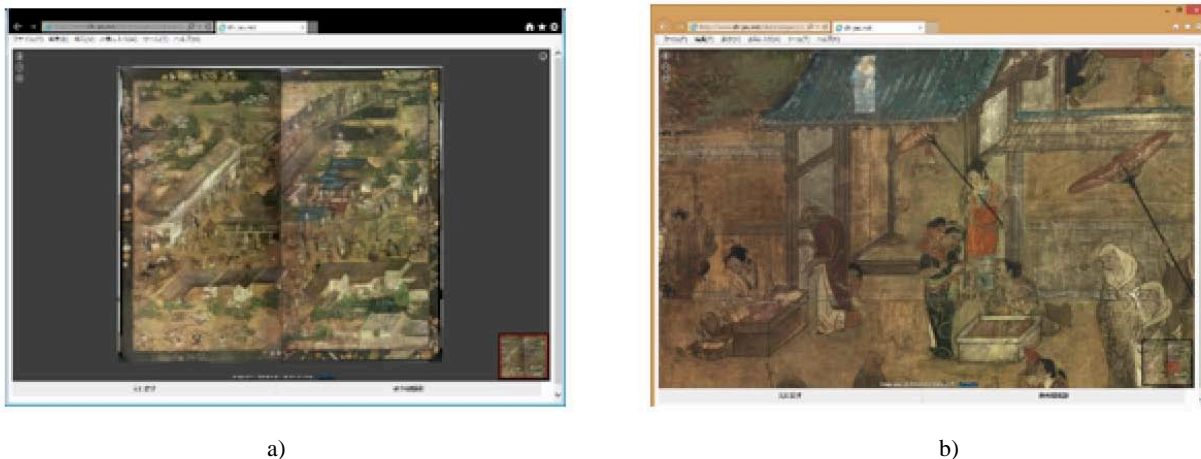


Figure 2: System for viewing *Rakuchū rakugai-zu* folding screens (PanoJS3): a) Initial screen; b) Zomming

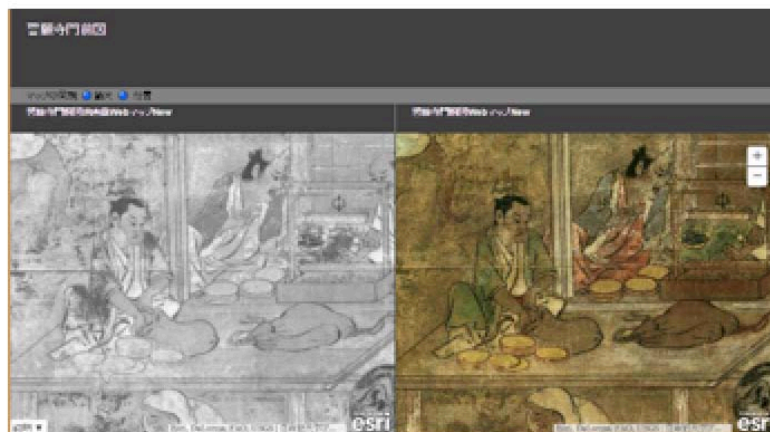


Figure 3. System for viewing *Rakuchū rakugai-zu* folding screens (ArcGIS Online).
Left: Near infrared image. Right: visible image

System for viewing and comparing *Rakuchū rakugai-zu* folding screens

Under the current project we built a system for viewing and comparing *Rakuchū rakugai-zu* folding screens using Google Maps API which allows the displaying of multiple contents in two windows. As an experiment, we used three *Rakuchū rakugai-zu* folding screens (“*Funaki Screens*”, “*Uesugi Screens*” and “*Seigan-ji monzen-zu Screens*”) and two *ezu* illustrations (picture maps): the “Imperial Household Agency *Rakuchū-ezu*” and “Kyoto University *Rakuchū-ezu*” which were drawn around early seventeenth century. By using Google Maps API we can display map and satellite image data provided by Google in Google Maps. An overview of these contents is shown in Table 1.

Contents	Years or Eras	Holders	Scale or Form	Artists
the Imperial Household Agency <i>Rakuchū-ezu</i>	1637	the Imperial Household Agency	1:1,500	Nakai Family
Kyoto University <i>Rakuchū-ezu</i>	1642	Kyoto University	1:1,368	Nakai Family
<i>Uesugi Screens</i>	Muromachi	Yonezawa city Uesugi Museum	One pair of six-folded screens	Kano Eitoku
<i>Funaki Screens</i>	Early Edo	Tokyo National Museum	One pair of six-folded screens	Iwasa Matabei
<i>Seigan-ji monzen-zu Screens</i>	Early Edo	he Museum of Kyoto	Two-folded screens	Iwasa Matabei (or his workshop)

Table 1: Contents in the system for viewing *Rakuchū rakugai-zu* folding screens

First, to display the two *Rakuchū-ezu* illustrations in Google Maps we import TIFF images of the *Rakuchū-ezu* illustrations in ArcMap 10.2.2, apply georeferences and save them in GeoTIFF. Next, map tiles of each *Rakuchū-ezu* illustrations are generated using GDAL included in the GIS data formats library provided by The Open Source Geospatial Foundation.

Google Maps allows the scaling of maps from level 0 to level 21, each level allowing the user to zoom in or out two sizes up or down, respectively. When creating map tiles it is necessary to determine which of these scale levels to adopt. For our project we created tile map images in eight different scales, from level 13, which displays the entire city of Kyoto in the window, to level 20. Viewing of *Rakuchū-ezu* illustrations is made possible by creating tile images at scaled levels that correspond to the currently shown map level.

Similarly, a set *Rakuchū rakugai-zu* folding screens is shown in Google Maps using the following steps. First, the *Rakuchū rakugai-zu* folding screens are imported into ArcMap 10.2.2 at an adequate size. GeoTIFFs containing coordinates are then exported, and tile images created. The created tile images of *Rakuchū-ezu* illustrations and *Rakuchū rakugai-zu* folding screens are then imported into Google Maps using Google Maps API. This comparative viewing system makes it possible to switch between *Rakuchū rakugai-zu* folding screens, *Rakuchū-ezu* illustrations from early modern period (Archives and Mausolea Department of the Imperial Household Agency 1969)³, and today’s maps and satellite images; synchronize screen movements and scaling. In addition, transparent displaying of *Rakuchū-ezu* illustrations is also possible by using the slider at top-right. Furthermore, preset loca-

³ Rakuchū Ezu in the Kyoto University Library Collection. (<http://edb.kulib.kyoto-u.ac.jp/exhibit/maps/map070/lime/map070.html>).

tion switched can be clicked on to show an enlarged view of that location. For our project we experimented with three landmarks: *Sanjō Ōhashi* bridge, *Seigan-ji* temple, and *Rokkakudō* temple. In this case, markers assigned to each location can be clicked on to bring out the enlarged view of the locations without having to click on the switch above.

Comparison between a modern map and “Kyoto University Rakuchū-ezu”

Many *Rakuchū rakugai-zu* folding screens are from the period between late medieval and early modern periods. There are two *Rakuchū-ezu* illustrations from the Nakai Family (whose ancestor was a purveying carpenter foreman from Kyoto to the Edo shogunate) that are accurate maps showing Kyoto during the time they were made (Table 1). While both practically contain the same places, “Kyoto University *Rakuchū-ezu*” depicts also *Sanjō Ōhashi* bridge between *Kawaramachi-dōri* street and *Kamo* River.

Figure 4 shows a modern map above and “Kyoto University *Rakuchū-ezu*”⁴ below. “*Funaki Screens*” and “*Seigan-ji monzen-zu Screens*” are displayed over both maps, with three red pins showing the locations of *Sanjō Ōhashi*, *Seigan-ji* temple, and *Rokkakudō* temple. Zooming in or out and shifting of the modern map above and the “Kyoto University *Rakuchū-ezu*” below can be synchronized by clicking the SYNCH ON/OFF button. In addition, clicking on the red pins marking objects on the maps or buttons of objects provided at top-left allows the user to zoom in on the clicked object.

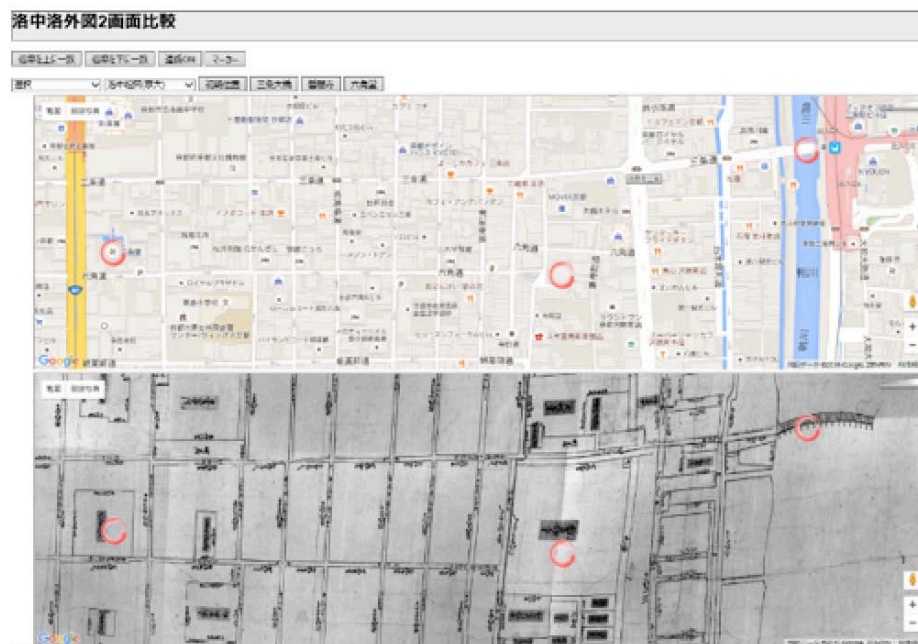


Figure 4. Modern map and “Kyoto University *Rakuchū-ezu*”:
above: modern map; below: “Kyoto University *Rakuchū-ezu*”

⁴ *Rakuchū Ezu* in the Kyoto University Library Collection.

Comparison between “Kyoto University *Rakuchū-ezu*” and “*Funaki Screens*”

In this comparison “Kyoto University *Rakuchū-ezu*” and “*Seigan-ji monzen-zu Screens*” are displayed above and below, respectively. As mentioned previously, *Rakuchū rakugai-zu* folding screens are not accurate representations of actual maps. In this comparison, the initial display of both windows are entirely covered by each set of folding screens, as shown in Figure 5, which can be freely zoomed in and out.

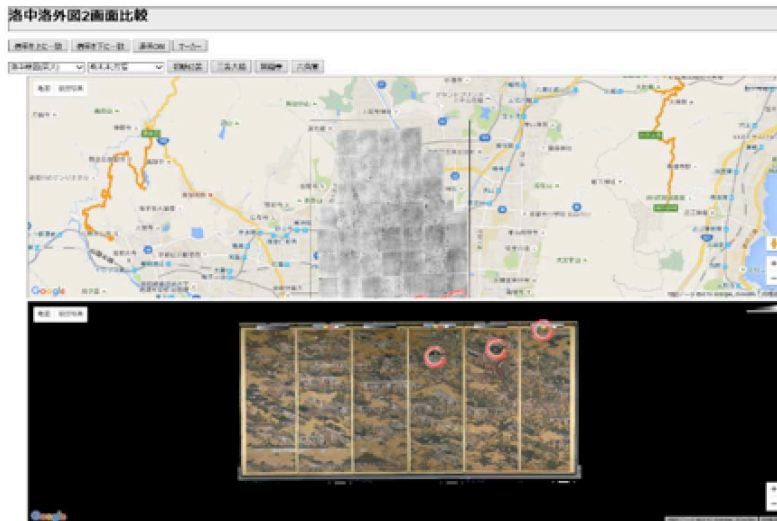


Figure 5. Initial windows showing “Kyoto University *Rakuchū-ezu*” and “*Funaki Screens*”:
above: “Kyoto University *Rakuchū-ezu*”; below: “*Funaki Screens*”

As shown in Figure 6, clicking the button of *Seigan-ji* temple shown in both windows will display the temple almost in the center.



Figure 6. *Seigan-ji* shown in “Kyoto University *Rakuchū-ezu*” and “*Funaki Screens*”:
above: “Kyoto University *Rakuchū-ezu*”; below: “*Funaki Screens*” (left panel)

The *Seigan-ji* temple depicted in “Kyoto University *Rakuchū-ezu*” is shown located to the southeast of *Sanjō-Teramachi*, to the east of which are the odoi embankment constructed by Toyotomi Hideyoshi and *Takase* River created by Suminokura Ryōi; along *Sanjō-dōri* we can also see *Sanjō Kohashi* and *Sanjō Ōhashi* bridges. Meanwhile, the left panel of “*Funaki Screens*” also depicts *Sanjō Kohashi* placed over *Takase* River and *Sanjō Ōhashi* over *Kamo* River along *Sanjō-dōri*. In addition to that, a Gion festival float procession can also be seen in front of the gate of *Seigan-ji* temple on the *Teramachi-dōri* side. Our comparative viewing system makes it possible to compare a 2D *ezu* illustration with a 3D birds-eye-view map, thus facilitating the understanding of the spatial context of *Sanjō-dōri* — a major street back then — and the views along *Teramachi-dōri*.

Comparison between “*Funaki Screens*” and “*Seigan-ji monzen-zu Screens*”

Let us next take a look at the viewing system comparing two sets of *Rakuchū rakugai-zu* screens. In this case we compare the “*Funaki Screens*” (left panel) — said to be by the painter Iwasa Matabei (or his workshop) — and “*Seigan-ji monzen-zu Screens*”, both from approximately the same period. As shown in Figure 7, “*Seigan-ji monzen-zu Screens*” is placed above and “*Funaki Screens*” (left panel) below, with initial locations displayed. Location markers of *Sanjō Ōhashi* bridge, *Seigan-ji* temple, and *Rokkakudō* temple are placed from top to bottom over “*Seigan-ji monzen-zu Screens*” and from right to left on “*Funaki Screens*”.



Figure 7. Comparison between “*Funaki Screens*” and “*Seigan-ji monzen-zu Screens*”: above: “*Seigan-ji monzen-zu Screens*”; below: “*Funaki Screens*” (left panel)

Clicking on the *Rokkakudō* marker will display *Rokkakudō* in both windows. While the shape and color of the roof of both *Rokkakudō* images are extremely similar, the *Rokkakudō* in “*Seigan-ji monzen-zu Screens*” is depicted in a birds-eye view seen from the east, while in “*Funaki Screens*” it is depicted in a birds-eye view seen from the south (Figure 8).

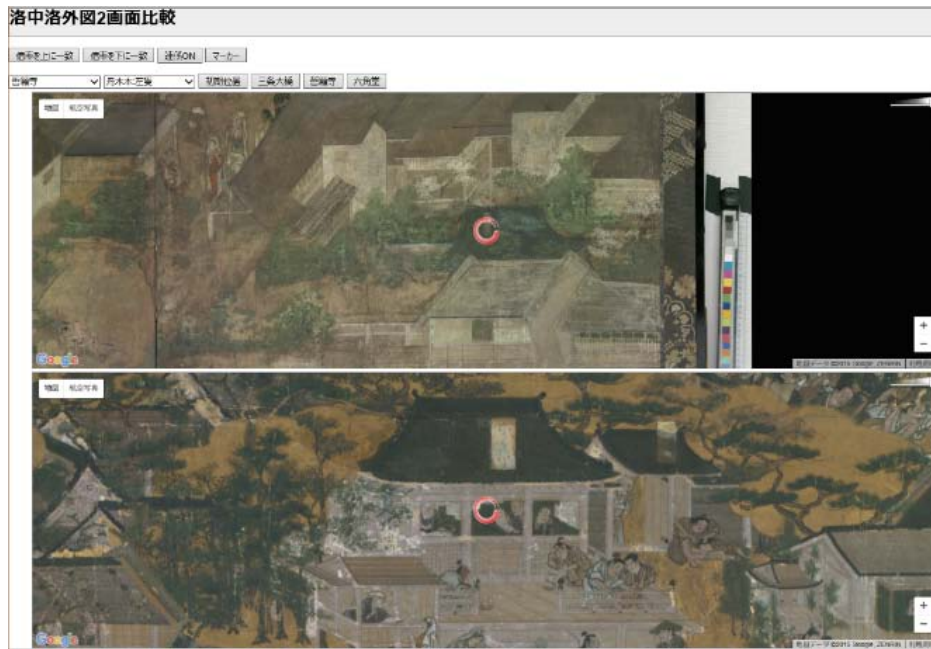


Figure 8. Comparison between the *Rokkakudō* temple in “Funaki Screens” and “*Seigan-ji monzen-zu* Screens”: above: “*Seigan-ji monzen-zu* Screens”; below: “*Funaki* Screens” (left panel)

Figure 9 shows the comparison of *Sanjō Ōhashi* after clicking on the *Sanjō Ōhashi* marker. While *Sanjō Ōhashi* is shown in a birds-eye view in both folding screens, it is depicted as seen from the southeast in “*Seigan-ji monzen-zu* Screens” and from the south in “*Funaki* Screens”. If we zoom in on the structure of the railings of the bridge or the *gibōshi* ornaments that decorate handrails, we can see very close resemblance. Not only that, the facial expressions of the people and other aspects depicted also look similar, hinting at the possibility that both folding screens may have been by the same painter (or workshop).



Figure 9. Comparison between the *Sanjō Ōhashi* in “*Funaki* Screens” and “*Seigan-ji monzen-zu* Screens”: above: “*Seigan-ji monzen-zu* Screens”; below: “*Funaki* Screens” (left panel)

Comparison between “Funaki Screens” and “Uesugi Screens”

Finally, let us compare two sets of *Rakuchū rakugai-zu* folding screens from different periods, the “Uesugi Screens” from *Muromachi* period and “Funaki Screens” from early Edo period. Being from different periods, some objects for comparison are missing from one or the other, while locations also differ greatly in places. A comparison of *Rokkakudō* temple depicted in both shows that the angle of the birds-eye view and other aspects such as the way the roof is depicted differ greatly (Figure 10). In this way, using this Web viewing system to compare *Rakuchū rakugai-zu* folding screens from different eras and by different painter can bring new perspective to the research of *Rakuchū rakugai-zu*.

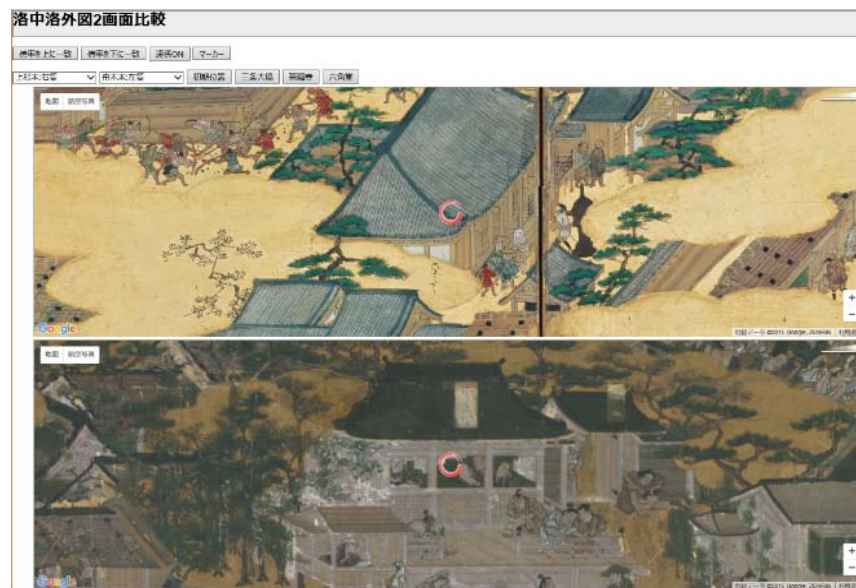


Figure 10. Comparison between “Funaki Screens” and “Uesugi Screens”:
above: “Uesugi Screens” (right panel); below: “Funaki Screens” (left panel)

Web viewing system development

There have been several image viewing systems for the viewing of individual sets of *Rakuchū rakugai-zu* folding screens, but our system not only allows the zooming in and out of maps and *Rakuchū rakugai-zu* folding screens, but also facilitates the comparing of 2D modern maps or *ezu* illustrations from the same era of the folding screens with *Rakuchū rakugai-zu* folding screens that have a 3D depiction of Kyoto. The system goes further to allow the comparison between different sets of *Rakuchū rakugai-zu* folding screens.

As a result, new insights from researchers of different fields can be anticipated. Not only that, this system can also be used at places like museums and art museums. Using this system at exhibitions in conjunction with the showing of actual *Rakuchū rakugai-zu* folding screens can promote better understanding of the folding screens being shown and even improve the quality of the exhibition space. We plan to include more *Rakuchū rakugai-zu* folding screens, while adding various functions such as memo and multi-window switching, as well as improving the interface to provide better usability of the system.

Conclusion

The aim of this research project was to build a portal site of *Rakuchū rakugai-zu* folding screens scattered around Japan and the world to provide a viewing system that allows the enlarging and reducing of high-resolution images of the folding screens. In regard to *Rakuchū rakugai-zu* folding screens images provided to us, we have also built a system to allow the displaying of buildings and other landmarks depicted in these folding screens for comparing with *ezu* illustrations and modern maps. In addition, images that we are able to share publicly are made available for public access in and outside of Japan. With images whose owners prefer not to make publicly available, we have introduced an authentication system allowing access only by registered researchers.

Such efforts can also be seen in other projects such as Cultural Heritage Online ⁵ and Google Art Project ⁶, and we hope to collaborate with such portal sites to enhance our system to allow the viewing of more *Rakuchū rakugai-zu* folding screens.

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⁵ Cultural Heritage Online. (<http://bunka.nii.ac.jp>)

⁶ Google Art Project. (<https://www.google.com/culturalinstitute/project/art-project>)

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