Original Article

Analyzing the impact of the spread of COVID-19 infections on people's movement in tourist destinations

Masahide Yamamoto (Faculty of Foreign Studies, Nagoya Gakuin University, myama@ngu.ac.jp)

Abstract

This study uses "Mobile Kukan Toukei™" (MOBILE SPATIAL STATISTICS) to analyze the impact of the novel coronavirus (COVID-19) infection on people's movements in tourist destinations in Kansai region (mainly Kyoto). Mobile Kukan Toukei is statistical population data created by the operational data of mobile phone networks. Comparison of the data before and after the spread of the disease showed that the impact was remarkable in many areas in April 2020. Urban areas such as Kyoto Station and Osaka Station showed relatively more robust recovery. However, several tourist areas could not bounce back despite the "GoTo" campaign by the Japanese government.

Keywords

mobile phone, statistical population data, Kansai region, COVID-19, tourism industry

1. Introduction

The number of foreign tourists visiting Japan, which had amounted to about 31.9 million in 2019, should have reached its peak in 2020 in anticipation of the Olympic Games. Japan's tourism industry witnessed a surge in inbound tourists until the end of 2019. However, because of the new coronavirus infection (COVID-19) pandemic, the number of monthly inbound tourists has consistently decreased by 97-99 % from the same month of the previous year since April 2020 (see Figure 1).

The tourism industry is facing a similar sharp decline in the domestic demands. The annual number of domestic guests at hotels and inns in 2020 has decreased by 48.9% compared to the previous year. The rapid spread of the infectious disease is urging people to rethink and change their lifestyles in various aspects.

A serious impact on the economy has been expected and observed due to restrictions on the movement of people in order to prevent the disease from spreading further. In other words, movement is one of the principal driving forces of the economy. This study attempts to analyze the impact of the pandemic on people's movements in tourist destinations in Kansai region (mainly Kyoto), based on statistical population data provided by a mobile phone company. Additionally, it examines some trends by comparing the population attributes in areas where the number of visitors recovered earlier than other areas and those where it did not.

2. Related studies

Numerous studies on the impact of the spread of the COVID-19 on tourism have already emerged since 2020. This paper aims to classify them into three categories.

2.1 Studies on economic impact on tourism

Most of those studies attempted to analyze the economic impact of the infectious disease or its prevention measures on the tourism industry. Yang et al. [2021] used statistical change-point analysis to investigate the impact of COVID-19

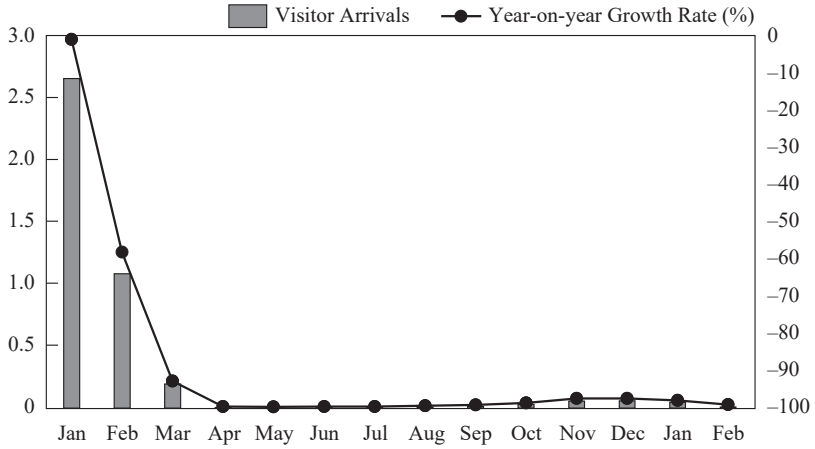

Figure 1: The monthly number of visitor arrivals and Year-over-year Growth Rate (Unit: million people)
Source: These figures are compiled from the data of the Ministry of Justice in Japan.

on people's mobility in nine tourism cities such as Bali, Dubai, Hong Kong, London, Mecca, New York, Osaka, Tokyo, and Singapore. They pointed out that there was a lag between the decrease in people's mobility and the introduction of lockdown measures, suggesting that the latter is not the reason for the movement reduction. Skare et al. [2021] measured the potential effects of the pandemic on the tourism industry using panel structural vector autoregression (PSVAR) on data from 1995 to 2019 of 185 countries and system dynamic modeling (real-time data parameters connected to the COVID-19).

Much of the research in this category considers the impact on a particular country or industry. Japutra and Situmorang [2021] explored the impact of the pandemic on hotels in Indonesia. It examined the deployed strategies and discussed their effectiveness. Chen et al. [2020] analyzed the impact of government restrictions during the COVID-19 pandemic on stock returns of U.S. travel and leisure companies. They demonstrated that the stringency of government restrictions has a negative impact on stock returns even after controlling the pandemic. Moreover, stock prices of travel and leisure firms with a smaller size, less tangibility, and higher cash reserves are more resilient to the COVID-19 related government restrictions. The airline industry has been hit the hardest due to these rRestrictions , followed by the travel and tourism and the casinos and gambling sectors.

2.2 Studies attempting to forecast future tourism

Some studies attempt to predict the future of the tourism sector. Zhang et al. [2021] combined econometric and judgmental methods to forecast the possible paths to tourism recovery in Hong Kong. They used autoregressive distributed lag-error correction model to generate baseline forecasts. These forecasts were also used to evaluate the economic effects of the pandemic on the tourism industry in Hong Kong.

Fotiadis et al. [2021] forecasted different scenarios for international tourism demand. By implementing two distinct methodologies (the Long Short Term Memory neural network and the Generalized Additive Model), they calculated the expected drop in the international tourist arrivals for the next 12 months.

Liu et al. [2021] attempted to forecast the recovery of tourism demand for 2021 in 20 destinations worldwide. An original scenario-based judgmental forecast established on the definition of a COVID-19 Risk Exposure index was proposed to overcome the limitations of traditional forecasting methods. Qiu et al. [2021] presented a two-stage three scenario forecast framework for inbound-tourism demand across 20 countries.

2.3 Studies on rehabilitation of tourism

Another category considers the post-pandemic tourism. Based on the review of 35 papers that studied the tourism industry in the wake of the pandemic, Sharma, Thomas, and Paul [2021] proposed a resilience-based framework for reviving the global tourism industry post-COVID-19. Their framework outlined four prominent factors for building resilience in the industry: government response, technology innovation, local belongingness, and consumer and employee confidence. They argued that using such inclusive resilience; the tourism industry may transform into a new global economic order, characterized by sustainable tourism, society's well-being, climate action, and the involvement of local communities. They also offered directions for future research in the area. Furthermore, Smart et al. [2021] examined how hotels in Oklahoma City had coped with challenges regarding the pandemic.

3. Methods

The survey was conducted from April 2016 to October 2020. The sites studied in this survey are tourist destinations in and around Kyoto City (Table 1). This study used "Mobile Kukan Toukei™" [(1)] (mobile spatial statistics) provided by NTT DOCOMO, Inc. and DOCOMO Insight Marketing, Inc. to deduce the number of visitors at specific tourist destinations and examine their characteristics. Mobile Kukan Toukei is statistical population data created by a mobile phone network. It helps to estimate the population structure of a region by gender, age, and residence.

Table 1: Survey areas and regional mesh codes

Survey Areas	Regional Mesh Code	Type of Codes
1. Kyoto Station	5235-3680	Tertiary
2. Osaka Station	5235-0349	Tertiary
3. Shinkyogoku	5235-4601	Tertiary
4. Kiyomizu Temple	5235-3692-2	1/2
5. Kinkakuji Temple	5235-4548-3	1/2
6. Arashiyama	5235-4514-3	1/2
7. Byodoin Temple	5235-2664-4	1/2
8. Todaiji Temple/Nara Park	5235-0627	Tertiary

Note: A regional mesh code is a code for identifying the regional mesh, which is substantially divided into the same size of a square (mesh) based on the latitude and longitude in order to use it for statistics. The length of one side of a primary mesh is about 80 km, and those of secondary and tertiary meshes are about 10 km and 1 km, respectively.

The survey areas were selected from the city center and tourist destinations of Kyoto, one of Japan's leading tourist cities. Additionally, tourist destinations in Osaka and Nara prefectures were added for comparison. This study examined the transition and attributes of the population in these regions during the survey, before considering the effects of the new coronavirus infection.

The specifications of the survey are as follows:

- Survey areas: In the mesh shown in Table 1.
- Duration: April and October in 2016, 2018, 2020
- Time period: 8:00–9:00, 12:00–13:00, 16:00–17:00
- Investigated Attributes: Gender, age (every 10 years), residence (prefecture, municipality)

4. Results

The following paragraphs discusses the transition and attributes of the population in each area based on the statistical population data mentioned above.

4.1 Transition in population in each period

Regarding the transition of the regional population, a reduction in population can be observed due to the pandemic in 2020 in every area.

The decrease was specifically remarkable in April 2020, which was probably due to the Japanese government's declaration of a state of emergency. This declaration, which was issued on 7 April, 2020 was initially targeted at seven prefectures such as Saitama, Chiba, Tokyo, Kanagawa, Osaka, Hyogo, and Fukuoka. Furthermore, the state of emergency was expanded to all prefectures on 16 April 2020.

Despite the ongoing pandemic, the declining tourist population recovered in October 2020 in business and commerce areas such as Kyoto Station, Osaka Station, and Shinkyogoku (see Figures 2, 3, and 4).

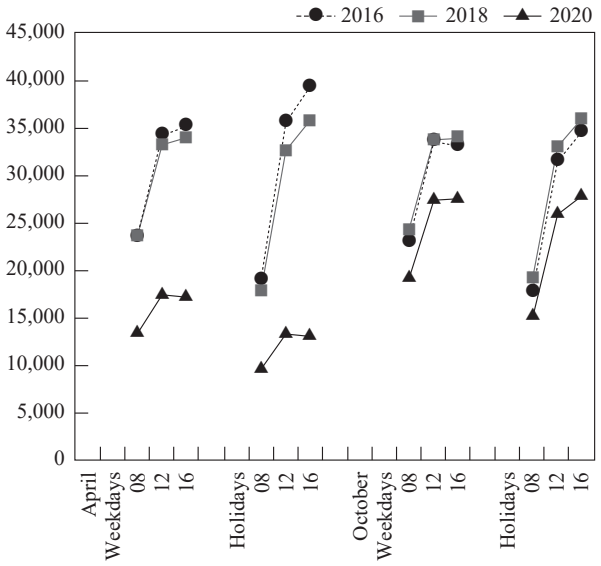

Figure 2: Transition in population at Kyoto Station

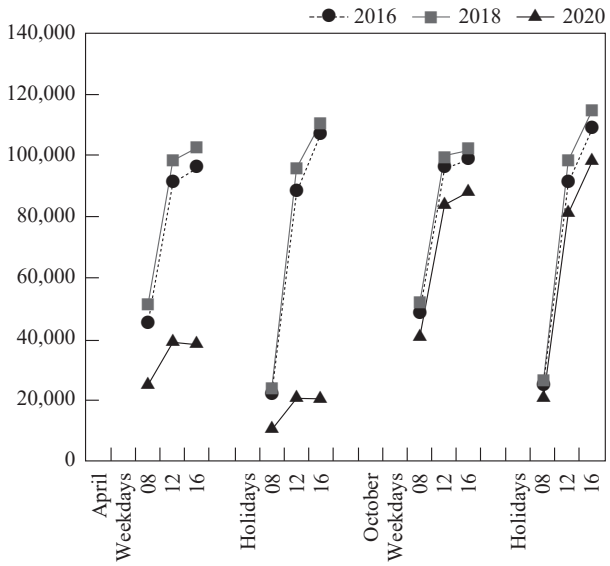

Figure 3: Transition in population at Osaka Station

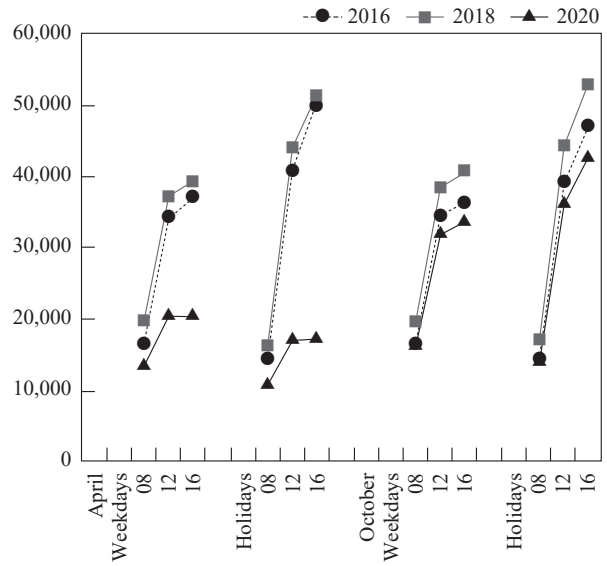

Figure 4: Transition in population at Shinkyogoku

However, the recovery was not strong in tourist areas that house famous temples. Figure 5 shows the transition in of the population at Kiyomizu Temple. As for Kinkakuji Temple, it remained almost the same as that in April (Figure 6).

The population of Arashiyama, which has many restaurants and souvenir shops, rebounded in October like Kyoto Station and Shinkyogoku (Figure 7). Byodoin Temple in Uji City (Figure 8) and Todai-ji Temple in Nara Prefecture (Figure 9) showed similar transitions to Kiyomizu Temple.

4.2 Characteristics of the population: Gender, age, and residence

Figures 10, 11 and 12 show the population attributes at Kyoto Station from 12:00 to 13:00 on holidays in October 2018, April

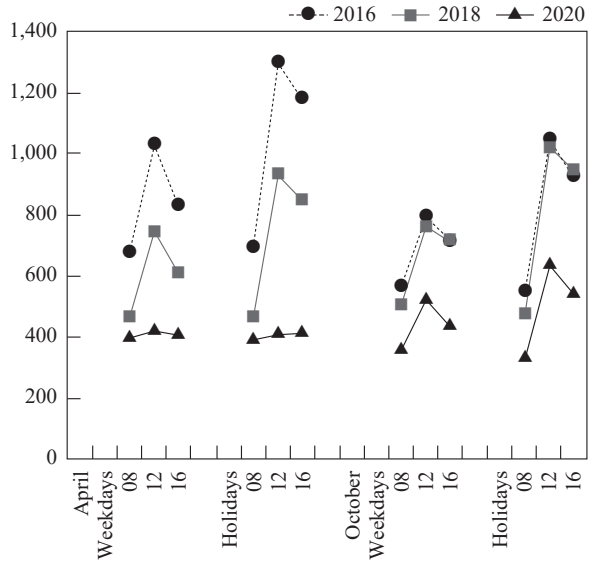

Figure 5: Transition in population at Kiyomizu Temple

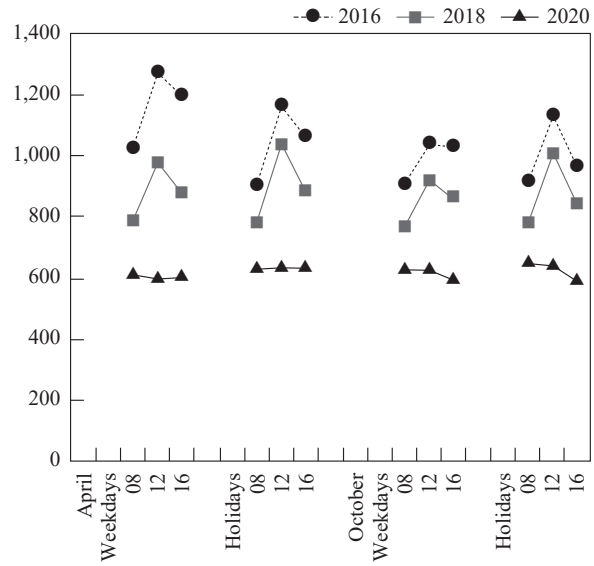

Figure 6: Transition in population at Kinkakuji Temple

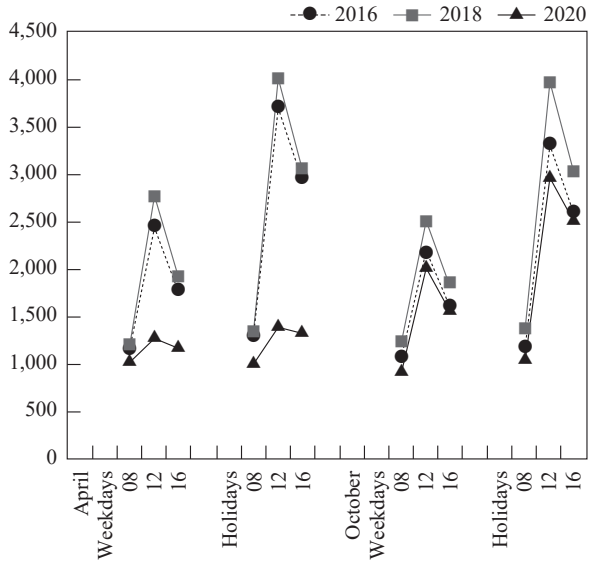

Figure 7: Transition in population at Arashiyama

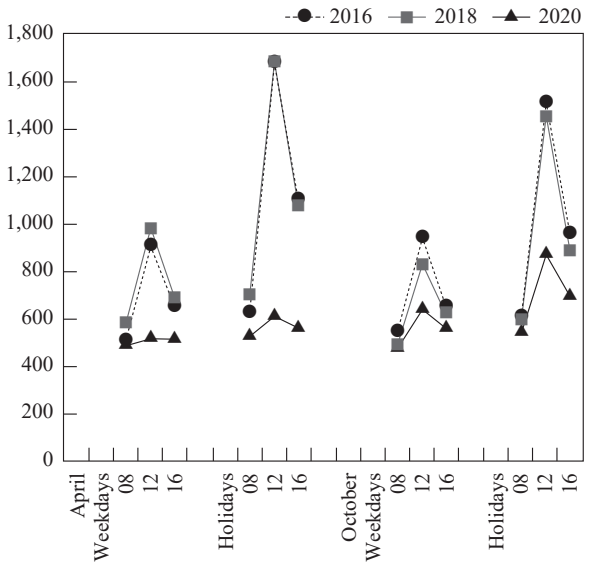

Figure 8: Transition in population at Byodoin Temple

and October in 2020, respectively. As illustrated in Figure 2, population of all generations decreased significantly in April 2020 and recovered in October 2020. Particularly, the recovery of women population in their 20s and late teens is remarkable.

Similarly, as for Kiyomizu Temple, where its recovery was weak as shown in Figure 5, the population decreased in both April and October in 2020 (see Figures 13, 14, and 15). There does not seem to be noticeable gap in any generation.

Regarding place of residence, the population at Kyoto Station in April 2020 (Figure 16) has fewer visitors from distant regions than that in October 2018 (Figure 17). A similar situation can be observed in October 2020 (Figure 18), which has recovered more strongly.

A similar tendency can be observed at Kiyomizu Temple (Figures 19, 20, and 21). Overall, travelers are thought to have avoided long distance traveling to reduce the risk of the infection.

5. Conclusion and future challenges

This study examined the statistical population data of eight areas in and around Kyoto City: Kyoto Station, Osaka Station, Shinkyogoku, Kiyomizu Temple, Kinkakuji Temple, Arashiyama, Byodoin, and Todaiji Temple. Comparing situations before and after the spread of the coronavirus disease, the impact was remarkable in many areas in April 2020. Urban areas such as Kyoto Station and Osaka Station showed relatively more robust recovery than other areas.

Conversely, several tourist areas could not bounce back from the rapid decrease despite the Japanese government's "GoTo" campaign, intended to revitalize domestic tourism.

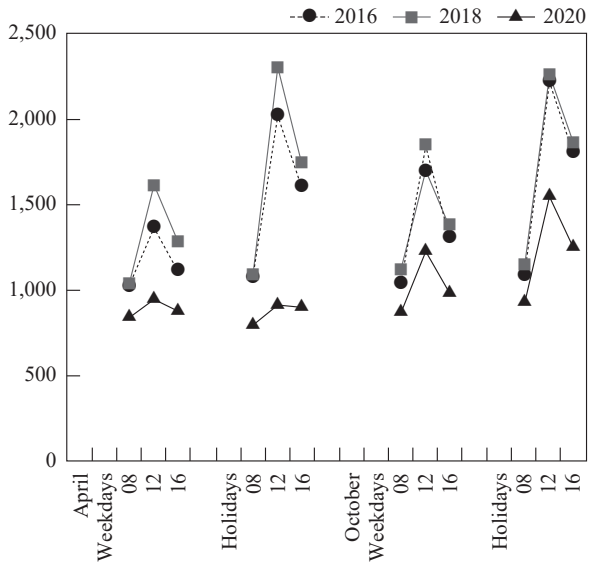

Figure 9: Transition in population at Todaiji Temple and Nara Park

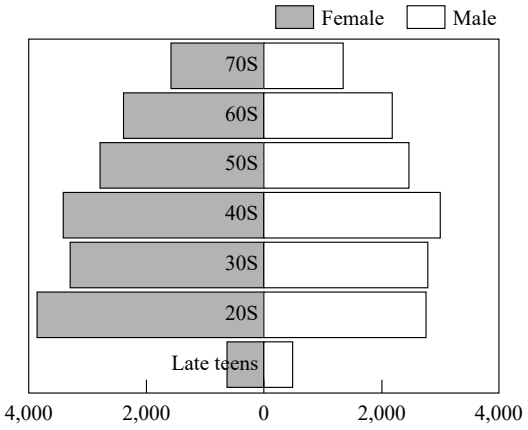

Figure 10: Gender distribution of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in October 2018)

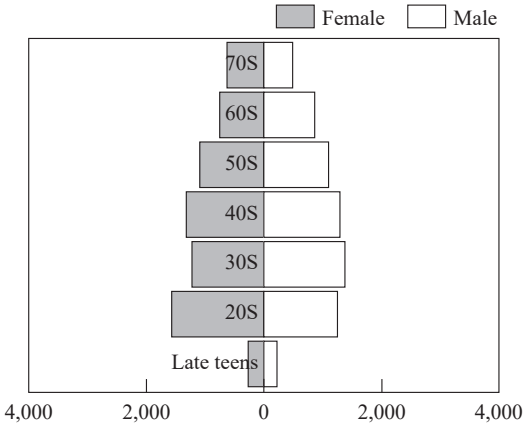

Figure 11: Gender distribution of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in April 2020)

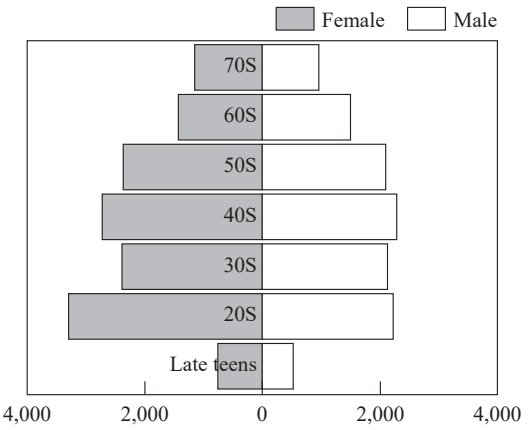

Figure 12: Gender distribution of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in October 2020)

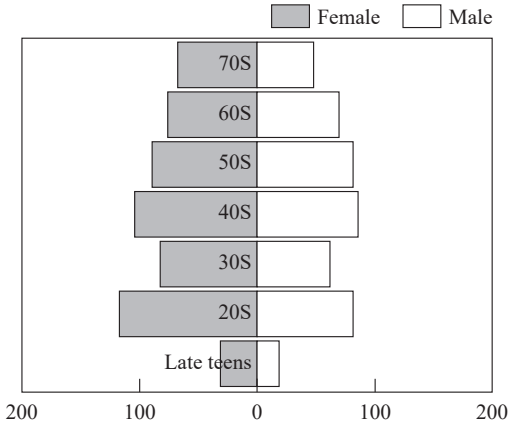

Figure 13: Gender distribution of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in October 2018)

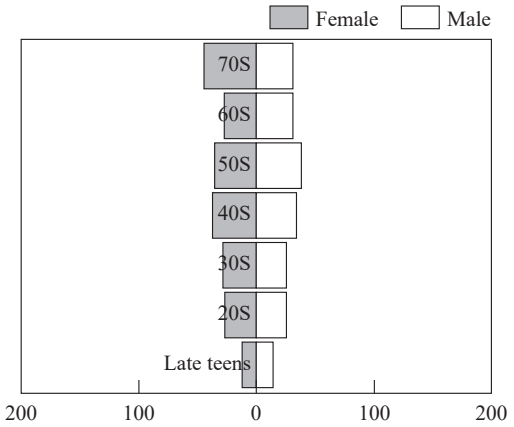

Figure 14: Gender distribution of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in April 2020)

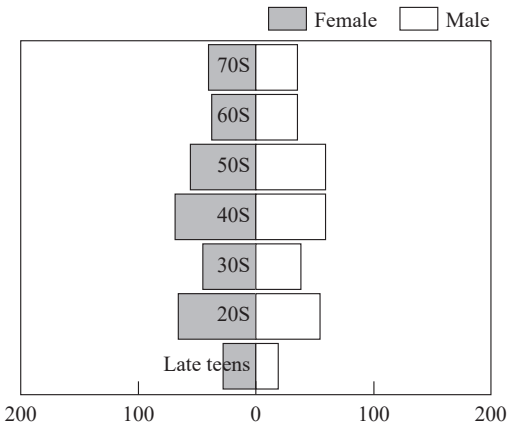

Figure 15: Gender distribution of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in October 2020)

It is likely that more visitors are coming back from closer regions than distant ones probably because of people's attempt to minimize the risk to get infected.

Even when using the Mobile Kukan Tokei, it is difficult to obtain data in a narrow area such as a specific tourist facility because unnecessary population data of people outside cannot be excluded. This study would like to extract data in such areas using Wi-Fi tracking sensors depending on the situation.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP19K12566.

Note

(1) "Mobile Kukan Toukei" is a trademark of NTT DOCOMO,

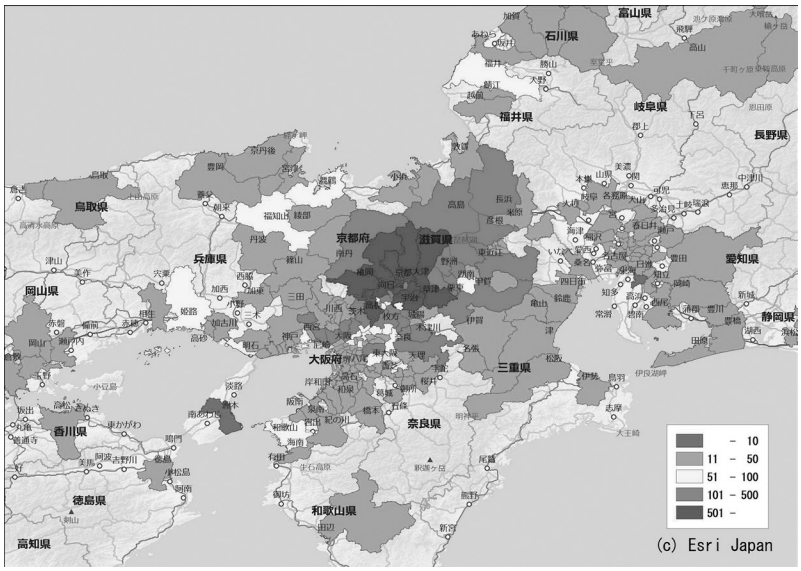

Figure 16: Residence of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in October 2018)

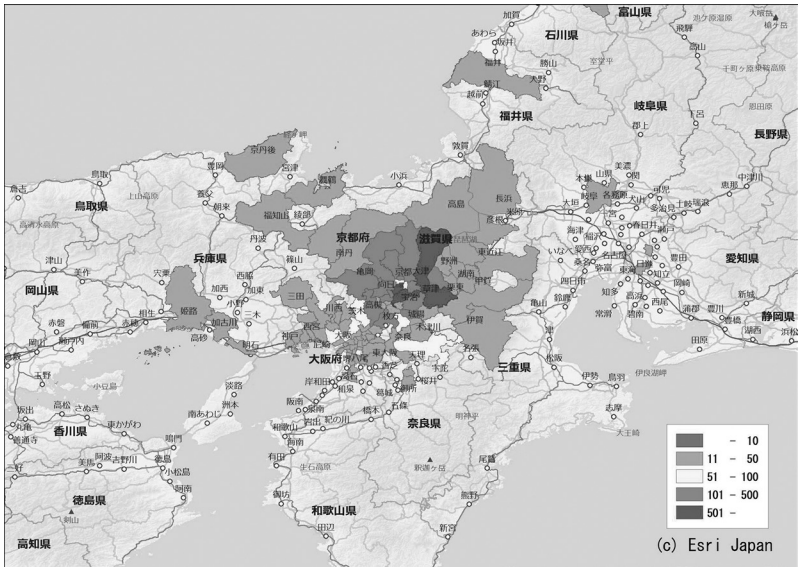

Figure 17: Residence of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in April 2020)

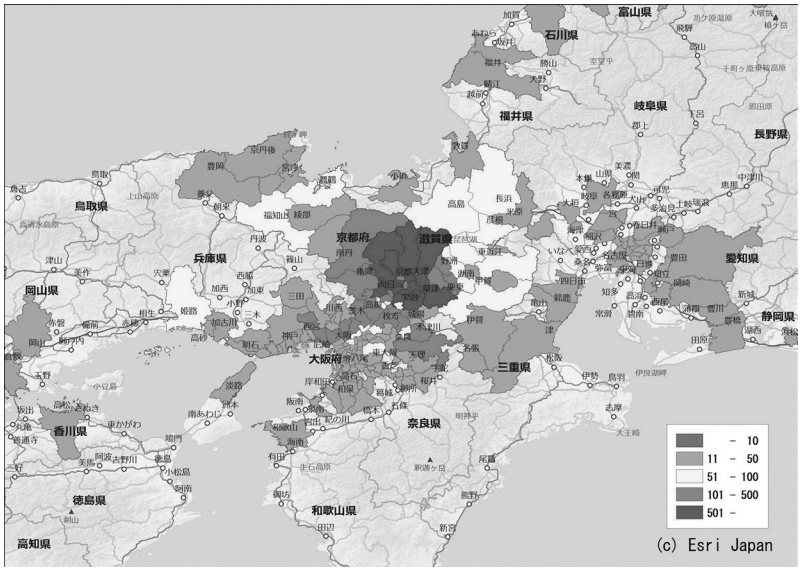

Figure 18: Residence of the population at Kyoto Station (12:00 a.m.-1:00 p.m. on holidays in October 2020)

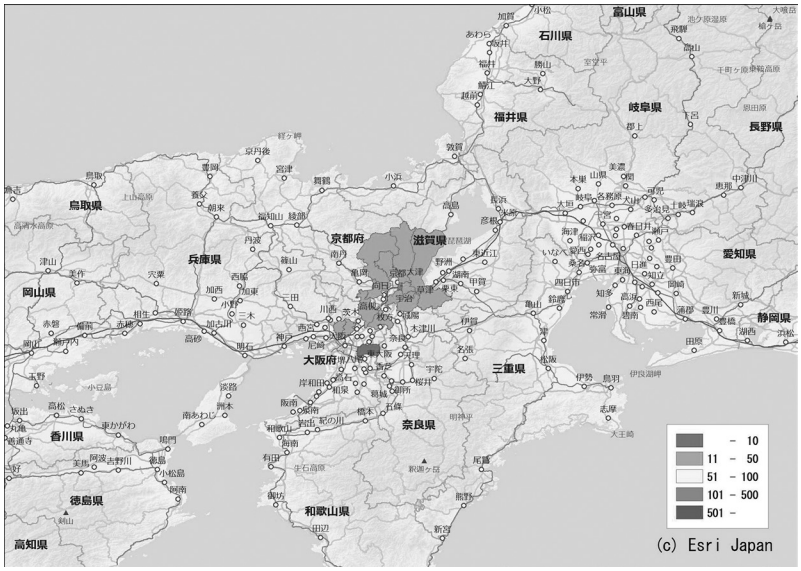

Figure 19: Residence of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in October 2018)

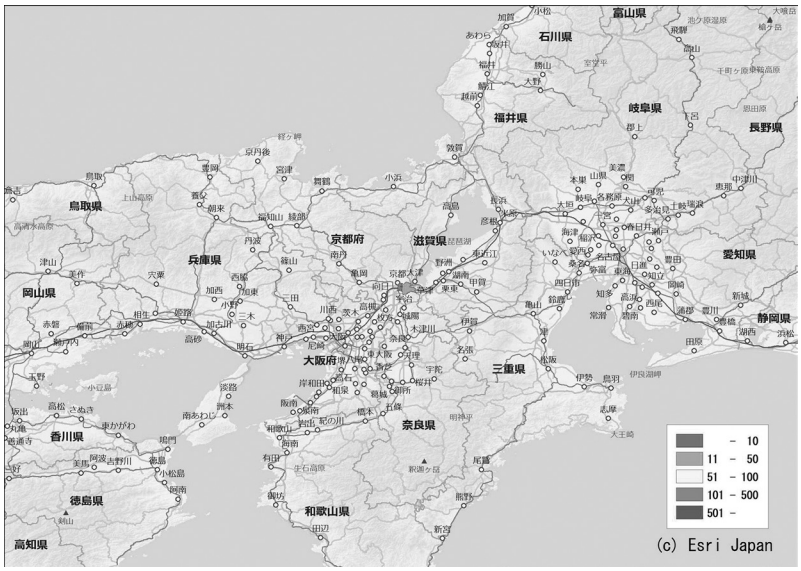

Figure 20: Residence of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in April 2020)

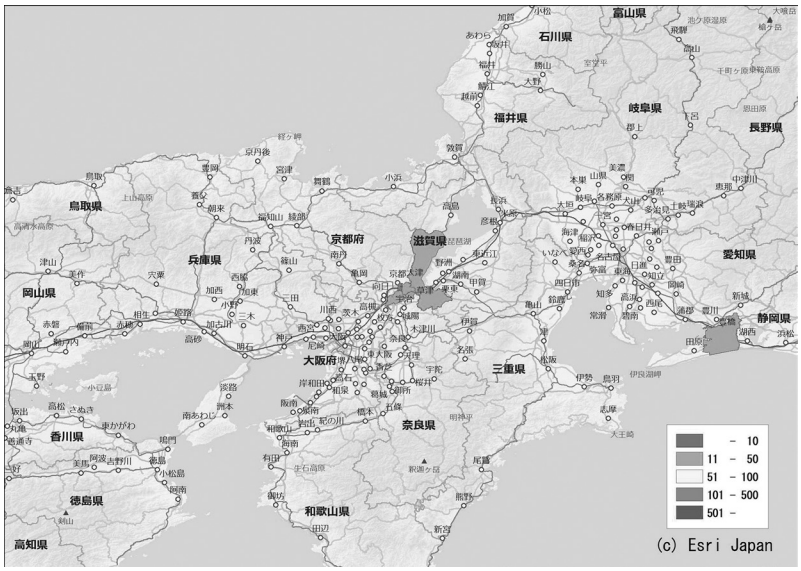

Figure 21: Residence of the population at Kiyomizu Temple (12:00 a.m.-1:00 p.m. on holidays in October 2020)

Inc. NTT DOCOMO's "Mobile Kukan Toukei" services are only available to subscribers in Japan.

References

Chen, M., Demir, E., García-Gómez, C., and Zaremba, A. (2020). The impact of policy responses to COVID-19 on U.S. travel and leisure companies. *Annals of Tourism Research Empirical Insights*, Vol. 1 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S2666957920300033).

Fotiadis, A., Polyzos, S., and Huan, T. (2021). The good, the bad and the ugly on COVID-19 tourism recovery. *Annals of Tourism Research*, Vol. 87 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0160738320302619).

Japutra, A. and Situmorang, R. (2021). The repercussions and challenges of COVID-19 in the hotel industry: Potential strategies from a case study of Indonesia. *International Journal of Hospitality Management*, Vol. 95 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0278431921000335).

Liu, A., Vici, L., Ramos, V., Giannoni, S., and Blake, A. (2021). Visitor arrivals forecasts amid COVID-19: A perspective from the Europe team. *Annals of Tourism Research*, Vol. 88 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S016073832100044X).

Qiu, R., Wu, D., Dropsy, V., Petit, S., Pratt, S., and Ohe, Y. (2021). Visitor arrivals forecasts amid COVID-19: A perspective from the Asia and Pacific team. *Annals of Tourism Research*, Vol. 88 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0160738321000177).

Sharma, G., Thomas, A., and Paul, J. (2021). Reviving tourism industry post-COVID-19: A resilience-based framework. Tourism Management Perspectives, Vol. 37 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S2211973620301537).

Skare, M., Soriano, D., and Porada-Rochon, M. (2021). Impact of COVID-19 on the travel and tourism industry. *Technological Forecasting & Social Change*, Vol. 163 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0040162520312956).

Smart, K., Ma, E., Qu, H., and Ding, L (2021). COVID-19 impacts, coping strategies, and management reflection: A lodging industry case. *International Journal of Hospitality Management*, Vol. 94 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0278431921000025).

Yang, M., Han, C., Cui, Y., and Zhao, Y. (2021). COVID-19 and mobility in tourism cities: A statistical change-point detection approach. *Journal of Hospitality and Tourism Management*, Vol. 47, 256-261.

Zhang, H., Song, H., Wen, L., and Liu, C. (2021). Forecasting tourism recovery amid COVID-19. *Annals of Tourism Research*, Vol. 87 (Retrieved April 12, 2021 from https://www.sciencedirect.com/science/article/pii/S0160738321000116).

(Received April 12, 2021; accepted April 28, 2021)