

# Examining the changes in the transitions and characteristics of populations in Nagoya City after COVID-19

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

## Abstract

*This study uses “Mobile Kukan Toukei™” (Mobile Spatial Statistics) to examine the impact of COVID-19 on the transitions and characteristics of population in Nagoya City. Mobile Kukan Toukei comprises statistical population data created using the operational data from mobile phone networks. Comparison of the data before and after the COVID-19 outbreak showed that the impact was remarkable in many areas in April 2020. Notably, urban areas such as Nagoya Station and Sakae showed relatively more robust recovery both on weekdays and holidays. However, several tourist areas did not bounce back on holidays, despite the Japanese government’s “GoTo” campaign. More visitors are perhaps coming from closer regions than distant ones as people’s attempt to minimize the risk of being infected.*

## Keywords

*mobile phone, statistical population data, Nagoya City, COVID-19, tourism industry*

## 1. Introduction

Japan’s tourism industry should have had an unprecedented increase in tourism demand due to the rapid increase in inbound tourists in recent years and the hosting of the Olympic Games in 2020. However, because of the COVID-19 pandemic, the number of foreign tourists visiting Japan dropped sharply from 31.9 million in 2019 to 4.1 million in 2020 and 246,000 in 2021.

Importantly, COVID-19 has precipitated changes in various aspects of people’s life globally, including their lifestyles. Further, many businesses have been forced to adapt to the new business environment. For instance, restaurants are struggling to transcend the conventional business boundaries, such as take-away and food delivery.

The tourism sector also needs to adapt to the new lifestyle and environment. For example, lockdowns have completely disrupted the movement of people. This study examines the pandemic’s impact on people’s movements in tourist destinations and business areas in Nagoya City using statistical population data provided by a mobile phone company. Furthermore, this study considers some trends by comparing the population attributes in areas where the number of visitors did and did not recover earlier than other areas.

## 2. Previous studies

Studies on the impact of the spread of COVID-19 on tourism have already emerged since 2020. 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 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 restrictions, followed by the travel and tourism and the casinos and gambling sectors.

## 3. Methods

This study used “Mobile Kukan Toukei™<sup>(1)</sup> (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. The survey was conducted from April 2016 to October 2020. The study sites included tourist destinations and business areas in Nagoya City, and are presented in Table 1 and Figure 1.

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.

Table 1: Survey areas and regional mesh codes

Survey Areas	Regional Mesh Code	Type of Codes
(1) Nagoya Station	5236-6700	Tertiary
(2) Nagoya Castle	5236-6721-2, 5236-6722-1	1/2
(3) Port of Nagoya Public Aquarium	5236-5700-3, 5236-5710-1	1/2
(4) Atsuta Shrine	5236-5752-2	1/2
(5) Kinjo Wharf	5236-4667-1, 5236-4667-2	1/2
(6) Kanayama Station	5236-5772-1	1/2
(7) Sakae	5236-6702	Tertiary
(8) Osu Shopping Street	5236-5792-1	1/2

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.

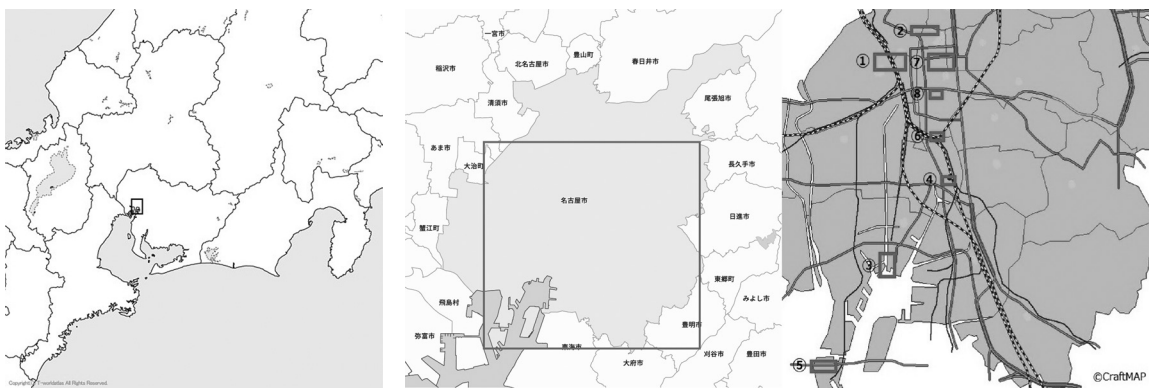


Figure 1: Survey areas in Nagoya City

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

This study first analyzed the aforementioned statistical population data to consider the pandemic's impact on the survey areas. The following subsection discuss the transition and attributes of the population in each area based on the data.

##### 4.1 Transition in population in each period

Data were collected from 8.00–9.00, 12.00–13.00, and 16.00–17.00 hrs. 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 Nagoya Station, Sakae, Kanayama Station, and Osu Shopping Street (see Figures 2, 3, 4, and 5, respectively).

However, the recovery on holidays in October was not steady

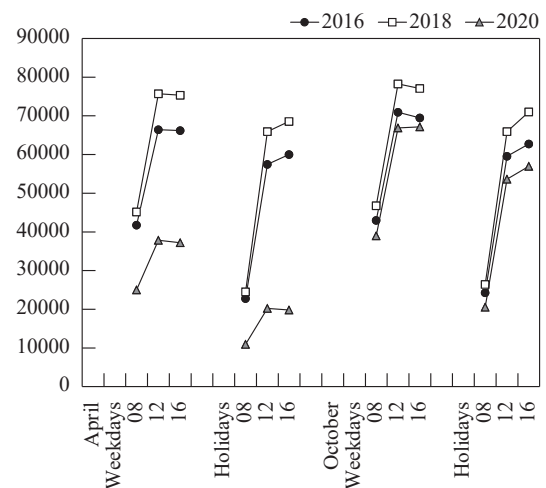


Figure 2: Transition in population at Nagoya Station

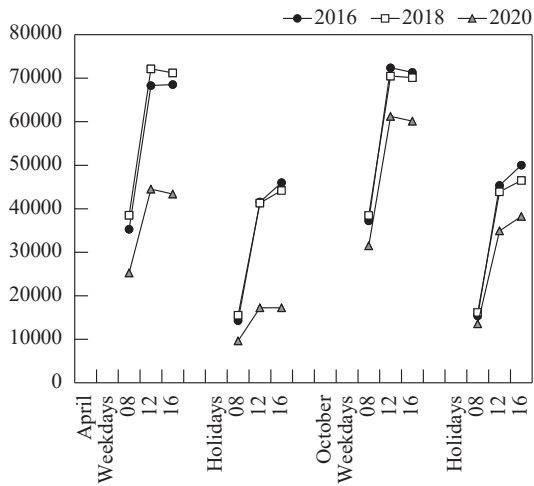


Figure 3: Transition in population at Sakae

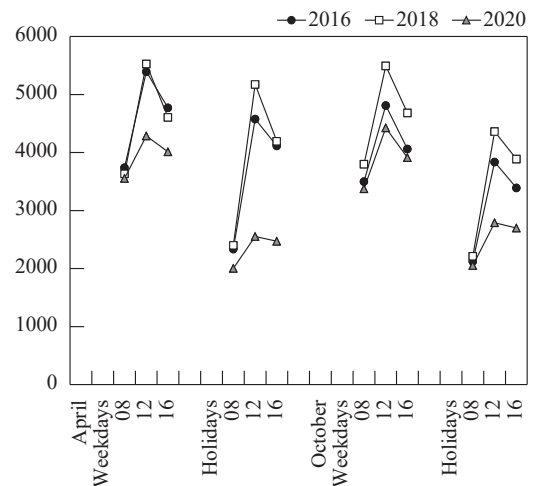


Figure 6: Transition in population at Nagoya Castle

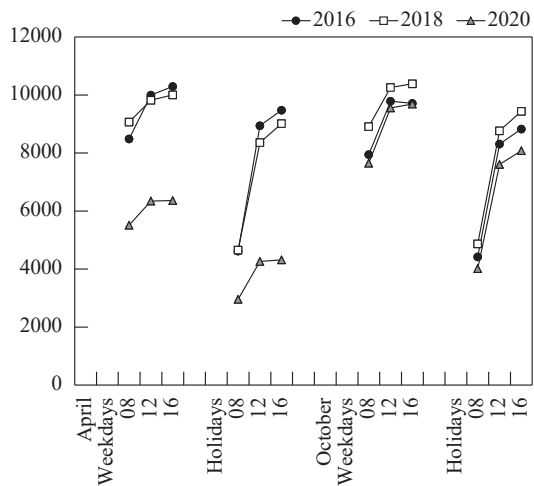


Figure 4: Transition in population at Kanayama Station

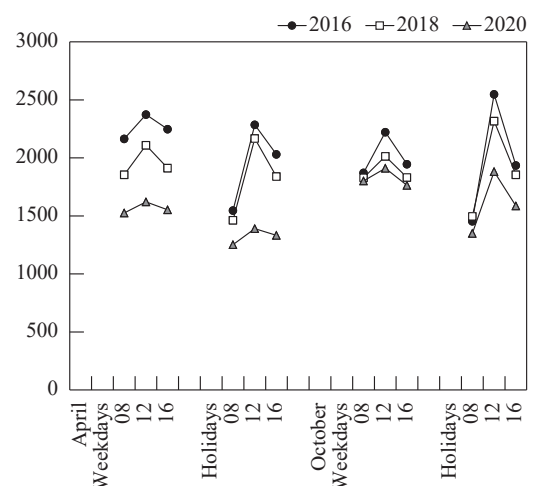


Figure 7: Transition in population at Atsuta Shrine

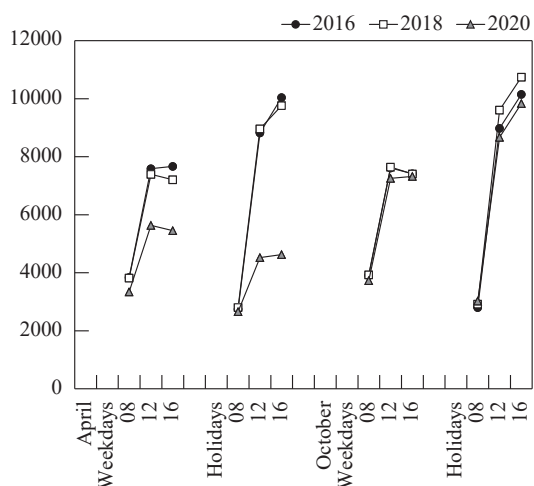


Figure 5: Transition in population at Osu Shopping Street

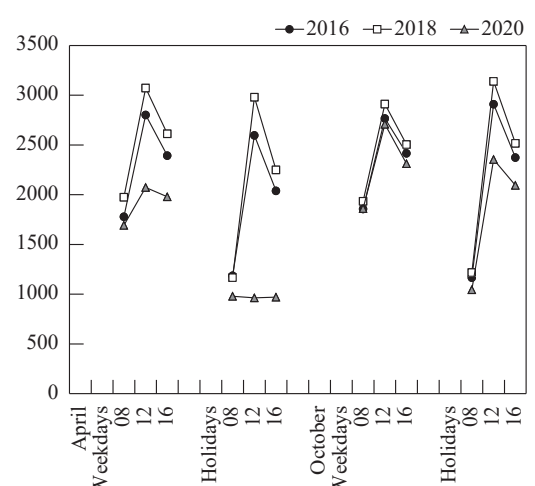


Figure 8: Transition in population at Port of Nagoya Public Aquarium

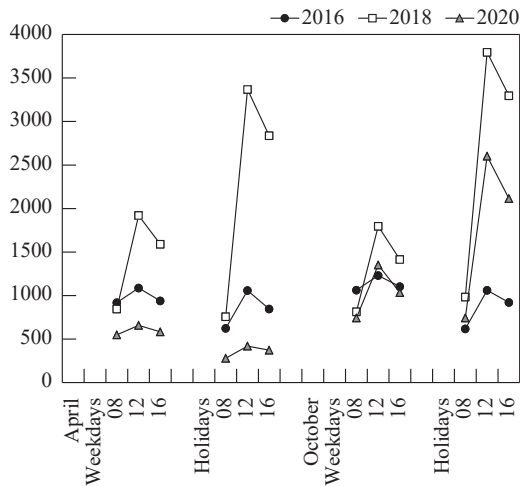


Figure 9: Transition in population at Kinjo Wharf

enough, especially in tourist areas (see Figures 6, 7, 8, and 9). Nevertheless, these areas showed a relatively solid recovery on weekdays. Although it is uncertain why the recoveries on holidays are weak, people may have tried to avoid congestion on holidays to reduce the risk of infection.

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

Figures 10 shows the population attributes at Nagoya Sta-

tion from 12:00 to 13:00 on holidays in April 2018 and April 2020, respectively. As illustrated in Figure 2, the population of all generations decreased significantly in many areas in April 2020 (see Figures 10, 11, 12, 13, 14, and 15).

Kinjo Warf houses a Lego theme park (based on the toy construction system) as its main attraction. Comparisons before and after the opening of the theme park (Figure 9) revealed that it had a remarkable impact on the number of visitors (especially on holidays in 2018).

Meanwhile, Nagoya Port Aquarium was expected to become a major competitor to the Lego theme park. Although both areas attract a large number of visitors in their 20s to 40s, those at Nagoya Public Aquarium are relatively younger.

Regarding place of residence, Nagoya Station had fewer visitors from distant regions in April 2020 than in April 2018 (Figure 18). However, the number of visitors from distant areas bounced back in October 2020 (Figure 19). A similar tendency can be observed at Sakae (Figures 20 and 21), Nagoya Castle (Figures 22 and 23), and Kinjo Wharf (Figures 24 and 25). Overall, travelers seemed to avoid long distance travel to reduce the risk of infection.

**5. Conclusion and future challenges**

This study examined the statistical population data of eight areas in Nagoya City to discern the impact of COVID-19. The impact was remarkable in many areas in April 2020. Urban areas

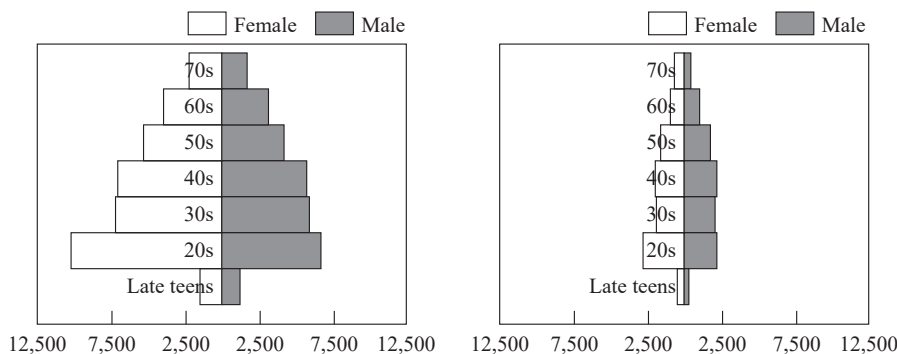


Figure 10: Gender distribution of the population at Nagoya Station (12:00 a.m.–1:00 p.m. on holidays in April 2018 and April 2020)

Note: The left and right figures show the result for 2018 and 2020, respectively. The same applies hereafter.

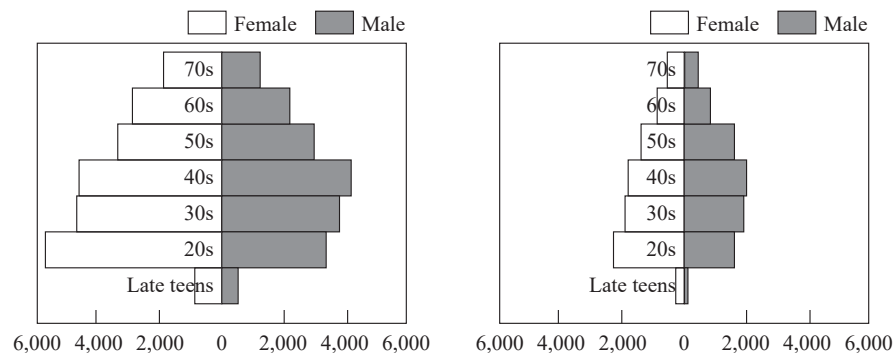


Figure 11: Gender distribution of the population at Sakae (12:00 a.m.–1:00 p.m. on holidays in April 2018 and April 2020)

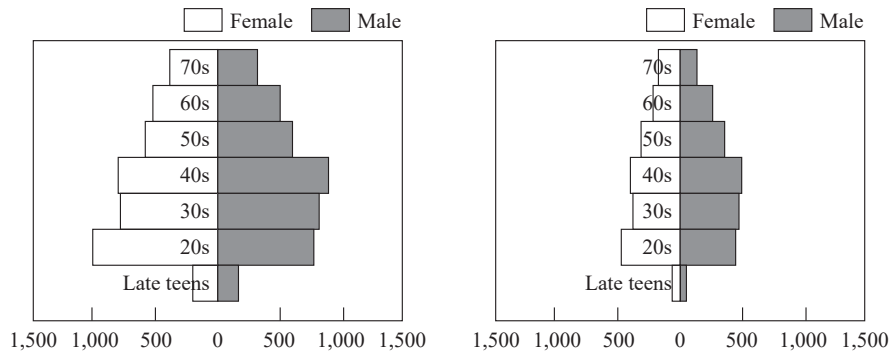


Figure 12: Gender distribution of the population at Kanayama Station (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

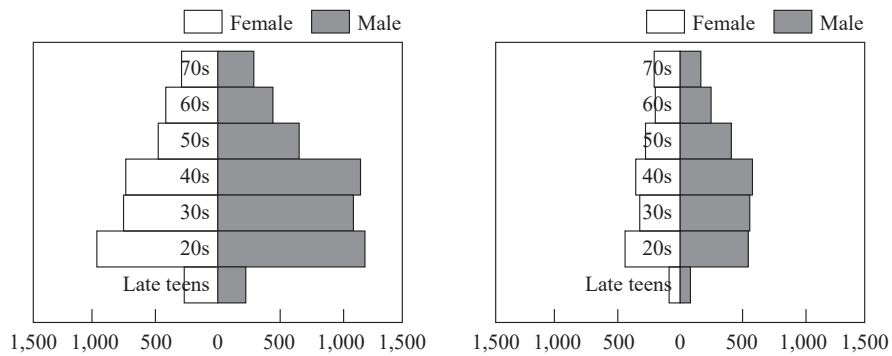


Figure 13: Gender distribution of the population at Osu Shopping Street (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

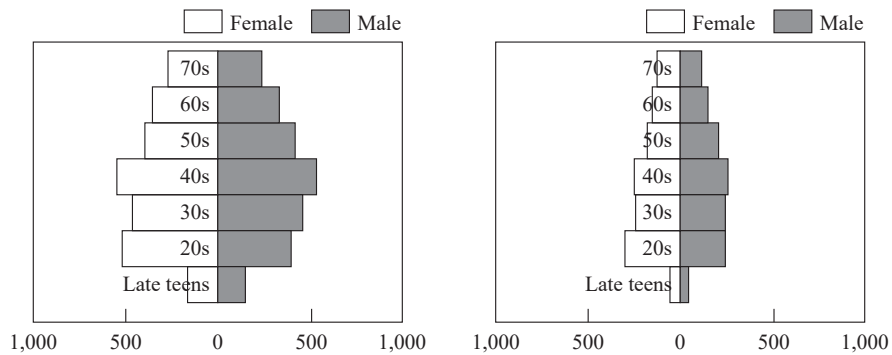


Figure 14: Gender distribution of the population at Nagoya Castle (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

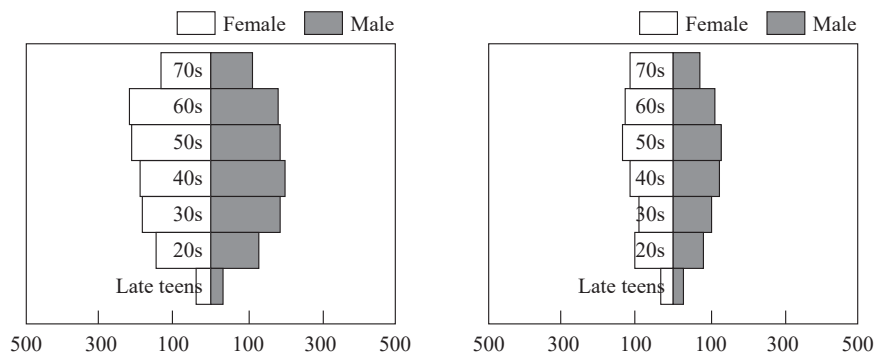


Figure 15: Gender distribution of the population at Atsuta Shrine (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

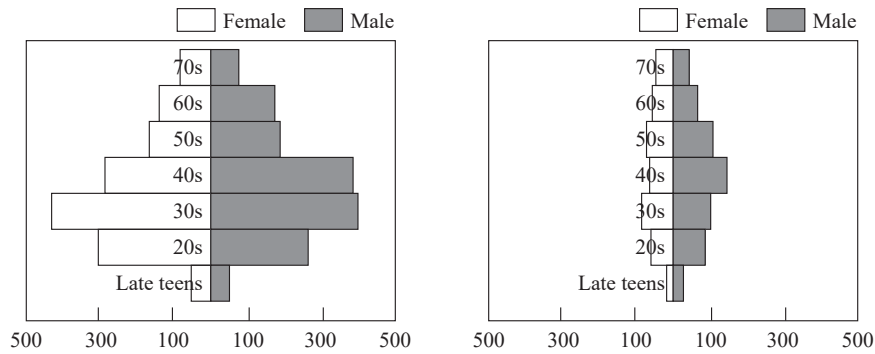


Figure 16: Gender distribution of the population at Port of Nagoya Public Aquarium (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

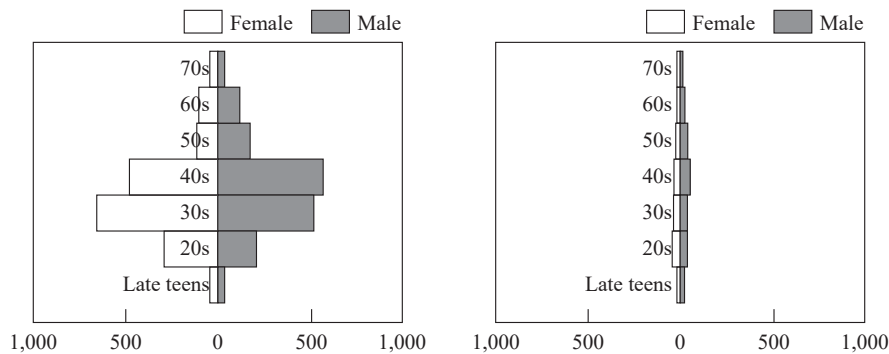


Figure 17: Gender distribution of the population at Kinjo Wharf (12:00 a.m.-1:00 p.m. on holidays in April 2018 and April 2020)

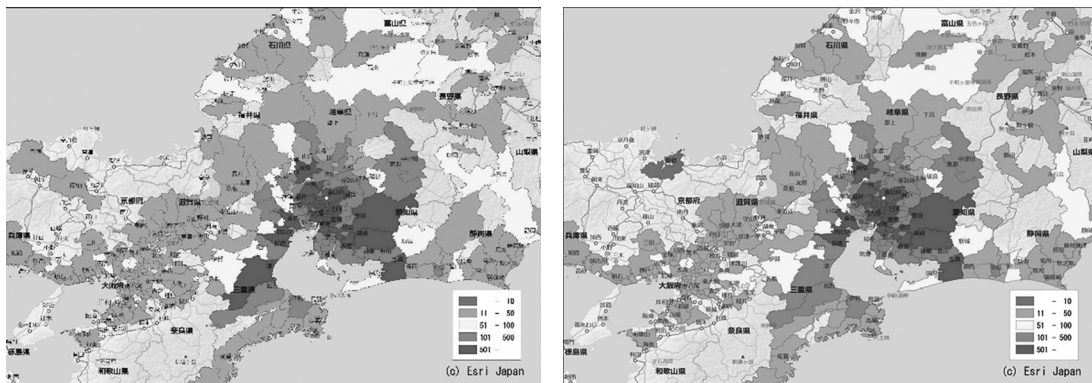


Figure 18: Residence of the population at Nagoya Station (12:00 a.m. –1:00 p.m. on holidays in April and October 2018)

Note: The left and right figures show the result for April and October 2018, respectively. The same applies hereafter.

such as Nagoya Station and Sakae showed relatively more robust recovery both on the weekdays and holidays than other areas.

Conversely, during holidays, several tourist areas could not bounce back from the rapid decrease despite the Japanese government’s “GoTo” campaign, which intended to revitalize domestic tourism.

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 Toukei, 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**

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**Note**

(1) “Mobile Kukan Toukei” is a trademark of NTT DOCOMO, Inc. NTT DOCOMO’s “Mobile Kukan Toukei” services are



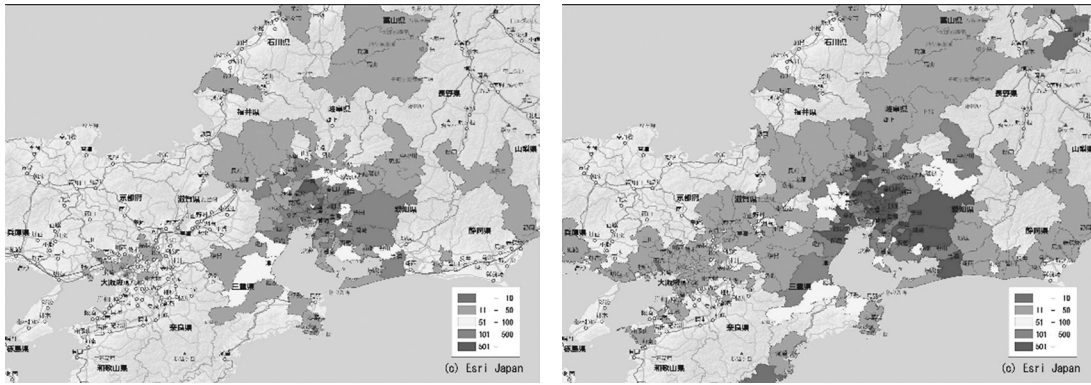


Figure 19: Residence of the population at Nagoya Station (12:00 a.m.-1:00 p.m. on holidays in April and October 2020)

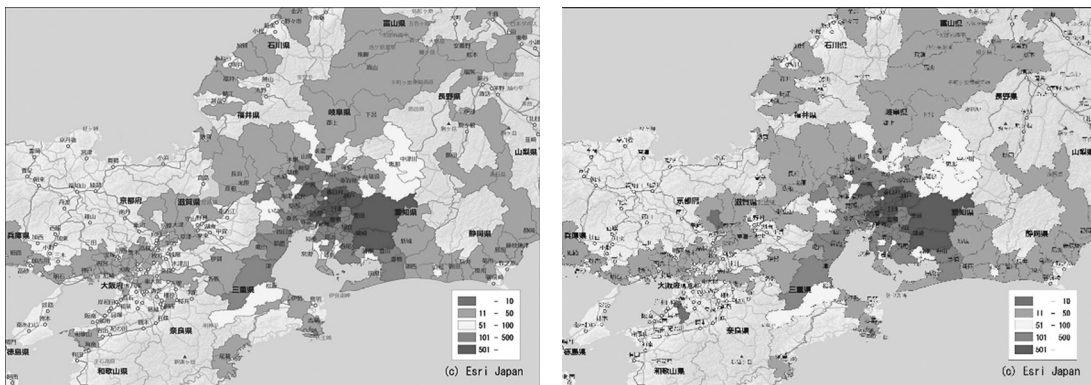


Figure 20: Residence of the population at Sakae (12:00 a.m.-1:00 p.m. on holidays in April and October 2018)

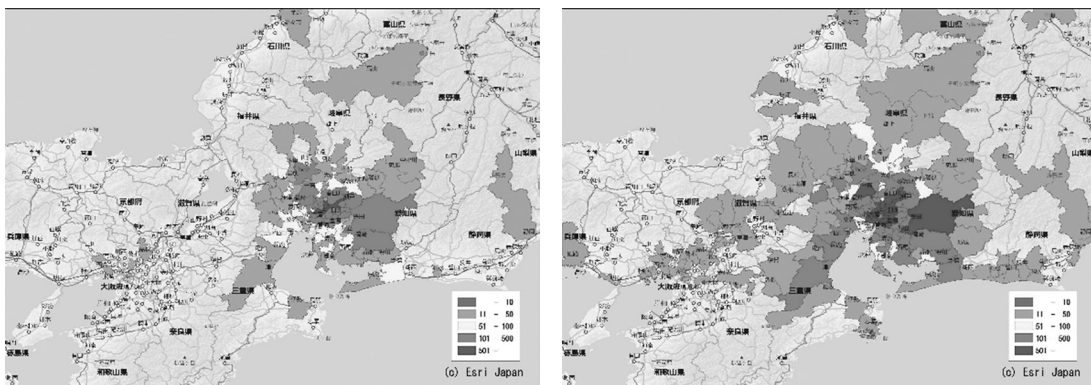


Figure 21: Residence of the population at Sakae (12:00 a.m. -1:00 p.m. on holidays in April and October 2020)

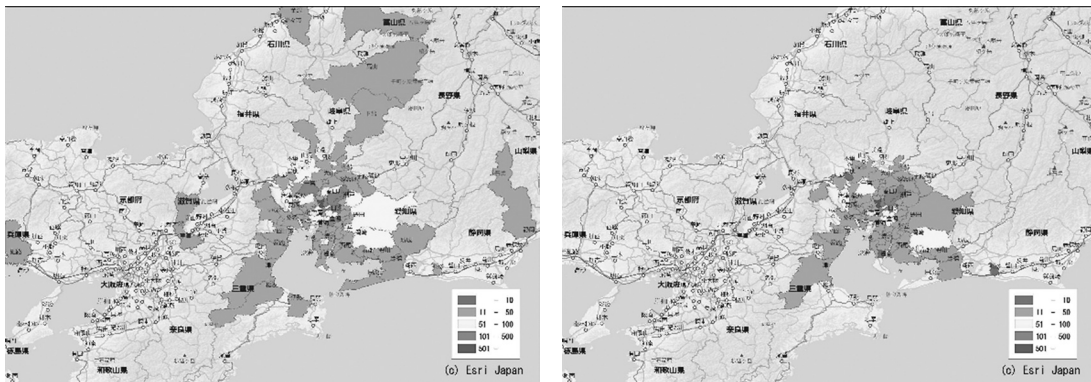


Figure 22: Residence of the population at Nagoya Castle (12:00 a.m.-1:00 p.m. on holidays in April and October 2018)

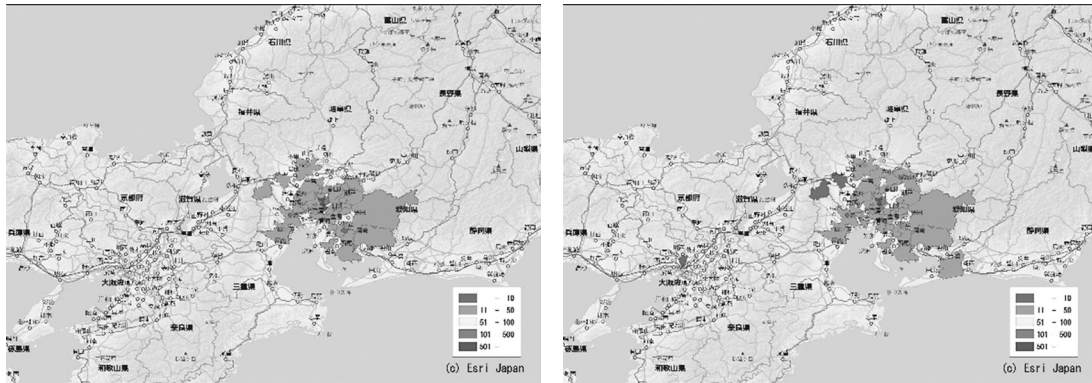


Figure 23: Residence of the population at Nagoya Castle (12:00 a.m.-1:00 p.m. on holidays in April and October 2020)

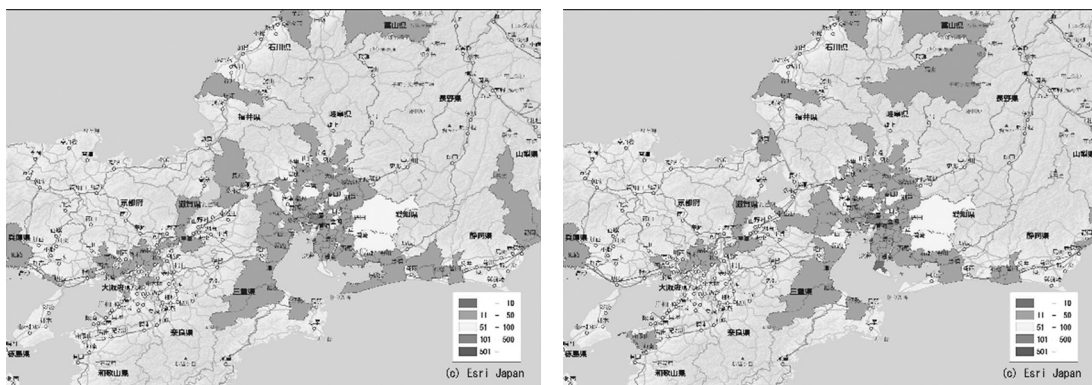


Figure 24: Residence of the population at Kinjo Wharf (12:00 a.m.-1:00 p.m. on holidays in April and October 2018)

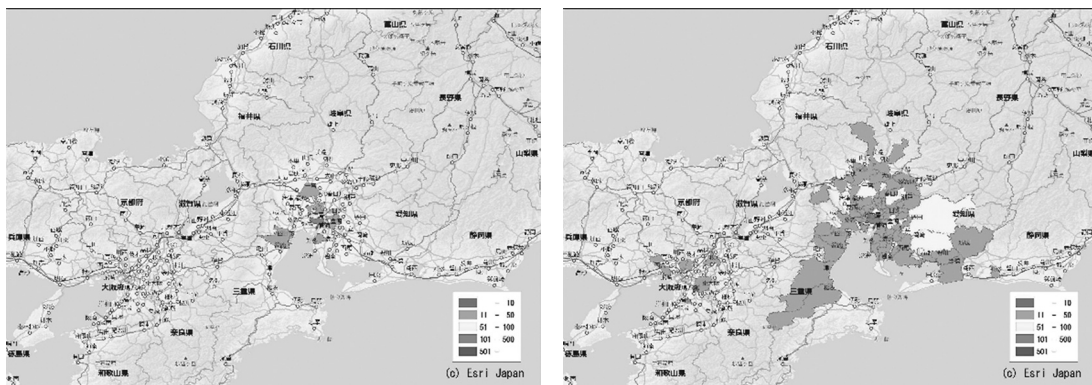


Figure 25: Residence of the population at Kinjo Wharf (12:00 a.m.-1:00 p.m. on holidays in April and October 2020)

only available to subscribers in Japan.

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