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ANALYSIS OF CHANGES IN THE ESTIMATED POPULATION OF TOKYO DURING THE COVID-19 PANDEMIC

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Abstract During the COVID-19 pandemic, telecommuting was recommended. However, previous studies have shown that the implementation rate of telecommuting varies greatly by occupation. In this study, we analyzed the estimated population in the 23 special wards of Tokyo at three time points (9 a.m., 2 p.m., and 7 p.m.) on weekdays using mobile spatial statistical data in July 2019, before the start of the pandemic, and in July 2021, during the pandemic. The results showed that the basic spatial patterns of the estimated population in 2019 and 2021 were similar. However, the spatial pattern of change (the ratio between 2019 and 2021) showed a clear difference. As expected due to stay-home requests and immigration/travel restrictions, there were significant decreases in urban centers, in downtown areas, and around airports. On the other hand, the increase in suburban residential areas, where stay-home requests were expected to increase the population, was mainly in the western part of Tokyo and was limited in the northern and eastern parts. The areas with the largest increase corresponded to those with a high percentage of white-collar residents. These results suggest that the occupational composition of the residents affected the population through the telecommuting rate of their occupation.

Keywords: estimated population, stay-home, occupational composition, COVID-19, Tokyo

1. Introduction

In Japan, the “stay-home” request during the COVID-19 pandemic called for the promotion of telecommuting and the curbing of unnecessary trips outside the home. However, whether such requests can be met depends on the situation of each individual. Nakazawa (2022), who estimated the teleworking rate by municipality using the Telework Population Survey, found that employment opportunities with relatively high income and high teleworking rates are geographically unevenly distributed and that the livelihoods of people who work in jobs that allow teleworking are supported by the jobs of people with relatively low income, for whom telework is not a feasible option. That paper also suggests that attention should be paid to the possibility of intra-regional disparities, whereby the livelihoods of people in telework-enabling jobs are supported by people with relatively low incomes who do jobs that cannot be easily replaced. Koizumi (2010) and Koizumi and Wakabayashi (2014) show spatial patterns of the occupational composition in the Tokyo metropolitan area using regional grid square data.

Based on these results, the occupations of residents living in the area and the occupational composition of workers in the area are thought to have a significant impact on the status of responses

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to stay-home requests. Therefore, we compared the changes in people flows by time period between 2019 and 2021 using this mobile spatial statistical data, coupled with population characteristics including occupation within the regional grid square data, with the aim of clarifying geographical factors in occupational composition that affect the changes in people flows.

2. Data and Method

The data used are mobile spatial statistical data showing monthly average estimated population within 500m grid squares. The coverage area is the 23 special wards of Tokyo (Fig. 1), and the number of grid squares in the coverage area is 2,641. In this study, three weekday time points (9 a.m., 2 p.m., and 7 p.m.) during July 2019 and July 2021 were included in the analysis in order to analyze changes in the weekday estimated population before and after COVID-19.

In this study, the local Moran statistic was applied to the ratio of the estimated population in 2021 to that in 2019 in order to identify high value districts surrounded by high value districts (HH districts) and low value districts surrounded by low value districts (LL districts). A first-order adjacency relationship was used for the weight matrix of the local Moran statistic.

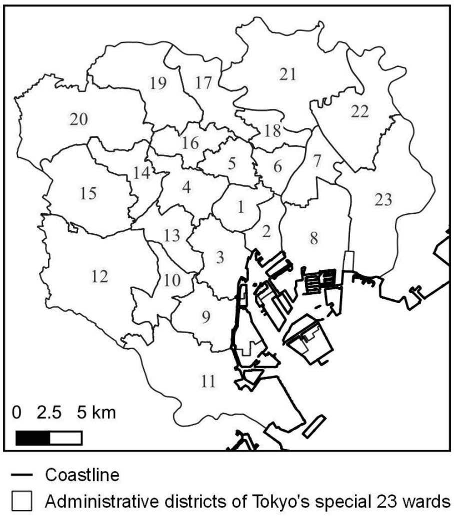

Fig. 1 Study area and the 23 special wards of Tokyo

3. Analysis Results

First, we analyzed the spatial autocorrelations of the estimated population at the three time points in 2019 and 2021 and of the ratio of the estimated population in 2021 to that in 2019 at each time point. The global Moran's I and Z scores are shown in Table 1. The spatial autocorrelation among the three time points was strongest at 9 a.m. However, the ratio between 2019 and 2021 at each time point showed that the strongest spatial autocorrelation was observed in the 2 p.m. results.

Table 1 Spatial autocorrelation values at each time point

	2019		2021		2021/2019 ratio	
	Moran's I	Z scores	Moran's I	Z scores	Moran's I	Z scores
9 a.m.	0.795	86.15	0.788	85.27	0.451	49.35
2 p.m.	0.782	84.83	0.771	83.54	0.498	54.01
7 p.m.	0.656	71.41	0.679	73.54	0.455	49.32

All values are significant at the 5% level.

Figure 2 shows the estimated population at 9 a.m. on weekdays in 2019 and the ratio between 2019 and 2021. The population exceeds 10,000 per grid cell in Chiyoda ward (1 in Fig. 1), including Tokyo Station (No. 1), Shimbashi (No. 4), and the National Diet Building (Nagatacho) (No. 6), and in the subcenters of Shinjuku (No. 2), Shibuya (No. 3), and Ikebukuro (No. 7). The ratio between 2019 and 2021 shows decreases in the city center and suburban business districts, such as Nakano (No. 9), Kinshicho (No. 11), Toyosu (No. 12), Kamata (No. 13), Nerima (No. 14), and Toyocho (No. 15), and along the radial transportation routes to the city center. Increases are observed mostly in suburban residential areas.

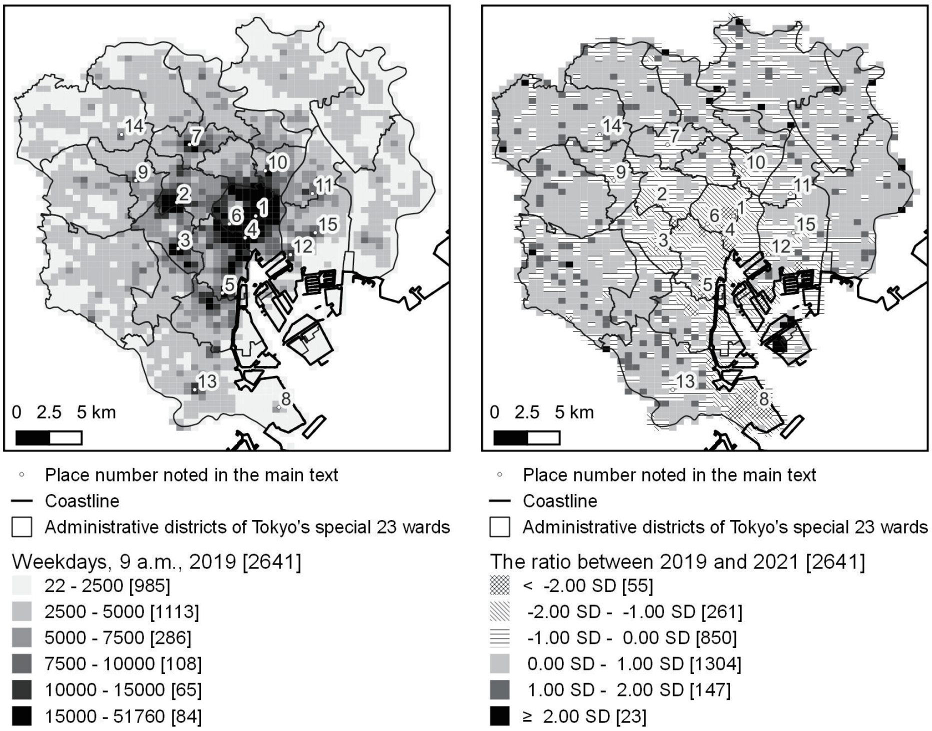

Fig. 2 Estimated population at 9 a.m. (left), and the ratio of the estimated population between 2019 and 2021 (right)

Figure 3 shows the estimated population in 2019 at 2 p.m. on weekdays and the ratio between the two years. The number of grid cells with population exceeding 10,000 was more pronounced around Shinagawa Station (No. 5) in addition to the districts mentioned above for 9 a.m. The results for the ratio between the two years were similar to those for 9 a.m., with the decrease being more pronounced in the central part of the city. However, compared with the 9 a.m. results, the increases in suburban areas were more pronounced, especially in the western suburban wards, such as Setagaya (12 in Fig. 1) and Suginami (15 in Fig. 1).

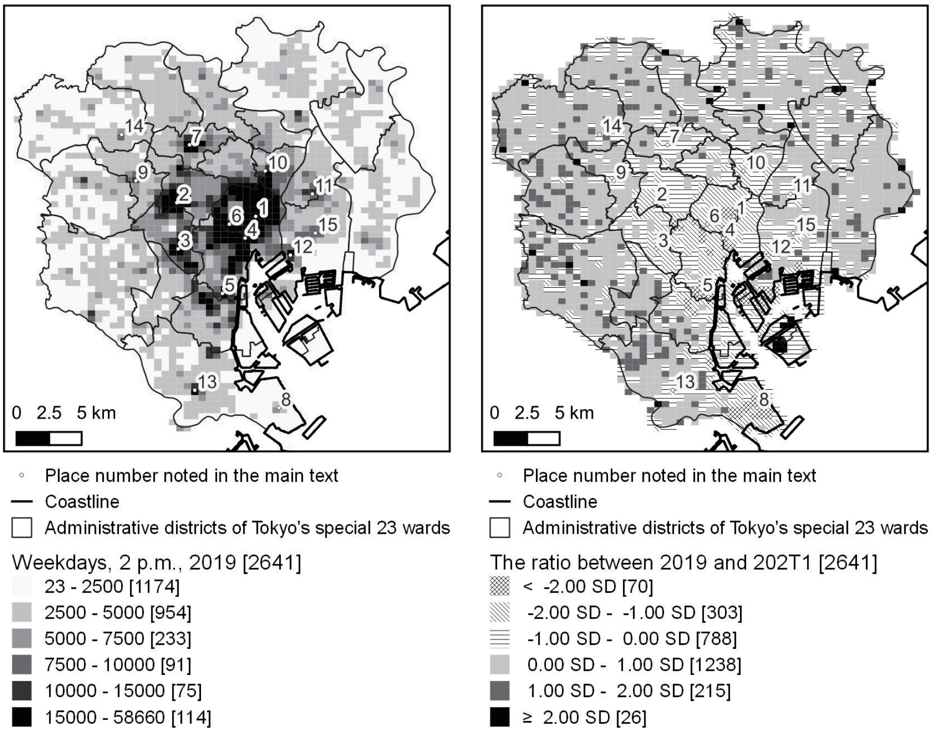

Fig. 3 Estimated population at 2 p.m. (left), and the ratio of the estimated population between 2019 and 2021 (right)

Figure 4 shows the estimated population at 7 p.m. on weekdays in 2019 and the ratio of the population between the two years. Among the three time points, the global Moran statistic was the smallest, showing a more dispersed appearance than at 9 a.m. and 2 p.m. The ratio showed large decreases in downtown areas such as Shinjuku, Shibuya, Ikebukuro, and Ueno (No. 10), in addition to the three central wards of Tokyo (Chiyoda, Chuo, and Minato), where there are many office workers. On the other hand, increases were seen not only in the suburbs but also in residential areas around the city center. The increase in the Ariake district in the southern part of Koto ward (8 in Fig. 1) may be related to the Tokyo Olympics 2020, which was held only for a limited part of the study period (Koizumi 2023).

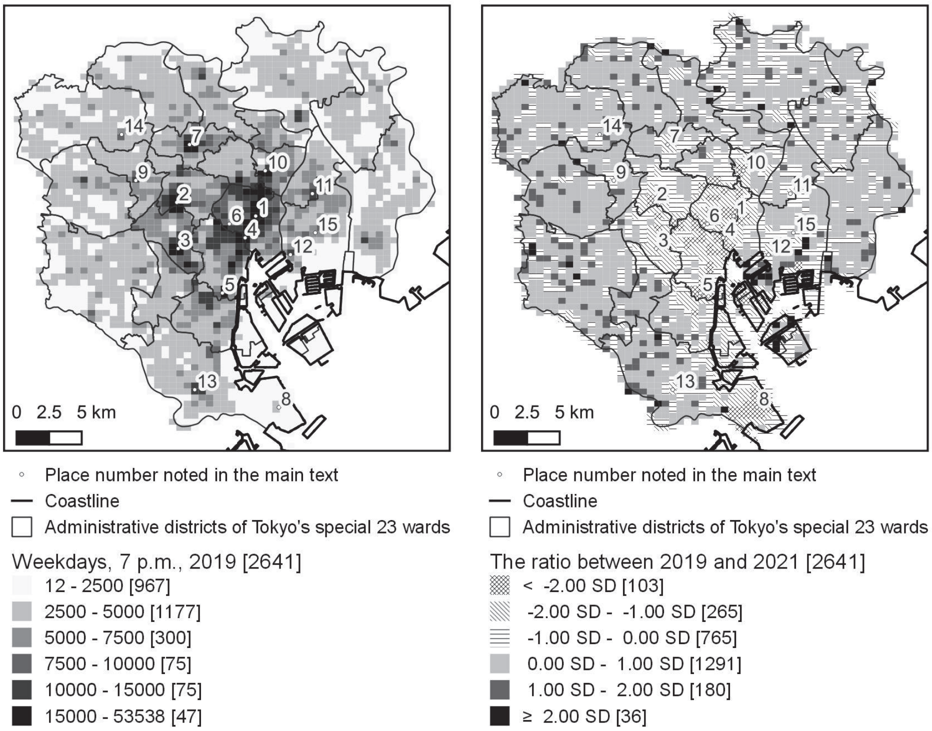

Fig. 4 Estimated population at 7 p.m. (left), and the ratio of the estimated population between 2019 and 2021 (right)

These analyses show that differences in the daily pattern before and after COVID-19 were limited. However, there were large regional differences in the ratios of the estimated populations between the two years. Among the 23 special wards of Tokyo, the three central wards and the wards of Shibuya and Shinjuku showed a decreasing trend in almost all areas. Decreases were also noticeable in the areas surrounding Haneda Airport (No. 8) and the Port of Tokyo. Such a decrease was also observed within approximately 6 km from the National Diet Building (No. 6). On the other hand, outside of these areas, the estimated population in 2021 was higher than in 2019 except for areas in front of major train stations and around major transportation routes. These increases were more pronounced at 2 p.m. in terms of time of day and in western suburban residential neighborhoods in terms of location.

Next, we analyzed the ratios between the two years at each time point. The local Moran statistics of the ratios between the two years were obtained and the clustering results are mapped and shown in Fig. 5.

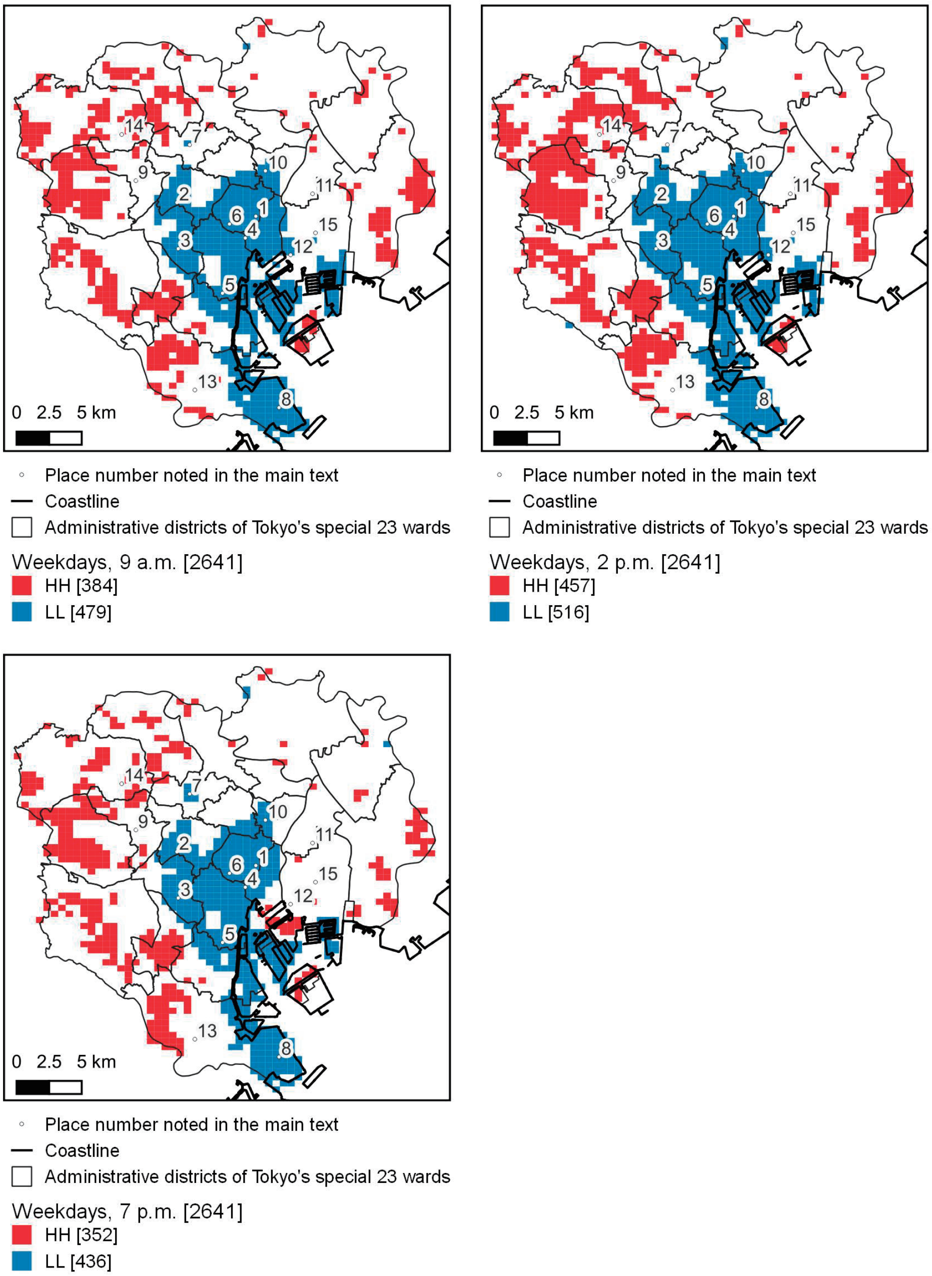

Fig. 5 Hotspots in the ratio of the estimated population between 2019 and 2021 at each time point

The change at 9 a.m. showed clusters of LL from central Tokyo to Haneda Airport. On the other hand, HH clusters were present in suburban areas, mainly in the western part of the city.

The range of LL clusters in the city center was larger at 2 p.m. than at 9 a.m. The HH clusters in the suburbs were also larger than those in the city center. The range of HH clusters in the suburban areas also expanded in Suginami, Setagaya, and Nerima wards (20 in Fig. 1).

The pattern of change at 7 p.m. was similar to that at 9 a.m.. The characteristic features were the expansion of LL clusters around Ikebukuro, which is a downtown area, and the HH clusters in the southern part of Koto ward.

4. Discussion

In this study, we focused our analysis on weekdays among the changes in the flow of people due to COVID-19. As a result, the following findings were obtained. First, the basic spatial pattern of the three time points in a day was the same before and after COVID-19. However, the analysis of the ratio of increase/decrease revealed a regional response to the stay-home policy during the COVID-19 pandemic.

Second, LL regions where the estimated population was significantly lower in 2021 than in 2019 included the three central wards of Tokyo, where there are more white-collar workers. In addition, this was also observed around Haneda Airport and the expressway connecting the airport to city center, and around the Port of Tokyo, the use of which was drastically reduced due to border control measures. On the other hand, the HH areas with a significant increase in the number of residences were unevenly distributed in the western part of the suburban residential areas. In the structure of residential areas in Tokyo, the western part of the city has a high percentage of white-collar workers (Koizumi 2010; Koizumi and Wakabayashi 2014). In other words, this result may indicate a geographical pattern in the proportion of workers engaged in occupations that made it possible to stay home, as indicated by Nakazawa (2022), against the background of the teleworking implementation rate by occupation. Since the HH areas included areas where family households reside rather than single-person households, the effect of school-age children attending classes from home rather than commuting to school may also have had an impact. However, given the pattern of the school attendance population, the effect of the occupational ratio of the resident population was considered more significant.

As described above, the stay-home request during the COVID-19 pandemic may have resulted in geographical differences via the proportion of persons employed in occupations that allowed them to stay home. Given that the stay-home program was intended to prevent the spread of infection, it is possible that these geographic differences also affected regional trends in the spread of infection.

Acknowledgments

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References

Koizumi, R. 2010. Spatial patterns of occupational structure and their changes in Tokyo metropolitan area. *Quarterly Journal of Geography* **62**: 61-70.*

Koizumi, R. and Wakabayashi, Y. 2014. Changes in the spatial patterns of occupational structure in the Tokyo metropolitan area after the bubble economy. In *Urban Development Challenges, Risks and Resilience in Asian Mega Cities*. ed. R.B. Singh, 351-366. Tokyo: Springer.

Koizumi, R. 2023. Mega-events and urban socio-economy: Urban development through Tokyo 2020 and Osaka 2025. In *Political Economy of the Tokyo Olympics: Unrestrained Capital and Development without Sustainable Principles*. ed. M, Aramata, 66-88. London: Routledge.

Nakazawa, T. 2022. Estimation of the teleworker ratio at municipality level during the COVID-19 emergency: Based on the national survey on teleworking. *E-journal GEO* **17**(2): 210-229.*

(*: in Japanese with English abstract)