Original Article

A comparative study on transitions in numbers and characteristics of visitors to hot springs

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Abstract

This study used "Mobile Kukan Toukei™" (mobile spatial statistics) provided by NTT DOCOMO, Inc. and DOCOMO Insight Marketing, Inc. to collect the location data of mobile phone users in order to count 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 is possible to estimate the population structure of a region by gender, age, and residence using this service of the company. First, I examined the data of the two hot springs, Wakura and Yamanaka. Then I compared the results of them. The opening of the Hokuriku Shinkansen brought more visitors to many areas in the prefecture. However, it also led to fewer visitors in some areas. Regarding Yamanaka hot springs, there was no significant difference in visits between different periods. Some visitors might have spent more than one night in Yamanaka hot springs. Although both Wakura and Yamanaka hot springs are a little far from Kanazawa, their results were contrary. A TV drama might have increased the number of tourists in Wakura.

Keywords

mobile phone, location data, hot springs, Shinkansen, visitor

1. Introduction

So far, maximum attempts have been made in academic research to study the possibility of using big data in tourism. Previous tourism marketing research has primarily focused on the ways service promises are made and kept, mostly generating frameworks to improve managerial decisions or providing insights on associations between constructs [Dolnicar and Ring, 2014]. *Big data* have become important in many research areas, such as data mining, machine learning, computational intelligence, information fusion, the semantic Web, and social networks [Bello-Orgaz et al., 2016]. To date, several attempts have been made to use large-scale data or mobile phone location data in tourism marketing studies.

Most studies dealing with big data in tourism were published after 2010. Fuchs et al. [2014] presented a knowledge infrastructure that has recently been implemented at the leading Swedish mountain tourism destination, Åre. Using a Business Intelligence approach, the *Destination Management Information System* Åre (DMIS-Åre) drives knowledge creation and application as a precondition of organizational learning at tourism destinations.

Xiang et al. [2015] tried to apply big data to tourism marketing. The study aimed to explore and demonstrate the utility of big data analytics to better understand important hospitality issues, namely, the relationship between hotel guest experience and satisfaction. Specifically, the investigators applied a text analytical approach to a large number of consumer reviews extracted from Expedia.com to deconstruct hotel guest experiences and examine the association with satisfaction ratings.

This study used "*Mobile Kukan Toukei*™" provided by NTT DOCOMO, Inc. and DOCOMO Insight Marketing, Inc. to collect the location data of mobile phone users in order to count 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 (see Figure 1). It is possible to estimate the population structure of a region by gender, age, and residence using this service of a particular company (see Figure 2).

The locations and characteristics of the individuals obtained herein are derived through a non-identification process, aggregation processing, and concealment processing. Therefore, it is

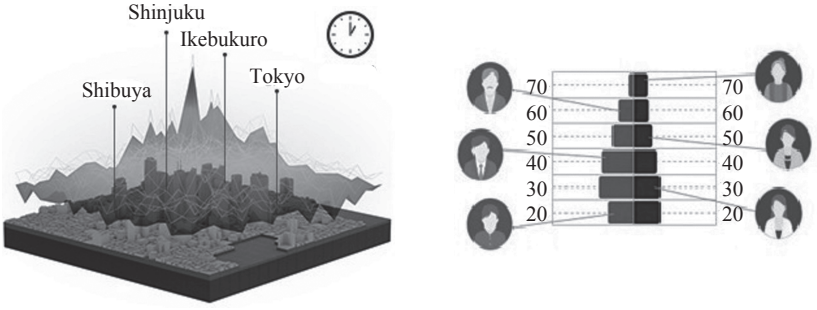

Figure 1: Location data of mobile phone users collected from Mobile Kukan Toukei

Source: Retrieved October 8, 2018, from https://www.nttdocomo.co.jp/corporate/disclosure/mobile_spatial_statistics/#p01.

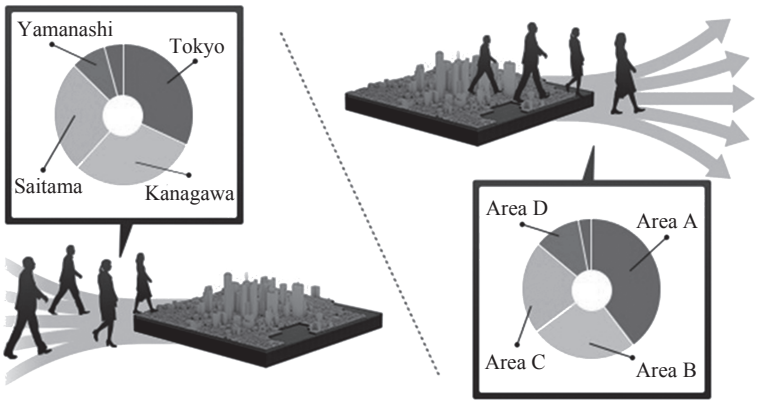

Figure 2: Location data of mobile phone users collected from Mobile Kukan Toukei
Source: Retrieved October 8, 2018, from https://www.nttdocomo.co.jp/corporate/disclosure/mobile_spatial_statistics/#p01.

impossible to identify specific individuals.

This study attempts to identify the number of visitors in different periods and their characteristics based on the location data of mobile phone users collected by the mobile phone company. In addition, I also attempt to demonstrate an alternative method to more accurately measure the number of visitors attracted by an event.

2. Previous studies

Studies on using mobile phone location data for tourism surveys can be traced back to 2008. Ahas et al. [2008] introduced the applicability of passive mobile positioning data for studying tourism. They used a database of roaming location (foreign phones) and call activities in network cells: the location, time, random identification, and country of origin of each called phone. Using examples from Estonia, their study described the peculiarities of the data, data gathering, sampling, the handling of the spatial database, and some analytical methods to demonstrate that mobile positioning data have valuable applications for geographic studies. Japan Tourism Agency conducted a similar study using international roaming service in December 2014 [Japan Tourism Agency, 2014].

Since the creative work of Ahas et al. [2008], several studies employing location data have emerged. Liu et al. [2013] investigated the extent to which behavioral routines could reveal the activities being performed at mobile phone call locations captured when users initiate or receive voice calls or messages. Using data collected from the natural mobile phone communication patterns of 80 users over more than a year, they assessed the approach via a set of extensive experiments. Based on the ensemble of models, they achieved prediction accuracy of 69.7 %. The experiment results demonstrated the potential to annotate mobile phone locations based on the integration of data mining techniques with the characteristics of underlying activity-travel behavior.

Alternative related studies have also been conducted. Gao and Liu [2013] attempted to examine the methods used to estimate traffic measures using information from mobile phones, accounting for the fact that each vehicle likely contains more than one phone because of the popularity of mobile phones. Steenbruggen et al. [2015] used mobile phone data to provide new spatio-temporal tools for improving urban planning and reducing inefficiencies in current urban systems. They addressed the applicability of such digital data to develop innovative applications to improve urban management.

As described above, this study surveyed previous related research. Among those studies, the present study could be characterized as similar to Ahas et al. [2008]. However, Ahas et al. [2008] is based on results obtained by analyzing data roaming activity. Mobile phone users in the study are obviously limited. Therefore, whether the knowledge gained applies to the average traveler is not clear. In the present study, I analyzed data provided by NTT DOCOMO, Inc., which is the largest mobile phone service provider in Japan. Therefore, their data should be more reliable in that the parameter is quite large.

Another study needs to be mentioned here. The Project Report that Okinawa Prefecture published [2013] is of a study that used location data obtained from a domestic mobile phone network. The aim of the project was to survey the characteristics and behavior of tourists who were visiting Okinawa Prefecture. Okinawa pref. conducted the survey in order to grasp the trends and needs of repeat customers. The survey revealed the composition of tourists to Okinawa Prefecture by residence, gender, and age. They examined how the number of travelers changes depending on the month (October 2012 and January 2013) and the day of the week.

3. Methods

This survey was conducted over two periods, the first from April 2014 to October 2015 and the second from December 27, 2015, to January 14, 2017.

The sites studied in this survey are tourist destinations in Ishikawa Prefecture, including Kanazawa city, which became nationally popular when the *Hokuriku Shinkansen* (high-speed railway) opened in 2015. The earlier period of the survey was to observe the effect of the opening, while the latter period was to assess the effect of the transition. Sometimes the earlier period was selected to be shown because the results were more

Figure 3: Survey areas

Figure 4: The regional mesh of Wakura Hot Springs

distinctive due to a shorter interval after the opening.

The survey areas are presented in Table 1 and Figure 3. There are two reasons the area around two hot springs was chosen. First, there are a number of hotels there, and therefore these places were likely to have a larger economic effect on the opening than other nearby areas. Second, the two hot springs are easily accessible from Kanazawa by train.

Kenrokuen, which is one of the most famous gardens in Japan, about ten minutes by bus from the Kanazawa station, was added to the survey area to see the direct effect of the opening.

When selecting these areas, it was essential to identify their "regional mesh codes." A regional mesh code is a code for identifying the regional mesh. It stands for an encoded area that is substantially divided into the same size of a square (mesh) based on the latitude and longitude in order to use it for statistics. With regard to regional mesh, there are three types of meshes: primary, secondary, and tertiary. 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.

In addition, split regional meshes also exist, which are a more detailed regional division. A half-regional mesh is a tertiary mesh that is divided into two equal pieces in the vertical and horizontal directions. The length of one side is about 500 m. Furthermore, the length of one side of a quarter and 1/8 regional meshes is about 250 m and 125 m respectively.

For example, the mesh code of Wakura Hot Springs, which is one of the survey areas, is a third order code 5536-5703 (Figure 4). If the survey area cannot be covered in one mesh, it is possible to combine multiple meshes, like Kenrokuen in Table 1. Kenrokuen Park was added to the survey areas to compare with the hot springs and enable observation of their distinctions.

4. Results

This study first analyzed the location data collected from NTT DOCOMO, Inc. to consider the effect of the opening of the Hokuriku Shinkansen on the survey areas. The periods during which the data were collected are 8.00-9.00, 12.00-13.00, and 14.00-15.00 hrs.

4.1 Transition in number of visitors in each time period

Figure 5 shows that Kenrokuen Park attracted more visitors in the afternoons probably due to the large number of tourists who visit the park on single-day trips.

Comparatively, Wakura, which is located on the Noto Peninsula, had more visitors (Figure 6) in the mornings (8:00 a.m.–9:00 am) than the other hot springs. Regarding Yamanaka hot

Table 1: Survey areas and regional mesh codes

	Survey Areas	Regional Mesh Code	Type of Codes
Kanazawa	Kenrokuen	5436-6572+5436-6573-1, 5436-6573-3	Tertiary, 1/2
Nanao	Wakura Hot Springs	5536-5703	Tertiary
Kaga	Yamanaka Hot Springs	5436-2299, 5436-2390	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.

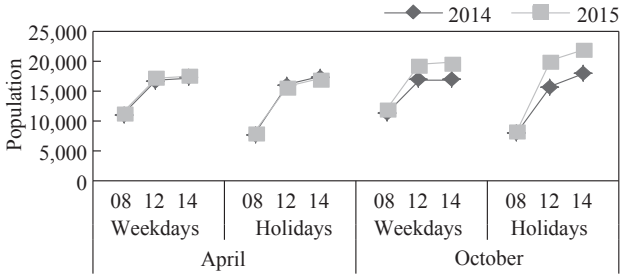

Figure 5: Visitor transitions at Kenrokuen

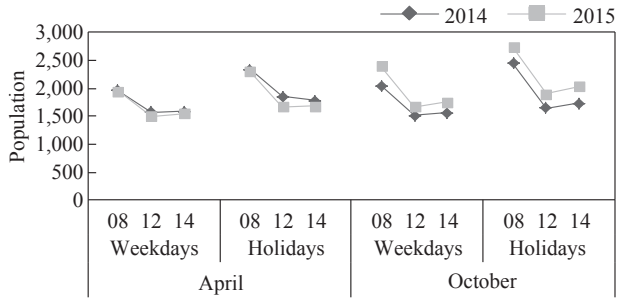

Figure 6: Visitor transitions at Wakura hot springs

springs, there was no significant difference in visits between different periods (Figure 7).

There are two possible explanations for these results. First, many visitors may have spent more than one night at Yamanaka hot springs. Second, the morning market held near Wakura hot springs may have increased the population there before noon.

Although both Wakura and Yamanaka hot springs are a little far from Kanazawa, their results were contrary. A TV drama might have increased the number of tourists in Wakura. "Mare," which was broadcast nationwide from March to September 2015, presented the story about a girl born in Noto Peninsula.

Figure 8 shows visitor transitions at the two hot springs and Kenrokuen. Notably, the transitions of the two hot springs

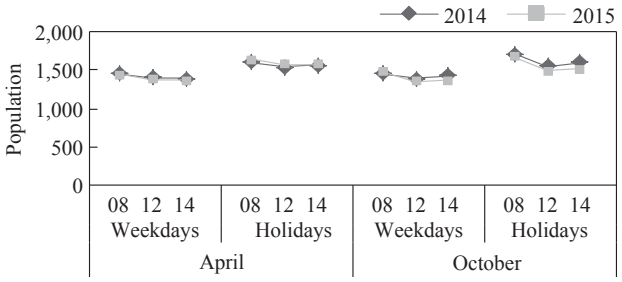

Figure 7: Visitor transitions at Yamanaka hot springs

show very similar fluctuations. The correlation coefficient between them is 0.586, whereas that between both hot springs and Kenrokuen is below 0.1 (see Table 2).

These values might suggest that the two hot springs are competitors. Visitors who like hot springs typically stay to enjoy them for more than one night, whereas many visitors might have enjoyed Kenrokuen without staying overnight.

4.2 Visitors' characteristics: Gender, age, and residence

The Kenrokuen Park attracted a variety of visitors, including many female visitors.

On the other hand, many elderly people (over 60 years old) visited the hot springs. I presume that the local people account for a large proportion of these visitors.

Figures 12, 13, and 14 illustrate the home residence areas of visitors to Kenrokuen, Wakura hot springs, and Yamanaka hot springs, respectively, on holidays in October 2015. These images show that Kenrokuen was successful in attracting many visitors from various areas in Japan. Wakura attracted more people from the Kanto region, whereas people in the Kansai region preferred Yamanaka (see Table 3).

These tendencies could be explained by accessibility. Yamanaka can be more easily accessed from the Kansai region, whereas Wakura is near to Noto Satoyama airport, which offers direct flights to Tokyo.

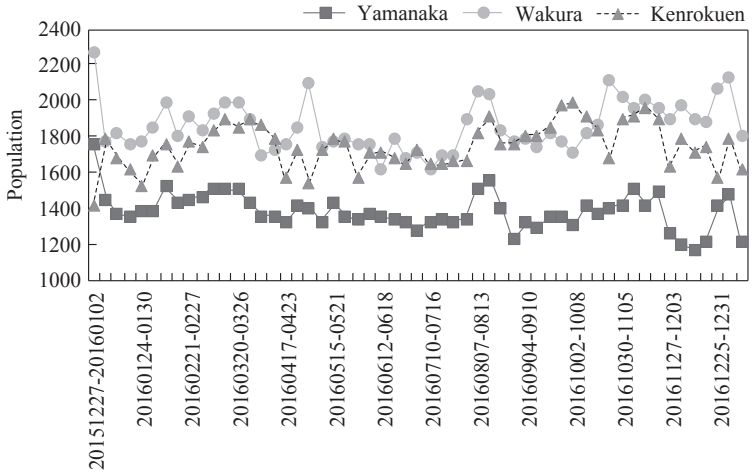

Figure 8: Visitor transitions at the two hot springs and Kenrokuen

Source: Weekly populations of three tourist destinations from Dec. 27, 2015, to Jan. 14, 2017.
Note: Right axis indicates population at Kenrokuen Park; left axis indicates population at the two hot springs.

Table 2: The correlation coefficient among the transitions of the population at tourist destinations

		Kenrokuen	Yamanaka	Wakura
Kenrokuen	Correlation coefficient	–	.087	.011
	Significance probability		.528	.937
	N	55	55	55
Yamanaka	Correlation coefficient	.087	–	.586 **
	Significance probability	.528		.000
	N	55	55	55
Wakura	Correlation coefficient	.011	.586 **	–
	Significance probability	.937	.000	
	N	55	55	55

Note: ** Correlation coefficient is significant at the 1 % level.

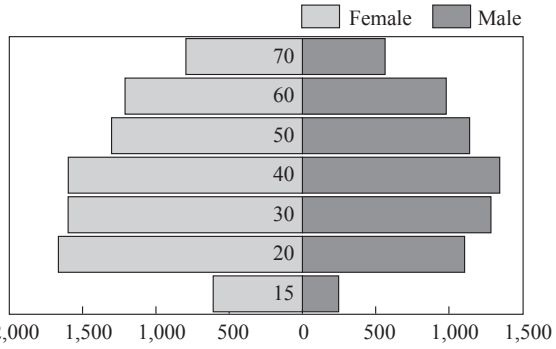

Figure 9: Visitors' gender distribution at Kenrokuen (2:00 p.m.-3:00 p.m., May 1-7, 2016)

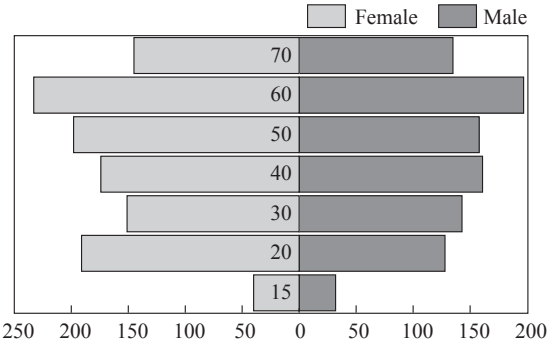

Figure 10: Visitors' gender distribution at Wakura hot springs (2:00 p.m.-3:00 p.m., May 1-7, 2016)

In general, visitors at the two hot springs were from smaller cities, perhaps due to tourist groups from those locations. Hot springs in the Hokuriku region are well known for their dependency on group tourism. Table 3 may suggest that dependency.

6. Conclusion and future challenges

Tourism is likely to become increasingly important to local economies. However, tourism industry has been suffering significant volatility in demand depending on the season and day of the week. In addition, there was significant loss of business

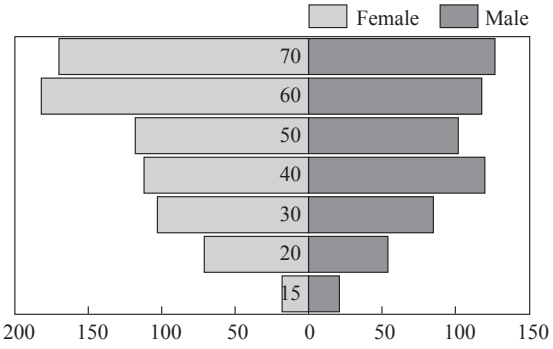

Figure 11: Visitors' gender distribution at Yamanaka hot springs (2:00 p.m.-3:00 p.m., May 1-7, 2016)

opportunities because of congestion during the busy season.

To cope with such volatility, various events have been held to eliminate the seasonal gap. Many events are newly launched. To date, it has been difficult to accurately grasp the extent to which these events attract visitors and the types of people who visit. However, by employing the recently provided Information and Communication Technology (ICT) services, it is possible to verify the number and characteristics of visitors to a particular event.

In this study, I attempted to identify the number of visitors at two points in time at various places in Japan and their characteristics using the location data of mobile phone users collected by the mobile phone company. As explained above, Wakura hot springs received more visitors in the mornings, whereas there was no significant difference in visitor populations at Yamanaka hot springs at different times of day. Additionally, Wakura attracted more people from the Kanto region, whereas people in the Kansai region preferred Yamanaka.

Numerous events have been recently held in Japan to attract visitors. In addition to using the *Mobile Kukan Toukei*, combining it with other ICT services, such as Google Trends, can help better predict the number of visitors at new events. Specifically, by combining the *Mobile Kukan Toukei* and the transition of the search results for a particular tourist destination, it would

Table 3: Visitors' residential distribution at two hot springs (12:00 a.m.-1:00 p.m. on holidays in October 2015)

Wakura hot springs		Yamanaka hot springs	
Nanao City, Ishikawa Pref.	1,706	Kaga City, Ishikawa Pref.	1,222
Kanazawa City, Ishikawa Pref.	69	Kanazawa City, Ishikawa Pref.	31
Naka Noto Town, Ishikawa Pref.	42	Komatsu City, Ishikawa Pref.	23
Nagaoka City, Niigata Pref.	26	Toyama City, Toyama Pref.	22
Oyama City, Tochigi Pref.	25	Yokkaichi, Mie Pref.	22
Kaga City, Ishikawa Pref.	25	Fukui City, Fukui Pref.	15
Toyama City, Toyama Pref.	23	Suita City, Osaka Pref.	14
Kahoku City, Ishikawa Pref.	23	Uchinada Town, Ishikawa Pref.	14
Shiga Town, Ishikawa Pref.	22	Setagaya Ward, Tokyo	13
Ojiya City, Niigata Pref.	22	Nomi City, Ishikawa Pref.	13
Ritto City, Shiga Pref.	20	Hakusan City, Ishikawa Pref.	13
Ichikawa City, Chiba Pref.	20	Sakae Town, Chiba Pref.	12
Noto Town, Ishikawa Pref.	19	Higashi Nada Ward, Kobe City, Hyogo Pref.	11
Misato City, Saitama Pref.	18	Kita Ward , Kyoto City, Kyoto Pref.	11
Fukui City, Fukui Pref.	18	Moriyama Ward, Nagoya City, Aichi Pref.	10
Funabashi City, Chiba Pref.	18	Suminoe Ward, Osaka City, Osaka Pref.	10
Ichinomiya City, Aichi Pref.	18	Nonoichi City, Ishikawa Pref.	10
Aoba Ward, Yokohama City, Kanagawa Pref.	17	Otsu City, Shiga Pref.	10
Takaoka City, Toyama Pref.	17	Shinjuku Ward, Tokyo	10
Higashimurayama City, Tokyo	16	Adachi Ward, Tokyo	10

Figure 12: Visitors' residence at Kenrokuen (12:00 a.m.-1:00 p.m. on holidays in October 2015)

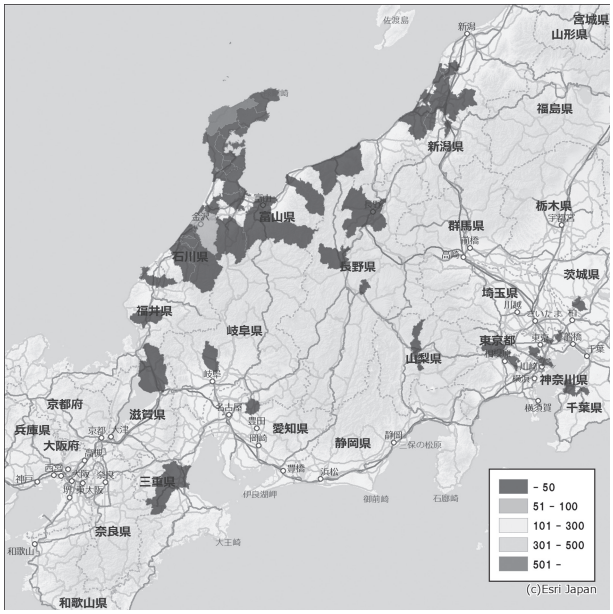

Figure 13: Visitors' residence at Wakura hot springs (12:00 a.m.-1:00 p.m. on holidays in October 2015)

be possible to more accurately predict the number of tourists. If we can realize more accurate demand forecasting, it would be possible to optimize the necessary goods and number of non-regular employees in advance. Moreover, understanding consumers' characteristics beforehand could enable us to optimize the services, which could influence customer satisfaction.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP15K01970.

Note

"Mobile Kukan Toukei" is a trademark of NTT DOCOMO, Inc.

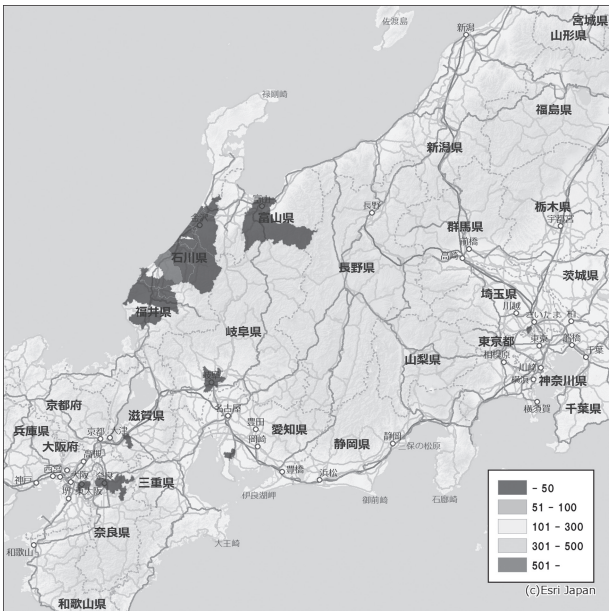

Figure 14: Visitors' residence at Yamanaka hot springs (12:00 a.m.-1:00 p.m. on holidays in October 2015)

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

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(Received October 10, 2018; accepted November 1, 2018)