

Analyzing urban resilience using temporal and spatial archive information before and after a disaster -Perspective of SDGs-

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Received: date / Accepted: date

Abstract In this study, point data from a phone book was used as geographical information that was regularly updated to obtain insights into changes in the urban industrial structure before and after a disaster. From these data, a quantitative approach was taken for regional trends in the affected areas before and after a disaster. This includes the population before and after a disaster and the demand for mental health support. Local governments also make new city plans for reconstruction; however, issues remain concerning their sustainability. This paper considers the viewpoints of disaster recovery planning, sustainability, and urban resilience while referring to previous studies.

Keywords Telepoint Data · Digital Archives · Spatio-Temporal Information · Resilience · Disaster recovery · SDGs

1 Introduction

The widespread use of various devices, such as smartphones, allows us to confirm our location and estimate the time to reach our destinations. Geographical information has various opportunities for creating several forms of non-verbal communication in our lives. In addition, the “Super City Initiative” and other proposals have called for the revision of the National Strategic Special Zones. Meanwhile, the urban use of microgeodata, such as GIS data, will be promoted

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further. Beyond the boundaries of industry-academia-government, smart city-related projects have been launched in various parts of the country aiming toward a “Smart city public-private partnership platform” [1]. Because interpolation is the subject of this paper, we highlight many prior investigations that addressed the relationships between individuals and a country. This was achieved by using SNS at the time of a disaster [2]. In addition, various support networks have been established, such as providing information sharing platforms for mobile base stations such as “Disaster Message Boards”. In the case of the 2011 Great East Japan Earthquake, various information links were made regarding the demand for goods and crisis information in the affected areas. Because Japan is an island country where unpredictable crises are likely to occur, discussions on how to raise resilience to disasters, urban regeneration, sustainable support, and mental care methods in disaster areas are necessary. These discussions and research can be used as effective knowledge for other countries. In this study, point data in a phone book was used as geographical information that is regularly updated to obtain insights into changes in the urban industrial composition before and after a disaster [4-6]. This data includes corporate registered data for each industry that is periodically updated in latitudinal and longitudinal coordinates. Trends in the number of contractors in each region and industry from 2012 to 2018 were identified. This paper focuses on the case of the 2011 Great East Japan Earthquake followed by a discussion of the surrounding areas, such as tsunami affected areas.

2 Purpose

In this study, point data in a phone book was used as geographic information that was regularly updated to obtain insights into changes in the urban industrial composition before and after a disaster [3-5]. This data includes corporate registered data of each industry that is periodically updated in latitudinal and longitudinal coordinates. Trends in the number of contractors in each region and industry from 2012 to 2018 were identified. This paper focuses on the case of the 2011 Great East Japan Earthquake followed by a discussion of the surrounding areas, such as the tsunami affected areas. There are too many uncertainties in earthquake predictions. As a result, there will be a need for continuous observation of industrial trends regarding countermeasures after earthquakes occur. Various factors such as regional characteristics and population form are necessary for reconstruction. Additionally, continuous mental health support from outside communities is required. Local governments also make new city plans for reconstruction; however, issues remain whether they are sustainable. This paper considers the perspective of disaster recovery plans, sustainability, and urban resilience.

3 Preview Research

Considerations for large-scale disasters can be addressed from various perspectives. Since the Great East Japan Earthquake, research on the awareness for the growing market demand for used cars, along with the contribution of ICT tools for communications during disasters, has been undertaken [6-8]. Furthermore, discussions about the transition of mobile tools in the event of a major disaster have been actively investigated from a transportation perspective. Additionally, research related to the redevelopment of disaster-stricken urban areas was undertaken due to the Great Hanshin-Awaji Earthquake [9]. In these research projects, annual business trends in the flooded areas were considered using telephone directory data. This study also discusses the importance of sustainability, issues, and past crisis comparisons as a reconstruction land readjustment project. Another approach using a phone was to identify how disasters have affected the diet that supports people's daily lives, which has also been investigated. Research was performed to determine what kind of tendencies were observed regarding food access difficulties that includes restaurants [10]. This survey extracted areas where damage was particularly severe along with changes in access regarding the rate of loss before and after a disaster. There is also research on how industrial forms have been reorganized, with a focus on Sendai City, the center of the disaster area [11-14]. Natural disasters recently caused by floods, such as torrential rain, have frequently occurred. These disasters are presumed to have been caused by global warming. As a result, there have been many problems with the operation of public facilities in municipalities, such as obtaining valuable documents and archives from libraries. Countermeasures have been developed in various regions; the damage status has been confirmed using research surveys [15]. Additionally, efforts are being made to assume the Nankai Trough for disaster simulations using human flow data. In the future, many evacuation routes using human flow data and telephone directory data will be used. This includes measures to improve reconstruction and resilience from familiar disasters to large-scale disasters. More diverse research teams are expected to require more case studies while using prediction models that undergo mathematical processing along with more proposals [16-17].

4 Dataset

In this study, telephone directory data was used to obtain the latest in industrial trends in municipalities across Japan. The analysis was performed using telephone book data with industry information in Japan between 22 June 2017 to 22 October 2018. The phone book data contains geospatial information (address and industry) of all stores and facilities (e.g. offices, hospitals, schools, parks, welfare facilities, medical facilities, etc.). This data allowed the analysis of a time series change. Moreover, the phone book data was updated every four months and also contains information for each store and facility. In addition,

the phone book contains a wide range of data from large corporations to individual business owners who do not have any corporations. Stores and facilities were classified into 25 major categories and 332 minor categories according to the type of industry.

5 Trends derived from previous studies

5.1 Relationship between the earthquake and used cars

Insights were obtained for companies that were registered as corporations that include used car dealerships before and after the Great East Japan Earthquake. The municipalities along the coast of Miyagi, which were large-scale due to the tsunami damage, were increasing after 2012. When considering Miyagi as a whole, 53 percent of used cars were in demand.

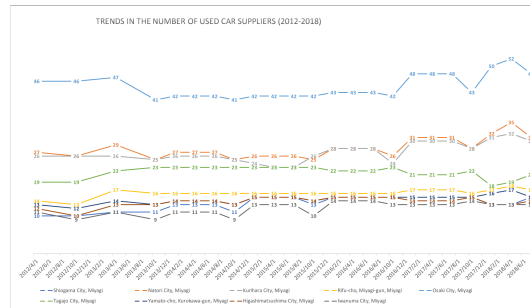


Fig. 1 Trends in the number of used car suppliers (2012-2018) (Top 10 in increasing trend)

As shown in Fig. 1, previous research revealed that the demand for used cars was very high immediately after the disaster. However, the demand remained flat from 2012 to 2018 because the tsunami damage was significant. Coastal cities (e.g. Shioyama City, Natori City) showed a slight, but increasing, trend in sales when analyzing the period between 2012 to 2018. This finding is one trend after a large-scale disaster in the coastal area where transportation means were cut off.

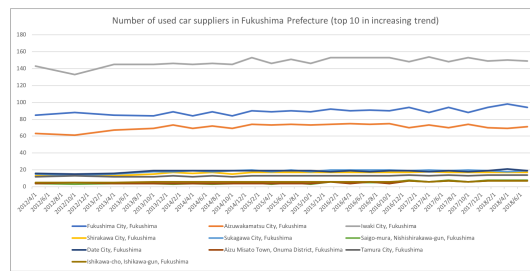


Fig. 2 Number of used car suppliers in the Fukushima Prefecture (Top 10 in increasing trend)

Fig. 2 focuses on Fukushima, which had a similar large-scale impact. In the Fukushima Prefecture, there are some areas where the population decreased or was inaccessible due to the nuclear power plant disaster. However, the demand for used cars is higher than the Miyagi Prefecture.



Fig. 3 Nationwide 2012-2018 used car supplier change chart

As seen from Fig. 3, the overall demand for used cars continued from Gifu and Ibaraki, followed by Aichi, Mie, and Tochigi. Fukushima was the top location for used car sales whereas Miyagi was in the middle for sales. Additionally, the demand for used car sales declined in Tokyo, Hokkaido, Hiroshima, Yamaguchi, Kumamoto and Fukuoka. Fig. 3 shows that Kumamoto, which had a large-scale disaster in 2016 along with Fukuoka and Hiroshima, suffered from floods due to heavy rain. This corresponds to a disaster; yet, there was no demand for used cars. It was inferred that the demand for used cars increased after a tsunami. This is demonstrated in the case of Miyagi where the division of railways and mountain roads occurred.

5.2 A multifaceted study on the reconstruction situation after a large-scale earthquake disaster

Industrial classification in which there was a particularly increasing trend	Increase in 2012-2018	Increase in 2012-2014
Renovation (housing)	812	836
Kimono	198	220
Elderly welfare and care services	104	105
Job-specific construction business (construction industry)	87	105
General construction business (construction industry)	86	100
Safe / key (house)	83	100
Car maintenance	73	89
Household watering equipment	73	71
Household cleaning (housing)	58	40
Household cleaning (interior)	57	39
Exterminating pests and rats	57	38
Building materials handling	50	35
Rental / Rental	40	30
convenience store	38	21
Welfare / Child Welfare / Disability Services / Rehabilitation	37	20
Water, gas, power	34	16
Shoes / Bag / Accessories	32	14
Exterior construction	30	12
Used goods buying and selling	29	12
Administrative scrivener	21	11
Nursery school, kindergarten	16	10
Used car purchase sales	15	10

Fig. 4 Industrial classifications where there was an increasing trend for areas affected by large-scale tsunami damage

As shown in Fig. 1, when there was a large-scale crisis, such as a tsunami, there was a great demand for used cars. A characteristic trend for Tagajo City was obtained [18]. As shown in Fig. 4, there was an increase and decrease in business between 2012 to 2018. In particular, it can be seen that renovations, kimonos, welfare centers, and construction-related businesses had the largest increase immediately after the 2012-2014 earthquake. On the other hand, it was inferred that mice extinction, cleaning, rehabilitation, convenience stores, and gas water supply businesses contributed to the rise in kindergarten classes and used car sales. Although demand for remodeling after the earthquake declined, it is speculated that cleaning-related issues (e.g. cleaning and mouse removal) were prominent and would continue to cause secondary damage due to tsunamis. In addition, the increase in convenience stores was presumed to be a good sign for the decline in elementary and junior high schools and the aging of welfare care-related facilities.

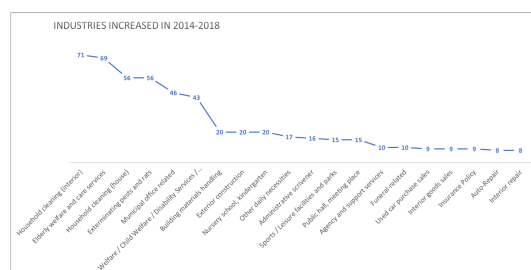


Fig. 5 Industries that increased in business between 2014-2018

Fig. 5 shows the number of contractors that increased, particularly between 2014 and 2018, in the tsunami-affected areas. House cleaning businesses saw the most growth whereas care-related and rat extermination businesses also increased. Additionally, leisure facilities such as sports, public facilities, and automobile repair centers also increased. Gradually, the infrastructure and transportation methods of local communities also increased. Cleaning and repair centers have been on the rise. Observing these signs is important as an indicator for resilience after a disaster.

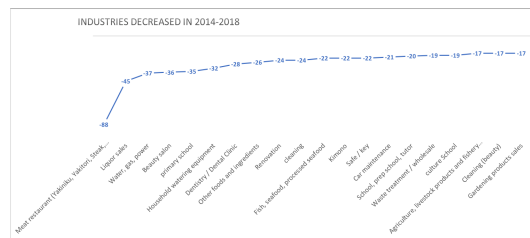


Fig. 6 Industries that decreased between 2014-2018

Fig. 6 lists the projects that decreased between 2014 to 2018 in the tsunami-affected areas. The number of restaurants, such as Yakiniiku and Steak, were declining. In addition, liquor sales were on a downward trend. Additionally, the number of beauty salons, dentists, and renovation / cleaning businesses have decreased significantly in comparison to 2012 to 2014.

5.3 Characteristic business in the affected areas

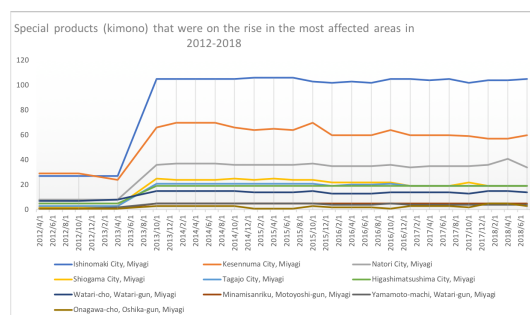


Fig. 7 Special products (Kimono) that were on the rise for the most affected areas in 2012 to 2018

Fig. 7 shows the time-series transition of the “Kimono” related business, which was listed as one of the top growing businesses. There has been a significant

upward trend since 2013/4, and there has been an active effort for Japanese culture in the region. This includes the increase in the number of tourists in the NHK drama series, such as “Amachan”, which is the theme of the earthquake disaster. It was observed that the number of business operators continued without any significant reductions in business.

6 Discussion

As shown in the analysis in Section: 3, the businesses that featured a significant decline were education and culture. Human resource development in the community after a disaster affects the subsequent sustainability of the community [19-20]. A previous study on the formation of a city near a catastrophe also stated that new housing plans do not progress. This is due to the vacant housing problem; however, renovations still continue. From the above, development of towns while focusing on renovations are progressing; there is a tendency to infer this is due to aging. Construction of sustainable business support and regional management to promote residency is important. These trends were also observed in Fig.4-5. However, there is a need for an educational and cultural environment for passing on to new generations from the perspective of inheriting memories from disaster-stricken areas and disaster recovery. Each region needs young leaders to conduct various educational activities using different activities, such as storytelling and illustrations, along with invitations to the creators. It can be inferred from the case study that the influx at an early stage makes the inheritance of local memories, along with the consensus building for the reconstruction of the affected areas, more fluid. This also has the potential of being a city that communicates new regional connections and how the city should be revitalized after a disaster. From this point of view, educational and cultural facilities were considered.

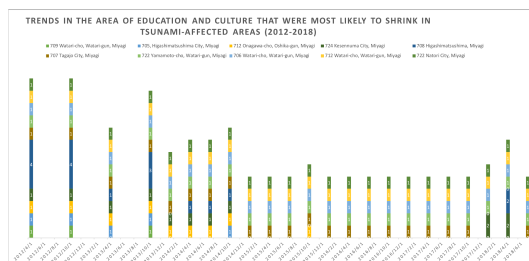


Fig. 8 Trends in the area of education and culture that were most likely to shrink in tsunami affected areas(2012-2018)

Industry numbering in Fig. 8

705: Business School / Classroom

706: Musical Instrument Sales and Repair

707: Language school
 708: Junior high school
 709: Sewing and handcraft materials and equipment sales
 712: High school
 722: Elementary School
 724: Audio equipment and services

Fig. 8 describes the time-series transition of businesses that are declining among educational and cultural businesses in the tsunami affected areas. A sharp downward trend has occurred in the above-mentioned industries since October 2013. This indicates that business schools and facilities related to manufacturing and hobbies such as music, sound, and handcraft are decreasing. A downward trend was also observed for junior and senior high schools.

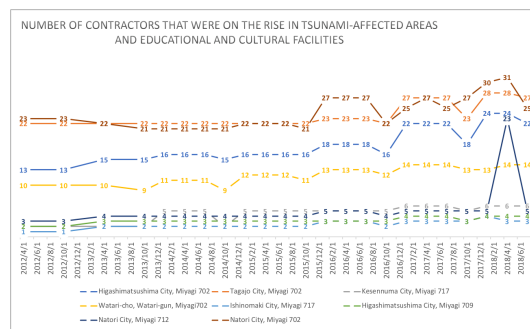


Fig. 9 Trends in the area of education and culture that were most likely to decline in tsunami affected areas(2012-2018)

Fig. 9 describes the time-series transition of businesses that were on the rise in education and culture in the tsunami affected areas. As inferred from Fig. 9, here is a description of the post-disaster education and culture business. There was a significant decrease; however, business increased, which is a benchmark for post-disaster recovery.

Industry numbering in Fig.9

702: Nursery / Kindergarten
 709: Sewing, handcraft materials, and equipment sales
 712: High school
 717: Library

From Fig. 9, it was observed that nursery schools and kindergartens have been increasing since 2016 in the three regions. This can be inferred as a positive sign that the development of children in the affected areas has begun. These signs will continue to be observed as a viewpoint of building a sustainable society after a large-scale disaster.

7 Summary

This paper focused on the case of the Great East Japan Earthquake in 2011 with the goal of obtaining quantitative considerations regarding the surrounding areas of the tsunami-affected areas using a telephone directory archive. There are too many uncertainties in earthquake predictions. There will also be a need for continuous observation of industrial trends regarding counter-measures after they occur. Various factors (e.g. characteristics of other regions, population form, etc.) are necessary for telephone directory data. Additionally, continuous external mental support is also required. Local governments also make new city plans for reconstruction; however, issues remain whether they are sustainable city plans. This study focused on quantitative considerations from the viewpoints of disaster recovery planning, sustainability, and urban resilience.

7.1 Considering on characteristics of tsunami-affected areas

(1) Previous research has shown that the demand for used cars was very high immediately after a disaster. Cities in the coastal areas that were damaged by tsunamis (e.g. Shiogama City and Natori City), saw their businesses as relatively flat with a modest increase from 2012 to 2018. However, these tendencies were adapted to the case of transportation, such as a tsunami, and the division of railways and mountain roads as described in the case of the Miyagi Prefecture.

(2) This describes the time-series transition of businesses that are declining among educational and cultural businesses in tsunami affected areas. A sharp downward trend has occurred in the above-mentioned industries since October 2013. This indicates that business schools and facilities related to manufacturing and hobbies (e.g. music, sound, and handcraft) are decreasing. This study also observed that there was a downward trend for junior and senior high schools.

7.2 Consideration of resilience perspective

(A) In Japan, a variety of businesses increased and decreased from 2012 to 2018 due to natural disasters. In particular, it can be seen that renovation, kimono, welfare care, and construction-related businesses had the largest increase immediately after the 2012-2014 earthquake.

(B) In particular, it is speculated that there was an increasing trend for several businesses. This includes: rat extermination; cleaning; rehabilitation; gas water supply; kindergarten; used car sales; and convenience stores. While the demand for remodeling after an earthquake has gradually declined, it was surmised that the conspicuous cleaning-related issues (e.g. cleaning and rat extermination) would yield secondary damage in comparison to the tsunami

disaster. The increase in convenience stores was presumed to be a good sign for the decline in elementary and junior high schools and the aging of welfare care-related facilities.

(D) Looking at Figure 9, nursery schools and kindergartens have been increasing since 2016 in the three regions. This can be inferred as a sign that redevelopment in the affected areas has begun. These signs need to be monitored continuously as a viewpoint of building a sustainable society after a large-scale disaster.

Acknowledgements We would like to thank and acknowledge the support from the 2019 Scholarly Scholars Research Grant Program(Leading Initiative for Excellent Young Researchers (LEADER)), which provided support for this research.

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