https://doi.org/10.20965/jdr.2015.p0196

Paper:

Comparison Between the Life Recovery Processes After the Mid-Niigata Earthquake and the Chuetsu-Oki Earthquake – Results of a Random Sampled Social Survey Using the Life Recovery Calendar and GIS-Based Spatiotemporal Analysis

Reo Kimura[*1], Munenari Inoguchi[*2], Keiko Tamura[*3], and Haruo Hayashi[*4]

[*1]School of Human Science and Environment, University of Hyogo
1-1-12 Shinzaike-honcho, Himeji, Hyogo 670-0092, Japan
E-mail: rkimura@shse.u-hyogo.ac.jp
[*2]Research Institute for Natural Hazards and Disaster Recovery, Niigata University, Niigata, Japan
[*3]Risk Management Office, Niigata University, Niigata, Japan
[*4]Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan
[Received October 24, 2014; accepted January 28, 2015]

This study focuses on recovery efforts following the Mid-Niigata Earthquake in October 2004 and the Chuetsu-Oki Earthquake in July 2007 in Niigata Prefecture. Results of a randomsample questionnaire survey conducted in affected areas and throughout the prefecture are analyzed using a life recovery calendar, which identifies disaster damage in affected areas and in Niigata with the objective of systematically understanding the status and process of rebuilding lives. Although the magnitude of devastation and the nature of the disasters differ, both have similar life recovery processes. It is to be noted, however, that the impact of the Mid-Niigata Earthquake lingered over a larger area for a longer period than for the Chuetsu-Oki Earthquake.

Keywords: mid-niigata earthquake, chuetsu-oki earthquake, random sampled social survey, life recovery, GIS (Geographic Information System)

1. Introduction

In an effort to systematically understand the status and process of rebuilding daily routines after a disaster, this study analyzes the results of 5,000 respondents random-sample questionnaire survey for identifying disaster damage in affected and surrounding areas by assessing the responses of disaster victims and other citizens. The March 2009 survey focused on the Mid-Niigata Earthquake on October 23, 2004, i.e., 4.5 years before the survey, and the Chuetsu-Oki Earthquake on July 16, 2007, i.e., 1.5 years before, both in Niigata Prefecture. The devastation caused by these disasters and the accompanying recovery efforts had not been seen since the 1995 Great Hanshin-Awaji Earthquake in Kobe. Unlike the earthquake in Kobe, which was urban and inland, both the 2004 and 2007 earthquakes in Niigata impacted on provincial towns in a time when Japan's population had begun rapidly aging.

2. Methodology

The survey targeted adults in three affected areas:

1) Areas undergoing a seismic intensity of 6 or more during the 2004 earthquake
2) Areas undergoing a seismic intensity of 6 or more in the 2007 earthquake
3) The rest of Niigata Prefecture.

Samples were extracted from resident registers using two-stage probability proportional to sampling size, i.e., target age and other attributes as of March 1, 2009.

Locations randomly sampled from target areas numbered 69, 56, and 125. Ten individuals from resident registers in each location were sampled so that one adult per household was sampled. sampled individuals were carefully identified to ensure gender balance, resulting in 50,000 survey respondents. Questionnaires were mailed to respondents, completed by them, and collected by mail after being distributed on March 15, 2009, with a deadline of April 17, 2009. Reminder postcards were sent to respondents who had not returned questionnaires by the end of March. It is to be noted that this survey technique is mentioned in references such as Kimura et al. (2010a [1], 2010b [2]) and Tamura et al. (2010) [3].

3. Life Recovery Calendar Results and Considerations

The life recovery calendar is explained assuming that recovery is completed little by little over time, not all at once. This is a "linear" rather than a "punctuate" concept, so the recovery calendar was developed as a measurement for clarifying the extent of life recovery processes in individual victims. This index was developed by Kimura et al. (2004) [4] and Kimura (2007) [5] to understand the recovery status of victims and affected areas. Specifically, responses in the questionnaire form were compiled when events occurred as milestones in their life recovery.

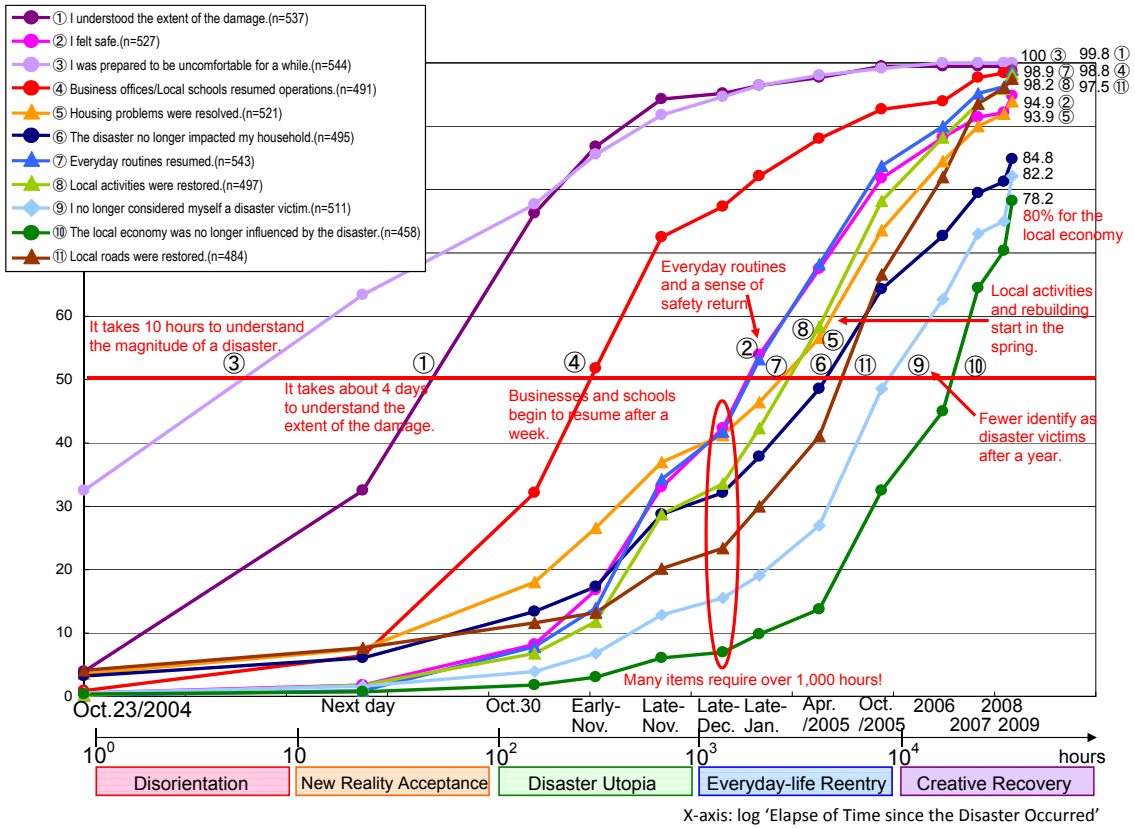

Fig. 1. Life recovery calendar for the 2004 Mid-Niigata Earthquake of March 2009.

Questions were accompanied by remarks such as "Little is known about how victims recover. Please think about how your feelings and behavior have changed over time since the earthquake and circle the time period that fits you best."

The following 12 items were provided:

1. I understood the extent of the damage.
2. I felt safe.
3. I was prepared to be uncomfortable for a while.
4. Business offices resumed operations.
5. Housing problems were resolved.
6. The disaster no longer impacted my household.
7. Everyday routines resumed.
8. Local activities were restored.
9. I no longer considered myself a disaster victim.
10. The local economy was no longer influenced by the disaster.
11. Local roads were restored.
12. Local schools resumed operations.

Events marking recovery milestones that many victims experienced were selected from ethnography interview results targeting victims of the 1995 Kobe and 2004 Mid-Niigata Prefecture earthquakes.

3.1. Life Recovery Calendar for the 2004 Mid-Niigata Earthquake

Figure 1 shows the life recovery calendar for the 2004 earthquake. The horizontal axis shows the logarithmic time lapse after the earthquake and tsunami. The notation 10^0 on the left indicates one hour after the earthquake, 10^2 hours (100 hours or 2–4 days after the earthquake), etc. The vertical axis shows the response rate for "feelings, actions, or circumstances" related to each questionnaire item. The time when a milestone is reached coincides with accumulated responses exceeding 50%.

A day after the earthquake, over half of respondents said they were "prepared to be uncomfortable for a while" (item 3). A week after the quake, over half of respondents "understood the extent of the damage" (item 1), and two weeks after, most respondents indicated that conditions had improved to the point that "business offices and local schools resumed operations" (items 4 and 12). Other items in the recovery process rapidly gained momentum two months after, which coincided with the beginning of spring. After two months, respondents felt that "everyday routines resumed" (item 7). After three months, respondents "felt safe" (item 2). After six months, respondents indicated that "housing problems were resolved" (item 5) and "local activities were restored" (item 8). After a year, respondents indicated that "local roads were restored" (item 11), the "disaster no longer impacted my household" (item 6) and "no longer considered [themselves] disaster victims" (item 9). Over two years were needed,

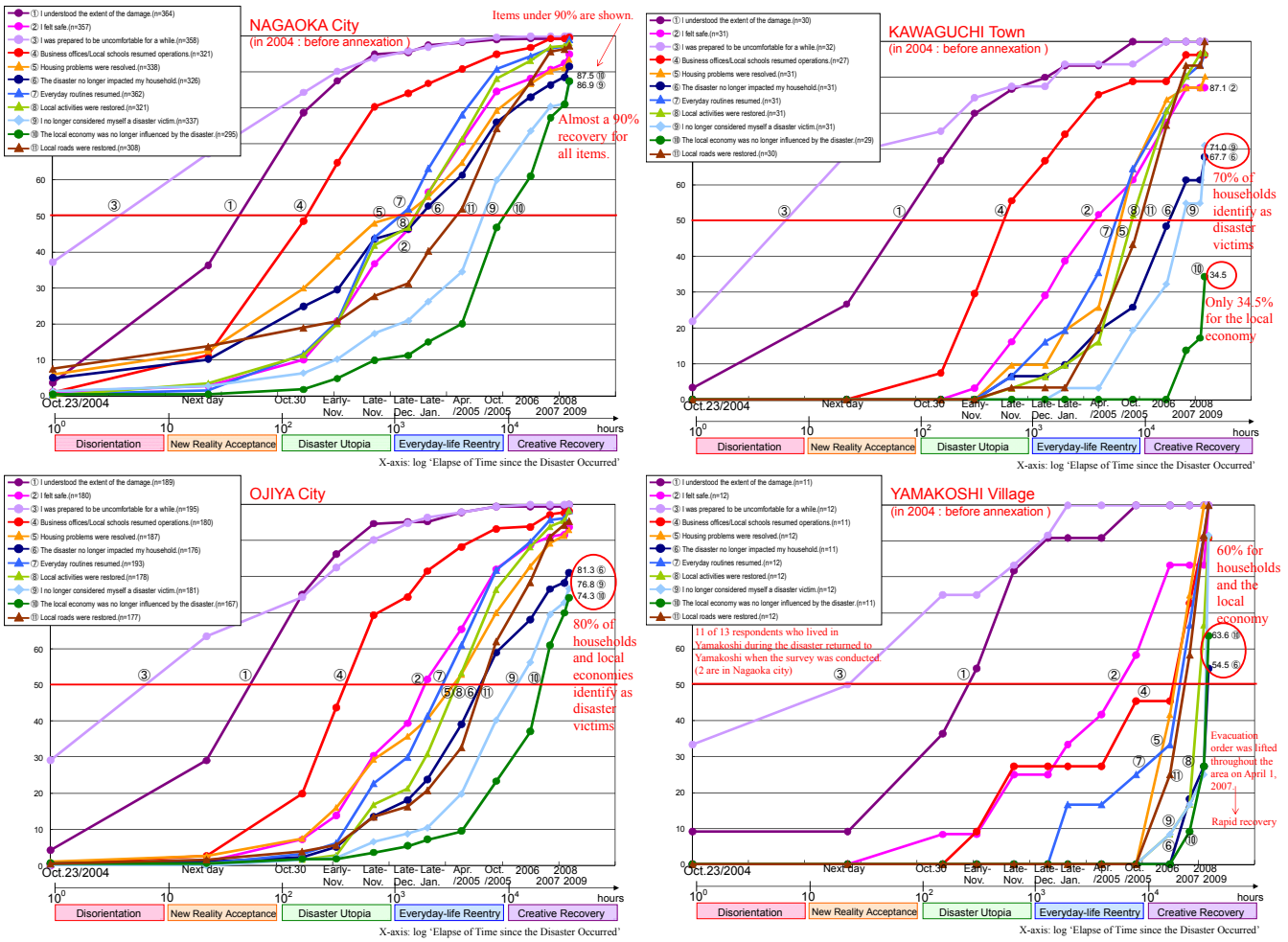

Fig. 2. Life recovery calendar for the 2004 Mid-Niigata Earthquake – Four local governments sustaining major damage.

however, for respondents to feel that "the local economy was no longer influenced by the disaster" (item 10).

In March 2009, or 4.5 years after the earthquake, over 20% of respondents felt that additional time was necessary for three items:

1) "The disaster no longer impacted my household" (item 6)
2) "I no longer considered myself a disaster victim" (item 9)
3) "The local economy was no longer influenced by the disaster" (item 10)

One benefit of the life recovery calendar was that the status of different regions could be compared. Almost 90% of respondents from Nagaoka City (i.e., the Nagaoka City area at the time of the earthquake and excluding the Yamakoshi Village area) indicated recovery was complete for all items at the time of the survey in March 2009. In contrast, only about 80% of respondents from Ojiya City felt that "the disaster no longer impacted on my household" (item 6) (81.3%), "I no longer considered myself a disaster victim" (item 9) (76.8%), and "the local economy was no longer influenced by the disaster" (item 10) (74.3%) (**Fig. 2**). About 70% of residents of Kawaguchi Town said, "I no longer considered myself a disaster victim" (item 9) (71.1%) and "the disaster no longer impacted on my household" (item 6) (67.7%), but only 34.5% said that "the local economy was no longer influenced by the disaster" (item 10).

In contrast, Yamakoshi Village, which was independent at the time of the earthquake and not part of Nagaoka City, responses to many of the items were less than 50% up to two years after the earthquake. The village had recovered rapid at the two-year point, however, and by the time of the survey, all items had attained a 90% recovery response, except for two, i.e., "the disaster no longer impacted on my household" (item 6) at 54.5% and "the local economy was no longer influenced by the disaster" (item 10) at 63.6%).

This rapid overall recovery is attributed to the fact that the evacuation order had been lifted in almost all areas as of April 1, 2007. The survey also found, however, that Kawaguchi Town was more negatively affected by the earthquake than Yamakoshi Village for two items – "I no longer considered myself a disaster victim" (item 9) and "the local economy was no longer influenced by the disaster" (item 10).

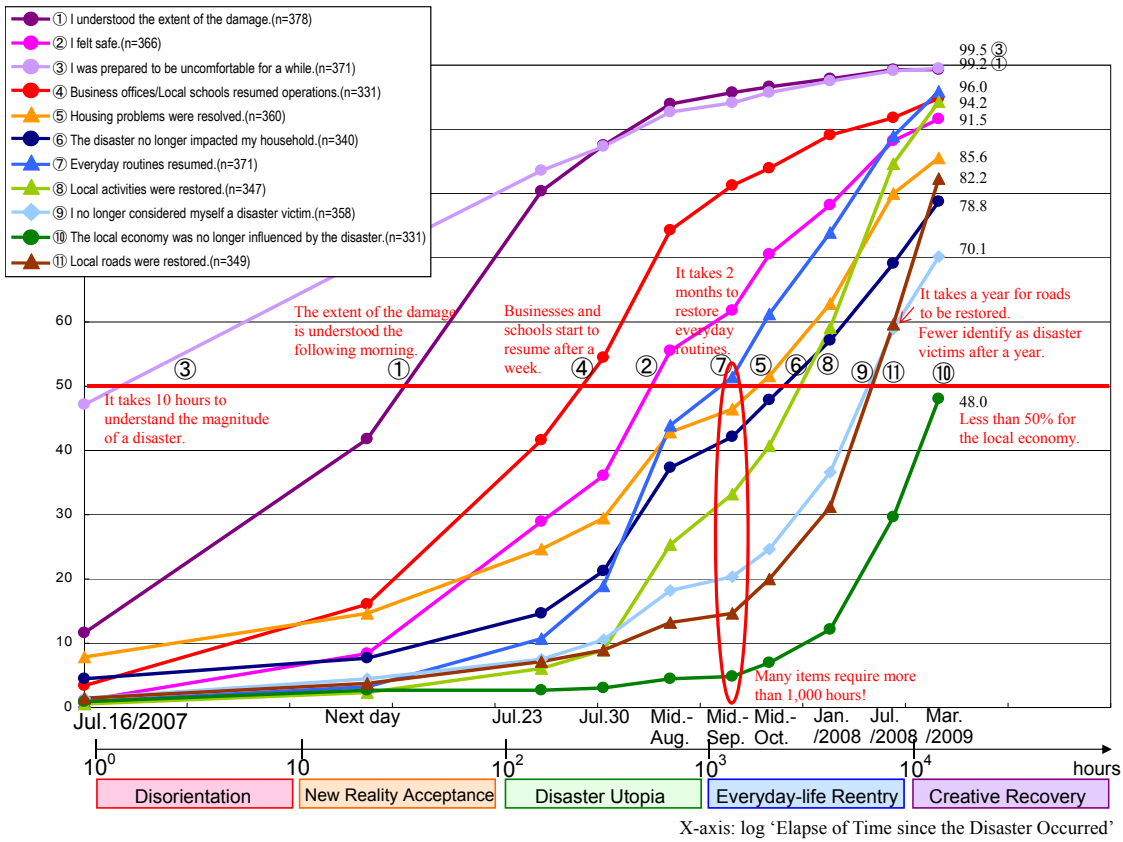

Fig. 3. Life recovery calendar for the 2007 Chuetsu-Oki Earthquake of March 2009.

3.2. Life Recovery Calendar for the 2007 Chuetsu-Oki Earthquake

Figure 3 shows the life recovery calendar for the 2007 earthquake. Over half of respondents said, "I was prepared to be uncomfortable for a while" (item 3) a day after the earthquake, and over half "understood the extent of the damage" (item 1). A week after the earthquake, some respondents noticed that "business offices and local schools resumed operations" (items 4 and 12), but two weeks were required for the majority to notice. After a month, they "felt safe" (item 2), and after two months "everyday routines resumed" (item 7). The majority felt that "housing problems were resolved" (item 5) after three months. Six months were needed, however, for most to note that "local activities were restored" (item 8) and "the disaster no longer impacted on my household" (item 6). After a year, most responded that "local roads were restored" (item 11) and "I no longer considered myself a disaster victim" (item 9).

In March 2009, 20 months after the earthquake, fewer than 90% indicated that "housing problems were resolved" (item 5), "local roads were restored" (item 11), "the disaster no longer affected my household" (item 6), "I no longer consider myself a disaster victim" (item 9), and "the local economy was no longer influenced by the disaster" (item 10). Specifically, 15% felt that housing was still an issue and roads had yet to be restored (item 11). Fewer than 30% still identified as themselves as disaster victims (item 9) but and over half felt that the disaster still influenced the local economy (item 10).

3.3. The 2004 and 2007 Earthquakes Compared

To identify differences in recovery status in the 2004 and 2007 earthquakes, **Fig. 4** superimposes their two life recovery calendars. The thinner line denoted by N is for the 2004 earthquake and the bold line denoted by O is for the 2007 earthquake. Despite differences in magnitude and nature, the two earthquakes had similar recovery processes and time needed for the accumulated total of each item to exceed 50%. All items except for "local roads were restored" required less time to exceed 50% after the 2007 earthquake faster than after the 2004 earthquake, leading us to conclude that recovery from the 2007 earthquake was faster recovery than that from the 2004 earthquake.

4. Results and Considerations of the Geographical Recovery Process in Affected Areas

We analyzed the postearthquake life recovery process using a geographic information system (GIS).

4.1. Geographic Disaster-Victim Identification Spread Between the Two Earthquakes

In analysis, respondents who said that the earthquake has affected them were denoted on a map for location data based on postal code. We estimated the kernel density to identify areas with high concentrations of affected respondents based on mapping and then simulated victim distribution in these areas (**Fig. 5**). We surmised that ar-

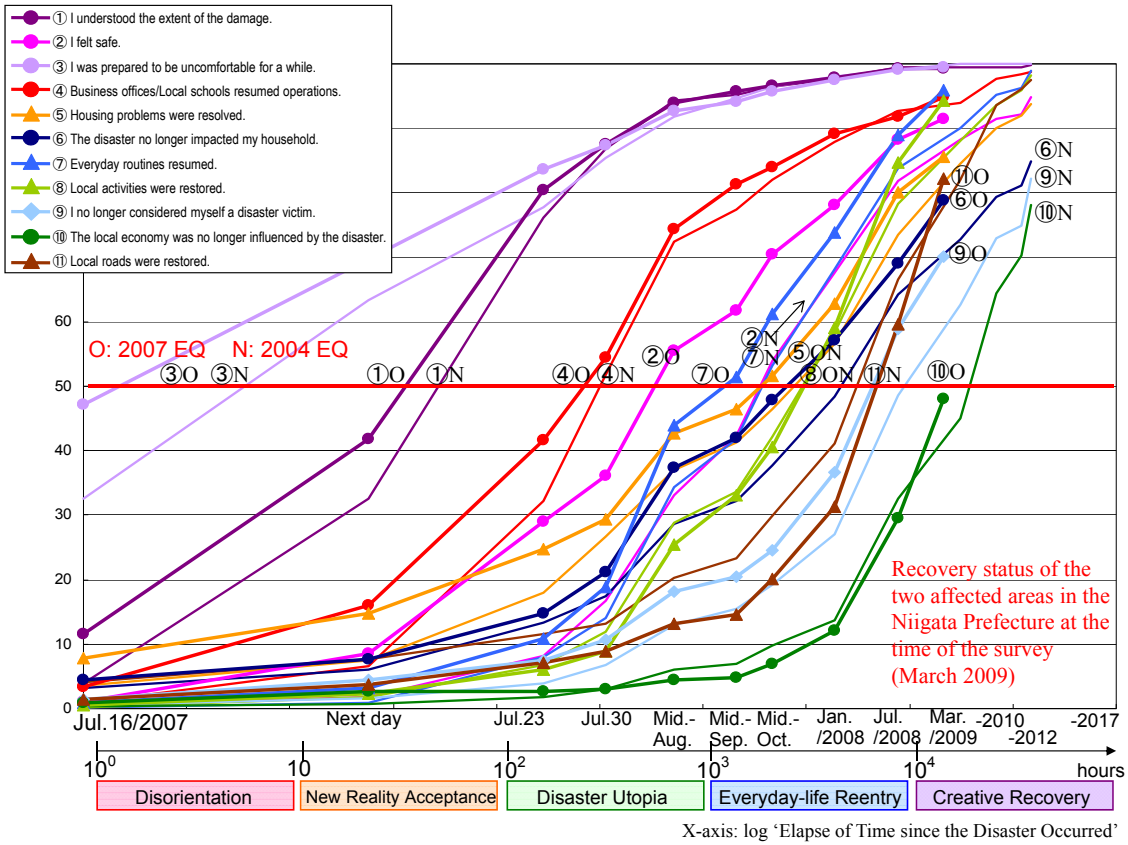

Fig. 4. Life recovery calendar comparing the 2004 (fine lines) and 2007 (bold lines with markers) events.

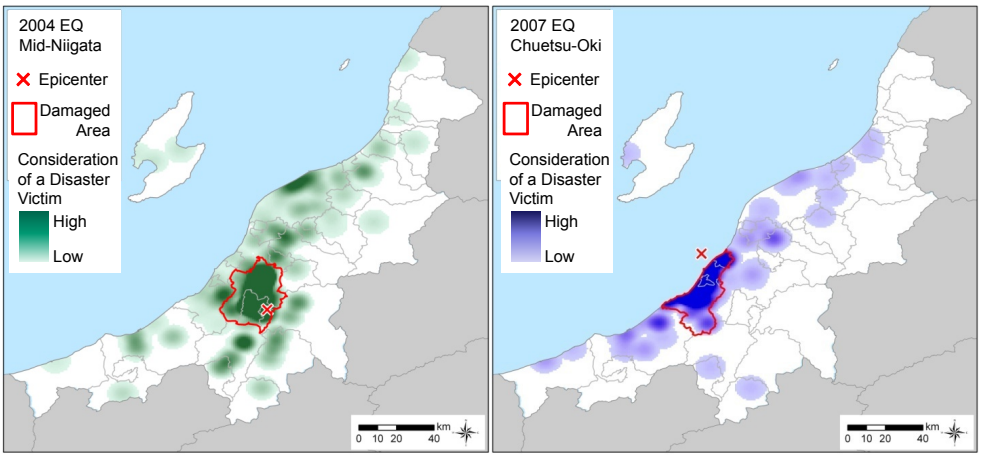

Fig. 5. Distribution of residents considering themselves to have been adversely affected by the earthquake.

eas enclosed in red lines were affected by the 2007 earthquakes before the survey based on physical information, including seismic intensity and devastation.

Geographical analysis indicated that many in areas with an estimated seismic intensity exceeding 6− identified themselves as victims of the 2004 earthquake, as did those in western Sanjo City, the Niigata city center, and the Shibata city center, which had intensities estimated at less than 5−. Results in areas with an intensity exceeding 6− and where serious devastation was expected showed that those far from the epicenter in Niigata and Shibata Cities did not consider themselves to be victims, suggesting that identification as a disaster victims spread over a wider area than actual intensity distribution. Although residents of coastal areas, including Kashiwazaki City and the Nishiyama Town district of Kashiwazaki City, Kariwa Village, and Izumozaki, where the estimated seismic intensity exceeded 6−, strongly identified themselves as disaster victims, while the sense of being a victim was weak in other areas.

A comparison of the two earthquakes showed that while seismic intensity levels spread in the same way, identification as a disaster victim greatly differed. The 2004 earthquake had a prefecture-wide impact on residents, including isolation in mountainous areas, structural damage throughout the area, and damage to industry.

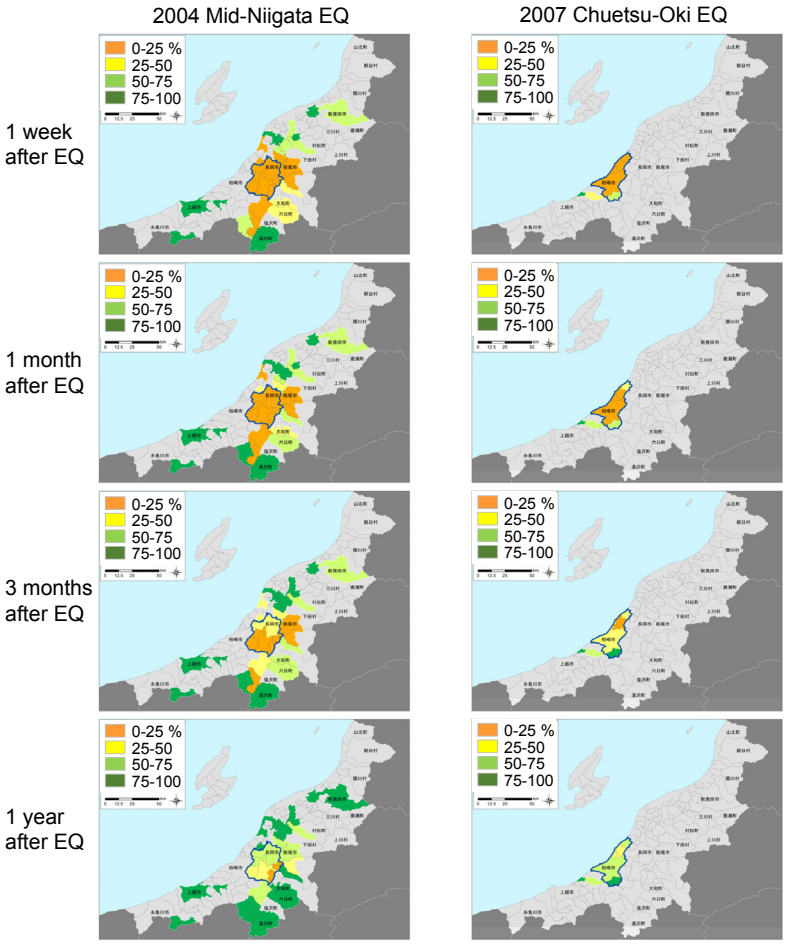

Fig. 6. Geographical differences in times when residents no longer defined themselves as disaster victims.

4.2. Geographical Analysis of When Residents No Longer Defined Themselves as Disaster Victims

We next analyzed the life recovery calendar (**Fig. 6**) for the time when residents no longer defined themselves as disaster victims (item 9). For the 2004 earthquake, less than 25% of residents of Nagaoka, Ojiya, and Tochio Cities felt that they were no longer victims after a week. It took one month for over 25% of Mitsuke City residents to feel this way. It took three months for over 25% of formerly Nagaoka City residents to feel this way. After a year, over 75% of Yamakoshi Village and Kawaguchi Town residents no longer defined themselves as disaster victims, whereas the rest of respondents in the prefecture indicated that they no longer defined themselves as disaster victims.

For the 2007 earthquake, Takayanagi and Yoshikawa Towns were the only places where over 50% of residents no longer defined themselves as victims a week after the earthquake. Over 25% of Izumozaki Town residents felt they were no longer victims after one month. Over 25% of Kashiwazaki City residents felt they were no longer victims after three months. After a year, over 50% of prefectural residents, except for those in Kariwa Village, no longer defined themselves as disaster victims.

4.3. Geographical Analysis of When Residents Felt the Local Economy Was No Longer Influenced by the Disaster

In looking at economic recovery, the slowest part of the recovery process, we focused on "the local economy was no longer influenced by the disaster" (item 10) (**Fig. 7**). For the 2004 earthquake, less than 25% of residents felt economic recovery a week after the earthquake in Nagaoka and Ojiya Cities, but after a month, over 25% of Muika Town residents felt economic recovery. After three months, over 25% of Mitsuke City residents were aware of economic recovery. Although less than 25% of residents in Tochio and Ojiya, Cities and Kawaguchi Town felt the economy had recovered after a year, the rest of prefectural residents felt that the disaster no longer impacted on the local economy. For the 2007 earthquake, in contrast, Takayanagi and Yoshikawa Towns were the only places where over 25% of residents felt economic recovery a week after the earthquake. This was also the case after a month. Three months after the earthquake, however, over 25% of Kashiwazaki City and Izumozaki Town residents felt the economy was no longer affected by the disaster, and after a year, over 50% of prefectural residents, except those in Kariwa Village, felt that the local economy was no longer influenced by the disaster.

In the case of both earthquakes, areas close to the epi-

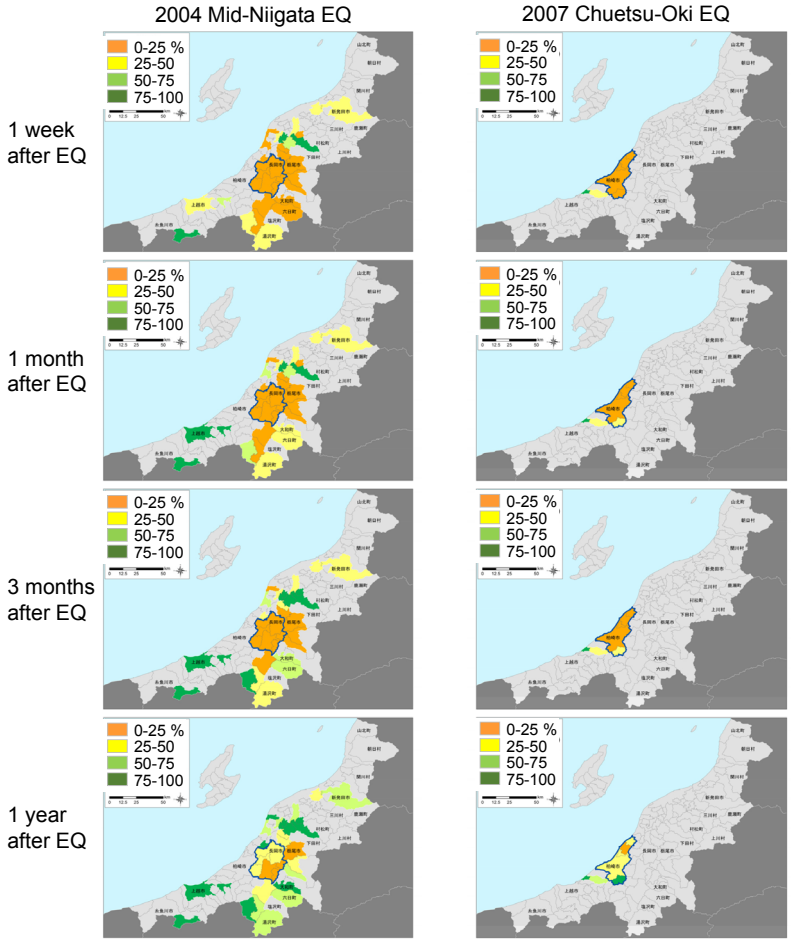

Fig. 7. Geographical differences in time periods when residents felt that the local economy was no longer influenced by the disaster.

center and those with the greatest seismic intensity experienced the slowest recoveries. The observation that "places with serious devastation received more generous support, so there is no major difference in economic impact" is false. The 2004 earthquake clearly impacted on residents over a wider area for a longer period than the 2007 earthquake.

4.4. Conclusions of Geographical Analysis

Geographical analysis of the recovery process after the two earthquakes detailed above demonstrated similarities and differences. Both showed a clear relationship between distance from the epicenter and recovery speed. Although each item entails a different recovery speed, areas closer to the epicenter or with a greater seismic intensity have a slower recovery. This contradicts the notion that areas with intense tremors recover faster because their recovery was supported more generously due to the scale of physical devastation. In reality, Yamakoshi Village and Kawaguchi Town, which were both near the epicenter of the 2004 earthquake, showed the slowest recovery for all items. In fact, analysis of the recovery status five years after the earthquake indicates that less than 50% of these residents felt the local economy has recovered.

Comparing recovery status one year after each disaster highlights differences in recovery speed. Although many areas surpassed 50% for all items after the 2007 earthquake, Yamakoshi Village has yet to exceed 50% five years later. In both cases of recovery, local economy recovery speed is slow and many residents identify themselves as disaster victims. After the 2004 earthquake, more areas had less than 25% of residents responding that recovery is progressing, demonstrating the extent that each earthquake had on residents. As suggested by the difference in the distribution of identification as disaster victims, a comparison of recovery status shows that the 2004 earthquake had a greater impact on victims' living.

References:

[1] R. Kimura, K. Tamura, M. Inoguchi, H. Hayashi, and Y. Urata, "Generalization of victims' behavior and life reconstruction processes – Socio-economic recovery from three earthquake disasters occurred in Hyogo Prefecture in 1995, Niigata Prefecture in 2004 and 2007 –," Journal of Social Safety Science, No.13, pp. 175-185, 2010 (in Japanese).

[2] R. Kimura, K. Tamura, M. Inoguchi, and H. Hayashi, "Influence of earthquake disaster experience on risk perception and damage estimation," Proc. of the 14th Japan Earthquake Engineering Symposium, pp. 4141-4148, 2010 (in Japanese).

[3] K. Tamura, R. Kimura, M. Inoguchi, and H. Hayashi, "Analyzing the subjective evaluation of governmental assistance under the impact of seismic disaster," Proc. of the 14th Japan Earthquake Engineering Symposium, pp. 4149-4156, 2010 (in Japanese).

[4] R. Kimura, H. Hayashi, S. Tatsuki, and K. Tamura, "Psychologically defined life reconstruction processes of disaster victims in the 1995 Hanshin-Awaji Earthquake," Journal of Social Safety Science, No.6, pp. 241-250, 2004 (in Japanese).

[5] R. Kimura, "Recovery and reconstruction calendar," Journal of Disaster Research, Vol.2, No.6, pp. 465-474, 2007.

Name:
Reo Kimura

Affiliation:
Associate Professor, Ph.D., Graduate School of Human Science and Environment, University of Hyogo

Address:
1-1-12, Shinzaike-honcho, Himeji, Hyogo 670-0092, Japan

Brief Career:
2003-2009 Assistant Professor, Graduate School of Environmental Studies, Nagoya University
2009-2011 Associate Professor, Graduate School of Environmental and Disaster Research, Fuji Tokoha University

Selected Publications:
• "Development of the method of clarifying the life reconstruction process based on the random sampled social surveys of the victims – Recovery and reconstruction calendar –," Proc. of the Int. Emergency Management Society (TIEMS) 17th Annual Conf., pp. 168-178, 2010.
• "Implementation and operation of a cloud-based participatory damage recognition system to obtain a common operational picture that supports a quick disaster response," Int. Journal for Infonomics (IJI), Special Issue Vol.1, Issue 1, pp. 834-840, 2013.
• "Current status and issues of life recovery process three years after the Great East Japan Earthquake questionnaire based on subjective estimate of victims using life recovery calendar method," Journal of Disaster Research, Vol.9, No.sp, pp. 673-689, 2014.

Academic Societies & Scientific Organizations:
• Japan Institute of Social Safety Science (JISSS)
• Japan Society for Natural Disaster Science (JSNDS)
• Japanese Psychological Association (JPA)
• Japanese Society of Social Psychology (JSSP)
• Japan Sociological Society (JSS)
• Seismological Society of Japan (SSJ)
• Japan Society of Civil Engineering (JSCE)

Name:
Munenari Inoguchi

Affiliation:
Assistant Professor, Ph.D. Informatics, Research Institute for Natural Hazards and Disaster Recovery, Niigata University

Address:
8050 Igarashi Nino-cho, Nishi-ku, Niigata City, Niigata, Japan

Brief Career:
2011- Research Institute for Natural Hazards and Disaster Recovery, Niigata University

Selected Publications:
• "Structure of web-based victims master database of the life rebuilding process – A study of the Great East Japan Earthquake of 2011 –," 15th World Conf. on Earthquake Engineering Proc., CD-ROM (8pp.), 2012.

Academic Societies & Scientific Organizations:
• Institute of Social Safety Science (ISSS)
• Japan Society for Natural Disaster Science (JSNDS)
• GIS Association of Japan (GISA)
• Japan Emergency Management Association (JEMA)
• Japan Society of Civil Engineers (JSCE)
• Institute of Electronics, Information and Communication Engineers (IEICE)
• Information Systems Society of Japan (ISSJ)
• Japan Association for Earthquake Engineering (JAEE)

Name:
Keiko Tamura

Affiliation:
Professor, Ph.D., Risk Management Office/Research Center for Natural Hazard and Disaster Recovery, Niigata University

Address:
8050 Ikarashi 2-no-cho, Nishi-ku, Niigata 950-2181, Japan

Brief Career:
2004-2006 Researcher, Research Center for Disaster Reduction Systems, Disaster Prevention Research Institute, Kyoto University
2006-2009 Associate Professor, Research Center for Natural Hazard & Disaster Recovery, Niigata University, Japan
2009-present Professor, Risk Management Office/Research Center for Natural Hazard & Disaster Recovery, Niigata University, Japan

Selected Publications:
• K. Tamura, "Defining recovery: 7-element model," Journal of Disaster Research, Vol.2, No.6, pp. 475-483, 2007.

Academic Societies & Scientific Organizations:
• Institute of Social Safety Science (ISSS)
• Japan Society for Natural Disaster Science (JSNDS)
• Japan Society for Civil Engineers (JSCE)

Name:
Haruo Hayashi

Affiliation:
Professor, Ph.D. (UCLA), Research Center for Disaster Reduction System (DRS), Disaster Prevention Research Institute (DPRI), Kyoto University

Address:
Gokasho, Uji-shi, Kyoto 611-0011, Japan

Brief Career:
1983-1988 Assistant Professor and Associate Professor, Faculty of Humanities, Hirosaki University
1988-1994 Associate Professor, Faculty of Integrated Arts and Sciences, Hiroshima University
1994-1996 Associate Professor, Disaster Prevention Research Institute, Kyoto University
1996-present Professor, Disaster Prevention Research Institute, Kyoto University

Selected Publications:
• Kyoto University/NTT Resilience Joint Research Group (H. Hayashi et al.), "Trial for the Disaster Resilience Society – Come over the Great East Japan Earthquake Disaster," Nikkei BP Consulting, Inc., 2012 (in Japanese).
• H. Hayashi et al., "Effective method for disaster prevention, 'Disaster Ethnography' – unrevealed witnesses of Hanshin-Aawaji Great Earthquake," Japan Broadcast Publishing Co., Ltd, 2009 (in Japanese).
• Kyoto University/NTT Resilience Joint Research Group (H. Hayashi et al.), "Creating Disaster Resilient Society – protecting lives, livings, businesses from disasteres and risks," Nikkei BP Consulting, Inc., 2009 (in Japanese).
• H. Hayashi, "Earthquake Disaster Prevention Study saving life," Iwanami Shoten, 2003.

Academic Societies & Scientific Organizations:
• Institute for Social Safety Science (ISSS)
• Japan Society for Natural Disaster Science (JSNDS)
• Japan Emergency Management Association (JEMA)