Spatial Distribution of Consent Forms
from Residents Vulnerable to Disasters

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Abstract: Based on the "Guidelines for Supporting Residents Requiring Assistance during Disasters" issued by the Cabinet Office of Japanese Government in March 2005, almost all local municipalities have been making efforts to list the residents requiring assistance during disasters using consent method. In this study under the joint research with municipal office of Miki City in Hyogo Prefecture which has adopted the consent method since 2007 and collected over 3,000 consent forms from its 80,000 population, we will examine spatial factors affecting submission rate of consent forms by calculating submission rate for each residents' association, and mapping results against hazard maps and questionnaire results asking strength of self-help, mutual-help and public- help against natural disasters. More specifically, regression analysis, regression analysis with spatial dummy variables and GWR (Geographically Weighted Regression) are applied and results are examined.

1. Introduction

It has been eight years since the Japanese cabinet issued the "Guidelines for Evacuation Support of Residents Requiring Assistance during Disasters" where the government urged local municipalities to list names of individuals who have difficulties in evacuating during disasters e.g. elderly and handicapped, and make detailed plans on how to actually help them. In many municipalities however, obstacles such as sectionalism and protection of personal information has limited progress of constructing systems and schemes of helping those who require assistance during disasters. According to Fire and Disaster Management Agency of Ministry of Internal Affairs and Communications, as of April 1st 2012, 97.8% of municipalities had already started listing their residents who require assistance and 83.5% had finished making lists and been renewing it, and 87.7% were making plans for listed individuals, only 28.8% however, had finished making plans and been renewing it. Furthermore, even in municipalities that have started listing and planning not everything is going smoothly with a number of municipalities, facing difficulties in registration and maintenance of listing database.

Meanwhile, the Great Eastern Japan Earthquake struck on March 11th 2011, causing massive damage along coastal areas with large scale tsunamis that followed the earthquake. This has led us to renew our

recognition that evacuation support and safety inquiry are important for ordinary citizens as well as citizens requiring assistance.

In this study we will show that submission rate for consent forms used for listing residents and assigning disaster support plans is different between sub-regions (residents' association) in Miki City where listing and planning of evacuation support have been conducted by consent method from October 2007. Then, we will try to verify whether submission rate is affected by factors such as hazard risks, accumulation of social capital and locality i.e. whether a region is suburbs, city center or residential areas by using multiple regression model with district dummy variables and GWR (geographically weighted regression). If it is shown that region have impacts on submission rate of consent forms, then it is suggested that local municipalities should take this factor into consideration when listing residents vulnerable to disaster or making plans against disasters.

2. Submission of Consent Forms in Miki City

Miki City as shown in figure1 is a local municipality located along Kakogawa River, the longest river in Hyogo Prefecture. It is connected to central area of Kobe City by Kobe Railway's Ao line. The city is located in a mountainous region and used to be agriculture oriented but had a name of "city of ironware" for its manufacturing. From the 1970s the city became a commuter city for Kobe City, seeing development of residential areas formed mainly by single family homes, but now it faces ageing and decreasing population. According to 2010 census the city's population is 81,038 (3,323 decrease from 2005) and number of households is 28,491.

Miki City comprises 7 districts of the older towns and villages that merged into Miki City (Miki, Miki-Minami, Bessho, Shijimi, Hosokawa, Kuchi-Yokawa and Yokawa) and 3 districts of the newly developed residential areas (Midori-ga-Oka, Jiyu-ga-Oka and Aoyama) which all have meeting halls of their own. Total of 199 residents' associations are present within the city.

With regard to supporting residents requiring assistance during disasters, the city has changed their method of listing names from information sharing method to consent form method in October 2007. District welfare commissioners visit each household with consent forms to obtain consent to collect and use personal information from residents requiring assistance during disaster.

3,146 consent forms are received as of August 25th 2011. Figure 2 shows choropleth map of 2,851 consent form submitters' address and submission rate (ratio of submitters against total number of residents registered in Basic Residents Register at October 1st 2008) for each of 199 residents'
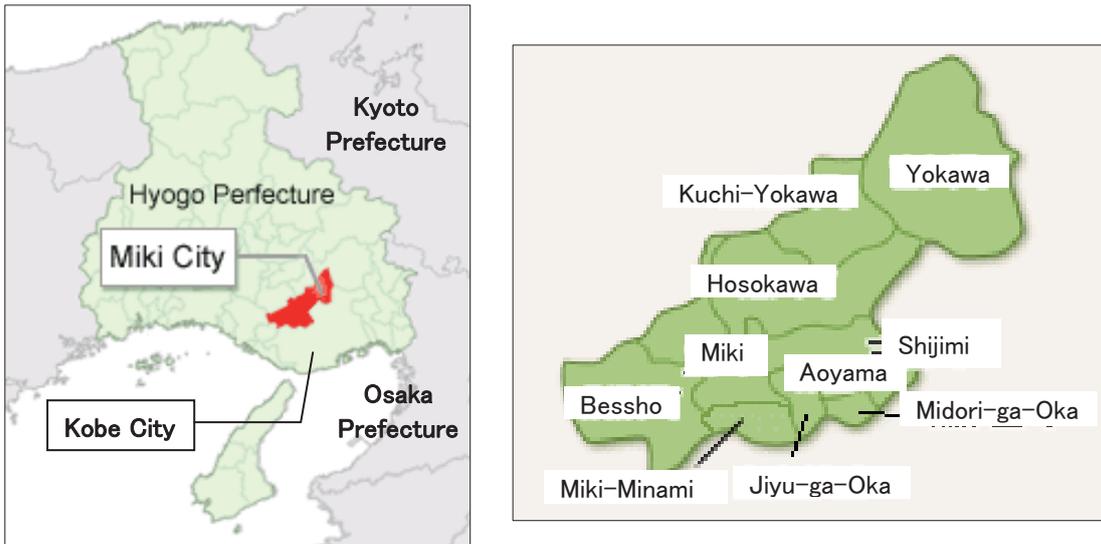
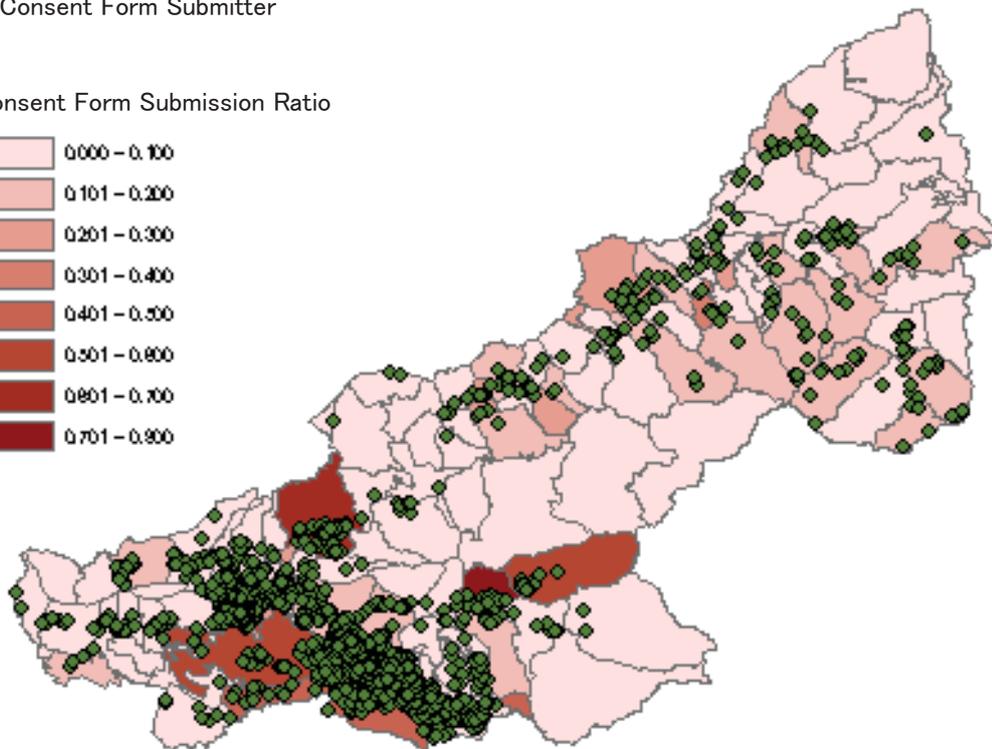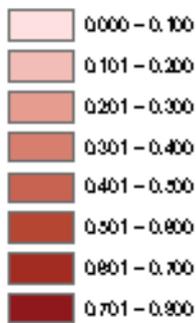Figure 1 Location of Miki City and Its Seven Districts

Figure 2 Spatial Distribution of 2,851 Consent Form Submitters

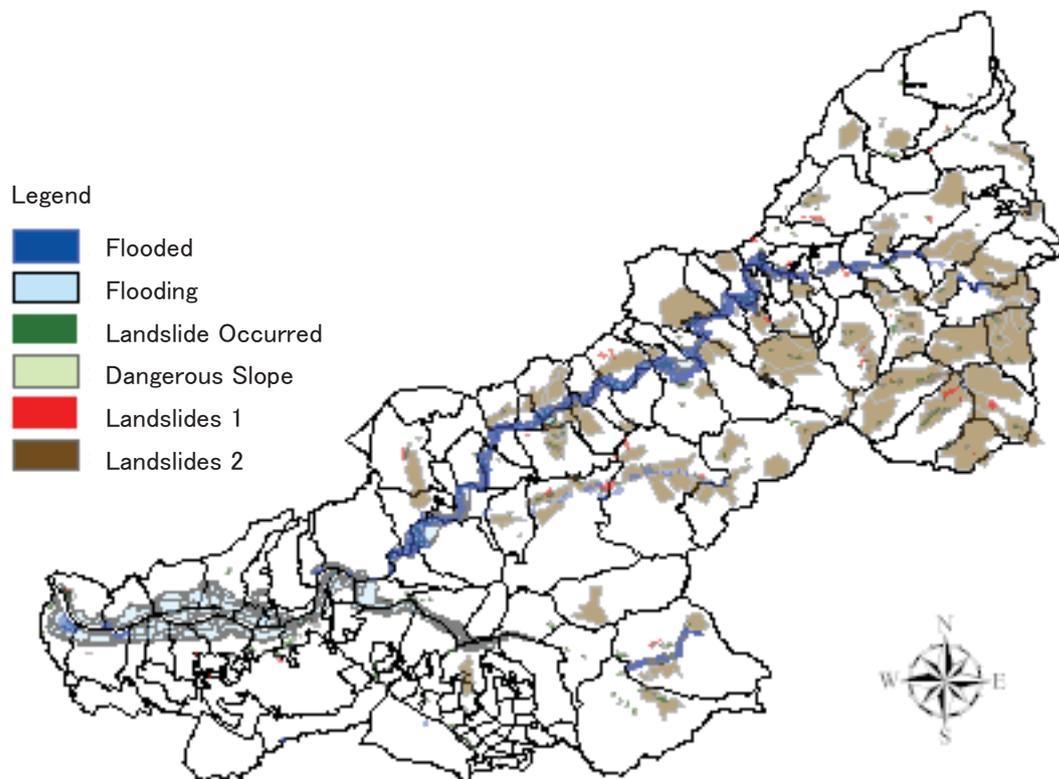and Submission Ratio for each of Residents Associationsl

Figure 3 Miki City Hazard Map

associations as of November 11th 2008. Figure 3 shows hazard map of Miki City. From figure 2 it is shown that submission rates are lower in mountainous districts of Yokawa, Kuchi-Yokawa, Hosokawa, and Shijimi.

3. Data for Analysis and Results

In order to clarify factors causing spatial variation in submission rate of consent forms, we prepared following data for 141 residents' associations (hereafter integrated residents' associations) by merging portion of 199 residents' associations with help of Miki City so that we can total statistical data by sub-regions.

1. Submission rate: ratio of submitters as of November 20th 2008 against total number of residents registered in Basic Residents Register at October 1st 2008.
2. Submission rate of elderly residents: ratio of submitters as of November 20th 2008 against total number of residents registered in Basic Residents Register at October 1st 2008 for those above age 65.

3. Elderly ratio: Ratio of residents above age 65 as of October 1st 2008 in the Basic Residents Register.
4. Hazard residence ratio: number of residents living in areas designated as dangerous (risk of flooding and landslides) in Miki City's hazard map against total number of residents as of October 1st 2008.

Using this data we constructed two models using submission rate in 141 integrated residents' associations as dependent variable and flood hazard residence ratio, landslide hazard residence ratio, and elderly ratio as independent variables. One model included district dummy variable while the other did not. In designing the models we prepared two hypotheses.

1. If two disaster hazard ratios are high, then that means that the particular residents' association is more vulnerable to disasters. Submission rates should be higher in associations with higher hazard ratios.
2. If elderly ratio is high, then that means that the particular residents' association has larger number of people whom they have to take care of, because elderly residents are more likely to be residents requiring assistance during disasters. Therefore submission rates should be higher in anticipation of support from the city.

We also hypothesized that for all three independent variables values of estimated parameters should be positive.

The result is shown in table 1. In model1 where district dummy variable is omitted, model does not possess interpretability with none of independent variable being significant. In model 2 where dummy variables for 10 districts were integrated, it is shown that submission rate is higher in certain districts (Miki, Miki-Minami, Jiyu-ga-Oka and Shijimi). Also, when we control residents' associations' promotion of consent form submission by using district dummies it is shown that flood and landslide hazard ratio both have significant positive estimated coefficient values, suggesting that geographical variations should be taken into consideration regarding spatial variation of consent forms submission.

Based on these results, in order to consider the possibility of local variation of regression parameters, we applied GWR by using the same model as model 1. In this study we applied GWR using ArcGIS version 10.0 with cross validation estimation, using same variables as used in model1 of multiple regression analysis.

Figure 4 displays spatial distribution of estimate values for constants and independent variables. It is shown that estimate values can be categorized into mountainous region (Yokawa, Kuchi-Yokawa, Hosokawa and Shijimi), newly developed residential region (Jiyu-ga-Oka, Aoyama and Midori-ga-Oka) and other region (Miki, Bessho and Miki-Minami). In general, coefficients for elderly ratio are negative

Table 1 Results of Regression Analysis

		Model 1		Model 2	
Coefficient of Determination		0.0198		0.3588	
Number of Sample		141		141	
		Coefficient	Std. Erorr	Coefficient	Std. Error
Constant		13.744	4.837 ***	0.845	5.810
Flood Hazard Residence Ratio		0.068	0.057	0.105	0.054 *
Landslide Hazard Residence Ratio		0.049	0.041	0.097	0.041 **
Elderly Ratio		−0.138	0.170	0.139	0.180
District Dummy	Miki			8.592	3.516 **
	Miki−Minami			35.870	5.605 ***
	Bessho			−2.544	3.824
	Shijimi			8.978	3.785 ***
	Hosokawa			−4.485	3.718
	Kuchi−Yokawa			3.746	3.410
	Midori−ga−Oka			−0.195	3.925
	Jiyu−ga−Oka			14.535	4.402 ***
	Aoyama			2.016	5.907

Notes: Base level for District Dummies is Yokawa. ***, ** and * dnote 0.01, 0.05 and 0.10 level of significance respectively.
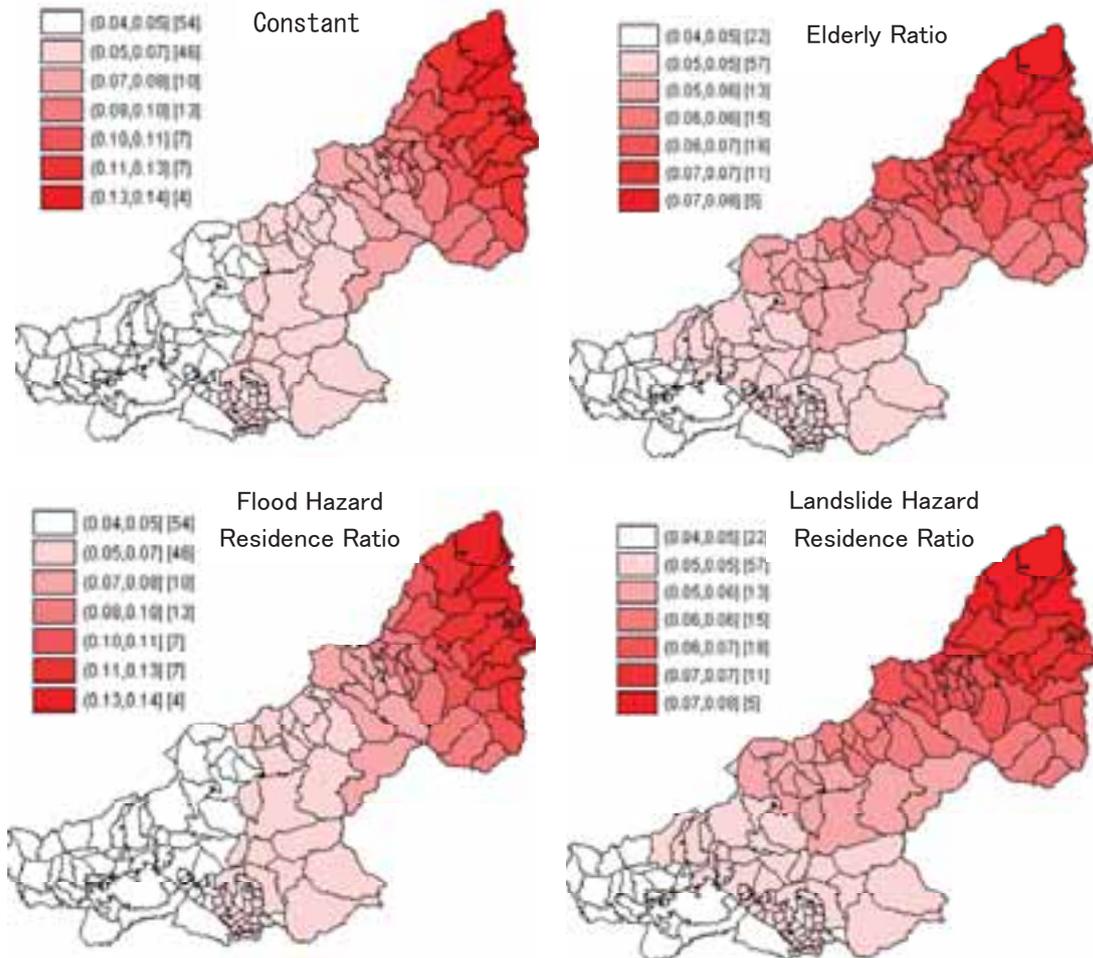

Figure 4 Results of GWR

for almost all districts. Looking closer at each region, in Yokawa district—a typical mountainous district—constant and absolute value for elderly ratio are low and submission rate increases according to level of risk represented as flood and landslide hazard ratio. In other districts such as Miki, Miki-Minami and Bessho where districts are relatively urbanized and residential districts of Jiyu-ga-Oka, Midori-ga-Oka and Aoyama, elderly ratio has larger impact on submission rate than hazard ratios.

4. Conclusion and Future Goals

Our study stemmed from the fact that progress of consent forms submission differed from district to district, and tried to clarify the variation of consent form submission rates using multiple regression analysis with district dummy variables and geographically weighted regression analysis. As a result it was shown that submission rates for integrated residents' associations were indeed affected by districts and flood and landslide hazard levels.

It is suggested by city workers that in such districts where neighbor ties are strong, people believe communities and residents' associations can take care of residents requiring assistance without the submission of consent forms, leading to attitudes that submission of consent forms is not necessary, although some associations actively promote submission. From this suggestion, we hypothesized that strong attitude of mutual-help will lower submission rate of consent forms while attitude of public help will raise submission rate of consent forms. In other words, we believe that attitudes towards mutual-help, self-help and public-help also affect submission rate of a district. We conducted "citizens' attitudes survey on supporting residents requiring assistance during disaster and measures against new strains of influenza" with cooperation of Miki City and United Residents' Association of Miki City from December 2008 to January 2009, obtaining 16,064 responses from 178 residents' associations that offered us cooperation (50.9% response rate based on all households registered in Basic Residents Register). In the survey we included survey items regarding our question, asking respondents to distribute 100 points to each of mutual-help, self-help and public-help. We would like to continue our study to see detailed differences between districts in attitude towards disaster prevention, consent forms submission and status on disaster prevention measures, and what approaches will be effective in promoting disaster prevention by making analysis using data from aforementioned survey and considering effects of social capital.

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