QUICK COLLECTION OF EARTHQUAKE DAMAGE INFORMATION AND EFFECTIVE EMERGENCY RESPONSE BY COLLABORATION BETWEEN LOCAL GOVERNMENT AND RESIDENTS

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ABSTRACT :

We developed a methodology for collecting quickly earthquake damage information and conducting effective emergency response by collaboration between a local government and residents. The methodology consists the PDCA cycle: "1. Orientation Meeting (Plan)", "2. Workshop (Do)", "3. Earthquake Drill (Check)", and "4. Evaluation Meeting (Act)". After discussing year's plan in the orientation meeting, community associations and city officials hold a workshop to make a disaster prevention map, which shows strong and weak points in the community area. After knowing the risk in the area, the participants discuss about what would happen during a large earthquake, and how to collaborate the city and the associations. During an earthquake drill, the collaboration is tested for emergency response and information sharing. First, residents carry out emergency response under a realistic disaster situation in community areas, such as fire fighting, rescue, and safety checking activities. Then, they make a damage information map after evacuating to the local community center, where government officials open a local emergency operation center to summarize the damage information of the community areas and send it to the emergency headquarter of the city. The headquarter summarizes all the data, and informs to the residents about important information, such as an evacuation order for a massive fire. After the drill, community members and the city officials discuss about how to improve the collaboration in an evaluation meeting. We applied the methodology to Toyohashi City in 2005 and 2006, and confirmed its validity and effectiveness.

KEYWORDS: Collaboration of Local Government and Residents, Earthquake Damage Information, Emergency Response, Disaster Prevention Map, Earthquake Drill, Damage Map

1. INTRODUCTION

When a large-scale earthquake occurs near a city, such as the 1995 Kobe earthquake, a local government is usually paralyzed by a deluge of damage information, and becomes extremely difficult to know the overall damage and to conduct effective countermeasures (see Figure 1(left)). To remedy this problem, Zama *et al*. (1998) proposed an idea to obtain city's damage information by collaboration between the government and residents (see Figure 1(right)). In the idea, city officials open local emergency operation centers at the community evacuation centers in school districts after a large earthquake,; they collect damage information within the districts with help from community associations, and send the information to the city's emergency headquarter. If all the school districts in the city are organized in such way, the headquarter can quickly obtain the information of the overall city's damage. When some areas are blank (no information), it is possible to check whether the areas are safe or devastated. It would be also possible to make prompt decisions, such as evacuation orders for big fires, and how to effectively use the city's limited resources.

In order to actualize the idea, we developed a methodology based on a PDSA cycle, and applied it to Toyohashi City in the Aichi prefecture in Japan in 2005 and 2006. As shown in Figure 2, Toyohashi City is close to the anticipated Tokai and Tonankai earthquakes. Figure 3 shows the estimated JMA (Japan Metrological Agency) intensities in the city for the Tokai - Tonankai combined earthquake, which indicates the most parts of city would suffer intensities 6 Lower to 6 Higher (nearly equal to 9 to 10 in the MMI intensities). In this paper, we explain first the proposed methodology, and second, how to apply to the city. Finally, we check the validity

of the methodology by an experimental earthquake drill in 2006.

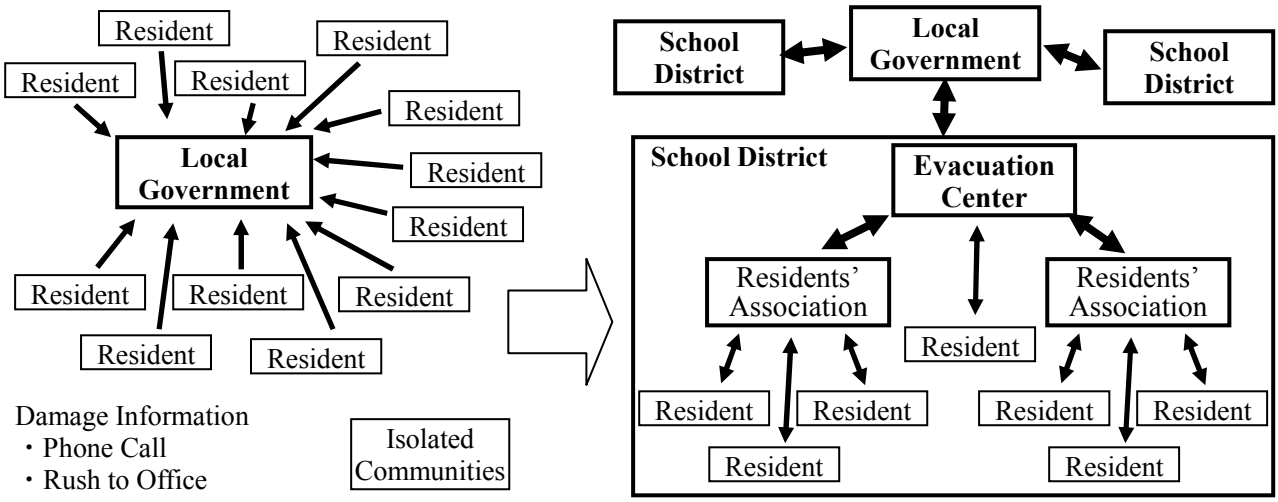

Figure 1 Information flows from community members to a city under a current earthquake disaster (left), and under the proposed methodology (right)

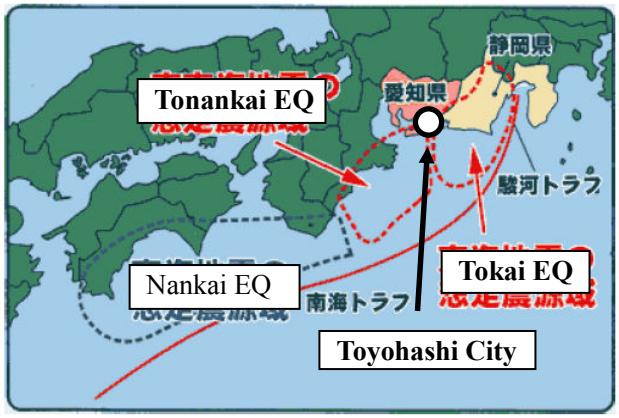

Figure 2 (up) Toyohashi City in the Aichi prefecture, and anticipated earthquakes, the Tokai and Tonankai earthquakes (Toyohashi City, 2003)

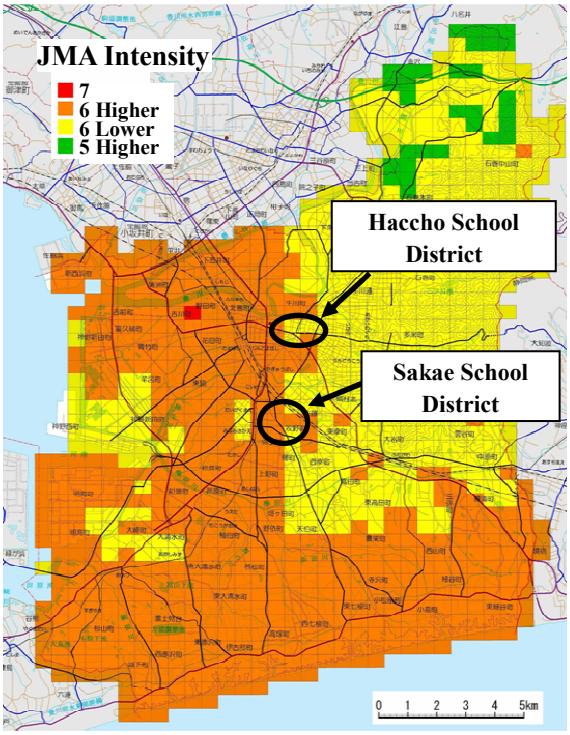

Figure 3 (right) The estimated JMA intensities in Toyohashi City for the Tokai - Tonankai combined earthquakes. And, the Haccho and Sakae school districts, in which we applied the proposed methodology (Toyohashi City, 2003)

2. THE METHODOLOGY FOR EFFECTIVE EMERGENCY RESPONSE AND INFORMATION SHARING, AND ITS APPLICATION TO TOYOHASI CITY, JAPAN

We explain the methodology for effective emergency response and information sharing by collaboration between a city and community associations, shown in Figure 1 (right), and how to apply it to Toyohashi City in 2005 and 2006. We worked with the city's officials of the disaster prevention and the city planning sections, and the community associations in the Haccho and Sakae school districts, which show high earthquake risk (see Figure 3).

As shown in Figure 4, we developed a methodology based on the PDCA cycle: "1. Orientation Meeting

(Plan)", "2. Workshop (Do)", "3. Earthquake Drill (Check)", and "4. Evaluation Meeting (Act)". In the first year (2005), we first held orientation meetings with the residents in both districts with local officials, and discussed about the earthquake hazard, the risk of the areas, disaster prevention plans. Next, we held a workshop in the Haccho districts to make a disaster prevention map, which indicated strong and weak points of the area, such as the locations of fire distinguishers, fire hydrants, storages of rescue equipments, weak walls and buildings, open spaces, and so on. Figure 5 shows an example of the map, which was made in Akumi and Azumada areas in the Haccho district in 2005 using a Web-GIS system (Ichii, et al. 2005). During the workshop, the participants also discuss about what will happen during a large earthquake, and how to collaborate between city and communities under a devastating situation.

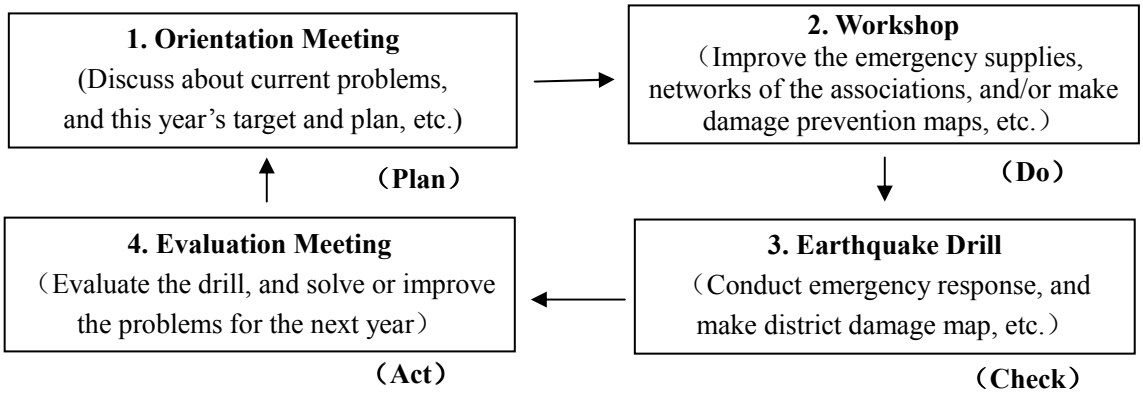

Figure 4 The PDCA cycle for quick collection of earthquake damage information and for effective emergency response, which were applied to Toyohashi City in 2005 and 2006

Figure 5 An example of a disaster prevention map which was made in Akumi and Azumada areas in the Haccho district in 2005 using a Web-GIS system (Ichii et al., 2005). For its location, see Figure 6.

Next, we conducted an earthquake drill for emergency response within the community areas (fire fighting, rescue, safety confirmation of elderly and disable people etc.), based on the disaster experience game (Kaji and Iwaki, 1998). At the same time, we conducted a drill to make community damage maps with help from the community associations. We confirmed that the city could obtain accurate and fast damage information and

carry out effective countermeasures by the collaboration between the local residents and officials. Finally, we held evaluation meetings to check and improve the methodology. In the next year (2006), we carried out the next PDCA cycle: orientation meetings (discussing this year's plan), workshops (disaster prevention maps in the Sakae district), and an experimental earthquake drill (see the next Section), and evaluation meetings (improve the methodology).

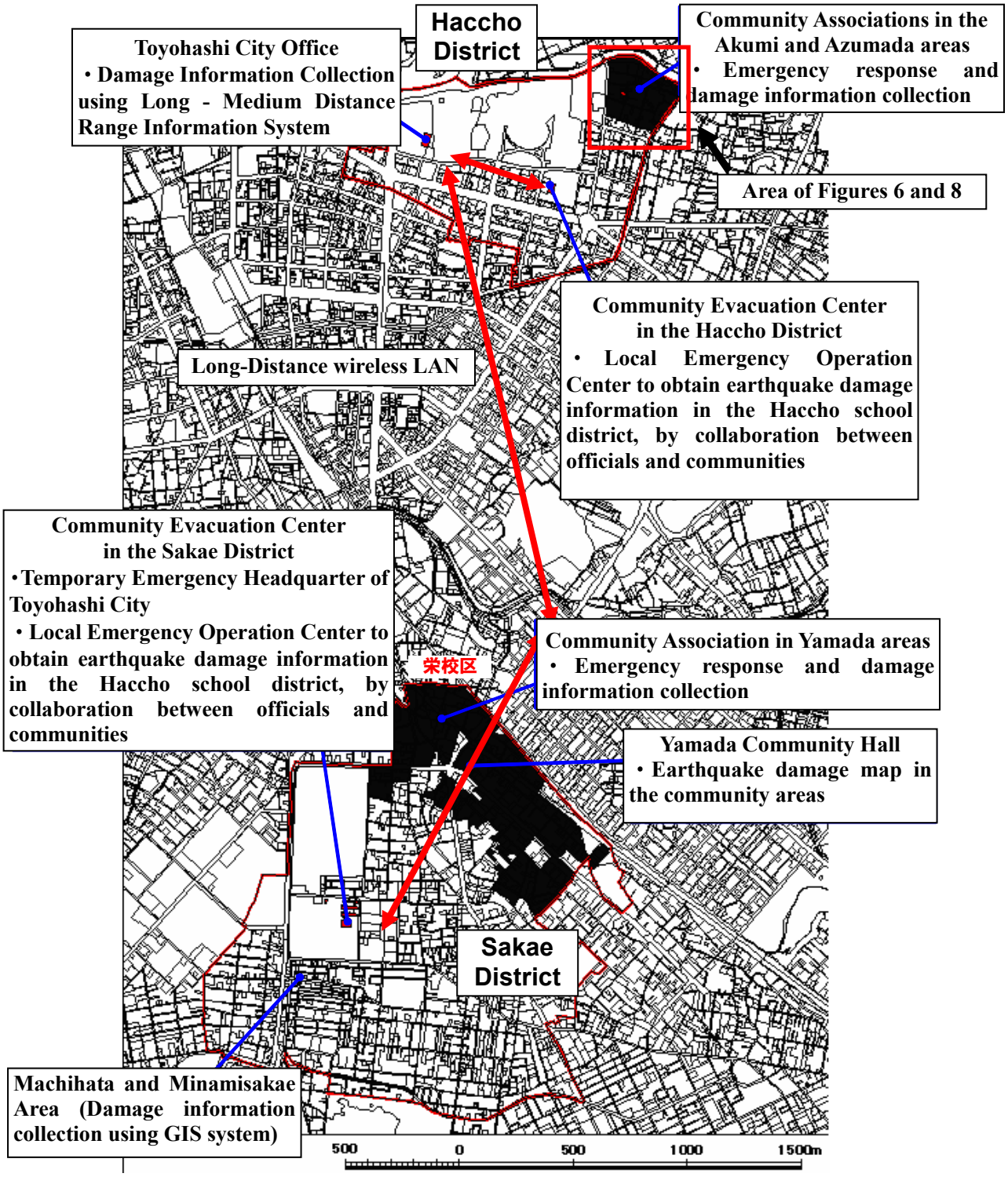

Figure 6 The area of the experimental earthquake drill in Toyohashi City in 2006. In the drill, community associations in the Haccho and Sake school district participated, in addition to the city officials.

3. EXPERIMENTAL EARTHQUAKE DRILL IN TOYOHASHI CITY IN 2006

We explain the experimental earthquake drill in 2006 in detail, which was carried out to check the validity of the proposed methodology. Figure 6 shows the Haccho and Sakae school districts and the community areas to participate in the drill. The drill was carried out by collaboration between Toyohashi City and the community associations of the two school districts. First, panels were suspended at electric poles just before the drill, which showed the information about earthquake damage, such as a fire breaking, a damaged building, and a blocked road (see Figure 7, and Pictures 1 and 2 for the panels). Figure 8 shows the locations of the damage panels in the Akumi and Azuma areas in the Haccho district. Similarly, the damage poles were set in the Yamada area in the Sakae district, as well.

Figure 7 Earthquake damage panels, which were suspended at electric poles in the community areas

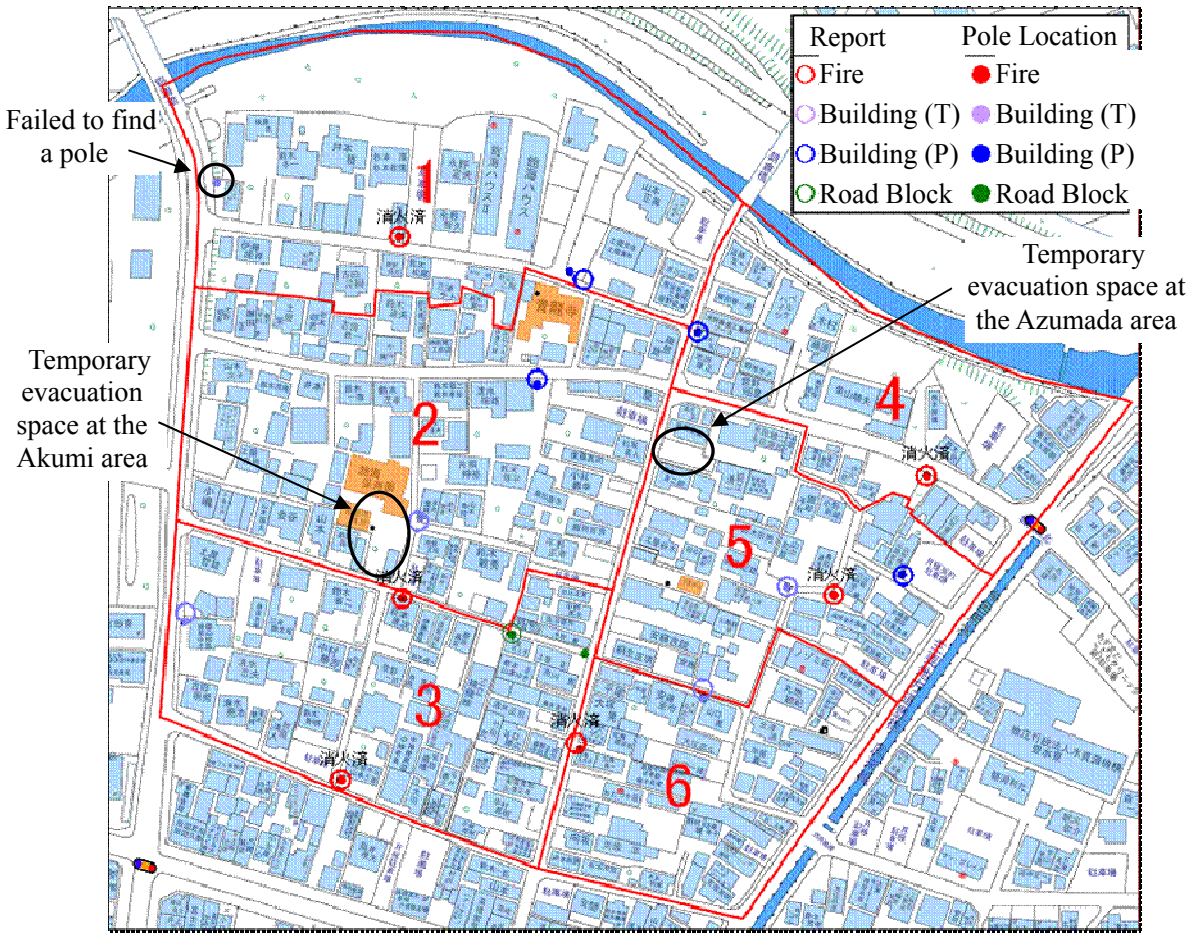

Figure 8 The earthquake damage map at the Akumi and Azumada areas (dots are the actual location of the poles, and circles are the locations which the community member reported).

When the drill started under the assumption of the Tokai earthquake, the local residents checked the community areas, and carried out emergency response. For example, when a resident found a panel of fire breaking, he/she gather people, and collect fire distinguishers and buckets with water as many as possible within 10 minutes (see Pictures 1). When a fire hydrant was close to the panel, people connected a hose to the hydrant and brought the nozzle to the panel (see Picture 2). When people succeeded to bring enough numbers of the fire distinguishers, buckets, and/or the nozzles within 10 minutes, a coordinator put a sticker of "Extinction Success" on the panel (see Picture 1). Otherwise, the coordinator put a sticker of "Extinction Failure". People also checked the safeties of elderly and disable people and brought them to the temporary evacuation spaces within the community areas (see Picture 3). After finishing emergency response at the panels, all the participants got together at the temporary spaces (see Figure 8 and Picture 4).

After checking the safeties of the community areas, people went to the community evacuation centers (see Figure 6 for the locations), and made the community damage maps, which indicated the locations and the type of damage (see Picture 8). Figure 8 is the damage map of the Akumi and Azumada areas, which was made by the community members within 30 minutes after starting drill. The information were very accurate for both the locations and the types, which shows that it is possible to obtain accurate damage information very quickly with the help of community associations. Next people gave the damage maps to the city officials, who opened the local emergency operation centers at the evacuation centers, and they summarized data and sent them to the city's emergency headquarter using the long-distance wireless LAN (see Picture 6, and Figure 6 for the location; Kawasaki Lab., 2006).

Picture 1 Emergency response drill (fire fighting by bringing fire extinguishers and buckets)

Picture 2 Emergency response drill (fire fighting by bringing a nose from a fire hydrant)

Picture 3 Safety check and evacuation drill (people check and bring elderly people a to evacuation spaces)

Picture 4 Safety check drill (check of the community at the temporary space within the community area)

Picture 5 Community damage map drill (making a damage map at the community evacuation center)

Picture 6 Local emergency response center (collecting the damage information of the school district)

Picture 7 City's emergency operation headquarter (Communicating with a community evacuation center)

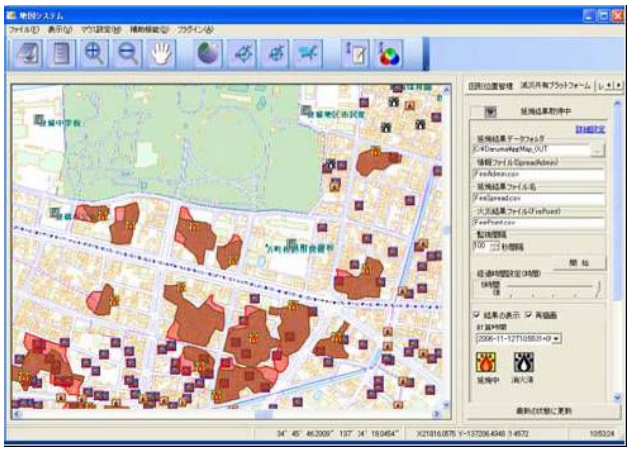

Figure 9 Example of fire spreading simulation (Results were used at the city's operation headquarter)

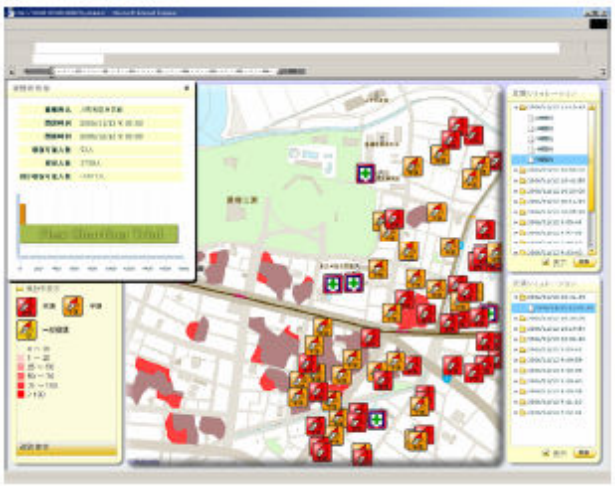

Figure 10 Capacity information of an evacuation center (Information shows that the center is still vacant)

Picture 8 Explanation of the city's damage and the evacuation order for big fire to community members

The city's emergency headquarter was temporary located at the community evacuation center of the Sakae districts during the drill (see Figure 6 for the location). At the headquarter, the city officials checked all the damage data, which were not only from the Haccho and Sakae districts, but also from the other districts, which were generated by a computer. They also communicated with the officials at the community evacuation centers using IP phones and FAX through the long-distance wireless LAN (see Pictures 6 and 7). Using software for simulating fire spreading, they estimated the possible burned area and its arrival time (see Figure 9; Kawasaki Lab., 2006). When an evacuation center would face the fire spreading, the headquarter issued an evacuation order. The headquarter also knew which evacuation center is full or vacant in real time using a Web-GIS system (see Figure 10; Ichii et al. 2005). Finally, the summary of damage and/or the evacuation order from the headquarter were informed to the community members at the evacuation centers (see Picture 8).

4. SUMMARY

We developed a methodology for collecting quickly earthquake damage information and conducting effective emergency response by collaboration between a local government and residents. The methodology consists the PDCA cycle: "1. Orientation Meeting (Plan)", "2. Workshop (Do)", "3. Earthquake Drill (Check)", and "4. Evaluation Meeting (Act)". Especially, the workshop is important to know the risk of the areas by making an earthquake prevention map, and discuss how to collaborate the community and the city. In addition, the earthquake drill based on the disaster experience game (Kaji and Iwaki, 1998) is very useful to check the effectiveness of the collaboration for emergency response, and collecting and sharing information. During the experimental drill in Toyohashi City in 2006, the city could collect the accurate damage data within 30 minutes with help of community associations. After the drill, we interviewed the city officials, and all the members acknowledged the effectiveness of the methodology. The members of community associations also acknowledged the usefulness of the disaster experience game for emergency response.

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