Clarifying the Function of the Emergency Mapping Team in order to Allocate the Limited Resources in the Time of 2011 Great East Japan Earthquake

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Abstract

The Great East Japan Earthquake that occurred in 2011 caused a tremendous amount of damage spanning over multiple prefectures due to severe vibrations and tsunami. In order to provide quick and appropriate disaster responses, prefectures must establish a common operational picture regarding damage situations and disaster response statuses among cities, "cho" districts, and villages. This is especially important along the coast to supplement basic functions of those municipalities. The needs of the front line disaster response workers were extracted, and the Emergency Mapping Team (EMT) clarified the characteristics and challenges related to the visualization of those needs. The EMT was put in place at the Cabinet Office to investigate how maps should be utilized.

Introduction

The Great East Japan Earthquake that occurred on March 11, 2011, caused ground-shaking, huge tsunami, liquefaction and explosion accident of nuclear plant. Those types of damages caused not only large physical impact such as human damage and building damage. The impacted area spread over 10 prefectures and 240 cities, wards, districts and villages. This catastrophe has two serious issues; one is “complex catastrophe”, the other is “wide-spread catastrophe.”

In addition, there was a tremendous amount of human and property damages. This disaster triggered a call

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for immediate lifesaving activities, restoration of utilities, and the dispersal of support for victims across many prefectures throughout Japan.

Theory

The effective and efficient implementation of disaster response measures necessitates a shared common operational picture. Sharing a common operational picture involves the dissemination of information regarding the state of damages and disaster response activities among disaster responders, thus enabling a common understanding of the situation. In Japan, there have been initiatives to realize a common operational picture through effective and efficient information collection at disaster response fields. A recent example of this is the Emergency Mapping Center that was established by the Niigata Disaster Management Headquarters after the Chuetsu Offshore Earthquake of 2007. In this case, a common operational picture enabled effective and efficient disaster response activities. In this case, a common operational picture enabled effective and efficient disaster response activity via the mapping.

Based on these experiences, we sought to develop a system to share a common operational picture to aid in a decision making process at the national level by visualizing information on maps. These maps provided a common operational picture for the large-scale disaster due to the Great East Japan Earthquake of 2011. In particular, we extracted information about needs, in order to elucidate the challenges for realization of sharing a common operational picture on the national level through our collaboration with the Cabinet Office. We believe that our system is effective for information processing and can be used to support the deployment of disaster resources in the future.

Method

The Cabinet Office Mapping Team operated from the day after the earthquake on March 12, 2011 until April 26 at a meeting room within the Cabinet Office. Initially we started our day at 10:00 a.m., and often continued until well past midnight when we just started the activities. As time progressed, we managed to end each day at around the end of a normal working day by clearly specifying the working time; however, we worked seven days a week until the situation stabilized. After April 2 when the system was well established and things were stabilized, we did not work on Saturday afternoons and Sundays. The Emergency Mapping Team was comprised of the maximum number of people per day during this period at the special meeting room (n=17). For the duration of the activities, the number of man-day was 278 in total (as counted by a half day). In reality, there were more people involved; we mobilized more people than 278 man-days due to the back-up system (Figure 1).

Procedures used for the mapping work were: (1) Organize a list of general affairs and needs; (2) Generate data, figures, and tables; (3) Data processing and spatial processing; (4) Mapping and layout; and (5) Regular updating and mapping. The primary author of this paper was responsible for the generation of data, figures and tables, and created a database for mapping and sharing the status recognition data. The co-authors were responsible for other procedures. Together, we generated maps in response to requests (Figure 2).

Figure 1. EMT meetings

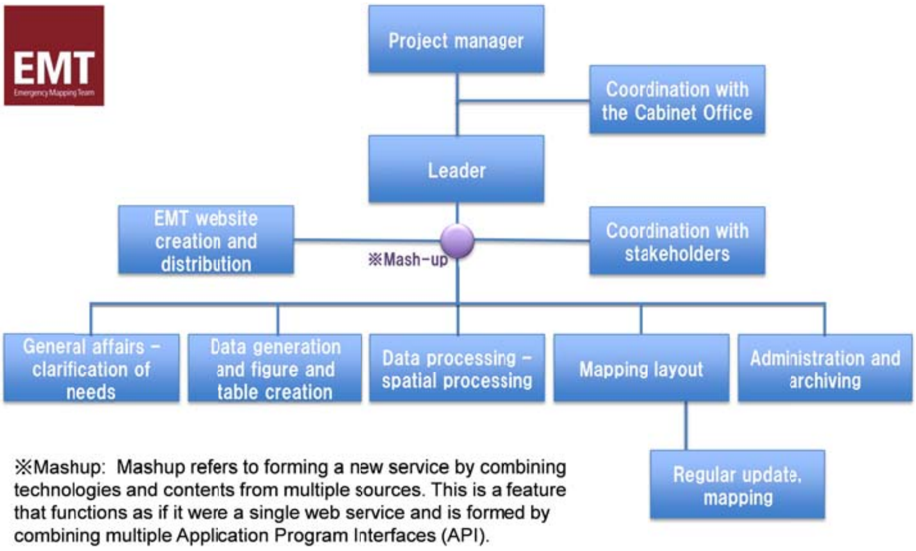

Figure 2. EMT structure (as of March 17, 2011)
(One week after the earthquake, six days after EMT launch)

The Emergency Mapping Team (EMT) generated a total of 500 maps during its operational period (March 21 through April 26). The maps were classified into 30 categories that were further subdivided into the following seven major categories: (1) Hazard observation information (63 maps); (2) Hazard scenario information [Areas under the nuclear plant evacuation advisory and directive (8 maps), Planned power outage by Tokyo Electric Power (5 maps)]; (3) Estimated damage compensation [Seismic intensity distribution for each building (1 map), Building distribution within areas under evacuation advisory and directive (5 maps), Building distribution in low-altitude areas (33 maps)]; (4) Actual damage [Isolated people (31 maps), Missing people (38 maps), Injured people (40 maps), Building damage (23 maps), Fires (13 maps)]; (5) Social infrastructure [Population and number of households in each municipality (2 maps), Distribution of population age 65 and over (8 maps), Facilities that can accept people who require assistance (7 maps), Satellite images of disaster areas (2 maps)]; (6) Response policy [Relationship between transportation centers and transportation capability (54 maps), Resources to consider for long-term evacuation designation (1 map), Resources to consider for specific disaster-afflicted area designation (1 map), Resources to consider for specific disaster-afflicted local public organizations (5 maps)]; and (7) Disaster response results [Evacuation center provisions (8 maps), Personal safety confirmation (1 map), Application of rescue methods (9 maps), Application of rescue methods and assistance methods (3 maps), Goods procurement (1 map), Temporary assistance staff dispatch (25 maps), Utility damage recovery (88 maps), Empty maps to record disaster response results (18 maps), Visualization of the recognition of disasters to the society by trend leaders (7 maps)].

Results

The 500 maps that were generated by the Emergency Mapping Team resulted from a series of spatial analyses using information that was superimposed onto maps. This process is commonly called "mashup." Mashup refers to the formation of a new service by combining technologies and contents from multiple sources. This allows the child to function in a single web service that was formed by combining multiple Application Program Interfaces (API). There were also issues with the data collected from the governments: (1) Issues with raw data (data was exchanged as hard copies); (2) Issues with the database (many of the Excel files generates could not be incorporated into the database); and (3) Issues with making data publicly available (collected data items were not uniform across different municipalities because they had different intentions and policies in making data publicly available). One of representative maps made with mashup is shown (Figure 3).

In order to create the map, which make all responders know the situation and construct the common operational pictures, the following process is needed;

1) We collected the data and reformat under the schema of standardized table
2) Put the geo-locational information on the each record
3) Visualize the Attribute data developing maps with the geo-locational information

Using the example of visualizing where and how much evacuation centers and shelters have how much evacuees day by day, the procedures would be explained precisely. First, we collected the data from the provided information by the municipal and local governments. We tried to organize the dataset by each evacuation centers and shelters day by day. Usually those datasets had no geo-locational information, while some of them had the street address or no clue of detecting the street address. Using the street address or the names of facilities we tried to detect the geo-locational information. Then we visualized the attribute data in graph and charts and also visualized it with the geo-locational information. From the graph we noticed the total numbers of evacuation centers and shelters declined in the process of time while some of them did not simply follow the trend (Figure 4 and 5).

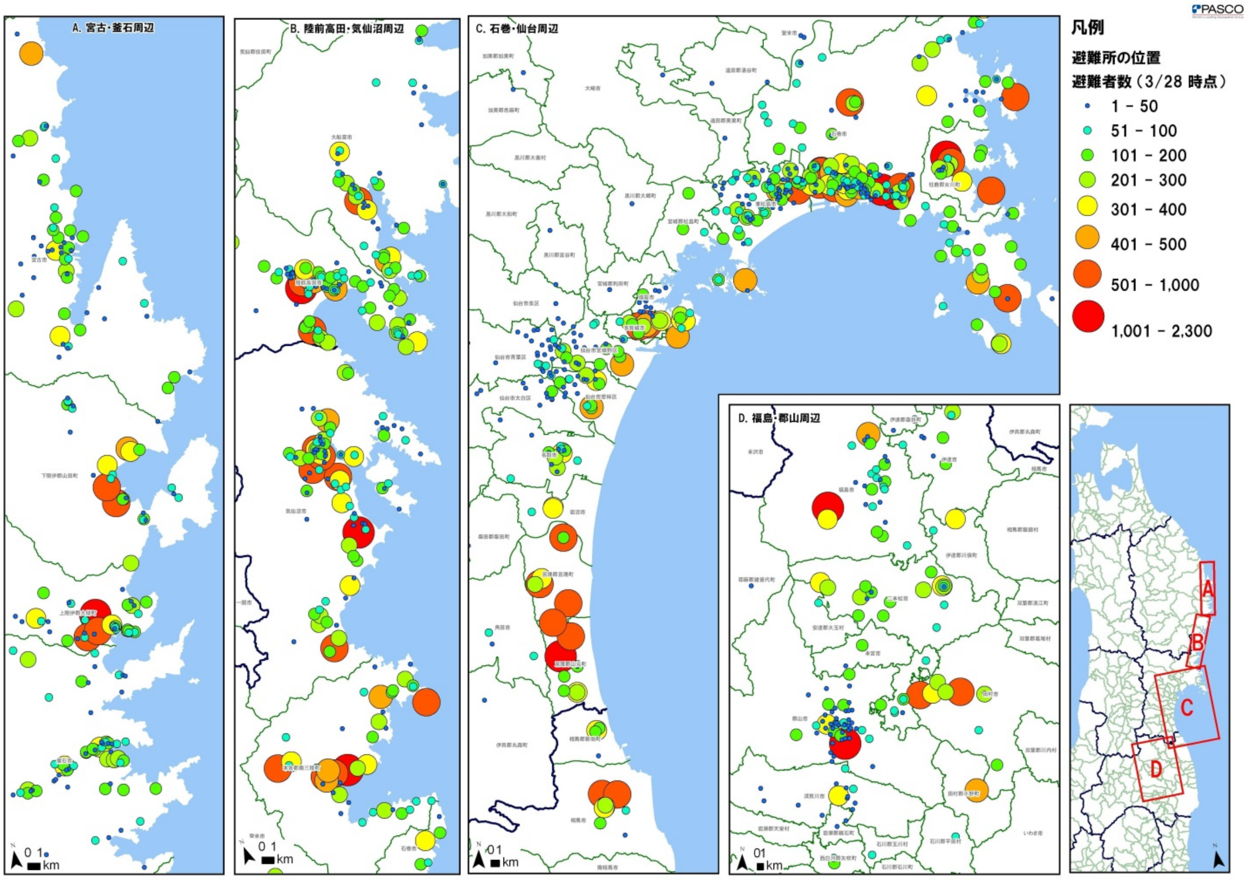

Figure 3. Maps of the location of evacuation centers and number of evacuees (March 28, 2011)

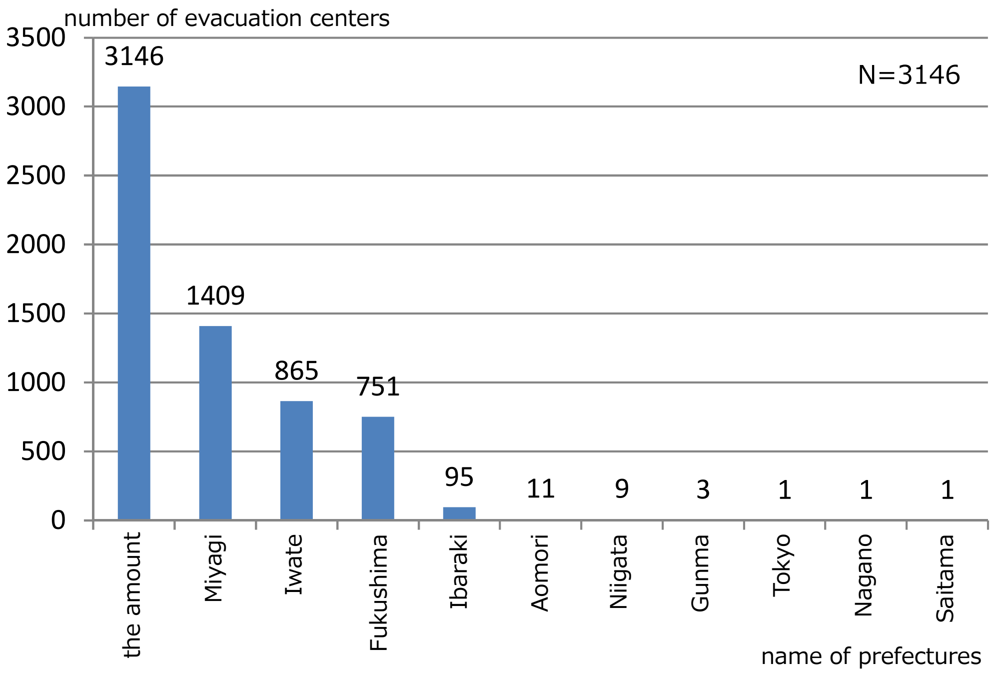

Figure 4. Number of evacuation centers by prefecture

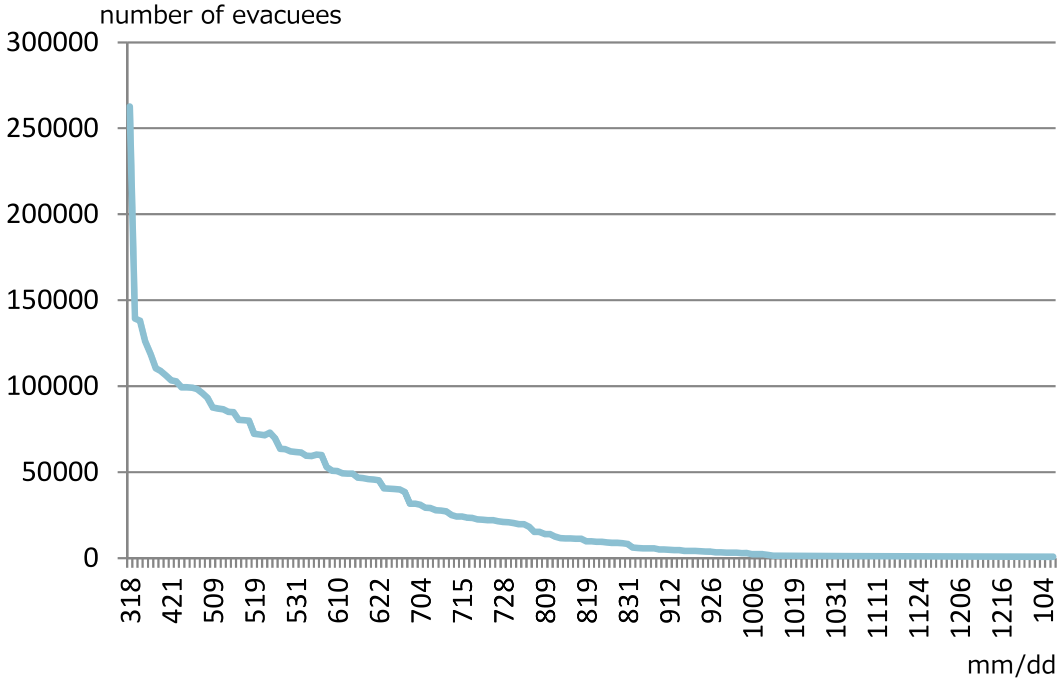

Figure 5. Chronological changes of number of evacuees

Discussion

The Great East Japan Earthquake hit wide over the prefectural boundaries, so the national government had to handle various pieces of information to allocate the limited resources; however, the scale of the disaster was large enough, confusion, lack of coordination and missed opportunities were all but inevitable. We implemented the Emergency Mapping Team Project in order to support the national activities and construct the common operational pictures among disaster responders. We accomplished certain results by collect the information from administrative information resource directly, and organized it by the geo-locational information in order to visualize it by the subjective maps, which actually helped decision-making process in the national level.

The Great East Japan Earthquake gave us the severe challenge to overcome. We still straggled to solve its problems in the reconstruction phase of the disaster process. We still need how to construct COP efficiently among organizations and agencies concerned. The place for us to go is that to the workflow of information analysis must be standardized and implemented in the certain way using the existing technology with the well-trained administrative officers. The function of the national training center should be needed to develop human resources, who can construct the task force to analyze the information and create the common operational pictures.

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