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Introduction of an approach to disaster mitigation using crisis-adaptive information sharing platform and technology

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Abstract

It is well known that a lack of information sharing led to the enlargement of earthquake damage in the Hyogo-ken Nambu earthquake of 1995 [1]. The Niigata-ken Chuetsu (the central Niigata prefecture) earthquake of October 23, 2004 and the Niigata and Fukushima heavy rainfall of October 2004, however, demonstrated that the lessons from past disasters had not been learnt, although the spread of the internet helped both collection and transmission of disaster information in various fields.

For the purpose of mitigating damages due to disasters, research on disaster mitigation using crisis-adaptive information sharing technology was commenced in 2004, as a joint project of 12 different organizations consisting of a government office and a government agency, national research institutes, universities, and private companies. The National Research Institute for Earth Science and Disaster Prevention (NIED) is in charge of leading the project, the development of disaster mitigating information sharing (DMIS) system, which plays an important role in the DMIS platform, and the investigation into information sharing in actual disaster mitigation activities conducted in local governments.

This paper introduces the outline of the project first, including the concept of the DMIS platform, which will be developed. Then, a few approaches conducted in the project last year by NIED are stated, including recent events of disaster in Japan.

Keywords: information sharing, platform, disaster mitigation, earthquake, heavy rainfall, joint project.

1 Introduction

A lot of earthquakes and typhoons attack Japan every year, since Japan is located on the Circum-Pacific seismic belt and is also located in the Asian monsoon district. In addition, the risk of man-made disaster is increasing. On behalf of mitigating damages due to such disasters, the joint project consisting of 12 different organizations was commenced last July as a three year program. In this project, information sharing technologies effective to disaster mitigation are developed. The disaster mitigating information is defined here as the visual and hearing information which is composed of not only damage information but geographical information, fundamental urban spatial data, damage estimation results, information on disaster mitigating countermeasures, etc., all of which are effective to disaster mitigation and reduction. The disaster mitigating information sharing platform (stated as the DMIS platform below in this paper), on which effective information is transmitted to and shared among the government, local governments, lifeline corporations, mass communications or local inhabitants. In addition, technologies collecting and transmitting information, estimating damage and evaluating the effect of disaster mitigating countermeasures are developed in this project. These technologies are integrated with the DMIS system through the DMIS platform. Figure 1 shows a schematic illustration of the DMIS platform, which will be developed in this project.

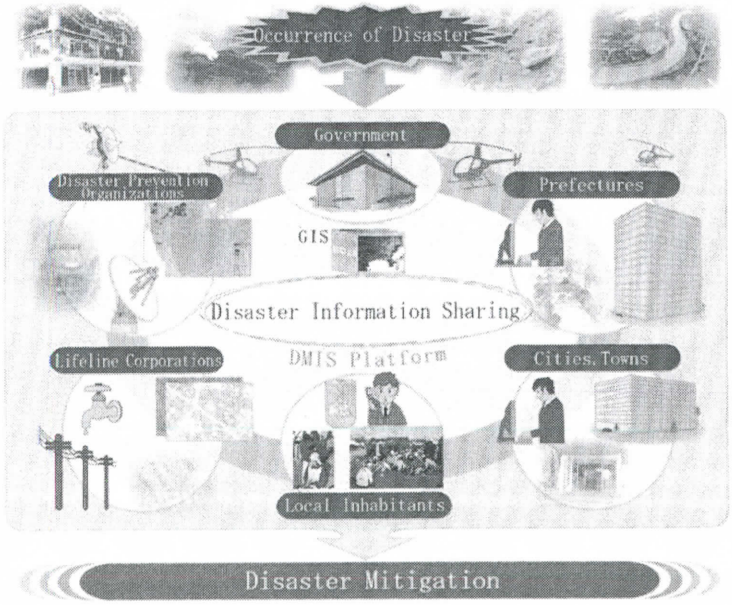

Figure 1: Schematic illustration of the DMIS platform.

2 Outline of the project

2.1 Development of the disaster information sharing platform

2.1.1 Development of the protocol for the disaster mitigating information sharing

In order to make information sharing effective in the head office of disaster countermeasures in the damaged local government, where disaster countermeasures to local inhabitants are directly carried out, the use of standard and common protocol as well as data formats is necessary in communicating with other organizations. In this program, the XML-based communication protocol adaptive to disaster information sharing is developed and methods to put it into practical use will be investigated and opened to the public.

2.1.2 Development of the information sharing system applied to local governments

In order to help local governments with quick and reliable responses of disaster countermeasures, the disaster mitigating information sharing (DMIS) system is developed in this program, functions and performances of which are designed, reflecting the examination of the following research programs. The system developed here mainly consists of the GIS processed in a time series.

2.2 Analysis and regulation on disaster information sharing rules

2.2.1 disaster information sharing in local governments

A local government shares disaster information with local inhabitants, lifeline corporations, disaster prevention organizations such as the police, the fire defense stations, the Self-Defense Forces, hospitals, the upper local government, etc., when a large disaster occurs. In this program, examinations are given on what kind of information items are required in what forms and in what accuracies during a disaster, in process of time. For that purpose, an interview or a questionnaire survey is applied to local government staff who have experienced disaster prevention activities in an actual disaster. Results of analyses and examinations obtained by the surveys are applied to a fundamental design of the DMIS (disaster mitigating information sharing) system developed in this project.

2.2.2 Disaster information sharing management

Surveys on activities during disasters are applied to people who have experienced disasters. A data base is made up, in which their activities are arranged in a time series. Based on the analysis based on the data base, the relationships between acquired data and activities and between accuracy of information and quality of activities are arranged at each event of disasters, each magnitude of disaster or an elapsed time from disaster's occurrence.

The reasonable combination of information in order for people to act the best response in terms of disaster countermeasures is examined and the result will be applied to the DMIS platform.

2.3 Development of spatial data preparation methods

An examination is given on spatial data which local governments possess in digital data and those which private companies have prepared and have sold. The data is summarized in terms of content, cost, precision, etc.

An examination is also given on a spatial data preparation method, taking locality and the damaged history due to disasters into consideration. The method enables an efficient processing of fundamental spatial data in the DMIS platform developed here.

The method is also applied to the actual proof test in which several tools and systems developed in this project are combined and applied experimentally to a few local governments and an availability of the systems will be verified.

2.4 Development of the system to collect disaster information by local inhabitants and to transmit disaster information to local inhabitants

Investigating the actual operating conditions of disaster information systems in local governments in Japan, problems existing in the present systems are extracted. Then, the effective way of information sharing between local inhabitants and an administrative organ will be examined.

The IT tools such as wearable PCs, GPS etc. and GIS are applied for the systems of disaster information collection and transmission which a wide range of users from an inhabitant through a specialist of disaster prevention can use. The development of the system is also carried out, by which disaster mitigating information collected by several information instruments are transmitted surely to the nearest head office of the fire defense or to the nearest head office of disaster countermeasures in the local government. In addition, the method to make disaster prevention information known to every local inhabitant is developed and the effectiveness of the method will be verified by field tests. In addition, the information sharing technology is developed, by which information collected by several information systems are shared through the DMIS platform.

2.5 Research on disaster mitigation countermeasures making efficient use of shared information

2.5.1 Development of the system supporting disaster prevention activities carried out by local inhabitants

The optimum operation simulator of regional fire fighting power is developed, extending the real time fire spread simulator of previous development in order to be able to evaluate the extinguishing power by local inhabitants. The simulations are conducted on the simultaneous occurring fire due to an earthquake etc., with the fundamental information obtained from the DMIS platform as input data. Then, the effect of an optimum allocation of fire fighting resource, consisting of the public fire fighting power and fire fighting resource by local inhabitants, is investigated.

2.5.2 Relief planning using the multi-agent simulation

Integrating the multi-agent simulation with the optimum supply simulation of the relief force, food and other relief goods, the new simulator which is able to estimate damage progress and to support relief planning during disasters will be developed in this program.

2.5.3 Optimum induction for evacuation of local inhabitants

The system is developed, by which the information to induce local inhabitants to evacuate, in consideration of the characteristics of evacuation activities in a local area or in a local core facility. This system obtains disaster information through the DMIS platform and carries out an evacuation simulation. Then, the information on the induction for evacuation is sent to a local area or to a local core facility through the DMIS platform.

2.5.4 Estimation of damage evolution on biological and chemical disaster

Receiving GIS data, meteorological data and social environment data through the DMIS platform, the diffusion simulation of poisonous substances is conducted in a short time. Then, the result is sent back to the DMIS platform and transmitted to the organization, which requested the simulation. In this program, damage evolution simulators and meteorological and diffusion estimation technologies are developed.

2.5.5 Information sharing with lifeline corporations

The examination is given on the information which lifeline corporations are able to supply and to request to acquire, by executing case studies in the past damaged earthquakes. Then, the effect of lifeline information sharing on disaster mitigation is investigated. Based on the results, the desirable method to make an effective use of the DMIS platform among lifeline corporations is investigated.

The test data base was constructed adopting the above desirable method, the information sharing experiment is carried out, connecting a prototype of the seismic disaster prevention information system (SUPREME) of Tokyo Gas Co. Ltd. with the DMIS platform. Then, subjects originated from both systems will be concretely extracted. A similar connection will enable information sharing between an electric company and the DMIS platform. Tokyo Electric Power Co., Ltd. also examines subjects existing peculiar to electric companies concerning disaster information sharing.

Government agencies and public corporations concerning road and road traffic management and telecommunication enterprises will join this project as lifeline corporations and the scope of research here will be enlarged.

3 Recent disasters and relating research activities

3.1 The Niigata-ken Chuetsu earthquake of October 23, 2004

The Niigata-ken Chuetsu earthquake of 2004 occurred in the central region of Niigata prefecture, Japan (Figure 2). The magnitude of the earthquake was M_J = 6.8 and 46 people died and 11000 houses were damaged due to this earthquake.

The damage investigation was conducted by each organization constituting this project individually in order to grasp the overall damage and damage mitigating activities at several head offices of disaster countermeasures in the damaged local governments. The actual condition concerning disaster information sharing in this earthquake was also investigated by a questionnaire and an interview to the staffs in the damaged local governments. The results obtained from the investigation will be applied to our development. A prototype of the DMIS system will be developed for a damaged local government in Niigata. Then, the effectiveness of the system will be evaluated by the local government staff who have experienced this earthquake.

Figure 2: Epicenters of earthquakes.

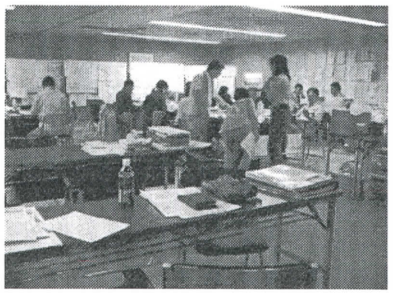

Photo 1: Nagaoka City, Niigata. (Head office of disaster countermeasures.)

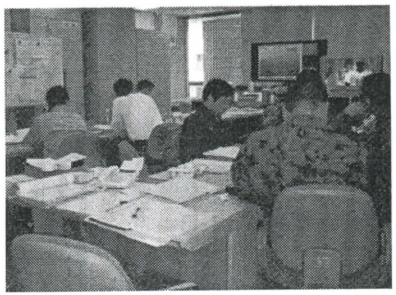

Photo 2: Fukuoka City, Fukuoka. (Head office of disaster countermeasures.)

3.2 The Fukuoka-ken Seiho-oki earthquake of March 20, 2005

The strong shaking attacked Fukuoka and Saga prefectures in Kyushu Island, Japan, where a seismic activity is low even in Japan. The magnitude of the earthquake was $M_J = 7.0$ and 1 person died and over 8000 houses were damaged due to this earthquake. Genkai-jima Island which is located west off Fukuoka City is strongly damaged. An interview to the head office of disaster countermeasures in Fukuoka City was conducted 1 week after the earthquake. A questionnaire and an interview survey will be carried out in details and the results will be reflected to our research.

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