Development of the Disaster Information System(DIS/Earthquakes)

by

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ABSTRACT

Utilizing the experiences of the Great Hanshin-Awaji Earthquake, the National Land Agency has been promoting the development of the Disaster Information System (DIS/Earthquakes) which uses the Geographic Information System (GIS). This system is expected to provide quick and appropriate decision making in all three phases, "preparation", "emergency measures" and "recovery/rehabilitation". Since April 1996, the National Land Agency has been operating the Early Estimation System (EES) which automatically estimates the scale of damage caused by an earthquake using the very limited information available immediately after an earthquake occurs. Currently, the agency is pursuing the development of an Emergency Measures Support System (EMS), which will consolidate and share information through the construction of an on-line network linked with other disaster-prevention organizations, and utilize such information in support of emergency measures such as rescue and medical care, emergency transportation, evacuation, lifelines, and volunteers..

Key Words : Disaster Prevention Information
Geographic Information System(GIS),
Early Estimation of Damage
Support of Emergency Measure

1 OVERALL CONCEPT AND STATUS OF DEVELOPMENT OF THE DIS

1.1 Background

The Great Hanshin-Awaji Earthquake, which occurred right under the city of Kobe on January 17, 1995, again showed the importance of rapid response activities by the national government, particularly the importance of estimating damage immediately after an earthquake.

If organizations concerned with disaster prevention have numerical map and geographical location data and a system that combines this data for quick and efficient application, they should be able to quickly determine the state of damage, and support rescue and recovery activities quickly and effectively.

The difficulty encountered in collecting appropriate information after the Great Hanshin-Awaji Earthquake reemphasized the importance of information. How to collect, put in order and analyze information efficiently have become major factors in recognizing the necessity of building a new system.

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The new basic plan of disaster prevention which was amended in July 1995 considers the importance of information in the following three stages: prevention, emergency measures and recovery/rehabilitation. It shall promote the construction of geographic information systems to support the realization of disaster-preventive measures.. It also states that the on-line database network shall be construct.

Based on this experience, the National Land Agency has been promoting preparation of a Disaster Information System by utilizing Geographic Information System (GIS) that manages information on topography, ground conditions, population, building stock, disaster response facilities, etc., connected to digital maps on a computer.

1.2 Overall concept

In order to develop the DIS, the National Land Agency is examining ways in which the Geographic Information System (GIS) is being used/utilized domestically and abroad in relation to disaster prevention. It has established committees and coordinating groups composed of academic experts on disaster prevention and systems development, and of persons from related agencies, incorporating the views of such groups into its development of the system.

As shown in Figure 1, the DIS focuses on three stages of an earthquake disaster. They are emergency period, recovery/rehabilitation period, and preparation period for the next disaster. This system is expected to effectively support quick and appropriate decision making by the organizations concerned.

The DIS includes plans for the preparation of a "Map and Disaster Prevention Information Data Base" containing map data and other information relating to government agencies, public facilities, roads, disaster prevention facilities, etc. Through a network, the system will tie in such information as post-earthquake damage, the status of emergency measures, and the state of reconstruction of public facilities, lifelines, etc. to digitalized maps on the computer.

As part of its effort to support post-disaster responses, the agency is also developing an Early Estimation System (EES), which aims to provide approximate estimates of the scale of damage in the immediate aftermath of a disaster, under conditions of limited information; and an Emergency Measures Support System (EMS), which aims to support a variety of emergency measures (details to follow).

As time passes, recovery/rehabilitation measures become more important, and here comes the Recovery/Rehabilitation Measures Support System, which provides information to support the establishment of recovery and rehabilitation plans at various levels, and to help manage their progress.

While the above deals with responses after a disaster, the agency is also considering utilizing its resources at the stage of "preparations for disaster." Such resources include its Map and Disaster Prevention

Information Data Base, which has accumulated over the course of developing the systems, and the know-how that the agency has developed in the past, including its methods of estimating earthquake damage.

By utilizing data bases that have been developed beforehand, the Earthquake Damage Estimation System estimates damage caused by hypothetical earthquakes, and, on the basis of such estimates, supports efforts to propose disaster-prevention and emergency-response measures. The Support System for the Improvement and Planning of Earthquake-related Disaster Prevention Facilities estimates the number of disaster prevention facilities needed, assists in the selection of possible sites, and forecasts the impact that such facilities would have, thus supporting the planning of appropriate earthquake-related disaster prevention facilities.

1.3 Status of development

The National Land Agency has been working on the development of such systems since fiscal 1995. For its Map and Disaster Prevention Information Data Base, it has developed digital maps on a scale of 1/25,000 and 1/2,500, and, as shown in Table 1, has prepared data linked to these maps on natural conditions, such as topography and geology, social conditions such as population, public works facilities, lifelines and disaster prevention facilities.

With regard to its comprehensive systems, the agency has been operating the EES since April 1996, and is currently pursuing the development of the EMS, which will create a network linking various disaster prevention-related agencies, and will consolidate, organize and analyze the information provided by such agencies in support of emergency measures.

2. THE EARLY ESTIMATION SYSTEM (EES)

2.1 The aims of EES development

The EES provides quick estimates of the approximate scale of damage caused by an earthquake under conditions of limited information immediately after the disaster. The system has been designed to provide information that will contribute to prompt and appropriate judgments relating to emergency measures.

In Japan, past records on earthquakes and earthquake damage are available, making it possible, to a certain extent, to organize a coherent picture of the relationship between earthquakes and the damage caused by them in different areas. By applying to such records analytical methods newly obtained in recent years, it has become possible to estimate injury and loss of human life resulting from buildings that are destroyed by earthquakes.

The EES is equipped with forecasting tools that utilize such know-how, as well as with a data base containing information on topography, ground conditions, buildings, population, etc. for the entire country. The system is also characterized by its ability to receive in real time data from seismographs installed in approximately 1200 locations around the country by both the Meteorological Agency and local governments, and to use such data on seismic intensity in its estimates. The EES is also connected to the Meteorological Agency's Comprehensive Observation System for Seismological Activity, which enables it to immediately use seismic data that has been collected by the Meteorological Agency. Based on this data, the system estimates the distribution of seismic intensity for each mesh (approximately 1 square km) in the country, and the damage to buildings and the casualties due to building damage (Figure 2).

2.2 Verification of estimates and results of system operation

In a simulated response to the Great Hanshin-Awaji Earthquake, the system produced estimates within roughly five minutes of its receipt of data from the Meteorological Agency. The system's estimate was that the earthquake destroyed approximately 100,000 buildings, and that damage resulted in casualties (deaths) to about 4,000 people. Thus, it was generally capable of assessing the scale of earthquake damage immediately after the disaster struck.

From the time the system went into operation in April 1996 through the end of March 1998, it has recorded 69 earthquakes with seismic intensities above 4, of which five have registered readings higher than 5. In the largest of these earthquakes, which occurred on May 13, 1997 in the Satsuma region of Kagoshima Prefecture, the system recorded a maximum seismic intensity of "weak 6," and estimated destruction to 832 buildings and resultant human casualties (deaths) of 15 (Figure 3). Although this exceeded the actually reported damage of 77 buildings totally or partially destroyed and one person seriously injured, it roughly expressed the scale of the largest earthquake disaster of the past two years. Because the system tends to estimate on the high side for earthquakes of this size, there is a need to consider making further improvements hereafter. However, when assessments of damage based on reports from the scene require time, the system permits a quick, albeit rough, grasp of the scale of damage caused by an earthquake, and in this way has contributed substantially to the material available for the government to make judgements on initial response activities.

Since September 1997, as a result of having added new forecasting categories, including the number of persons seriously injured, the number in critical condition, and the number evacuated, the system's information is being used by related agencies in preparing emergency response activities. Hereafter, the agency plans to encourage the use of the system for speedier launches of response activity, and as preliminary information for the EMS, which is now under development.

3. THE EMERGENCY MEASURES SUPPORT SYSTEM (EMS)

3.1 The aims of the EMS development

The EMS establishes a mechanism for organizing and sharing information through the GIS on damage sustained in a disaster and on the status of preparations and actions relating to various emergency measures. This is information that must be shared, and which the system provides by organizing information that is available from related agencies, and other information required for the adoption of emergency measures. The system constructs a data network that links related agencies through use of data processing and telecommunications methods.

Under the EMS, the agency will develop a system that takes such shared information and generates from it useful, value-added information that can be utilized in the formulation of emergency measures, ranging from rescue and medical care to emergency transportation, evacuation, lifelines, and volunteer-related activities.

3.2 The construction of networks linked with related agencies

By constructing an on-line network that ties the DIS to the various disaster-prevention information systems owned by related agencies, it will become possible to share data bases and to exchange information among related agencies. With ample consideration given to needs for safety during disasters, the agency will utilize the Central Disaster Prevention Radio Network as its means of telecommunications, a system being developed to link related agencies.

By overlapping onto digitalized maps information gathered from related agencies and previously established data bases of disaster prevention-related information, and, moreover, by organizing such information onto reports and providing it to related agencies as effective, added-value information aiding various emergency measures, the EMS fosters the following kinds of objectives and makes it possible for the government to execute prompt and appropriate emergency measures , together.(Figure 4):

- the sharing of various kinds of information;
- coordination with related agencies;
- greater efficiency in analyzing and organizing data.

3.3 Applications of the EMS

The EMS will be systematically developed with a focus on the following kinds of applications, which consolidate onto the GIS the information and knowledge that has been gathered regarding the emergency measures that will be required immediately after earthquakes.

* Support system for rescue and medical care

  To support the dispatching of rescue and emergency medical teams, the transporting of injured or sick persons outside the disaster area, and the transporting of medical supplies, etc.

* Support system for emergency transportation

  To support emergency transportation activity for food, water and other material.

* Support system for evacuation
To support evacuation measures, such as the appropriate accommodation of large numbers of evacuees during extensive disasters.

* Support system for lifelines
To support the utility industry and others in their efforts, so as to foster the effective and concentrated restoration of lifeline functions.

* Support system for volunteers
To support an efficient and appropriate deployment of volunteers.

These systems are being methodically developed, beginning with those for which mechanisms of information distribution etc. have been established.

4. FUTURE OUTLOOK

In this way, the DIS is being built through the methodical development of systems appropriate for each stage. To utilize the DIS even more effectively, however, there is a need to reinforce its ability to distribute information--to coordinate with related agencies and the media, to release public information to businesses, residents, etc.--and to dynamically introduce new technologies.

First, in terms of strengthening coordination with related agencies, there is the need to go beyond the establishment of mechanisms for the sharing of disaster prevention information during disasters, and to work toward increased coordination aimed at enhancing the sharing and maintenance of information during ordinary times as well. There is also the need to foster use of data bases in everyday operations and to use the system in training activity and in programs aimed at developing disaster-prevention specialists. Moreover, as a step toward closer coordination with local governments, the further sharing of data bases should be encouraged between such governments and the departments and bureaus possessing map information and data bases on houses etc.

By appropriately providing businesses, residents and others with information organized according to objectives of utilization, the effectiveness of disaster prevention measures is strengthened. Conversely, it would also be possible to consider a system of information gathering that utilizes the Internet and other means to collect such information from businesses and residents.

Among the new technologies that will be considered as a part of fostering more sophisticated uses of the DIS are those aimed at securing methods of data transmission, including the Central Disaster Prevention Radio Network, the telecommunications systems of other agencies, satellite telecommunications, the Internet, and so on.

Among the possible methods of gathering information from disaster areas is the utilization of remote sensing technology which would allow the assessment of scale of damage over wide areas and mobile terminals. Mobile terminals can also be utilized as a mechanism for providing appropriate information from the DIS to disaster sites.

To supplement the development of the GIS data base, efforts should be made to utilize the digital maps and disaster-prevention information that are being developed by the private sector, as well as satellite photography. In addition, to foster more sophisticated uses of the GIS, efforts to promote the utilization of car navigation technology should be considered.

Making the DIS easier to use is also an issue that needs to be dealt with hereafter, and in this regard efforts should be made to improve display methods through such means as adopting three-dimensional display technology, utilizing more versatile visualization technology, and so on. Also, it will be necessary to provide better methods of checking the system and the disaster prevention structure and of providing better ways of enhancing their utilization.

While always considering systematic and technological improvements, the agency will develop the DIS in stages, coordinating its efforts more and more closely with other agencies. The aim will be to develop a system that supports disaster prevention measures that utilize information in the most effective way possible.

Table 1 Map and disaster prevention facilities data base (1/2)

Data Item		Major Attribute
Basic Map	* Map of Prefecture Boundaries #	
	* Map of Administrative Districts and Coastlines #	
	* 1/2,500 vector map	
	* Town name and numbers	* Total population, households
Natural conditions	* Surface layer features (Mesh data) #	* Soil classification
Social conditions	* Population/Households #	* Name, family, etc.
	* Business Places #	* Office, employees
Earthquake	* Epicenter, scale in the past #	* date, scale, seismic intensity, etc.
Basement, etc.	* Active fault #	* Direction of displacement, activity, etc.
	* Dangerous sediment disaster area #	* Classification, degree of risk
	* Dangerous liquefaction area (Mesh data)	* Degree of risk
Buildings	* Multistoried buildings	* Name, address, number of floors, height, etc.
	* Underground markets, underground passageways	* Name, address, floor area, etc.
	* Special disaster prevention districts (petrochemicalcomplex, etc.)	* Name, supervisor, floor area, etc.
	* Facilities that stock hazardous items	* Number of stocked places
Public civil engineering facilities	* Roads #	* Road No., traffic lanes, width, etc.
	* Railways and stations #	* Type, name, Line No., etc.
	* Harbors #	* Supervisor, name, etc.
	* Quays	* Supervisor, available boat capacity alongside pier, etc.
	* Airports #	* Type, manager, runway length, etc.
	* Heliports #	* Type, name, area, etc.
	* Coastal maintenance facilities	* Type, length, height, etc.
Lifelines	* Electric power	* Supplying district, number of households, etc.
	* City gas	* Supplying district, number of households, etc.
	* Water supply	* Supplying district, number of users, etc.
	* Sewage water	* Processing district, population, etc.
	* Telephone	* Operating district, number of subscribers, etc.
	* Broadcasting station	* Name of broadcast station, address, etc.

Table 1 Map and disaster prevention facilities data base (2/2)

Data Item			Major Attribute
Disaster prevention facilities	* Police station	#	* Name, address, number of cars, etc.
	* Fire station	#	* Name, address, number of cars, etc.
	* Self-Defense Force facilities	#	* Name, address, number of cars, etc.
	* Maritime Safety Agency facilities	#	* Name, address, number of vessels, etc.
	* Hospitals	#	* Supervisor, name, number of beds, etc.
	* Hygienic facilities	#	* Name, address, manager, etc.
	* Office buildings for administrative organs	#	* Type, name, address, etc.
	* Designated institutions	#	* Name, address, telephone no., etc.
	* Schools	#	* Type, name, address, number of classes, etc.
	* Education facilities, etc.	#	* Type, name, address, supervisor, etc.
	* Public areas	#	* Name, address, area, manager, etc.
	* Wide-area shelters		* Name, total area, number of refugees, etc.
	* Refuge facilities		* District name, structure, number of persons to be admitted, etc.
	* Social welfare facilities	#	* Type, name, address, etc.
	* Roads for emergency transportation		* Name of route
	* Transportation base points for large regions		* Name, supervisor, space, etc.
	* Distribution facilities	#	* Type, name, space, etc.
	* Places reserved for emergency use		* Items stored, quantity, etc.
	* Temporary Heliports		* Name, address, size of take-off/landing space, etc.
	* Emergency water supply		* Number of places, name, capacity, etc.

Items indicated with a # have been developed as national numerical information and cover all of Japan.

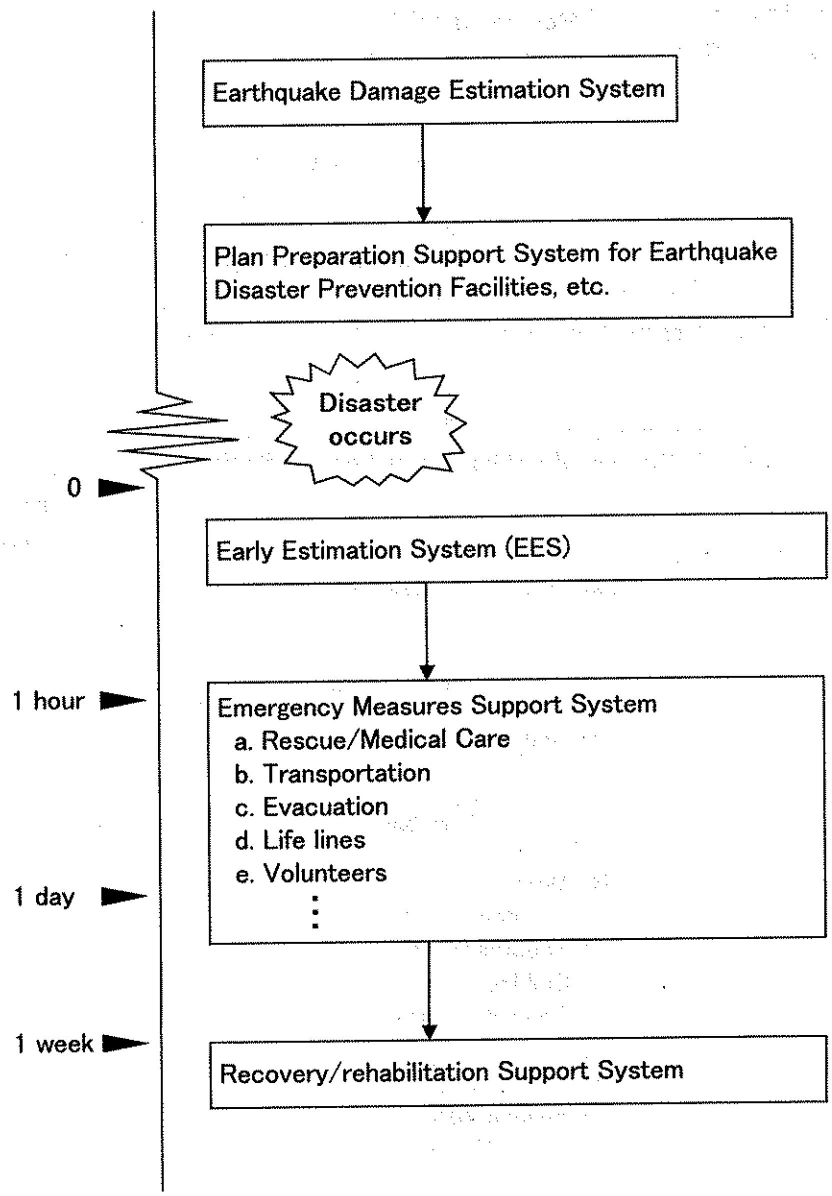

Figure 1 Composition of Disaster Information System (DIS /Earthquakes)

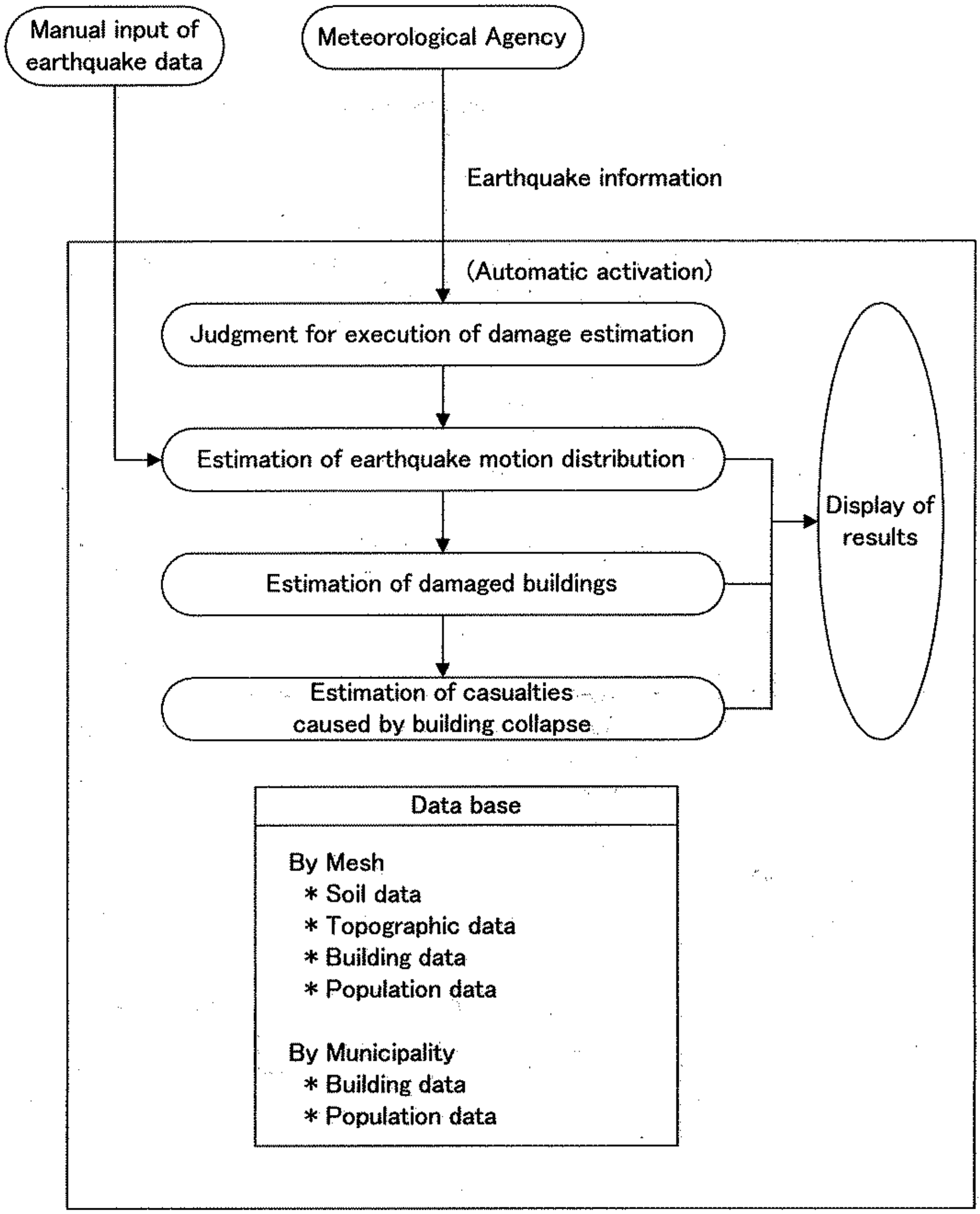

Figure 2 Flow of Earthquake Damage Estimation

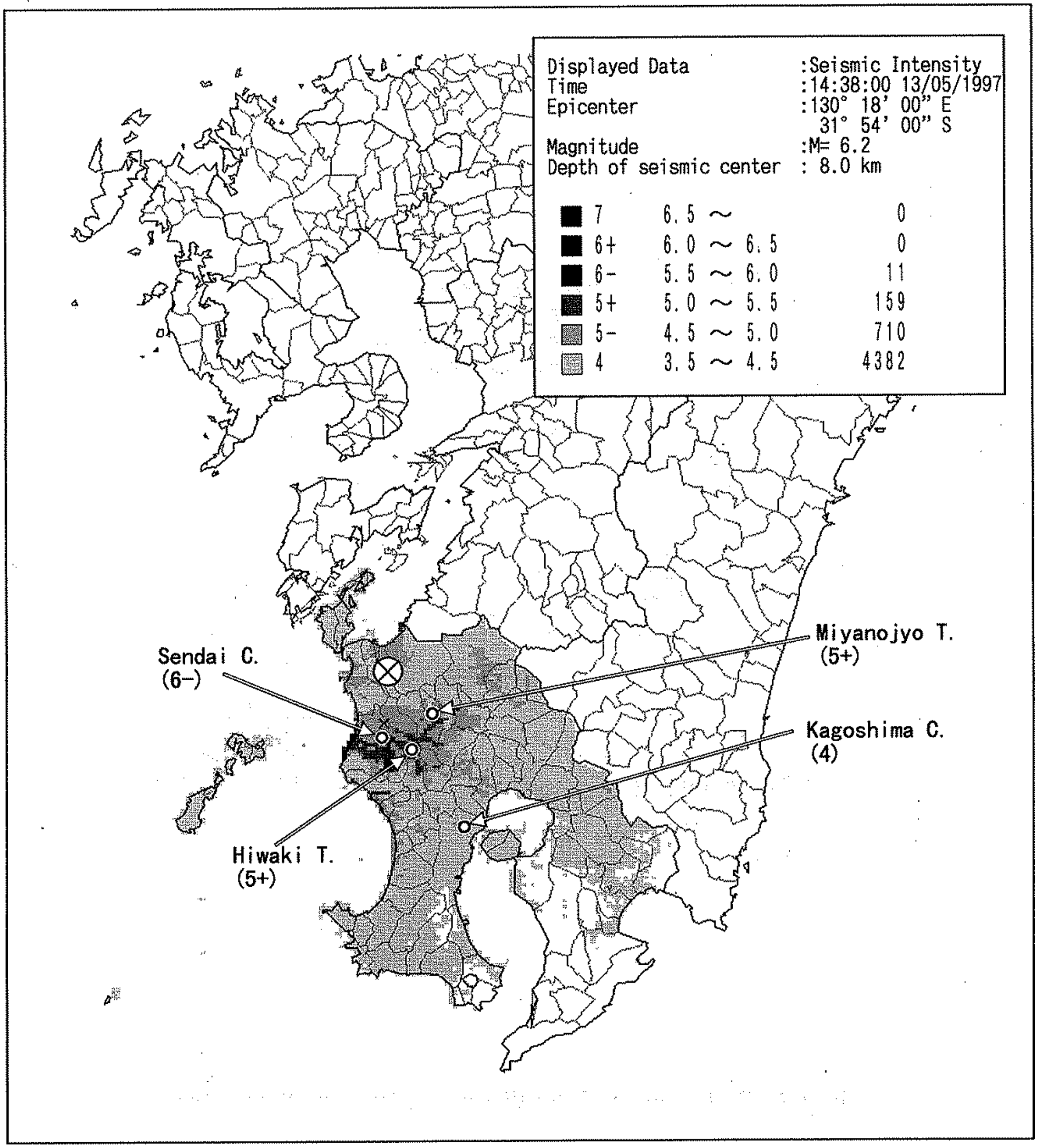

Figure 3 The estimated result of distribution of seismic intensities in the case of the earthquake in the Satsuma Region of Kagoshima Prefecture on May 13th, 1997

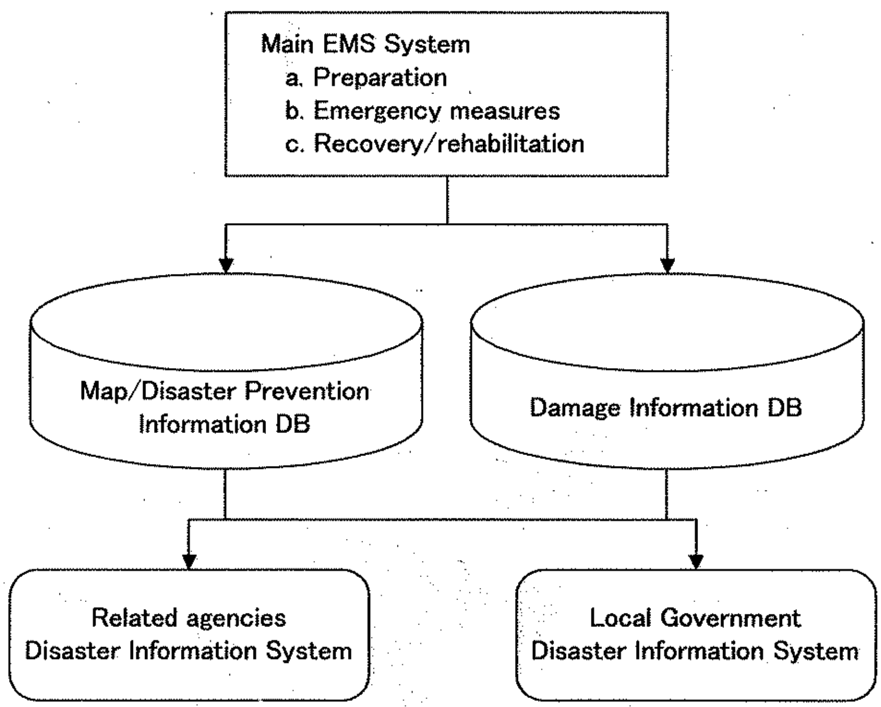

Figure 4 System Image of EMS (Emergency Measures Support System)

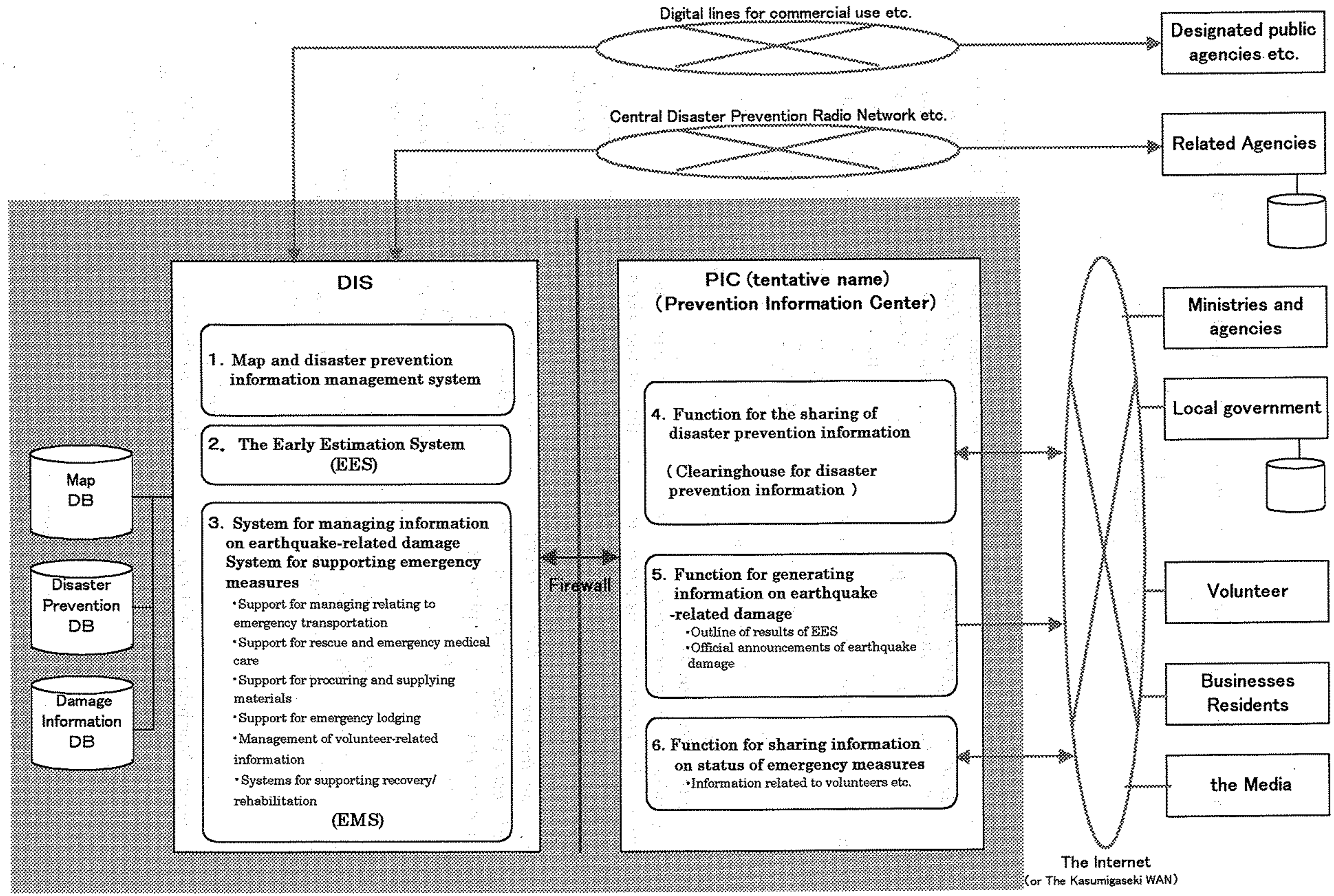

Figure.5 Future Image of the Disaster Information System (DIS/Earthquakes)