A STUDY ON THE CONSTRUCTION OF A DISTRIBUTED DATA-SHARING INVENTORY FOR ASSISTING DECISION-MAKING IN RESPONSE TO WATER DISASTERS

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ABSTRACT: The construction of a distributed data-sharing inventory for evaluating damage (including the importance, risk, and damage value) to waterfront structures and their surrounding SOC facilities was suggested in this study for effectively responding to water disasters. The spatiotemporal data converged with the disaster risk data, and SOC facility data must be used for prompt disaster response. These data, however, are distributed and managed by different government and related institutions, and there is no integrated data management or supply system. Therefore, the integrated management of these data and the estimation of the importance, risk, and damage value of facilities according to the disaster risk are required for swift disaster response.
An inventory-related module was developed in this study for collecting data from the database being managed by each institution, and to standardize the data, which are required in estimating the importance, risk, and damage value of SOC facilities. Also, an integrated inventory management module that manages and supplies the importance, risk, and damage value data of SOC facilities estimated based on the collected data was developed. The distributed data-sharing integrated inventory system for disaster response proposed in this study is expected to provide the data required for swift decision-making in response to disasters, and to be utilized for the maintenance of SOC facilities.

1. RESEARCH BACKGROUND AND OBJECTIVE

Global warming and the corresponding abnormal weather patterns have been increasing of late globally. This increases the atmospheric temperatures, causes sudden and rapid climate changes and heavy rains, among other abnormal elements, and thus triggers massive rainfall and flooding. These natural disasters bring about a series of human damage as well as SOC infrastructure damage, including that of bridges and railroads, thereby inflicting direct and indirect damage on the nation. Over the last ten years, 52 cases of serious natural-disaster damage occurred, killing or leaving missing 920,000 people, a severe human damage that could not be translated into any monetary value (Lee, 2013). In particular, the damage caused to riverside and waterside structures not only led to the loss of evacuation paths but also spread to areas inside and outside jetties, making the continuous monitoring of disaster damage imperative. To proactively respond to disasters, decisions should be made based on the integrated information combining disaster information, site situation information, SOC infrastructure information, and damage and safety information. The provision of national-level proactive measures is closely related to the safety of SOC infrastructures, and decision-making, including such provision, makes it possible to offer high-accuracy response measures for the people. This can thus reduce the disaster damage, including the human and socioeconomic damage (Jo et al., 2014; Jo et al., 2014; Gang et al., 2014).
To continuously monitor the safety and damage situation of SOC facilities, an inventory must be constructed that would integrate all the disaster-related data and SOC facilities information distributed in all the departments of the central government and the related agencies of the local governments. Furthermore, the inventory must be able to continuously collect data and disseminate information as the basic data for creating the required information, such as the importance, risk, and damage value of SOC facilities, by constructing an integrated management system for the collected disaster data. Besides, conversion to the space data required in the right position, and data reclassification by use and purpose, will enable support for disaster prevention operations and for the provision of public services by facilitating efficient decision-making to quickly respond to disasters.
This study was conducted to build an integrated inventory management system based on the inventory management

and design of connected modules that would continuously collect and standardize information related to disasters and SOC facilities that are being collected and managed separately by each relevant agency, optimize the information in accordance with the purpose of the facilities (e.g., the importance, risk, and damage value), provide the information to the users upon their request, and enable information update and reclassification as needed.

2. RESEARCH SCOPE AND DESCRIPTION

The data items were classified and selected by purpose to collect the data by purpose so as to support disaster response decision-making based on the importance, risk, and damage value of facilities. The importance criteria of facilities must be reviewed and analyzed to evaluate the importance of facilities during a disaster. To do this, the facilities that can be managed and those that provide a relatively high public benefit were selected as target facilities, based on the Special Act on the Safety Control of Public Structures and the Framework Act on the Management of Disasters and Safety. First, the facilities were classified largely into SOC facilities, energy/industrial facilities, and construction facilities, and then they were subdivided as follows. The SOC facilities were subdivided into bridges, tunnels, dams, river facilities, water supply and drainage facilities, and communication/broadcasting facilities. The energy/industry facilities were subdivided into power generation/electric power facilities, power transmission and transformation facilities, and major industrial facilities. Lastly, the construction facilities were subdivided into apartment houses, multiuse facilities, retaining walls, and cut slopes (Table 1). The risk of facilities was evaluated in three steps. In the first step, the probability based on the Bayesian network was analyzed. In the second step, the structural and functional risks were analyzed to evaluate the risk of facilities. In the third step, the EAP decision was made according to the risk of each facility. For the inventory proposed in this study, the flood scenario information and external force information (water level, pressure, etc.), which are required for probability analysis, were constructed. In the second step, the probability of failure for each flood scenario, the size of the failure (by part and section), real-time monitoring information, and the status of the facilities, which are required for risk analysis, were provided. The data calculated in each step are collected to support disaster response decision-making (Table 2). For the evaluation of the damage value of facilities, the domestic-space DB and the general statistics DB were considered in general according to the damage value calculation process of the multidimensional method (Table 3).

Table 1. DB Items Required for Facility Importance Estimation

Classification		Importance		
		1st	2nd	3rd
SOC facility	Bridge	Traffic	Detour facility	Safety rating
	Tunnel	Traffic	Detour facility	Safety rating
	Stream	Pump station	Street use	Benefit
Energy/industry facility	Power	Power type	Location	Safety rating
	Industry facility	Facility type	No. of employees	Yearly sales
Construction facility	Public housing	No. of residents (households)	Construction life span	Safety rating
	Multi-use facility	Facility use	No. of users	Safety rating

Table 2. DB Items Required for Facility Risk Estimation

Classification	Attribute	Contents
1	Address	Location information
2	Street name address	Location information
3	PNU code	Location information
4	Coordinate (X)	Location information
5	Coordinate (Y)	Location information
6	Altitude	Height of facility

Table 3. DB Items Required for Facility Damage Estimation

Classification	Attribute	Contents
1	Address	Location information
2	Street name address	Location information
3	PNU code	Location information
4	Building use (RAW)	Building use raw data
5	Building use	Building use reclassification
6	Building structure (RAW)	Building use raw data
7	Building structure	Building use reclassification
8	Gross area	Building gross area (floor area)
9	Ground floors	Building ground floors
10	Approval date	Building use period
11	No. of households	No. of households in a building
12	Industry classification	7th industry classification/reclassification
13	No. of employees	No. of employees in a building

3. INVENTORY DEVELOPMENT FOR THE CALCULATION OF THE IMPORTANCE, RISK, AND DAMAGE VALUE

To support disaster response decision-making, data items were constructed and standardized for each goal that was selected to support disaster response decision-making, and these were transformed into space information (Fig. 1).

Table 4. Facility Importance DB Construction for TB Areas

Facility	Street Name Address	PNU Code	Coordinate (X)	Coordinate (Y)	Importance		
					1st	2nd	3rd
Daecheon 119 Safety Center	129 Dalseo-daero, 58-gil, Dalseo-gu, Daegu	2729011900105970008	128.5067495	35.8249681	Industrial area	Type 1 neighborhood facility	
Seongseo Hospital	1152 Dalgubeol-daero, Dalseo-gu, Daegu	2729010700112720009	128.49321	35.8510383	Commercial area	Medical facility	
Hosan High School	86 Dalseo-daero, 109-gil, Dalseo-gu, Daegu	2729012500103570059	128.4821625	35.8490036	Residential area	Education & research facility	
HRD Korea	213 Seongseogongdan-ro, Dalseo-gu, Daegu	2729010600109710005	128.5060735	35.8360193	Industrial area	Education & research facility	
Gura2gyo			128.4926859	35.8180259	38321.000	1 place (Daecheongyo)	B grade
Daecheongyo			128.5034644	35.8178752		2 places (Wolseonggyo & Wolamgyo)	
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Daemyeongje					Wolseong pump station	Bicycle road	Park (Gateball field)

Table 5. Facility Risk DB Construction for TB Areas

Facility	Address	Risk			
		Altitude	PNU Code	Coordinate (X)	Coordinate (Y)
Daecheon 119 Safety Center	597-8 Daecheong-dong, Dalseo-gu, Daegu	20.91	2729011900105970008	128.5067495	35.8249681
Seongseo Hospital	1272-9 Sindang-dong, Dalseo-gu, Daegu	21.18	2729010700112720009	128.49321	35.8510383
Hosan High School	357-59 Hosan-dong, Dalseo-gu, Daegu	23.67	2729012500103570059	128.4821625	35.8490036
HRD Korea	971-5 Galsan-dong, Dalseo-gu, Daegu	30.35	2729010600109710005	128.5060735	35.8360193
Korea District Heating Corp.	895 Daecheon-dong, Dalseo-gu, Daege	21.09	2729011900108950000	128.4895504	35.8313901

Dongyang Composition Co., Ltd.	742 Daecheon-dong, Dalseo-gu, Daegu	21.750	2729011900107420000	128.5052287	35.820153
. . .	. . .	. . .	. . .	. . .	. . .
Samunjingyo (Goryeong direction)	Dasan-myeon, Goryeong-gun, Gyeongsangbuk-do	29.14		128.4752005	35.8117051

Table 6. Facility Damage DB Construction for TB Areas

Facility	Name Street Address	PNU Code	Coordinate (X)	Coordinate (Y)	Damage													
					Building Use (RAW)	Building Use Code	Building Structure (RAW)	Building Structure Reclassification	Building Structure Code	Gross Area	Ground Floors	Underground Floors	Total Floors	Approval Date	Industry	No. of Employees	Completion	No. of households
Daecheon 119 Safety Center	129, Dalseo-daero 58-gil, Dalseo-gu, Daegu	2729011900105970008	128.5067495	35.8249681	Type 1 neighborhood facility	COM1	Reinforced concrete			433.8	2			1995	Neighborhood facility			
Seongseo Hospital	1152, Dalgubeol-daero, Dalseo-gu, Daegu	2729010700112720009	128.4932100	35.8510383	Medical facility	MED1	Reinforced concrete			3907.11	7			1998	Medical facility			
Hosan High School	86, Dalseo-daero 109-gil, Dalseo-gu, Daegu	2729012500103570059	128.4821625	35.8490036	Education & research facility	EDU1	Reinforced concrete			13041.02	5			2009	Education & research facility			
Daegu Facility Safety Management Office	58, Seongseogongdan-ro, Dalseo-gu, Daegu	2729011900108910000	128.4889423	35.8338552	Work facility	GOV1	Reinforced concrete			7861.37	3			1996	Public work facility			
Seongseo Woobang Ushell Apartment	995, Dalgubeol-daero, Dalseo-gu, Daegu	2729010400100240000	128.4754592	35.8538413	Public housing	RES2	Reinforced concrete	Reinforced concrete	CON	13033.7731	15	2	17	20071030			2007	118

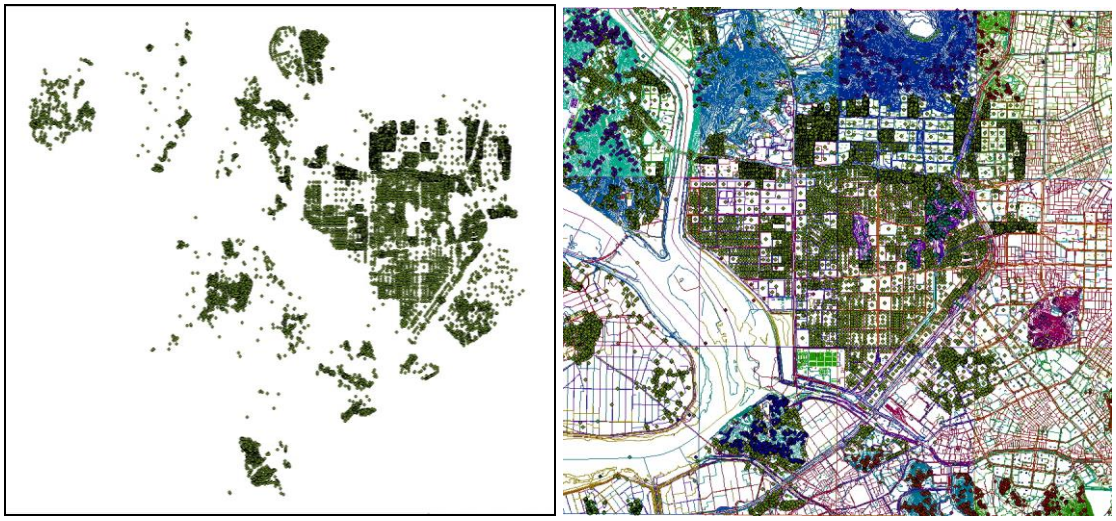

Figure 1. Space information for the facilities in the TB region.

4. CONCLUSION

This paper proposes an inventory development method for calculating the importance, risk, and damage value of facilities to support disaster response decision-making. For this purpose, the domestically available databases were analyzed based on the importance and risk of DIMSuS and HAZUS-MH. Information for evaluating facilities is essential to quickly respond to disasters and accidents. An inventory system was constructed for this distributed information so that the information could be collected, updated, reclassified, and quickly supplied to the users through the inventory management/connection modules. In the future, a hub-type integrated inventory system will be developed considering the scalability, standardization, and connectivity of the system.

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