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A STUDY ON THE PROCESS FOR DISASTER RECOVERY IN CITIES

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SUMMARY

The purpose of this paper is to identify urban conditions expedient to quick recovery. First, the main conditions required for recovery are examined and arranged. Next, on the basis of this arrangement, past major earthquakes and great fires are considered to clear requirements needed for restoration and reconstruction. Finally, this paper, spotlighting Osaka City, examines whether the requirements are met. As a result of this investigation, it is clear that man-power and space for recovery are lacking in Japanese big cities.

INTRODUCTION AND OBJECTIVES

The set-up of targets for or the evaluation of actions against urban disaster prevention necessarily requires the viewpoint that "the total amount of possible damages must be minimized". The damages mentioned above include not only direct ones but also indirect ones, whose reduction is an important issue for urban disaster prevention. The total amount of damages or the amount of indirect damages is related closely to the process of recovery from disasters. This paper, noting and considering the recovery process, aims at identifying conditions for reducing the total amount of urban damages.

RESTORATIVE FUNCTIONS AND BACKGROUND

1) Restorative functions: The restorative functions are broken down by the strength and contents of actions taken to objects into (i) emergency functions, (ii) rehabilitative functions, and (iii) developmental functions. As stated later, the emergency functions act in an emergency step, the rehabilitative functions in a recovery step, and the developmental functions in a reconstruction step. The emergency function encourages emergency activity through facilities and resources reserved or ready for temporary application. The rehabilitative function repairs failed or damaged portions to recover facilities and systems. The developmental function enhances urban properties (including disaster prevention ones) through developing and rebuilding cities, and is indispensable for reconstruction.

2) Restorative background: It is the restorative background that provides the city with restorative functions. Table 1 outlines the contents of the restorative background.

Table 1 Restorative Functions and Background (Only main contents)

Restorative Background \ Restorative Functions	Emergency Function	Rehabilitative Function	Developmental Function
Man-power Background	—Autonomous disaster prevention organization —Public disaster prevention organization	—Aid groups —Volunteers —Technicians —Semi-experts —Mutual aid	—Technicians —Experts
Physical Background	—Stored material —Relief goods —Relief Fund	—Materials for recovery —Facilities for recovery —Recovery fund	—Reconstruction materials —Reconstruction fund
Spacial Background	—Space and routes for emergency activity —Refuges and temporary evacuation shelters —Site for waste debris	—Site for recovery —Site for waste debris disposal —Site for temporary dwellings	—Site for reconstruction —Site for permanent houses
Systematic Background	—Back-up system —Blocking system	—Network system —Community system —Transportation system	—Strategic system —Coordinate system —Community system
Informational Background	—Info. transmission network —Emergency broadcasting	—Recovery procedure —Planning info. —Technical info.	—Reconstruction program —Planning info. —Technical info.

Table 2 Outlined Contents of Disasters

Disasters	Date of occurence	Killed	Total Number of Destroyed building	Area Burnt Down (km²)
Kanto Great EQ.	1923. 9/1	142, 807	701, 627	35.96
Fukui EQ.	1948. 6/28	3, 895	50, 560	2.16
Niigata EQ.	1964. 6/16	26	8, 427	2.06
Miyagi-Ken Oki EQ.	1978. 6/12	27	7, 573	—
Nihonkai-Chubu EQ.	1983. 5/26	104	5, 089	—
Tottori Great Fire	1952. 4/17	3	7, 240	1.61
Sakata Great Fire	1976. 10/29	1	1, 774	0.23

EXAMINATION OF RECOVERY PROCESS OF TYPICAL DISASTER

1) Selection of typical disasters: Taking into account the sizes of damages and easy access to their data, the sample disasters shown in Table 2 have been selected for case studies. For each one, reports of its investigation and the history of restoration have been referenced wherever possible for examination.

2) Debris disposal: The Sakata Great Fire and the Miyagi-Ken Oki Earthquake(EQ.) produced 70,000 m^3 of debris and 60,000 m^3 of debris, respectively, which debris were disposed at rivers and reclaimed grounds as an emergency response.

For each case, an emergency response took a week. The data obtained during the phase of the short time recovery stated that the Sakata Great Fire and the Miyagi-Ken Oki EQ. had produced 17 m^3 of debris and 14 m^3 of debris per destroyed house, respectively.

Also, for the other disasters, nearly similar data has been obtained, indicating that 10 to 20 m^3 of debris were produced per completely destroyed house during short time recovery.

During recovery and reconstruction after the Sakata Great Fire, some 5 m^3 of debris were produced for the wooden house and some 900 m^3 of debris for the building not made of wood. Less debris were produced for the combustible house than non-combustible one, because more things had been burned away for the former.

3) Accommodation of evacuees and supply of houses: In the phase of emergency response, many people are obliged to live at evacuation shelters. In many cases, public buildings such as public halls and schools are used as shelters. If such places could not be secured as in the Great EQ. of 1923, many people must live in camps. (about 10,000 people in the case of the Great EQ. of 1923)

Emergency refuge is terminated in several days to two weeks. After this period, evacuees enter temporary dwellings or houses of their acquaintances and relatives, or move outside the disaster area. After the Great EQ. of 1923, 30 percent of the evacuees entered their acquaintances' houses and 50 percent moved outside. After the Sakata Great Fire, some 70 percent of the sufferers entered their acquaintances' houses or moved outside. In the territorial society, its community system provides such solution.

Next, in the phase of middle term response, it is a great problem to furnish temporary dwellings. As shown in Table 3, in many cases, the number of

Table 3 Public Response on Housing Supply in case of Towns below

Cities or Areas (Disasters)	A) Number of Completely Damaged House*	B) Temporary Dwellings Built		N of Public Restorative houses
		Number (B÷A)	start work	
Tokyo Metropolice—Kanto EQ.	370,000	23,000 (6.2%)	3 days after	utdoor tent
Fukui City —Fukui EQ.	14,339	1,107 (7.7%)	2 days after	250
Niigata City —Niigata EQ.	2,238	636 (28.4%)	—	
Sendai City—Miyagi-Ken Oki EQ.	715	70 (9.8%)	9 days after	
All Area — Nihonkai-Chubu EQ.	1,579	249 (15.8%)	—	
Tottori City —Tottori Fire	5,228	920 (17.6%)	—	1,566
Sakata City —Sakata Fire	968	198 (20.5%)	2 days after	192

* except partially damaged houses and non-dwelling buildings

temporary dwellings built is about 10 to 30 percent of the number of houses completely destroyed or burnt down. The building of temporary dwellings depends upon the supply of sites and the amount of building materials. If sites have not been secured at convenient places as in the Nihon-Kai Chubu EQ. the problem occurs that few sufferers want to enter temporary dwellings that have been built with much effort by goverment. After the Great EQ. of 1923, great parks used as sites for temporary dwellings and, after the Sakata Great Fire, the yards of elementary schools as such sites.

After the Miyagi-Ken Oki EQ., few temporary dwellings were built. This would be because there were many vacant houses that could be used as first-aid houses; sufferers were given priority for entering public houses. Thus, the amount of vacant houses is a significant parameter for restorative power.

4) Recovery of life lines: Table 4 shows the incidence of sufferings (ratio of the number of damaged houses) and the number of days more than 80 percent of the damaged houses took for their recovery. Recent disasters show that the recovery of electric power service takes several days and that of waterworks and gas service take several weeks. In general, electric power service and telephone lines are recovered faster than waterworks and gas supply.

After Fukui EQ., a total of 1800 engineers (man-days) came. The recovery of life lines indispensably needs man-power support from outside the disaster area nearby for the recovery of waterworks and a total of 4500 engineers (man-days) was mobilized for the recovery telephone lines.

Also, after Miyagi-Ken Oki EQ., many engineers were sent from Tokyo to recovery gas supply.

Table 4 Life-Lines Interrupted Ratio and the Recovery Term in EQ.

Life-Lines	Kanto Great EQ. (1923)	Fukui EQ. (1948)	Niigata EQ. (1964)	Miyagi-Ken Oki EQ. (1978)	Nihonkai-Chubu EQ. (1983)
−Electric Power	unkown 3~4 months	100 (%) 2 months	83 (%) 3~4 days	99 (%) 3~4 days	unkown 1 day
−Water Supply	70 (%) 1 month	90 (%) 6 months	70 (%) 3 months	4 (%) 3 months	83 (%) 2 week
−Gas Service	57 (%) 1~2 yrs.	unkown 6 months	87 (%) 4 months	unkown 3 weeks	unkown 3 week
−Tele-Comunication	unkown 1~2 yrs.	100 (%) 5 months	91 (%) 2 weeks	1 (%) 3 days	unkown 1 day

Note: (Life-Lines Interrupted Ratio) = (Houses in Trouble) ÷ (Total Houses of the Area)

RESTORATIVE BACKGROUND IN OSAKA CITY

On the basis of the above analysis, this Section discusses whether or not Osaka City meet full spatial and human requirements for recovery and reconstruction.

1) Damage level of earthquake: Assuming that an earthquake with a magnitude of 8.0 occurs off the coast of the Kii Peninsula in winter during dinner-time, has prepared a disaster prevention plan. In that case, it is predicted that damages of the level 3 shown in Table 5 are caused. Our investigation has set damages of five levels including the level 3 shown in Table 5 for the examination of recovery conditions. The level 1 is associated with the case that no fire results from the earthquake and the level 2 with fires result from the earthquake only locally.

Table 5 Imagined Damage Level of Earthquake for Simulation

Degree of Damage	Level I	Level II	Level III	Level IV	Level V
−Buildings Completely Destroyed or Burnt down	9,851 (2.3%)	34,720 (8.2%)	59,58 (14.1%)	Twice of Level III	Three Times of Level III
−Buildings Partially Destroyed	24,538 (5.8%)	31,744 (7.4%)	39,098 (9.2%)		
−N of Persons Rendered Homeless	49,067	160,531	271,987		

( ) :Damaged buildings Rate to all buildings in Osaka City

2) Spatial requirements: In this Sub-section, we discuss whether spatial requirements for waste debris and temporary dwellings construction are enough to quick recovery in Osaka city.

a) Sites for waste debris disposal Using data of the Sakata Great Fire, it was simulated how wide spatial demands would be necessary in case of both short time recovery and long time recovery, respectively. Figure 1 shows results of this study. In the phase of emergency response for debris, damages of up to level 4 can be covered by utilizing public grounds in Osaka city. For computing the needed size, it was assumed that waste are stacked to a height of 3 meters and 50 percent of the sites can be utilized.

b) Sites for building temporary dwellings Our computation is based on the assumption that the sufferers select houses one to two months after the occurrence of the earthquake as shown in Table 6.

Table 6 Where to Live after Evacuation ? (based on a questionnare to citizens)

− Staying at Evacuation Shelter	12.1 %	−To Vacant Apartments	15.0 %
− To Private Temporary Dwellings	16.3 %	−Outside the Disaster Area	14.4 %
− To Acquaintances or Relatives	31.6 %	−Others	10.6 %

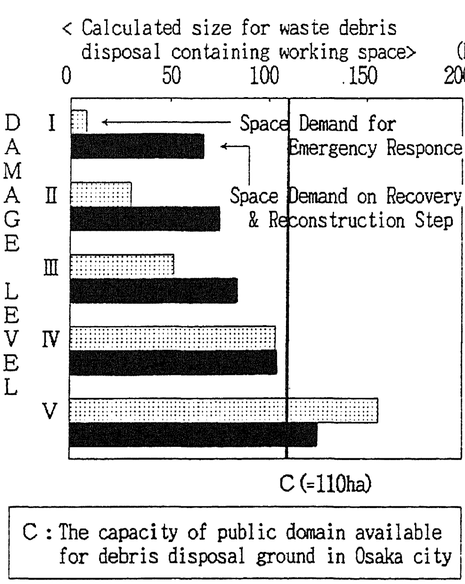

Fig. 1 Simulation of Required Size for Debris Disposal after a Disaster in Osaka City (Effective use rate of ground= 50%)

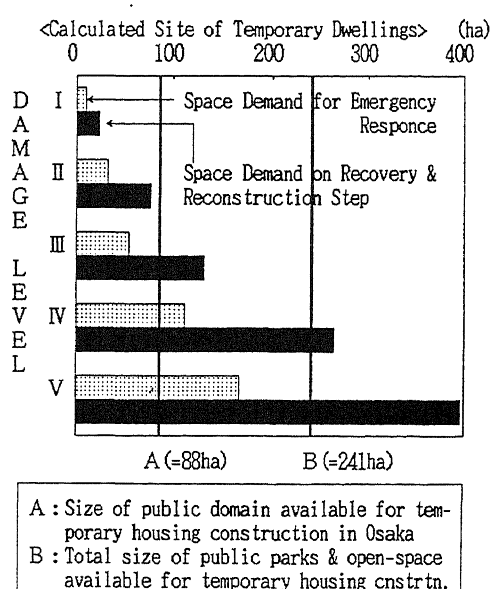

Fig.2 Simulation of Required Size for Temporary Dwellings Construction in Osaka City

In our examination, the facilities for use in the accommodation of the sufferers are refuges (including schools and gyms) plus temporary dwellings. Figure 2 show results. In our computation, it was assumed that the building of a temporary dwelling requires a site of $46m^2$. For 30 percent of the sufferers including those who want to live in temporary dwellings, only damages of up to level 2 can be covered.

3) Human requirements: Discussed here are general volunteers and experts.

a) General volunteers Data of Niigata EQ. tells that up to 0.25 volunteers are required per house completely destroyed. According to this data, damages of the level 3 require 15,000 to 20,000 volunteers per day. Since, in current days, the spirit of mutual support lacks, such many volunteers may not be secured.

b) Experts Expert staff members are needed to measure the damages of houses. Assuming that, during rough investigation right after the earthquake, 30 houses are investigated by a pair of experts in two days, the number of experts needed is as shown in Table 7. Assuming that, during detailed investigation for recovery, 15 houses are investigated by a pair experts in 30 days, the number of experts needed is as shown in Table 7. These requirements cannot be covered by 540 city staff members; their achievement requires support by architects and others.

The next problem is number of administrative staff members responsible for land readjustment. If, as in the Sakata Great Fire, one administrative member treat of an area of 2 ha, damages of level 2 and level 3 require 300 and 600 administrative staff members, respectively. Osaka City has no more than 317 administrative staff members for readjustment.

Table 7 Required Man-power for Diagnosis of Damaged Buildings

		Level I	Level II	Level III	NOTES
Number of Buildings need to be Diagnosed		24,538	31,744	39,098	
Number of Technical Diagnosticians	– For Check-List Diagnosis in an emergency[1]	1,636	2,116	2,607	during 2 days
	– For Intensive Diagnosis[2]	3,272	4,233	5,213	during 30 days

NOTES: 1) It takes 2 days to diagnose 30 buildings by a pair of staffs
2) It takes 30 days to diagnose 15 buildings by the same pair

CONCLUSIONS

1) It is very important to simulate emergency actions to be taken and the recovery and reconstruction process after the possible occurrence of a great earthquake to clear what is needed for recovery and reconstruction.

2) What most lacks among the requirements for recovery and reconstruction in great cities in Japan is man power. Thus, volunteer and support organizations must be cultivated.

3) Spatial requirements for recovery and reconstruction are not met fully. Free grounds such as parks must be secured.

NOTE

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