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Urban Diagnosis: A Methodology of Integrated Disaster Risk Management

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Synopsis

This paper gives an outline of the research outcomes obtained in the fiscal year 2006 by the COE Research Group of Integrated Disaster Risk Management. The primary objective of our entire research activities is to develop and extend a methodology of "urban (regional) diagnosis" for integrated disaster risk management (IDRiM). There are four research focuses, Disaster Risk Management (Disaster risk governance and participatory disaster risk management), Safety control of urban space, Social group conflict analysis, and Social systems for disaster risk reduction and risk sharing. With our related research focuses positioned by a proposed 5-storied pagoda model, their primary results are discussed.

Keywords: integrated disaster risk management, urban diagnosis, disaster risk governance, participatory disaster risk management, safety control of urban space and socio and eco risk management, social systems for risk reduction and risk sharing.

1. Introduction

Our entire group consists of the following four laboratories which used to come under the Division of Integrated Management for Disaster Risk (IMDR) until the beginning of fiscal year 2005 as a result of DPRI's reorganization. They are: Disaster Risk Management (focusing on disaster risk governance and participatory disaster risk management), Safety Control of Urban Space (Clarification of Structural Mechanism of Traditional Wood Frames, and Development of Structural Health Monitoring System and Reliability of Uncertain Structures),Water Resources Systems Planning (Social Group Conflict Analysis), and Social Systems for Disaster Risk Reduction and Risk Sharing (Development of a Method to Estimate Economic Losses in Industry, Ambiguity, Risk and Earthquake Insurance Premiums, Flood Risk Communication Support Tool for Making Participant Original Hazard Map). For us to collaboratively work on the 21 century's DPRI-COE Research Project, we have developed a methodological framework for integrated disaster risk management, that is called "urban (or regional) diagnosis". (When we mean to include rural areas, local communities or area-wide regions, "regional diagnosis" is better used.) In the following the term "urban diagnosis" is used to mean also "regional diagnosis".

2. Urban diagnosis

According to Okada (for instance, 2006) Urban Disaster Diagnosis (UDD) is proposed as a methodology

- to overall assess the spatial risks of urban, regional and community areas under disaster threats.
- to serve as a scientific framework to make a holistic diagnosis of the current status (status-quo) of safety and security of the urban space focused
- to prescribe prospective countermeasures to enhance their quality.

UDD needs to be developed in analogy with physiological risk assessment

UDD also provides us with a methodological framework for developing and positioning a set of tools such as:

- monitoring and measuring techniques
- fragility curves, risk curves

- vulnerability assessment, damage and loss estimation
- economic evaluation of possible alternatives
- prioritizing a bundle of policy issues
- resolving conflicts
- collaborative modeling and partnership formation for shared prescriptions
- a set of information and communication media
- a set of process technology

Though not described here about how specifically it applies to each of our research focuses, the above list gives a comprehensive set of tools, models and information media which come under UDD.

Another useful conceptual construct developed within the framework of UDD is the 5-storied Pagoda Model (Fig. 1).

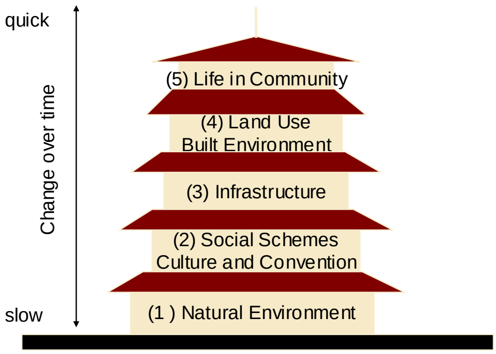

Fig. 1 5-storied pagoda model

This conceptual model offers a useful perspective on the rough positioning of our research focuses as explained later.

3. Disaster Risk Management (N.OKADA and M. YOKOMATSU)

1) Community Diagnosis for Sustainable Disaster Preparedness (pagoda model: level 1)

The research presents the "community diagnosis" method which addresses the need for sustainable disaster preparedness at the community level with the assistance of disaster experts. To this end, we present the PDCA management cycle and knowledge creation model. Based on these concept models, we introduce and demonstrate community diagnosis as a method of implementing participatory disaster preparedness.

Disaster preparedness is observed as a participatory community management process, where all participating agents are expected to share knowledge. We discuss the type of knowledge required and how it can be better accumulated and used. This process is analyzed by the knowledge creation model. Community diagnosis is proposed as a method for completing this knowledge creation cycle to enhance disaster preparedness. We discuss the first two phases of community diagnosis. The knowledge externalization phase is designed as a diagnostic survey, the questionnaire survey implying the metaphor that "the community's disaster preparedness needs to be checked. "The knowledge combination phase is designed as a prescriptive workshop which is held to find a solution (prescription) to enhance the community preparedness by face-to-face communication. We present an ongoing empirical study of community diagnosis in urban Nagoya.

Table 1. Community Preparedness Index (CPI)

	Housing safety	Storage	Shelter	Special Support	Community Linkage	Fire	Emergency Contact
Higashiyama	3.45	4.74	5.94	5.14	** 4.55	** 5.20	4.95
A Town	3.35	** 4.31	5.95	5.16	5.03	6.21	** 4.57
K Town	3.46	4.86	++ 6.35	5.33	5.38	6.63	5.03

**: the mean score (CPI) is significantly lower ($P < .05$) than that of the other two areas.
++: the mean score (CPI) is significantly higher ($P < .05$) than that of the other two areas.

Fig. 2 CPI (A Town, Higashiyama, K Town)
(source Matsuda and Okada, 2006)

We also discuss the scheme of the participatory process which makes this study unique. From the tentative results of this community diagnosis, externalized local knowledge regarding" repeatability of preparedness" and "scale of a community" is discussed.

4. Safety Control of Urban Space (Y. SUZUKI)

Methodologies of Retrofitting Traditional Wooden Houses (pagoda model: level 2)

To make clear the structural mechanism of traditional wood frames to evaluate the seismic performance of wooden buildings like Japanese temples, shaking table tests and static tests using several scale models is described and typical experimental results were carried out. From experiments, it is found that the horizontal restoring force of wooden frame without walls depends mainly on the bending moment resistance from tie beams and the restoring force due to column rocking. The equilibrium relationship between the total restoring force and all the bending moments involved is established and verified. Using this equilibrium relationship, it is possible to evaluate the restoring force due to column rocking. The restoring force due to column rocking is the major part of the total restoring force when the frame deformation is small. The bending moments from tie beams become dominant as the deformation increases. The traditional wooden frame has the large flexibility and deformability. It is essential to take advantage of the structural mechanisms found from this study in the seismic and enhancement design of traditional wooden buildings.

A ladder type frame is developed as a reinforcement method using large deformation efficiency of the traditional framework. Its performance is verified with shaking table experiments.

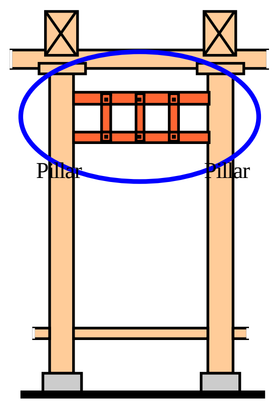

Fig.3 Ladder type frame

Fig.4 illustrates the results of the shaking table tests. It is found that ladder type frame reduce deformation angle similar to retrofitted members with 12 or 24 dampers. If dampers are installed, attenuation effects are increased. As for ladder type frame, its components and the member of the bundles are easy to be designed according to required seismic performance.

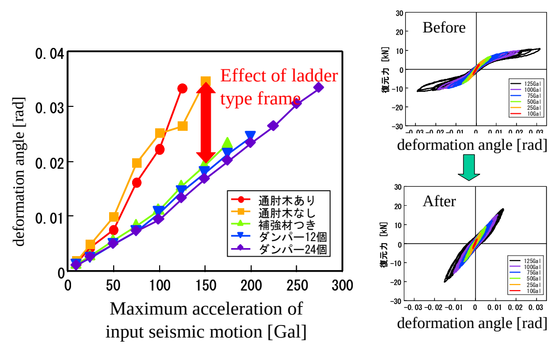

Fig.4 results of the shaking table tests

5. Socio and Eco Risk Management (Y. HAGIHARA)

Social group conflict analysis (pagoda model: level 3,4,5)

Social conflict between people insisting on environment and people insisting on development comes to be seen frequently. Especially, this tendency is conspicuous in water resources development because its

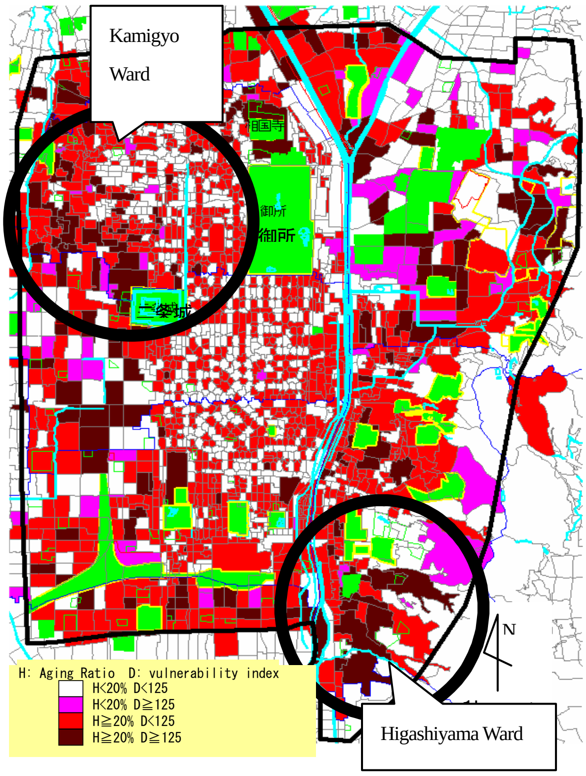

Fig.5 Distribution of weak areas against earthquake

influence is generally widespread. The probability of such conflict should be thought as risk of the project. Management of such conflicts must be considered on any future development project to avoid their intensification and prolongation. A mathematical model is built up to analyze such conflict and to see what kind of equilibrium states could occur. The model mainly consists of two parts. The first one concerns changing process of strategy, which interest parties would choose. The second one sets the model about preference of interest parties, which is needed to set a pay-off matrix in the first part of the model. Furthermore, the model is applied to Nagara River Problem as a case study.

The conflict between people insisting on environment and people insisting on development comes to be seen frequently. Management of such conflict and inducing consensus between them must be considered on a future development project. Without such understanding, appropriate development would not be achieved. People are defined as groups categorized by some features, and assumed to have distribution of opinions. Then, the conflict incidental to development project is modeled as interactive phenomenon of conflict situation and residents' opinion distribution between development and environment. Through the model analysis, it can be seen how the conflict would reach stable states.

Evaluation method of seismic risk and coping capacities in Kyoto city (pagoda model: level 3,4,5)

Kyoto city is historical and cultural area, and many aged persons are living there.. However, the area has potential risk for earthquake by active faults. This research concretely shows the weak area against seismic risk. It might be significant information for mitigation plan. Dangerous factors, such as blind alley and aged persons, are clarified. And the weak area against disasters is defined by them with GIS. It is found that these weak areas are concentrated in Higashiyama and Kamigyo Wards.

6. Disaster Risk Governance (H. TATANO and M. HATAYAMA)

Development of a method to estimate economic losses in industry (pagoda model: level 3,4)

As to avoid double counting economic losses, it is shown important to distinguish the effects between disaster and recovery [Tatano, et.al.,2000, Tatano, 2006]. When we estimate total economic loss which includes foregone revenue in industries, these two effects should be estimated in the consistent way. When we estimate total economic loss, the loss caused by the disaster and net present value of recovery actions should be summed up. According to Tatano, et.al. (2000), the total economic losses of a firm equals to "foregone revenue" plus "recovery cost. This means that it is consistent with the conventional loss estimation framework which defines total economic loss of a firm as sum of direct and indirect losses if the direct loss is estimated as "recovery cost of the damaged assets" and the indirect loss are defined as "foregone revenue". The further research is conducted in this year to find the consistent way for aggregation of the economic losses in an economy [Nakano et al, 2006]. For this purpose, economic losses of a firm is reconsidered and it is found that difference of the net cash flows between the scenarios with and without a disaster is also the consistent measure of the total economic loss of a firm(Fig.6). A method to conduct consistent aggregation of economic losses over an economy is investigated. The method requests us to sum up all the difference of the cash flows over industries in the economy and calculate the net present value of them. The net present value is shown to be coincident with the foregone revenue of the damaged firms and resource expenditures of firms which provide recovery services, which are the real opportunity cost of the economy. A case study was also conducted to apply the methodology for estimation of total industrial losses in the Niigata Chuetsu Earthquake. We conducted a questionnaire survey for damaged firms and collected 521 valid response from nonmanufacturer and 328 from manufacture. It is estimated that the total economic loss was about 584 billion yen, including 265 billion yen in recovery cost and 318 billion yen losses in profit [Nakano, et.al..2007]. We found this was enormous damage for the regional economy because the Gross Regional Product of the Chuetsu-region was about 2148 billion yen in 2003

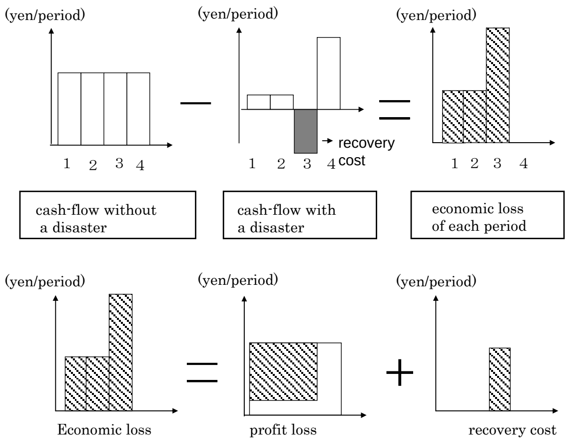

Fig.6 Economic Loss of a firm

An Empirical Analysis of Individual Heterogeneity Effect on Ambiguity Aversion (pagoda model: level 5)

We empirically investigates the influence of the ambiguity on the decision to buy hypothetical earthquake insurance and the relationship with individual characteristics based on MEU model using questionnaire data [Fujimi and Tatano, 2006]. For that purpose, we develop the econometric model consistent with theoretical model derived from axioms. The main results of this paper are summarized as follows. First, respondent's preferences to the insurance with 1, 5, and 10% appraisal risk are generally inconsistent with expected utility theory. Second, respondents demanded more than 20% reduction in premium to offset each appraisal risk. Third, the ambiguity premium is larger in men who purchase earth-quake insurance, have never received insurance payment, and distrust insurance companies than each correspondents, and increases with age, education level.

Table 6 Risk and ambiguity premium (Yen)

Reference probability	α= 1%	α= 5%	α= 10%
Expected loss	15,273	14,863	14,350
Risk premium	5,861	5,782	5,683
Ambiguity premium	-2,198	-2,098	-2,988
Willingness to pay	18,936	18,546	17,045

Design of Institutional arrangement for trustworthy construction market (pagoda model: level 4,5)

It is one of the most basic countermeasures against earthquakes to construct quake-proof buildings. This study provides an institutional framework where constructors and building inspectors are motivated to work stringently.

In general, it is difficult for a building client to observe the quality of the building (e.g., earthquake-resistance). Then, the constructors can take moral hazard actions to seek their profits. Hence, a client would hesitate to close a construction contract with a constructor.

A performance-based contract framework we propose to solve this problem includes two-staged inspection via building inspectors (Fig.7) [Yoshida, et.al., 2006].

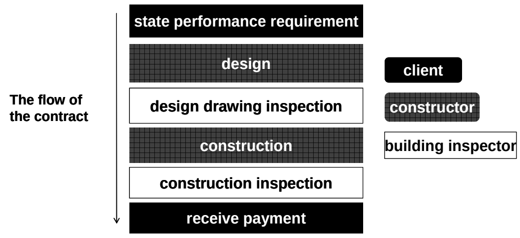

Fig.7. The flow of performance-based contract

At the first stage, the building inspector ascertains whether or not the design drawing has the potential to satisfy the client's performance requirement. At the second stage, the building inspector ascertains whether or not the construction is conducted along with the inspected design drawing. We analyze this problem with using the game theory with incomplete information (Fig.8). It is shown that the social optimal contract can be concluded if the building inspector carries out adequate two-staged inspection.

In addition to the moral hazard problem regarding constructors, we also analyze the institutional arrangement where building inspectors are motivated to carry out stringent inspections. If building inspectors

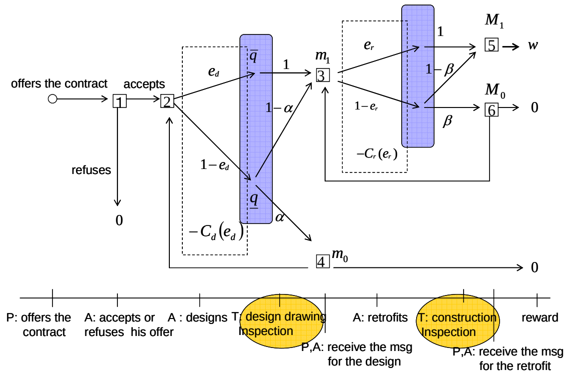

Fig.8. The model with performance-based contract

carry out negligent inspections, the opportunities to impose penalty on negligent constructors can be lost. Hence, the problem regarding building inspectors are more serious than the one regarding constructors. We propose post-inspection payment plan in which the payment for building inspectors is based on the inspection results reported by them [Yoshida et.al., 2007]. It is shown that post-inspection payment plan is effective in both the moral hazard and adverse selection problems.

A Flood Risk Communication Support System for Flood Disaster Response Planning in a Community (pagoda model: level 4,5)

To realize safe autonomous evacuation, citizens should obtain well developed "mental model" for evacuation which includes appropriate perception mechanism to preserve flood risk and flexible "alternative set" for evacuation actions. Aiming at constructing well developed mental models which citizens' evacuation actions are determined based on, the paper develops a flood risk communication support system. Through communication among stakeholders assisted by the system, changes in flood risk perception and increase in the flexibility of the alternative plans of evacuation actions are observed in the experimental workshops in Kiyosu City, Aichi prefecture.[Kawashima, et.al. 2006]

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都市診断法：総合的な災害リスクマネジメントの方法論

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要　旨

本研究は、京都大学防災研究所21世紀 COE研究プロジェクトの一環で旧総合防災研究グループが2005年度に行った研究成果の概要をとりまとめたものである。　本研究活動全体の主たる目的は総合的な災害リスクマネジメントのための方法論として、都市診断技法を開発し、発展させることである。すなわち、災害リスクマネジメント（災害リスクガバナンス、参加型災害リスクマネジメント）、都市空間の安全制御、地域水環境システム、防災社会システムの4つの研究課題を取り上げた。　五層モデルを用いて各研究の位置づけを示すとともに、それぞれの研究成果について概説した。

キーワード:　総合的な災害リスクマネジメント，都市診断，災害リスクガバナンス，
参加型災害リスクマネジメント，都市空間の安全制御，社会・生態環境研究，防災社会システム