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POLICY ANALYSIS ON BUILDING REGULATIONS AND THE RECOVERY OF EARTHQUAKE / TSUNAMI AFFECTED AREAS

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ABSTRACT: The paper examines the situation and causes of recent big earthquake and tsunami disasters especially in the case of the Great East Japan Earthquake in 2011, and analyzes the damage to extract lessons on safety of buildings and recovery of cities from the view point of building regulations such as the Article 39 of the Building Standard Law. In addition, the Article 8 of the Ordinance of City Planning Law resulted in not so effective against tsunami in March 2011. Control mechanisms of building construction should be integrated into socio-economic, institutional, technical and other policy tools.

Key Words: Great East Japan Earthquake, Building Standard Law, City Planning Law

INTRODUCTION

The impact of earthquake can be reduced by policy measures such as earthquake resistant building design and construction standards, proper planning, education and trainings. The risk will increase as urbanization is adding extra pressures on building construction. In the case of “tsunami disaster”, the Building Standard Law (BSL) of Japan allows local governments to create their own regulation based on its Article 39. However the regulation has not been utilized so often against tsunami. Moreover, the Article 8 of Ordinance of the City Planning Law (CPL) resulted in not so effective in tsunami affected areas of the Great East Japan Earthquake on March 11, 2011 except some areas in Sendai Plain.
The paper examines the outline situation and causes of recent large scale earthquakes and tsunamis, and analyzes the responses and reconstruction processes. Then, it shows how responded to the disaster, and how can people avoid the same disasters in the future based on the valuable lessons from the Great Hanshin-Awaji (Kobe) earthquake in 1995, Sumatra Tsunami in 2004, Pakistan earthquake in 2005, Java earthquake in 2006, Peru earthquake in 2007, Sichuan earthquake in 2008, Haiti earthquake in 2010 and the Great East Japan Earthquake. Since many large scale disasters have happened during these ten years, this paper tries to comprehensively summarize the reasons of damages and what are the lessons in terms of earthquake and tsunami safety of building and cities.
The demands ultimately help in creating conducive environment for policy intervention, in realizing institutional mechanism to mitigate disasters for the municipal authorities and creating demand for competent professionals. In Japan, demands for seismic assessment and retrofit of houses that follow old seismic codes before 1981, could be realized mainly by raising awareness.

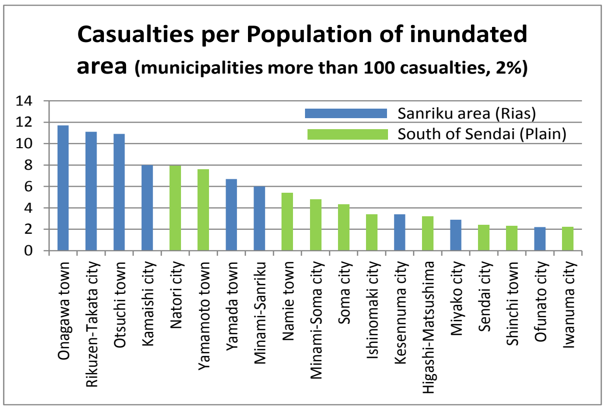
Table 1: Earthquake and Tsunami Disasters with over 15,000 casualties (1960-2011)

	Country: Earthquake	**Year**	**Mg**	**Death** (A)	**Collapse** (B)	Casualty ratio A/B x 100
1	China: Hebei (Tangshan Earthquake)	1976	7.8	242800		
2	Indian Ocean Tsunami	2004	9.0	226408	470000	48.1
3	Haiti Earthquake	2010	7.0	222576	(189273)	(117.6)
4	China: Sichuan (Wenchuan Earthquake)	2008	8.1	87576	5461900	1.6
5	Pakistan Kashmir Earthquake	2005	7.6	73328	272000	26.9
6	Peru: Chimbote, Huaras	1970	7.8	66794	(>15000)	
7	Iran: Manjil Earthquake, Rudbar	1990	7.7	35000		
8	Iran: Kerman, Bam Earthquake	2003	6.7	31830	55000	57.8
9	Armenia: Spitak Earthquake	1988	6.8	25000		
10	Guatemala Earthquake	1976	7.5	22870		
11	India: Bhuj Earthquake (Gujarat)	2001	8.0	20023	(339000)	(5.9)
12	Japan: Great East Japan Earthquake	2011	9.0	19295	127185	15.2
13	Iran: Tabas Earthquake	1978	7.4	18220		
14	Turkey: Kocaeli Earthquake	1999	7.8	17118	(60000)	(28.5)
15	China: Yunnan Earthquake	1970	7.8	15621		
ref.	Japan: Great Hanshin-Awaji Earthquake	1995	7.3	6434	111123	5.7

Source: the BRI's "World Seismic Disaster Catalog", and United Nations. Events in gray box represent the earthquake disasters that occurred in 2001-2011. Part of collapse data, http://earthquake.usgs.gov/research/external/reports/08HQGR0102.pdf etc. ( ): not confirmed data

DAMAGE ANALYSIS OF THE GREAT EAST JAPAN EATHQUAKE

Firstly, the damage of the Great East Japan Earthquake on March 11, 2011 is analyzed in this section to verify the current policy measures of building regulation against tsunami disasters. Fig 1 shows ratio of casualties per population in the inundated area by affected municipality including dead and unknown persons as of 30 Dec., 2011 reported by the National Police Agency. Blue columns of in the figure indicate Sanriku area where main geographical condition is "rias" coast that was suffered from severer damages, while green columns imply plain area in Sendai Plain and the southern regions.



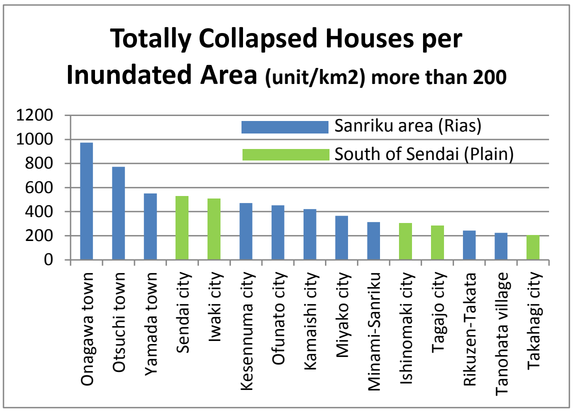


Fig 1 Ratio of Casualties by Municipality   Fig 2 Totally Collapsed Houses per Inundation Area

(1) The maximum ratio of human damage (casualties including death and unknown) per population of the inundated areas in a municipality is recorded as 12 % in Onagawa town. Otsuchi town and Rikuzen Tkata city claimed the following large ratio of human damage per population in the inundated areas that were almost 11 %.
(2) Since no damage by tsunami can be observed outside of inundated areas, Fig 1 and Fig 2 represent

human damage and physical damage per inundated area respectively. The density of human and physical damages in Otsuchi town and Onagawa town are the severest. The third concentrated damage was seen in Yamada town. Kesennuma city and Kamaishi city follow them as the areas of collective and massive damages both in human and physical aspects.

(3) The gravity of physical damage can be measured by the totally collapsed ratio. The density of houses and population in the inundation area of these cities was lower than in Onagawa and Otsuchi town. If the ratio of unknown per human damage will represent severity of human damage, Onagawa town reached 39 % as the highest ratio and Otsuchi town, Minami Sanriku town follow high ratio. They are the municipalities that are ranked in Fig 2 as the heavily damaged areas.

(4) Fig 3 and Fig 4 shows the severity of damage by municipality, classifying the characteristics of regions. The indicator of Fig 4 may represent characteristics of damage and will help to compare with other disasters. The proposed indicator is calculated as “number of human damage (as a sum of death and unknown) per 100 totally collapsed houses” in each affected municipality. Coburn, Spence and Pomonis defined similar ratio as “Lethality Ratio” in 1992. The following data is formed after extracting municipalities that have larger fluctuation because of its smaller numbers.

(5) The ratio varies almost 100 times under this indicator. Rikuzen-Takata city recorded more than 50 persons’ human damage per 100 totally collapsed houses, while Sendai city’s indicator shows around 2 persons. Fig 4 tries to classify the damages however there was not so clear characteristics from above mentioned data. Analysis on other big disasters in the world is conducted utilizing the same indicator (casualty ratio: number of casualties per 100 totally collapsed houses) in the latter section.

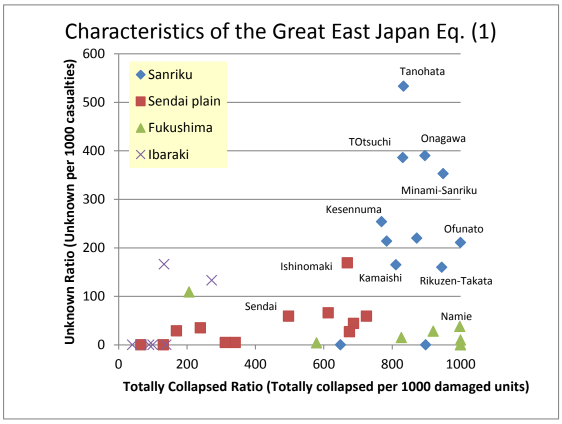


Fig 3 Unknown Ratio and Totally Collapsed Ratio

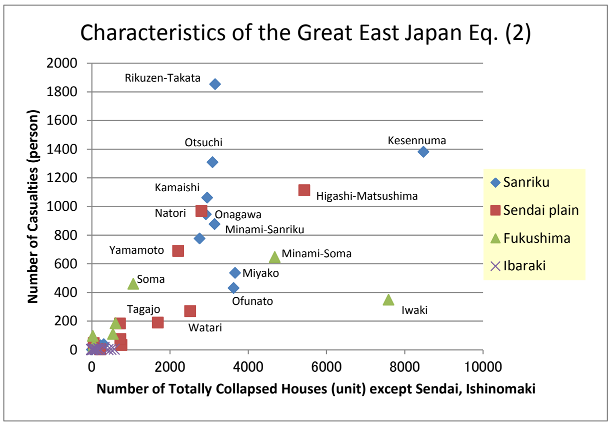


Fig 4 Totally collapsed houses and Casualties

Photo 1: Otsuchi town, Iwate prefecture, Photo 2: Onagawa town, Miyagi prefecture (both Apr. 2011)

DAMAGES AND RECOVERY OF RECENT BIG EARTHQUAKE DISASTERS

Indian Ocean Tsunami (2004): Numerous people including tourists from Europe and North America were drowned and died by Indian Ocean Tsunami. The tsunami caused by the Sumatra Earthquake on 26 December 2004, killed in total approx. 230,000 people in 12 countries. One of the reasons why the tsunami brought so many victims lies in the tourists from the Western countries at Christmas vacation who did not notice the danger of tsunami. This Tsunami provided an opportunity for the Western countries to acknowledge natural disasters. The “World Conference on Disaster Reduction (WCDR)” that was held in Kobe in January of 2005, only less than a month after the Indian Ocean Tsunami, proved such global awareness. In total 158 countries have participated in the WCDR, and the “Hyogo Framework for Action (HFA) 2005- 2015” was adopted.

From experiences in Aceh after the 2004 tsunami, many lessons can be learned. There were remaining ships in the residential area where is located a few kilometers from the coast line of Aceh as a memory of disaster. There are huge amount of construction sites of new houses in the areas. However, because of so rapid reconstruction of public facilities and houses, some houses were constructed with lower earthquake resistance and lower quality than before. Some completed recovery houses were still vacant in some residential zones as no infrastructure was provided as of Dec. 2007.

Photo 3: Bam, Iran after 2003, reconstruction

Photo 4: Aceh, Indonesia in 2005 (by UNCRD)

Pakistan Earthquake (2005): Kashmir (Pakistan) earthquake occurred on October 8, 2005 at 9AM. Most of victims were killed by collapse of houses, schools and other buildings.

Java Earthquake (2006): Java earthquake claimed more than 5,000 casualties on May 27, 2006 early in the morning. More than 200,000 houses were destroyed, and crushed the residents.

Photo 5: Barakot, Pakistan (Mar. 2006)

Photo 6: Java, Indonesia (Sept. 2006) reconstruction

Wenchuan Earthquake (2008): Wenchuan Earthquake occurred on May 12, 2008 in the afternoon. Around 90,000 people were killed mainly in Sichuan Province of China. Many of them claimed their lives by being pressed with collapsed buildings particularly their own houses. The affected area extended from cities that have hundreds of thousand populations to villages in the mountain regions more than 500km long range of areas. It was just before the Beijing Olympic Game, the Chinese government quickly responded, such as the rapid provision of temporary houses. It was ten times larger in number of units within the same period compared with the case of the 1995 Great Hanshin-Awaji Earthquake. The reconstruction of houses finished within 2 years although the original recovery plan needed 3 years.

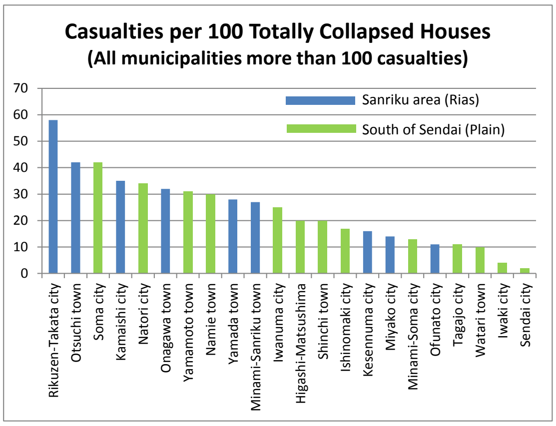
One of the factors why the recovery has been completed so fast is "Partner Assistance" system that has contributed to recovery of a heavily affected city through the support by a designated province in China. This system was applied from the initial stage to whole reconstruction and proved effective, partly because of competitive atmosphere of the system. The traumatic care of victims and recovery of cultural heritages are included. Retrofitting of vulnerable buildings remains a major issue as a lesson.

Photo 7: suburb of Pisco, Peru (Aug. 2007)

Photo 8: a village in Sichuan, China (June 2008)

DOMESTIC AND INTERNATIONAL COMPARISON OF THE DAMAGES

The Fig 5 and Fig 6 show the comparison of disasters in different areas using a proposed indicator. From the indicator that sets forth number of casualties per 100 totally collapsed houses, the range of numbers varies from 60 to 2 or 1 in both figures that Fig 5 shows difference among municipalities in the Great East Japan Earthquake affected areas and Fig 6 indicates difference of recent huge disasters.



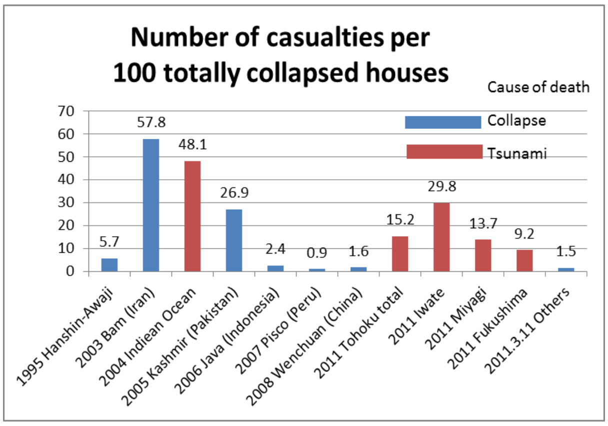


Fig 5 (2011 Japan) and Fig 6 (recent world) Number of casualties per 100 totally collapsed houses

The following observation can be pointed out from above-mentioned figures and field visits:
(1) Number of Fig 5 represents the "inclination" of Fig 4. Although there may exist slight difference of judgment and definition of a "totally collapsed house" among municipalities, large difference of value cannot be explained. From the data in Fig 7, it is not so clear the difference of each municipality. The difference of prefectures may be analyzed (although the highest casualties in Iwate prefecture in the Fig 6 cannot be explained from the Fig 7 that indicates the awareness of risk in Iwate was the highest).
(2) Fig 5 shows lower "casualty (mortality) ratio" in Ofunato city even though it is located in Sanriku. The reasons why the ratio in Soma city, Natori city and some other plain areas resulted in higher ratio compared with average of Iwate or Sanriku region may also provide social or historical reasons of the damages. Since this paper focuses on institutional aspect, further research is executed.
(3) Fig 6 indicates also the wide range of difference of casualty ratio in the recent huge disasters. In general, tsunami disasters claimed rather higher ratio than the other cases. One of the reasons may be the frequency of a disaster (Huge tsunamis occur every thousand years while huge earthquakes can be experienced once per several hundred years, as it is said "disaster comes when it is forgotten").
(4) Fig 6 also suggests that the large difference of casualty ratio between the higher cases such as Iran and Pakistan (and in the case of Haiti, the casualty ratio became over 100 persons by official statistics) and lower cases in China 2008, Peru 2007 and Java 2006. The case of Kobe in 1995 set forth the middle level of casualty ratio. (5) and (6) are the tentative hypotheses based on the current data.
(5) Photos 6-8 that were taken one week or a few months after each disaster show the typical damage of houses. Photo 6 of Indonesian case shows a reconstructed house. The collapsed wall was seen at the back right side. That was the former house with very thin brick wall. Not only in Indonesia but also in Peru (Photo 7), and China (Photo 8) people constructs one story house with light roof materials and thin wall, especially in rural regions. The local residents use traditional construction systems.
(6) Photo 3 in Iran and Photo 5 in Pakistan indicate modern construction methods. In case of Iran people uses steel frame brick infill structures. As the damage of pure (dried) brick houses was severer than the steel frame type, many reconstructed buildings adopted the steel frame structure. In the case of Pakistan in 2005, reinforced concrete buildings like schools, hospitals and apartment houses were collapsed and caused many casualties. It means that even modern structure, it causes severe human damage if the structure was not properly designed and constructed.

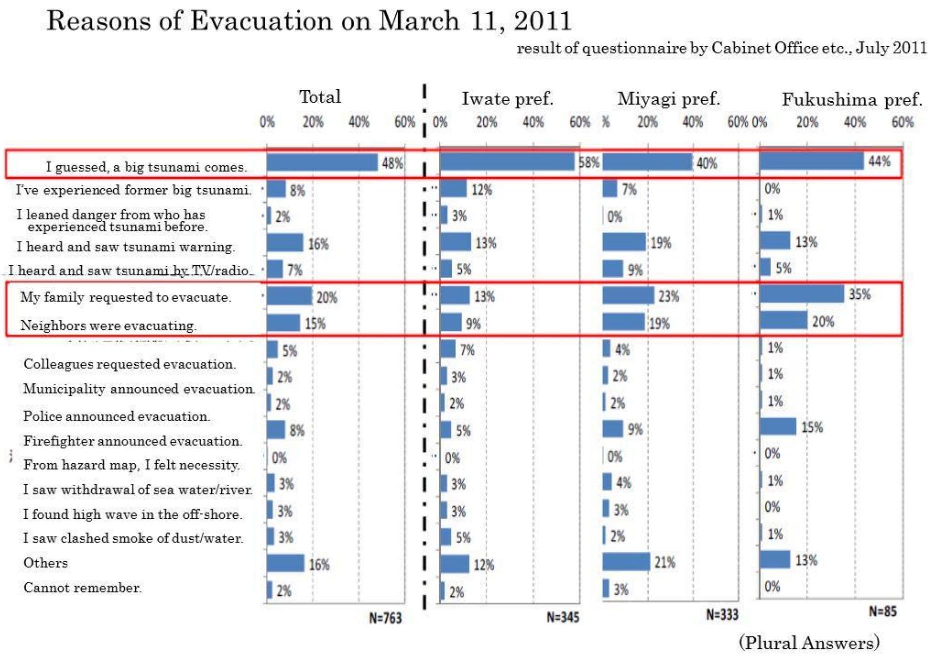
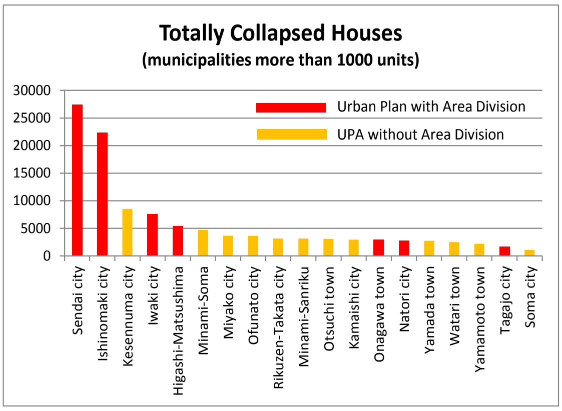


Fig 7 Reasons (chance) of Evacuation on March 11, 2011

Based on the data on damages of the Great East Japan Earthquake from the view point of building control and urban planning, i.e. Fig 8 to Fig 11, further observations can be pointed out as follows:

(1) Fig 8 shows two exceptionally large damaged cities in terms of physical damage. Both Sendai city and Ishinomaki city are classified as the area of "Urban Planning with Area Division". That means the pressure of development and increase of population are expected in these cities. Therefore, in order to effectively invest resources into designated Urbanization Promotion Area (UPA) without investing into Urbanization Control Area (UCA) (almost ten times difference of casualty ratio between two cities).
(2) Fig 9 clearly indicates the characteristics of urban planning with Area Division (red columns). Accumulated houses existed in the area and were damaged. The damaged houses include collapsed houses, half collapsed houses and partially damaged houses. However, top six municipalities in the Fig 9 cannot be found in the Fig 10. That means in urbanization promotion areas especially in the Sendai plain, housing damage in tsunami inundation areas turned out large number, while human damage was not so severe if compared with Sanriku where there is no UPA except Onagawa town.
(3) Fig 10 shows the same data as Fig 6 with classification by urban planning type. As same as the Fig 8, all municipalities in Fig 10 established urban planning. That means heavily damaged areas on houses (Fig 8) and human (Fig 10) were basically controlled under urban planning system with rather strict building control systems that are connected each urban planning.
(4) In the Fig 11, not so specific difference between urban planning with Area Division and without Area Division can be observed.



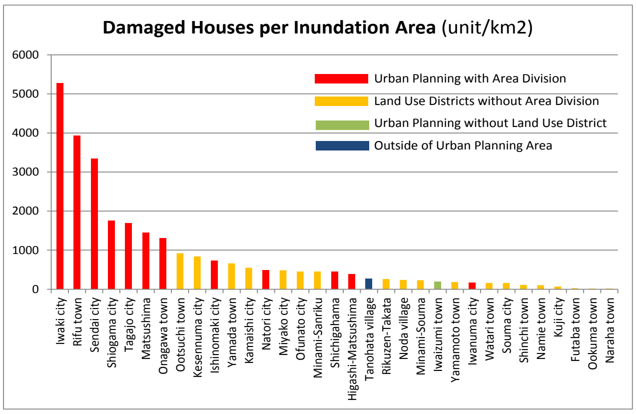
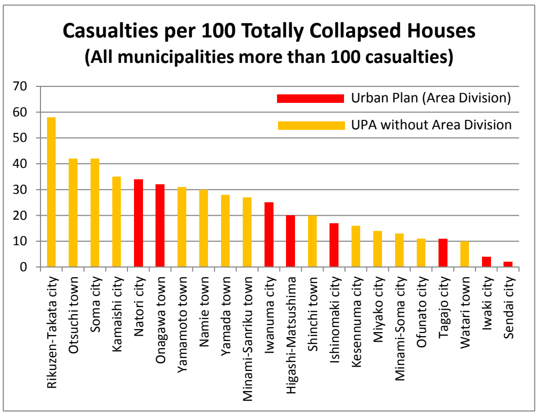


Fig 8 Totally collapsed houses by municipality Fig 9 Damaged houses per Inundation area



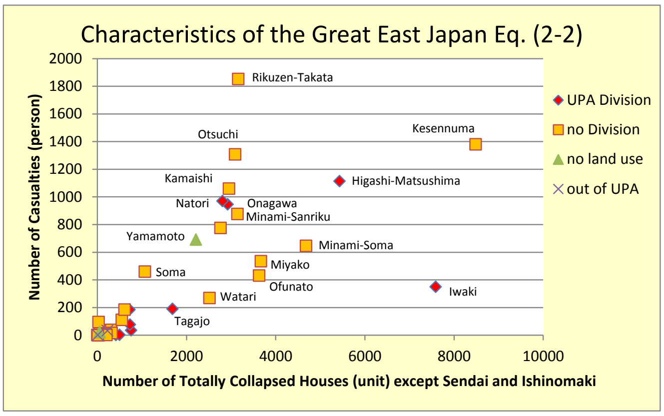


Fig 10 Casualties per 100 totally collasepd houses Fig 11 Totally collpased houses/casualties
(Values of Fig 10 & Fig 11 are the same as Fig 6 & Fig 4 respectively. UPA: Urban Planning Area)

JAPANESE BUILDING REGULATIONS AGAINST DISASTERS

"Area Division" system and building control systems that are prescribed in the City Planning Law (CPL) and the Building Standard Law (BSL) are expected to play significant roles to prevent tsunami and earthquake disasters. However, before the Great East Japan Earthquake, a few cases of "Disaster Hazard Area (DHA)" under the Article 39 of BSL were applied to prevent tsunami disaster. The reason why DHA has not been so popular in the case of tsunami can be explained as follows:

(1) DHA aims to prevent disasters utilizing locally applicable control codes through designation of the area. There exist approximately 17,800 DHA in Japan (2007 MLIT), however most of them were designated against land slide to restrict housing construction in the steep slope areas. DHA against tsunami risk was not established except a few cases as the frequency of occurrence is quite rare and residents do not agree to prohibit from building their houses. There is no national financial support.
(2) As shown in the Table 2, DHA provides permanent restriction while other building control system in the disaster affected area like the building control based on the Article 84 of BSL, sets normally two months' limitation or in the case of the Great East Japan Earthquake maximum 8 months' control. DHA controls will not be necessary for the area without any development pressure.
(3) DHA was sometimes used in the recovery projects after damaged disasters. In the case of Aonae area of Okushiri town after a big tsunami of the off coast of South-West of Hokkaido earthquake in 1993, DHA was introduced to the high risk area in the old residential zone after the new hilly safe area was developed utilizing the "Collective Removal project against Disasters" with subsidies from national government (by MOC, current MLIT). This was the unique case after tsunami under DHA.
(4) As shown in the Table 4 in the Appendix, Iwate prefecture requested all affected municipalities to set DHA to the heavily tsunami affected area in April 2011. However Kamaishi city decided not to use DHA in July 2011 and other municipalities are also reluctant to apply DHA. On the contrary, Miyagi prefecture set building control in large areas using the Article 84 of BSL. Sendai city and Yamamoto town utilize DHA to control building construction in tsunami hazardous areas.

Table 2: Comparison of Building Control based on the BSL Article 39 and Article 84

Building Standard Law	**Article 39** (Disaster Hazard Area: **DHA**)	**Article 84** (Control in Affected Area)
Designation of area	Based on bylaw of local governments	By Specialized Admin. Authority *1
Duration of control	Permanent measures	Max. two months *2
Construction control	Prohibit housing, limit other building (no national intervention)	Prohibit / limit building construction in the project planned area
Application to Great East Japan Earthquake	Iwate: Urge municipality to set bylaw Miyagi: Pref. started to plan to apply	Iwate pref.: No application Miyagi: Applied to 5 municipalities
Response of municipalities	Iwate: Mayors are prudent (negative) Miyagi: Part of Minami-sanriku town	Miyagi: Enterprises were embarrassed then try to permit some construction
Applied cases	Hokkaido, Okushiri town, Aonae area	Great Hanshin-Awaji Eq. (Kobe etc.)

*1 Specialized Administrative Authority: Mayors that put building officer, Governor of prefecture in other cases
*2 Based on a special law, max. 6 months' additional extension was possible this time, Miyagi extended till Nov. 11.

As shown in the Table 2 and Table 4, the basic direction toward reconstruction of Miyagi prefecture and Iwate prefecture seems to select different way as the case of building restriction in early stage. It seems that Miyagi prefecture aims to improve urban structure using this opportunity especially in the coastal zones, while Iwate prefecture seems to be struggling to maintain population in the tsunami affected areas and then restriction of building construction in Iwate prefecture is not so strict compared to Miyagi prefecture because the population decrease trend is expected severer in the remote regions from big cities. However, it may be caused simply because of the difference of urban planning settings of both prefectures, i.e. Miyagi prefecture sets Area Division and most of coastal areas are prohibited to construct buildings while there is no Area Division (UPA and UPC) and construction of buildings is not so strictly controlled in the coastal cities and towns in Iwate prefecture.

RECOVERY POLICY MEASURES FOR TSUNAMI AFFECTED AREAS IN JAPAN

Total 40 types of project systems are designated as the principal project in the Law on the Special Area for Reconstruction of the Great East Japan Earthquake that was established in December 2011. Major project systems are “Collective Removal Project against Disasters”, “Recovery Base Project against Tsunami (a new system based on the new Law on Tsunami Disaster Management Regional Development)”, “Land Readjustment Project for Urban Renewal”, “Public Operated Housing for Disaster Victims” and “Improvement Project of Small-Scale Residential Area”. Characteristics are summarized in the Table 3.

Table 3: Characteristics of Major Basic Project Systems to be applied to Reconstruction (in 2011)

Basic Projects	**Collective Removal project against Disasters**	**Recovery Base project against Tsunami (new)**	**Project on Land Readjustment for Urban Recovery**	**Public Operated Housing after Disasters**	**Improvement of small-scale residential area**
Subsidies	Cost for public works incl. land development except sell land	Total mounding cost, Development of evacuation building and Public works etc.	Cost for public works incl. land, totally mounding (40 persons/ha)	Cost for public houses for low income people, aid for the aged	Public works, clear vulnerable units, community facilities etc.
Area	No relation to Urban Planning	Principally within Urban Planning Area (UPA)	Within Urban Planning Area (UPA)	No relation to Urban Planning	
Scale	More than five (usual 10) houses	Principally 2 projects per urban, and approx. 20 ha per project	No condition	No condition	More than 15 (5) units, with 50% vulnerable units
Condition	Designation of Disaster Hazard Area is requisite	Define area for land purchase, Step by step extension will be possible	Consolidated area to develop road system. Division of project area	No condition	Consolidated area is preferable
Process	Agreement of MLIT minister on removal plan	Planning decision as urban facility, project approval of prefecture (or MLIT)	Urban planning procedures are needed (from planning decision to liquidation)	No need for urban planning permit, need financial MLIT agreement	No need for urban planning permit, need financial MLIT agreement
Aid ratio	All costs will be covered (special case by national grant + special tax).			Depend on the tax condition (local debt will be reimbursed by rent).	

The application of 40 project types will be selected by the local government within this fiscal year (by March 2012) and those reconstruction projects will be executed within 3-5 years utilizing mainly national supplementary budget that will be provided to the local governments of affected areas soon. Author tries to analyze execution process of reconstruction projects from urban planning view point. As for December 30, 2011 national government has announced these systems and budgetary framework to the local governments. Now local governments are discussing with community on the concrete projects for reconstruction based on the basic plans and future prospect in each community that have been basically created in 2011.

The basic issue of these areas is the trend of decreasing population that will be heavily influenced to decide future urban plan of reconstruction areas. Table 4 shows estimated population based on a research study by Hayashi and Saito in 2011. While population of Miyagi prefecture will decrease less than 20%, total population of Iwate prefecture will decrease more than 30% by 2040 from 2005 within these 35 years. In addition, decrease of regional population is estimated almost 50% in the tsunami affected areas both in Miyagi prefecture and Iwate prefecture. The reconstruction plan will be influenced by such regional population prospect as shown in the Table 4.

LIMITS OF JAPANESE BUILDING REGULATIONS AGAINST TSUNAMI

Both of the Building Standard Law (BSL) and the City Planning Law (CPL) in Japan lay down several Articles related to recovery processes after disasters. However, the term of “tsunami” appears only once in the BSL and in the case of CPL, it does not contain the term of “tsunami” in the law before 2011, because most of recovery processes were prepared against urban fire in these laws. The Japanese history of urban disaster focuses on spread of fire in the city since Edo era and large-scale urban fire

also occurred recently in Kobe city in 1995 at the Great Hanshin-Awaji Earthquake. Therefore, current urban planning system in Japan seems to deal with tsunami disaster management not so clearly. The devastated tsunami that occurred on March 11, 2011 resulted in the first huge tsunami disaster during almost one century of history of both legal systems.
There is no UPA in the 2011 tsunami affected areas in Iwate prefecture, while most of Sendai plain in Miyagi prefecture is clearly divided into UPA and UCA. Most of Sanriku areas are not applied "Area Division (to classify into UPA and UCA)" even in Miyagi prefecture like Minami-sanriku Town and Kesennuma City, because there was not so much pressure on increase of population. Area Division system should be applied to the area where urban settings are already formulated or where urban development is expected within the next 10 years. Especially in the latter UPA case, the standard of setting area prescribes not to principally designate tsunami hazardous areas based on the Article 8 of the Ordinance of CPL. However, in 1964 when the current CPL was established there existed few scientific and engineering knowledge on tsunami to establish legal system, and with other reasons such as indicated below, the regulations do not function well in reality.

The reasons why CPL did not function well against tsunami in spite of Article 8 of its Ordinance:
(1) **Social Reasons**
- When the UPA was firstly designated, the areas where consensus could be easily obtained were selected. Already urbanized city areas had the first priority.
- UPA was basically set in the regions that rapid increase of population occurred.
- Many new public facilities and care houses for the elderly were constructed in the UPC areas with tsunami risks, because of consolidation of municipalities and progress of aged society.

(2) **Physical Reasons**
- People thought that it will be easy to evacuate from tsunami, since the most advanced information technology and early warning systems are established.
- People who lived in the coastal area thought that seawalls, river gates and tsunami evacuation buildings would protect residents from tsunami disasters.

(3) **Economic Reasons**
- UPA tends to be designated in and around already urbanized area, because of efficient use and maintenance of infrastructure, such as roads, sewerage and water supply.
- To move to safer area, in particular change of urban setting is almost impossible in normal time even though all people recognized their high risk (partly because of financial reason of municipality).
- The movement to protect agricultural land becomes weaken as demand of agricultural land will not increase and because of higher exchange ratio (strong yen) and excessive domestic rice production etc.

(4) **Institutional Reasons**
- The Article 8 of the Ordinance of CPL does not include "tsunami hazard" application to already urbanized areas. It regulates only newly urbanized (planned) areas.
- In the regulation of Article 8, the terms of "principally" and "hazardous area against tsunami" are used without clear definitions. There is no detail explanation in the MLIT guideline of urban planning.

CONCLUSIONS

Concentration of population into urbanization area and rapid improvement of social infrastructures due to the economic growth mostly in emerging countries would be common now in the world economy. As frequent earthquake and tsunami disasters during the 21st century (e.g. Sumatra Tsunami in 2004, Kashmir Earthquake in 2005, Sichuan Earthquake in 2008, and the Great East Japan Earthquake and Tsunami in 2011) proved such demands for disaster management. In each on-site observation, the collapse of buildings caused major damages in the earthquake related disasters. Therefore, quality of new houses and in the case of tsunami location of new urban area is the key to successful recovery. Moreover seismic retrofitting became popular in Japan after the Great Hanshin-Awaji Earthquake, while there are few cases of retrofitting of existed buildings in many countries.
Further field investigation will be needed to follow the reconstruction processes in the affected areas

of the Great East Japan Earthquake. Comparison of prefectures and cities provide lessons on the reconstruction process under the different urban planning settings and conditions, and will be helpful to improve urban planning systems. One sided control mechanism for implementation of building cannot solve the problems. Building control has to be integrated with socio-economic, institutional, technical and other tools to achieve safety of buildings and built-environment. In order to mitigate earthquake risk, all stages of building construction, from location, planning, construction to maintenance, are important. Awareness creation is instrumental for building culture of safety and demands for intervention in disaster mitigation. The demands ultimately help in creating conducive environment for policy intervention, in realizing institutional mechanism of code enforcement and land use control for the municipal authorities and in creating demand for competent professionals.

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APPENDIX DATA

Table 4: Comparison of Population and Urban Reconstruction of Miyagi and Iwate prefectures

	Miyagi Prefecture	**Iwate Prefecture**
Total population	2,360,218 persons (2005)	1,385,041 persons (2005)
Estimated pop.	1,894,000 persons (2040)	962,000 persons (2040)
Ratio(2040/2005)	- 19.8% (affected area - 46.8%)	- 30.5% (affected area - 48.8%)
Aged ratio(05-40)	20.0% (2005) → 34.3% (2040)	24.6% (2005) → 38.0% (2040)
Basic Concept for Reconstruction (part of land use and development)	Miyagi Pref. Recovery Plan: Recovery focusing on tsunami disaster management of coastal areas applying removal to high land, separation of work and home, multiple protection against tsunami from the lessons	Iwate Pref. Recovery Basic Plan: Based on agreements with residents, improvement of residential area for safety and development connected with land use plan considering tsunami disaster management
Current situation (building control)	Pref. set building control based on City Planning Law etc. after BSL Article 84.	Pref. has recommended municipalities to use BSL Article 39, but no execution.

Data: Miyagi Pref. Recovery Plan, http://www.pref.miyagi.jp/juutaku/saigaijouhou/20111221plan_honbun.pdf
Iwate Pref. Recovery Basic Plan, http://www.pref.iwate.jp/view.rbz?nd=2974&of=1&ik=1&pnp=2974&cd=35093

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