JOINT CONFERENCE PROCEEDINGS
9th International Conference on Urban Earthquake Engineering/ 4th Asia Conference on Earthquake Engineering
March 6-8, 2012, Tokyo Institute of Technology, Tokyo, Japan

RECENT ACTIVITIES OF JST-JICA PROJECT ON EARTHQUAKE AND TSUNAMI DISASTER MITIGATION IN PERU

Fumio Yamazaki[1)], Shoichi Nakai[2)], Shun'ichi Koshimura[3)], Taiki Saito[4)], Saburoh Midorikawa[5)], Carlos Zavala[6)], Zenon Aguilar[7)], Miguel Estrada[8)], and Tadahiro Kishida[9)]

1) Professor, Chiba University, Japan
2) Professor, Chiba University, Japan
3) Associate Professor, Tohoku University, Japan
4) Chief Research Engineer, IISEE, Building Research Institute, Japan
5) Professor, Tokyo Institute of Technology, Japan
6) Professor, National University of Engineering, Peru
7) Associate Professor, National University of Engineering, Peru
8) Associate Professor, National University of Engineering, Peru
9) JST-JICA Assistant Professor, Faculty of Engineering, Chiba University, Japan

yamazaki@tu.chiba-u.ac.jp, nakai@faculty.chiba-u.jp, koshimura@tsunami2.civil.tohoku.ac.jp, tsaito@kenken.go.jp
smidorik@enveng.titech.ac.jp, czavala@uni.edu.pe, zaguilar@zergeosystemperu.com, estrada@uni.edu.pe, tkishida@faculty.chiba-u.jp

Abstract: This project conducts a comprehensive research towards earthquake and tsunami disaster mitigation in Peru under the framework of "Science and Technology Research Partnership for Sustainable Development (SATREPS)", sponsored by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA). The project focuses on five research fields such as seismic motion and geotechnical issues, tsunami, buildings, spatial information database and damage assessment, and disaster mitigation plan. It has been two years since the project has started after signing on the Record of Discussion (R/D) in January 2010. During these periods, researchers from different fields coordinate the schedule and collaborate together to achieve the overall project goals. This paper describes the scope of the work and the progress of the JST-JICA Project on Earthquake and Tsunami Disaster Mitigation in Peru.

1. INTRODUCTION

A project of "Enhancement of Earthquake and Tsunami Disaster Mitigation Technology in Peru" has started since 2010 to conduct a comprehensive research towards earthquake and tsunami disaster mitigation in Peru. This project is performed under the strong collaboration among Peruvian and Japanese researchers with the framework of "Science and Technology Research Partnership for Sustainable Development (SATREPS)". Fig. 1 shows the project system between two research institutes and two funding agencies. Research institutes in Japan primary consist of Chiba University, Tohoku University, Building Research Institute, and Tokyo Institute of Technology. Research institutes in Peru primary consist of National University of Engineering, Peru (UNI), Geophysical Institute of Peru (IGP), Direction of Hydrology and Navigation (DHN), and National Institute of Civil Defense (INDECI). Fumio Yamazaki and Carlos Zavala are leading the research teams as the principal investigators of this project. Japan Science and Technology Agency (JST) supports the Japanese institutes for the data collection of the global earthquake and tsunami disasters. Japan International Cooperation Agency (JICA) supports the project for Peruvian institutes by sending the Japanese experts, machinery, and inviting the Peruvian trainees to Japan. This joint sponsorship is unique and specially developed for the framework of SATRES projects.

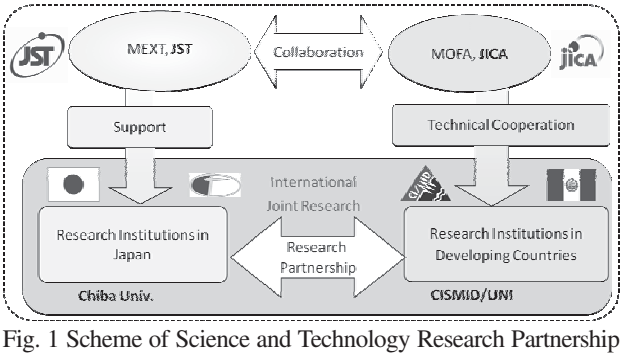

Fig. 1 Scheme of Science and Technology Research Partnership for Sustainable Development (SATREPS)

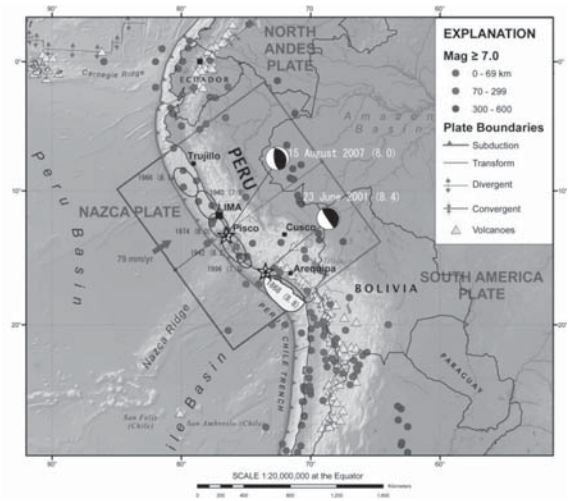

Fig. 2 Tectonic Setting and Epicenters of Earthquakes in Peru (modified from USGS, 2007)

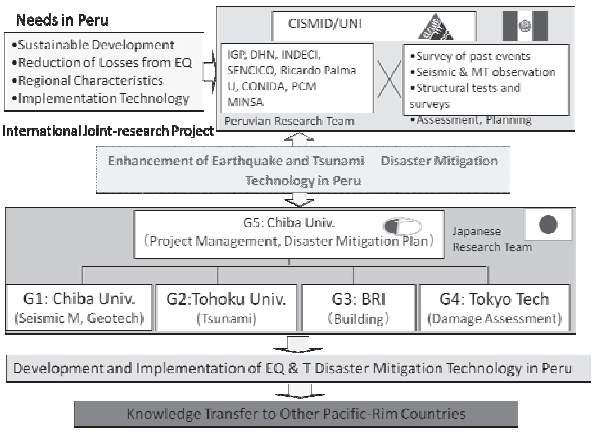

Fig. 3 Organizational structure of the project

2. BACKGROUND AND OBJECTIVES

Earthquakes and tsunamis are major concerns in the Asia-Pacific region towards sustainable developments for these countries. Understanding natural hazards and upgrading societal resilience are necessary to reduce disaster risks. Since earthquakes and tsunamis are rare events, the data collection is important in a global scale. Therefore, the international collaboration is a key among these countries by sharing their experiences. Currently, Japan is one of the leading societies in the field of international disaster mitigations because of its long history for challenging the earthquake and tsunami disasters.

Peru also has a long history for the earthquake and tsunami disasters with the similar seismic environment to Japan. Fig. 2 shows the tectonic settings for this region. Large plate-boundary earthquakes occurred recently in the offshore of Atico (M_w 8.4, June 23rd, 2001) and in the offshore of Pisco (M_w 8.0, August 15th, 2007). Seismic shakings and tsunami caused hundreds of fatalities with a large number of building failures and infrastructure damages. Hence, earthquakes and tsunamis are major concerns in Peruvian society too.

Peru and Japan have a long-term relationship which started in 1873 with the diplomatic relation. A large number of immigrants from Japan settled down in Peru in the early 20th century. In 1987, Japan-Peru Center for Earthquake Engineering and Disaster Mitigation (CISMID) was established in National University of Engineering (UNI) by the support of Japanese government. CISMID became a leading center of earthquake engineering research in South America, and has collaborated with many Japanese research institutions such as Building Research Institute in Tsukuba, Japan.

Scopes of this joint research project between Peru and Japan are described into four points: 1) contribution of Japanese science and technology to disaster mitigation in Peru, 2) providing research fields to Japanese geoscience and earthquake engineering, 3) contribution to international tsunami research for subduction-zone earthquakes, and 4) promotion of disaster mitigation and capacity building by sharing the knowledge between countries.

3. RESEARCH ORGANIZATION AND TOPICS

Fig. 3 shows the research organization of this five-year project. The project primary comprise five main research topics: Strong motion prediction and development of seismic microzonation (Group 1); Development of tsunami effects based on numerical simulations (Group 2); Enhancement of seismic resistance of buildings based on structural experiments and field investigation (Group 3); Development of spatial information database using remote sensing technology and earthquake damage assessment for scenario earthquakes (Group 4); Development of earthquake and tsunami disaster mitigation plan and its implementation to the society (Group 5). Each research has the collaboration research groups in Japan and Peru to fulfill the project objectives. For instance, the researchers in Chiba University work together with IGP in the field of seismic motions and geotechnical issues. Similarly, Tohoku University collaborates with DHN in evaluating the tsunami hazard in Peru. Building Research Institute and CISMID collaborate to evaluate the building vulnerability in Peru. Tokyo Institute of Technology and CISMID perform the damage assessment together against the earthquakes in Peru. Finally, these works are summarized and implemented into disaster mitigation plans in Peru by collaborating with Chiba University and INDECI.

Fig. 4 shows the research topics and items for each group in the project. Based on the research outputs from the four groups (G1-G4), the disaster mitigation plan group (G5) will propose mitigation strategies for earthquake and tsunami disaster and implement those into Peruvian societies.

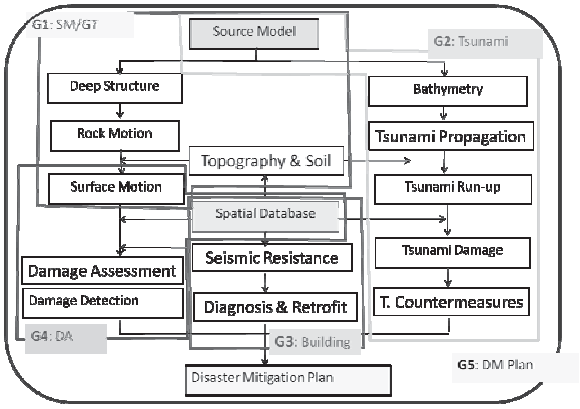

Fig. 4: Research topics and items of the project and the groups in charge the items

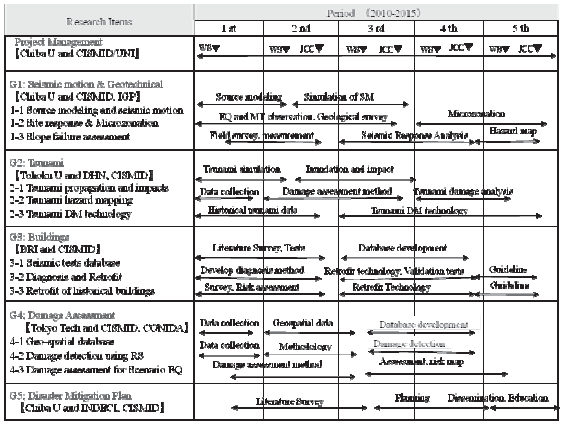

Fig. 5 Timeline of the project

A part of Metropolitan Lima including Callao was one of the study areas which are densely populated in Peru. City of Tanca was also selected as the study area which locates in south of Peru near the boundary between Chile. Pisco (the 2007 event) Camana, and Arequipa (the 2001 event) are also considered in developing hazard and damage assessment models.

4. SCOPE OF WORK

JICA sent a study team to Peru from August 5th to 13th in 2009 to investigate the details of the technical cooperation for the project. The team and the Peruvian organizations came to an agreement on the matters listed in the document (JICA 2009). The objective was agreed to develop technologies and measures for assessment and mitigation of earthquake/tsunami disasters caused by large-magnitude inter-plate earthquakes occurring off the coast of Peru. This objective will meet the demands in Peruvian and Japanese societies, and these outcomes will be applied to pacific-rim countries, especially to neighboring countries facing to the risks of large-magnitude inter-plate earthquakes and tsunamis. Therefore, the project will contribute to the advance of research for Peruvian and Japanese societies as well as provide the earthquake and tsunami technologies to the pacific-rim countries.

The followings are seven listed outputs in the master plan developed by JICA.

1. Scenarios of large-magnitude inter-plate earthquakes are identified to cause the most significant losses in Peru.

2. Geographical information of the study areas is prepared.

3. Tsunami disaster losses in study areas by scenario earthquakes are estimated, and mitigation technologies are developed.

4. Strong motions and ground failures in study areas by scenario earthquakes are simulated.

5. Earthquake disaster losses are estimated against scenario earthquakes, and the mitigation technologies are developed.

6. Technologies are developed for evaluating the structural seismic resistances and those retrofit, which are applicable to building characteristics in Peru.

7. Earthquake/tsunami disaster mitigation is promoted in the study areas.

Fig. 5 shows the time schedule of the five-year project. The leading members of the project will meet annually either in Peru or Japan at the project workshop. The Joint Coordinating Committee (JCC) will be organized annually in order to approve the annual work plan, to review the progress, to exchange opinions and to discuss details of the project for the implementation into Peruvian society.

5. RESEACH ACTIVITIES

Each group performs the research on the basis of the master plan. Group 1 studies the seismic motions and geotechnical aspects in Peru. Fig. 6 shows the selected earthquake scenarios based on the work by Peruvian and Japanese researchers. The scenarios come from two major previous earthquakes. One is 1746 great earthquake (M_w 8.6) that destroyed City of Lima completely, and the other is 1868 great earthquake (M_w 8.8) which caused the significant tsunami damages in Peru. G1 also performs the site investigation to measure the shear wave velocity profile at Lima by array mictrotremor observations. These results are available at more than 200 sites in Peru and will be used for creating the hazard maps.

Group 2 studies the tsunami simulations and these damage mitigations. Fig. 7 shows the example results of tsunami propagation simulations performed by Tohoku University and DHN. These results are currently utilized to obtain the inundation map in Lima and referenced for the evacuation plan at La Punta district in City of Lima.

Group 3 studies the seismic resistance of Peruvian structures and retrofit of historical buildings. Fig. 8 shows the structural tests for masonry buildings. These tests are performed in CISMID and National Yokohama

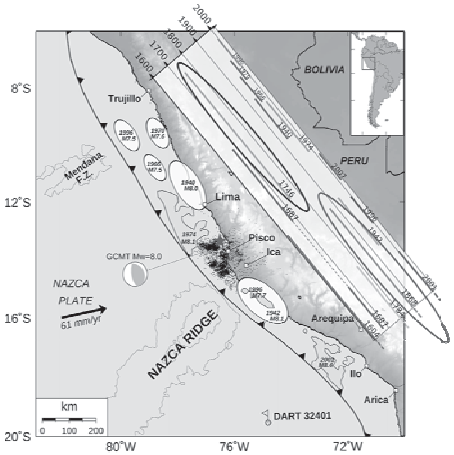

Fig. 6 Scenario Earthquakes for Peru

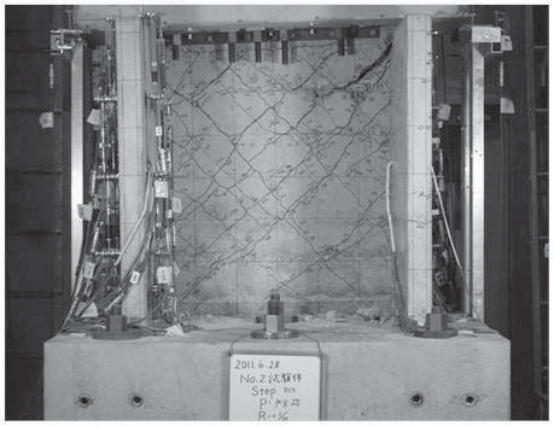

Fig. 8 Structural Test in National Yokohama University

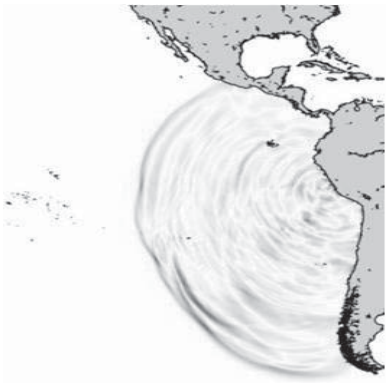

Fig. 7 Tsunami Simulation Results

Fig. 9 Building Inventory in Lima

University to create the database to study the effective retrofit methods for the regional structures.

Group 4 performs the damage assessment in Peru. Fig. 9 shows the building inventory in Lima obtained by the census data, satellite images, landuse map and elevation maps. On the basis of these building inventories, the earthquake damages will be evaluated against the scenario earthquakes provided by Group 1.

6. FIELD SURVEY FOR THE 2010 MAULE EARTHQUAKE IN CHILE

A magnitude M_w 8.8 earthquake occurred off the Pacific coast of Maule, Chile at 3:34 am (local daylight saving time), on 27 February 2010. The epicenter was located at 35.909° S 72.733° W with a depth of 35 km. The event took place at the boundary of the Nazca and South American plates where they converge as the Nazca plate moves below the South American plate. Tsunamis were generated by the earthquake to hit the coastline of Chile, and propagated to Pacific islands and even to Japan. Although the project interest is large-magnitude inter-plate earthquakes in the offshore of Peru, this event in Chile is also considered to be good a reference for the project purpose. After the occurrence of the earthquake, joint field survey teams by Japanese and Peruvian researchers were planned with the collaboration by Chilean researchers. JST provided the financial support to send the three survey teams to Chile. Fig. 10 shows the team members for each group. Team 1 collected the ground truth data using GPS survey with satellite images. Team 2 surveyed tsunami run-up water-depth measurements and damages. Team 3 investigated the detailed building damages with the background of seismic motions and geotechnical aspects. We coordinated the research activities and wrote the reconnaissance report. This report is now available at the project website (JST-JICA SATREPS Peru Project Chile Earthquake Field Investigation Team, 2010).

7. PROJECT MANAGEMENT AND OUTCOMES

Since SATREPS are funded by two agencies, both have the different objectives throughout the projects. JICA in Ministry of Foreign Affairs (MOFA) supports the project as a part of Official Development Assistance (ODA), which requires the development of practical technologies to Peruvian societies. On the other hand, JST in Ministry of Education, Culture, Sports, Science and Technology (MEXT) expects the scientific achievements by developing the novel theories and new technologies. Therefore, the project balance is taken by providing the

Fig. 10 2010 Chile Earthquake Reconnaissance Survey (a) Team 1, (b) Team 2, (c) Team 3

Fig. 11 Japanese Experts activities in Peru (a) Presentation at Peru Congress, (b) Tsunami Simulation Seminar, (c) Field Survey of Historical Buildings

equipment such as seismograph network, structural testing devices, and building database, and also by developing the technologies related to image analyses, tsunami simulations, and survey technologies.

Large portion of the budget was spent to providing the structural testing equipment and seismographs and microtremor devices based on the communication between Peruvian and Japanese researchers. These equipments are mainly purchased in Japan by Chiba University and shipped to Peru by JICA. The shipping process is relatively complicated and very new for Japanese researchers including petition of tax exemption and installation of equipment in sites.

The other focus of the project is the technical support by sending the Japanese experts to Peru and inviting the Peruvian researchers to Japan. Most of the Japanese researchers, especially the young researchers, have good experiences by working with Peruvian researchers to perform the laboratory tests and field surveys. Fig. 11 shows the Japanese researchers activities in Peru by organizing the lectures, seminars and filed survey.

Three short-term trainees have already studied in Japan from 6 to 8 months at Chiba University and Tohoku University. Two doctoral students are studying in Yokohama National University and Chiba University with the support by MEXT. We had the project workshop from March 9th to 11th in 2011 at Chiba University by inviting 15 and 5 researchers from Peru and Latin American countries, respectively. Fig. 12 shows the group picture at the workshop before the public symposium, for which more than 200 people attended. The technical tour was also organized for tsunami facility at Port and Airport Research Institute (PARI). After this technical tour, we met the 2011 Tohoku earthquake in City of Kamakura. Fig. 13(a) – (c) show the activities by Peruvian researchers and trainees in 2011. Fig. 13(a) is the technical tour at PARI, Fig. 13(b) shows the field survey for Tsunami damaged areas by Mr. Jimenez, he was a short-term trainee in Tohoku University, and Fig. 13(c) shows the seismograph data collections by Mr. Gonzales and Ms. Uriarte, both were short-term trainees in Chiba University.

8. CONCLUSIONS

An international research program named "Science and Technology Research Partnership for Sustainable Development (SATREPS)" has started under the joint sponsorship of JST and JICA. This paper describes the project background, objectives and research activities for the past two years. The progress of the projects is presented as a result by the strong collaboration between Peruvian and Japanese researches. The field survey for 2010 Maule Earthquake in Chile was also performed by coordinating the Peruvian and Japanese researchers with the support by Chilean researches. The activities by young researchers in Japan are described as a short-term trainee and doctoral student. The project will continue to conduct a comprehensive research towards earthquake and tsunami disaster mitigation in Peru for coming three years. Seismic losses and those mitigation technologies are studied regarding the regional characteristics in Peru under strong collaboration among Peruvian and Japanese researchers. The project will also provide the educational opportunities for younger Peruvian researchers.

Fig. 12 The 2nd Japan-Peru Workshop on Enhancement of Earthquake and Tsunami Disaster Mitigation Technology in Peru at Chiba University in March, 2011

Fig. 13 Activities by Peruvian Researchers and Trainees in Japan (a) Technical Tour at PARI, (b) Tsunami Damage Survey at Onagawa, (c) Training for Seismograph Data at Chiba University

Acknowledgements:
This project is supported by Japan International Corporation Agency and Japan Science Technology under the framework of Science and Technology Research Partnership for Sustainable Development (SATREPS). Authors acknowledge both of agencies for these support which enable us to perform the international joint research with overseas universities and researchers. Authors also acknowledge the Japanese Embassy in Peru and Peruvian Embassy in Japan for providing the opportunities to exchange the opinions from different institutes and organizations.

References:

JICA (2009), "Minutes of meeting between JICA detailed planning survey team and the National University of Engineering.

JST-JICA SATREPS Peru Project Chile Earthquake Field Investigation Team (2010), "2010 Chile Earthquake and Tsunami Technical Report," http://ares.tu.chiba-u.jp/peru/pdf/output/tr/JST-JICA-CHILE-EARTHQUAKE-AND-TSUNAMI-REPORT.pdf

USGS (2007), "Poster of the Ica, Peru Earthquake of 15 August 2007 -Magnitude 8.0, Earthquakes Hazard Program USGS," 2007, http://earthquake.usgs.gov/earthquakes/eqarchives/poster/2007/20070815.php

JOINT CONFERENCE PROCEEDINGS
9th International Conference on Urban Earthquake Engineering/ 4th Asia Conference on Earthquake Engineering
March 6-8, 2012, Tokyo Institute of Technology, Tokyo, Japan

URBAN PLANNING PROCESS FOR RECOVERY THROUGH COMPARISON OF MIYAGI AND IWATE PREFECTURES

Shoichi Ando

Director of International Institute of Seismology and Earthquake Engineering (IISEE), The Building Research Institute (BRI), Tsukuba, and Professor of the University of Tokyo,
ando@kenken.go.jp (IISEE/BRI), ando@mps.t.u-tokyo.ac.jp (The University of Tokyo), Dr.

Abstract: Miyagi prefecture and Iwate prefecture took different recovery policies after the 2011 Great East Japan Earthquake.The difference was caused by the future perspectives on reconstruction of each affected area and it results in different recovery processes and projects on housing and building reconstruction. Application of various types of system provides an opportunity to analyze issues of each reconstruction process and future issues of the urban planning systemsthat are provided by the City Planning Law and the Building Standard Law. The authorproposes recovery policies through comparisonto other reconstruction case such as theGreat Hanshin-Awaji Earthquake, Indian Ocean Tsunami etc.

1. URBAN PLANNING AND THE GREAT EAST JAPAN EARTHQUAKE

Both of theBuilding 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[i]the term of "tsunami" in the law,because most of recovery processes were prepared against urban fire. 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, 2011represents the first huge tsunami disaster during more than half century of history of both legal systems.[ii]

Within the 3 most affected prefectures by the Great East Japan Earthquake, Miyagi prefecture and Iwate prefecture are now taking different recovery processes especially for restriction of housing and building reconstruction.This paper reviews the processes of both prefectures in terms of housing and building reconstruction and summarizes key issues from April up to December 2011 in order to avoid future problems of middle and long term recovery.

There is no"Urbanization Promotion Area (UPA)[iii]"in the 2011 tsunami affected areas in Iwate prefecture, while most of Sendai plain in Miyagi prefecture is clearly divided into UPA and Urbanization Control Area (UCA)[iv].

Most of Sanriku areasare not applied "Area Division (to classify into UPA and UCA)" even in Miyagi prefecture like Minami-sanriku Town and Kesennuma City, because there was notso much pressure on increase of population. Area Division system should be appliedto the area where urban settings are already formulated or where urban development is expected within the next 10 years. However, in 1964 when the current City Planning Law was established there existedfew scientific and engineering knowledge on tsunami to establish legal systems, and both laws do not function well in reality.

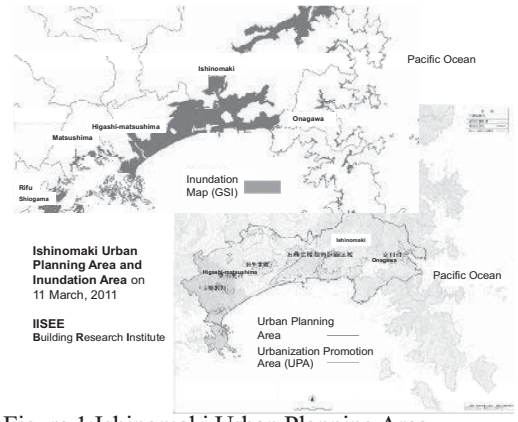

Figure 1:Ishinomaki Urban Planning Area
(pink; inundated areas by GSI, red line; Urbanization Promotion Area)

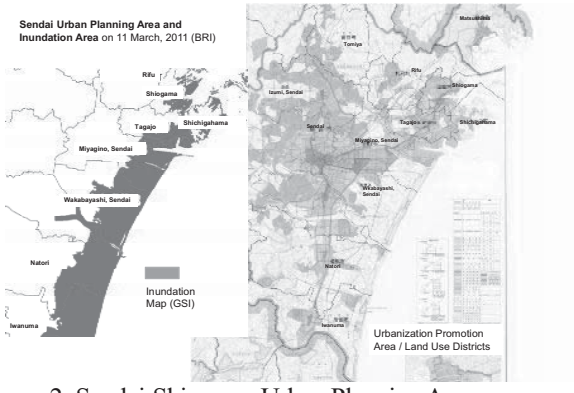

Figure 2: Sendai-Shiogama Urban Planning Area
(Pink; inundated areas, colored zones; Land Use Districts in UPA)