Review:

SATREPS Project on Enhancement of Earthquake and Tsunami Disaster Mitigation Technology in Peru

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[Received November 24, 2012; accepted November 29, 2012]

This project conducts comprehensive research on earthquake and tsunami disaster mitigation in Peru in 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, i.e., seismic motion and geotechnical, tsunami, buildings, damage assessment, and disaster mitigation planning. Almost three years have passed since the five-year project started in March 2010. During this period, researchers in different fields from Japan and Peru collaborate to achieve the overall objectives of the project. This paper summarizes the research framework and progress of the JST-JICA project on earthquake and tsunami disaster mitigation technology in Peru.

Keywords: earthquake, tsunami, disaster mitigation, international cooperation, Peru

1. Introduction

A new international research program called "Science and Technology Research Partnership for Sustainable Development (SATREPS)" was started in 2008 under the joint sponsorship of Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA). The scheme of SATREPS is shown in **Fig. 1**. JICA, supervised by the Ministry of Foreign Affairs (MOFA), supports the project as a part of Official Development Assistance (ODA), which requires the implementation of practical technologies to Peruvian society. At the same time, JST, under the Ministry of Education, Culture, Sports, Science and Technology (MEXT), expects us to achieve scientific goals, e.g., developing novel theories and new technologies.

Research proposals in the following four fields were invited to apply for the SATREPS grant: 1) Environment and Energy, 2) Bio-resources, 3) Natural Disaster Prevention, and 4) Infectious Disease Control. A proposal submitted by the present authors, "Enhancement of Earthquake and Tsunami Disaster Mitigation Technology in Peru," was granted as one of the projects in the field of natural disaster prevention in April 2009.

This project conducts a comprehensive research for earthquake and tsunami disaster mitigation in Peru considering regional characteristics, in strong collaboration among researchers of Peru and Japan. The first author, F. Yamazaki, is the principal investigator (PI) of the Japanese team and the second author, C. Zavala, is the PI of the Peruvian team. After the preliminary acceptance of our project, the preparatory phase started to plan the details of the joint research considering the needs of the developing country (Peru) and the promotion of science and technology on the global issue (disaster mitigation).

The Record of Discussion (R/D) was signed on January 15, 2010, by the responsible authorities of the two nations, i.e., JICA and National University of Engineering in Lima, Peru. The project then was formally started and will continue for a five-year period until March 2015. This paper describes the overall objectives, research plan, and progress of the SATREPS Peru project.

2. Background and Objectives of the Peru Project

Natural disasters are one of the major threats to the people of the world. Earthquakes and tsunamis are major obstacles to sustainable development, especially for countries in the Asia-Pacific region. Understanding of natural hazards and upgrading of societal resilience are necessary in order to reduce disaster risks. Since earthquakes and tsunamis are rare but devastating events, data collection on a global scale is necessary and international collaboration is inevitable for reducing losses due to these events, as highlighted in the Hyogo Framework of Action [1]. In this sense, Japan is expected to serve a leading role in the promotion of international disaster mitigation because of its long history of coping with natural disasters.

Peru is located in the circum-Pacific seismic belt of high seismic and tsunami risk. **Fig. 2** shows tectonic set-

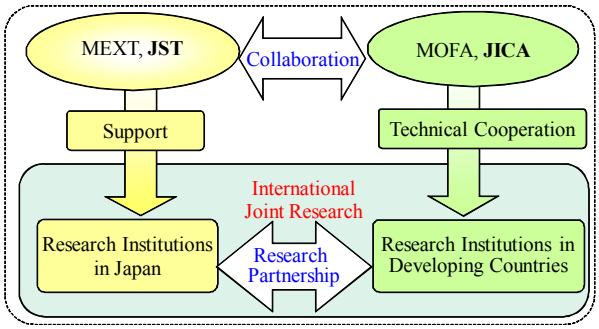

Fig. 1. Scheme of Science and Technology Research Partnership for Sustainable Development (SATREPS).[1]

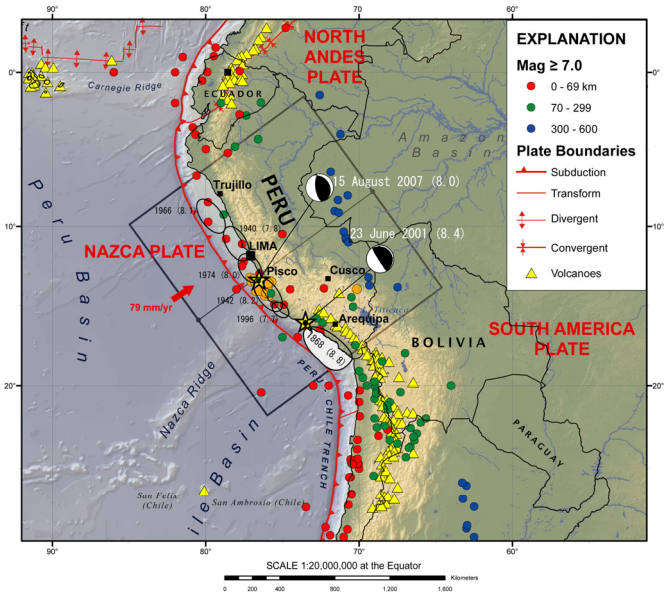

Fig. 2. Tectonic settings and epicenters of earthquakes in Peru and surrounding regions (modified from USGS [2] and Chlieh et al. [3]).

tings and epicenters of earthquakes in Peru and the surrounding regions. Note that both Peru and Japan are located in similar seismic environments, frequently hit by damaging earthquakes and tsunamis. In this region, large plate-boundary earthquakes have occurred recently offshore of Atico (Mw = 8.4, June 23, 2001) and offshore of Pisco (Mw = 8.0, August 15, 2007). A large number of buildings and infrastructures were destroyed, hundreds of people were killed, and tsunamis were generated by these events. Thus, in recent years, earthquake and tsunami disaster mitigation has drawn considerable attention in Peru.

Not only due to the physical similarities of the two countries, Peru and Japan have had a long-term relationship since 1873 when official relations started. A large number of immigrants from Japan settled in Peru in the early 20th century.

Their relationship in the field of disaster mitigation technology also has some history. Japan-Peru Center for Earthquake Engineering and Disaster Mitigation (CISMID) was established at the National University of Engineering (UNI) in 1987 through the support of the Government of Japan. CISMID, as one of the leading centers for earthquake engineering research in Latin America, has collaborated with many Japanese research institutions, notably the Building Research Institute (BRI) in Tsukuba, Japan.

1. http://www.jst.go.jp/global/english/about.html

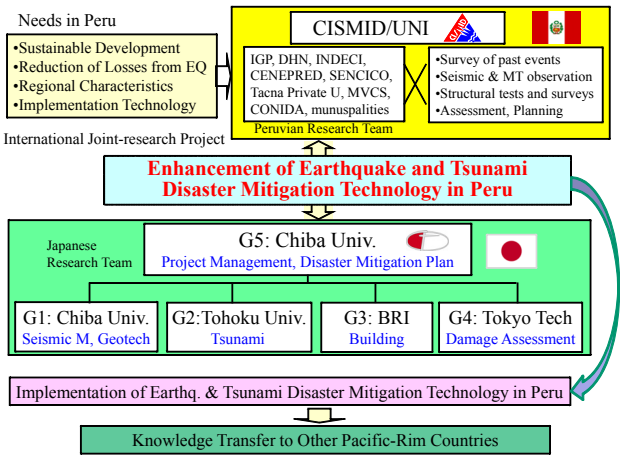

Fig. 3. Structure and member organizations of the project.

The significance of this joint research between Peru and Japan is summarized in the following four points: 1) the contribution of Japanese science and technology to disaster mitigation in Peru, 2) the providing of research fields to Japanese geoscience and earthquake engineering communities, 3) contributions to international research on tele-tsunamis caused by subduction-zone earthquakes, and 4) the promotion of disaster mitigation and human resources development through the sharing of knowledge from joint international research.

3. Overall Research Plan and Member Organizations

In this research project, comprehensive research on earthquake and tsunami disaster mitigation in Peru will be carried out through strong collaboration among researchers from Peru and Japan. **Fig. 3** shows the organizational structure of this five-year project. Joint research will be carried out on five main research topics: 1) Strong motion prediction and development of seismic microzonation; 2) Development of tsunami countermeasures based on numerical simulation; 3) Enhancement of seismic resistance of buildings based on structural experiments and field investigations; 4) Development of spatial information databases using remote sensing technology and earthquake damage assessment for scenario earthquakes; 5) Development of earthquake and tsunami disaster mitigation plan and its implementation into society.

Japanese research team consists of five groups (G1 to G5 in **Fig. 3**) corresponding to the five topics.

Peruvian research team consists of CISMID/UNI, Na-

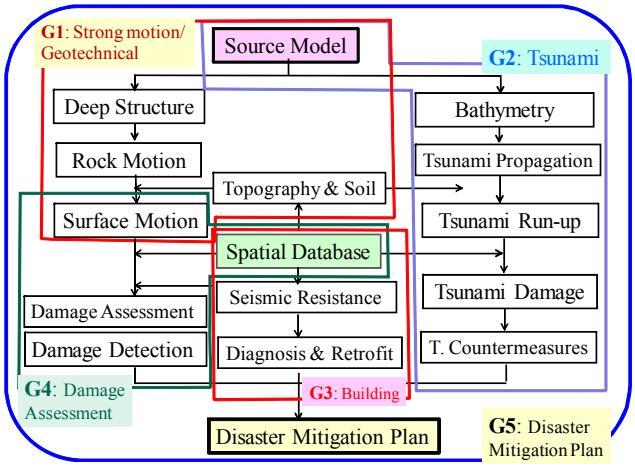

Fig. 4. Flowchart and research topics of the Peru project and the five groups in charge.

tional Institute of Civil Defense (INDECI), Geophysical Institute of Peru (IGP), Direction of Hydrology and Navigation (DHN), National Committee for Aerospace Research and Development (CONIDA), Disaster Prevention and Study Center (PREDES), National Institute of Culture (INC), Ministry of Housing, Construction, and Sanitation (MVCS), National Service of Training for the Construction Industry (SENCICO), Tacna Private University (UPT), National Office of Electronic Government and Information (ONGEI-PCM), and Municipalities in the project's study areas.

In 2011, "National System for Disaster Risk Management: synergistic, decentralized, participatory and cross system (SINAGERD)" was issued by the Peruvian Government. Under this new law, a new government agency called CENEPRED (Centro Nacional de Estimación, Prevención y Reducción del Riesgo de Desastres) was established. CENEPRED is in charge of the reconstruction, estimation, prevention, and reduction stages of the disaster risk management process, while INDECI is in charge of the preparedness, response, and rehabilitation stages. These two organizations are considered the two pillars supporting the Presidency of the Council of Ministers (PCM) in disaster risk management. Considering the importance of CENEPRED in natural disaster reduction in Peru, we invited CENEPRED to be one of the key members of the project in August 2012.

Figure 4 shows research topics and items of the project and the groups in charge of them. Based on research output from four groups (G1-G4), the disaster mitigation plan group (G5) will propose and implement earthquake and tsunami disaster mitigation plans for case study areas in Peru. Two case study areas, Metropolitan Lima (including Callao) and Tacna, were selected after preliminary surveys. In addition to these two areas, areas affected in recent earthquakes, i.e., Pisco in the 2007 event and Camana and Arequipa in the 2001 event, were also selected as developing hazard and damage assessment models.

4. Scope and Prospected Outputs of the Project

The Japanese Detailed Planning Survey Team organized by JICA visited Peru from August 5 to 13, 2009, for the purpose of working out the details of the technical cooperation program concerning the project. During its stay in Peru, the team exchanged views and had a series of discussions with Peruvian organizations concerned, led by CISMID/UNI. As a result, the team and Peruvian organizations agreed on the matters referred in the document [4].

The objective of this project has been agreed to as "developing technologies and measures for the assessment and mitigation of earthquake and tsunami disasters caused by large-magnitude interplate earthquakes occurring off the coast of Peru." It is further envisaged that such technologies be widely used in Peru and also disseminated and applied in other Pacific-rim countries, especially in neighboring countries facing the risks of large-magnitude interplate earthquakes and tsunamis. In addition, the project is expected to contribute to human resources development as well as research advancements in Peruvian and Japanese institutes involved in the project.

The following seven expected outputs are listed in the agreed-upon master plan:

1) Scenarios of large-magnitude interplate earthquakes are identified that will potentially cause the most significant losses in Peru (G1, G2).

2) Geographical information on study areas is prepared (G4).

3) Tsunami disaster losses in study areas by scenario earthquakes are estimated and mitigation technologies are developed (G2).

4) Strong motion and ground failure in study areas by scenario earthquakes are simulated (G1).

5) Earthquake disaster losses in study areas by scenario earthquakes are estimated, and mitigation technologies are developed (G4).

6) Technologies for evaluating seismic-resistance and structural retrofit are developed, adapted to building characteristics of Peru (G3).

7) Earthquake and tsunami disaster mitigation is promoted in study areas (G5).

The schedule of the five-year project is shown in **Table 1**. To implement the project, JICA will provide the services of JICA experts (Japanese research members), machinery, equipment and other materials necessary for conducting the project and will receive Peruvian personnel for technical training in Japan. Actual joint research is carried out by the five joint research groups. In addition to group-based technical collaborations, project members meet annually either in Peru or Japan on occasions of project workshops and other events.

Table 1. Schedule of SATREPS Peru project.

Research Items	Period FY (2010-2014)				
	2010	2011	2012	2013	2014
Project Management 【Chiba U and CISMID/UNI】	WS▼	WS▼ JCC▼	WS▼ JCC▼	WS▼ JCC▼	WS▼ JCC▼
G1: Seismic motion & Geotechnical 【Chiba U and CISMID, IGP】 1-1 Source modeling and seismic motion 1-2 Site response & Microzonation 1-3 Slope failure assessment	Source modeling EQ and MT observation, Geological survey Field survey, measurement	Simulation of SM	Seismic Response Analysis	Microzonation	Hazard map
G2: Tsunami 【Tohoku U and DHN, CISMID】 2-1 Tsunami propagation and impacts 2-2 Tsunami hazard mapping 2-3 Tsunami DM technology	Tsunami simulation Data collection Historical tsunami data	Inundation and impact Damage assessment method	Tsunami DM technology	Tsunami damage analysis	
G3: Buildings 【BRI and CISMID】 3-1 Seismic tests database 3-2 Diagnosis and Retrofit 3-3 Retrofit of historical buildings	Literature Survey, Tests Develop diagnosis method Survey, Risk assessment	Database development Retrofit technology, Validation tests Retrofit Technology		Guideline Guideline	
G4; Damage Assessment 【Tokyo Tech and CISMID, CONIDA】 4-1 Geo-spatial database 4-2 Damage detection using RS 4-3 Damage assessment for Scenario EQ	Data collection Data collection Damage assessment method	Geospatial data Methodology	Database development Damage detection Assessment, risk map		
G5; Disaster Mitigation Plan 【Chiba U and INDECI, CENEPRED, CISMID】	Literature Survey		Planning	Dissemination, Education	

5. Research Activities

First, we selected the two case study sites, Lima and Tacna, for this research project. The Lima metropolitan area is the capital and the largest city in Peru, with about eight million in population. Tacna is the regional capital city of the Tacna Region in southern Peru on the border with Chile.

Scenario earthquake events for damage assessment were determined based on recent studies [5, 6]. Two major historical earthquakes shown in **Fig. 5** were selected for this purpose because these two events are the most damaging and are expected to have significant effects on Peru.

The first event is the 1746 Lima-Callao earthquake (Mw8.6) that destroyed the city of Lima completely and produced about 6,000 deaths. The second event is the 1868 southern Peru (Arica) earthquake (Mw8.8), which produced large tsunamis along the coasts of Peru and Chile. (Note that Arica, now a part of Chile, belonged to Peru at that time.) The earthquake almost completely destroyed Arica, Tacna, Moquegua and Arequipa areas, with about 25,000 deaths. The recurrence of these mega-earthquakes is anticipated along the Peru-Chile Pacific coast [7].

Each group performs research on the basis of the master plan. Group 1 studies seismic motion and geotechnical aspects in Peru. In this regard, ten accelerometers were provided to Peru in this project to enhance seismic observation systems in Peru. **Fig. 6** shows the location of the new accelerometers together with existing ones on the Lima's subsurface soil map [8, 9]. Seismic records obtained by the instruments are posted on the CISMID web page.

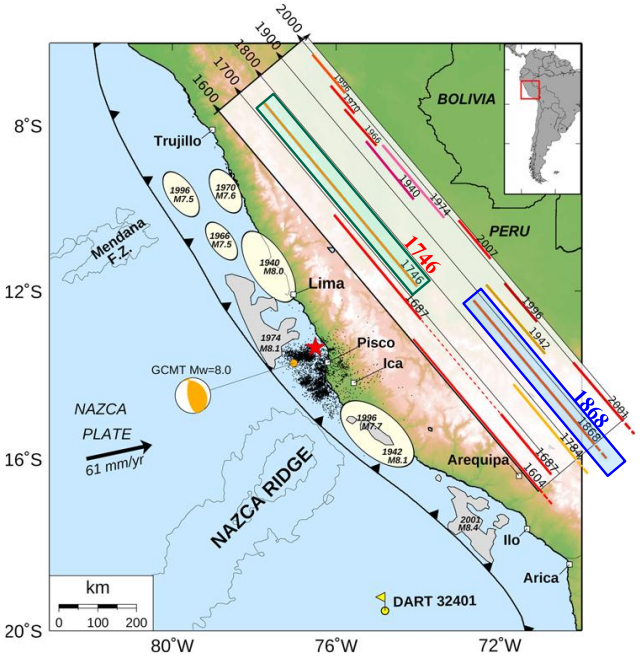

Fig. 5. Location of major earthquakes in Peru [5] and two scenario earthquakes employed in this study.

Group 1 also performs site investigations to measure ground response and shear wave velocity profiles at the case study sites by microtremor observations. Based on microtremor and seismic observations and existing geological data, the amplification ratios of the Fourier spectra were proposed for Lima to produce microzonation

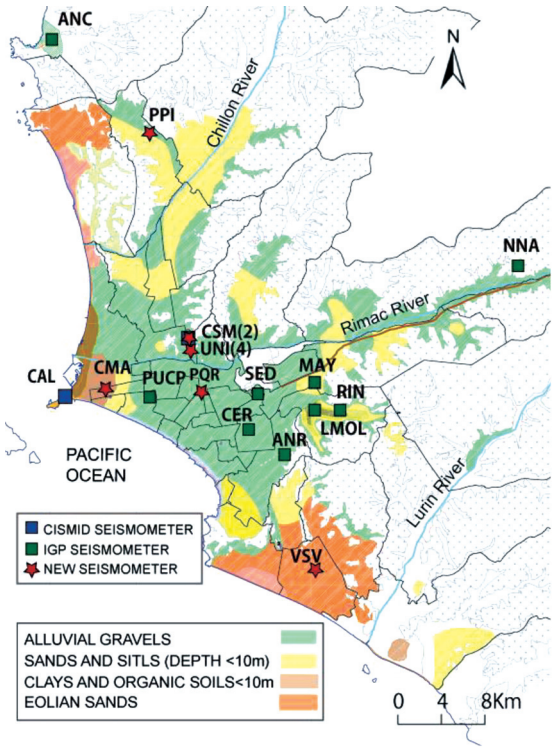

Fig. 6. Location of seismometers in Lima on a soil distribution map [8, 9].

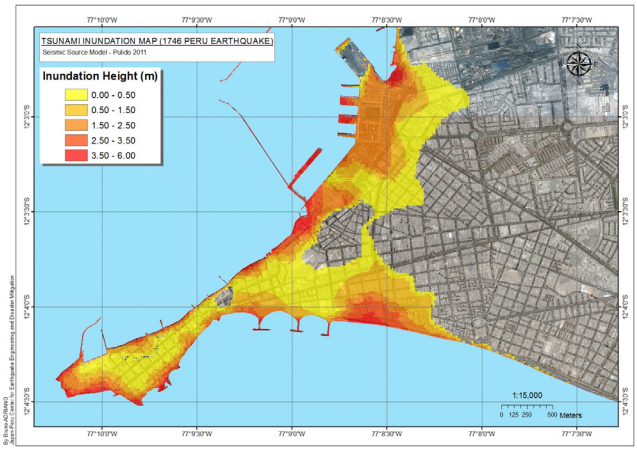

Fig. 7. Result of tsunami inundation simulation at La Punta for the 1746 Lima-Callao earthquake [11].

maps [8].

Group 2 studies tsunami modeling, numerical simulation, damage assessment, and evacuation planning. Adriano et al. [10] calculated tsunami inundation areas for the 2001 Atico earthquake, and compared the computed tsunami run-up height with field observation data. The study shows good agreement between them, which confirms the application of numerical simulation to tsunami hazard evaluation in Peru. **Fig. 7** shows a result of tsunami propagation simulation for the 1746 Lima-Callao earthquake [11]. This kind of results are currently utilized to map inundations in Callao and are referenced in evacuation planning in the La Punta district in Callao [12].

Fig. 8. Structural test at CISMID using the newly introduced jack system (bottom).

Group 3 studies seismic resistance and retrofit of buildings in Peru. The structural laboratory of CISMID was established in 1987, and since then, initially introduced testing equipment had been used. New structural and material testing systems were recently introduced using the JICA's budget for this project, as shown in **Fig. 8**. Using the new equipment, cyclic loading tests were conducted for a typical structural system in Peru [13]. These experiments create a database to determine effective retrofit methods for buildings in Peru, combined with field survey data.

Group 4 assesses seismic damage to buildings in the case study sites for the scenario earthquakes. **Fig. 9** shows an example of a building inventory in Lima obtained from the combined use of census data, satellite images, and land-use and digital elevation maps [14]. Group 4 also develops the methods of earthquake damage detection using satellite optical and Synthetic Aperture Radar (SAR) images. For the 2007 Pisco earthquake, building damage detection was carried out using high-resolution optical satellite images [15] and moderate-resolution satellite SAR (ALOS/PALSAR) intensity images [16]. These damage detection methods are considered to be useful in early damage assessment after the occurrence of large-magnitude earthquakes.

Integrating all output from each research group, Group 5 proposes disaster mitigation plans for the case study areas. Various spatial data including land-use, roads and buildings, geological profiles and elevations should be gathered in addition to studying laws and regulations related to urban planning in Peru. **Fig. 10** shows the land-

Fig. 9. Satellite image and photographs taken in the field survey for building inventory development in Lima [14].

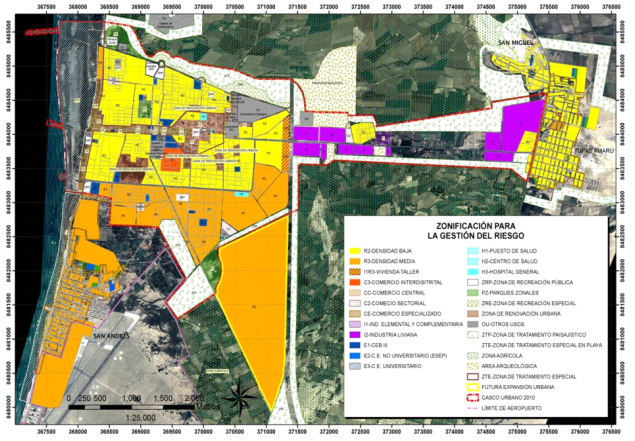

Fig. 10. Land-use plan for Pisco city proposed by CISMID after the 2007 Pisco earthquake.

use plan for central Pisco city proposed by CISMID after the 2007 Pisco earthquake. Since buildings in this area were severely damaged due to strong seismic motion, soil condition was the major factor for this proposed land-use.

6. Joint Field Survey for the 2010 Maule, Chile, Earthquake

An earthquake with a moment magnitude (Mw) of 8.8 occurred off the coast of the Maule Region of Chile on February 27, 2010, at 03:34 local time (06:34 UTC). The event took place at the convergence boundary where the Nazca plate subducts under the South American plate. The tsunami generated by the earthquake hit the coastline of Chile and propagated across the Pacific Ocean to Pacific islands and Japan. As a part of the SATREPS Peru project, three survey teams, supported by JST and consisting of Japanese and Peruvian researchers, were dispatched to affected areas from early April to May, 2010, as shown in **Fig. 11**. The reason why such international groups conducted the field survey was that lessons from the 2010 Chile event are expected to apply to earthquake and tsunami disaster mitigation technologies in Peru because the two countries have common regional tectonics and similar natural/social environments.

The first survey team collected quick damage data with the aid of GPS and high-resolution satellite images. Georeferenced photos and videos were taken in hard-hit areas such as the example shown in **Fig. 12**. The results of field survey and analysis using high-resolution satellite images and collected GIS data were presented in a paper [17].

The second survey team, consisting of tsunami scientists, focused on measurement of tsunami inundation height, flow depth and inundation extent, inspection of structural damage, and collection of eyewitness accounts. Using inundation depths obtained in the field survey and through damage inspection using pre- and post-event satellite imagery in Dichato, tsunami fragility curves were constructed for the first time in southwestern Pacific countries [18].

The third survey team, consisting of structural engineers, geotechnical engineers, and seismologists, conducted a field investigation on strong motion, local site effects, and building damage. In order to evaluate the seismic source model, Pulido et al. [19] calculated coseismic vertical displacements and compared them with observed uplift and subsidence values measured along the coastline as well as with displacements obtained from strong ground motion and high-sampling GPS records. Saito et al. [20] summarized detailed information on buildings damaged due the earthquake.

The reconnaissance report was written and posted on the project's website [21]. These studies will be used for understanding earthquake and tsunami disasters in South America.

7. Project Management and Outcome

For project management, project workshops are held annually either in Peru or Japan. The first workshop was held at the CISMID conference hall in Lima on March 15 and 16, 2010, as shown in **Fig. 13**. In this kick-off workshop, the Japanese Ambassador to Peru, the JICA

Fig. 11. The 2010 Maule, Chile, earthquake reconnaissance survey teams set up by SATREPS Peru Project. Team 1 to 3, left to right.

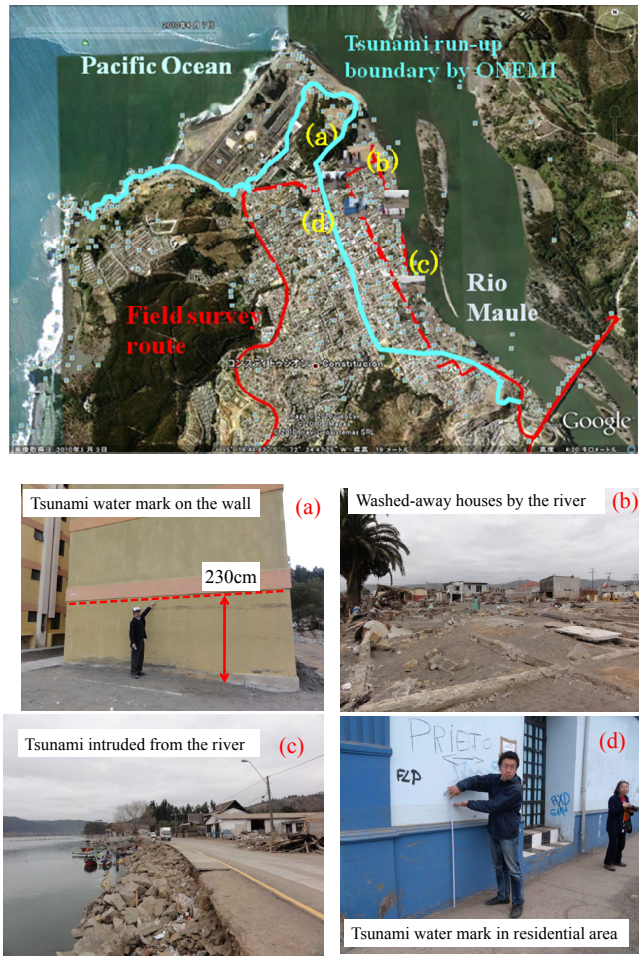

Fig. 12. Field survey route and photo shooting points on a satellite image of Constitución (top) and geo-referenced field photos (bottom).

Fig. 13. Participants in the first workshop on March 15–16, 2010, at CISMID/UNI in Lima, Peru.

Fig. 14. Participants in the second workshop on March 9-10, 2011, at Chiba University in Chiba, Japan.

Lima office Director, and JST representatives attended in addition to 25 Japanese researchers. From the Peruvian side, the president and directors of UNI, representatives of the Peru International Cooperation Agency (APCI), and members of the project and other engineers/students participated. We also invited ten earthquake engineering researchers from neighboring Latin American countries. The total number of participants, including the audience, was about 500 for this two-day workshop. The reason for such significant attention to this project in Peru was partially due to the 2010 Maule, Chile, earthquake, which occurred about two weeks before the workshop.

The second workshop was held at Chiba University in Chiba, Japan on March 9 and 10, 2011, as shown in **Fig. 14**. Fifteen researchers from Peru and five from neighboring Latin American countries were invited together with Japanese members. After the two-day workshop, participants from overseas and some Japanese members went on a technical visit to the Port and Airport Research Institute (PARI) in Yokosuka, Japan, to observe its large-scale tsunami testing facility. After viewing an artificial tsunami in the morning, the 2011 Great Tohoku earthquake occurred in the afternoon when they were in Kamakura. This workshop thus became truly unforget-

Fig. 15. Participants in the third workshop on March 13, 2012, in Tokyo, Japan.

Fig. 16. Activities of Japanese researchers in Peru; (a) seminar at Peruvian Congress on earthquake and tsunami disaster mitigation technology, (b) tsunami simulation seminar and training at CISMID, (c) training of young researchers in Lima about microtremor measurement.

table, especially for the overseas participants.

The third workshop was held with more than 70 participants in Japan again on March 13, 2012 (**Fig. 15**) because of the one-year anniversary of the 2011 Tohoku earthquake. We discussed the progress of the project and the annual schedule for the coming fiscal year. The participants also attended the International Symposium on Earthquake and Tsunami Disaster Reduction, commemorating the Tohoku earthquake, held in Sendai from March 14 to 16, organized by JICA, JST, and National Research Institute for Earth Science and Disaster Prevention (NIED). For this symposium, members from four SATREPS projects related to earthquake and tsunami, i.e., Indonesia, the Philippines, Peru and Chile, participated and shared knowledge and technologies in this field.

One of the important aspects of the Peru project is technical supports by sending Japanese experts to Peru or inviting Peruvian researchers to Japan. Japanese researchers, especially young researchers, gain experience by working with Peruvian researchers in performing laboratory tests and field surveys. **Fig. 16** shows activities of Japanese project members in Peru, such as (a) a seminar at the Peruvian Congress, (b) a tsunami simulation seminar and training, and (c) training in microtremor measurement.

The project also invites young Peruvian researchers for human resources development. Five short-term trainees have already been invited to study in Japan, with the support of JICA, at Chiba University, Tohoku University and the Building Research Institute. Three doctoral students from CISMID/UNI selected for Japanese Government Scholarships by MEXT are now studying at Yokohama National University, Chiba University and Tokyo Institute of Technology.

The Joint Coordinating Committee (JCC), defined in the minutes [4], was organized soon after the start of the project. JCC provides oversight on the project and meets annually and as necessary, in order to fulfill the following functions:

1) Approve an annual work plan of the project,
2) Review progress of the annual work plan,
3) Review and exchange opinions on major issues that may arise during implementation of the project,
4) Discuss other issues pertinent to smooth implementation of the project.

The first JCC meeting was held in September 2011 in Lima, Peru, attended by the president of UNI, the director of the JICA Peru office, APCI representative, the Japanese Ambassador to Peru, and related organizations of Peru and Japan. The progress of the project was accepted by the JCC.

Fig. 17. Activities in August 2012 at (a) the second JCC meeting at CISMID, (b) a visit of the Public Awareness Center of INDECI in Arequipa, (c) the Peru-Chile-Japan International Symposium in Tacna.

In August 2012, the mid-term project review was conducted in Lima together with the second JCC (**Fig. 17a**) following the project evaluation procedure of JICA. The evaluation team, consisting of JICA consultants and headquarters members and JST observers, interviewed Peruvian stakeholders and judged that the progress of the project as on schedule. After the review activities, the 25th Anniversary Symposium of CISMID was held on August 17 and 18. The presence and role of CISMID in the field of earthquake disaster mitigation in Peru and South America was found to grow steadily.

After the events in Lima, Japanese and Peruvian researches visited the Public Awareness Center of INDECI in Arequipa (**Fig. 17b**). We discussed support from Japan for public awareness and education on earthquakes and tsunamis in Peru, based on experience in Japan.

It is recognized that subduction zone earthquakes in southern Peru, like the 1868 event, affect both Peru and Chile. Fortunately, the SATREPS Chile project on tsunami disaster reduction started in the beginning of 2012 and collaboration between the two government agencies, INDECI (Peru) and ONEMI (Chile), also started recently in response to earthquakes and tsunamis near borders of Peru and Chile. Given these circumstances, members of both SATREPS projects gathered in Tacna, near the border, on August 20, 2012. The first Peru-Chile-Japan symposium on earthquake and tsunami disaster mitigation was held with the participation of representatives from CENEPRED, INDECI, ONEMI, JICA, and UNESCO as well as SATREPS researchers and local residents (**Fig. 17c**). We wish this event be just the first-step in international collaboration in earthquake and tsunami disaster mitigation in South America.

8. Conclusions

An international research program called "Science and Technology Research Partnership for Sustainable Development (SATREPS)" has been started under joint sponsorship by JST and JICA. This paper has described the background, objectives and research activities of the SATREPS project "Enhancement of Earthquake and Tsunami Disaster Mitigation Technology in Peru." The project has been promoted by five research groups, i.e., seismic motion and geotechnical, tsunami, buildings, spatial information database and damage assessment, and disaster mitigation planning.

Almost three years have passed since the five-year project started in March 2010. During this period, researchers in different fields from Japan and Peru collaborate to achieve the overall objectives of the project. To promote the project, JICA has provided equipment and other materials for Peru and has received Peruvian personnel for technical training and meetings in Japan. Japanese researchers were dispatched to Peru to promote joint research and to give training courses.

A field survey of the 2010 Maule, Chile, earthquake was also carried out by coordinating Peruvian and Japanese researchers. Three project workshops have already been held either in Peru or Japan with the attendance of researchers from Japan, Peru and Latin America countries. The project has also contributed to human resources development by providing educational opportunities to young Peruvian researchers at Japanese universities and research institutes.

The project will continue for two more years and is expected to contribute greatly in enhancing earthquake and tsunami disaster mitigation technology in Peru and neighboring Latin America countries.

Acknowledgements

This project is supported by Japan International Corporation Agency (JICA) and Japan Science and Technology Agency (JST) in the framework of Science and Technology Research Partnership for Sustainable Development (SATREPS).

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[4] Japan International Cooperation Agency, "Minutes of meeting be-

Appendix A. List of the Project Members

Group	Peru	Japan
G1	Zenon Aguilar (CISMID)	Shoichi Nakai (Chiba University)
	Jorge Alva (CISMID)	Toru Sekiguchi (Chiba University)
	Fernando Lazares (CISMID)	Hiroaki Yamanaka (Tokyo Tech)
	Diana Calderón (CISMID)	Hiroshi Arai (NILIM)
	Ronald Woodman (IGP)	Nelson Pulido (NIED)
	Hernando Tavera (IGP)	Shin Koyama (BRI)
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