



Science and Technology Research Partnership for Sustainable Development (SATREPS) supported by JST and JICA



## Enhancement of Technology to Develop Tsunami-Resilient Community



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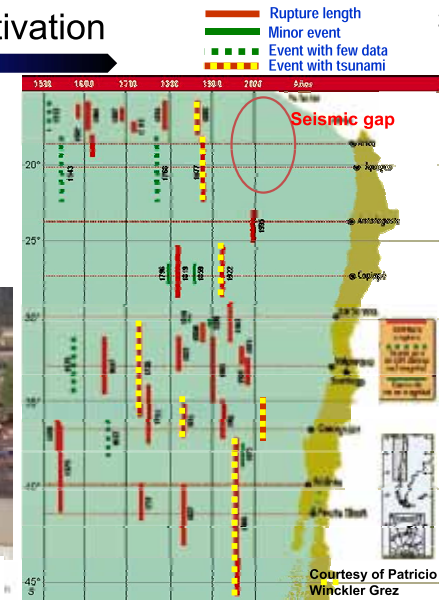
SATREPS For the Earth, For the Next Generation

## Background and Motivation

- Damage in Chile and Japan due to the 2010 Concepcion tsunami
- Another Tsunami in the northern part of Chile



Dichato struck by the 2010 Concepcion Tsunami  
Photo courtesy of Felipe Labrana Vasouez



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## Background and Motivation

- The 2010 Concepcion tsunami hit a modern area, the Port of Talcahuano, in which shipping containers were washed away and drawn into the sea by the tsunami
- This kind of tsunami damage would be caused in the northern part of Chile as well as Japan and other countries.

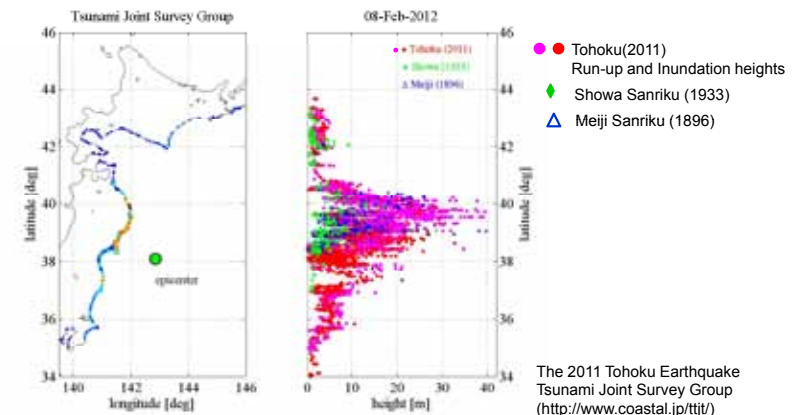


SATREPS For the Earth, For the Next Generation

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## Background and Motivation

- 20,000 dead and missing by the 2011 Tohoku tsunami in the Tohoku region, which is one of the areas that push most forward tsunami measures in Japan.



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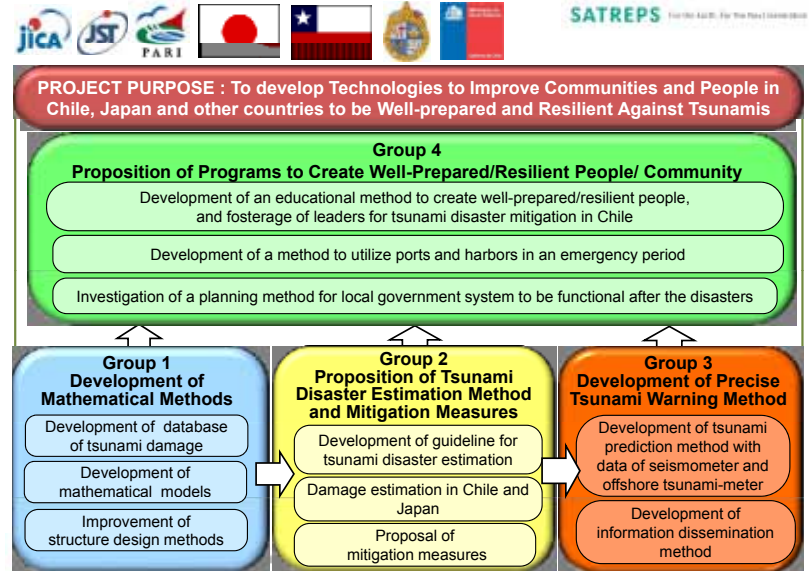
## Background and Motivation

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- Many tsunami disasters in Chile and Japan
- Many experiences and lessons from the disasters
  - Experience of the tsunami inundation due to the 1960 Valdivia earthquake promoted people's evacuation in Dichato in 2010.
  - Education of tsunamis promoted school children's evacuation in Kamaishi in 2011.
- Collaboration and cooperation
  - to develop and enhance measures to mitigate and/or control tsunami disasters
- We want to make the world that **no one would be killed by tsunamis and community would be resistant and resilient to tsunamis.**

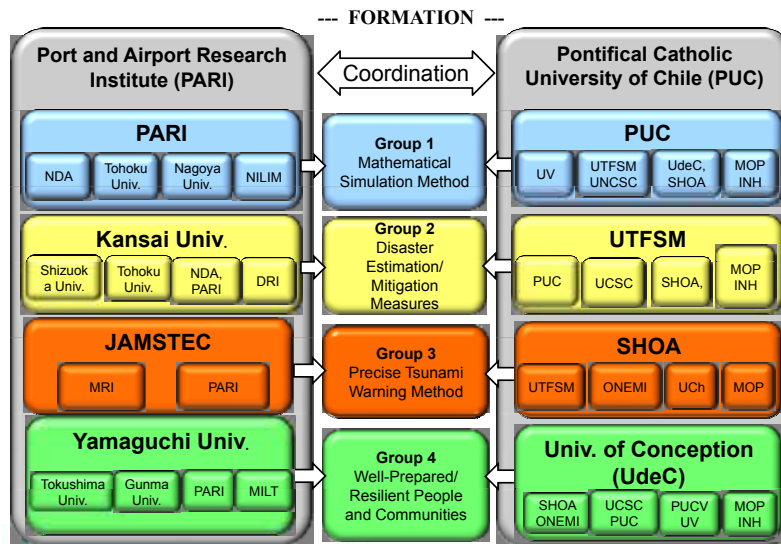
## Enhancement of Technology to Develop Tsunami-Resilient Community

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## Enhancement of Technology to Develop Tsunami-Resilient Community

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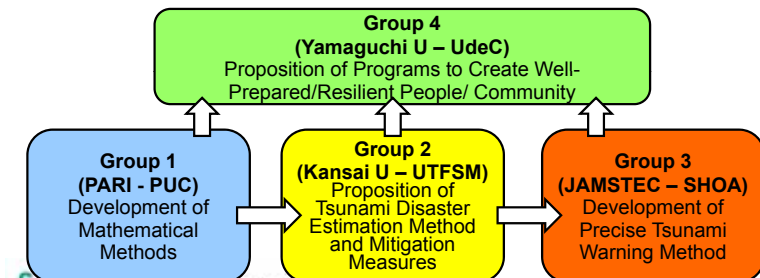
## Purpose and Formation

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### PURPOSE

To develop Technologies to Improve Communities and People in Chile, Japan and Other Countries to be Well-prepared and Resilient Against Tsunamis

### FORMATION



## G1 Development of Mathematical Models

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### Output

Mathematical simulation methods are developed to estimate tsunami damage.

### Activities

1. **Mathematical simulation models** are developed and improved to estimate tsunami damage accurately.
2. **Databases on disasters by the 2010 Chilean earthquake tsunami and 2011 Japanese earthquake tsunami** are constructed to understand and estimate disasters by possible tsunamis in the future.
3. **Impacts of tsunamis** are evaluated to improve planning and design methods for tsunami-disaster mitigation structures in view of the disasters by the 2010 Chilean earthquake tsunami and 2011 Japanese earthquake tsunami.

## Impacts of Tsunami

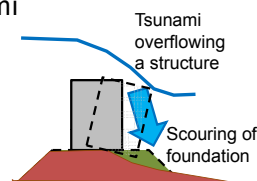
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## Mathematical Models

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- Tsunami inundation and runup, considering effects of rigid obstacles (seawall, RC buildings, etc)
  - Detailed structure and building data as well as digital surface data, such as LIDAR data
- Tsunami debris such as shipping containers, ships, boats, automobiles, etc.
  - e.g. PARI's model of STOC
- Scouring of sea bed
  - e.g. Takahashi et al. (2000)
- Tsunami bore and/or breaking tsunami
  - e.g., Iwase et al. (2001)



Ex. Tsunami inundation and debris calculation with the model of STOC and data of structures and houses

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## G2 Proposition of Tsunami Disaster Estimation Method and Mitigation Measures<sup>13</sup>

### Output

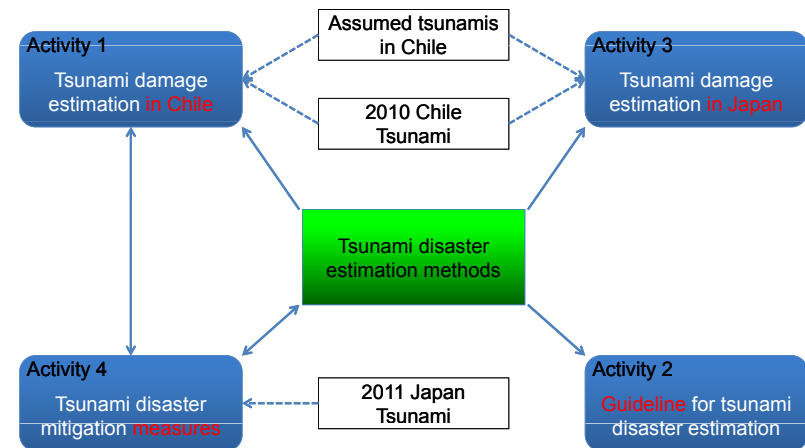
Tsunami disaster estimation methods and mitigation measures are proposed.

### Activities

1. Tsunami damage in the project study area is estimated for possible tsunamis generated off the coast in Chile in the future.
2. A guideline for tsunami disaster estimation is developed in Chile, based on mathematical simulations on possible tsunamis generated off the coast in Chile in the future.
3. Tsunami damage in Japan is estimated based on mathematical simulations on possible tsunamis generated off the coast in Chile in the future.
4. Tsunami disaster mitigation measures are proposed in accordance with tsunami disaster scenarios in Chile and Japan obtained.

## Framework of G2 Research

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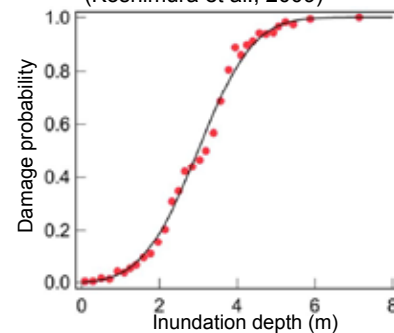
## Tsunami Damage Estimation

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Tsunami hazard mapping in a pilot site



Tsunami fragility curve (Koshimura et al., 2009)



## Tsunami Disaster Mitigation Measures

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Example of city planning against tsunami disaster (Kamaishi City, Iwate)



Residential region Residential region with restriction for buildings Non residential region

## G3 Development of Precise Tsunami Warning Method

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### Output

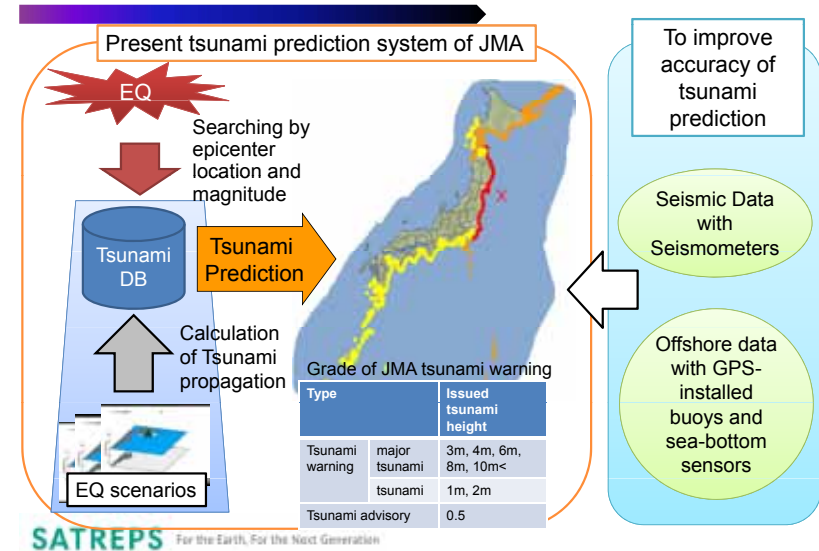
Precise tsunami warning method is developed.

### Activities

1. Precise tsunami prediction method is developed, incorporating data of seismometers and offshore tsunami-meters.
2. A method to disseminate tsunami information is developed in Chile with the use of Japanese experiences as references.

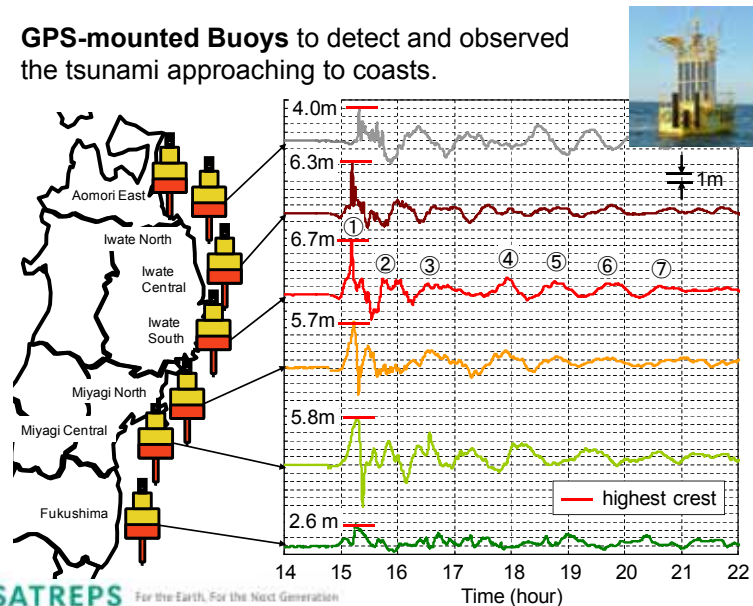
## Precise Tsunami Prediction Method

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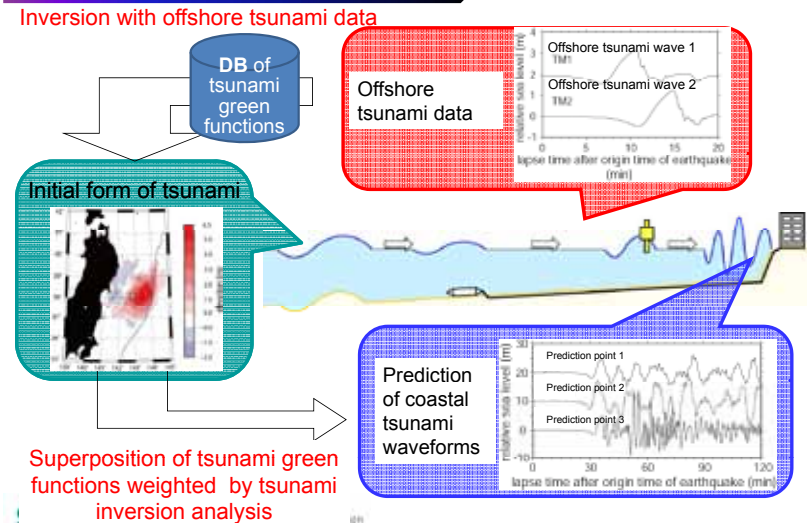
## GPS-mounted Buoys to detect and observed the tsunami approaching to coasts.

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## Real-time Inversion to Predict Tsunami in Coasts

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## G4 Proposition of Programs to Create Well-Prepared/Resilient People/ Community

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### Output

A program is proposed to create well prepared and resilient people and community.

### Activities

1. Educational methods are developed to create well prepared and resilient people against tsunamis, and leaders are fostered for tsunami disaster mitigation in Chile.
2. Method to utilize ports and harbors in a rescue phase after a tsunami disaster is developed with use of Japanese experiences as references.
3. Planning method for local government system to be functional after a tsunami disaster is investigated.

## Education Methods

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### Five sub-activities:

1. Evacuation
2. Education
3. Information system
4. Fostering leaders for tsunami disaster mitigation in Chile Education
5. Workshops, Seminars and Symposiums

A lot of people escaped to hills and continued to stay there until there were no impacts of the tsunami. because they had the experience of the 1960 Valdivia tsunami



I experienced the tsunami here in 1960, the last EQ was almost same as the 1960 EQ. So, I thought the tsunami came surely and escaped to the hill with neighborhoods.



I directed the evacuation way to visitors in the town, and saved some people from the tsunami flow riding this horse.

Because my father said to stay on the hill for a while, we continued there.

Actual evacuation of primary school children and junior high school students on March 11, 2011

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Photo courtesy of Katada Lab. Gunma Univ. (Photo taken by a resident in Unosumai district of City of Kamaishi)



Evacuation drill in Antofagasta, Chile, Aug. 2010

Ex. Tool for public education

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Tsunami book for kids  
Fear of Tsunami (First edition)

Japanese version was published first, and Spanish version was made with supports of Chilean counterparts



Revised edition of Tsunami book for kids  
Fear of Tsunami (First edition)

Japanese version was revised with lessons from the 2011 Tohoku tsunami

## Outreach

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- Symposiums, seminars and workshop every year in Chile or Japan
  - to disclose findings and results of the research project to the public
  - to foster disaster mitigation leaders in community, municipality, government, ...



- Development of well-prepared/resilient people and community against tsunamis

We should and can develop **useful and distinguished outputs to mitigate and reduce tsunami disasters** in Chile, Japan and the world.

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Thank you for your attention.

Please support for our research activities!