Conicyt/Fondap Excellence Research Center

CIGIDEN
Interdisiciplinary Research for Resilience and Risk Reduction

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Director CIGIDEN
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CONICYT Ministerio de Educación
Gobierno de Chile

EX UMBRA IN SOLEM

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1. CIGIDEN
2. Learning from Recent Chilean Tsunamis
3. Pilot Study on Earthquake and Tsunami Impacts in Iquique
4. Summary

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1 CIGIDEN

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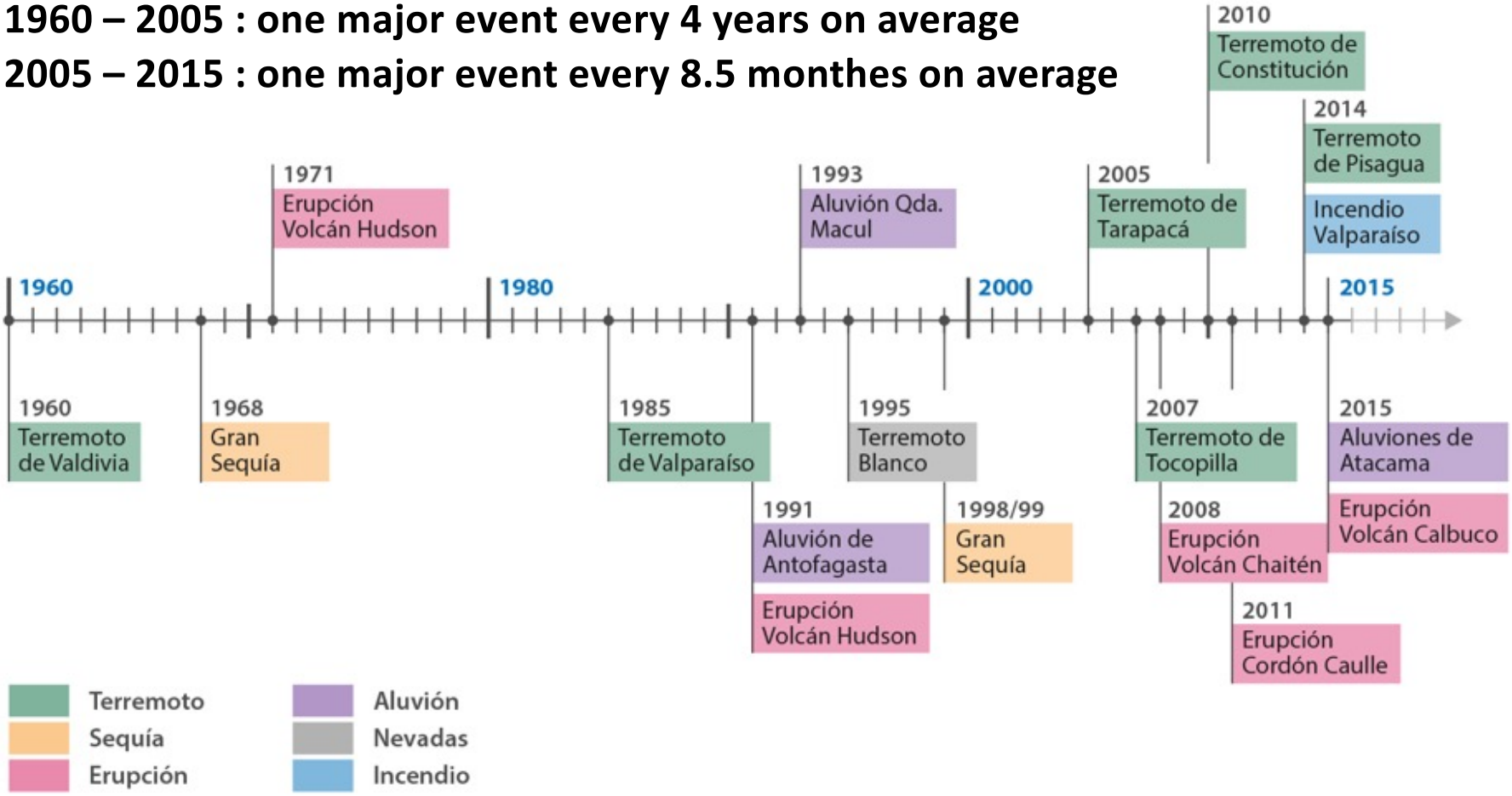
COHABITING WITH NATURAL HAZARDS

1960 – 2005 : one major event every 4 years on average

2005 – 2015 : one major event every 8.5 monthes on average



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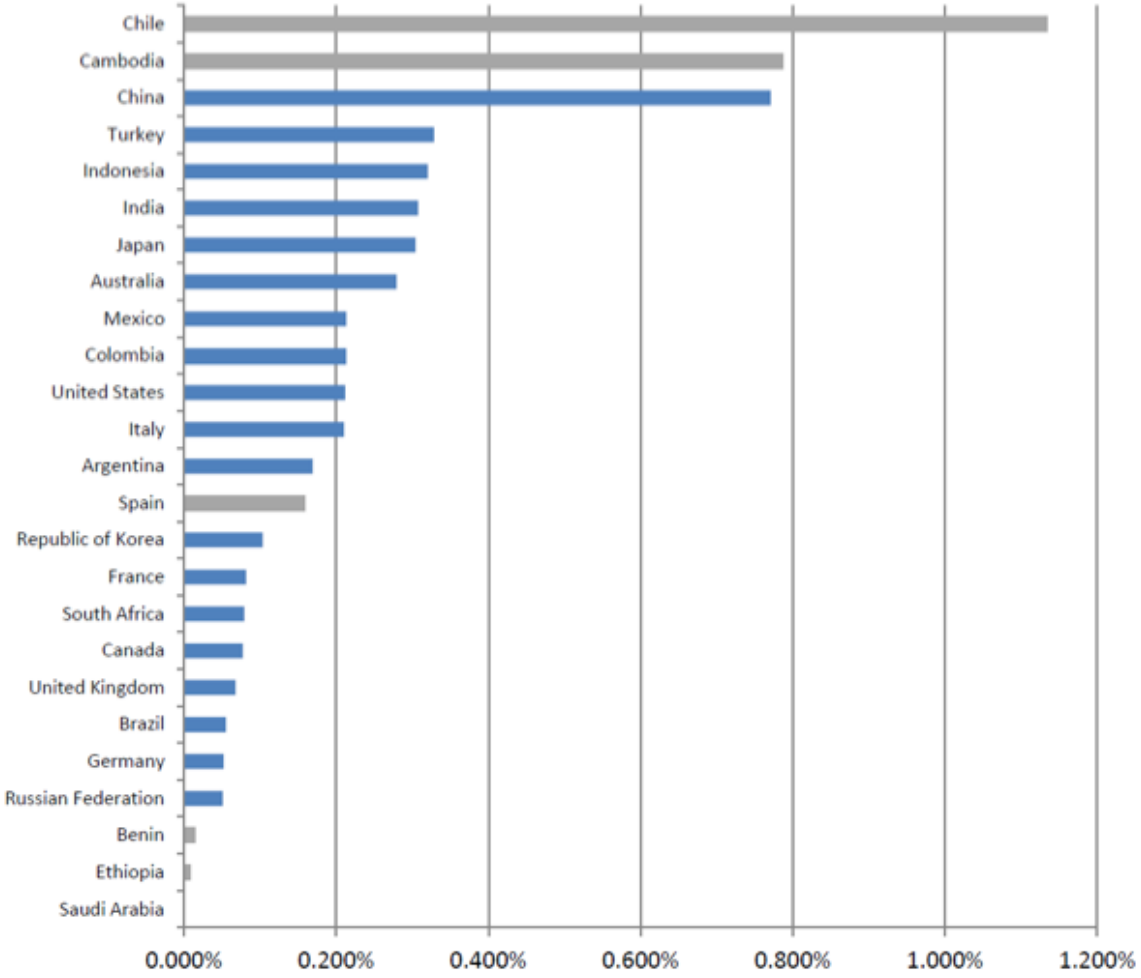
COMPARATIVE NUMBERS FOR DISASTER´S LOSSES



In 2015, Chile's government spent around **MM$300 US$ only in emergency response**

OECD 2012

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CONICYT/FONDAP CALL FOR PROPOSALS IN 2012

Diagnostic:

- Massive systemic failure after the 2010 Earthquake and Tsunami
- Available research knowledge did not reach the society
- Interdisciplinary research needed to tackle society issues

What Fondap program asked for:

- Excellence Research Centers in prioritary areas to create or consolidate research teams
- Scientific basis to contribute in the definition of EWS, efficient mitigation strategies, and emergency response
- Research aimed to understand and improve social resiliency
- Coordination with national institutions and collaboration with international research institutions

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CIGIDEN RESEARCHERS

Faculty

- 7 Principal researchers
- 22 Associate researchers
- 16 Adjunct researchers

Young researchers

- 10 Postdoctoral fellows
- 53 Undergraduate students
- 98 Master students
- 32 Doctoral researchers

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CIGIDEN RESEARCH LINES

SOLID EARTH PROCESSES AND ASSOCIATED HAZARDS

Gabriel González (UCN)

Structural Geology, Geotectonic, Upper Faults, Seismology

SURFACE WATER PROCESSES AND ASSOCIATED HAZARDS

Rodrigo Cienfuegos – Director (UC)

Coastal Processes, Tsunami Research, floods and landslides

VULNERABILITY AND RISK ANALYSIS OF PHYSICAL AND SOCIAL SYSTEMS

Juan Carlos De la Llera (UC)

Seismic Engineering, vulnerability of Engineered systems, Risk Analysis, Seismic Isolation

DMSLab

Aldo Cipriano – Deputy Director(UC)

Disaster management simulation and training

EMERGENCY RESPONSE AND MANAGEMENT

Paule Repetto (UC)

Mental Health and Psycho-social determinants for resiliency, Protocols and Training for first responders, Humanitarian Logistics, Evacuation

SUTAINABLE RISK MITIGATION

Roberto Moris (UC)

Urban Planning, Risk Perception, Education, Decision Making Analysis for Recovery and Sustainable Reconstruction

INFORMATION, COMMUNICATION, AND EMERGING TECHNOLOGIES FOR DISASTER MANAGEMENT

Gonzalo Bacigalupe (U. Massachusetts)

Early Response Systems and messages, Remote Sensing and Wireless Sensor Networks, Social Networks and Mass Media communication in emergency situation

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INTERNATIONAL ADVISORY BOARD

Dr Richard Allmendinger

Chair of the Earth and Atmospheric Sciences Department
Cornell University

Dr William Siembieda

Director – Resilient Communities Research Institute
California Polytechnic State University

Dr Joannes J. Westerink

Chair of the Department of Civil,
Environmental Engineering and Earth sciences

University of Notre Dame

Dr James Kendra

Director – Disaster Research Center
University of Delaware

Dr Vilas Mujumdar

Retired Director of Engineering Research Centers
National Science Foundation

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NATIONAL AND INTERNATIONAL NETWORKS

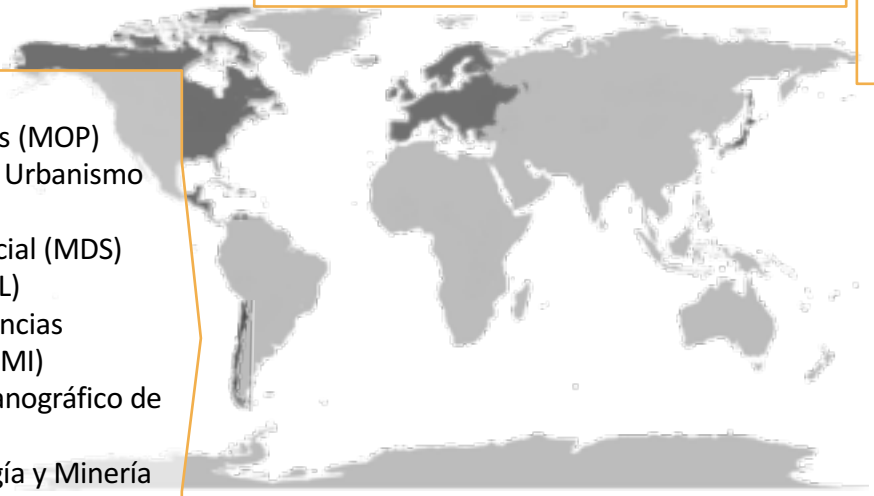
North America
- University of Notre Dame
- Cornell University
- University of Washington
- Johns Hopkins University
- University of Delaware
- University of Massachusetts
- US Geological Survey (USGS)

EUROPE
- German Research Center for Geoscience (GFZ)
- DLR
- TU Delft
- Université de Grenoble
- Université de Bordeaux
- INRIA
- Global Earthquake Model (GEM)

ASIA PACIFIC

- Japan International Cooperation Agency
- Port and Airport Research Institute

Through SATREPS project
- Meteorological Research Institute
- Japan Agency for Marine-Earth Science and Technology
- Kansai University
- Tohoku University



CHILE
- Ministerio de Obras Públicas (MOP)
- Ministerios de la Vivienda y Urbanismo (MINVU)
- Ministerio de Desarrollo Social (MDS)
- Ministerio de Salud (MINSAL)
- Oficina Nacional de Emergencias Ministerio del Interior (ONEMI)
- Servicio Hidrográfico y Oceanográfico de la Armada de Chile (SHOA)
- Servicio Nacional de Geología y Minería (Sernageomin)
- Dirección Meteorológica de Chile (DMC)
- Instituto Nacional de Hidráulica (INH)

Proyects
- **Chilean representative in GEM**
- **Participation in the Global Seismic Network with GFZ**
- **Research project on tsunami mitigation with Japanese institutions (SATREPS)**
- **JICA-AGCI Platform for Capacity Building in Latin America KIZUNA**
- **Kokoronokea project on Disasters and Mental Health with JICA-MINSAL**
- **Newton-Picarte fund with Manchester U. and U Chile**

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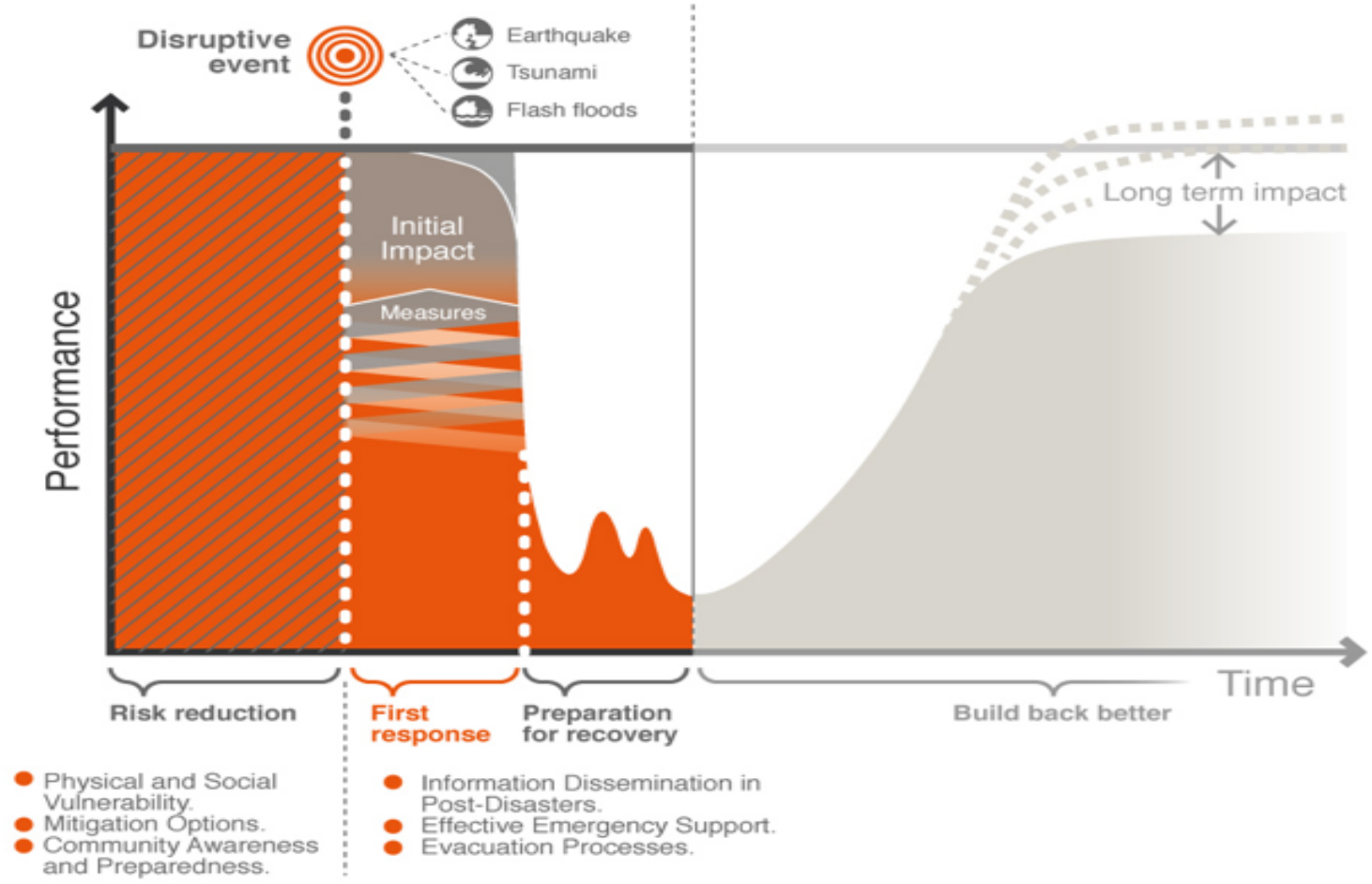
CIGIDEN'S RESEARCH PROJECTS IN THE RESILIENCE FRAMEWORK



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POST DISASTER RECONNAISSANCE TEAMS

- Rapid response interdisciplinary research teams
- Hazard consequences characterization and understanding
- Prompt transfer of discoveries and recommendations to the society

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RISK ASSESSMENT FOR EXTREME EVENT SCENARIOS

1. Hazard Characterization

- Deterministic earthquake scenarios
- Synthetic PGA/PGV maps
- Tsunami inundation maps

2. Exposure model for Iquique Building count per Block

- Night and daytime population distribution
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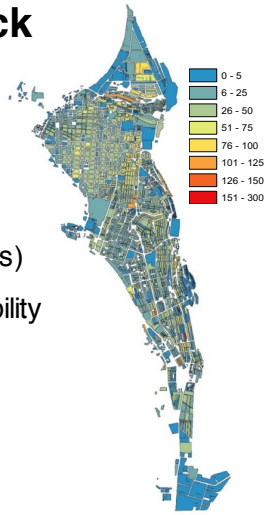
- Building type distribution



3. Physical vulnerability

- Development and adaptation of seismic fragility curves
- Calibrateion using 2014 Pisagua EQ

4. Damage/Loss assesment

- Physical damage to buildings, essential facilities and lifelines
- Casualties
- Downtime for essential facilities and lifelines
- Economic losses

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5. Network risk assessment and evacuation modelling

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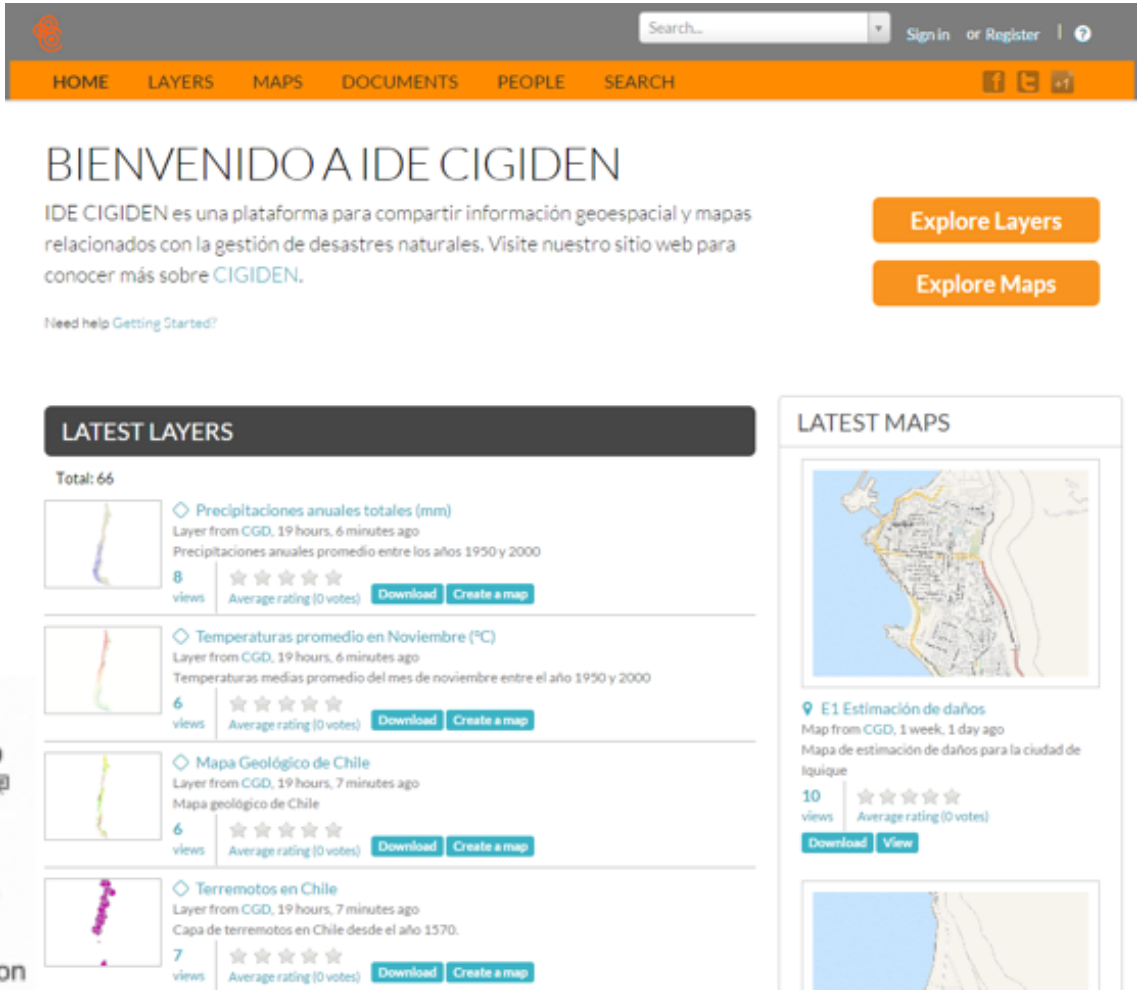
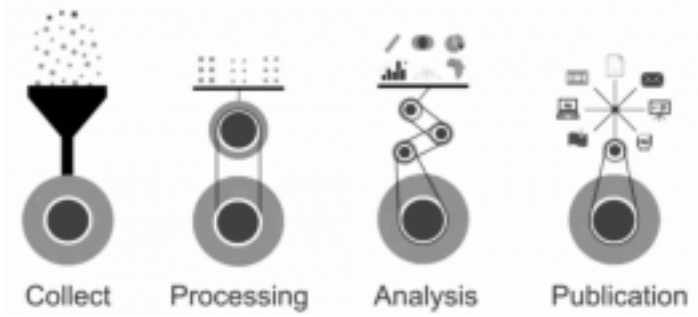
OPEN SPATIAL DATA INFRASTRUCTURE REPOSITORY

- ide.cigiden.cl





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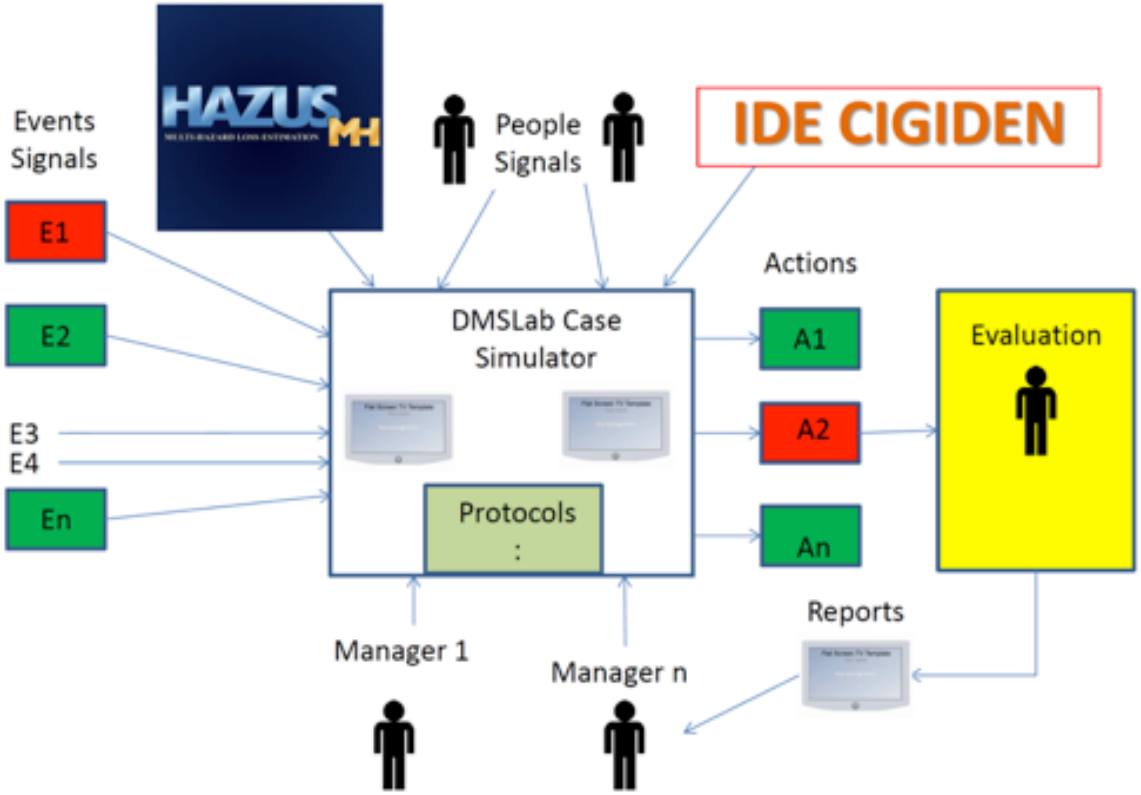
DISASTER MANAGEMENT SIMULATION LAB

- Pilot development as a training tool for emergency managers
- Disaster scenarios
- Protocol testing
- Psychological response of key actors
- Training
- Evaluation



FINISHED THESIS AND GRADUATED STUDENTS

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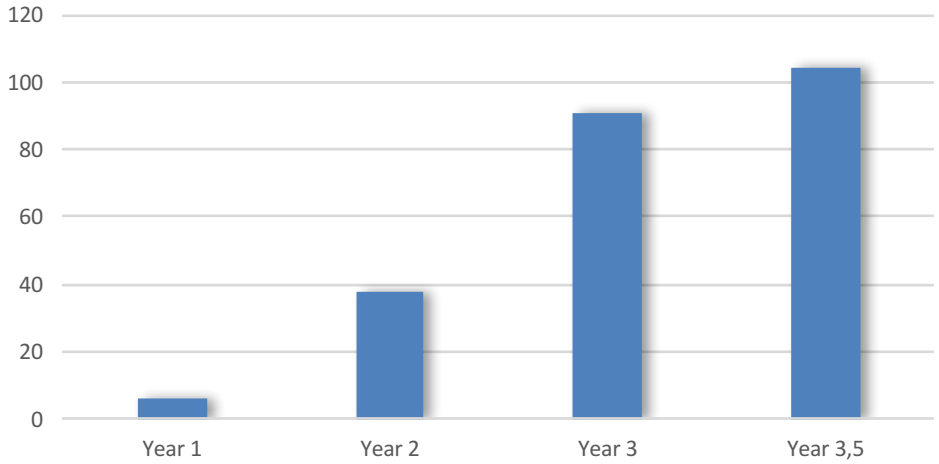
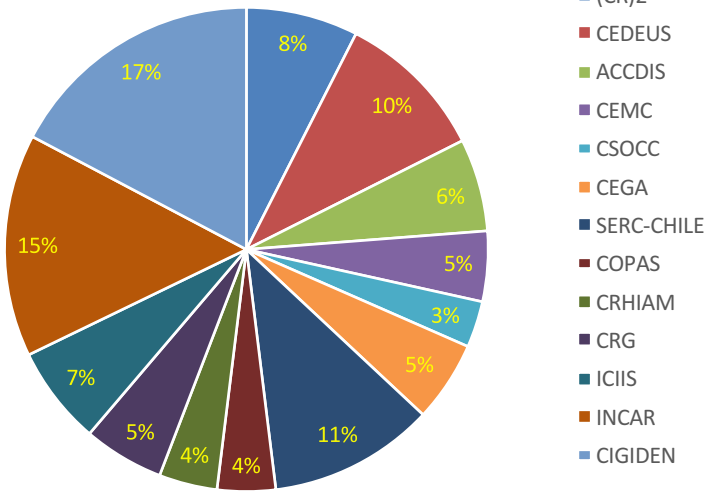
SCIENTIFIC PRODUCTION

Cumulative Number of ISI publications



% ISI Publications – FONDAP Centers (2012-2015)



Source: CONICYT (dataciencia.conicyt.cl)

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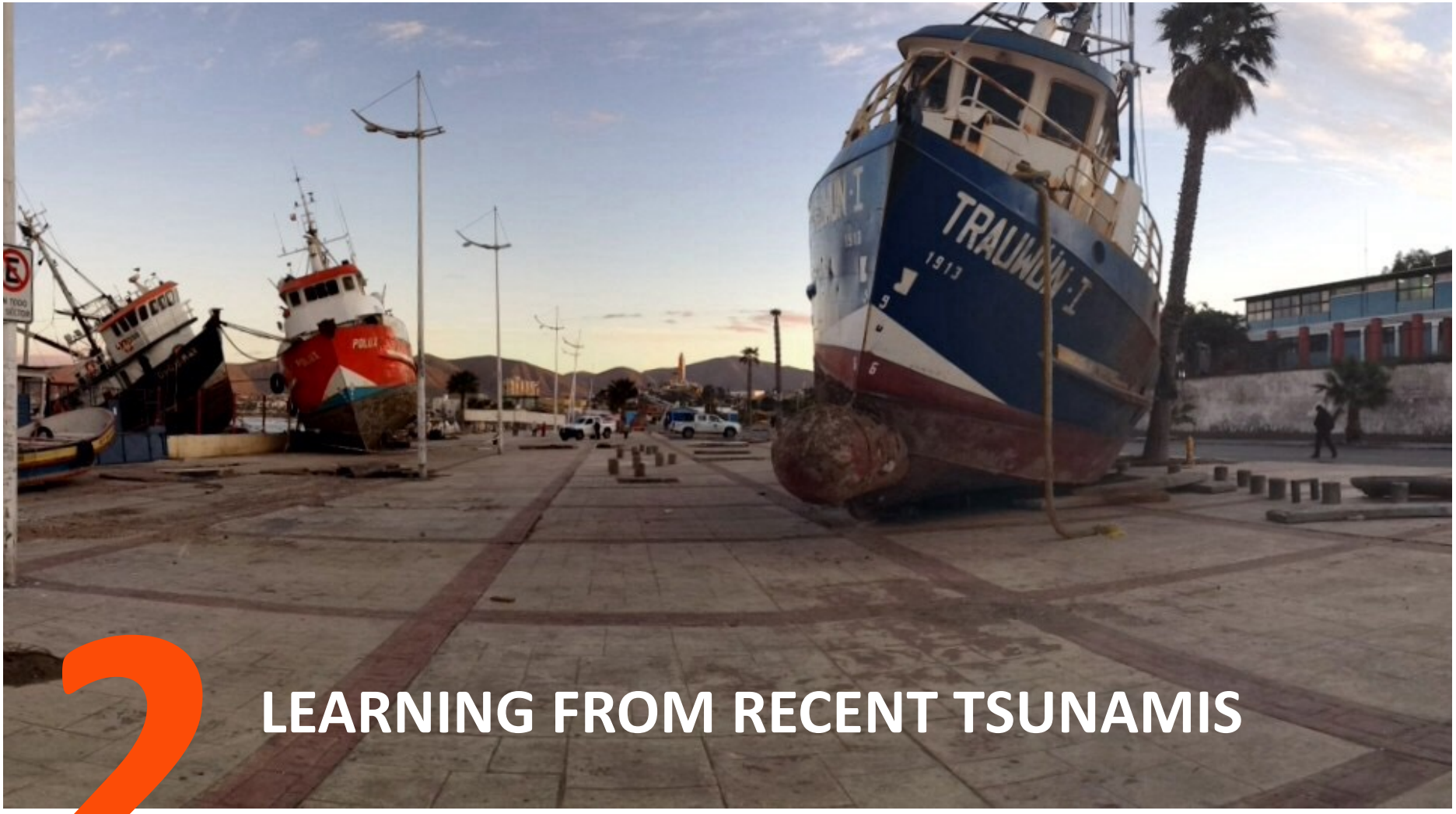

2 LEARNING FROM RECENT TSUNAMIS

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CONFUSION IN THE WAKE OF THE 27F TSUNAMI

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CHILE – JAPAN COLLABORATION ON TSUNAMI RESEARCH

Ministerio de Obras Públicas
Gobierno de Chile

CONICYT
Ministerio de Educación
Gobierno de Chile

PARI

CIGIDEN

JST

JICA

SATREPS For the Earth, For the Next Generation

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THREE DESTRUCTIVE TSUNAMIS IN FIVE YEARS

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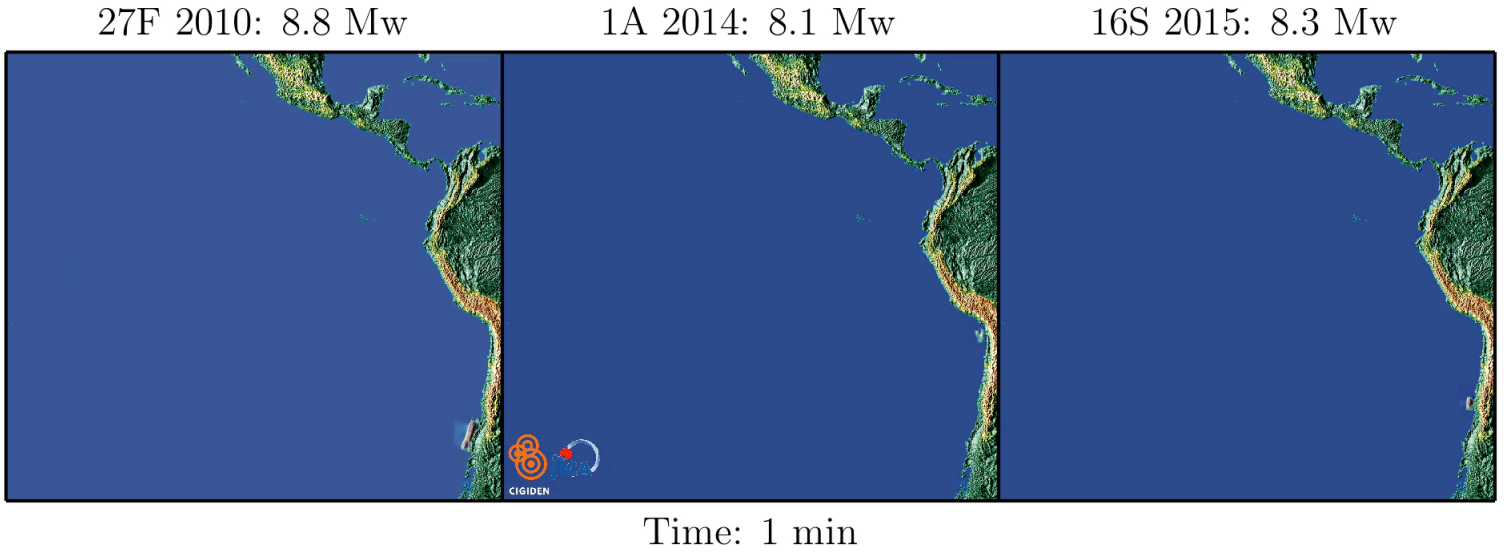
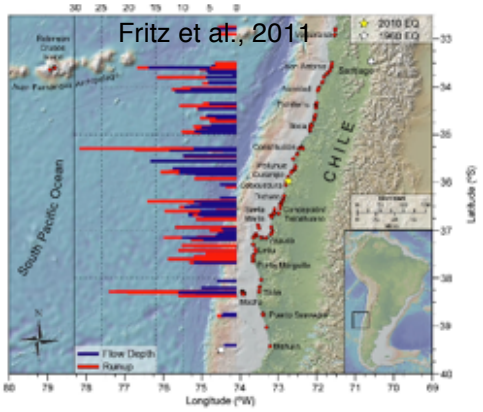
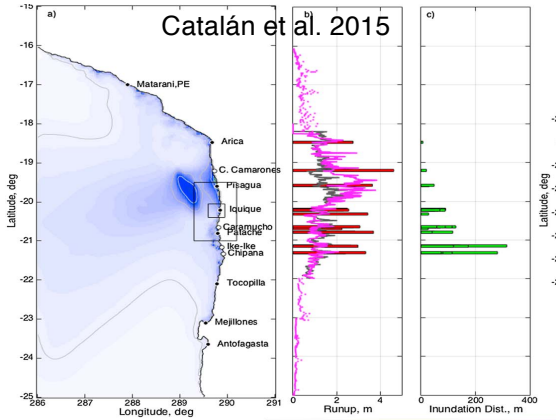
CHILE: ONE OF THE LARGEST TSUNAMI EXPORTER IN THE WORLD

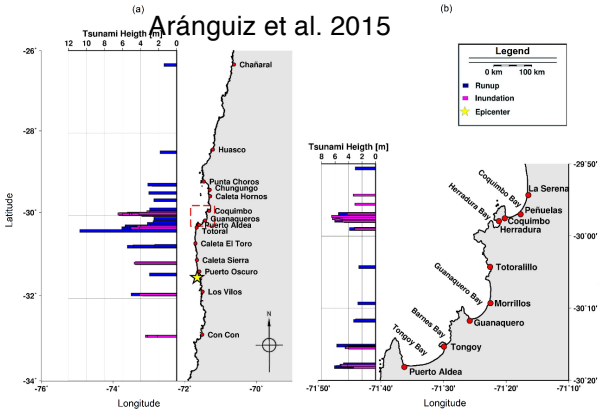
Tsunami simulation @CIGIDEN



Post-Tsunami Surveys







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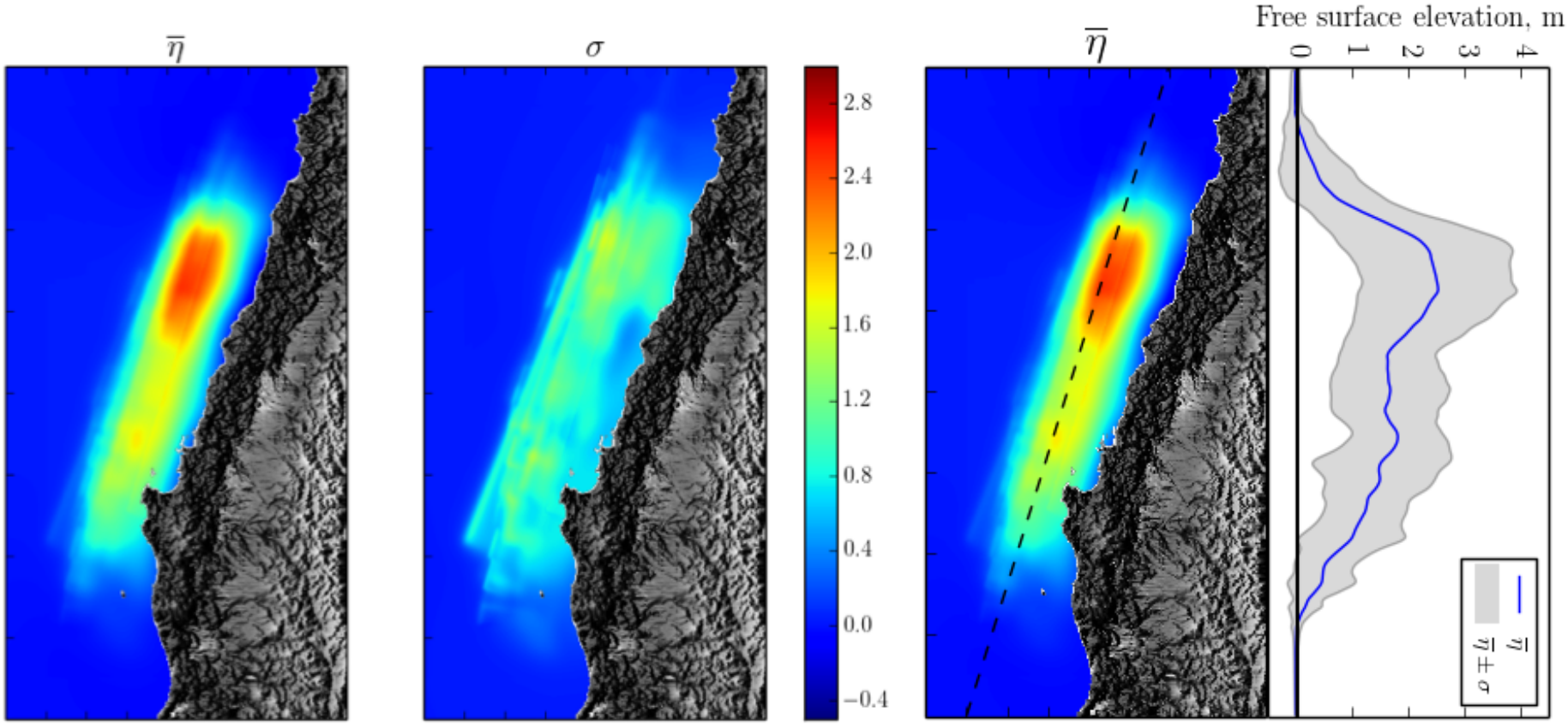
EPISTEMIC SEISMIC SOURCE UNCERTAINITY IMPOSES BIG CHALLENGES FOR TSUNAMI ALERTING



Initial conditions for the 27F tsunami from 23 published seismic ruptures

Source: UTFSM/UCN/UCSC/CIGIDEN

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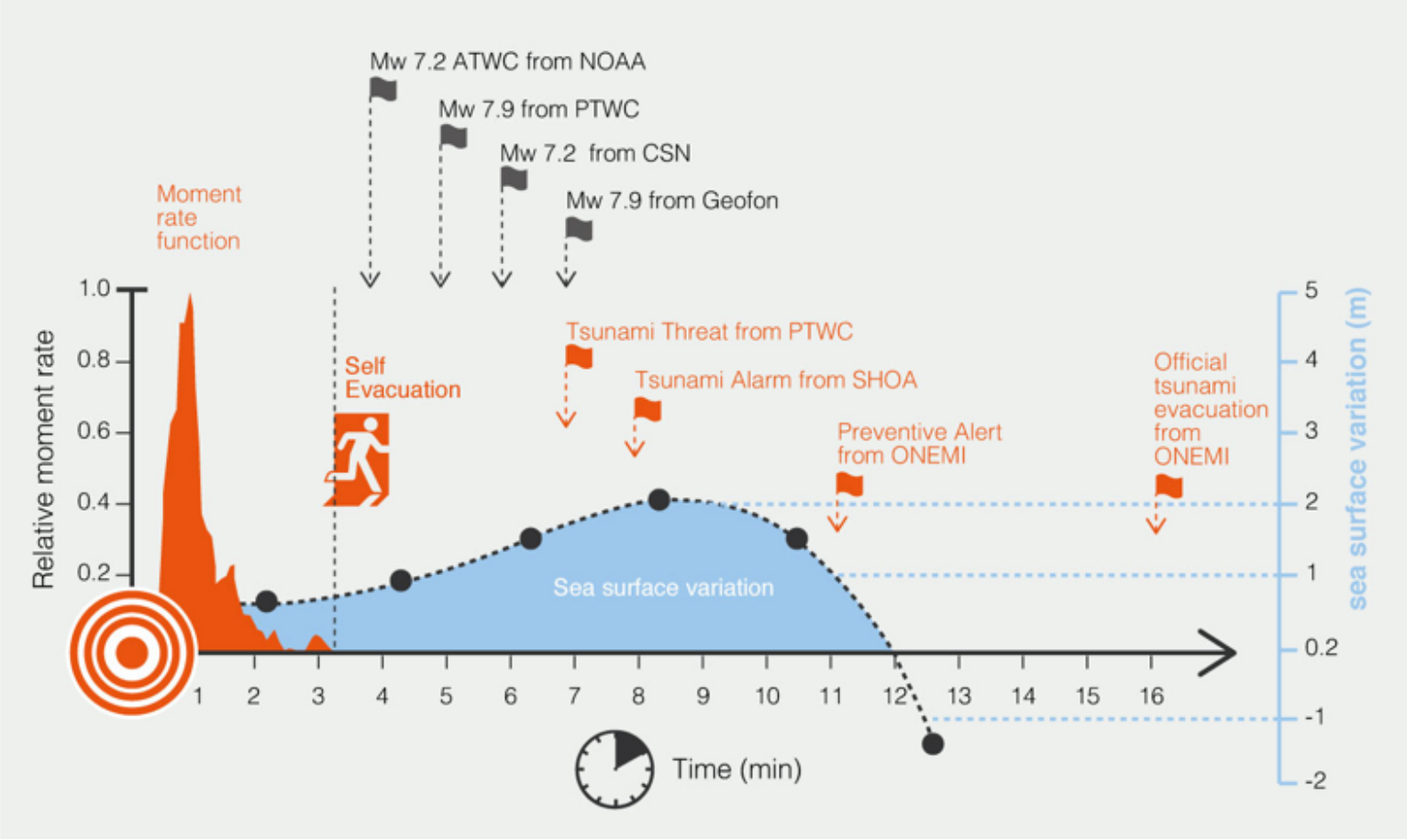
EARTHQUAKE-TSUNAMI-ALERT TIMELINE FOR THE ILLAPEL 2015 EVENT



Source: Analysis from Onemi and SHOA official reports. Modeled data by CIGIDEN

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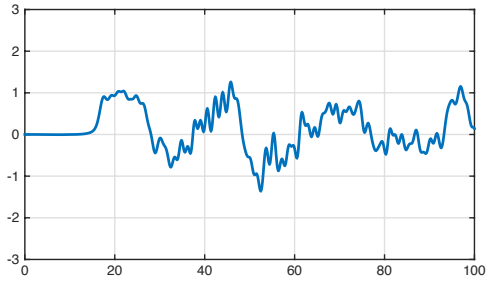
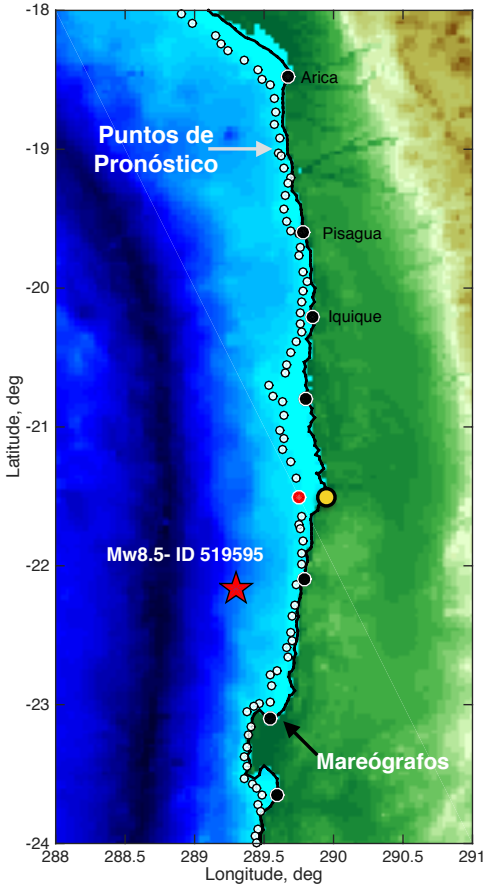
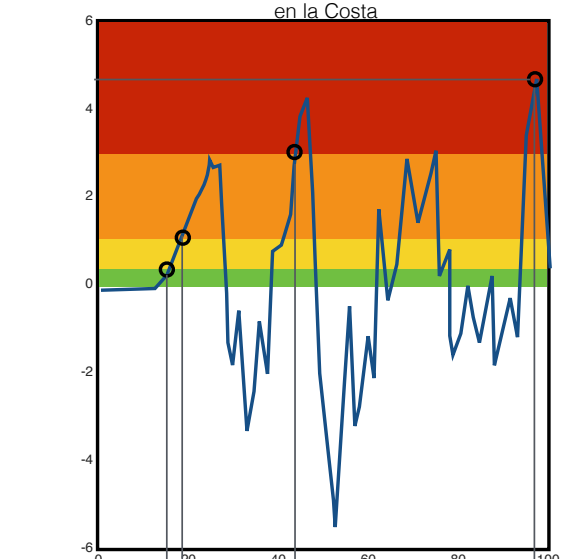
NEW TSUNAMI EWS IN OPERATION AT SHOA

Ejemplo de Serie de Tiempo en Punto de Pronóstico





Desplazamiento Simulado de la Superficie Libre en la Costa



Tiempo en que se supera por primera vez el nivel de 30 cm

Tiempo en que se supera por primera vez el nivel de 1 m

Tiempo en que se supera por primera vez el nivel de 3 m

Tiempo y altura de la maxima amplitud

- **Developed by UTFSM in collaboration with UC for SHOA with the support of Conicyt Fondef and Fondap programs and the SATREPS program of JICA-JST**

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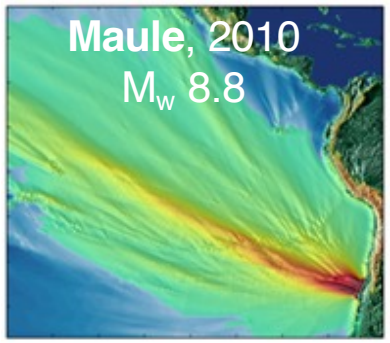
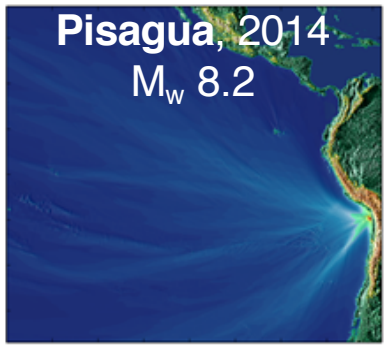
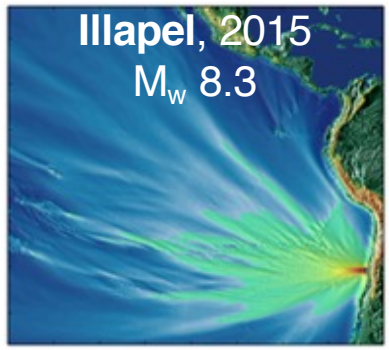
EXPORTING TSUNAMI KNOWLEDGE FROM CHILE

- Fast arrival of first tsunami waves to the coast
- Edge waves and local amplification in embayments results in te occurrence of many consecutive destructive waves
- New EWS for tsunamis made in Chile
- Self evacuation is key against tsunamis since detection and alerting technologies maybe blurred with uncertainity
- Technological positivism should not undermine citizen action







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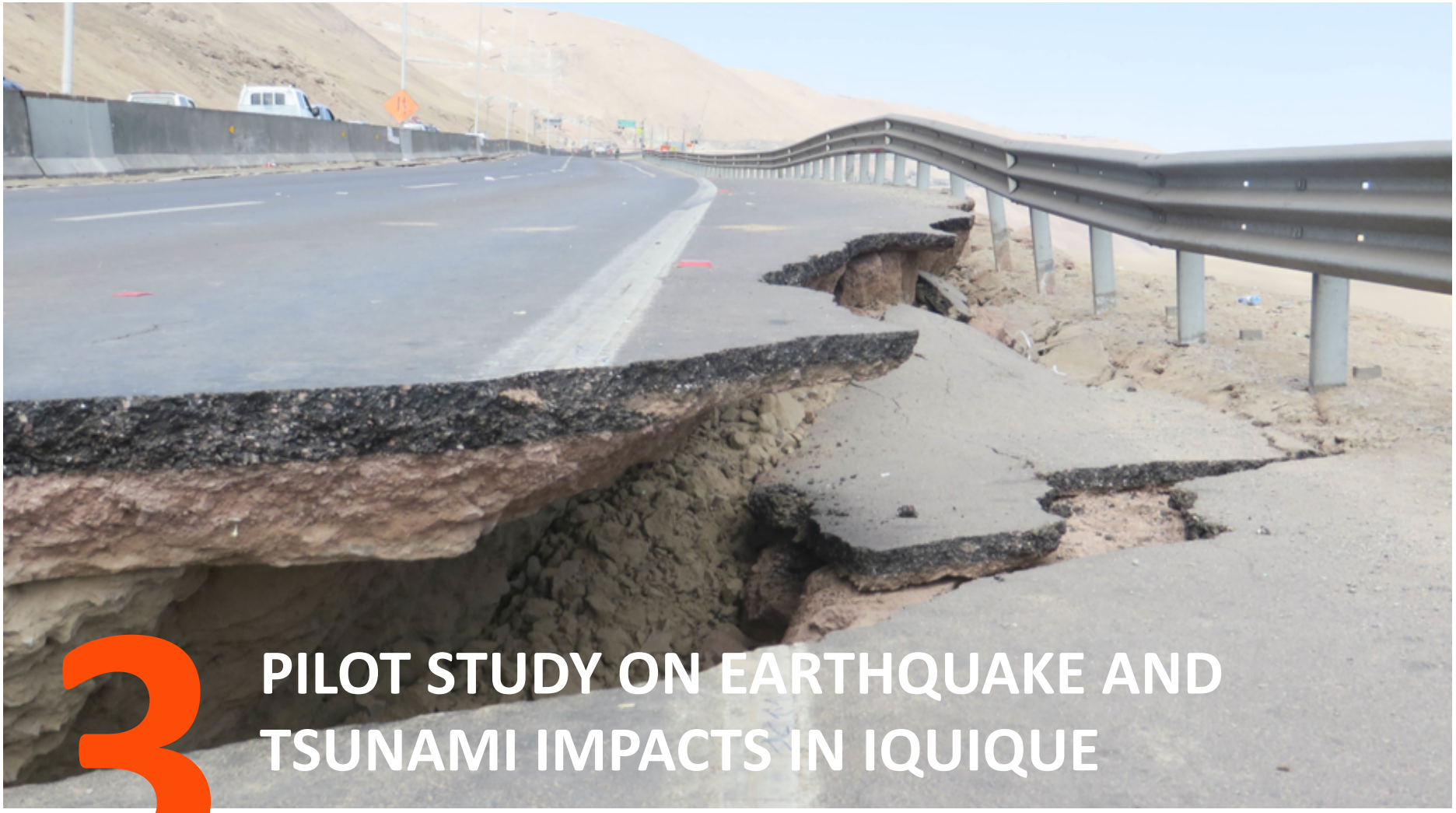

3 PILOT STUDY ON EARTHQUAKE AND TSUNAMI IMPACTS IN IQUIQUE

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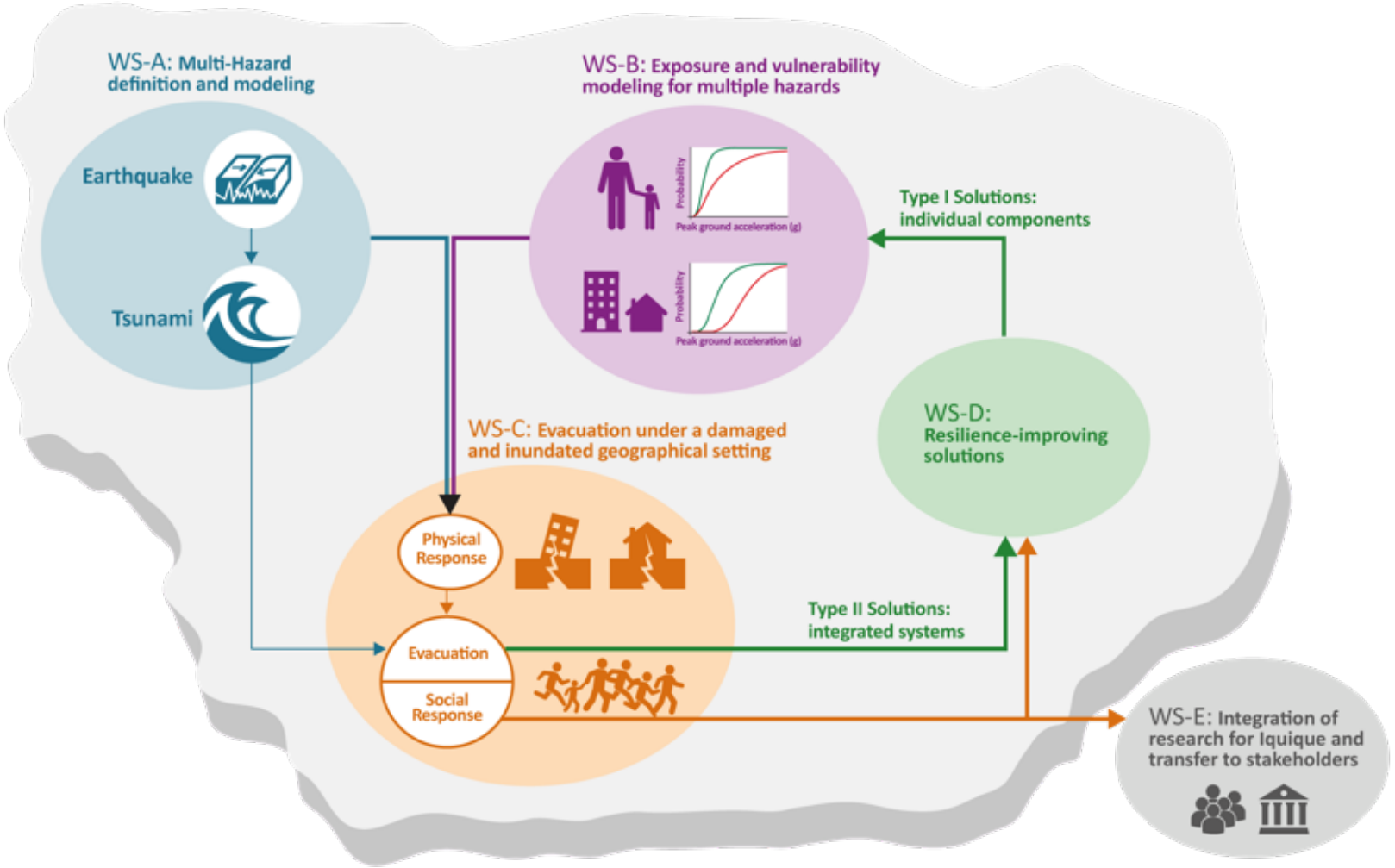
INTEGRATING FRAMEWORK FOR RISK ANALYSIS



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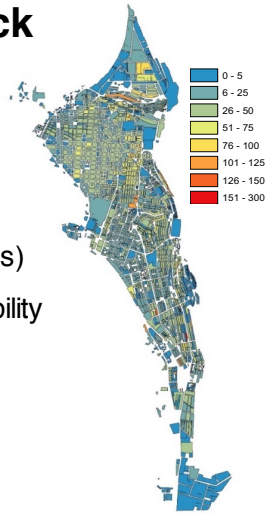
RISK ANALYSIS STEP BY STEP

1. Hazard Characterization

- Deterministic earthquake scenarios
- Synthetic PGA/PGV maps
- Tsunami inundation maps

2. Exposure model for Iquique Building count per Block

- Night and daytime population distribution
- Essential facilities (health, education, emergency).
- Lifelines (water, electricity, roads)
- Liquefaction/landslide susceptibility
- Building type distribution



3. Physical vulnerability

- Development and adaptation of seismic fragility curves
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4. Damage/Loss assesment

- Physical damage to buildings, essential facilities and lifelines
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5. Network risk assessment and evacuation modelling

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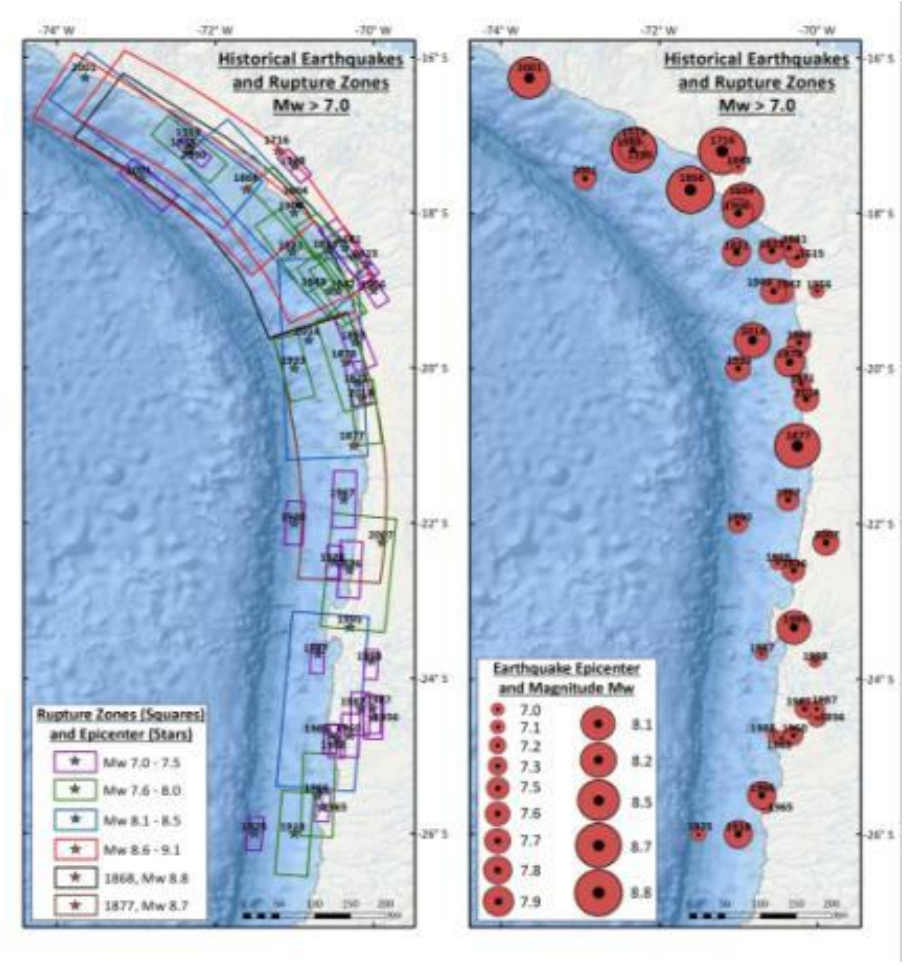
HISTORICAL KNOWLEDGE ON SEISMIC HAZARD



Largest known earthquakes in the area

Epicenter location	Year	Mw
South of Perú	1513	8.7 (aprox)
South of Perú	1716	8.8 (aprox)
South of Perú	1604	8.0 (aprox)
North of Chile	1877	8.8 (aprox)
North of Chile	1995	8.1 (no tsunami)
North ofChile	2014	8.2

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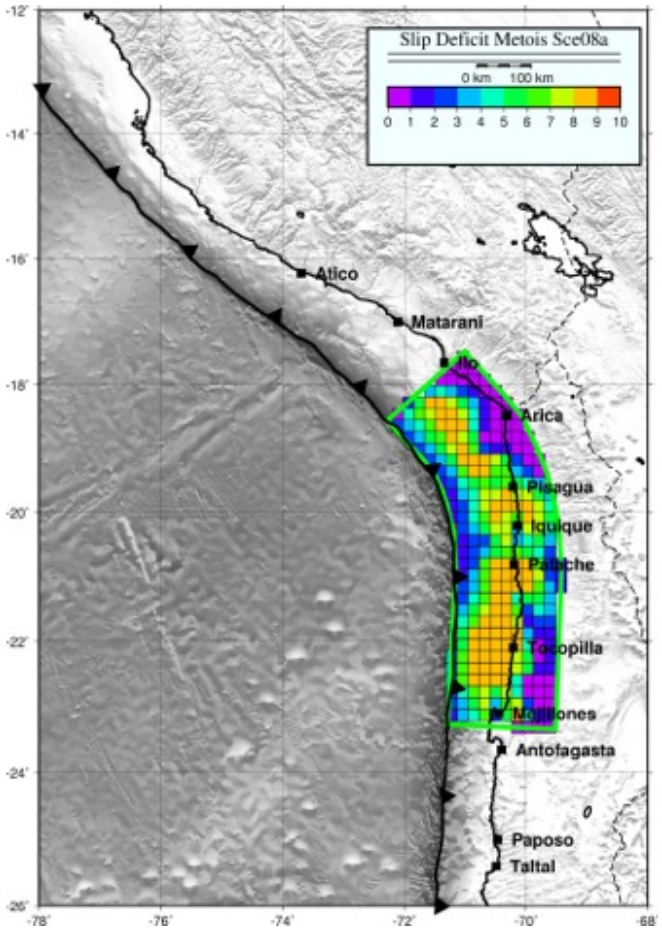
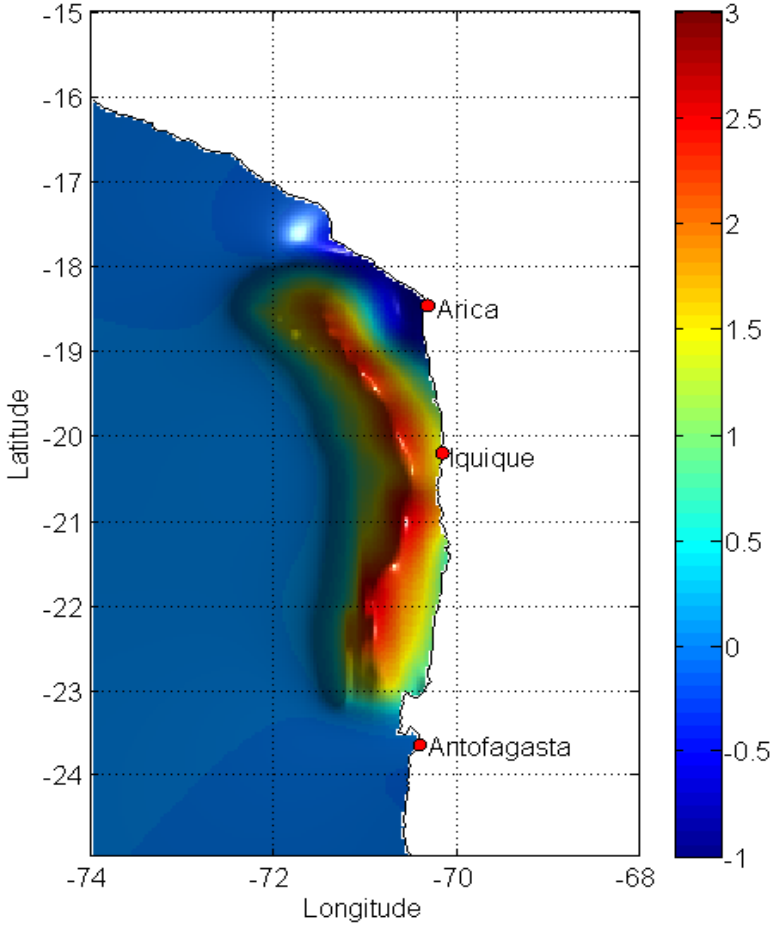
POTENTIAL RUPTURE SCENARIO IN THE SEISMIC GAP FROM SLIP DEFICIT

Slip deficit (Métois et al., 2016)



Initial condition for tsunami



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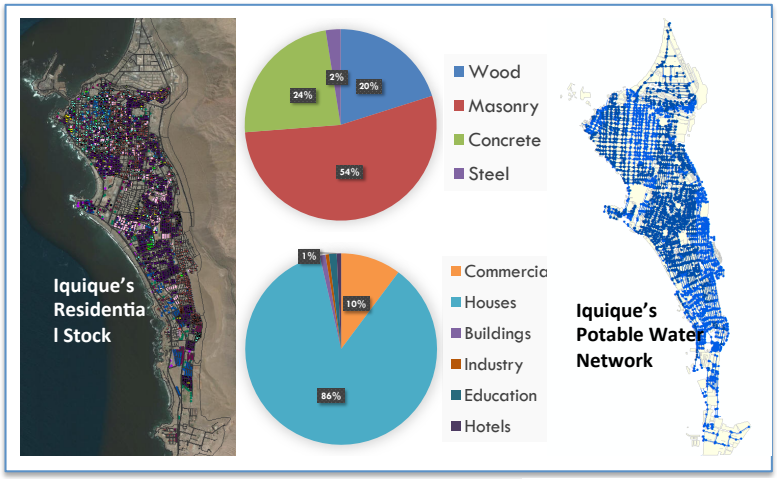
SEISMIC RISK ASSESSMENT

Scenario: City of Iquique using Hazus MH

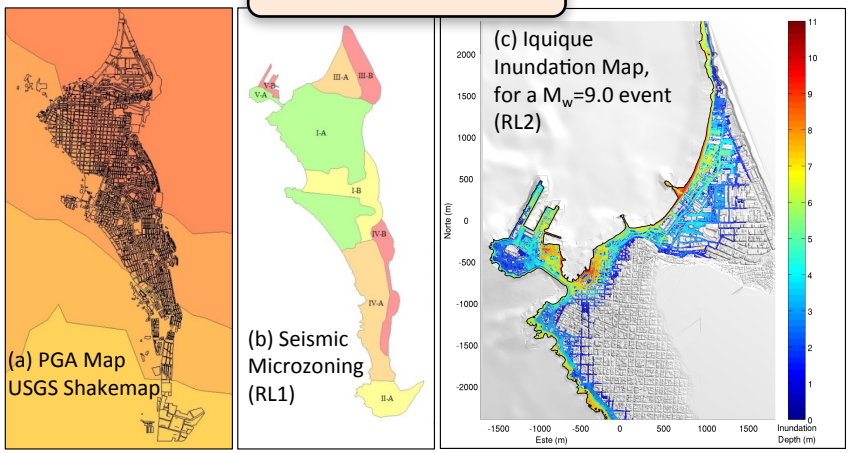
First stage:

- ✓ Earthquakes
- ✓ Tsunamis
- ✓ Economic and Social impacts

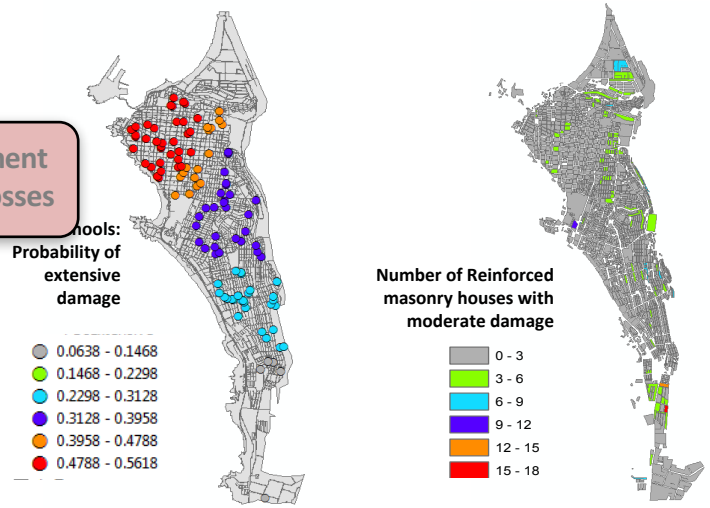
Exposure and Vulnerability Model



Hazard Assessment



Risk Assessment Damage & Losses



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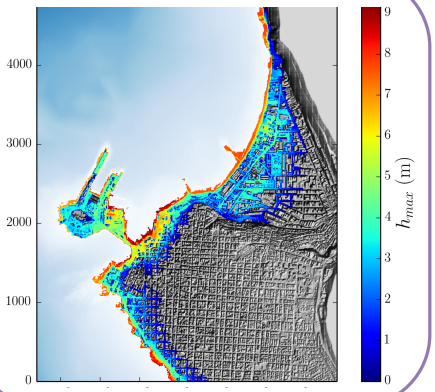
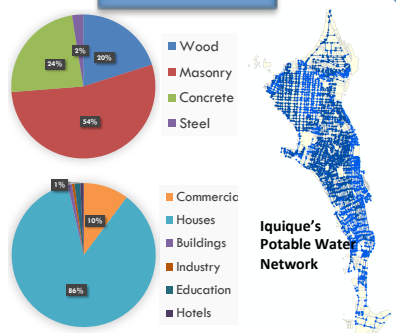
TSUNAMI RISK ASSESSMENT

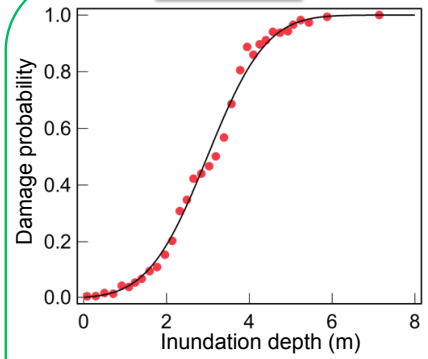
Mapas de Amenaza



Exposición

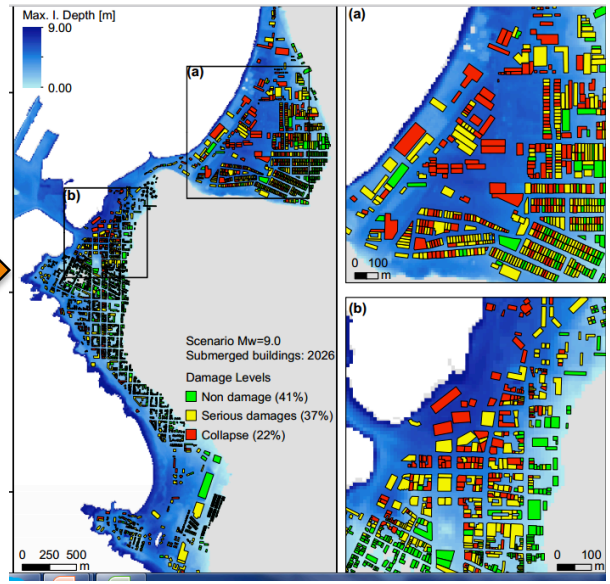


Fragilidad



Fragility curve of houses and buildings against tsunamis (Koshimura et al., 2009)

Riesgo



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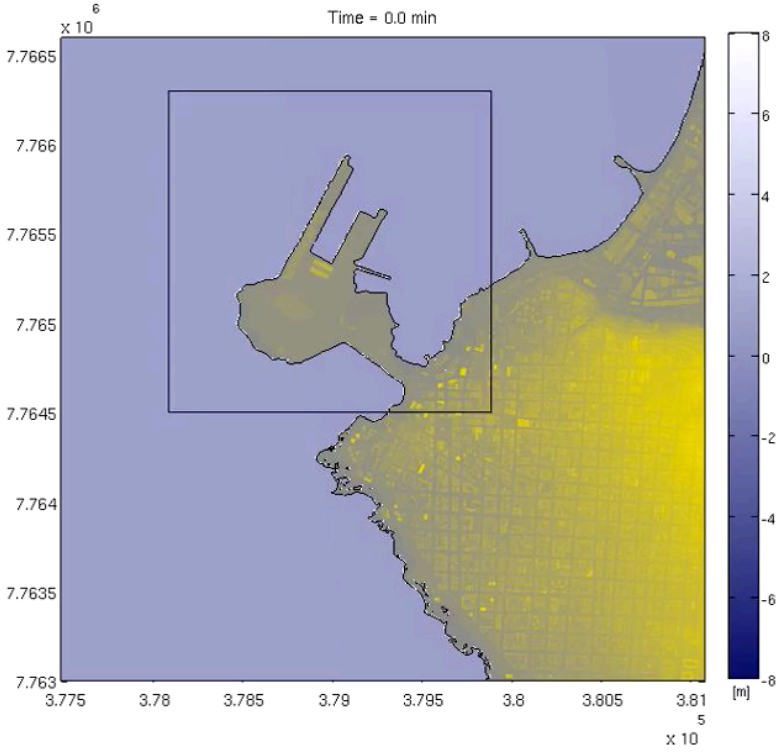
POTENTIAL TSUNAMI SCENARIO FOR EVACUATION



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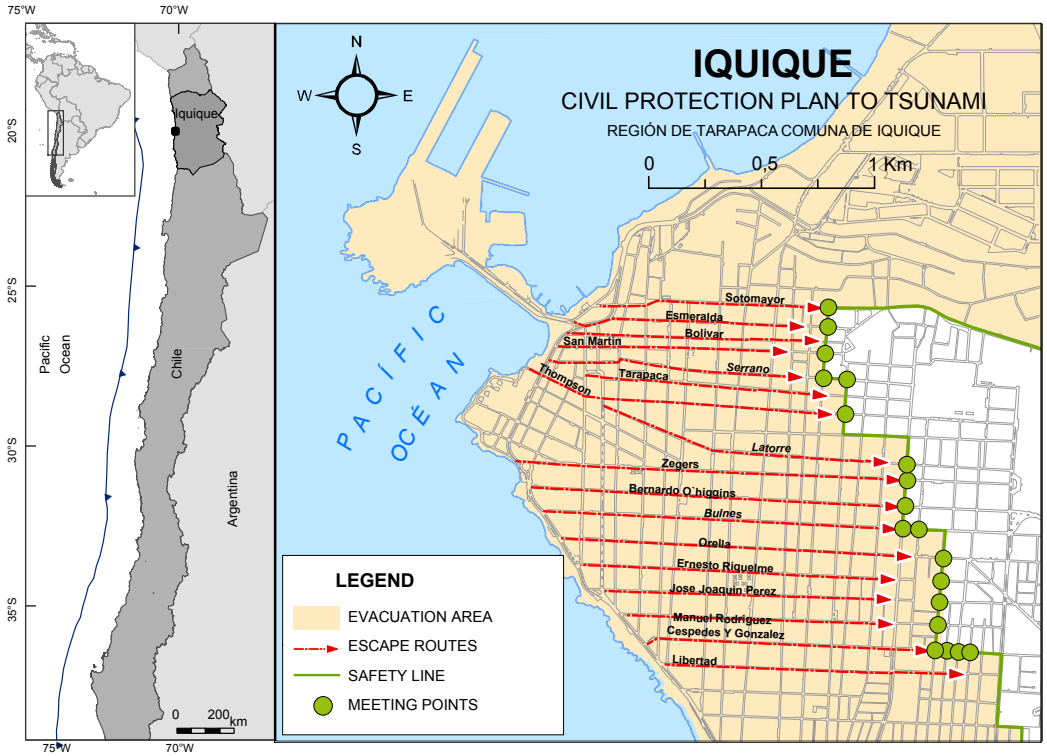
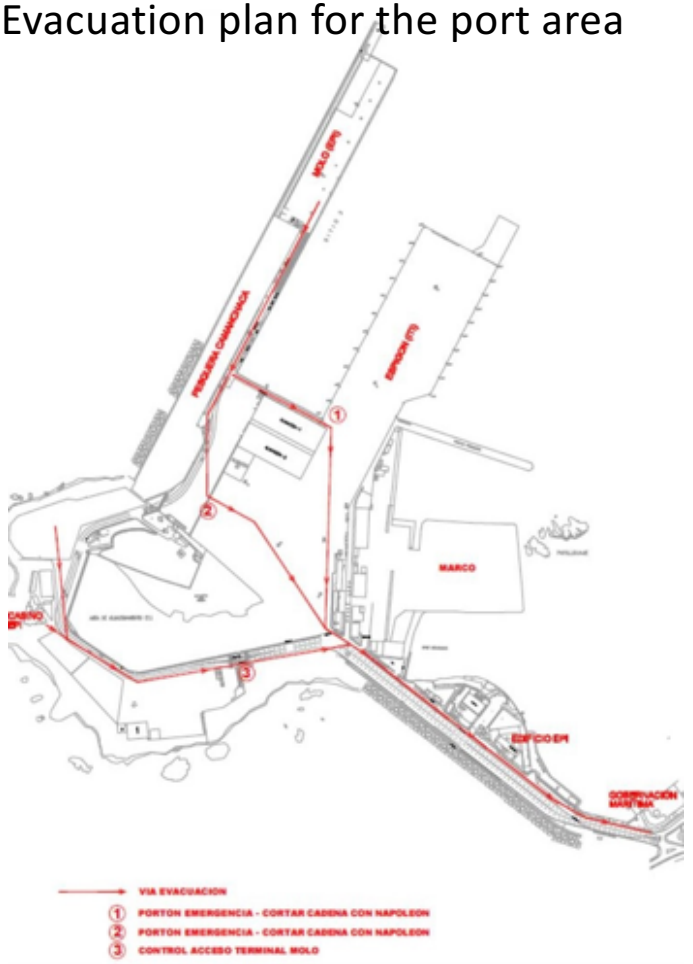
EVACUATION PLANS: FROM A MAP TO REALITY

Official evacuation routes in the City of Iquique



Evacuation plan for the port area



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EX UMBRA IN SOLEM

FIELD WORK TO “MAP” EVACUATION ROUTES

- Detailed mapping of the main evacuation using video and gps
- Diagnostic of the current state of evacuation routes
- Development of a methodology to clasify the “vulnerability” of the evacuation routes

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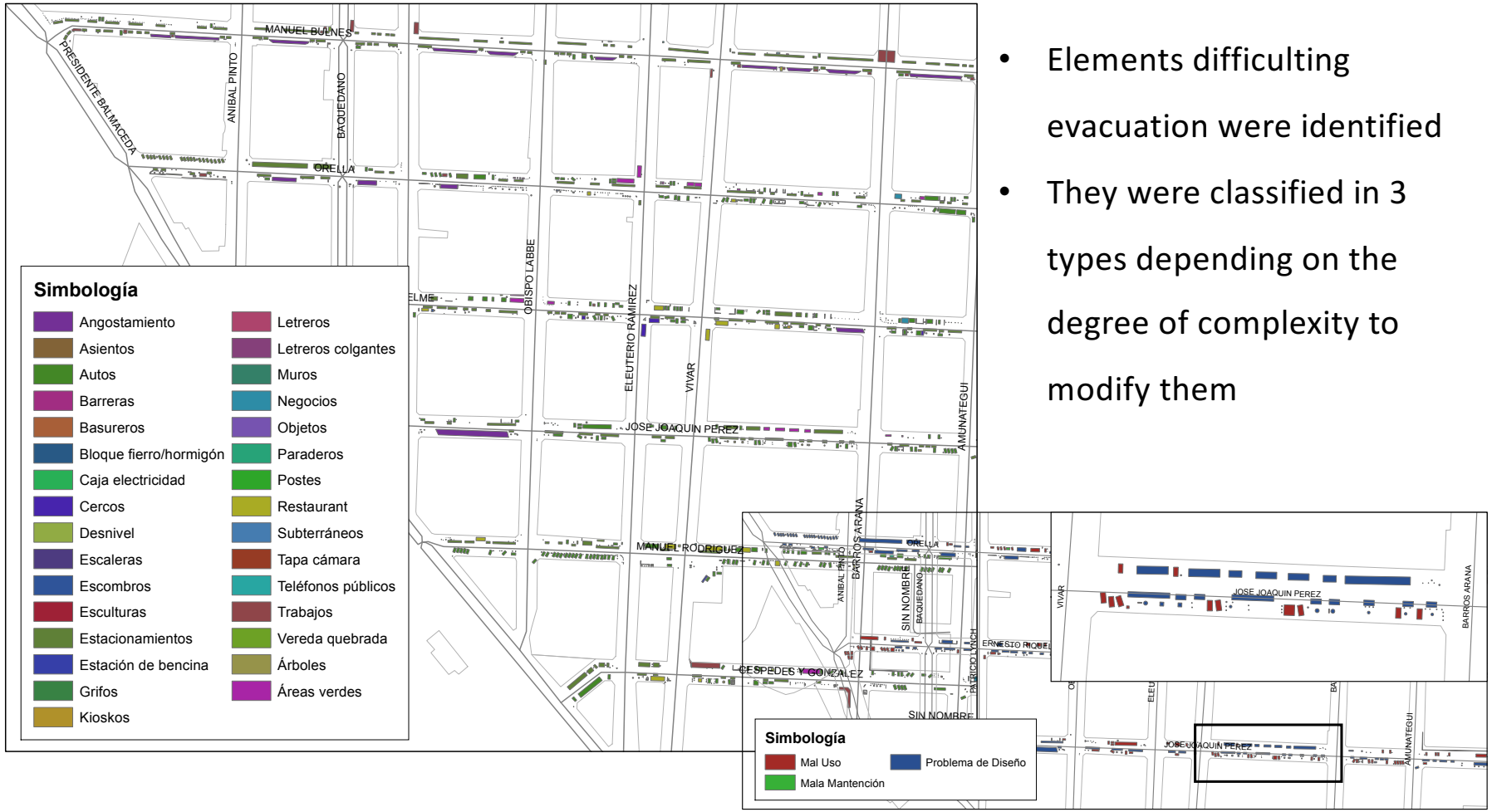
MAPPING VULNERABILITY OF EVACUATION ROUTES



- Elements difficulting evacuation were identified
- They were classified in 3 types depending on the degree of complexity to modify them

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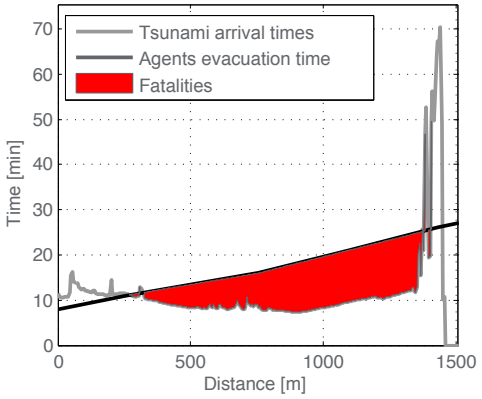
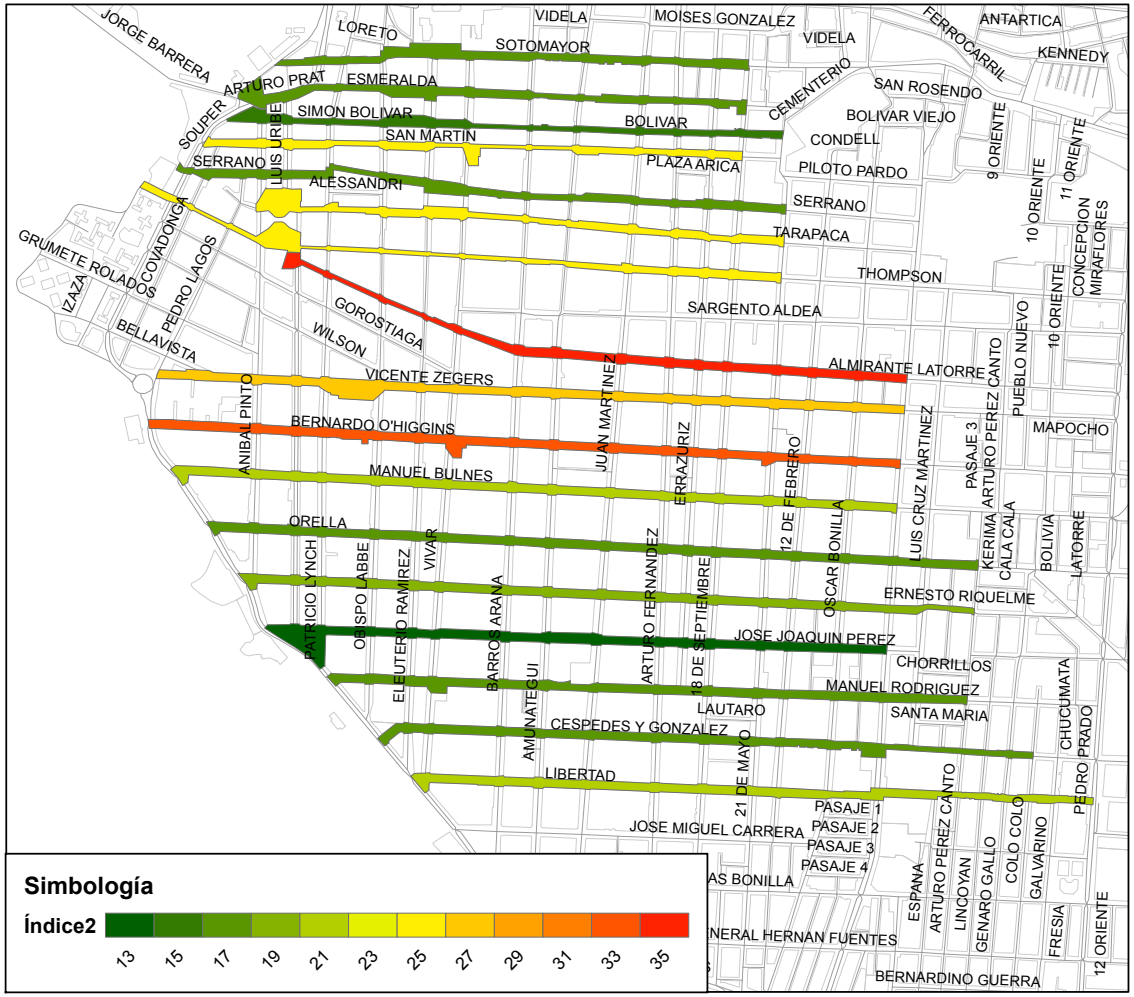
MAPPING URBAN REALITY



- Agent modeling of evacuation processes can help quantifying potential improvements



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4 SUMMARY

SUMMARY

- The good Chilean seismic culture was disconnected from tsunami risks in 2010
- New findings and lessons learned from recent disasters are now being incorporated much faster into public policies thanks to a more effective collaboration between public and private sectors, and research (role of Conicyt and the Fondap program)
- It is very important to enhance this type of collaborations and to expand it to local governments and citizens (engagement)
- Chile is called to play an important role in disaster resilience being subjected to frequent extreme natural events and important political and cultural challenges

DON´T FORGET

"What is the most tragic is that the collective genius of all of these experts, combined with the sensors and satellite observations and seismographic data and all the other tools of science and technology, could not send the important message at the key moment: Run. Run for your lives."

-Joel Achenbach, Washington Post, January 30, 2005

TALCAHUANO, 27 DE FEBRERO 2010 - 3:34 hrs

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- Port of Iquique
- Municipality of Iquique
- ONEMI
- SHOA
- Minister of Public Works

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Conicyt/Fondap Excellence Research Center

CIGIDEN
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August 26th 2016

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