



“Chile’s National Tsunami Warning System”

Captain Carlos A. Zúñiga
Director



152 years of charting Chile from the sea

SHOA's mission



To provide safety for maritime, river and lake navigation.



To constitute the official Service of the Chilean State in everything related to hydrography, nautical cartography, oceanography, tidal waves, nautical geography, navigation, nautical astronomy and time signals.



To contribute, through research, to the development and promotion of other related national and international activities of national interest, and providing the necessary scientific information.



Relevance of SHOA

Hydrographic area

Hydrographic Information for Safe Navigation

SHOA's hydrographic work supports navigational safety and the continuous updating of national nautical charting.

363

paper charts and
337 electronic
chart

95%

of Chile's economy
depends on
the sea



- Produces and updates nautical charts essential for safe navigation.
- Integrates hydrographic surveys, geodesy, field control, and technical processing
- After major earthquakes, reviews and updates charting to safeguard its accuracy.



Relevance of SHOA

Oceanographic area

Capabilities Supporting Ocean Observation

- **Continuous monitoring of critical variables:** climate change, sea level, tsunamis, and waves.
- **Operational forecasting for navigation:** currents, tides, and oceanographic conditions.
- **Technical support for marine scientific research and decision-making in the maritime domain.**
- **NTWC (SNAM):** 24/7 tsunami threat monitoring, under international standards and coordination.





SHOA's crew



270

101

Enlisted personnel



14

Officers



155

Civilian employees





ACCIONES OPERATIVAS

RUTINAS

Fecha	01/01/2018
Hora	08:00
Operador	...
Estado	...
...	...

PARAMETROS CARACTERÍSTICAS DE LOS	...
...	...
...	...
...	...

...	...
...	...
...	...
...	...

ARMADA

SNAM Chile
Sistema Nacional de Alarma de Maremotos

SNAM Chile
Sistema Nacional de Alarma de Maremotos

SNAM Chile

Sistema Nacional de Alarma de Maremotos

Valparaíso 6.0 Earthquake - May 31, 2026



Sismo de mediana intensidad remece a las regiones entre Coquimbo y Maule: Epicentro fue en Quintero

De manera preliminar, el CSN informó que tuvo una magnitud de 6,0.

31 de Mayo de 2026 | 17:36 | Por [Javier Riquelme](#), Emol.



Domingo 31 mayo de 2026 | 17:48

Sismo de magnitud 6.0 se percibió en 5 regiones del país: van 4 réplicas en 1 hora

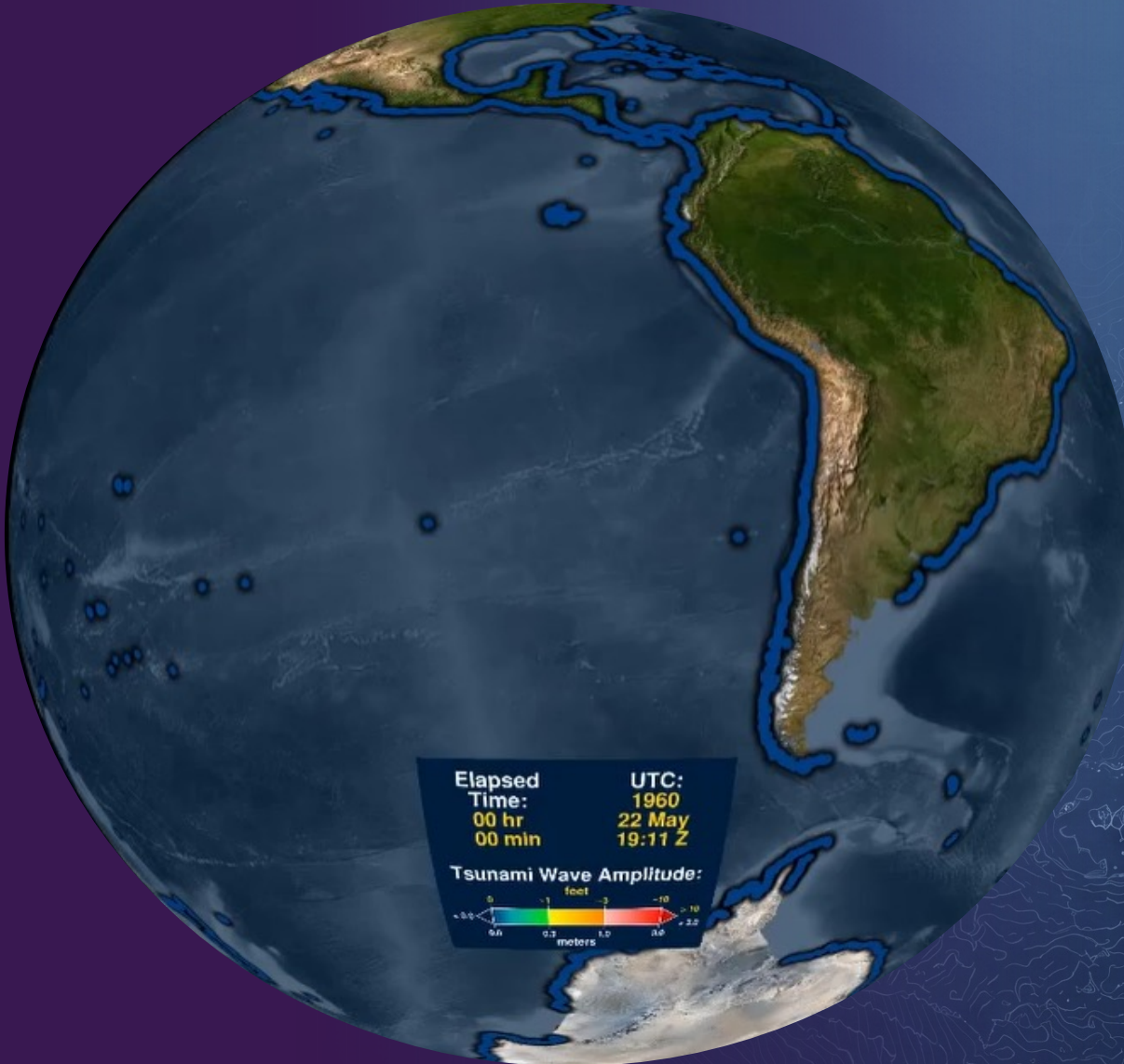


ÚLTIMOS SISMOS (1)

Fecha Local / Lugar (2)	Profundidad	Magnitud
2026-05-31 18:14:31 15 km al O de Quintero	26 km	3.7
2026-05-31 18:10:00 14 km al O de Quintero	26 km	4.0
2026-05-31 17:52:11 32 km al NO de Valparaíso	27 km	5.0
2026-05-31 17:46:58 16 km al O de Quintero	27 km	4.5
2026-05-31 17:34:18 23 km al O de Quintero	30 km	6.0



1960 Earthquake and Tsunami



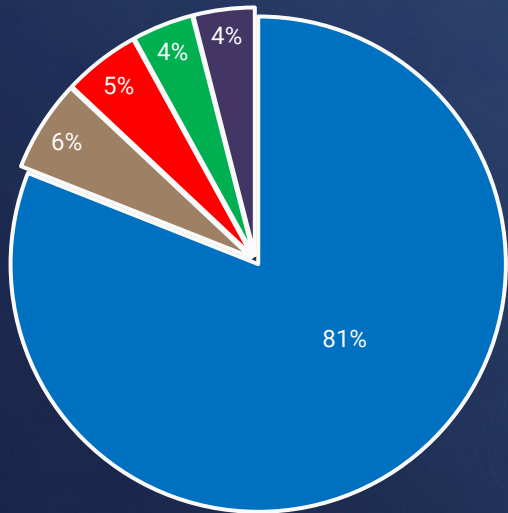
- Strongest Earthquake recorded on instrumental era – Magnitude 9,5.
- Impact on all Pacific Basin, with casualties reported in Hawaii and Japan, among other countries.
- Establishment of the Pacific Tsunami Warning and Mitigation System (PTWS).
- Establishment of Chile's National Tsunami Warning System (SNAM).



Sources of origin

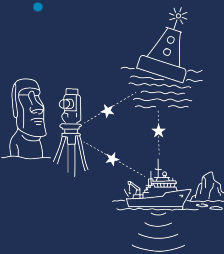


Tsunamigenic sources



- Earthquakes (81%)
- Post-Earthquake collapse / Landslides(6%)
- Volcanic eruptions (5%)
- Collapses / Landslides (4%)
- Others (4%)

Source: PTWS Extraordinary Meeting for the Tonga Event, 2023.



Flood Flow Effect

Waves Simulator



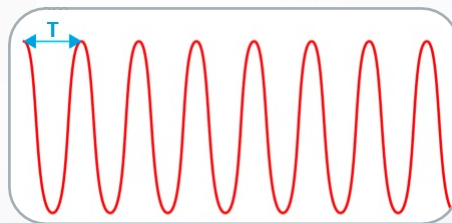
Both wave trains with the same amplitude, but different periods.

SOURCE: Japan International Cooperation Agency (JICA)



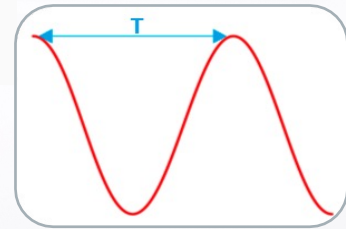
Wind wave

PERIOD
30 SECONDS



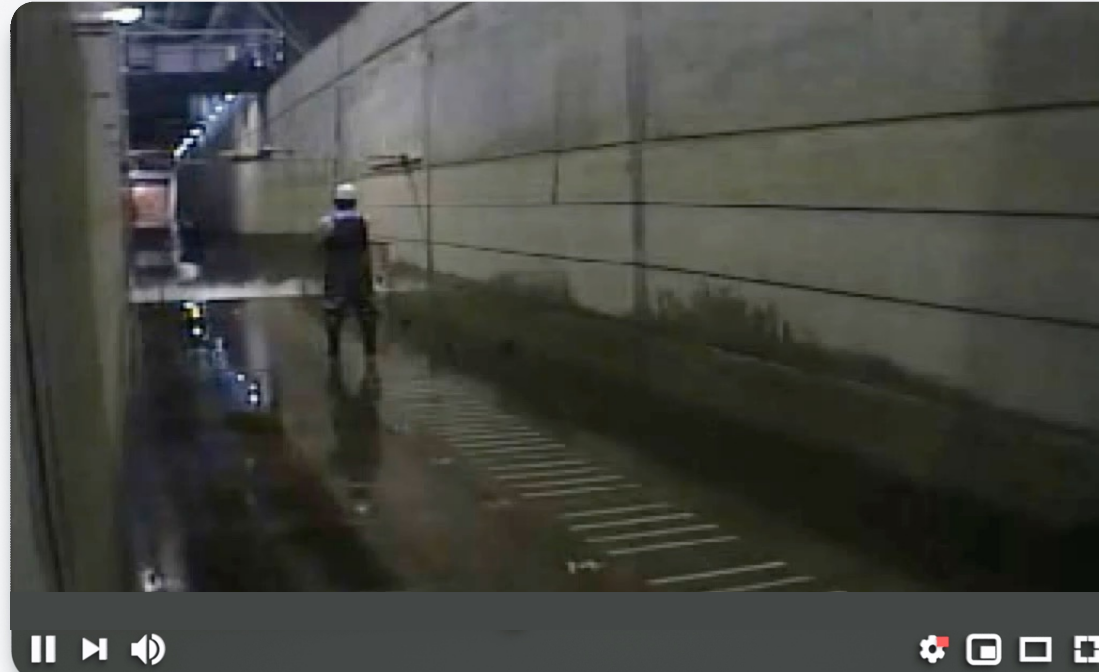
Tsunami Wave

PERIOD
90 MINUTES



Flood Flow Effects

Tunnel that simulates a 50 cm wave



Major historical earthquakes

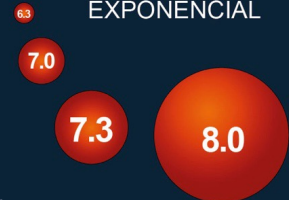
DATOS NACIONALES

CHILE: LA HISTORIA DE UN PAÍS SÍSMICO
Gráfico según la magnitud

9.5	Valdivia 22 de mayo de 1960
8.8	Constitución 27 de febrero de 2010
8.5	Vallenar 10 de noviembre de 1922
8.4	Coquimbo 16 de septiembre de 2015
8.3	Chillán 24 de enero de 1939
8.2	Iquique 1 de abril de 2014
8.2	Ovalle 6 de abril de 1943
8.2	Valparaíso 16 de agosto de 1906
8.0	Antofagasta 30 de julio de 1995
7.9	Iquique 13 de junio de 2005
7.8	San Antonio 3 de marzo de 1985
7.7	Tocopilla 14 de noviembre de 2007
7.7	Illapel 8 de julio de 1971
7.6	Chiloé 25 de diciembre de 2016

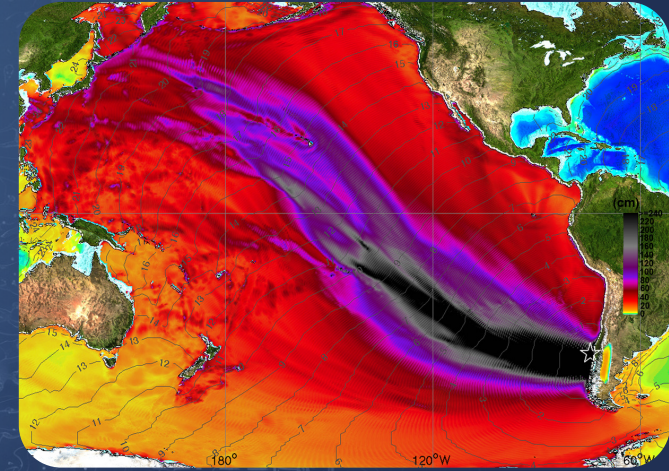


ESCALA
EXPONENCIAL

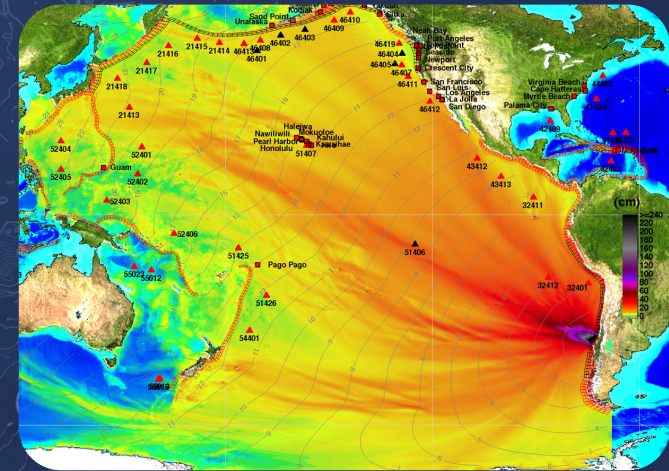


DATOS INTERNACIONALES

9.5	Chile, Valdivia 1960
9.2	Alaska 1964
9.1	Sumatra, Indonesia/India 2004
9.0	Tohoku, Japón 2011
8.8	Chile, Constitución 2010
8.7	Sumatra, (Nias) Indonesia 2005
8.5	Sumatra, Indonesia 2007
8.4	Chile, Coquimbo 2015
8.3	Islas Kuriles, Rusia 2006
8.2	Chile, Iquique 2014
8.1	Samoa 2009
7.7	Sumatra, (Mentawai) Indonesia 2010
7.6	Chile, Chiloé 2016
7.5	Palu Indonesia 2018
7.0	Haiti 2010



Modelo tsunami 1960 (fuente: NOAA)



Modelo tsunami 2010 (fuente: NOAA)

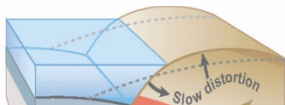


Seismic GAP

Segments or sections of a fault that have not been activated in an unusually long time. These processes accumulate energy, associated with a high coupling (locking), allowing us to assume that a plate rearrangement should occur in that space in the short or medium term.

Through GNSS studies, it can be said that, based on the average of the last 450 years, 1 earthquake of magnitude 8 or higher has occurred in Chile every 12 years. (Source: CSN)

Interseismic period (decades to centuries)



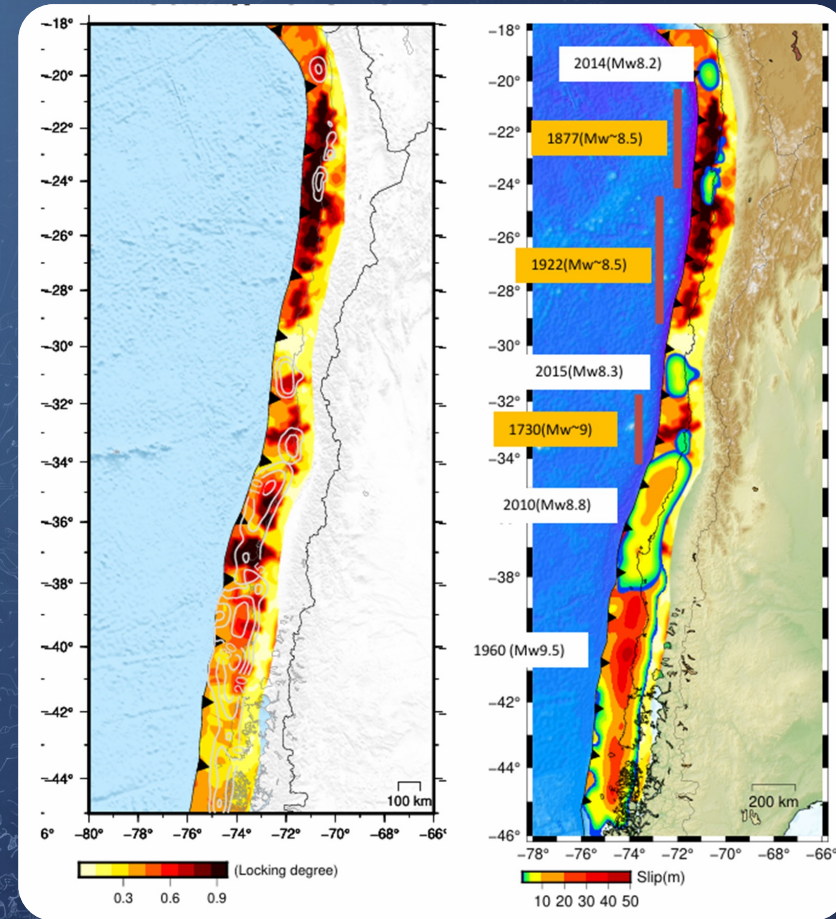
"65% de probabilidades": Qué se sabe del pronóstico de terremoto sobre magnitud 8 de Sismología

Sergio Barrientos, director del Centro Sismológico Nacional de la Universidad de Chile, afirmó en una entrevista que hay posibilidades que el próximo año ocurra un gran evento sísmico en el país.

Stuck area ruptures, releasing energy in an earthquake



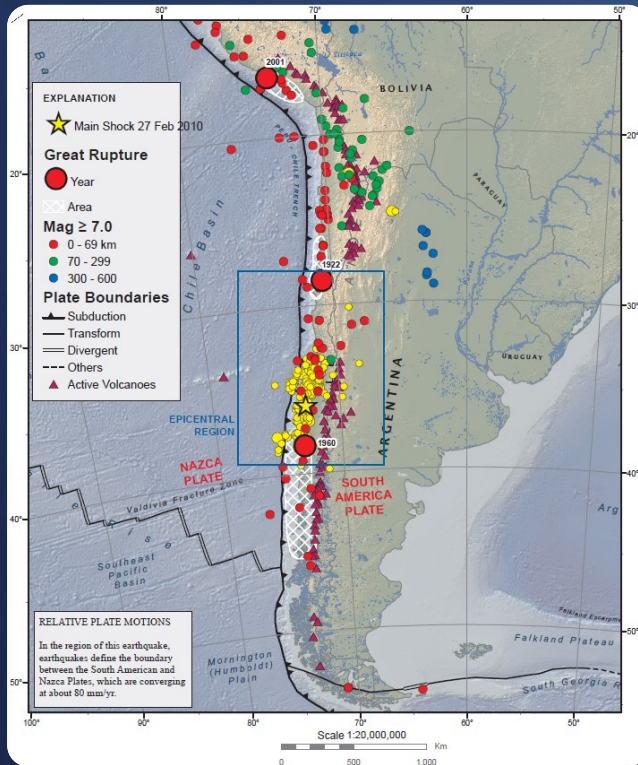
Coupling 2018 - 2023



Source: Dr. Marcos Moreno, Tsunami Diploma Program (PUCV), 2024.



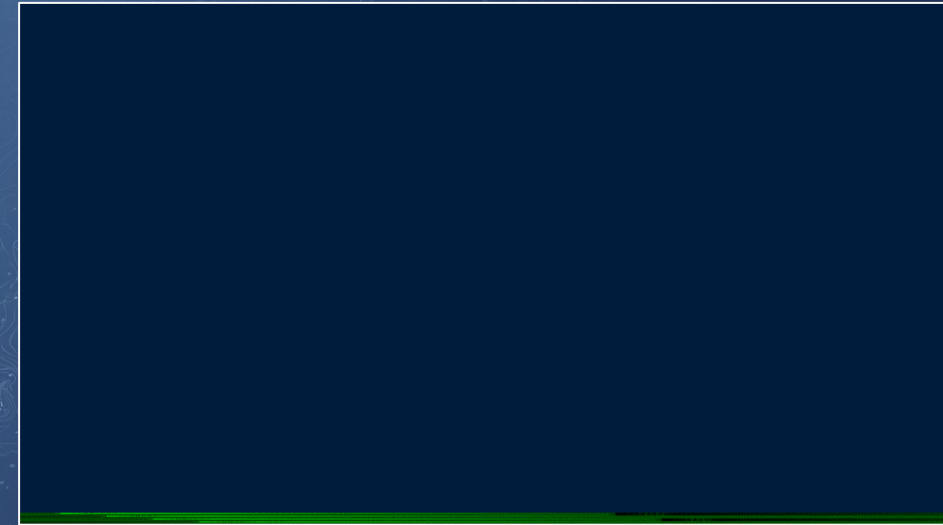
2010 Maule Earthquake



Chile's seismotectonics are controlled by the convergence of the Nazca Plate beneath the South American Plate at a rate of ~ 66 mm/year.



The 2010 Maule earthquake occurred in an area where the previous $M > 8.5$ event was the 1751 earthquake (M 8.8–9.0).



Tsunami propagation following the earthquake. The previous tsunamigenic earthquake occurred in 1835 (M 8.5).



SNAM: National and international recognition

Sistema Nacional de Alarma de Maremotos - SHOA

1



Formal International Recognition

SHOA as the IOC-UNESCO focal point and the national agency responsible for tsunami warnings in Chile.

2



Multilateral Recognition

Active participation in the PTWS/ICG PTWS and regional technical leadership.

3



United Nations Recognition

Chile included by UNDRR among five countries with advanced tsunami warning systems.

4



Expert Recognition

Public recognition by ITIC and PTWC of SNAM's progress, technology, personnel, and contribution to the international system.

5



Scientific Validation

SIPAT's operational design and implementation have been documented in a scientific paper published in Coastal Engineering Journal, indexed in Web of Science.

6



Recent International Projection

Registration of SNAM as an Ocean Decade Action for 2025–2029.



National and International Recognition



Source: The 5 Most Modern Tsunami Warning Systems in the World (UNDRR, 2020).



National Tsunami Warning System

- Supreme Decret No 26, January 11, 1966.

Mission

- Tsunami hazard assessment within the national responsibility area.



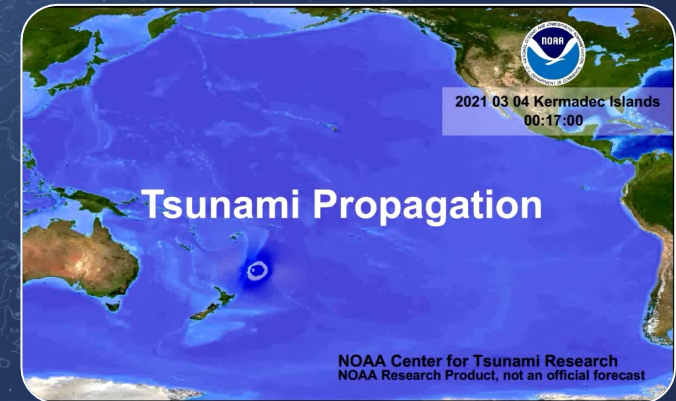
- Advanced technology systems, with national scientific contribution.

- High level of professionalism and training.

- Redundancy in monitoring, command/control and communications systems.

- High cost of maintenance and renovation.

- Operation under national and international protocols.



Emergency Evacuation Actions



SENAPRED

SERVICIO NACIONAL
DE PREVENCIÓN Y
RESPUESTA ANTE
DESASTRES



CENTRO
SISMOLÓGICO
NACIONAL



SHOA

SERVICIO HIDROGRÁFICO
Y OCEANOGRÁFICO DE LA
ARMADA DE CHILE

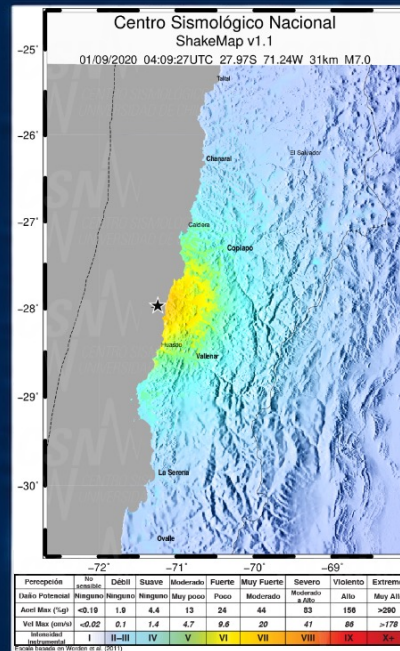


Report
following
felt shaking

Two consecutive intensities equal
to or greater than VI/II or one
equal to or greater than VIII

Preventive Evacuation

Intensity - Mercalli –
Subjective



5 min
BULLETIN
DISSEMINATION



Determination of earthquake
parameters: epicenter - depth
– magnitude

Magnitude = Objective



5 min
FIRST PRODUCTS
(PTWC / NTWC / GFZ)



Archipiélago de Juan Fernández		Chile Continental	Resumen de Propuesta	
Bloque	Decisión	Nombre del Bloque		
1	Precución	Arica y Parinacota		
2	Precución	Tarapacá		
3	Precución	Antofagasta Norte		
4	Precución	Antofagasta Sur		
5	Alerta	Atacama Norte		
6	Alerta	Atacama Sur		
7	Alerta	Coquimbo		
8	Precución	Valparaíso		
9	Precución	Libertador B. O'Higgins		
10	Precución	Maule		
11	Precución	Ñuble - Bio Bio		
12	Informativo	Araucanía		
13	Informativo	Los Ríos		
14	Informativo	Los Lagos Norte		
15	Informativo	Los Lagos Sur		
16	Informativo	Aysén		
17	Informativo	Magallanes		
18	Informativo	Antártica Chilena		
19	Precución	Juan Fernández		
20	Alerta	San Félix		
21	Precución	Isla de Pascua		

Information

Advisory

Warning

Alarm



The population is evacuated while the event analysis is
carried out.



Analysts determine the earthquake characteristics.



The preventive evacuation is maintained or canceled
according to SHOA's assessment.

National Tsunami Warning System



SNAM Operation



How is it evaluated?

SIPAT

Technological platform for Tsunami Threat estimation based on numerical tsunami modeling (pre-modeled scenarios).

For a given seismic event, the platform provides a rapid, sector-based assessment of tsunami threat levels across Chile's 21 predefined blocks.



**CHILE DIVIDED INTO
21 BLOCKS**

Threat Modeling Capability

15,000 Active Pre-modeled Scenarios



Near-Field: 9,000 scenarios

High-density concentration designed for immediate responses to events with an epicenter off the coast of Chile.



Far-Field / Regional: 6,000 scenarios

Preventive macro-regional coverage spanning the entire perimeter from southern Mexico to southern Peru.



How is it evaluated?

SIPAT

Technological platform for Tsunami Threat estimation based on numerical tsunami modeling (pre-modeled scenarios).

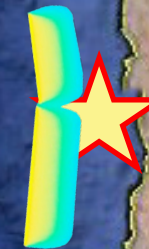
Following a seismic event, it provides a rapid, sectorized assessment (21 blocks) of the different threat levels for Chile

+15,000
Scenarios



Seismic
parameters

Selected Candidate



Candidates



Scenario

★ Real event

DATABASE



How is it evaluated?

SIPAT

Technological platform for Tsunami Threat estimation based on numerical tsunami modeling (pre-modeled scenarios).

Following a seismic event, it provides a rapid, sectorized assessment (21 blocks) of the different threat levels for Chile

- ALARM
- WARNING
- ADVISORY
- INFORMATION

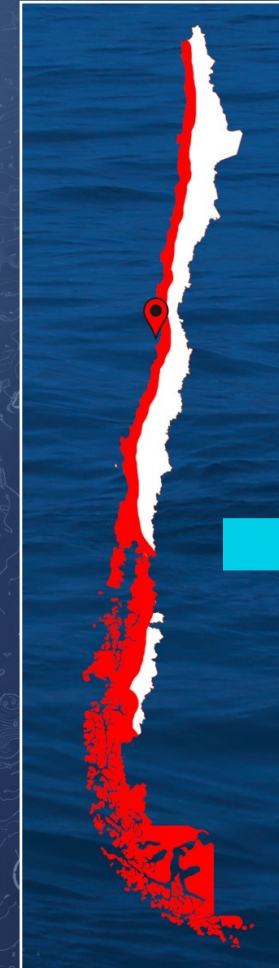
2015 Coquimbo Earthquake

Magnitude	8.4 (Mw)
Date	16/SEP/15
Time	19:54 Hora Local
Epicenter	31.553°S; 71.864° W
Depth	11,1 km
Geographic reference	42 km al W de Canela Baja
Region	Coquimbo
Source	Centro Sismológico Nacional (CSN)

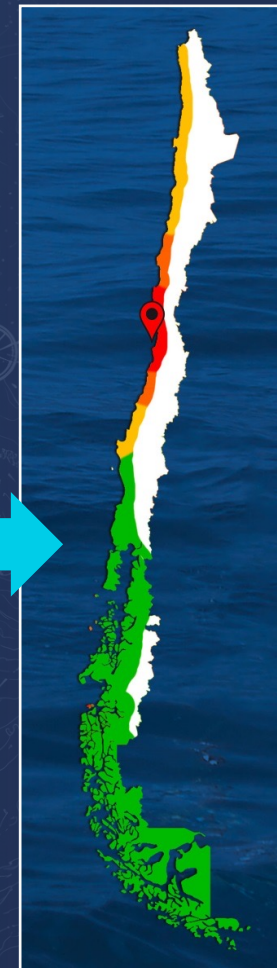


IMPLEMENTATION
FASE-W
CONTINUOUS UPDATING OF
SEISMIC INFORMATION FOR
NEAR-FIELD EVENTS

Before SIPAT



After SIPAT



GNSS-Based Rapid Characterization of the Seismic Source

GNSS-based seismic solutions are essential for enabling real-time tsunami modeling.

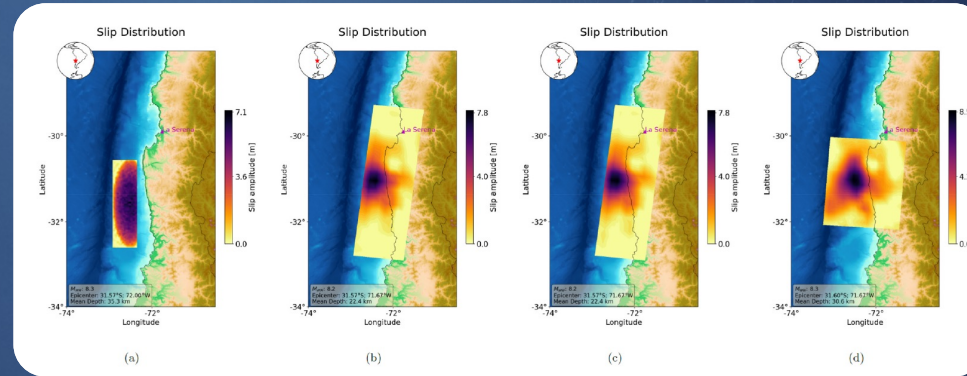
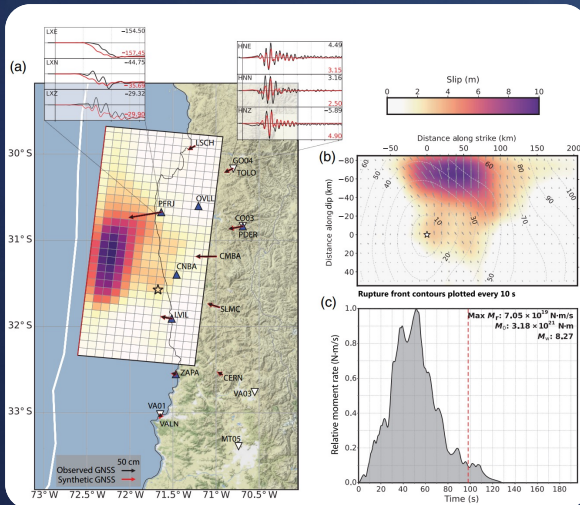
RESEARCH ARTICLE | AUGUST 04, 2022

Beyond the Teleseism: Introducing Regional Seismic and Geodetic Data into Routine USGS Finite-Fault Modeling

Dara E. Goldberg; Pablo Koch; Diego Melgar; Sebastian Riquelme; William L. Yeck

Author and Article Information

Seismological Research Letters (2022) 93 (6): 3308–3323. <https://doi.org/10.1785/0220220047> Article history



Sifon et al., 2026

473

- GNSS improves the speed and accuracy of earthquake source characterization.
- It enables the generation and continuous refinement of finite-fault models.
- Finite-fault models are critical for tsunami forecasting, as magnitude and epicenter alone are insufficient.

• *GNSS integration is driving the next generation of real-time tsunami early warning systems.*



Dissemination: Operational redundancy infrastructure



INTERNET

- Wired and WiFi connection (3 Providers)
- Satellite Link (2 Providers: Axess / StarLink)



COMPUTING EQUIPMENT

- Critical equipment: Duplicated or Triplicated
- 02 Video Walls
- 02 Video Conference Systems (SENAPRED – Navy)



TELEPHONY – SATELLITE

- Fixed Line: Internal Telephone Exchange
- Satellite: 02 Base units (Inmarsat – Iridium)
- 02 Mobile units (Inmarsat – Iridium)
- 02 Iridium PTT lines



RADIO COMMUNICATION

- VHF: 02 Base units (SENAPRED-CSN)
- 01 Base unit (NAVY)
- HF: 01 unit
- UHF: 01 Mobile unit (SENAPRED-CSN)
- 01 Mobile unit (NAVY)



DATA BACKUP

- 01 SHOA Server
- 01 SNAM Server
- Nube Amazon (Servicios SAVTEC)



AUDIOVISUAL BACKUP

- Audio and video backup system
- Call recording/backup at SHOA Telephone Exchange



Emergency Evacuation Actions

Tsunami Type	Threat Status	Evacuation Areas	Expected Amplitude	SNAM Chile National Tsunami Warning System 
 Instrumental	 INFORMATION	 No action required	<0.3m	
 Minor	 ADVISORY	Evacuation of the population outside the Advisory Zone, which includes beach areas, rocky shores, wetlands, estuaries, river mouths, coastal promenades, marinas, coastal roads, coves, ports, and piers.	0.3 - 1m	
 Moderate	 WARNING	Evacuation of the population to the Safety Area, or Safe Zone, established at an elevation above 30 meters, or as determined by local authorities.	1 - 3m	
 Major	 ALARM		≥3.0m	





Tripartite Protocol | CSN – SHOA – SENAPRED

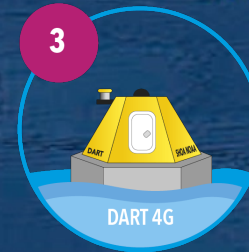
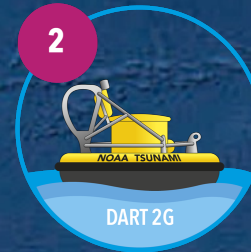
Tripartite Protocol | CSN – SHOA – SENAPRED

Monitoring Network

DART and oceanographic buoys – Sea level station



Isla de Pascua



Monitoring

SHOA annually trains field observers from the different Maritime Governorships (GG.MM.) and Port Captaincies (CC.PP.) in order to have trained personnel on the ground for tsunami observation.

Sea Level Station

1 Pressure Sensor + 1 Surface Radar

Satellite + GPRS (Mobile Telephony)

Real Time

2 SHOA Server + Cloud (Amazon)

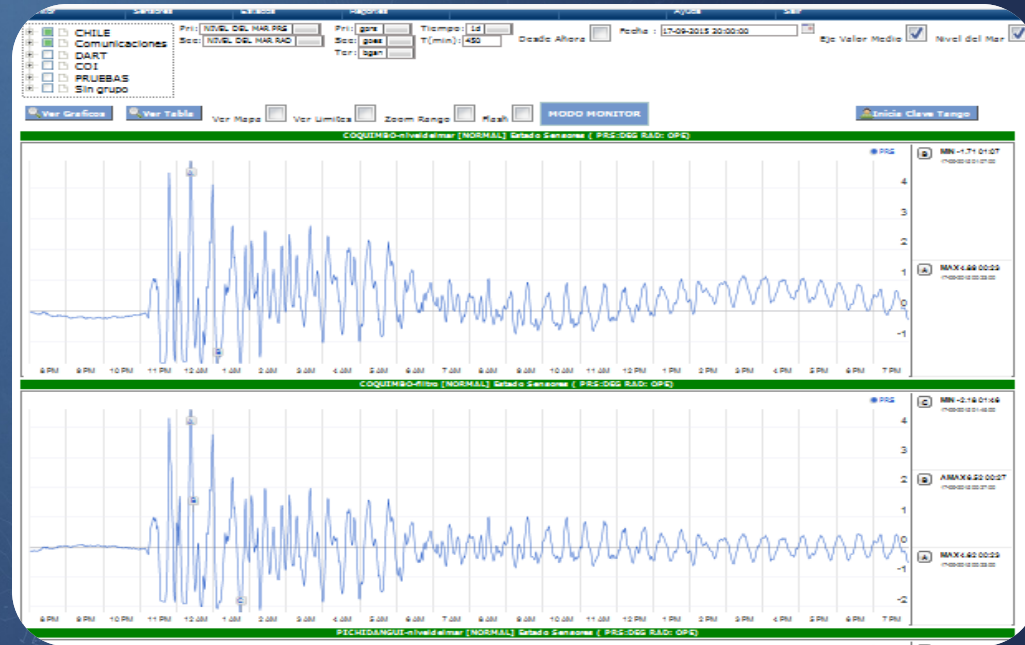
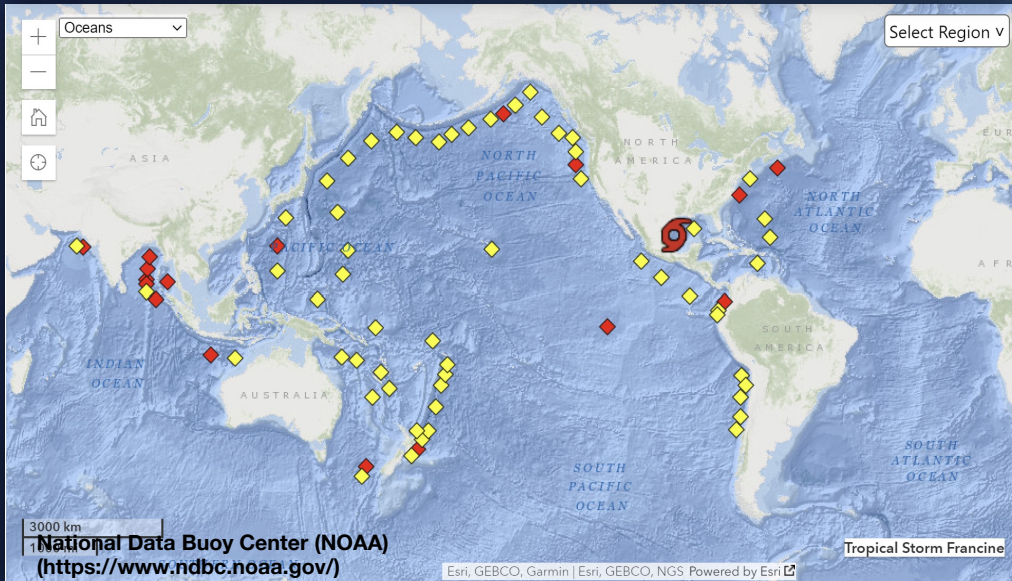
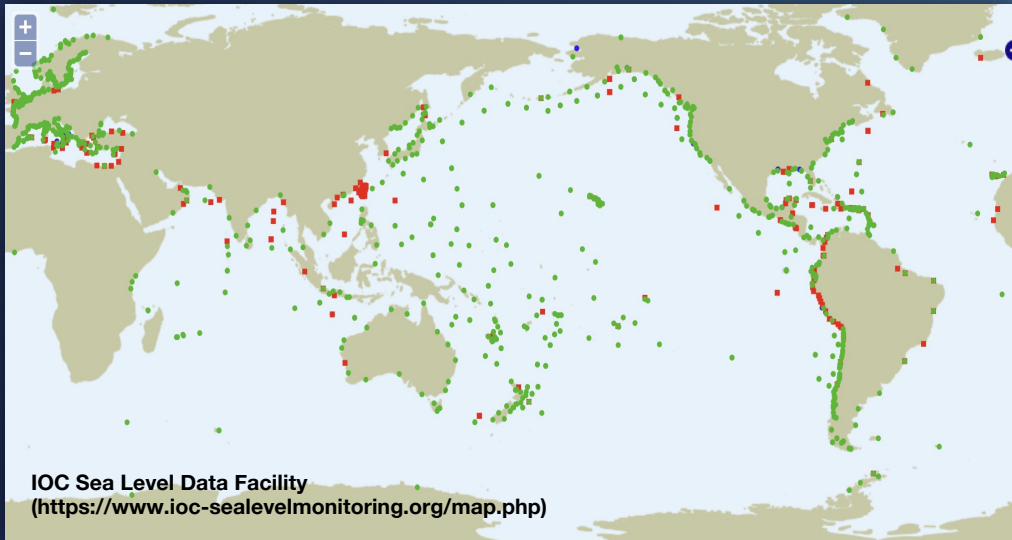
Tidal fluctuations are filtered out

Currently, an "H" type structure is used



International Monitoring Network

DART buoys – Sea Level Stations



Tsunami-related sea level records from the Coquimbo station. Coquimbo 2015 event.

Information from platforms such as the IOC Sea Level Data Facility and the National Data Buoy Center (NOAA) constitutes an essential input for ocean monitoring, early anomaly detection, and support for national and international tsunami warning centers.



Cancellation

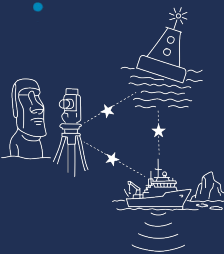
SHOA is responsible for determining the Total Cancellation of the Advisory state and the downgrading of the Tsunami Alert or Warning states through partial cancellations.

ACTIVATION / CANCELLATION BY TSUNAMI AMPLITUDE (AT in meters)

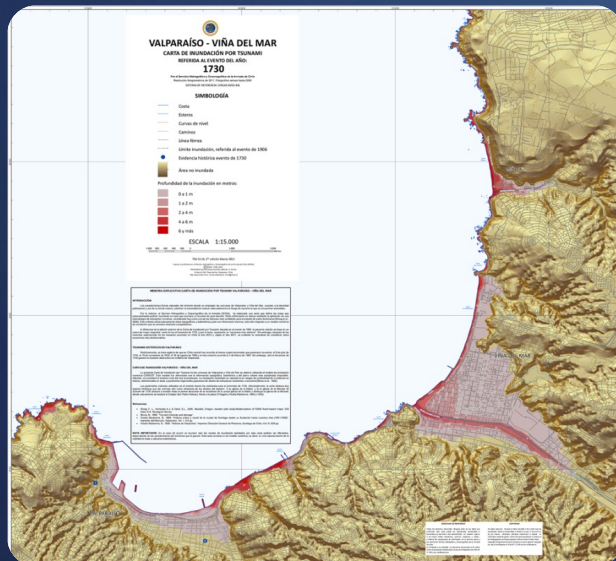


EVACUATION CANCELLATION MUST BE DECREED BY SENAPRED

All Sea Level Stations (SLS) belonging to the same SIPAT block must present Tsunami amplitudes lower than 0.3 meters for at least three consecutive tsunami periods.



Tsunami Inundation Charts



Map showing areas that could be inundated and their depth in the event of a tsunami.



CITSU are based on a probable extreme event, considering available scientific background and technologies.



LAW No. 21364 introduces changes to:

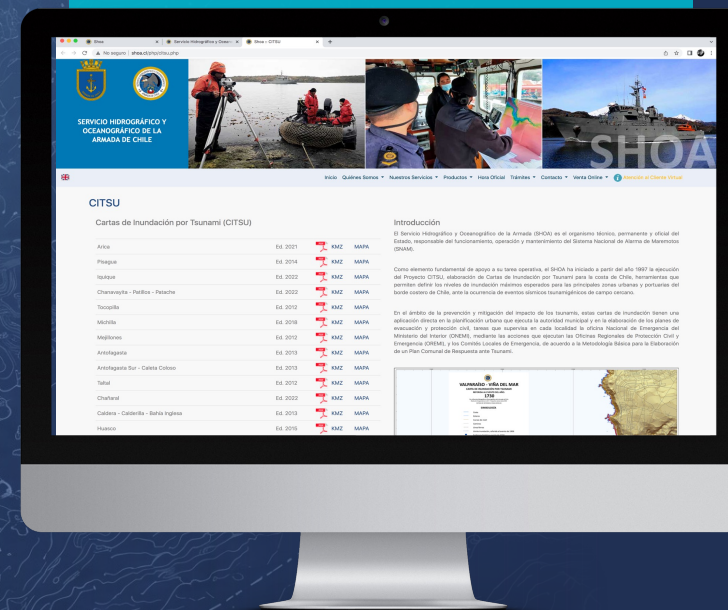
- Their format.
- Their explanatory report.
- Their publication and distribution.
- It implements methodology, processes, and documentation for validation.

Under the SINAPRED Law, they become Disaster Risk Management instruments, binding for territorial planning.

CITSU IN FORCE

77

From Arica to Puerto Williams
Available on the website:
www.shoa.cl



SNAM

National Tsunami Warning System

"Because tsunamis cannot be predicted, we must be prepared to respond under demanding scenarios. Training and modern, redundant systems are therefore essential to fulfilling our mission."



INFORMATION



ADVISORY



WARNING



ALARM





Thank you



152 years of charting Chile from the sea