

# DIRECCIÓN DE HIDROGRAFÍA Y NAVEGACIÓN



## THE PERUVIAN TSUNAMI WARNING CENTER

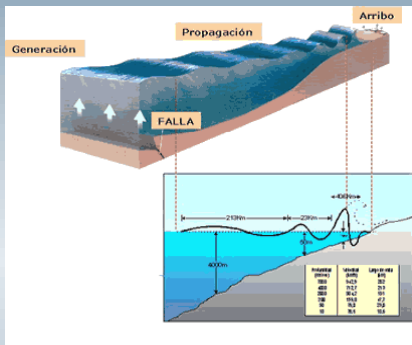
*César Jiménez*

WWW.DHN.MIL.PE

## TSUNAMI



The Tsunamis are a set of several marine waves of long period generated by a perturbation, generally an earthquake with epicenter on the sea.

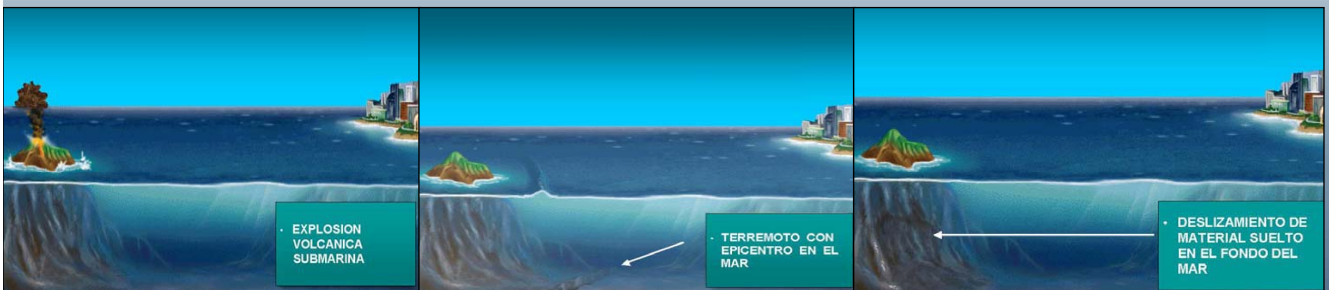


津波

**Tsunami:** word of japanese origin used in many languages as english and spanish.

**TSU = PORT, NAMI = WAVE**

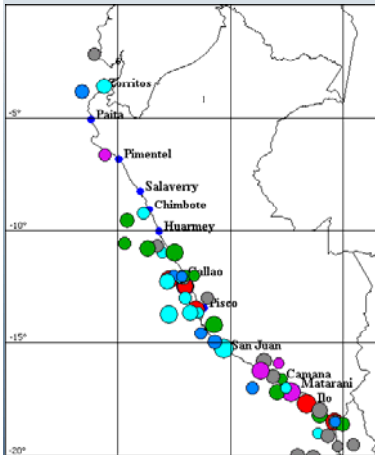
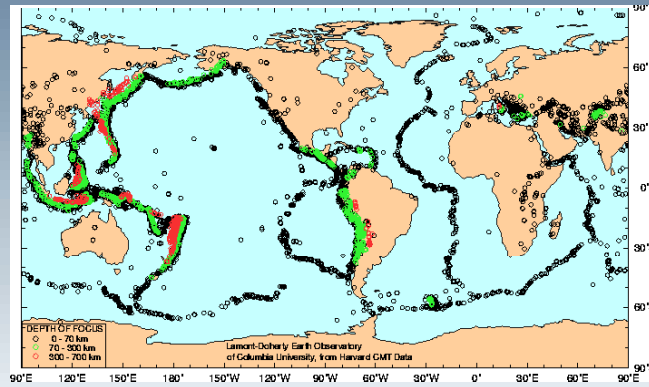
Literally, it means «waves in the port», no damage at offshore, but can be destructive in coasts.



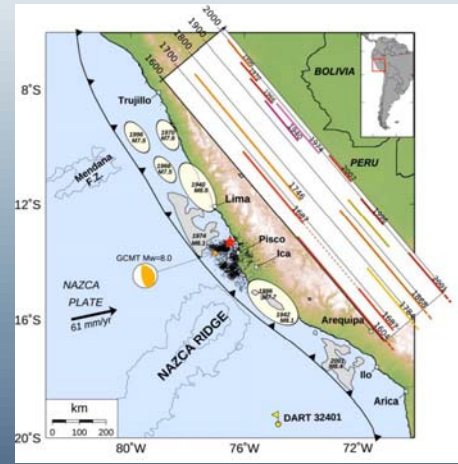
# HISTORICAL PERUVIAN TSUNAMIS



Seismicity of the world: Peru is located in the Pacific Ring of Fire. Therefore, there is a great seismic, tsunami and volcanic activity.



Earthquakes generators of tsunami in Peru (1513-2007). The last great earthquake in Peru was in Pisco 2007.



## CALLAO TSUNAMI, 1746 (CENTRAL PERU)

**EPICENTER**  
 11.9°S; 77.1°W

**MAGNITUDE**  
 > 9.0 Mw

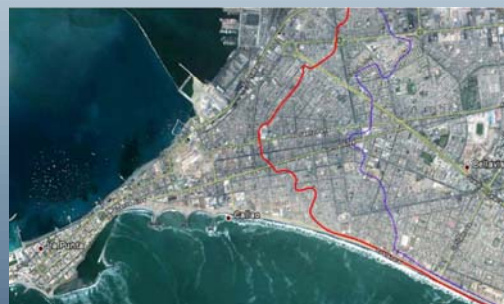
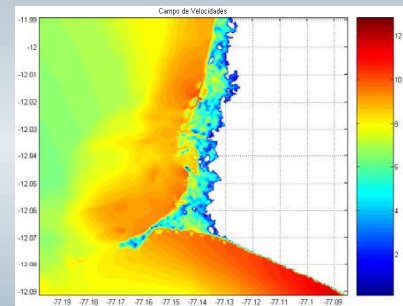
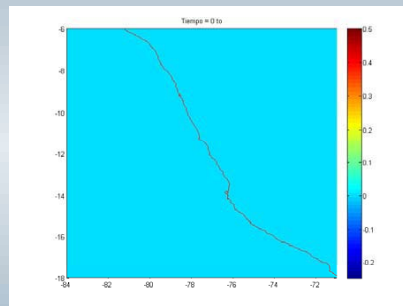
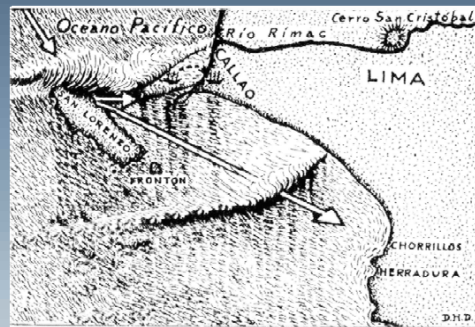
**DATE**  
 October 30, 1746

**TIME**  
 22:30 Local Time

**ARRIVAL TIME**  
 30 minutes

**MAXIMUM WAVE HEIGHT**  
 10 m (Callao)  
 24 m (Miraflores cliffs)

**EFFECTS**  
**CASUALTIES:**  
 5000 in Callao  
 200 survivors  
**EXTENSIVE DAMAGES**



## CAMANA TSUNAMI, (SOUTHERN PERU) 2001

**EPICENTER**  
16.15°S; 74.4°W

**MAGNITUDE**  
8.4 Mw

**DATE**  
Saturday June 23, 2001

**TIME**  
20:33:13 GMT

**ARRIVAL TIME**  
15 minutes

**MAXIMUM WAVE HEIGHT**  
7 to 8 m

**EFFECTS**  
**CASUALTIES: 23**  
**EXTENSIVE DAMAGES**



## PISCO TSUNAMI, 2007 SOUTHERN PERU

**EPICENTER**  
13.67°S; 76.76°W

**MAGNITUDE**  
8.0 Mw

**DATE**  
August 15, 2007

**TIME**  
23:40 GMT

**ARRIVAL TIME**  
20 minutes

**MAXIMUM WAVE HEIGHT**  
10 m (Lagunillas)

**EFFECTS**  
**CASUALTIES:**  
500 (earthquake)  
03 (tsunami)  
**EXTENSIVE DAMAGES**



# CHILEAN TSUNAMI FEB 2010



## EPICENTER:

Lat: 36.1 S  
Lon: 72.6 W

MAGNITUDE: 8.8 Mw

DATE: Feb 27, 2010

TIME: 06:33 GMT

115 km NNE of Concepción

Subduction zone Nazca-Pacific plates.

### PAITA

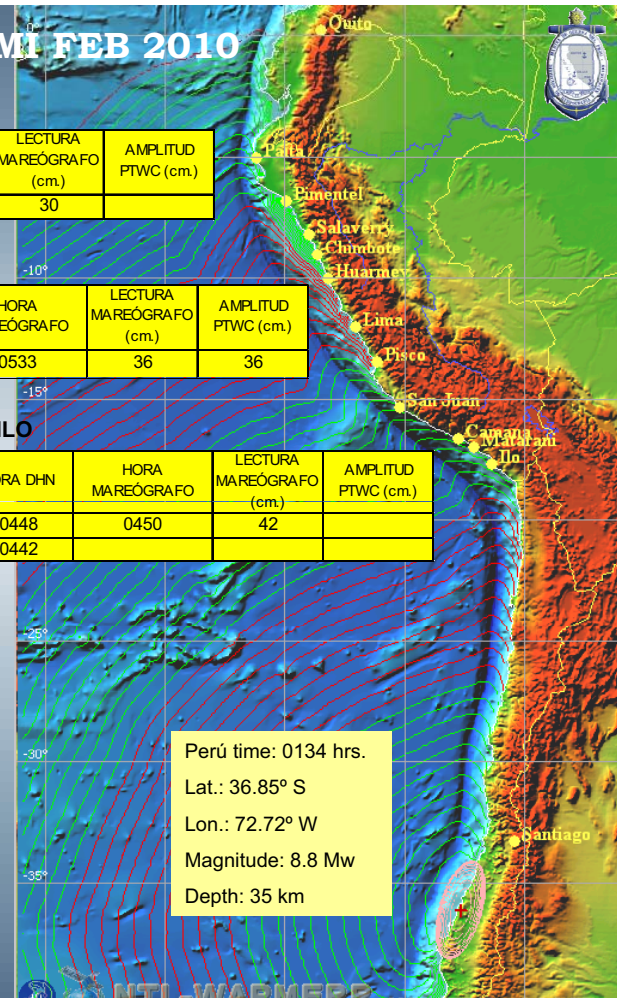
HORA PTWC	HORA DHN	HORA MAREÓGRAFO	LECTURA MAREÓGRAFO (cm.)	AMPLITUD PTWC (cm.)
	0653	0649	30	

### CALLAO

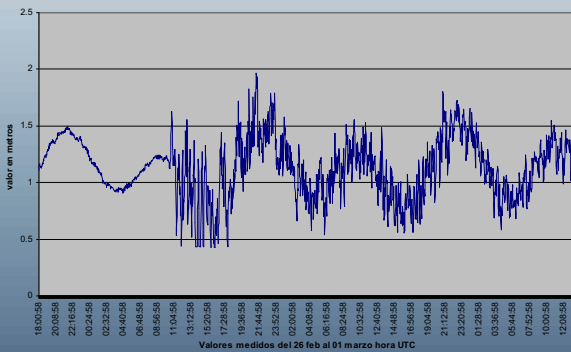
HORA PTWC	HORA DHN	HORA MAREÓGRAFO	LECTURA MAREÓGRAFO (cm.)	AMPLITUD PTWC (cm.)
0545	0539	0533	36	36

### MATARANI / ILO

HORA PTWC	HORA DHN	HORA MAREÓGRAFO	LECTURA MAREÓGRAFO (cm.)	AMPLITUD PTWC (cm.)	
		0436	0448	0450	42
			0442		



Variación del nivel del mar en la punta



Valores medidos del 26 feb al 01 marzo hora UTC



## MIRAFLORES BAY



Observation time: 1020  
Tidal phase: Descendent  
Amplitude: 15 cm  
Moon phase: Full

## MIRAFLORES BAY

Hora de observación: 1020  
Fase de Marea: Descendente  
Amplitud: 15 cm  
Fase Luna: Llena





## PARACAS BAY

Observation time: 0830  
Tidal phase: Descendent  
Amplitude: 100 cm  
Moon phase: Full

## CALETA LAGUNILLAS (ICA)

Hora de observación: 1740  
Fase de Marea: Ascendente  
Amplitud: 106 cm  
Fase Luna: Llena



## COMPONENTS OF A TSUNAMI WARNING SYSTEM



This system allows to provide early warning in case of an imminent tsunami. Consists of the following elements:

- 1) **Seismographic network** .- In order to detect the focal parameters and calculate the focal mechanism of great earthquakes generators of tsunami. The seismic network of Peru is managed by IGP (Geophysical Institute of Peru).
- 2) **Tide gauge network**.- This consists of strategically stations located along the Peruvian coast. Verifies that the tsunami has originated and is traveling through the sea. This tidal network is managed by DHN (Directorate of Hydrography and Navigation).
- 3) **Geodesic Network**.- Composed of several permanent GPS stations. Allows real-time detection of coseismic deformation of the crust, this will decide if it will generate a tsunami (before seismic calculations). But should be managed by IGP and IGN (National Geographical Institute).
- 4) **Database of tsunamis simulated**.- A set of seismic source events (Green functions) for all the peruvian coasts simulated by numerical modeling. Will allow a fast calculation of arrival times and maximum wave height for warning purposes. This system is not implemented yet.
- 5) **A system of alerting the public**.- Formed by a group of sirens, radio and television messages to issue an evacuation notice to people living in potential flood areas. This system will be managed by Civil Defense and regional and local governments.

All elements of the seismic, tide gauge and geodetic networks must be interconnected to a central operation through redundant radio, fax-telephone and satellite communications, and the signals arriving in real time, so that operators can process data and make the right decision and to give timely warning to evacuate.

# PERUVIAN TSUNAMI WARNING CENTER

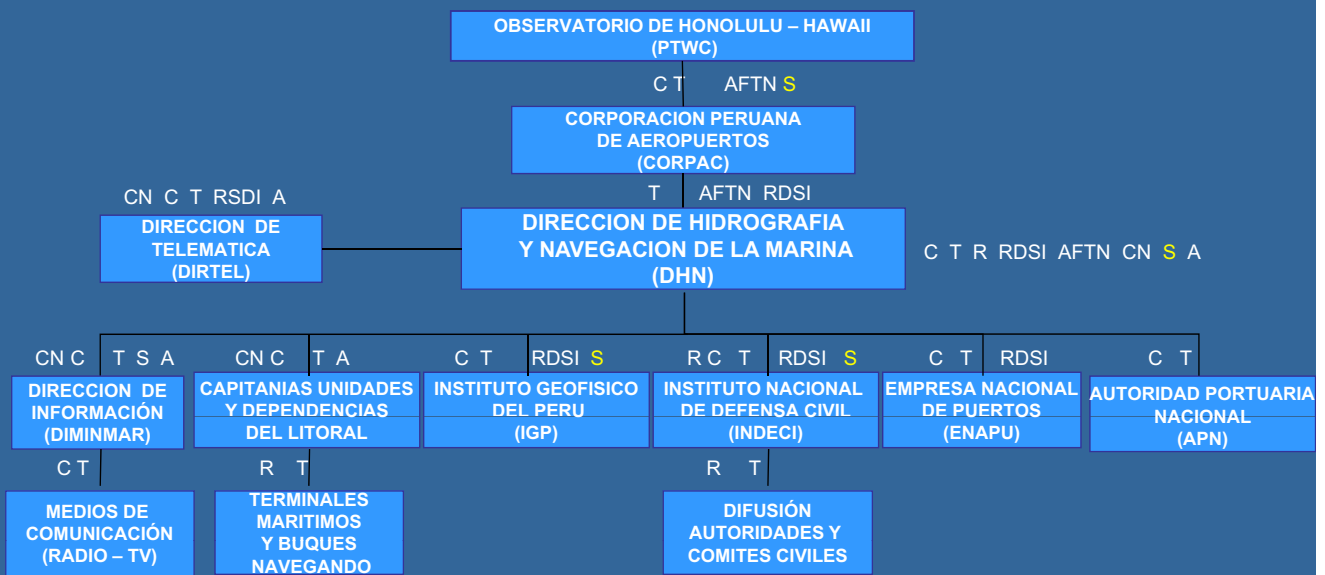


The National Tsunami Warning System is managed by DHN of peruvian navy and integrated by several institutions:

IGP: through seismic service  
 INDECI: civil defense      APN:  
 port authority      DICAPI: navy  
 authority CORPAC, etc.



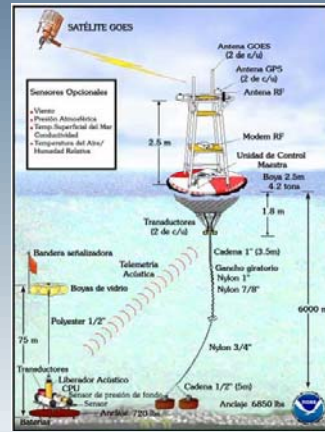
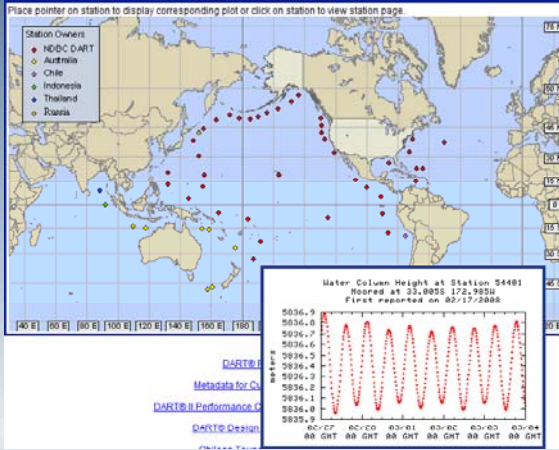
## FLOWCHART OF COMMUNICATIONS OF TSUNAMI WARNING SYSTEM



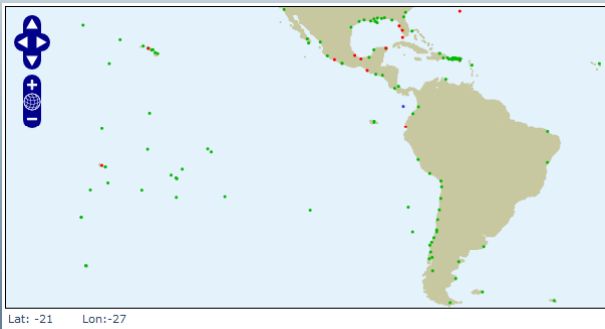
- C = Correo electrónico
- T = Teléfono
- R = Radio
- RDSI = Red Digital de Servicio Integrado
- AFTN = Aeronautical Fixed Telecommunication Network – Satelital
- CN = Comunicaciones Navales
- S = Teléfono Satelital
- A = Sistema Troncalizado



# SEA LEVEL MONITORING: DART BUOY SYSTEM

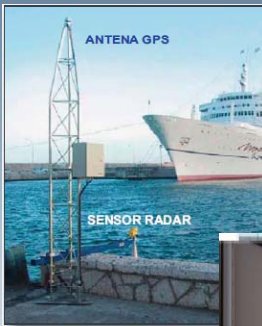


# SEA LEVEL STATION MONITORING FACILITY



Previous station	Station: Callao,La-Punta_PE	at 2011-03-04 02:02 GHT	Next station																										
[more details]	[GTS message]	[show data]	[show on map]																										
<table border="1"> <tr><td>Code</td><td>Call</td></tr> <tr><td>Country</td><td>Peru</td></tr> <tr><td>Location</td><td>Callao,La-Punta_PE</td></tr> <tr><td>Status</td><td>Operational</td></tr> <tr><td>Local Contact</td><td>Dirección de Hidrografía y Navegación (Peru)</td></tr> <tr><td>Other Contact</td><td>Pacific Tsunami Warning Center (USA)</td></tr> <tr><td>GLOSS ID</td><td>173 (Igoita handbook)</td></tr> <tr><td>Latitude</td><td>-12.071</td></tr> <tr><td>Longitude</td><td>-77.174</td></tr> <tr><td>Connection</td><td>GTS message</td></tr> <tr><td colspan="2"><b>Sensor 1</b></td></tr> <tr><td>Type of sensor</td><td>prs</td></tr> <tr><td>Sampling rate (min)</td><td>2</td></tr> </table>				Code	Call	Country	Peru	Location	Callao,La-Punta_PE	Status	Operational	Local Contact	Dirección de Hidrografía y Navegación (Peru)	Other Contact	Pacific Tsunami Warning Center (USA)	GLOSS ID	173 (Igoita handbook)	Latitude	-12.071	Longitude	-77.174	Connection	GTS message	<b>Sensor 1</b>		Type of sensor	prs	Sampling rate (min)	2
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<h3>Sealevel at Callao,La-Punta_PE station - (1.8379 m)</h3> <p>From 2011-02-25 02:02 to 2011-03-04 02:02 @IOC-VLIZ</p> <p> <input type="button" value="Last 30days"/> <input type="button" value="Last 7days"/> <input type="button" value="Last day"/> <input type="button" value="Last 12 h"/> <input type="button" value="Absolute levels"/> </p> <ul style="list-style-type: none"> <li>• use left icons to zoom &amp; scroll</li> <li>• Relative level= signal - average over selected period [shown]</li> <li>• Absolute level= as received</li> </ul>																													

# PERUVIAN TIDAL NETWORK



**10 TIDAL STATIONS WITH LEVEL SENSOR OF RADAR TYPE (MICROWAVE 26 GHz). DATA COMMUNICATION IN REAL TIME**





# GPS GEODESIC STATION (DHN-IRD)

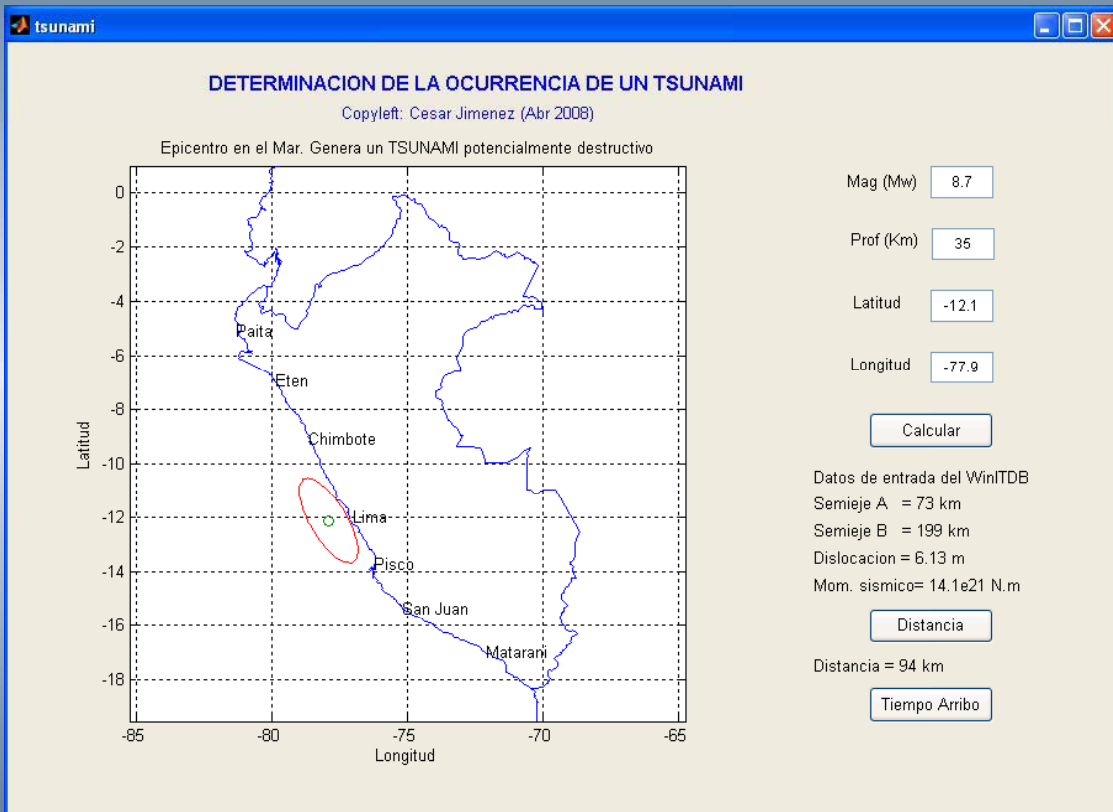


An application in the field of prevention of natural disasters would be the implementation of a tsunami early warning using GPS signals in real time. When there is a great earthquake, tectonic stresses relax and change the position of geodesic point (located in San Lorenzo island).

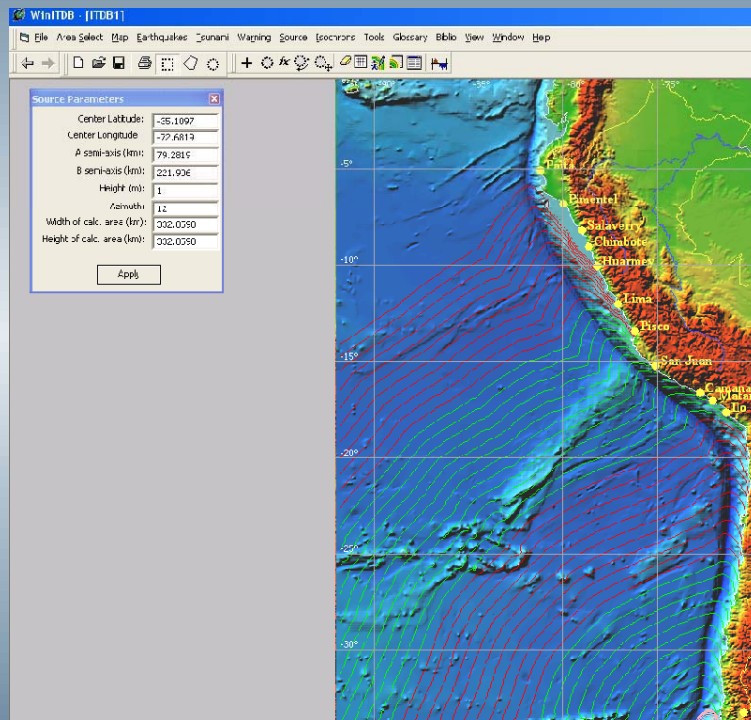
We can measure this sudden changes in the geographical coordinates: latitude, longitude and altitude. If the variation exceeds a certain threshold, the alert would be given for.



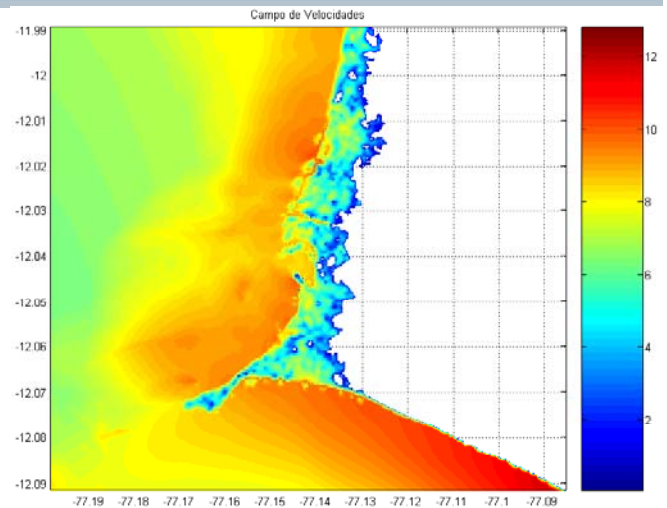
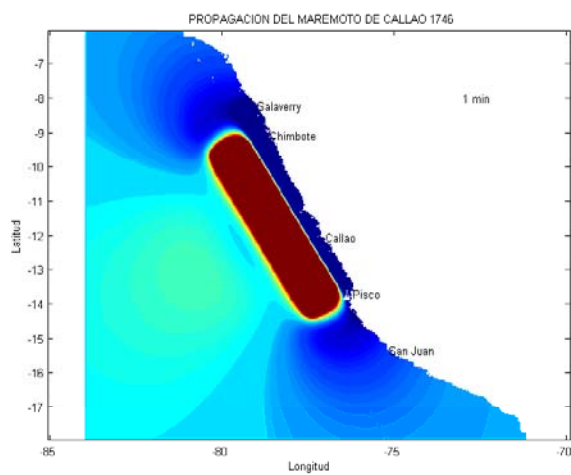
# SOFTWARE FOR DETERMINATION OF TSUNAMI AND FAST CALCULATION OF ARRIVAL TIMES



# TSUNAMI NUMERICAL MODELING: WIN ITDB

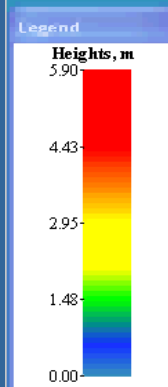


# TSUNAMI NUMERICAL MODELING TUNAMI-N2



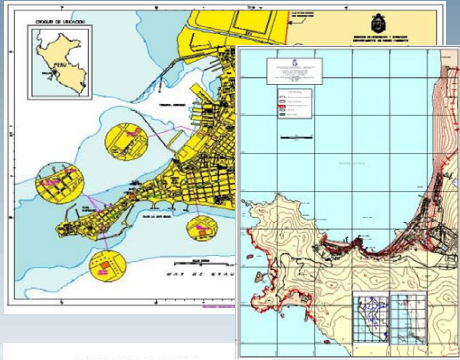
**TSUNAMI  
NUMERICAL  
MODELING:  
COMMTT**

**EXAMPLE CHILEAN  
TSUNAMI, FEB 27,  
2010**



**PREVENTION MEASURES**

# Tsunami Workshops; Training in Schools, Universities and publics/privates institutions



## REGLAS DE SEGURIDAD EN CASO DE TSUNAMIS

<http://www.dhn.mil.pe>

- Information about Tsunamis published in the Web-site of DNH
- General information: definition, origin, generation, history of peruvian tsunamis
- Information about national and international tsunami warning system.
- Downloadable information: videos, simulations, journal,
- Inundation maps
- Preliminar report of Tsunamis

<http://www.dhn.mil.pe>

## INUNDATION MAPS



- DHN is elaborating and publishing in the web the tsunami inundation maps of every important city located in the peruvian coasts. It's downloadable information.
- There are 98 inundation maps.



**“EL SISTEMA DE ALERTA DE TSUNAMI MÁS EFICAZ ES LA EDUCACIÓN DE LA POBLACIÓN COSTERA”**

**! GRACIAS !**