Tsunami Risk Assessment in Chile

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1960 tsunami height

Sievers (1961), Lagos et al. (2008)
PUERTO SAAVEDRA / MAY 22, 1960

Photo by Municipalidad de Puerto Saavedra (1960)
2010 tsunami height

Lagos et al. (2010)

The maximum tsunami heights were recorded in coastal cliffs.
2010 tsunami height (Meters)

Lagos et al. (2010)
2010 tsunami impact on coastal communities

Lagos et al. (2010)
Social housing after tsunami

Dichato, Region del Biobio, 2010

Tsunami inundation depth

Lagos et al. (2010)
Threat

Vulnerability

Risk

Tsunami inundation areas

Homogeneous threat

Differentiated threat

Population

Risk
2003. Probable scenario
2012. Worst case scenario
Validation scenarios

- Historical data
- Tsunami deposits
A destructive tsunami, which enveloped the coast for a distance of over 1000 km, occurred almost simultaneously with the second earthquake. For the first time in its history, the port of Valparaíso was flooded and considerably damaged. In the lower area of Almendral, all houses, fortifications and warehouses were destroyed by the flood. Goods prepared for shipment to Peru were washed away with the warehouses. In particular, 80,000 sacks (fanegas) of wheat were lost.
2012. Worst case scenario
Maullín, after 1960 tsunami
Validation scenario with tsunami deposits

Lagos et al. (2009)
Using Tsunami Deposits and Observed Tsunami Heights to Test Source Models of 1960 Chile Earthquake

Lagos & Cisternas (2007)

Abstract

Numerical tsunami simulations of the giant 1960 Chile earthquake (Mw 9.5) were performed with several source models. The computed inundation areas are compared with 1950 tsunami deposits and observed tsunami heights.

Tsunami simulations focus was the Pacific coasts of the south-central Chile, examining the Rio Maullín estuary in detail, localised at 41.5°S midway along the 1960 rupture; in this place the 1960 earthquake lowered the area by 1.5 m, and the ensuing tsunami spread sand across lowland soils. The tsunami heights at the coast were greater than 9 m above sea level, and in much of this flooded area, the tsunami reached a height of 4.5 m.

Fault parameters of source models examined in this study consider four sources from Kanamori and Cipar (1974) with the same length, width, slip, strike and dip but different rake and depth; six sources proposed by Cisternas (1989) with the same length, strike and rake but different width, slip, dip and depth; and one source from Barratén and Ward (1990). The results allow propose the earthquake source models for tsunami generation that better fit with real evidences.

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REFERENCES

Tsunami Risk Zoning in South-Central Chile

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Abstract
The recent 2010 Chilean tsunami revealed the need to optimize methodologies for assessing the risk of disaster. In this context, modern techniques and criteria for the evaluation of the tsunami hazard were applied in the coastal zone of south-central Chile as a specific methodology for the zoning of tsunami risk. This methodology allows the identification and validation of tsunami hazard; the spatialization of factors that have an impact on the risk; and the zoning of the tsunami risk. For the hazard evaluation, different scenarios were modeled by means of numerical simulation techniques, selecting and validating the results that better fit with the observed tsunami data. Hydrodynamic parameters of the inundation as well as physical and socioeconomic vulnerability aspects were considered for the spatialization of the factors that affect the tsunami risk. The tsunami risk zoning was integrated into a Geographic Information System (GIS) by means of multicriteria evaluation (MCE). The results of the tsunami risk zoning show that the local characteristics and their location, together with the concentration of poverty levels, establish spatial differentiated risk levels. This information builds the basis for future applied studies in land use planning that tend to minimize the risk levels associated to the tsunami hazard.

Lagos (2010)
FIELD EVIDENCE

- Tsunami
- Subsidence

- 1960
- after 1450-1620
- 1280-1390
- 1020-1190

Cisternas et al. (2005)
Depósito tsunami 1960.

X No encontrado.

Límite inundación de acuerdo a sobrevivientes (Atwater et al. 1999).

- Depósito tsunami 1960.
- No encontrado.

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Límite inundación de acuerdo a sobrevivientes (Atwater et al. 1999).

Selected scenario

Lagos (2007)
Some products to assess Tsunami risk in Chile
INUNDATION AREA TSUNAMI 1960

Worst case

Lagos (2007)
INUNDATION AREA TSUNAMI 1837

Lesser event

Lagos (2007)
Tsunami Hazard

Lagos (2007)
Tsunami inundation depth

Lagos (2007)

Bahía de Maullín

Rio Maullín
Tsunami velocity

Lagos (2007)
Altitude

Lagos (2007)
Slope

Lagos (2007)
Distance to safety zone

Worts case

Lagos (2007)
Population density

Lagos (2007)
Tsunami hazard

Lagos (2007)
Other examples: Tsunami inundation depth in urban areas

Lagos (2012)
Distance to safety zone

Lagos (2012)
Risk without vertical evacuation

Risk with vertical evacuation

Ramos (2011)
Mapa de Peligro de Tsunami de Talcahuano
Región del Biobío

Profundidad de inundación por Tsunami (m)

Profundidad máxima de inundación (m)

Velocidad máxima de la corriente (m/s)

Mareograma modelado gráficos A y B

Talcahuano

Mapa de Localización Región del Biobío

Alto (> 2)

Medio (0.5 - 2)

Bajo (0 - 0.3)

Velocidad de la corriente (m/s)

A.- Altura de Tsunami (m)

B.- Velocidad de la corriente (m/s)

Selección de elevaciones y velocidades de Tsunami y velocidad de la corriente. Las elevaciones máximas corresponden a crestas de olas; las elevaciones negativas son depresiones de olas o los tiempos cuando el agua fluye hacia el mar.

Lagos et al. (2010)