Numerical Simulation of the 2010 Tsunami impact in Talcahuano

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OBJECTIVES

• We aim to improve our understanding of tsunami hydrodynamics along the coast of Chile
• Implement and validate the high-resolution numerical tsunami model STOC on the 2010 event
• To validate high-resolution tsunami hazard mapping methods and means of estimating the drift of containers in port areas
STOC (Storm surge and Tsunami simulator in Oceans and Coastal areas) solves the Averaged Navier Stokes (RANS) at different scales (2D, 3D)

- STOC ML for tsunami propagation at large scales (includes several vertical layers, quasi 3D)
- STOC-IC for tsunami inundation and flow-structure interaction (3D)
- STOC–DM for drifting of floating bodies
THE FEBRUARY 27TH 2010 TSUNAMI

- 8.8 Mw subduction earthquake on February 27th 2010, 3:34 AM
- More than 600 km along the coast were impacted
- Damage in coastal settlements, cities and ports
- 156 tsunami casualties and 24 disappeared

High variability of runups with a maximum measured runup of 29 m over a cliff
- In many places runup was larger than 10 m
- Witnesses say that at least four destructive waves hit Talcahuano

Fritz et al., 2011
CONCEPCION BAY

- Geometry and bathymetric conditions create conditions for tsunami amplification through resonance (Aránguiz et al., 2015)
- The first wave was not the most damaging
- Floating objects were drifted from the port area (ships and containers) and reached the city
• Wide inundation in the city and port area
• Several consecutive tsunami waves
• Ships and containers were drifted by the tsunami
MODELING THE TSUNAMI IMPACT WITH THE STOC MODEL

- 8 nested grids (4.4 km -> 2 m)
- 170 containers distributed in 4 areas (only 1 story)
- STOC –ML configured with only one layer (hydrostatic) for tsunami propagation, STOC-DM is used to reproduce the containers’s drift
INITIAL FREE SURFACE DEFORMATION FROM SEISMIC SOURCE

Slip from Delouis (2010)

Free surface deformation
NUMERICAL MODELING

Large scale tsunami modeling

2 m grid simulation using high resolution lidar data for Talcahuano

t = 129 min
VALIDATION ON THE INUNDATION EXTENSION

Numerical model

Measurements

- Fritz et al. 2010
- Koshimura et al. 2010
- Inundation zone (Koshimura et al. 2010)
HAZARD MAP FOR THE FEBRUARY 27th TSUNAMI IN TALCAHUANNO INCLUDING ARRIVAL TIMES
TRAJECTORIES OF CONTAINERS FROM THE PORT AREA OF TALCAHUANO
SIMILAR FEATURES FOR DIFFERENT TSUNAMIS

Time: 0 min

27F 2010

1A 2014

16S 2015