Tsunami Resonance Along the Chilean Coast: The role of bay shape and source location

Patricio A. Catalán[a,b] and Benjamín Díaz[a]

[a]*Departamento de Obras Civiles, Universidad Técnica Federico Santa María*

[b]*CIGIDEN*

The occurrence of tsunami amplification in coastal areas due to resonance and energy trapping has been a subject of a long history of research. Reports of its occurrence exist for a large number of tsunami events, suggesting it is a fairly ubiquitous process. However, although it is understood that resonance is a relevant process, the characteristics of local responses are not always well understood. For instance, at certain locations existing records suggest that different modes can be excited by different tsunami events, suggesting that while an overall system response can exist, the details of the actual system response can also be dependent on the characteristic of the source. To which extent either mechanism governs the response at a particular location, it is not completely understood. Advancing in this understanding can be of importance in detecting tsunami hot spots, for example.

In order to understand how different locations along the Chilean coast respond to tsunamis, a systematic study of the resonance at number of bays has been conducted, combining different methods. Actual sea level data from tide records (with and without tsunamis) have been used to determine the background spectra and also tsunami spectra. For the latter, we have been able to use up to six tsunami events, thereby allowing assessing source dependencies. Next, numerical solutions of a free oscillation model are estimated to determine potential modes and their spatial structure. Comparison among these modes and background spectra allows identifying natural modes, even though discriminating between local and shelf modes can be difficult. Finally, numerical modeling of simple-source tsunamis located at different locations relative to the location of interest allows estimation of the dependency on tsunami travel path in triggering resonance.

The methodology is applied to five different bay configurations. Results indicate that responses can vary significantly depending on some geometric characteristics of the bay. For instance, well enclosed and shallow bays tend to respond in the same way regardless of source characteristics and relative location. On the other end, more open and deeper bays show sensitivity on either the tsunami source or the relative location of it, thereby exhibiting different behavior for different events. Further work needs to be done aimed at establishing whether bay morphology could be used to predict its behavior.

References

Rabinovich, A. (2009), Seiches and Harbor Oscillations, in Y. C. Kim, ed., 'Handbook of Coastal and Ocean Engineering', World Sci., , pp. 193--236.

Cortés, P.; Catalán, P. A.; Aránguiz, R. & Belloti, G. (2017), 'Tsunami and shelf resonance on the northern Chile coast', Journal of Geophysical Research 122(9), 7364-7379.