EVALUATION OF THE KICK'EM JENNY SUBMARINE VOLCANO TSUNAMI THREAT FOR PUERTO RICO

by

Carlos G. Andrade von Hillebrandt
Undergraduate Mechanical Engineering/UPR/Mayaguez

Supervised by

Aurelio Mercado Irizarry
Retired Professor in Physical Oceanography
Department of Marine Sciences/UPR/Mayaguez

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Introduction

Kick ‘em Jenny Worst Case Event

By Carlos Andrade and Aurelio Mercado

Tasks

This report will discuss the potential risks associated to a tsunami caused by a Kick ‘em Jenny event, an undersea volcano north of Grenada. In addition, the process for simulating such an event is elaborated. We were tasked with the case of a submarine mass movement due to a collapse of the volcano edifice, but it could not be carried out due to the lack of sea surface initial conditions. Instead, we modelled an explosion worst case scenario as described in http://uwiseismic.com/General.aspx?id=53: “Studies show that the worst eruption that Kick 'em Jenny is capable of under any circumstances might generate a wave with an amplitude of 10m in open waters at a distance of 10km from the vent. Waves of this amplitude could be generated only if the volcano began to erupt in water depths of less than about 130m. Currently the depth to the vent is 268m.”

The tsunami model to be used is MOST, which being hydrostatic, is not well suited for this task. But since the initial condition is going to be given 10 km away from ground zero, it is possible that any departure from hydrostatic balance might be small. At least on the Caribbean Sea side of the wave front.

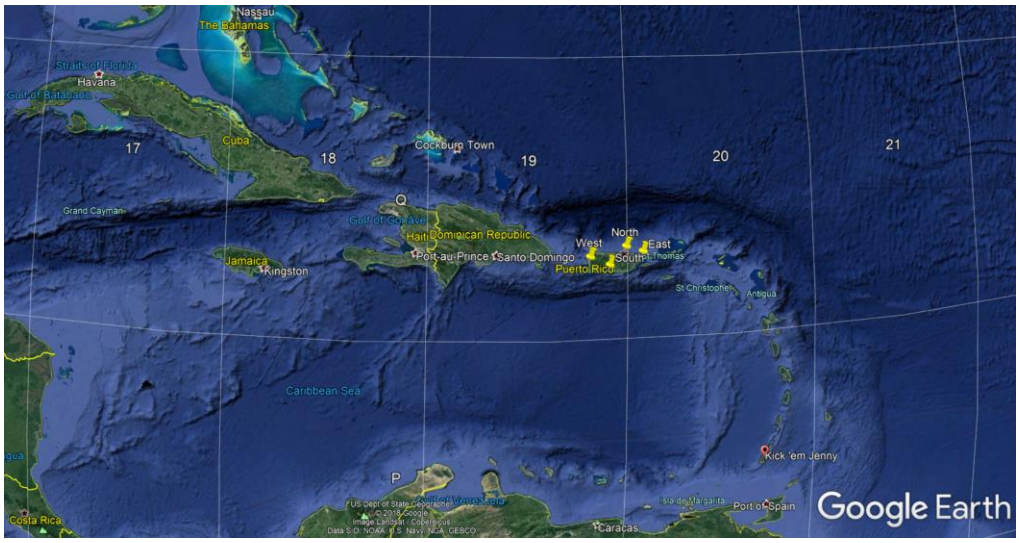

Figure 1 – Study location.

Figure 1 above shows the location of the volcano relative to the island of Puerto Rico. Sea surface time series will be measured at the four yellow thumbtacks around the island. Figure 2 shows a recent image of the volcano.

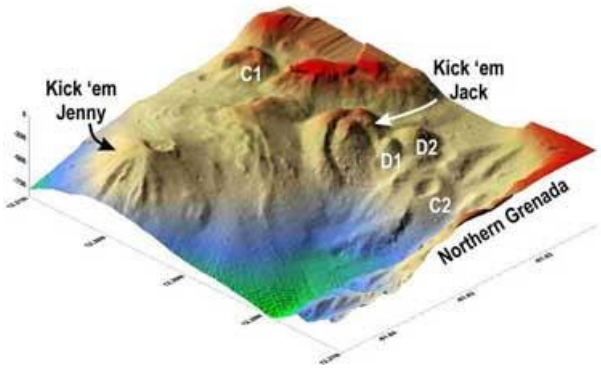

Figure 2 - Kick 'em Jenny SeaBeam image

Modeling Event

Undersea volcanoes can generate tsunamis by either a landslide event or submarine explosion. According to the University of the West Indies the worst possible case for a tsunami generated by Kick 'em Jenny would be caused by a submarine explosion. It could have a wave with an amplitude of 10 meters at 10km from the vent as described in http://uwiseismic.com/General.aspx?id=53. This amplitude would be found in open waters. Using this information an initial sea surface deformation was created at a 10 km radius from the Kick 'em Jenny crater. Figure 3 shows a red ring with the 10 km radius around the volcano. As can be seen, unobstructed open waters are located predominantly from southwest to northeast. Due to this, deformations were only included for this area which resulted in a semi-circle. This is highlighted in figure 4 where the green points are 10 meters of deformation (see Figure 5 for a 3d view). The Method of Splitting Tsunamis, or MOST, was used for generating the data found in this report. This is the principal model used in the NOAA Center for Tsunami Research (NCTR). The MOST model was run using an interface developed by the NCTR, known as ComMIT. The deformation expressed previously was propagated across open ocean using this interface. This information was used to generate the graphs found in this report. MOST also has the ability to model inundation at higher resolution for sections of Puerto Rico, but was not used due to the low wave elevations observed near certain points around the island. Thus it was assumed that inundation would be minimal around the island.

Disclosure

Several factors may limit the proximity to which the event simulated correlate to the true worst case event described by the University of the West Indies. These include the following:

- The 10-meter deformation was expressed by placing a value of 10 meters on each corner node of the ring. Due to the resolution of the propagation grid (1800 meters), this resulted in extending the 10-meter elevation over 1800 meters which can exaggerate the effects of the tsunami
- Following the semicircular shape was limited due to the few nodes that were available around the corner of the ring

- Deformation was only expressed for the northeast to southwest semicircle. No deformation was expressed for the opposite side. Expressing the opposite side may cause

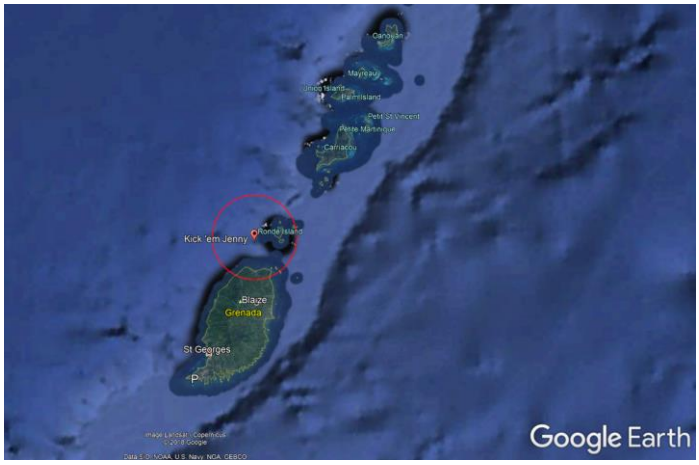

Figure 3 - Circle with center around Kick 'em Jenny and 10km radius

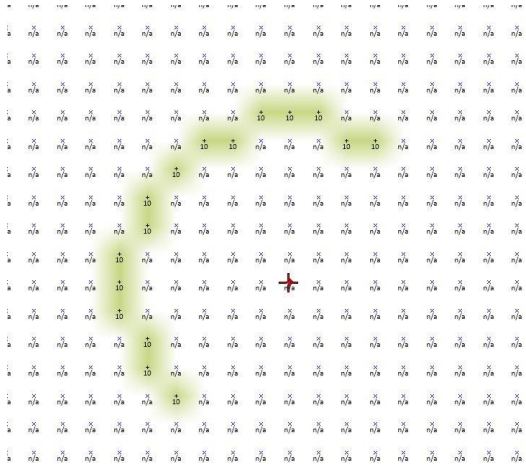

Figure 4 - Modified points around Kick 'em Jenny. Red cross is location of volcano

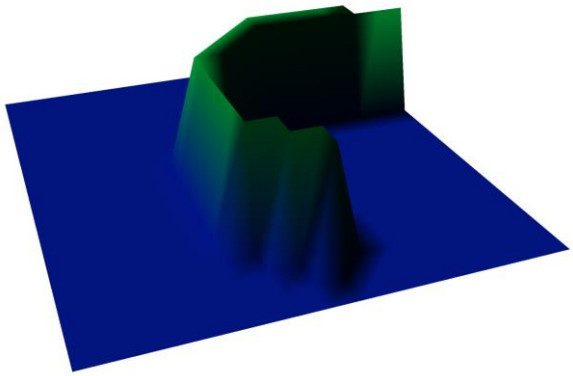

Figure 5. 3d wave approximation at 10 km from source according to http://uwiseismic.com/General.aspx?id=53.

unforeseen effects on the propagation of the wave in the Caribbean, but was ignored due to uncertainty of how the waves would appear in this direction.

- The positioning of the crater is latitude12.3 and longitude -61.64. The bathymetry grid does not contain that exact point and as such this location was approximated to latitude 12.291667 and longitude -61.641667.
- The nearest approximation to 10 km from the crater location with the grid resolution used is 10.8 km or 9 km. It was decided to use 10.8 km as a means of exaggerating the possible risk to Puerto Rico

Results

The time series of sea surface elevation were taken at the four locations shown in Figure5. Figures 6 to 9 show the time series. Note the different vertical scales.

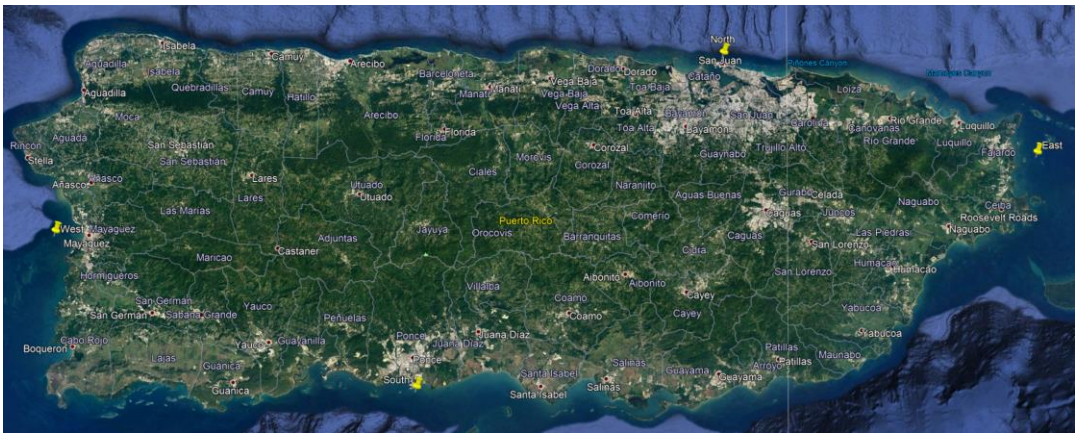

Figure 6 - Tide gage locations around Puerto Rico

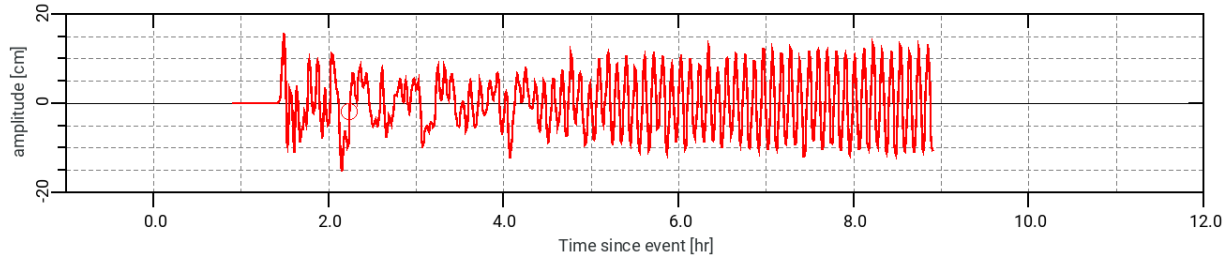

Figure 7. Tide gage location near Ponce.

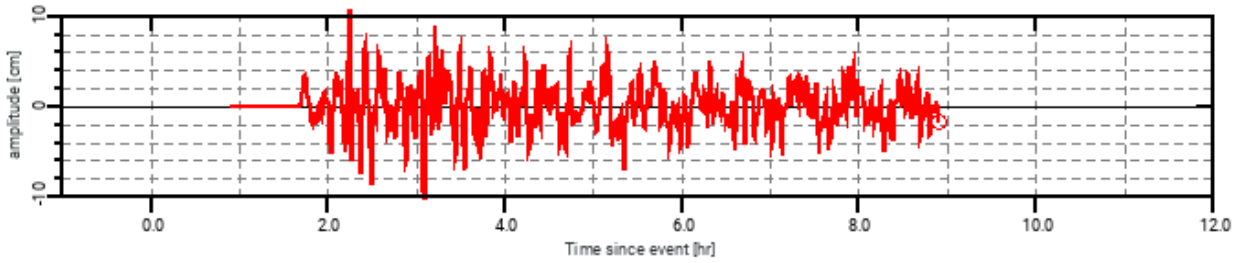

Figure 8. Tide gage location near Mayaguez

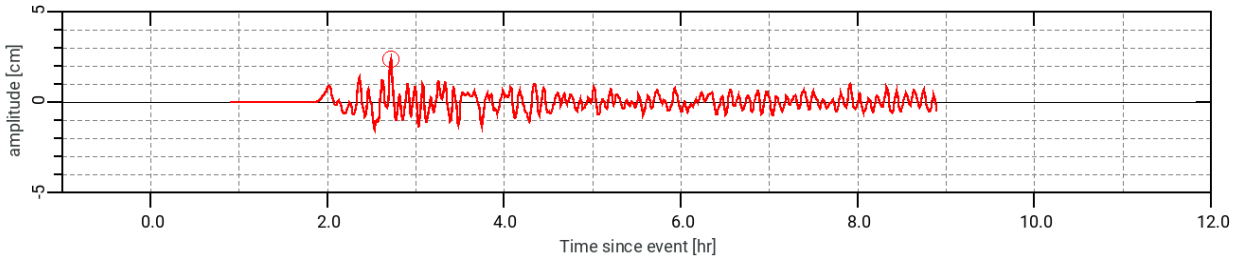

Figure 9. Tide gage location near San Juan

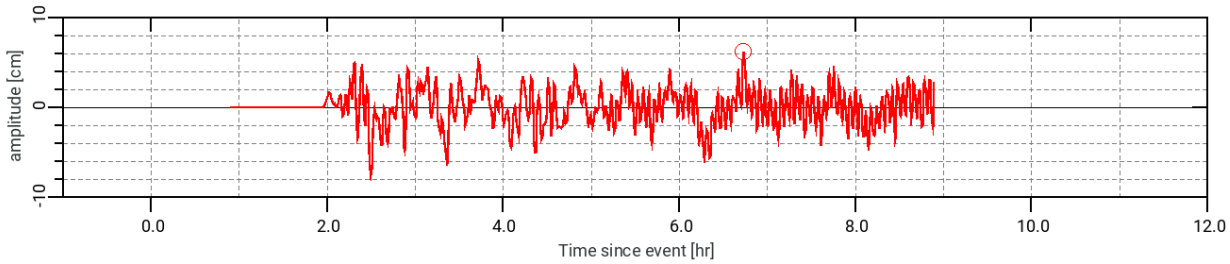

Figure 10. Tide gage location near Fajardo

Conclusions

The following table shows the most relevant statistics as observed by the four virtual buoys.

Site	Water Depth (m)	Approximate Arrival Time	Maximum Wave Amplitude (m)
Ponce	18.1	1 hr + 30 min	0.156
Mayaguez	7.9	1 hr + 45 min	0.108
San Juan	19.7	2 hrs	0.024
Fajardo	11.7	2 hrs	0.061

At all four buoy sites the first arrival is a peak, not a trough. And that first peak is not the highest. The highest could be the second, or third, wave.