

NTHMP Gulf of Mexico States Report

By: **Juan J. Horrillo**
Charles Williams
Yoshinori Shigihara

Accomplishments & Near Future Works and Challenges

The Gulf of Mexico (GOM) states Tsunami Program is a state level risk reduction program that promotes tsunami planning, preparedness and hazard mitigation among GOM's coastal communities, in cooperation with NOAA's National Weather Service and other federal, state and local agencies. The GOM states were included to the U.S. Tsunami Warning System in January 2005. Potential tsunami sources for the GOM are local submarine landslides and earthquakes along the Caribbean plate boundary faults. Preliminary modeling of potential tsunami sources outside the GOM by Knight (2006), indicated a very low threat and may not pose a tsunami hazard to the GOM coastal communities; however, ancient submarine landslides within the GOM may have generated tsunamis as it was examined by the Atlantic and Gulf of Mexico Tsunami Hazard Assessment Group, ten Brink *et.al.* 2009. In their findings, they stated that submarine landslides in the GOM are considered a potential tsunami hazard for the following reasons:

- 1- Some dated submarine landslides in the GOM have a post-glacial age.
- 2- Large landslides in the GOM have been found in the submarine canyons and fan provinces extending from present Mississippi and other former large rivers that emptied into the GOM. These large submarine landslides were probably active before 7500 years ago.
- 3- Recent suggestions from seismic records of small-scale energetic submarine landslides in the GOM indicate that there is a probability of recurrence.

Therefore, NTHMP's GOM state representatives are working in the construction of tsunami inundation maps originated by submarine landslide events that might certainly be a threat to the GOM's communities. This work has been partially and successfully accomplished in our previous project, "*Construction of the first tsunami inundation map in the Gulf of Mexico*" (Horrillo *et.al.*, 2010) funded by NTHMP-NOAA in 2009 (NA09NWS4670006).

A- Accomplishments

The following table summarizes GOM's executed and currently tasks up today.

Task Description	FY	Amount Granted To TAMUG	% executed
1. Construction of the first tsunami inundation map in the Gulf of Mexico	2009	\$70,958.00	100%
2. MMS Tsunami Inundation Model Validation Workshop March 28 to April 1, 2011 Texas A&M University at Galveston	2011	\$0.00	100%
3. NTHMP Tsunami generated by Subsea/Subaerial Landslide Workshop April 1 to 3, 2011 Texas A&M University at Galveston	2011	\$0.00	100%
4. Proceedings edition for the Model Validation Workshop	2012	By UCAR \$6,300.00	100%
5. Construction of five (5) tsunami inundation maps in the Gulf of Mexico	2012-2014	\$338,206.00	4%
6. Proposal to the NTHMP for FY13-15. A probabilistic methodology for hazard assessment of tsunami generated by subsea landslide and for construction of tsunami inundation maps in the Gulf of Mexico	2013-2015	\$0.00 Submitted to NTHMP/NOAA	0%

1- Construction of the first tsunami inundation map in the Gulf of Mexico. (done/2010)

The project results showed that tsunamis generated by ancient landslides have indeed the potential to cause severe damage and flooding to some GOM coastal communities. Our study proved that such landslide sources can cause

inundation of the order of 6 - 8 feet (~1.8 - 2.4 m) in Port Aransas, TX, comparable in term of inundation to severe storm surge. Tsunami energy focusing was identified in several regions along the US GOM coastline as well. For instance, regions most likely to be impacted are located at the southern tip of South Padre Island TX, Grand Isle LA., and the coastal strip from Fort Walton Beach to Cape San Blas FL., see Construction of Tsunami Inundation Maps in the Gulf of Mexico. Report to NTHMP (Horrillo *et.al.*, 2010).

2- MMS Tsunami Inundation Model Validation Workshop March 28 to April 1, 2011 Texas A&M University at Galveston (done/2011)

This workshop, under guidance from the NTHMP Mapping and Modeling Subcommittee (MMS), was tasked with developing and implementing the strategy for validation of tsunami inundation models. This effort starts the process of clearly defining the validation procedure for all models will need to follow to obtain NTHMP funding, as stated in the NTHMP Strategic Plan Performance Measure. The initial list of NTHMP benchmark problems was established based on the OAR-PMEL-135 report (Synolakis *et. al.*, 2007). Besides reviewing current model validation efforts, one of the goals of this workshop was to revise and/or add to the list of benchmark problems.

3- NTHMP Tsunami generated by Subsea/Subaerial Landslide Workshop April 1 to 3, 2011 Texas A&M University at Galveston (done)

The Tsunami Generated by Subsea/Subaerial Landslide Workshop was part of an initiative of the NTHMP's Mapping and Modeling Subcommittee members as a first step to address systematically US coastal hazard due to submarine landslides. Main objectives of this workshop were to bring the current developments and findings of submarine/subaerial mass movements and their hazard they possess to the US coast by assembling contributions from active tsunami researchers and government institutions and provide full coverage of scientific evidences and numerical modeling aspects of this coastal hazard. It was reaffirmed that the workshop outcomes facilitated the NTHMP's strategies to establish best practices to improve flood mapping products due to subsea/subaerial landslide model development, and create guidelines for landslide tsunami sources and validation benchmark for numerical models.

4- NTHMP Validation Models Workshop Proceedings (done)

TAMUG held the NTHMP tsunami model validation workshop in April, 2011. There was a need to put together workshop proceedings for the NTHMP, NOAA. The work consisted in: a) to generate the benchmarks description and data summary; b) to perform the cross-models comparison; c) to include recently proposed new benchmarks problems; d) to correct the proceedings according to revision by MMS members.

5- Construction of five (5) tsunami inundation maps in the Gulf of Mexico (current/started: Nov/2012)

It is projected that five (5) new tsunami inundation maps will be completed during FY12-FY14 period. The construction of the tsunami maps will be based on identified past events of local submarine landslides and other local landslide sources determined by means of a probabilistic approach. The probabilistic analysis aims to estimate the hazard expressed in terms of slope failure. Three additional (for a total of six) landslide scenarios capable of producing tsunamis will be identified for inundation assessment and planning. The probabilistic analysis will be equally applicable to the oil and gas industry as the recent deep water oil spill event in the GOM suggests that an established method to tsunami hazard assessment is warranted, as such hazards may put offshore oil rigs and pipelines at risk of failure, causing severe damage and oil spills. Consequently, the goal of this project is to establish a systematic production of tsunami hazard maps along the GOM US coast aimed to provide guidance to state emergency managers and optimize real-time tsunami warnings to coastal communities and infrastructures.

6- Proposal to the NTHMP for FY13-15. A probabilistic methodology for hazard assessment of tsunami generated by subsea landslide and for construction of tsunami inundation maps in the Gulf of Mexico (submitted to NTHMP-NOAA for approval)

The project aims to develop a GOM's customized methodology for tsunami hazard assessment that combines probabilistic submarine landslide analysis with a deterministic estimate of: a) sediment slope stability; b) wave propagation and runup. The nondeterministic assessment is based on a large number of Monte Carlo simulations in which distributions of certain parameters are used to carry out simplified slope stability analyses for the generation of extreme values of the initial tsunami wave configuration. This study will be carried out by a qualified team of research professionals with a proven track record on probabilistic hazard assessments, tsunami hydrodynamics, and underwater sediment slope stability modeling. Results of this study will play a role in advancing our understanding of landslide tsunamis, and thus contribute to building a safer GOM coastal community. The motivation of this proposal is driven by the strategic plan of the NTHMP program that recommends that over the next 5 years program resources be weighted appropriately between activities that improve the level of community preparedness and the state of tsunami science.

B- Near Future Works and Challenges

1- Complete GOM Tsunami Mapping

Our final goal is to assess the tsunami hazards generated by submarine landslides that may impact coastal community and infrastructure in the Gulf of Mexico by using a non deterministic approach. This will be achieved by developing a methodology for tsunami hazard assessment that combines probabilistic submarine landslide hazard analysis with a deterministic estimate of: a) sediment slope stability; b) wave propagation and inundation. Actions to materialize this goal are underway, as GOM states had submitted a proposal (see numeral 6 on Accomplishment section) to the NTHMP-NOAA for approval.

2- Complete review of applicable inundation model results with GOM's state emergency manager representatives

GOM's state emergency manager representatives are planning to revise the modeling work obtained in our first tsunami study (see numeral A-1 on Accomplishment section) as an initial step to incorporate tsunami hazard into GOM's state emergency plan. Based on our hurricane preparedness program experience and the tsunami effects obtained in our previous and recent studies, we will anticipate discussion on tsunami versus storm surge effects, tsunami warming issues, inundation maps for evacuation, outreach education and awareness programs.

3- Regional workshop for GOM's states on inundation maps for evacuation

To disseminate our work described in numerals A-1 and A-5 and incentive tsunami mitigation plan throughout GOM's coastal communities, we are planning to hold a tsunami workshop where all GOM's state emergency manager representative will be able to participate. We are planning to use multiple tsunami scenarios obtained in our study for Port Aransas, TX. as an exercise.

4- Complete community/county seminar to complete "playbook" for evacuation planning from the multiple tsunami scenarios developed from the modeling work.

The regional workshop outcomes will be circulated throughout GOM's coastal communities. We are planning to hold community seminars for awareness, outreach education and evacuation planning. Tsunami scenarios obtained from previous studies will be used to represent different level of tsunami hazard.

References

Horrillo, J. J., A. L. Wood, C. Williams, A. Parambath and G-B. Kim, 2010. Construction of Inundation Maps in the Gulf of Mexico. Report to the National Tsunami Hazard Mitigation Program, NOAA.

Knight, W, 2006. Model Predictions of Gulf and Southern Atlantic Coast Tsunami Impacts from a Distribution of Sources, *Science of Tsunami Hazards*, 24, 304-312.

Synolakis, C. E. and E. N. Bernard and V. V. Titov and U. Kanoglu and F. I. González, 2007. OAR PMEL-135 Standards, criteria, and procedures for NOAA evaluation of tsunami numerical models. Technical report, NOAA Tech. Memo. OAR PMEL-135, NOAA/Pacific Marine Environmental Laboratory, Seattle, WA.

ten Brink, U., D. Twichell, P. Lynett, E. Geist, J. Chaytor, H. Lee, B. Buczkowski, and C. Flores, 2009. *Regional Assessment of Tsunami Potential in the Gulf of Mexico*: U.S. Geological Survey.