TAMUG-NTHMP Projects Summary: For a Safer Gulf of Mexico Coastline

Gulf of Mexico (GOM) coasts were included to the U.S. Tsunami Warning System in January 2005. Since FY08, the National Tsunami Hazard Mitigation Program (NTHMP) have provided grants to states, commonwealths, and territories to improve tsunami preparedness of at-risk areas toward the common goal of reducing tsunami losses. Shortly, in 2009, Texas A&M University at Galveston (TAMUG) got its first grant (NA09NWS4670006) from NTHMP to determine the tsunami risk along the GOM coastline and to determine at a specific location (Port Aransas TX) tsunami inundation limits based on three ancient landslides described by ten Brink *et.al*., 2009 (named as: Easts-Break, Mississippi Canyon and West Florida Landslides). This project, documented in Horrillo et al., 2010, was funded 100% by NTHMP. The study showed that tsunamis generated by ancient landslides have indeed the potential to cause severe flooding to the 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 terms of inundation, to severe storm surges. Also in this work, tsunami energy focusing was identified in several regions along the US GOM coastline. Regions most impacted were located at the southern tip of South Padre Island TX, Grand Isle LA., and the coastal strip from Pensacola to Cape San Blas FL.

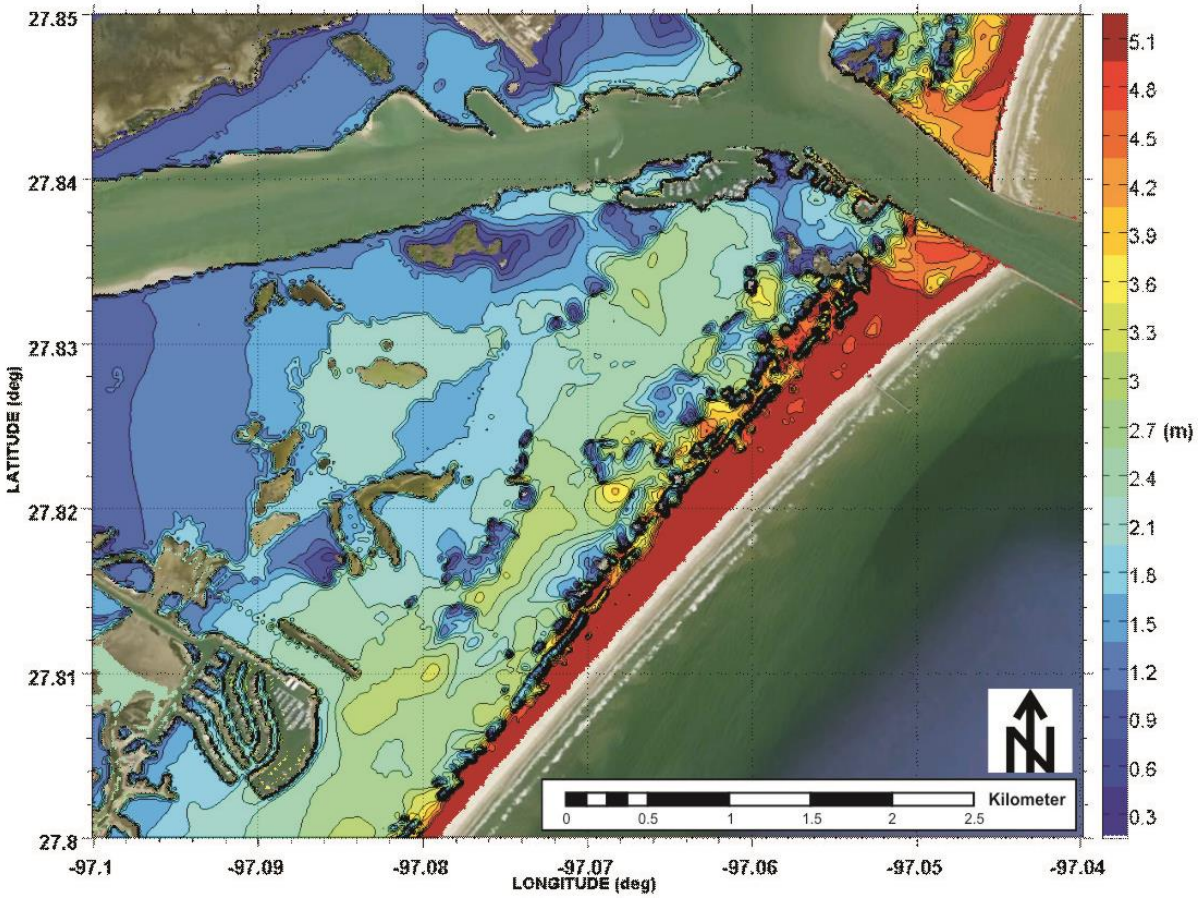

Figure 1. Inundation depth in Port Aransas, TX caused by the Mississippi Canyon Submarine Landslide.

Next, TAMUG under guidance from the NTHMP Mapping and Modeling Subcommittee (MMS), was tasked with developing and implementing the strategy for validation of existing or available

tsunami inundation models. This effort originated the NTHMP's Model Validation Workshop that was carried out in TAMUG, March 28 to April 1 /2011 and funded/organized by the NTHMP and the University Corporations for Atmospheric Research UCAR-NOAA, Boulder, CO. The work accomplished in this workshop started the process of clearly defining the validation procedure of all NTHMP's models need to follow to obtain NTHMP funding, as stated in the NTHMP Strategic Plan: "All NTHMP-funded models will meet established standards by 2012". Specifically, a model is deemed validated when it is able to successfully simulate a series of tsunami benchmark problems, covering all the relevant tsunami processes required. The initial list of NTHMP benchmark problems was established based on the OAR-PMEL-135 report list, Synolakis et.al., 2007. Besides reviewing current model validation performance, one of the goals of this workshop was to revise and/or add to the list of benchmark problems. Detailed information of this workshop can be found in, NHMP, 2012.

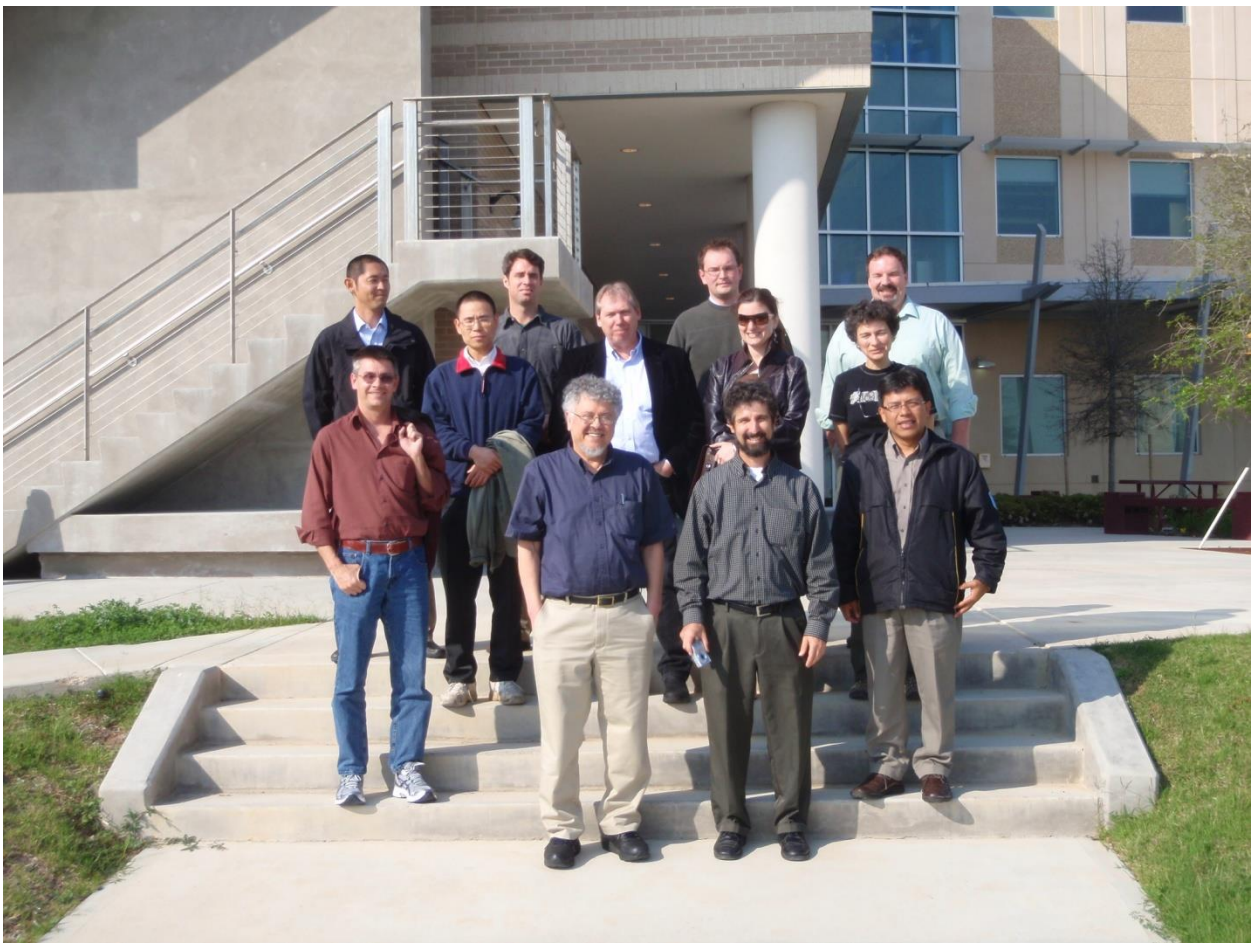

Figure 2. Participants of the NTHMP's Models Validation Workshop, Texas A&M University at Galveston, March 28 to April 1, 2011.

Subsequently, the NTHMP decided to run the Tsunami Generated by Subsea/Subaerial Landslide Workshop (April 1-3 /2011) back to back to the Model Validation Workshop to reduce efforts

and cost. The Tsunami Generated by Subsea/Subaerial Landslide Workshop was part of an initiative of the NTHMP-MMS members following suggestion of Dr. Eddie Bernard as a first step to address systematically US coastal hazard possesses by 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. The Workshop was hosted by the Maritime System Engineering Department (MASE), TAMUG under the coordination of Dr. Juan J. Horrillo and collaboration of Dr. Amanda Wood, Gyeong-Bo Kim (TAMUG graduate student), Nichole Parker and Jaime Padgett. The Workshop provided an unique opportunity to exchange vital information of existing subsea/subaerial sources (ancient, present and potential); submarine landslide characterization, availability of bathymetry data, best fit methodology for numerical modeling, identifying lab/field experiment for NTHMP model validation and to concur on new trend and future investigations (e.g. the probabilistic approach). Old and new methodologies were presented to determine their applicability in the actual context of applications.

Figure 3. Participants of the NTHMP's Tsunami Generated by Subsea/Subaerial Landslide Workshop, Texas A&M University at Galveston, April 1 to 3, 2011.

As it was mentioned before, in general the workshop was an account and evaluation of the current level of submarine/subaerial landslide development, its possible implementation, and finally to concur on new lines of investigation. Other workshop goals were enhancing cooperation amongst participants and to grasp the strength and weakness of current information and numerical approaches.

The workshop outcomes facilitated the NTHMP to establish best practices to improve flood mapping products due to subsea/subaerial landslides, coordinate subsea/subaerial landslide model development, and create guidelines for landslide tsunami sources and validation benchmark for numerical models. They also benefited the activities and strategic goals of the

NTHMP and other US coastal agencies contributing in final products as NTHMP's tsunami mapping development, mitigation, planning, and education effort.

In FY12, TAMUG was granted by the NTHMP with another project to continue the tsunami effort in the GOM "**Construction of five (5) tsunami inundation maps in the Gulf of Mexico**" (NA12NWS4670014). The main goal of this project (currently in execution) is to construct five additional tsunami inundation maps at specific locations along the US GOM coastline. In this project, the inundation maps are constructed based on the three ancient submarine landslide scenarios, mentioned earlier and described in detail by ten Brink *et.al*, 2009. Additional landslide scenarios (three more) are created using a probabilistic method for a total of six source cases or scenarios. Locations for the construction of tsunami maps at specific locations are selected according to a preliminary study aiming to determine vulnerable regions along the US GOM coastlines.

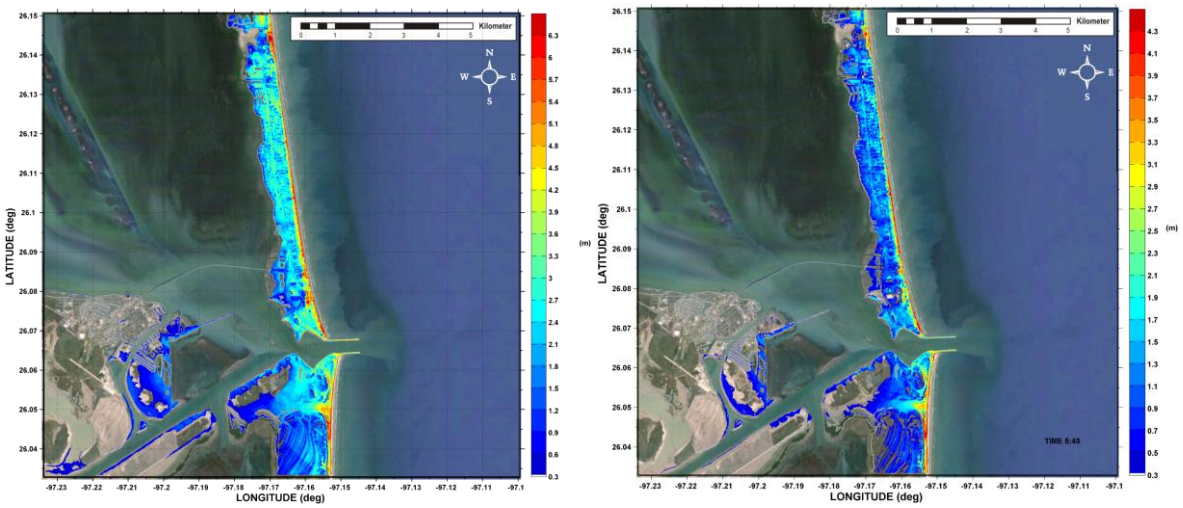

Figure 3. Maximum Inundation depth in South Padre Island caused by the East-Breaks Submarine landslide (Left panel). Right panel portraits the inundation depth in South Padre Island, TX generated by a probabilistic submarine landslide named Transect D in our studies

Recently, a new grant "**A probabilistic Methodology for Hazard Assessment of Tsunami Generated by Submarine Landslide and for Construction of Tsunami Inundation Maps in the Gulf of Mexico**" (NA13NWS4670018) was funded through the sustainability of current tsunami activities, FY13 NTHMP. This project is currently in execution and it is giving us the opportunity to increase our soil database and develop new tsunami-landslide sources and scenarios using the probabilistic approach. Thus, we will be able to increase the resolution for the probabilistic estimation of tsunami-landslide sources.

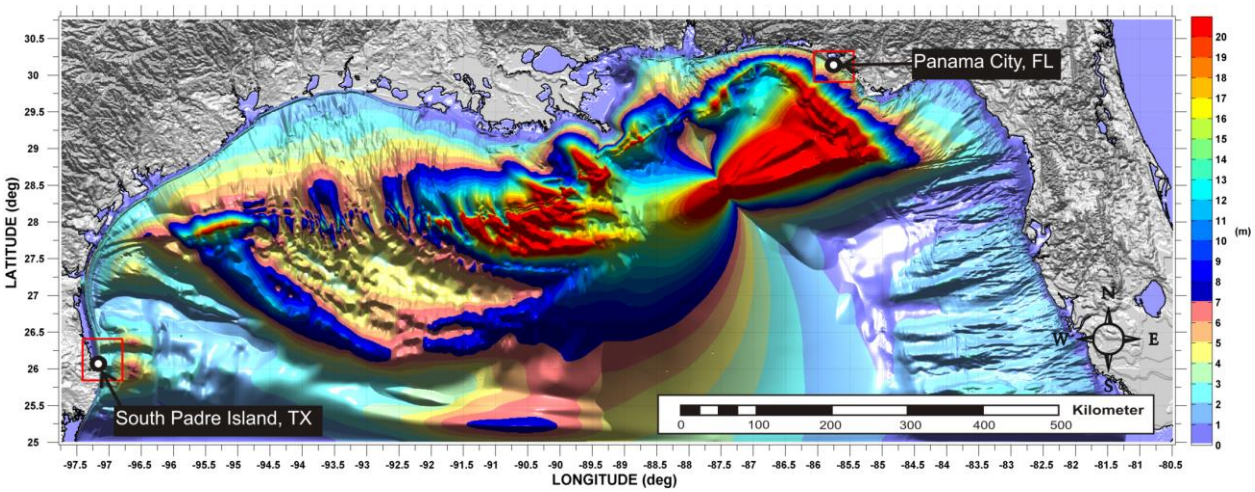

Figure 4. Maximum tsunami wave amplitude generated by a submarine landslide calculated by using a probabilistic approach.

In FY14 TAMUG was granted with the project "**Implementing NTHMP-MMS Strategic Plan in tsunami hazard mitigation products for the Gulf of Mexico"** (NA14NWS4670049). The project objective is to implement recent developments recommended in the National Tsunami Hazard Mitigation Program Modeling - Mapping Subcommittee - Strategic Plan (NTHMP-MMS-SP) into our current GOM tsunami products. The successful implementation of the SP's objectives in our products will result in the following outcomes using NTHMP-developed standards: a) development and implementation of temporal-low-order inundation maps for tsunami hazard areas (community) where inundation studies have not yet been assigned/executed or where little bathymetric and elevation data exists; b) inclusion of maritime products in our current tsunami inundation maps projects to assist the maritime community and to meet port emergency management and other NTHMP customer requirements.

Reference

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NTHMP-MMS 2012. Guidelines and Best Practices to Establish Areas of Tsunami Inundation for Non-modeled or Low-hazard Regions. http://nthmp.tsunami.gov/modeling_guidelines.html

Synolakis C.E., Bernard E.N., Titov, V.V., Kanoglu, U and Gonzales F.I. (2007). ''OAR PMEL-135 standards, criteria, and procedures for NOAA evaluation of tsunami numerical models''. Report No. 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 Tsuami Potential in the Gulf of Mexico*: U.S. Geological Survey.