

NTHMP Grant Close-Out Narrative Report  
**November 27, 2015**

Award Number: NA14NWS4670041

Project Dates: September 1, 2014 – August 31, 2015

Recipient: University of Delaware

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### **GOALS AND OBJECTIVES**

Task1 is to begin an investigation of dynamic tidal effects on tsunami behavior. Several high population locations on the East Coast are located in regions, which are strongly affected by estuarine tidal flows, with prominent examples being New York, NY and Norfolk, VA. Both of these areas have been or are presently being modeled as part of FY10-12 or FY13 work, but these investigations do not take into account any potential effects of the tidal conditions.

Task 2 is to further refine our set of sources used for east coast modeling, mainly by (1) extending the suite of candidate continental margin SMF sources to include a broader set of cases from the geological record, (2) performing a broader range of simulations for the CVV volcanic cone collapse based on events which are less extreme than the presently utilized 450 km<sup>3</sup> slide volume, and (3) examine the role of our modeling approach in determining the hazard associated with each event.

Task 3 is to conduct a comparison of our previously developed inundation lines with published FEMA hurricane flood maps for selected areas we have directly modeled. The goal is to determine whether there is sufficient agreement between the two families of results to allow using the FEMA maps as proxies in areas where tsunami inundation maps have not yet been developed.

### **TASKS/SUBTASKS FUNDED**

Task 1: Tidal effects on tsunami inundation at estuarine and river entrances.

Task 2: Refinement and extension of potential SMF sources and source modeling techniques for tsunami activity in the North Atlantic.

Task 3: Examining the correspondence between tsunami and storm surge inundation estimates for use as the basis for mapping tsunami hazards in non-modeled U.S. East Coast areas.

## ACCOMPLISHMENTS

All tasks are related to MMS.

**Task 1:** Tidal effects on tsunami inundation at estuarine and river entrances.

A methodology was developed for performing dynamic simulations of tide and tsunamis with FUNWAVE-TVD, to estimate effects of tide elevation, current and phase on tsunami inundation, in estuaries subjected to significant tidal forcing. This method was applied to the Chesapeake Bay and Hudson River estuaries. Results are reported in Shelby et al (2015a,b) and Tajalli Bakhsh et al (2015).

**Task 2:** Refinement and extension of potential SMF sources and source modeling techniques for tsunami activity in the North Atlantic.

Ongoing work with the Carbonate Research Group at the University of Miami has led to the development and testing of SMF landslide sources for the West Bahamas Bank. This work has been reported at several conferences, and a journal paper has been submitted. Reanalysis of east coast SMF sources using deformable slide models is underway.

**Task 3:** Examining the correspondence between tsunami and storm surge inundation estimates for use as the basis for mapping tsunami hazards in non-modeled U.S. East Coast areas.

Work is ongoing to compare existing storm surge inundation maps and tsunami inundation maps for areas that have had high-resolution tsunami inundation modeling. Due to the greater likelihood of hurricane events in the South Atlantic area, it is likely that such an approach will have to take into account regional variations in storm probability and shelf geometry that we are just developing an understanding of now. Collaboration with Gulf of Mexico group established. Groups working on development of a joint methodology.

We are also examining the tendency of the wide East Coast continental shelf to provide a somewhat source-independent control on the longshore distribution of tsunami wave height, due to refractive and focusing effects. This analysis is based on a comparison of direct modeling results and use of ray-tracing. Preliminary results have been presented at or accepted for conferences. An extensive ray tracing analysis has been conducted to examine the source-independent control on along-coast distribution of tsunami wave heights due to the wide US East Coast shelf. A journal paper covering this work is in preparation.

This effort is continuing with FY15 funding.

**Reporting:** Project work carried out or documented during the FY14 period has been reported in a number of papers, presentations and reports:

1. Grilli, S. T., O'Reilly, C., Harris, J. C., Tajalli Bakhsh, T., Tehranirad, B., Banihashemi, S., Kirby, J. T., Baxter, C. D. P., Eggeling, T., Ma, G. and Shi, F., 2015, "Modeling of SMF tsunami hazard along the upper U. S. East Coast: Detailed impact around Ocean City, MD", *Nat. Hazards*, **76**, 705-746, [doi:10.1007/s11069-014-1522-8](https://doi.org/10.1007/s11069-014-1522-8)
2. [Grilli, S. T., Grilli, A., Tehranirad, B. and Kirby, J. T., 2015, "Modeling tsunami sources and their propagation in the Atlantic Ocean for coastal tsunami hazard assessment and inundation"](#)

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- [mapping along the U. S. East Coast", \*Proc. Coastal Structures & Solutions to Coastal Disasters Joint Conference, Boston, Sept. 9-11, in press.\*](#)
3. Schnyder, J. S. D., Eberli, G. P., Kirby, J. T., Shi, F., Tehranirad, B., Mulder, T., Ducassou, E., Hebbeln, D. and Wintersteller, P., 2015, "Paleo-tsunamis caused by submarine slope failures along western Great Bahama Bank", *Geophys. Res. Lett.*, submitted.
  4. [Shelby, M., Grilli, S. T. and Grilli, A. R., 2015a, "Dynamic tide-tsunami interaction in the Hudson River estuary", Research Report No. CACR-15-10, Center for Applied Coastal Research, Dept. of Civil and Environmental Engineering, University of Delaware.](#)
  5. Shelby, M., Grilli, S. T. and Grilli, A. R., 2015b, "Tsunami hazard assessment in the Hudson River estuary based on dynamic tsunami-tide simulations", *Pure and Applied Geophysics*, submitted (November 2015).
  6. [Tajalli Bakhsh, T. S., Grilli, S. T. and Grilli, A. R., 2015, "Dynamic tidal effects on tsunami coastal hazard in large estuaries: Case of the Chesapeake Bay/James River, USA", Research Report No. CACR-15-09, Center for Applied Coastal Research, Dept. of Civil and Environmental Engineering, University of Delaware.](#)
  7. Tehranirad, B., Harris, J. C., Grilli, A. R., Grilli, S. T., Abadie, S., Kirby, J. T. and Shi, F., 2015, "Far-field tsunami hazard on the western European and US east coast from a large scale flank collapse of the Cumbre Vieja volcano, La Palma", *Pure and Applied Geophysics*, **172**, 3589-3616, [doi:10.1007/s00024-015-1135-5](#)
  8. Tehranirad, B., Kirby, J. T., Shi, F. and Grilli, S. T., 2015, "Does morphological adjustment during tsunami inundation increase levels of hazard?", *Proc. Coastal Structures & Solutions to Coastal Disasters Joint Conference, Boston, Sept. 9-11, in press.*
  9. Tehranirad, B., Kirby, J. T., Callahan, J., Shi, F., Banihashemi, S., Grilli, S. T., Grilli, A., Tajalli Bakhsh, T. and O'Reilly, C. 2014, "Tsunami inundation mapping for the upper East Coast of the United States", *AGU Fall Meeting*, Abstract NH12A-04, San Francisco, Dec. 15-19.
  10. Tehranirad, B., 2015, "Effects of bathymetry on tsunami propagation on the US East Coast; Application of ray tracing to tsunamis", presented at *Young Coastal Scientists and Engineers Conference - North America, Newark, July.*
  11. Tehranirad, B., Kirby, J. T., Shi, F., Grilli, S. T. and Grilli, A. R., 2015, "Is continental shelf bathymetry the main control for tsunami inundation patterns on the US East Coast?", presented at *Geological Society of America Meeting, Baltimore, October.*
  12. Tehranirad, B., Kirby, J. T., Callahan, J. A. and Shi, F., 2015, "Tsunami inundation mapping for Atlantic City, NJ NGDC DEM", Research Report No. CACR-15-01, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. (DRAFT).
  13. Tehranirad, B., Kirby, J. T., Callahan, J. A. and Shi, F., 2015, "Tsunami inundation mapping for the northern half of the State of New Jersey", Research Report No. CACR-15-02, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. (DRAFT).
  14. Tehranirad, B., Kirby, J. T., Callahan, J. A. and Shi, F., 2015, "Tsunami inundation mapping for New York City", Research Report No. CACR-15-03, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. (DRAFT).
  15. Tehranirad, B., Kirby, J. T., Callahan, J. A. and Shi, F., 2015, "Tsunami inundation mapping for Montauk, NY NGDC DEM", Research Report No. CACR-15-04, Center for Applied Coastal

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Moved up [1]: Shelby, M., Grilli, S. T. and Grilli, A. R., 2015, "Dynamic tide-tsunami interaction in the Hudson River estuary", [Research Report No. CACR-15-10](#), Center for Applied Coastal Research, Dept. of Civil and Environmental Engineering, University of Delaware. -

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Moved up [2]: <#>Tajalli Bakhsh, T. S., Grilli, S. T. and Grilli, A. R., 2015, "Dynamic tidal effects on tsunami coastal hazard in large estuaries: Case of the Chesapeake Bay/James River, USA", [Research Report No. CACR-15-09](#), Center for Applied Coastal Research, DepC... [1]

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Research, Department of Civil and Environmental Engineering, University of Delaware. (DRAFT).

16. [Tehranirad, B., Kirby, J. T., Callahan, J. A. and Shi, F., 2015, "Tsunami inundation mapping for Nantucket, MA NGDC DEM", Research Report No. CACR-15-05, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. \(DRAFT\).](#)
17. [Tehranirad, B., Kirby, J. T. and Shi, F., 2015, "Tsunami Inundation Mapping for Virginia Beach, VA NGDC DEM", Research Report No. CACR-15-11, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. \(DRAFT\).](#)
18. [Tehranirad, B., Kirby, J. T. and Shi, F., 2015, "Tsunami Inundation Mapping for Cape Hatteras, NC NGDC DEM", Research Report No. CACR-15-12, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. \(DRAFT\).](#)
19. [Tehranirad, B., Kirby, J. T. and Shi, F., 2015, "Tsunami Inundation Mapping for Myrtle Beach, SC NGDC DEM", Research Report No. CACR-15-13, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. \(DRAFT\).](#)
20. [Tehranirad, B., Kirby, J. T. and Shi, F., 2015, "Tsunami Inundation Mapping for Savannah, GA NGDC DEM", Research Report No. CACR-15-14, Center for Applied Coastal Research, Department of Civil and Environmental Engineering, University of Delaware. \(DRAFT\)](#)

[Draft reports and first drafts of un-reviewed inundation map products may be obtained from the unlinked webpage http://www.udel.edu/kirby/nthmp\\_protected.html.](http://www.udel.edu/kirby/nthmp_protected.html)

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### UNMET RESULTS

None.

### SUMMARY

In one or two paragraphs, state how this grant has contributed toward achieving the NTHMP's vision and mission as described in the NTHMP Strategic Plan.

Work during FY14 begins the process of refining and extending the scope of basic first-draft inundation mapping carried out in FY10-12 and FY13 tasks. Methodologies for providing inundation estimates for unmapped areas are under development and this work will continue in FY15, as part of a multistate effort also involving the Gulf of Mexico. Additional slide sources on the Grand Bahama Bank, with potential impact on Florida, complete our north-to-south range of first generation slide sources and will now allow us to generate final maps for Florida communities, which will be completed shortly. The entire family of slide sources is being re-examined using more advanced models employing deformable slides with various rheologies. We are taking part in multistate effort looking at slide-generated tsunamis, and are planning an NTHMP benchmark workshop on this topic to be conducted in FY15 (summer 2016). We have completed a study of tide/tsunami interaction for two east coast estuarine entrances with strong tidal currents. Results indicate that the presence or absence of a significant tidal impact is site specific, which possibly warrants a closer look at all such entrances during routine inundation studies.

Checklist of forms to prepare and submit with final progress report narrative:

- Federal Financial Report (SF425)

Reports on Federally-owned property (SF428A, SF428B, or SF428C) are not required on grant closeout. That's because equipment purchased using funds from NTHMP grants belongs to the NTHMP partner state, territory, or university making the purchase. The equipment is not "Federally-owned," and therefore, no forms about disposition of equipment or reimbursement of funds to the Government is required.