University: College of Charleston

Name of University Researcher Preparing Report: B. Lee Lindner

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Partners or Cooperative Project: Partners

Project Title: Interactive hurricane surge depictions

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SECTION 1: PROJECT OBJECTIVES (taken verbatim from the proposal)
The general goal of this research is to enhance the public's appreciation of the dangers associated with hurricane storm surge. The specific goal is to improve the current local NWSFO Hurricane Watch/Warning packages so that they will more effectively alert the public of the risks posed by tropical systems and the uncertainty involved in forecasting their strength and movement.

Specific objectives include:

1) Simulate surge depth at landmarks throughout the metropolitan area for a variety of hypothetical hurricanes.
2) Develop an interactive internet site where the public can examine the risk they face from surge from a variety of hurricane types.
3) Survey randomly-selected participants as to the advantages and shortcomings of our approach.
4) Identify shortcomings of the current package format and content
5) Survey the public as to where they received their Watch/Warning information and how effective the current packages are
6) Survey the public to determine personal characteristics of those most likely not to evacuate
7) Increase public awareness that many escape routes become flooded, and hence encourage the public to have an evacuation plan in place long before a storm approaches.
8) Assist Project Impact personnel in better preparing residents for hurricanes (multi-agency involvement)
9) Identify educational opportunities to promote/improve public understanding and response to tropical cyclone threats

SECTION 2: PROJECT ACCOMPLISHMENTS AND FINDINGS

2.1 Completed work

Over two dozen undergraduate students received funding from our COMET grant to do field work as specified in the grant proposal. Specifically, they gathered about 2000 data points at locations throughout the tri-county area. Each data point consists of a photograph of a landmark, GPS measurements of exact latitude and longitude, general descriptions, time and date. The data collection phase of this project is now virtually completed, and this is the most labor intensive part of the project. The PI worked with college webmasters to set up web page space for the development of the model and storage of the data until it is ready to be ported to NOAA. Robert Bright has worked with NHC personnel in running the SLOSH model for a variety of landfall locations and hurricane intensities, as specified in the proposal. Frank Alsheimer has worked with NOAA CSC personnel on securing web space and coordinated tours for the students involved in the project.

One dozen undergraduate students this past year have worked on the web page design and the database management. Additionally, three graduate students, Tim Kent, Danielle Timmons and Janet Johnson, have done the bulk of the GIS and HTML work while serving as unpaid interns at the NWS office (however, they received funds from this grant). Graduate students in our Masters in Environmental Studies program are required to do either a thesis or an internship, and two of these three students opted for an internship (Tim Kent is attending NC State), which was also treated as a thesis. Interns are required to complete 600 hours apiece minimum, and hence these two students devoted 1200 hours towards the project, although they also assisted NWS staff on other tasks for some of that time, as is required for NWS interns.

The students and principal investigators have designed the entire web site, which is almost completely operational. Specifically, several introductory web pages have been written which describe the project, provide some background material on hurricanes, list the student and faculty names of those involved, note the sponsors (standard COMET text still needs to be inserted), provide contact links, and most importantly, provide an interactive map with which hurricane surge can be simulated. Rather than include many, many figures in this report, we thought it better to simply describe how one can access the model online. At this time, you can access the web site (http://www.cofc.edu/~hurricanesurgesimulator/index.html), although we need to point out that all the web pages are preliminary and that much, much polishing remains to be done (hence, focus at this time on the general structure of the website and the model, and not on the specific wording which will likely be completely rewritten). One would click on the ‘surge models’ link, and then click on the ‘hurricane surge map’ link, and a map of the area appears with landmarks highlighted (data on over 2000 landmarks has been collected, but only ten percent of those are currently on the map). Users will then click on a landmark repeatedly until a menu pops up. Most landmarks are currently not working, but a few are functional. For example, click on the island on the lower right of the map. The web site zooms into another map, and you would click on the island on the lower left of this map. The web site zooms in further to reveal street names, and you click on one of the landmarks on the left side of the island. You may need to do this twice, until a menu comes up. Users then select the type of hurricane and tide they

wish to examine. At this time we have only input the Charleston landfall SLOSH scenario and the low tide data (there are ten different landfall scenarios which have been simulated). Topographic data for all landmarks has also been input. Once you select the hurricane type, an image of that landmark appears with a blue overlay simulating the depth of surge. In other words, when completed, a user would select a landmark near his home and be able to visualize the depth of water at his home (topography is extremely flat here, so that a landmark within a block or so of your home is likely the same height as your home). We hope to have all landmarks entered into the system and fully operational in a couple of months.

2.2. Unanticipated accomplishments

One undergraduate student spent his summer writing an introductory page in spanish, so that spanish-speaking residents can also make use of the site. This was not an objective in the proposal, but became obvious to us as this work proceeded. The principal investigator also took a trip to the National Hurricane Center and met with Chris Landsea and Jamie Rhome. Both have expressed strong interest in this research, and provided some valuable feedback. Preliminary results were presented at the Eleventh Mini-technical conference of the Palmetto Chapter of the American Meteorological Society (AMS) in Columbia in March 2005, the AMS Applied Climatology conference in Savannah in April 2005, the Twelfth Mini-Technical conference of the Palmetto Chapter of the AMS in Columbia in March 2006, and the Thirteenth Mini-Technical conference of the Palmetto Chapter of the AMS in Columbia in March 2007 (details below). In other words, we have made very efficient use of the COMET travel funds.

2.3. Work to be completed in the next few months

While the grant has run out of money and the period of research has finished, we intend to complete the interactive web site in the coming months anyway. The data on all the landmarks has been organized and placed into databases, and soon these will be placed into a GIS map. The HTML coding is nearly completed and we hope to have all the hurricane scenario databases loaded into the system. To make a long story short, the web site as it currently stands proves the concept we proposed, and now we simply need to flesh it out and fill in the missing pieces (thus, there should be no technical problems to impede our completion).

Additionally, the Principal Investigators plan to present the results at appropriate conferences. Lee Lindner will attend the AGU Ocean Sciences meeting in Orlando this March and Frank Alsheimer plans to attend the AMS conference on hurricanes and tropical meteorology in Orlando this April.

While we made substantial progress on completing the goals of the project and the first two objectives, we unfortunately did not have time to do the survey of the public (objectives 3 to 9 above). We had anticipated that this project would call for a lot of work, but it turned out to be overwhelming. Each of the three dozen undergraduates

invested at least 100 hours of his/her time, and the two primary graduate students invested at least 600 hours each, along with copious time invested by both principal investigators. We do hope to do the survey work, although that will not be done in the next few months.

SECTION 3: SUMMARY OF BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

There have been no significant problems encountered with this project at the NWS. The new Charleston NWS SOO, Frank Alsheimer, who replaced the NWS Principal Investigator on the proposal, Dan St. Jean, had no problems immediately assisting and cooperating in this project. Additionally, Frank Alsheimer served as internship/thesis committee member for both graduate students, and also served as a mentor to the graduate students in their thesis work. In order for the undergraduate students to better appreciate the purpose of their research and to have them see how their piece of the research fits in with the mission of the NWS, four tours of the Charleston NWS forecasting office were arranged and conducted by Robert Bright and Frank Alsheimer. The above mentioned tours allowed groups of students to understand the workings of an NWS office and present the NWS as a possible career path to those students. Robert Bright and Frank Alsheimer have also served as contact points for undergraduate students desiring further research opportunities. Also, Frank Alsheimer prepared unpaid internships for graduate students and has supervised their NWS tasks, which include shadow forecasting and development of climatological databases. The latter helped in part to the development of a NOAA COMET proposal to examine synoptic climatology of high impact events .

Preliminary concepts on technique and display have already been discussed with the South Carolina Emergency Management community. The availability of additional tools to get the public to evacuate during the threat of hurricane landfall have become even more critical in light of the devastating Hurricane Katrina. The results of the research will be incorporated into the significant hurricane outreach efforts by the NWS Charleston WFO. Our forecasting has benefited primarily by improvements in our ability to more effectively convey hurricane risks to the public.

Additionally, WFO Charleston is participating in an internal NWS experimental program to create Tropical Cyclone Hazard Graphics during the threat of impact. These graphics depicting the expected impacts of the event will be posted to the web when the Charleston CWA is under a tropical cyclone watch or warning. The results of this partner's project will provide supplemental information to those graphics.

SECTION 4: SUMMARY OF BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

The following undergraduate students worked extensively (at least 100 hours each) on this project and either received grant funding or course credit (usually both): Nancy Barton

Anne Chalmers
Jessica Darone
Claire Dupont
Ryan Evsich
Ashley Fields
Katherine Frederick
Kristen Frye
Alexandra Gatlin
Lesley Germanow
Evgeni Gurovich
Brandon Harris
Raymond Harris
Tobias Hawthorne
Daniel Johnson
Pat Kablick
Tim Kent
Amber Kuss
Andrew Lassiter
Andrew Livingston
Jennifer Mantini
Geoff Miller
Jennifer Morrison
Chinedu Ngadiuwu
Brice Orange
Kristi Owens
Sammy Perkins
F. Elliotte Quinn
Eliza Reock
Thomas Rolfson
Sterling Savage
Cameron Self
Jay Sonner
Zachary Spring
Kristen Steele
Jennifer Thomas
Blake Williams

It would be an understatement to say that these undergraduate students are getting valuable research experience, as well as a deep understanding of the difficult issues the NWS faces in trying to present the risks associated with hurricanes to the public. We offer many meteorology courses here at the College of Charleston, but no laboratory courses, and hence this experience truly helped the students understand the concepts presented in lecture class. Eleven College of Charleston special topics research courses have been created which utilize Charleston NWS office facilities and personnel as part of the students educational experience.

Students who took one of the tours additionally could see how a watch or warning box is created at the terminal, which again helps them visualize how their research fits in with the NWS mission. NWS personnel also have served as contacts and mentors for the students. Six of the undergraduate students and both graduate students also benefited greatly by attending scientific conferences, presenting their part in the research and also chatting with other meeting participants.

Two graduate students made this research the basis of their thesis, and hence benefited enormously as a result. In addition to having a worthwhile project to pursue, they also benefited greatly by having mentors at the local NWS office as well as potential job contacts.

4.2. Summary of problems encountered

GPS hand-held units utilized in the field to collect the data have occasionally failed or been misused by the students. This problem has been remedied by revisiting those datapoints and recollecting the data there. Additionally, some datapoints have been unevenly spaced, which defeats the project goal of having a datapoint within two city blocks of every resident. This problem has been remedied by thinning out datapoints too close together and sending teams out to collect additional datapoints to fill in holes in the original data collection. Finally, the graduate student mentioned in the proposal who desired to make this project her thesis experience has opted to change the direction of her thesis work. However, two other graduate students enthusiastically joined the project and made this research the basis of their thesis, thus more than ably filling in for the original student. These graduate students have not made the rapid progress we had anticipated, in large part because of having to work full-time jobs while in school, and as a result we had two no-cost extensions. Also, the shear volume of labor required was overwhelming, but we managed to accomplish the primary goals of the project.

SECTION 5: PRESENTATIONS AND PUBLICATIONS

Lindner, B. L., S. Perkins, L. Germanow, R. Evsich, K. Steele, T. Kent, F. Alsheimer and R. Bright, Visualizing Hurricane Surge (abstract), Proceedings Volume, Eleventh Mini-technical conference of the Palmetto Chapter of the American Meteorological Society, p. 9, 2005.

Lindner, B.L., D. St. Jean, C. Cockcroft, and S. Brueske, Predictions of storm surge flooding with the use of hurricane climatology (abstract), 15th Conference on Applied Climatology, http://ams.confex.com/ams/15AppClimate/techprogram/paper_90600.htm , 2005.

Lindner, B.L., D. St. Jean, C. Cockcroft, and S. Brueske, Predictions of storm surge flooding with the use of hurricane climatology, 15th Conference on Applied Climatology, http://ams.confex.com/ams/pdfpapers/90600.pdf , 2005.

Lindner, B.L., D. Timmons, J. Johnson, F. Alsheimer and R. Bright, A Prototype Next Generation Hurricane Storm Surge Warning System (abstract), Proceedings Volume, 12th Mini-technical conference of the Palmetto Chapter of the American Meteorological Society, p. 8, 2006.

Lindner, B.L., R. Evsich, D. Timmons, J. Johnson, and F. Alsheimer, On the display of hurricane surge (abstract), Proceedings Volume, 13th Mini-technical conference of the Palmetto Chapter of the American Meteorological Society, p. x, 2007

Johnson, Janet, 2007. Storm surge simulator project. M.S. in Environ. Stud. Internship report. 122 pp., College of Charleston, Charleston, SC.

Timmons, Danielle, 2007. Hurricane storm surge simulator. M.S. in Environ. Stud. Internship report. 128 pp., College of Charleston, Charleston, SC.

Section 6: Summary of University/Operational Partner Interactions and Roles

The university and operational investigators worked together extremely well on this project, as was detailed in this report earlier. The university investigator was responsible for managing student involvement in the project. Without the operational investigator's involvement in the creation and management of the unpaid internships, this project never would have been completed. Communication by email and telephone was very frequent as this project progressed. Indeed, it can truthfully be stated that this project led to much closer relations and cooperation between the university and NWS office.