

Final Report

Investigation of Responses of North Carolina Shorelines and Coastal Wetlands to Sea Level Rise

PI Number: 048

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1. Summary of originally proposed research

The response of shorelines and coastal wetlands to sea level rise is a major challenge to natural resource managers, planners, coastal property owners, and scientists. The value of the coastal zone for fisheries, recreation, coastal ecosystem integrity, water quality, storm damage protection, and other benefits is extremely high. However, some coastal areas are highly vulnerable to sea level rise. In this proposal, we will investigate current and short-term responses of shorelines and coastal wetland ecosystems responding to the rise of sea level. In particular, we will study the migration and variability of the migration patterns of beach and dune systems and coastal wetlands, and the extent of inundation and the water level variation in the wetlands. To accomplish our objectives, we propose to use and analyze multi-source data. The analyses of multi-source data include investigation of the migration of shorelines, mapping the extent of the inundation and water level variation in coastal wetlands, verification by ground-truthing and surveys, fusion for the multi-source data, detection of changes automatically, and establishment of coastal shoreline and wetland databases for North Carolina. The research will

- further our understanding of the response of shorelines and coastal wetlands to sea level rise,
- further our understanding of shoreline and dune migration and of the extent and rates of change of the wetland ecosystems in the coastal region, and
- provide insight and valuable information for coastal resource management, including monitoring and assessment of shorelines, coastal ecosystems, wetland conservation, water resources management, and natural hazards.

Keywords: coastal studies, remote sensing, sea level rise.

2. Accomplished research activities

Since 2000, the PI and Co-Is have carried out a series of investigations on the North Carolina coasts using primarily the JERS-1 SAR and PALSAR data from the JAXA, and other remotely sensed data from US. They have analyzed the data, and conducted fieldworks in ground truthing. All the activities were financially supported by the East Carolina University, and other US funding agencies. Also, the JERS-1 L-HH SAR data

from this JAXA's research program were the primary data sources for one masters' student (T. Zheng) thesis in the Dept. of Geography, East Carolina University. The PI and his colleagues have developed a database and methodologies for the studies of responses of North Carolina shorelines to sea level rise. They presented their work at PI meetings of 2001, 2004 and 2007 in Japan and numerous professional conferences, and published in peer-reviewed journals. The titles and abstracts of the published work are enclosed first. Then, the titles of presentations in professional conferences are listed.

3. Future plans

Although the JAXA sponsored research program ends, the datasets obtained through the program will be available to the PI and his colleagues who are passionate in research related to coastal environments using remotely sensed data. The PI and his colleagues will continue on this subject. They want to reduce the uncertainty of shoreline identification/delineation in marsh predominant and estuarine creek/stream areas by the JERS-1 and ALOS SAR data by rigorously testing the shoreline delineation methods, coupled with the available and additional AVNIR-2 and PRISM data. The PI and his colleagues also plan to expand the spatial extent to cover the entire estuarine shorelines.

Other on-going research activities include a) the investigation of shoreline change through time and delineate areas of high erosion rate (hot spots) in order to reveal infrastructure and human vulnerabilities and property at risk, b) the analysis of shoreline changes at the hot spots with land use and land cover type, topography, morphology, wave energy, sea level rise, and other factors to predict future shoreline changes, and c) the integration of the sea level affecting marshes model and remotely sensed datasets to study coastal areas of large spatial extent. All are linked to the three objectives related to

shorelines and shoreline changes in responses to the sea level rise in the original proposal

4. Articles published or in press

- [1] Liao, M., Gao, W., Wang, Y., and Jiang, Y., 2011. The sea level affecting marshes model and remotely sensed datasets: an integrated method for an area of large spatial extent. *Annals of GIS*. 16 p. In press.
- [2] Liao, M., Wang, Y., Wang, C., and Liu, L., 2010. Modification of a scattering-model-based speckle filter applied to coastal environments: a LULC study using PALSAR data. *International Journal of Remote Sensing*. 31(8), 2101-2107.
- [3] Wang, Y., Liao, M., and Wang, C., 2009. Applications and analyses of satellite-borne L-band synthetic aperture radar data in coastal environments. *Geography Compass*. 3(4), 1465–1482.
- [4] Wang, Y., and Allen, T. R., 2008. Estuarine Shoreline Change Detection Using Japanese ALOS PALSAR HH and JERS-1 L-HH SAR Data in the Albemarle-Pamlico Sounds, North Carolina, USA. *International Journal of Remote Sensing*. 29(15), 4429–4442.
- [5] Wang, Y., 2004. Seasonal change in the extent of inundation on floodplains detected by JERS-1 Synthetic Aperture Radar data. *International Journal of Remote Sensing*. 25(13), 2497-2508.
- [6] Zheng, T. and Wang, Y., 2003. An adaptive filter to reduce SAR speckles: a case study of mapping an inundation extent on the North Carolina coastal floodplain using the JERS-1 SAR data. *The North Carolina Geographer*. 11, 33-44.

5. Publications in the proceedings and presentations

- [1] Jiang, Y., Liao, M., Wang, Y., and Gao, W., 2011. A study on coastal changes using SLAMM, and remotely sensed and geo-

- spatial datasets. *The Proceedings of the International Geoscience and Remote Sensing Symposium, 2011 (IGARSS'2011)*. To be held at Sendai, Japan. 1-5 August 2011.
- [2] Wang, Y., Jiang, Y., Liao, M., and Gao, W., 2010. Using remotely sensed and geo-spatial datasets and sea level affecting marshes model to study coastal changes. *The 65th Annual Meeting of the Southeastern Division of the Association of American Geographers*. Held at Birmingham, AL. 21-23 November 2010. An 8-page paper was accepted for an oral presentation.
- [3] Wang, Y., Liao, M., Jiang, Y., and Gao, W., 2010. Integration of the Sea Level Affecting Marshes Model (SLAMM) and remotely sensed data to study coastal changes. *The Fall Meeting of the Atlantic Estuarine Research Society*. Held at Kitty Hawk, NC. 4–6 November 2010. An invited oral presentation.
- [4] Liao, M., Jiang, Y., Gao, W., and Wang, Y., 2010. Sea level affecting marshes model and remotely sensed and geo-spatial datasets for an area of large spatial extent. *The Second International Conference on Global Change and the Environment in Asia and Pacific (GCEAP): Inland Waters and Coastal Environment*. Held at the Chinese University of Hong Kong, Hong Kong. 28-29 October 2010. A 9-page paper was accepted for an oral presentation.
- [5] Wang, Y., Liao, M., Wang, C., and Liu, L., 2009. Analysis of Land Cover Types Using a Modified Scattering-model-based Speckle Filter and ALOS PALSAR Data. *The American Society for Photogrammetry and Remote Sensing (ASPRS) 2009 Annual Meeting*. Held at Baltimore, MD, USA. March 2009. An oral presentation.
- [6] Wang, Y., Liao, M., and Wang, C., 2008. Modification and extension of an existing scattering-model-based speckle filter to coastal environments. *The 63rd Annual Meeting of the Southeastern Division of the Association of American Geographers*. Held at Greensboro, NC, USA. Nov. 23-25, 2008. An 8-page paper was accepted for an oral presentation.
- [7] Wang, C., Liao, M., and Wang, Y., 2008. Study on feature extraction and terrain classification of ALOS/PALSAR polarimetric data. *The First International Conference on Environmental Remote Sensing for Pearl River Delta Region*. Held at the Institute of Space and Earth Information Science, The Chinese University of Hong Kong, Hong Kong, China. 10–11 January 2008. An oral presentation was given, and an abstract published.
- [8] Wang, C., Liao, M., Wang, Y., and Gong, J., 2007, Extraction and analysis of coherent targets using quad-pol ALOS-PALSAR L-band data. *The third International Workshop on Envisat ASAR Interferometry and its fifth International Workshop on ERS SAR Interferometry: Advances in SAR Interferometry from ENVISAT and ERS missions*. Held at ESA ESRIN in Frascati, Italy. Nov. 26-30 2007 by the European Space Agency (ESA). An oral presentation was given and a full paper published in the Workshop Proceedings by ESA.
- [9] Wang, Y., Fan, C., Gong, J., Liao, M., and Sun., G., 2008. Using the super-resolution reconstruction method to improve the spatial resolution of the ALOS PRISM triplet images. *The American Society for Photogrammetry and Remote Sensing (ASPRS) 2008 Annual Meeting*. Held at Portland, OR, USA. May 2008. A five-page long paper published in the conference CD.
- [10] Wang, Y., 2007. Using the ALOS

PALSAR HH and JERS-1 L-HH SAR Data to Detection Estuarine Shoreline Changes of North Carolina Coast, USA. *The 2nd ALOS PI meeting*. Held at Kyoto, Japan. Nov. 19-23, 2007. A presentation was given, and a full paper was published in the Conference Proceedings.

[11] Wang, Y. and Allen, T. R., 2007. Estuarine shoreline mapping and accompanying infrastructure and human vulnerabilities: recent advances in using high spatial-resolution remote sensing. *The SEDAAG Annual Meeting of 2007*. Held at Charleston, SC, Nov. 18-20, 2007.

[12] Wang, Y. and Allen, T. R., 2007. Initial observation of North Carolina shoreline changes using Japanese ALOS PALSAR and JERS-1 SAR data. *Atlantic Estuarine Research Society and Southeastern Estuarine Research Society, Spring 2007 Meeting*. Held at North Carolina Aquarium at Pine Knoll Shores, NC. March 15-17, 2007. An abstract was published.

[13] Wang, Y., 2004. Using JERS-1 SRA Data to Map Temporal Status and Change of the Extent of Inundation on the Coastal plain of North Carolina, U.S.A. A presentation at the *2nd ALOS PI Workshop and Final Meeting of the JERS-1 Research Invitation (RI) Program*. Held at Hyogo, Japan, January 19-23, 2004.

[14] Wang, Y., 2003. Seasonal change of inundation extent on floodplains detected by JERS-1 SAR data, *North Carolina GIS Conference*. An invited presentation. *Held at Winston-Salem*. February. 20-21, 2003.

[15] Wang, Y., White, S. A., and Zheng, T., 2003. Seasonal changes of inundation extent on coastal plain of North Carolina detected by using JERS-1 SAR data, *Coastal GeoTools03*. A presentation and an abstract were published on a conference CD. Held at Charleston, South Carolina, Jan. 6-9, 2003.

[16] Wang, Y., White, S. A., and Zheng, T., 2002. Using JERS-1 SAR data to map temporal change of inundation extent: a case study on the floodplains of North Carolina. *The 57th Annual Meeting of the Southeastern Division of the Association of American Geographers*. A presentation and an abstract were published on pp 41. Held at Richmond, Virginia, Nov. 24-26.

[17] Wang, Y., Gares, P. A., and Brinson, M. M., 2001. Investigation of responses of North Carolina shorelines and coastal wetlands to sea level rise. A presentation was given at the *1st ALOS PI Workshop, Snow & Ice, Hydrology & Water Resource, and Ocean*. March 28-30, 2001, Tokyo, Japan.

6. Appendix A. Five published articles