Florida Coastal-Forcing Project

"Waves and Winds in the Nearshore"

Progress Report #1

submitted to

The Florida Department of Environmental Protection
Office of Beaches and Coastal Systems

and

The Beaches and Shores Resource Center

William R. Dally, Ph.D., P.E.

Surfbreak Engineering Sciences, Inc.
1010 Atlantic Street, Suite A-2
Melbourne Beach, Florida 32951

Florida State University
Purchase Order # F37792

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1. Wave Gage Network

1.1 Directional Wave Measurement Technologies

Three wave gage manufacturers have been contacted: RD Instruments (RDI), Nortek, and Sontek. All deal in acoustic Doppler technology; however, RDI presently owns the U.S. patent for measuring waves using a single acoustic doppler current profiler (ADCP). Sontek has not developed this type of gage, but markets an acoustic doppler velocimeter (ADV) wave gage. This gage is identical in concept to an electromagnetic current meter 'PUV' instrument, but claims better performance and lower maintenance. Nortek manufactures and sells their own ADCP-based directional wave gage outside the U.S., and the Nortek representative indicated that Nortek may challenge the patent rights of RDI. This process will most likely take several years, so no competition in the ADCP-based arena is anticipated in the foreseeable future. Nortek does market an acoustic PUV instrument similar to Sontek's. Copies of the brochures that describe these instruments are attached.

1.2 Instrument Costs

Several papers written on the ADCP-based instrument indicate significant improvement in the ability to resolve directional wave spectra as compared to a single-point PUV; however, the cost is also greater: ~ $35,000 for the ADCP, versus ~ $9,000 for an ADV. It is also noted that performance of the ADCP is not quite as good as that of a linear array of pressure transducers, such as that deployed at the Field Research Facility in Duck, North Carolina. However, linear arrays must be custom-made (apparently no company markets them commercially), and because they entail multiple gages (~10), they are more difficult to install and maintain. The components alone cost approximately $35,000, and analysis software would also have to be acquired or written from scratch. Finally 'slope-arrays', formed by three pressure transducers arranged in a triangle, are also available. These are comparable in cost and performance to a single-point PUV, but are supposedly easier to maintain.

1.3 Fiber-Optic Communications

Neither RDI nor Nortek have first-hand experience with the use of fiber-optics for gage communications; however, both confirmed the possibility of electrical noise contamination when using conventional copper cables, especially over long distances and for long-period (permanent) deployments. Fiber-optic communication has been used with Sontek acoustic PUVs during experiments at the Army's Field Research Facility. All manufacturers agreed that the use of fiber-optics would completely eliminate even the possibility of communications contamination.. Manufacturers of off-the-shelf RS-232 and RS-422 fiber-optic converters have been identified, and it appears that any of the wave gage instruments could be modified to contain such a converter. The fiber-optic laser does require additional power, which can be supplied via the gage power cable. It would not be feasible however to run the fiber-optics from the gage backup batteries for any length of time.

1.4 Conduit-Drilling

A significant amount of information has been gathered on the idea of using conduit as a means of the protecting power and communications cables between each FDEP gage and its shore station. To date, two conduit-drilling companies have been contacted: the Fischel Company, and UTIL-X. Both companies have some experience with drilling conduit for long distances under lakes, and their representatives indicated that doing the same in the nearshore is entirely feasible (both said ATT has done it). This idea shows great promise for improving the survivability of the wave measuring system, as well as in reducing maintenance and replacement costs. However, conduit-drilling is very expensive - on the order of $80 per lineal foot (i.e. $80,000 for a typical 1000-ft run). In addition, the drilling contractors believed that a barge would be required for the installation, further adding to the expense. Although drilling costs might be reduced significantly with competitive bidding for multiple installations, conduit-drilling easily stands to be the most expensive facet of the wave gage network. This must be balanced against the long-term costs of periodically replacing conventional steel-armored cables. More importantly, the cost must be compared to value of the wave data (especially during storms) and the loss in value if real-time web capabilities are lost or significant gaps occur in the data record due to cable failures.

1.5 Preliminary Testing Plan

Based upon these findings, at face-value it would appear that the RDI ADCP-based system is the best option for the FDEP network; however, this technology is very new, and somewhat unproven. However, all of the manufacturers contacted are willing to loan their instruments on a short-term (~2 weeks) basis, free of charge. Consequently a preliminary field test is planned, in which as many gages as possible are to be operated side-by-side during a 1-2 week deployment. All borrowed gages will operate in a self-record mode, so that no shore station and cabling are required. Sebastian Inlet is being considered as a location for this test, as there is already an electromagnetic PUV operating there. Stuart, Florida is also a possibility, as Martin County presently supports a wave gage program with an electromagnetic PUV and a slope array. This test will provide first-hand experience with most of the available wave measuring technologies, and therefore will bolster confidence in making the final selection for the wave gage trial system, the development of which is to follow immediately thereafter.

2. Wave-Hindcast Database

2.1 Sample Deepwater Hindcast Data

Forty years of wave hindcasting data for the Brevard and Indian River County region have been acquired from Oceanweather, Inc. for the time period from January 1, 1958 to December 31,1997. These data, known as the AES-40 hindcast, were generated using the WAM wave hindcasting model, driven using the most recent weather products available from the National Centers for Environmental Prediction global reanalysis project. These wind fields were further enhanced for tropical and extratropical storms using a numerical cyclone model. A plot of energy-based significant wave height, H_S, is presented in Figure 1. Seasonal and longer-term behavior, punctuated by major storms, is clearly evident. The wave model runs were made consistently throughout the entire 40-year hindcast, and so data of this type are useful in studying coastal processes on decadal scales. The WAM model is valid only in deep water however, and consequently the grid points where data are archived are located tens-of-miles offshore in some instances. Nevertheless, preliminary examination of the last tens years of the record shows a strong correlation between parameterized coastal forcing (e.g. Radiation Stress and wind stress) and the beach survey data available from the north fillet of Sebastian Inlet, located at the boundary between Brevard and Indian River Counties.

2.2 Shallow-Water Transformation

The goal of the hindcasting component of the Coastal-Forcing Project is to archive wave information in the nearshore around the entire State at high resolution, so that users will not have to conduct further hindcast modeling themselves. In order to bring the AES-40 wave information close to shore, a second wave model is required. This model must not only be valid in shallow water (e.g. to represent refraction), but must still contain the essential elements of wind-wave generation that are contained in deepwater hindcasting models. To this end, the numerical model STWAVE has been acquired from the U.S. Army Corps of engineers, along with a user's guide that also describes briefly the model's underlying governing equations and theoretical basis. The published literature that supplies details for this basis is being collected for review, and the numerical algorithm is being studied. Once operational, STWAVE will be used to transform the AES-40 data to the location of the PUV gage at Sebastian Inlet, which is situated in nominally 24 ft of water. Comparisons to the gage data for the overlap in records (8/96 to 12/97) can then be performed. In addition, comparisons to shallow-water applications of the WISWAVE II hindcasting model are also planned.