Final Technical Report for the Project:

Temporal & Spatial Variability of Bathymetry of a Natural Beach, N00014-93-1-0074

Long Term Goal

The long term goal of this project was to investigate the coupling between waves, breaking-wave driven circulation, and morphological evolution near the shore. Accurate, detailed predictions of wave properties in the nearshore given the incident wave conditions and local bathymetry were obtained to allow for simulation of the forcing mechanisms in models that couple wave-driven flows, sediment transport, and changing bathymetry. For the last several years efforts have been focussed on analyzing wave, current, and morphological observations made in the Duck94 and SandyDuck field experiments conducted near Duck, NC.

Analysis of Duck94 Observations

One-dimensional Boussinesq shoaling wave models have been compared with observations made on the cross-shore transect of the Duck94 pilot experiment. The momentum balance described by the shallow water equations was verified by comparison with mean longshore currents observed along the Duck94 transect. A 1D morphological evolution model was shown to predict the offshore sandbar migration observed in Duck94. Near-bed fluid accelerations were shown to be important to onshore bar migration.

Analysis of SandyDuck Observations

The evolution of waves, currents, and bathymetry on a natural beach was observed during the SandyDuck field experiment on the North Carolina coast. Pressure gages, current meters, and sonar altimeters were deployed between July and December 1997 on a two-dimensional grid extending 370 m from near the shoreline to about 5 m water depth and spanning 200 m along the coast. The grid was large enough to sample significant bathymetric inhomogeneities and their effects on wave evolution and circulation. Data return was greater than 98%. Significant processing was performed in near-real time, and maps of nearshore wave heights and directions, bathymetry, mean flows, and setup every 3 hours for 120 days have been produced. The spatially extensive instrument arrays allow quantitative investigations of sea and swell, edge waves, shear waves, alongshore inhomogeneous circulation, and changing morphology.

A Boussinesq model for the nonlinear evolution of nonbreaking, directionally spread waves is being tested by comparison with the array observations. The model is initialized with wave directional spectra estimated from pressure sensor array data acquired in 8-m water depth, and model predictions compared with wave observations at shallower depths. Nonlinear Boussinesq theory predicts accurately the observed wavenumbers.

A cross-shore transect of buried (to avoid flow-induced pressures) pressure gages provides estimates of the wave-breaking induced setup. The observations are being compared with models for setup and with the corresponding offshore directed near-bottom flows (undertow).

DTIC QUALITY INSPECTED 3

20000308 042

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1 March 2000	Final (1994-1999)

4. TITLE AND SUBTITLE
Temporal and Spatial Variability of Bathymetry of a Natural Beach

5. FUNDING NUMBERS
N00014-93-1-0074 (G)

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

a. DISTRIBUTION / AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

12. DISTRIBUTION CODE
APPROVED FOR PUBLIC RELEASE

13. ABSTRACT *(Maximum 200 words)*

The coupling between waves, wave-breaking driven circulation, and morphological evolution near the shore was investigated with field observations (eg, Duck94, SandyDuck) and model studies. Engergetics-based sediment transport models driven with observed currents were shown to predict offshore sediment transport and migration of sand bars observed during storms. The field data suggest onshore transport and bar migration observed during calm periods is related to nonlinearities in shallow water waves that produce asymmetrical near-bottom fluid accelerations.

14. SUBJECT TERMS
surfzone, waves, nearshore currents, sediment transport, beach erosion

15. NUMBER OF PAGES
7

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
unclassified	unclassified	unclassified	UL

The pier and neighboring bathymetry produce strong alongshore gradients in the wave field. Waves 100 m downwave of the pier are smaller and more normally incident than waves 300 m downwave. The alongshore gradients are largest for waves propagating with the biggest angles relative to the shore normal (eg, for waves propagating past the pier).

Analysis of Other Observations

During this project several small field experiments were conducted. Acoustic and electromagnetic current meters were deployed in 8 m depth at the end of the Scripps pier in July 1998 and in the surfzone near the Scripps pier in October 1998. Results from these deployments suggest that acoustic doppler velocimeters perform well in the nearshore and surfzone. A manuscript describing the results is in preparation.

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Statistics

29 Papers published/in press, refereed journals

34 Proceedings/conference presentations

2 Undergraduate students supported

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2 Post-docs supported

0 Other professional personnel supported

EEO/Minority Support

2 Female undergrad student

1 Female grad student

0 Minority grad students

1 Asian grad students

0 Female post-docs

0 Minority post-docs

1 Asian post-doc