NorthWest Research
Associates, Inc.
P.O. Box 3027 • Bellevue, WA 98009-3027

NWRA-CR-98-R179 4 February 1998

The Importance Of Alongshore Nonuniformity In Longshore Current Predictions

Final Report

For Contract N00014-95-C-0011
For the Period 20 November 1994 - 19 November 1997

Prepared by

Joan Oltman-Shay
joan@nwra.com

and

Uday Putrevu
putrevu@nwra.com

Prepared for
Dr. Thomas Kinder
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5660

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
23 January 1998

3. REPORT TYPE AND DATES COVERED
Final Report, covering period of 20 Nov 94 - 19 Nov 97

4. TITLE AND SUBTITLE:
The Importance of Alongshore Nonuniformity in Longshore Current Predictions

5. FUNDING NUMBERS
Contract N00014-95-C-0011

6. AUTHOR(S)
Joan Oltman-Shay and Uday Putrevu

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
NorthWest Research Associates, Inc.
14508 NE 20th Street
P.O. Box 3027
Bellevue, WA 98009-3027

8. PERFORMINGORGANIZATION REPORT NUMBER
NWRA-CR-98-R179

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Program Officer
Office of Naval Research
Ballston Tower One, 800 N. Quincy St.
Arlington, VA 22217-5660
Attn: Thomas Kinder, ONR 321 - ref: Contract N00014-95-C-0011

10. SPONSORING /MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The long-term goal of this research is to increase our understanding of nearshore (shoreline to nominally 15 m depth) fluid dynamics and to enhance our predictive modeling of waves and currents in that region.

The three year objective funded in this contact was to investigate the effects of longshore variations of the bottom topography and short-wave field on nearshore currents.

This final report describes the tasks we undertook to achieve our objective, the results of these tasks, the scientific impacts of our results, and lists the publications associated with this contract.

14. SUBJECT TERMS
longshore currents, nearshore circulation, nearshore mixing

15. NUMBER OF PAGES

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	none

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

THE IMPORTANCE OF ALONGSHORE NONUNIFORMITY IN LONGSHORE CURRENT PREDICTIONS

ABSTRACT

The long-term goal of this research is to increase our understanding of nearshore (shoreline to nominally 15 m depth) fluid dynamics and to enhance our predictive modeling of waves and currents in that region.

The three-year objective funded in this contact was to investigate the effects of longshore variations of the bottom topography and the short-wave field on nearshore currents.

This final report describes the tasks we undertook to achieve our objective, the results of these tasks, the scientific impacts of our results, and lists the publications associated with this contract.

WORK COMPLETED

To achieve our objective, we undetook several tasks. These are listed below and described in detail in the next section.

- An evaluation of the limitations of using a simple model to evaluate the effects of alongshore variations of topography for longshore currents (Putrevu *et al.,* 1995; Sancho *et al.,* 1997)
- An extension of the dispersive mixing of momentum (Putrevu and Svendsen, 1997)
- A comparison of model predictions of longshore currents with field data (Svendsen *et al.*, 1997)

RESULTS

Sancho, Svendsen, and Putrevu, 1997 (Modeling of longshore currents over longshore nonuniform topographies: Effects of second-order terms, under review, *J. Geophys Res*). As discussed later, Putrevu *et al.* (1995) found that alongshore inhomogenieties of the bottom topography induce alongshore pressure gradients which can significantly influence the longshore currents. For the case in which the alongshore variations of the bottom topography are weak, Putrevu *et al.* suggested that the alongshore pressure gradient can be calculated in a simple way. This work was designed to evaluate the limitations of the simple model proposed by Putrevu *et al.* The results show that the Putrevu *et al.* model works in cases in which the alongshore variations in the bottom topography vary over lengths that are long in comparison with the surf zone width. For cases in which the alongshore variation of the topography occurs over relatively short distances (like, *e.g.*, in a rip-channel) the simple model of Putrevu *et al.* does not work even if the absolute magnitude of the changes is relatively small.

Svendsen, Sancho, Oltman-Shay, and Thornton, 1997 (Modelling nearshore circulation under field conditions, Proc. Waves 97 Conference, Virginia Beach). This work compares DELILAH field data with model predictions using the quasi-3D SHORECIRC circulation model with forcing provided by the (linear) REF/DIF short-wave shoaling model. The data comparison shows much better agreement than comparisons with earlier modelling efforts, but there are still some noticable discrepancies. Close analysis suggests the source of discrepancy is primarily in the short-wave forcing and its lack of proper representation of the irregular short wave motion.

Putrevu and Svendsen, 1997 (Shear dispersion in the nearshore, in revision, *J. Fluid Mech.*). In this work, we extended the results of Svendsen and Putrevu (1994) to the general case in which the assumptions of alongshore uniformity and steady state are abandoned. This work showed that it is possible to account for the dispersive-mixing effects of the vertical nonuniformity of the short-wave-averaged velocity field over an abitrary bottom topography without resorting to a fully three-dimensional calculation. The results, however, are far more complicated than the results for the simple situation considered by Svendsen and Putrevu (1994). In particular, this work shows that the results obtained by Svendsen and Putrevu represent only the leading term of the complete result. The importance of these additional terms is at present unknown.

Putrevu, Oltman-Shay and Svendsen, 1995 (Effect of alongshore nonuniformities on longshore current predictions, *J. Geophys Res. 100*, 16119-16130). This work demonstrates that the often neglected alongshore bathymetric inhomogeneities in the surf zone induce alongshore pressure gradients that can contribute at first order to the forcing of longshore currents. This point is demonstrated via both an ordering argument, and by examination of analytical solutions of the depth-integrated, wave-averaged equations of mass, momentum, and energy. The work differs from previous efforts in considering the effect of bathymetric inhomogeneities within the surf zone, in isolation of the bathymetric inhomogeneities outside the surf zone that lead to alongshore variations in breaker height. In addition, this analytical study provides the tools to assess the importance of alongshore pressure gradients for varying wave and beach conditions.

IMPACTS

Scientific results that will influence the modeling of nearshore waves and currents include the following.

It is important to account for alongshore nonuniformities of the bottom topography. For instance, the alongshore current could deviate by up to 30% from the mean for a 10% deviation of the bottom topography, and the location of maximum current variability is inshore of the location of maximum topography variability. Existing models of alongshore currents (which typically assume alongshore uniformity) easily can be extended to include minor alongshore variations as long as these variations occur over lengths that are much larger than the surf zone width.

It is possible to account for the dispersive mixing effects of the vertical nonuniformity of the short-wave-averaged velocity field over an arbitrary bottom topography without resorting to a fully three-dimensional calculation.

PUBLICATIONS

Putrevu, U., J. Oltman-Shay, and I.A. Svendsen, 1995. Effect of alongshore nonuniformities on longshore current predictions, *J. Geophys Res. 100*, 16119-16130.

Putrevu, U., and I.A. Svendsen, 1997. Shear dispersion in the nearshore, in revision, *J. Fluid Mech.*

Sancho, F.E., I.A. Svendsen, and U. Putrevu, 1997. Modeling of longshore currents over longshore nonuniform topographies: Effects of second-order terms, under review, *J. Geophys Res.*

Svendsen, I.A., F.E. Sancho, J. Oltman-Shay, and E.B. Thornton, 1997. Modelling nearshore circulation under field conditions, Waves97 Conference, Virginia Beach.