

**Intermediate Scale Coastal Behaviour:
Measurement, Modelling And Prediction.**

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LONG-TERM GOAL

Our overall goal is to achieve a better understanding and better predictions of coastal behaviour at intermediate (event/season/year/decade) scales. We aim to bring together researchers from Europe and North America to gain the best possible benefit from developments in field observation, theory and numerical modelling.

SCIENTIFIC OBJECTIVES

We are following a four-pronged collaborative approach. Data on intermediate scale behaviour from both sides of the Atlantic are being studied and ways are being sought to project these observations onto a manageable number of descriptive parameters or basic patterns. Top-down modelling uses these data products to develop black-box (data extrapolation) and grey-box (behaviour-oriented) models for the observed behaviour. Bottom-up modelling investigates the predictive potential of process-based models, making best use of process results from US and European field campaigns, combined with existing modelling expertise. There is also a vital linking activity aimed at ensuring that the data, top-down modelling and bottom-up modelling activities interact fully, in order to bring together the most productive aspects of each into a predictive capability for intermediate-scale coastal change.

APPROACH

This project is designed to create interaction between European and North American scientists who are already involved in research related to intermediate scale coastal behaviour. We have a four part approach to achieving this interaction, through workshops, exchanges, support for Research Fellows, and additional research support.

WORK COMPLETED

Workshops:

Two Workshops have been held during the year.

In November 1997 a Workshop entitled 'How can we assess the skill and predictability of coastal morphological forecasts?' was held at HR Wallingford, UK. The Workshop was organised by Richard Soulsby, and attended by 13 participants, including representatives from all of the NICOP collaborators (except the Naval Postgraduate School, Monterey), and Dr Alan Weinstein from ONR Europe. The programme for the Workshop included a number of short presentations from each of the collaborators, and an excellent Guest Presentation by Dr Mike Davey of the Hadley Centre for Climate Prediction and Research on 'Quantifying Skill in Forecasts'. More than half the time was given to discussions, resulting in a lively and very productive meeting. At the end of the Workshop the NICOP collaborators identified ways to advance the methods and understanding of predictability, and agreed to report on progress at the next NICOP Workshop. A summary of the Workshop presentations and discussions has been produced by David Huntley (University of Plymouth).

The second Workshop, entitled 'Processes in coastal morphological development and their description through field or laboratory experiments or by mathematical modelling', was held at the Danish Hydrological Institute in Copenhagen in June 1998 (just prior to the ICCE Meeting). The Workshop was organised by Julio Zyserman (DHI) and Rolf Deigaard (ISVA). All of the NICOP collaborators, and Reg Beach from ONR, participated. As before, the format of the Workshop consisted of short

presentations but allowed most time for discussions, and again there was general agreement that it was very productive. Some of the results are described in the next section. A summary of this Workshop has been produced by Julio Zyserman (DHI).

Exchanges:

Cross-Atlantic exchanges and visits supported by this NICOP project are listed in the table 1.

Research Fellows:

At Plymouth, PhD student Ken Kingston was appointed on 1st October 1998. He has been involved in the application of Genetic Algorithms and Neural Networks to nearshore morphological data, particularly ARGUS imagery from the US, Australia and the UK. He has also developed the installation for the new ARGUS system to be deployed at the COAST3D site at Teignmouth, UK.

Also at Plymouth, partial funding has been provided for Dr Brad Morris, a Post-doctoral Fellow. Brad is primarily funded through the EC INDIA project, working on video systems to be used at the inlet in Faro, Portugal, but he will also be relating his observations and analysis to the ARGUS images, and he attended the second NICOP Workshop in Copenhagen.

Nils Dronen was appointed at ISVA for the period 1 November to 31st December 1997, and continues his involvement with NICOP as a PhD student.

At HR Wallingford, Andy Peet is employed as a Post-doctoral Fellow and is focussing on the appropriate measures of predictive skill for coastal morphodynamic models.

Table 1: Table of exchanges and visits between Europe and North America.

Name	Position	Home Institution	Institution visited	Purpose	Dates
Stefan Aarnikhof	PhD student	Delft Uni. and Delft Hydraulics	1. OSU 2. OSU	ARGUS Workshop Research on ARGUS imagery	July 1998 July-Oct 1998
Tony Bowen	Professor	Dalhousie	HR Wallingford	NICOP Workshop	Nov. 1997
Mark Davidson	Senior Lecturer	Plymouth	1.CRF, Duck 2.OSU	SANDY DUCK ARGUS Workshop	Oct. 1997 July 1998
Rolf Diegaard	Assoc. Prof	ISVA/DHI	Dalhousie	Workshop on SANDY DUCK	May 1998

Nils Dronen	PhD student	ISVA	1.CRF, Duck 2. Dalhousie	SANDY DUCK Workshop on SANDY DUCK	26 Sept – 12 October 1997 May 1998
Diane Foster	Post-Doctoral Fellow	Dalhousie	ISVA	Research on wave boundary layers	2 June – 13 July 1998
Edie Gallagher + 2 other research support staff	Post-doctoral Fellow	NPS	Netherlands	COAST3D Fieldwork	October/November 1998
Piet Hoekstra	Asst. Prof.	Utrecht U.	CRF, Duck	SANDY DUCK	October 1997
Rob Holman	Professor	OSU	1.HR and Plymouth 2. Utrecht.U. 3. DHI 4. Plymouth	NICOP Workshop and Visit to proposed ARGUS field site Establish ARGUS field station NICOP Workshop Establish ARGUS field station, Teignmouth	Nov. 1997 Dec. 1997 June 1998 Jan. 1999
Ken Kingston	PhD student	Plymouth	OSU	ARGUS Workshop, and additional 1 week	July 1998
Brad Morris	Post-doctoral Fellow	Plymouth	DHI	NICOP Workshop	June 1998
Nathaniel Plant	Post-doctoral Fellow	Twente	Orlando	ICCE'98	July 1998
Ad Reniers	Project Engineer and Asst. Prof .	Delft Hydraulics and Delft University	CRF, Duck	SANDY DUCK (NPS group)	September/October 1997
Paul Russell	Senior Lecturer	Plymouth	CRF, Duck	SANDY DUCK	Oct. 1997
Ed Thornton	Professor	NPS, Monterey	1. DHI 2. Netherlands	NICOP 2 nd Workshop COAST3D Fieldwork	June 1998 October/November 1998
Richard Whitehouse	Project Manager	HR	CRF, Duck	SANDY DUCK	October 1997
Kathelijne Wijnberg	Post-doctoral Fellow	Utrecht U.	1.CRF, Duck 2.OSU	SANDY DUCK ARGUS Workshop	Oct. 1997 July 1998

Nathaniel Plant, who obtained his PhD with Rob Holman at OSU, started work at Twente in May 1998 as Post-doctoral Fellow, funded by the NICOP grant. He is collaborating on the EC PACE project, studying nearshore bar behaviour.

Additional Research Support:

A new ARGUS station has been installed at the COAST3D site at Egmond in the Netherlands, jointly funded by NICOP, COAST3D and Rijkswaterstaat. The system is operating as an important element of the COAST3D field measurements at Egmond.

At Plymouth, considerable effort has been expended maintaining and enhancing the ARGUS station at Perranporth (North Cornwall, UK). Severely corroded camera housings have been replaced with purpose-built plastic housings. After several attempts hampered by bad weather, a new pressure sensor has been deployed offshore from the Perranporth ARGUS station, but final connection to the ARGUS logging system awaits suitable weather and low tide conditions to complete the cabling.

The new ARGUS station at the COAST3D site at Teignmouth has been designed and is nearing completion, and the power and telephone connections to the site made. Provisional plans have been made with Rob Holman (OSU) to deploy the system in January 1999, in time for the COAST3D fieldwork which takes place in the Spring and Autumn of 1999.

RESULTS

Investigations of the potential of evolutionary programming and neural networks to the data and top-down modelling aspects of this project (see Scientific Objectives above) are being carried out by Ken Kingston and Mark Davidson (Plymouth). These techniques show promise so far in three areas. Most successful has been the application of evolutionary computation to the determination of the three dimensional characteristics of reflective wave fields as measured by nearshore arrays of sensors. The method allows the efficient determination of the frequency-dependent reflection coefficient for shorelines, and a paper on the technique is in preparation. Neural Network techniques are also showing promise for the objective classification of ARGUS video images into a small number of beach states. The third area under investigation, but needing further research, is the use of neural network techniques to predict transformations between beach states using basic wave conditions and a set of user-defined evolutionary rules. An interesting result for the macrotidal beach at Perranporth is that the movement of the inner bar, measured by the ARGUS system, shows a strong correlation with the tidal range variations over spring/neap cycles, with incident wave conditions having only a secondary influence. These results are supported by a simple model of a macrotidal beach.

At Twente, a Delft Hydraulics model for nearshore sediment transport model has been applied to nearshore bars, with the wave climate inputs simulated by Monte Carlo methods, based upon 12 years of observations. Bed elevation prediction is found to be strongly dependent on the chronology of the waves, thus demonstrating the very limited long-term predictive skill of this type of model. Top-down modelling of nearshore bar migration is being applied to data for the Dutch coast, with promising results.

Research on bottom-up modelling carried out at ISVA and DHI is focussing on the existence of instabilities. A morphological instability mechanism for a coast with longshore bars, studied by Nils Dronen, Jorgen Fredsoe and Rolf Deigaard, has been found to lead to the formation of rip channels. Other work by Diane Foster, Jorgen Fredsoe and Tony Bowen on instabilities in wave boundary layers is in progress.

An important NICOP result relevant to the linking activity is the identification of an appropriate objective measure of skill for coastal morphological models, to replace the subjective 'reasonably good agreement' assessment used previously. Andy Peet (HR Wallingford) has made an in-depth study of measures of skill as relevant to coastal profile and coastal area models. Tests of various skill-scores used by meteorologists were made against model results from 5 different CP models produced within the COAST3D project, and compared with bathymetry changes at Egmond. The score which seemed to have the 'right' sort of behaviour was the Brier Skill Score. This was confirmed by asking the NICOP morphology experts to assess the model results subjectively during the Copenhagen Workshop. Their expert opinions matched most closely to the Brier skill scores. In these skill tests, two cases had been modelled, an erosive condition and an accretive condition. The different models gave very different results for the erosive case, and not all were able to do better than the 'null hypothesis' of no bathymetry change (Brier scores between -1 and 0.4). In the accretive case, all models got negative

Brier scores of between -1.9 and -0.2 , showing that a better prediction would have been no bathymetry change! This is a salutary lesson in the capabilities and defects of such models. Similar analyses for Coastal Area models are now in progress.

IMPACT/APPLICATIONS

Explicit recognition of the need to consider predictive skills of coastal morphology models is driving much of our research and will have an important impact on the practical as well as research aspects of coastal science.

TRANSITIONS

The interlinking of a number of US and European projects, in modelling and in fieldwork, is central to this NICOP project.

RELATED PROJECTS

Our NICOP funds are being used to ensure collaboration between the SANDY DUCK field work in the US and the EC Projects COAST3D, INDIA, PACE and SASME.

REFERENCES

SASME Web Page: <http://www.wldelft.nl/sasme/sasme.htm>

COAST3D Web Page: <http://www.hrwaalingford.co.uk/projects/COAST3D>

INDIA Web Page: <http://www.pol.ac.uk/jjw/INDIA.html>