Intermediate Scale Coastal Behaviour:
Measurement, Modelling And Prediction

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14. ABSTRACT

NICOP funding for this project ends at the end of September 2001, but the goals of the consortium of researchers continue. 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.

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LONG TERM GOAL

NICOP funding for this project ends at the end of September 2001, but the goals of the consortium of researchers continue. 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.

OBJECTIVES

We follow a four-pronged collaborative programme of objectives. Data on intermediate scale behaviour from both sides of the Atlantic are studied and ways 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 has been very successful in creating interaction between European and North American scientists who are already involved in research related to intermediate scale coastal behaviour. Our approach to achieving this interaction has been through workshops, exchanges, support for Research Fellows, and additional research support.

WORK COMPLETED

Workshops:

The highlight of this year was undoubtedly our Final Workshop, held on Sunday 10 June 2001 in Lund, Sweden, just prior to the Coastal Dynamics 2001 Conference. More than 60 people attended the Workshop which was organised around the four areas of our research: Data, Bottom-up Modelling, Top-Down Modelling and Linking and Prediction. The Workshop ended with a short but lively discussion session. Each session consisted of short summary talks by a number of NICOP-funded researchers, and each was led by the lead European researcher. A total of 13 speakers participated. Although we clearly have a long way to go before we can fully understand and predict coastal evolution, the approach taken by our group in addressing directly the non-linear, complex behaviour of coastal systems was well received and sparked many discussions both during and following the Workshop. Feedback from the Workshop was very positive and vindicated our view that focussed Workshops of this kind, with ample time for discussion and debate, are remarkably productive in terms of stimulating thought and fresh approaches to the research.

An ARGUS Workshop was held at Oregon State University in July/August 2001, and involved participants from three of the seven collaborating Institutions (Plymouth University, University of Twente and Oregon State University). The major task for the Workshop was co-ordinating the development of a set of tools for the analysis and scientific interpretation of ARGUS imagery, but there was also opportunity to discuss scientific results and plan future projects.

Exchanges:

Name	Position	Home Institution	Location visited	Purpose	Dates
Tony Bowen	Professor	Dalhousie University	Lund, Sweden	Final Workshop And CD01	June 2001
Diane Foster	Assistant Professor	Ohio State U (ex Dal)	Lund, Sweden	Final Workshop And CD01	June 2001
Ken Kingston	PhD student	U. Plymouth	i) U. Twente ii) Lund, Sweden iii) OSU	Research collaboration Final Workshop And CD01 ARGUS Workshop	October 2000 June 2001 July/Aug 2001
i) Aart Kroon ii) Gerben Ruessink iii)Irene van Enckevort	Ass. Prof Research Fellow Research Student	Utrecht Uni/ Delft Hydraulics (through Twente)	i) Lund, Sweden ii) OSU	Final Workshop and CD01 ARGUS Workshop	June 2001 July/Aug 2001
Rolf Deigaard	Assoc. Prof.	ISVA	OSU, NPS	Research visits	June 2001
Joergen Fredsoe	Professor	ISVA	OSU, NPS, Ohio State U., Dal.	Research visits	June/ July 2001
i) Rolf Deigaard ii) Dorthe Petersen iii) Hakeem Johnson	Professor PhD student Researcher	DHI/ISVA	Lund, Sweden	Final Workshop And CD01	June 2001
Rob Holman	Professor	OSU	i) Lund, Sweden ii) OSU	Final Workshop and CD01 ARGUS Workshop	June 2001 July/Aug 2001
Nathaniel	Post-	Twente/	i) Lund, Sweden	Final	June 2001

Plant	doctoral fellow	NRLSSC		Workshop And CD01	
			ii) OSU	ARGUS Workshop	July/Aug 2001
Ad Reniers	Post-doctoral Fellow	NPS, Monterey	Lund, Sweden	Final Workshop and CD01	June 2001
Huib de Vriend	Professor	Twente	Lund, Sweden	Final Workshop and CD01	June 2001
James Sutherland Richard Soulsby	Project Leader Project Manager	HR Wallingford	Lund, Sweden	Final Workshop and CD01	June 2001

Research Fellows supported:

Ken Kingston (Plymouth). PhD student. Appointed 1st October 1998. Genetic Algorithms and Neural Nets for the analysis of ARGUS images. Post-graduate Research Fellow: May – September 2001.

Brad Morris (Plymouth). Post-doctoral Fellow (25% NICOP: 75% EC INDIA Project). Video observations at Faro, Portugal. To April 2001.

Sanne L. Niemann (ISVA). Research Assistant.

Hakeem Johnson (DHI). Research Engineer.

James Sutherland (HR Wallingford). Research Fellows. Measures of predictive skill for coastal morphodynamic models.

Nathaniel Plant (U. Twente). Post-doctoral Fellow. Appointed May 1998 (after a PhD at OSU with Rob Holman). Analysis of field data and idealised morphologic models.To December 2000.

Additional Research Support:

The 5-camera ARGUS system overlooking the COAST3D site at Teignmouth, UK. continues to provide excellent images of the remarkable estuarine sand banks in the region. The costs associated with maintaining this site, principally telephone bills, are funded by this grant.

Time series of wave data for the Teignmouth site have been identified from the archive of wave model output available from the UK Meteorological office, and relevant data have been obtained through HR Wallingford. These data complement in situ inshore data obtained from the pier at Teignmouth.

Costs of telephone links to the Perranporth ARGUS site in UK are also covered by the NICOP grant. This macrotidal site is linked to a major nationally funded project on swash sediment dynamics, and is also being used to test remote measurements of intertidal topography. Proposals for establishing a system for measuring wave and tide conditions at this site are still under discussion and will unfortunately not now be completed by the end of the grant. However the insurance funds received

after the previous unsuccessful attempt are still available and will be used when current activity results in a viable solution.

RESULTS

In this final year of the project a number of papers describing the results have been published, submitted or are in the final stages of preparation.

The productive collaboration between Plymouth (Mark Davidson, Ken Kingston, Cyril Mallet, Eduardo Siegle, David Huntley), the Netherlands (Gerben Ruessink, Stefan Aarnikhof, Nathaniel Plant) and OSU (Rob Holman) on the analysis and interpretation of ARGUS images has continued. A paper has been submitted which compares different techniques for the detection of the shoreline and other nearshore features. The neural net technique has advanced to the stage where it can now be used to provide quantitative mapping of intertidal morphology to an accuracy approaching that of interpolated in situ measurements. Neural net methods have also proved their value in quantifying subtidal bar morphology, allowing removal of spurious effects of tide and wave conditions from the derivation of water depth from breaking wave patterns. Analysis of long-term ARGUS-type images from an exposed and highly active inlet in Portugal has allowed the identification of seasonal and long-term changes in inlet morphology. Attempts to describe complex bathymetric time series in terms of a limited number of parameters have included a study of the fractal behaviour of evolving beach cusps, and a test of fitting ARGUS imagery to a parametric descriptor of nearshore bars. Whilst these two studies have provided useful insights into the problem, it is clear that finding solutions requires considerable further work.

Work on process (bottom-up) modelling at Dalhousie (Tony Bowen, Diane Foster – now at Ohio State U), ISVA/DHI (Rolf Deigaard, Nils Drønen, Dorthe Petersen, Hakeem Johnson), NPS (Ed Thornton, Ad Reniers – ex-Delft Technical U) and HR (James Sutherland) has progressed on several scales. At the smallest scale, the Dalhousie group have carried out comparisons between observations and modelling of small-scale, high-resolution sand suspension events in the boundary layer. In general quasi-steady state models provide prediction which are consistent with the observations. Ultimately these studies aim to determine what levels of complexity can be <u>omitted</u> from larger-scale modelling; Tony Bowen and Huib deVriend both argue that soundly-based simplicity can only come <u>after</u> proper assessment of complexity. 1D, 2D and 3D models at ISVA have been used to study the influence of dimensionality on sand bar evolution. An important conclusion is that undertow must be included in order to model bar evolution realistically. Also at ISVA a new model of sand spit evolution has been developed. At NPS, non-linear modelling of the influence of wave group forcing has been applied to conditions at Palm Beach, Australia and the results compared with ARGUS imagery. The modelled evolutions over 14 days or so show changes which are remarkably similar to those observed. The study shows no tendency to equilibrium, but the response has features of both forced and free behaviour. Considerable progress has also been made in the application of 'operational' models to large data sets. DHI (Hakeem Johnson) has applied the MIKE models to wave spectra and morphological change observed at Duck, with encouraging agreement with general trends. HR (James Sutherland) has applied COSMOS and PISCES models to the more tidally dominated COAST3D sites, again with encouraging results. In these model/data comparisons the Brier Skill Score, identified by our project as the most suitable for quantifying agreement, has proved its value.

Although the distinction between top-down and bottom up models is false (all models contain elements of both process understanding and empirical parameterisation) studies which investigate the implications of starting with simplified process modelling have also continued at Twente, OSU and Plymouth. At Twente (Nathaniel Plant – now at NRLSSC) and OSU (Rob Holman) the successful bar migration model has been followed up by a study of the influence of morphologic feedback, based on a simplified cross-shore sediment transport model. At Plymouth (David Huntley) investigations of a cellular automata model for beach cusps have been extended to determine sensitivity to regular as opposed to stochastic forcing; the initial growth rate of cusps is highly sensitive to forcing, but the long-term scale and stability of cusp morphology are much less sensitive.

An important aim of this project has been to bring together the different elements of coastal research, specifically the data, top-down modelling and bottom-up modelling. This outline of results shows that we have achieved a great deal in this regard. However there is still along way to go before we can claim to have optimised the prediction of nearshore morphological change, and the project has also been immensely valuable in raising many useful questions which will direct our future research. For example, can the surprising success of simple 'top-down' parameterisations such as the Irribarren number be explained (and extended) through complex process models? Will simple patterns such as linear and crescentic bars and even planar beaches arise as emergent behaviour in complex models? Can we define integral properties of the coastal system which are both robust and useful for coastal management? To what extent are different scales of coastal behaviour linked (ie are there limits to the value of smaller-scale studies for application to larger-scale predictions)? And, from the user perspective, what is the optimum mix for prediction between modelling effort and field data collection? Addressing these and other questions will continue to occupy the partners as they hope to continue collaborative meetings beyond the end of this project.

IMPACT/APPLICATIONS

This NICOP project aims to assess prospects for the understanding and prediction of intermediate and large-scale coastal change. The Final Workshop provided a direct route for the dissemination of our results to a wider audience, primarily of academics but including users and practitioners attending the CD01 Conference.

TRANSITIONS

The project has been instrumental in the development of new programmes of research. The EC-funded HUMOR project described below in the section on Related Projects involves all four of the European partners in this NICOP project and will through them continue to link to the North American participants. A second EC-funded project, CoastView, is also described below and involves two of the four European partners as well as Professor Rob Holman from OSU.

RELATED PROJECTS

The NICOP funds have successfully created collaborative links between US programmes, particularly the Sandy Duck field work, and European projects COAST3D, INDIA, SASME, SEDMOC and SWAMIEE, and have spawned new collaborations particularly in the European projects HUMOR and CoastView.

All four of the European collaborating institutions on this programme are involved in a new EC-funded project entitled HUMOR, which started in February 2001. The overall aim of the HUMOR project is 'to develop reliable assessment and forecasting techniques to better understand, model and predict the physical and geomorphological processes governing medium and long-term natural changes of the coastal zone, including the impact of anthropogenic activities'. The total value of the 3-year project is 2.6 MEuros.

CoastView is another new EC-funded project, co-ordinated by Plymouth and involving two of the NICOP European partners and Prof. Rob Holman from OSU. It consists of a consortium of researchers and users aimed at developing the ARGUS system as a tool for coastal zone management of direct use to managers. The project has a total value of 2.9Meuros and is expected to start early in 2002.

The participants in this NICOP-funded collaboration agreed at the Final Workshop that the four years of collaboration funded through this NICOP project had been very stimulating and productive. We are enthusiastic about seeking ways to continue meeting together in Workshops whenever possible, as the 'Lund Group'. Plans are currently being discussed to meet prior to the next International Conference on Coastal Engineering taking place in Cardiff, UK in July 2002.

PUBLICATIONS (cumulative)

SASME Web page: http://www.wldelft.nl/sasme/sasme.htm
COAST3D Web page: http://www.hrwallingford.co.uk/projects/COAST3D
INDIA Web Page: http://www.pol.ac.uk/jjw/INDIA.html
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