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SID 5 Research Project Final Report

- **Note**
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Project identification

1. Defra Project code: FD2116

2. Project title:
   Review and formalisation of geomorphological concepts and approaches

3. Contractor organisation(s):
   HR Wallingford Ltd
   Howbery Park
   Wallingford
   Oxon
   OX10 8BA

4. Total Defra project costs (agreed fixed price): £ 100,000

5. Project: start date ..... 01 February 2004

   end date ..... 28 February 2005

6. It is Defra's intention to publish this form.
Please confirm your agreement to do so.....**YES** ☒ **NO** ☐

(a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.

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In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

EXECUTIVE OVERVIEW OF PROJECT FD2116
REVIEW AND FORMALISATION OF GEOMORPHOLOGICAL CONCEPTS AND APPROACHES FOR ESTUARIES

The Final Report FD2116/TR2 was prepared by HR Wallingford, ABPmer and Professor J Pethick.

This report describes the outcomes of Defra project FD2116 which has developed a framework for Expert Geomorphological Assessment (EGA) including the systematic development of conceptual models of estuarine systems which can form one basis for prediction. The project has been completed as part of the joint Defra/Environment Agency R&D Programme within the Estuaries Research Programme (ERP).

The report discusses the relevant scales to be considered, issues surrounding the formation of a conceptual model based on data and understanding, and the application of predictive models. These have been achieved and a consistent and formalised approach to the use of geomorphological based methodologies in estuarine prediction has been established. This has the potential to benefit the quality and effectiveness of studies associated with flood defence and estuarine impact.

The EGA approach relies upon collation, synthesis and interpretation of various types of data from estuaries. Key issues associated with data have been reviewed in the present report, together with presentation of a framework for development of a conceptual understanding of estuary morphology. This is necessary to facilitate the understanding of morphological change and the impacts arising from engineering works and other activities. The following steps for a consistent approach have been proposed:

- Scoping of study
- Conceptual model development of estuary
- Prediction of impacts
- Synthesis of impacts
- Draw conclusions (discussion with key parties as required to refine conclusions)
- Presentation of results

EGA and associated methods (described below) can be summarised as the analysis and application of data together with a knowledge of estuarine processes and specific geomorphological tools blended by experience. The basis of the processes and techniques are often well known but can be misapplied if the methodology is not clear, if the range of applicability of the technique is exceeded, or if there are

shortcomings with the data which the technique requires. Furthermore, the assessment of uncertainty in prediction, a vital part of evaluating risk in estuary management, is frequently lacking from EGA studies. Experience plays an important role in allowing the investigator to reduce the risk of misapplication of EGA techniques, but the end user is not always aware that they are benefiting from this attribute. The formalisation of the process as described in this report has led to a clear framework which provides the end user with the opportunity to appreciate and realise such benefits.

For the prediction of impacts there is a range of tools available to investigate estuary process and morphology, as described for example in EMPHASYS (2000a). It is noted that the predictive approaches require careful analysis, validation and expert interpretation. In general terms two classes of approach have been taken to predicting morphological change in estuaries: (1) the "bottom-up" or process-based approaches and (2) the "top-down" or systems approaches. There is a third category of methods, the so called "hybrid" approach which arises from the combined use of "bottom up" and "top down" techniques. The bottom-up component provides an understanding of the forcing processes and the top-down component provides information on the system state and how that state wants to change as the forcing is changed.

The present report draws together and summarises the use and application of, mainly, the top-down class of assessment methodologies that may be considered for use in developing EGA approaches. The study has examined the use and application of assessment methodologies and tools that may be considered for use in EGA, building on the top-down methodologies investigated in the report "Modelling Estuary Morphology and Process" (EMPHASYS, 2000b). The study has developed the assessment of the following tools:

- Historical Trend Analysis (HTA);
- Sediment budget analysis and modelling;
- Estuary translation or Rollover model;
- Geological methods for estuarine studies;
- Regime theory and relationships;
- Entropy-based relationships;
- Tidal asymmetry analysis and relationships;
- Analytical methods and solutions; and
- Intertidal profile form.

The application of these tools has been illustrated using a variety of case studies and, where possible, guidance in the use of the particular assessment tools in terms of their applicability, data requirements, and outputs has been developed.

The applicability of the models for estuary morphology modelling has been summarized and information is provided to aid the selection of method(s) for different studies. Recommendations on how the research can be taken forward, how it can be linked with other projects in the Estuaries Research Programme and developed have been given.

References

EMPHASYS (2000a). A guide to prediction of morphological change within estuarine systems, Version 1B, produced by the EMPHASYS consortium for MAFF project FD1401, Estuaries Research Programme, Phase 1, December 2000. Report TR 114, HR Wallingford.
Download from http://www.hrwallingford.co.uk/projects/ERP/index.html

EMPHASYS (2000b). Modelling Estuary Morphology and Process, produced by the EMPHASYS consortium for MAFF project FD1401, Estuaries Research Programme, Phase 1, December 2000. Report TR 111, HR Wallingford.
Download from http://www.hrwallingford.co.uk/projects/ERP/index.html

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the scientific objectives as set out in the contract;

- the extent to which the objectives set out in the contract have been met;
- details of methods used and the results obtained, including statistical analysis (if appropriate);
- a discussion of the results and their reliability;
- the main implications of the findings;
- possible future work; and
- any action resulting from the research (e.g. IP, Knowledge Transfer).

The main objectives of this project were:

• To review critically the current geomorphological understanding and concepts related to the medium (month-year) to long term (decadal) behaviour of estuaries, and,
• Through formalisation of Expert Geomorphological Assessment and Historic Trend Analysis, to provide a resource for the end user so that he/she can substantially increase the quality of their analysis.

These objectives were met in full and the benefits arising are that a consistent and formalised approach to the use of geomorphology in estuarine prediction has been established. This will improve the quality and effectiveness of studies associated with flood defence and estuarine impact.

In addition to providing a documented and indexed resource for users, the research has also provided underpinning knowledge through achievement of the following scientific objectives:

1. To review the use and application of data used in geomorphological assessment in estuaries
2. To review critically, and produce guidance in, the use and application of geomorphological assessment tools
3. To provide a framework for systematic development of the conceptual models of estuarine systems in geomorphological studies and their use as a basis for prediction of change
4. To undertake case studies demonstrating the results of Objectives 1 to 3
5. To produce the deliverables of the project, including a Technical Report and a Technical Summary
6. To disseminate the results of the study to end users
7. To link and provide support to Broad Scale Modelling projects FD2107 and FD2117
8. To provide a resource that is both user-friendly and peer-reviewed

Objectives 1 to 5 have been met in full. The project Technical Report is a document stretching to more than several hundred pages and the executive summary placed in section 7 gives the main findings. Knowledge has been captured in a standardised format which will allow others to evaluate the applicability of particular methods for their own analysis of estuary geomorphology and geomorphological evolution.

The results have been disseminated to end users through presentations and discussion at a well attended seminar held in London on 25th April 2005 and through the publication and presentation of a paper at the Defra conference in July 2005. Outputs from the research have been carried forwards to the ERP2 project FD2107 on hybrid modelling of estuary morphology. This link was recognised as scientific objective 7 in the listing of possible future work provided in the report.

With reference to scientific objective 8, the project team considered that they achieved a Technical Report that was user-friendly. The report was reviewed rigorously internally within the project by the team of experts, as well as externally by an invited expert reviewer, and by Defra on technical and policy grounds.

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Whitehouse, R., Cooper, N., Pethick, J., Spearman, J., Townend, I. and Fox, D. 2005. Dealing with geomorphological concepts and broad scale approaches for estuaries. Proceedings 40th Defra Flood & Coastal Management Conference, The University of York., July 2005. 06A.5.1- 06A.5.12. www.defra.gov.uk

The project Technical Report has also been publicised through the following website:
http://www.hrwallingford.co.uk/projects/ERP/index.html