General enquiries on this form should be made to:
Defra, Science Directorate, Management Support and Finance Team,
Telephone No. 020 7238 1612
E-mail: research.competitions@defra.gsi.gov.uk

SID 5 Research Project Final Report

- **Note**

  In line with the Freedom of Information Act 2000, Defra aims to place the results of its completed research projects in the public domain wherever possible. The SID 5 (Research Project Final Report) is designed to capture the information on the results and outputs of Defra-funded research in a format that is easily publishable through the Defra website. A SID 5 must be completed for all projects.

  A SID 5A form must be completed where a project is paid on a monthly basis or against quarterly invoices. No SID 5A is required where payments are made at milestone points. When a SID 5A is required, no SID 5 form will be accepted without the accompanying SID 5A.

- This form is in Word format and the boxes may be expanded or reduced, as appropriate.

- **ACCESS TO INFORMATION**

  The information collected on this form will be stored electronically and may be sent to any part of Defra, or to individual researchers or organisations outside Defra for the purposes of reviewing the project. Defra may also disclose the information to any outside organisation acting as an agent authorised by Defra to process final research reports on its behalf. Defra intends to publish this form on its website, unless there are strong reasons not to, which fully comply with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

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Project identification

1. Defra Project code: FD1912

2. Project title: SANDPIT: effects of offshore dredging

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

4. Total Defra project costs: £ 155,352

5. Project: start date ..... 01 November 2001

   end date ..... 30 April 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.

Defra recognises that in a small minority of cases there may be information, such as intellectual property or commercially confidential data, used in or generated by the research project, which should not be disclosed. In these cases, such information should be detailed in a separate annex (not to be published) so that the SID 5 can be placed in the public domain. Where it is impossible to complete the Final Report without including references to any sensitive or confidential data, the information should be included and section (b) completed. NB: only in exceptional circumstances will Defra expect contractors to give a "No" answer.

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.

PROBLEM AND OBJECTIVES

The demand for, and production of, aggregates (sand and gravel/shingle) in Europe has been met traditionally from land-based pits, but in recent years offshore sources have made an increasingly important contribution. The volume of sand required in the near future (10 to 20 years) will be of the order of 100 to 1000 million m^3 per country surrounding the North Sea. Massive mining of sand from large-scale mining and extraction pits/areas in the middle and lower shoreface (depths of 10 to 30 m) will be required in future in many European countries.

Large-scale mining pits will have a significant impact on the near-field and far-field (up to the coast) flow and wave patterns; the flow velocities inside the pit will be reduced and the wave heights may also be reduced, depending on the depth of the pit. As a consequence, the sand transport capacity inside the pit will decrease and sediments will settle in the pit area, resulting in deposition. Thus, the pit may act as a sink for sediments originating from the surrounding areas. Hence, erosion of the sea floor may take place in the immediate surrounding of the pit. This may lead to a direct loss of sediment from the nearshore zone (beaches). Indirect effects result from the modification of the waves moving and refracting over the pit, which may lead to modification of the nearshore wave conditions (wave breaking) and hence longshore currents and sediment transport gradients and thus to shoreline variations. The mining areas need to be situated in the offshore shoreface zone to minimise the effects of nearshore coastal erosion but the mining of sand will be progressively more expensive at greater distances from the shore. Research is required to find the optimum balance between the effect on the coast and the costs of mining.

The technical and environmental evaluation of sand mining activities requires fundamental knowledge of morphological processes, sand transport processes, sand budgets and ecology in the offshore coastal zones. The EU SANDPIT Project was undertaken to gain scientific understanding of the physical (and to a lesser extent ecological) processes involved.

RESULTS AND CONCLUSIONS FROM THE PROJECT

Net and gross annual sand transport rates

The infill and migration of sand excavation pits takes place through the mechanism of sediment

transport, which in turn is driven by the combined effects of currents and waves. Thus the prediction of infill and migration of mining pits depends crucially on the gross and net annual sediment transport rates outside the pit, determined from the annual (or preferably multi-annual) climate of waves and currents. Estimates of gross and net annual sand transport rates have been determined for four contrasting sites in the North Sea, English Channel and Atlantic Ocean..

Models of sand transport are not yet reliable enough to predict the gross and net sand transport rates in coastal seas with sufficient accuracy. Therefore the prediction of the morphodynamic evolution of sand mining pits in coastal seas is not yet sufficiently accurate. The basic cause for this is the lack of reliable field data for deep water in coastal seas. During the SANDPIT Project a new field data set of depth-integrated sand transport rates was obtained. At present this is the only well documented data set of depth-integrated sand transport available for deep water in coastal seas. As one data set is not enough to improve the reliability of the existing sand transport models, more field surveys are required.

Pits in flat bed regions

A comprehensive study was undertaken that involved simulating a series of scenario tests as a means of assessing the variation of key parameters associated with offshore sand mining pits. The most basic question is: *what are the near-field and far-field effects of aggregate extractions?* The scenario tests considered the different pit configuration aspects, including the depth of water, position relative to the coastline, pit volume and pit shape, as well as other aspects such as the ambient current and wave regime and the sediment grain size. Key parameters investigated were the local aspects of changes to the hydrodynamics and morphology in and around the pit, and impacts on the coastline.

The modelling involved the application of sophisticated area models that simulate the predominant hydrodynamic and sedimentological processes and included updating of the bathymetry and evolving the seabed over a period of years. In some cases new techniques were employed in order to apply the models to such long timescales (years to decades). The results provide a quantitative assessment of the impacts of large sand extraction pits both in the vicinity of the pit and at the coastline. The degree of variability in the results obtained by the models used by the various participants, in some cases using the same software, highlights the fact that prediction of sediment transport in the coastal environment is still undergoing development. A mixture of numerical modelling and field data collection is still the best approach to get a reliable, quantitative estimate of the morphological changes in the vicinity (near-field) of sand mining pits. Numerical models without calibration based on field data can be used only to assess the qualitative differences between various pit scenarios.

Pits (excavations) in sand bank regions

In the framework of the SANDPIT Project, both idealized morphodynamic models and numerical morphodynamic models have been applied to investigate the stability conditions of possible mining sites and the effects of sand extraction from different kinds of sand ridges. The most basic question concerns the consequences of sand bank mining activities on the availability of the resource itself: *will the sand bank recover after removing the sand?* Another important question is: *what are the near- and far-field impacts of sand bank mining in sand bank region?* The following guidelines are given:

- Model results show that the infilling of a pit is faster in the case of excavation from the crests of banks than from the troughs, and for the case of deeper excavations.
- Idealized morphodynamic models (based on theoretical bed stability analysis methods), can provide a qualitative evaluation of the different extraction scenarios.
- Numerical models can give quantitative results, but not very accurate information if un-calibrated models are used. The accuracy can be improved considerably by calibrating the model using a trial dredge pit. Long term simulations of near-field and far-field effects may cover a period up to about 25 years.

Ecological processes

Based on a limited literature review, the key effects of aggregate extraction are as follows.

- The recovery time of the sea floor community depends on the extraction method, volume and

intensity, and on the sediment type and the flora and fauna associated with it. Indirect effects related to the sediment plumes, and effects on higher trophic levels, are generally of minor importance and extend over shorter timescales.

- The impact of small-scale sand extraction will be limited in dynamic areas of low ecological importance; most of these sand extractions will be on small space-scales and short time-scales and the community is able to recover within a relatively short period (months to a year). Cumulative effects of several (small) extractions, or small-scale extraction in combination with other functions may have a negative effect on the recovery time scales. No information on the ecological impact of very large sand extractions is available.
- Most of the sediment in the overflow (spill) settles rapidly as a density current below and astern the dredger. The effects of burial on the biota depend on several factors, including the rate of deposition, sediment characteristics and the ability of the benthic organisms to cope with a rapid deposition of sediment. Impact of deposition during sand extraction in sandy habitats is in general believed to be less than the impact of extraction in gravel habitats with many sessile and encrusting epi-benthic species.

POSSIBLE FUTURE WORK

Topics identified for further work include:

- Research for the better understanding of sediment transport rates (especially wave-related sediment transport) and bed roughness in the context of sand/aggregate extraction.
- A project to carry out scenario testing to investigate the variation in model outputs arising from the use of different models used in the UK, and the methods of schematising the model inputs (which were seen to cause as much variation as using different models).
- Development of a standard scheme for classifying bedforms on the seabed, making use of acoustic techniques such as multi-beam data that are used by different disciplines such as sedimentology, geology and habitat mapping. As yet, there is no agreed classification of bedform types.
- Future research projects on sand/aggregate extraction could usefully involve a wide range of relevant disciplines.

PUBLICATIONS AND FURTHER INFORMATION

The detailed and practical results from the SANDPIT Project are presented in a hardbound book with ISBN number: ISBN 90-800356-7-x, available on the site of the publisher (**www.aquapublications.nl**). Websites with information and publications from the SANDPIT project are: **sandpit.wldelft.nl** and **etip.cordis.lu**

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 Project Report has been supplied to Defra as a separate Word document with Figures and Tables embedded as this template was unable to accept it.

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.

Chesher T.J., and Soulsby R.L. (2005). Local and coastal physical impacts of large offshore sand extraction pits. A scenario-testing study using numerical models. HR Wallingford Report TR151.

Diesing, M., Schwarzer, K., Zeiler, M. and Klein, H. (2004). Comparison of marine sediment extraction sites by means of shoreface zonation. J. Coastal Res., Special Issue 39 (Proceedings of ICS 2004).

Hearn, S.J. (2004). European SANDPIT project sand mining experiments. SANDPIT field deployments of ADCP Spring and Autumn 2003. HR Wallingford, Report TR140.

Soulsby, R.L., Chesher, T.J. and Brampton, A.H. (2005). Effects of offshore dredging – results of the SANDPIT project. Proc. 40th Defra Flood and Coastal Management Conference (submitted).

Van Rijn, L.C., Soulsby, R.L., Hoekstra, P. and Davies, A.G. (Eds.) (2005). SANDPIT – Sand transport and morphology of offshore mining pits. Process knowledge and guidelines for coastal management. Aqua Publications, The Netherlands. [The detailed and practical results of the SANDPIT Project are presented in this hardbound book with ISBN number: ISBN 90-800356-7-x, available on the site of the publisher **www.aquapublications.nl**.]

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