Dealing with sandy coasts – new methods from SANTOSS research project

Project Summary SC060027/S1

A new way of calculating sand movement across the sea bed near coastlines should help coastal managers and others to better understand and predict how sand shifts along coasts, according to a new report by the Environment Agency.

Many activities in coastal management, science and engineering need to consider the impact of the movement of sediments in the coastal zone, due to natural processes or as a result of engineering or other works. This report presents the results of a project to improve our understanding of aspects of sediment (primarily sand) transport in the coastal zone.

The research project SANTOSS, run by a consortium of UK and Dutch universities with funding from UK and Dutch research councils, aimed to improve our understanding of and ability to predict sand movement in the coastal zone. The Environment Agency hired HR Wallingford to represent its interests on the user group of the project, to interpret the research results in practical terms, and to produce this report to share the research results with other professionals.

The project was primarily concerned with the "sheet-flow" regime of sand transport. This occurs at the sea bed under the action of very large storm waves, which produce a slurry of water-sand mixture at the sea bed which is swept back and forth by the wave velocities, and carried by tidal, wave- or wind-driven currents that carry the slurry of sand with them, or by asymmetries in the wave motion that result in a net drift of sand. These sheet-flow conditions are not well understood, and yet they carry vastly more sand than occurs over a rippled sea bed. Although extreme storm conditions are rare, they can have a disproportionate impact on the long-term sand transport, and hence on the shape of beaches and the adjacent sea bed. The sediment transport formula developed in this project applies equally to moderate conditions (rippled beds) and extreme conditions (sheet flow).

The research was carried out using laboratory experiments and numerical computer modelling. The main outcomes of the project are summarised below.

The report describes the aspects of research which have a direct bearing on practical management, science and engineering issues, and explains how they can be used. These are as follows.

When carrying out desk studies of coastal issues, a new formula (the SANTOSS formula) is available as MATLAB computer code to calculate the transport rate of sand. It includes processes not considered in most previous formulae, and hence is expected to give more accurate and realistic estimates of sand movement, especially in the shallow nearshore region where waves become steep and forward-leaning as they approach breaking.

A large database of laboratory observations of suspended sediment transport rates under large simulated wave conditions is now available. If the sediment and wave conditions at a study site match those in the database, the latter can be consulted to give direct estimates of sediment behaviour for coastal studies requiring such information.

If physical modelling is run in connection with a coastal study, be aware that oscillating water tunnels (used in lab studies) may underestimate net sediment transport rates by up to a factor of two compared with equivalent measurements in large (near full-scale) wave flumes and, for certain cases with fine sand, even the direction of transport can be reversed. The tunnels do, however, more accurately simulate near-bed behaviour than could be produced in small wave flumes.

If a large field measurement study is done as part of a coastal study, it would be useful to take detailed measurements of wave orbital velocities, to obtain measures of the asymmetries in velocity and acceleration required as inputs to the SANTOSS sediment transport formula.

When advocating numerical modelling, make use of the SANTOSS sediment transport formula at the heart of coastal profile models or coastal area models for studies in which its strengths are appropriate and its limitations are not important. Integrating the formula into such models is best tackled by modellers familiar with the individual models. The strengths and limitations of the formula are outlined in the report.

The new SANTOSS formula has advantages over older methods in that it covers a wide range of wave, current and sediment conditions, is based on a large dataset, can handle extreme (sheet-flow) as well as moderate (rippled-bed) conditions, and incorporates a wide range of physical processes.

The report serves a second function in that it describes, in terms aimed at coastal managers, physical processes involved in the near-shore zone, types and capabilities of coastal numerical models, and descriptions and capabilities of sediment transport prediction methods.

The report is aimed at coastal managers, engineers and scientists working in the Environment Agency, Department for Environment, Food and Rural Affairs (Defra), local authorities, harbour authorities, energy providers and engineering consulting firms. Within the Environment Agency it may also be of interest to scientists, policy-makers, asset management staff, and those with an interest in the take-up of research.

Activities that might be assisted by this report include planning, assessment and design of coastal defences; wind farms and other nearshore technology; harbour and marina developments; and dredging and reclamation, including beach nourishment and use of beach control structures.

This summary relates to information from project SC060027, reported in detail in the following output(s):

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