Marine aggregate dredging; Friend or foe of the coastline?

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1 Introduction

In the UK, particularly in southern and south-eastern parts of England and in South Wales, sand and gravel dredged from the offshore seabed makes an important contribution to the aggregate needs of the construction industry. In addition, sediments from the seabed have been used to carry out numerous hydraulic fill schemes for important industrial or commercial development, and to supply beach recharge schemes. Marine aggregate dredging also reduces the need for new inland sand and gravel pits, which are rarely popular developments.

In addition, the use of large dredgers not only to collect but also to transport large quantities of sand and gravel, often delivering them to wharves in major cities, reduces heavy goods vehicle movements and reduces the costs of transport of these very bulky materials. Despite these advantages, there are very few other marine activities that engender so much concern about their possible adverse impacts, not only in and close to the dredging areas but also further afield.

This keynote lecture reviews the continuing debates about and research into the environmental effects of marine aggregate dredging, with particular emphasis on the potential changes along or close to coastlines.

2 Methods

A variety of methods have been applied, over many years, both to assess the consequences of dredging already carried out and to predict changes that proposed future dredging may cause. The earliest approaches were empirical, often based on unfortunate experiences, for example following errors of judgement in allowing dredging too close inshore.

In the 1960s and 1970s, greater insight into the movements of sediment over the seabed in and around proposed dredging areas was gained by means of field data collection, principally by using radioactive tracers. At about the same time, early computer modelling of wave refraction was being used to assess how dredging for aggregates, or of navigation channels, could affect wave conditions well away from the deepened areas of the seabed.

In recent times, the understanding of natural hydrodynamic and seabed sediment processes has increased rapidly. This together with more detailed computer modelling has led to the assessments of the effects of dredging becoming more sophisticated. In addition, detailed monitoring of changes in and around aggregate extraction areas has provided not only important data on the dredging activities and their effects, but further useful information on natural sediment transport and morphodynamic processes operating on the seabed.
3 Results

The results presented here come from:

- The modelling of the hydrodynamic and sediment transport regime of the region surrounding a proposed dredging area and the predictions of the changes to those regimes that dredging will cause, and
- Monitoring of the changes in and around the extraction area as dredging proceeds, and the analysis of the survey data collected.

Much of the modelling and analysis of proposed dredging is publicly available and can be used for other planned coastal or offshore, e.g.:

- Predictions of extreme offshore wave conditions and illustrations of how they propagate inshore;
- Simulations of tidal propagation, simulating water levels and currents at any location;
- Evidence for and predicted rates of regional sediment transport over the seabed;
- Evaluation of the underwater extent of beaches, and of sediment transfers between them and the seabed.

A large number of studies predicting the effects of proposed dredging have led to general conclusions that provide an initial assessment of future similar dredging plans, namely:

- In depths greater than about 15m below lowest tidal level, the net sediment transport direction is dominated by tidal currents and scarcely altered by wave action;
- Changes in tidal currents caused by aggregate extraction are typically insignificant outside an area having diameters roughly twice that of the dredged area;
- Changes in the natural patterns and rates of sediment transport caused by aggregate dredging will be restricted to a similar “near field” zone;
- Noticeable changes in extreme wave conditions can extend rather further from dredging areas, but, such changes are not predicted to extend as far as the coastline.

Monitoring of seabed levels in and around dredging areas, and sometimes even on beaches, has provided further evidence that is used to validate computer modelling of the effects of aggregate extraction, improving confidence in future assessments. In particular, this monitoring has typically shown:

- Little or no evidence of any infill of dredged areas where the natural seabed was of gravel or gravelly sand;
- No discernable changes in bed levels outside dredged parts of such areas;
- Rapid infill, and little or no measurable change in bed levels, surrounding dredging areas situated on or close to tidal sandbanks;
- No evidence of atypical changes in beaches or coastlines closest to aggregate dredging areas.

4 Discussion and conclusions

Offshore dredging has made a significant contribution in supplying the demand for high quality aggregate in England and Wales. Necessarily, such dredging disturbs and damages the natural seabed, and the resulting increases in water depth alter tidal currents, waves and sediment transport close to each dredging area.
However, a large number of studies have concluded that any changes are very limited in spatial extent and do not extend as far as any coastline for any aggregate dredging area licensed in the last 20 years or so. In addition, detailed surveys have shown no changes in bed levels around dredging areas and, where such dredging takes place in immobile deposits of gravel and sand, no evidence of infill of the dredged depressions.

Despite this extensive body of work, and the undoubted benefits of beach recharge sourced from offshore dredging areas, the generally negative public perception of aggregate extraction has not greatly altered over that same period. The commonest concern is that such dredging will result in beach sediments being draw-down into the dredged areas by a combination of wave stirring and gravity. This is a consequence of a single licence, where about 100 years ago, dredging was permitted landwards of the toe of a shingle beach at Hallsands in Devon. Limits were placed on aggregate dredging areas to prevent this occurring again ever since, but despite this and a very conservative approach in assessing each new application for offshore dredging over the last 40 years, the same concerns are still raised today.

It is intriguing that so much research and analysis has failed to counter the convenient myth that connects coastal erosion and offshore aggregate dredging in the UK. As a result, it is questionable if further similar but more detailed and expensive efforts would be any more successful, or whether other approaches are needed to improve understanding and allay fears.

5 Bibliography


Inman D L and Rusnak G S, 1956. "Changes in sand levels on the beach and shelf at La Jolla, California". US Army Corps of Engineers, Beach Erosion Board, Technical Memorandum No.82.

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