The Earth in our hands

- how geoscientists serve and protect the public

12 MARINE AGGREGATES

About these briefings

The Earth is a dynamic planet. It is active and productive, offering humanity enormous opportunities. However, living on it also presents us with many dangers; some of our own making.

In our interaction with the Earth, geoscientists are in the front line. They seek and find the raw materials we use for agriculture, roads, buildings, energy, water supply and all the industries that provide wealth and health.

Geoscientists help society understand natural hazards and mitigate their effects. Such dangers include floods, landslips, volcanic eruptions and earthquakes.

Geoscientists also help to minimise hazards we have created (or made worse) by our activities. These include subsidence, and the disposal of waste.

With their unique understanding of the immensely long time spans over which Earth processes operate, geoscientists help communities world-wide to learn how to use the planet's resources safely, wisely, and sustainably.

This series of information sheets is dedicated to bringing this role to public attention.

Further information

- *British Marine Aggregate Producers Association (BMAPA), **www.bmapa.org**
- Quarry Products Association (QPA) **www.qpa.org**
- Joint Nature Conservation Committee **www.jncc.gov.uk**
- English Nature **www.english-nature.org.uk**. See also **www.english-nature.org.uk/uk-marine** - CAPS project to establish management schemes on selected UK marine Special Areas of Conservation (2001)
- *Marine aggregate dredging and the historic environment* (British Marine Aggregate Producers Association and English Heritage)
- *Regional Environmental Assessment for Aggregate Extraction in the Eastern English Channel* (non-technical summary January 2003) East Channel Association (ECA) **www.eastchannel.info**
- The Marine Biological Association of the UK promotes scientific research into all aspects of life in the sea **www.mba.ac.uk**
- English Heritage science **www.english-heritage.org.uk**
- The Crown Estate, owned by the Sovereign, oversees 55% of the foreshore and all seabed out to the 12-mile limit. **www.crownestate.co.uk**
- Office of the Deputy Prime Minister, Eland House, Bressenden Place, London SW1E 5DU **www.odpm.gov.uk**

The Earth in our hands

Published by:
The Geological Society of London
Burlington House
Piccadilly
LONDON W1J 0BG
Tel: +44 (0)20 7434 9944
Fax: +44 (0)20 7439 8975
Email: enquiries@geolsoc.org.uk
Web site: www.geolsoc.org.uk

© The Geological Society of London. Any part of this document may be reproduced free of charge, but with acknowledgement.

Further copies are available on request (preferably by email). Individual copies are free, and will be posted anywhere without charge. Multiple copies attract both charge and postage. Please contact the Society if you wish to order more than one copy. All leaflets in this series can now be downloaded free as colour PDFs from www.geolsoc.org.uk.

Series Editor: Ted Nield
Written by: Cally Oldershaw

The Geological Society gratefully acknowledges the assistance of its External Relations Committee (Chair, Dr Hazel Rymer) and the following scientists, who (in a personal capacity) read and commented on earlier drafts of this briefing.

Alan Brampton
Elizabeth Clements
Richard Fox
Richard Griffiths
Mark Russell
Rick Stevenson (ERC)

The Geological Society gratefully acknowledges the assistance of the British Marine Aggregate Producers Association (BMAPA) in providing illustrations for this leaflet.

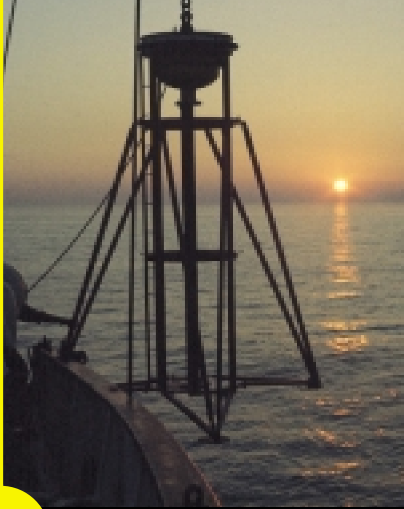
August 2003

The Geological Society of London is a Registered Charity, No. 210161

The Geological Society

The Earth in our hands

- how geoscientists serve and protect the public



12 MARINE AGGREGATES

What are marine aggregates?

Marine aggregates are sand and gravel dredged from the seabed. (See also *EIOH 11, Aggregates*). As early as the 1550s, marine sand and gravel were being extracted from the River Thames. By the 17th Century, providing ships' ballast from marine sources had developed into a major operation controlled by Trinity House (London), the profits of which financed lighthouses, lightships and buoys. The modern industry can be traced back to the 1930s and the first suction dredgers with pumps mounted on deck, and a suction pipe deployed over the side.

One major use for marine aggregate is to replenish eroded beaches.

BMAPA

Why we need marine aggregates

Marine aggregates are an important resource, and supplement land-won and recycled aggregates in meeting the UK's total aggregate needs (see *EIOH 11, Aggregates*).

Marine aggregates from UK licensed areas contribute about 7% of UK construction needs. They are low-cost bulk materials, large quantities of which can be transported to supply demand in distant markets. Of total sand and gravel needs, marine sources supply:

- 22% in England and Wales
- 36% in London and the South East, and
- 90% of the demand for sand in South Wales.

BMAPA

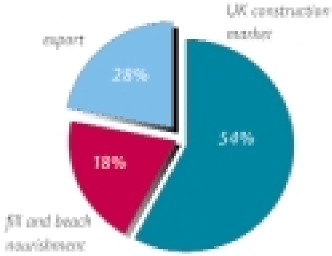


Fig 1: Use of marine aggregates

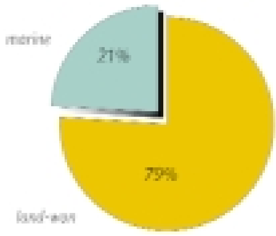


Fig 2: The sand and gravel needs of England & Wales (5-year average)

Fig 3: Licensed areas for marine aggregate dredging

The Geological Society

The three broad markets supplied by the UK marine aggregates industry are:

- landings to uk ports for construction
- landings to continental european ports for construction
- beach replenishment.

During the late 1980s annual production peaked at 27 million tonnes, but in recent years this has stabilised at around 23 million tonnes.


BMAPA

Marine sand is also used in:

- water filtration
- golf course bunkers
- steel making
- agricultural drainage
- glass manufacture.

Marine aggregates offer several advantages.

- fewer quarries – current UK marine aggregate production is equivalent to operating 50 land-based quarries.
- reduced traffic – a typical dredger can deliver the equivalent of 250 truckloads of aggregate. Every day, 15,000–20,000 tonnes of marine aggregate are delivered into landing points along the River Thames (equivalent to 1000 20-tonne truckloads). Rail deliveries from London wharves equate to 50,000 truckloads.
- they require less cement to make high-quality concrete than many other aggregates.

Aggregate reserves – where, and why?

Offshore aggregate deposits occur where they do because of geological history. Marine sands and gravels are mainly found along the courses of ancient rivers, formed during the last Ice Age, when sea levels were much lower than they are now. Their sediments were submerged and reworked by rising sea levels as the glaciers melted (c.15,000 years ago). Marine aggregates are therefore localised – the floor of the sea is not the same everywhere and, as on land, the resource can only be worked where it is found.

The largest market region supplied by the industry borders the southern North Sea, including wharves along the south east coast of England from Ipswich to Poole and the Thames and Medway rivers. It also includes landings to near-continental Europe (mainly Holland and Belgium, with some to northern France). The total volume of marine sands and gravel received by the Southern North Sea region amounts to around 17 million tonnes per year, of which 10 million tonnes are delivered to the UK. A further four million tonnes are supplied to local markets in the northeast of England, the Bristol Channel and around the Irish Sea.

Since the mid-1990s, over 20 million tonnes have been supplied to coastal defence projects, particularly for "beach recharge" (replacing sand and gravel washed offshore). As sea levels rise, this use is likely to become increasingly important (see below).

Licences and environmental assessment

Marine aggregates are finite and require careful management. The marine aggregates industry carries out regular exploration and mapping of the seabed, in order to understand reserves within existing licence areas and identify new ones.


BMAPA

Licence areas correspond to the localised nature of the geological processes that formed the resources. Many existing licence areas (e.g., off the east coast of England, Thames Estuary) have been dredged for over 30 years. As a result, commercial resources of sand and gravel are becoming exhausted, and in places only three to seven years' supply of coarse aggregate remains. As the resources become sandier, production difficulties and loading times increase and quality declines.

To replace these old resources the industry is now looking to dredge deeper waters such as those of the eastern English Channel (c. 30km south of Beachy Head). Companies seeking such permission must make an application to the Office of the Deputy Prime Minister (ODPM).

Licence applications follow a process that includes preparing a comprehensive environmental assessment. Permission to dredge will only be given if the ODPM issues a favourable "Government View" following extensive consultation with a wide range of stakeholders. The Crown Estate issues licences to dredge once a favourable Government View has been given.

The role of the geologist

In assessing marine aggregate resources, the geologist will look at the ratio between sand and gravel, the lithology (rock type) of the gravels, the grading of the sand and the silt, clay and shell content (See also *EIOH 11, Aggregates*). The geologist also has a key role to play in carrying out environmental assessments:

- mapping seabed morphology and sediment type
- mapping coastal morphology and rock type
- assessing changes in seabed and coastal morphology using records and earlier maps.

The role of the marine aggregate geologist involves:

- prospecting (i.e. looking for new sand and gravel resources)
- licensing – developing newly identified resources through the "Government View" system. This includes Environmental Impact Assessment (EIA), incorporating coastal impact and sediment transport to assist habitat/biotope mapping.
- resource management – managing production and quality; monitoring how the requirements attached to a licence permission are fulfilled.

Environmental concerns

Large-scale dredging operations will have environmental consequences. Typical concerns are that such dredging might damage archaeological interests, cause coastal erosion, adversely affect fishing and marine life, not only within the extraction area but further afield, as a consequence of turbidity.

Physical environment

Marine aggregate dredging raisesconcerns that:

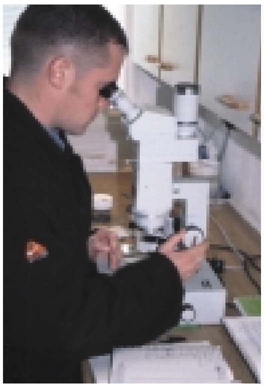
- waves and tides may be altered by changes in the sea-bed and increase the potential for erosion
- beaches will shrink as dredging removes or interrupts natural sediment transport processes supplying them
- beaches will be "drawn-down" into the dredged depressions, to replace the sand and gravel removed by dredging
- the character of the seabed in the dredging area will be permanently altered, hence reducing its habitat value.

The changed water depths after dredging do have a local effect on waves and tidal currents, but dredging takes place so far offshore that these changes are unlikely to extend to the coastline.

Changes to waves crossing a dredging area could influence a much larger area. However, dredging occurs in waters so deep that waves are insensitive to the modest change in seabed level. This effect is routinely studied using computer simulations, to ensure that no changes in shoreline wave conditions will occur.


BMAPA

In most cases, sediment transport is from the coastline into deeper water, so it is unlikely that offshore dredging will disrupt supply of sand or gravel to a beach. However, to guard against this, regional studies of the natural movements of seabed sediments are undertaken, often in co-operation with local maritime councils. These provide a better understanding of the origins and transport of the seabed sediments, and how they relate to the dynamic processes and long-term evolution of the coastline and its beaches. Global trends are also important in modelling. For example, increased storminess associated with global warming will have deflating effects on our beaches.


BMAPA

Turbidity is routinely included in assessments of environmental effects of dredging operations. Even when some dredged sediment is returned to the seabed after sorting, the amount suspended in the water column remains large only for a short period as the dredger passes, extending over a narrow strip either side of its path. Soon after the vessel moves away, concentrations of sediment fall to levels comparable to natural ones – e.g., during storms. Deposition outside the extraction area typically does not extend more than a few hundred metres "down tide".

After dredging, the seabed reverts to a relatively flat area with a sediment cover mainly consisting of sand and fine gravel (coarser gravel having been removed) and often difficult to distinguish from natural, undisturbed seabed surrounding the extraction area.

There are three levels at which environmental concerns are addressed:

- **The licence application process.** Numerical modelling undertaken as part of the environmental impact process is used to assess the implications of a new dredging licence (changes to waves, tides and sediment processes). If these indicate significant changes to natural processes, the licence is refused.
- **Mitigation and monitoring.** Once a licence is issued, where concerns for the physical environment have been identified, comprehensive mitigation and monitoring will be required. Should any of these indicate significant effects, dredging operations can be suspended immediately.
- **Research.** By developing understanding and knowledge on specific issues, their significance can be assessed with greater confidence and appropriate mitigation and monitoring measures identified.

The biological environment

There are also concerns are for the life and biodiversity of an area.

- Fine sediments may may become suspended, clouding the water and affecting habitats and biodiversity
- Dredging noise may affect species
- Fishing may be affected by physical changes to the sea-bed
- Organisms may be removed and the habitat changed

Concern focuses at two scales:

- *Direct effects* resulting from removal of sand and gravel – loss of habitat, benthos (bottom dwelling organisms) and change in seabed sediments.
- *Indirect ('far-field') effects*, mainly from the dispersion of fine sediment by tidal currents and natural bed load transport to areas far from dredging activity.


BMAPA

Studies have been carried out to assess how quickly and in what sequence species recolonise shallow water areas after dredging. Probable recovery time is c. 2–3 years. Different or additional species may also take the opportunity to colonise dredged areas.

In deeper waters, scallops, starfish and shore urchins are particularly common on the seabed with worms beneath the surface. The environment is relatively stable and recolonisation will probably take longer (c. 4–6 years, although some species may return immediately) than in shallow waters, where wave action regularly disturbs the seabed.

As with concerns over the physical environment, these issues are addressed at three levels.

- **The Licence Application process.** Collection of baseline environmental data (benthos, seabed sediments) informs a comprehensive assessment of the existing environment and the potential effects of dredging (direct and indirect).
- **Mitigation and monitoring.** Minimisation of the area available to be dredged/actually dredged – i.e. minimising the "impact footprint". Although an area licensed is c.1400km^2, only 180km^2 may be dredged in a year. Of this, 90% of actual activity can be linked to just 13km^2. Exclusion zones can protect sensitive areas. Hi-tech monitoring can be used to check impact predictions.
- **Research.** Studies have demonstrated that dredged areas do recover, though the timescale can vary from 2-8 years depending upon site-specific conditions.

Fisheries issues can be broken down into:

- **Fish stocks** – i.e. the potential to reduce fish numbers, affect spawning or cause "avoidance behaviour" (frightening the fish off).
- **Fishing activity** – either through reducing stock levels (directly or through knock-on effects reducing spawning potential), changing the distribution of stock ("avoidance") or probably most significantly, through spatial conflict between the respective activities.

In terms of solutions, the fish stocks are principally addressed through minimising the dredged area (the "footprint"), and avoiding areas of particular sensitivity – e.g., spawning areas or migration routes. Dredging may be restricted in time or extent to mitigate its effect.

From the perspective of fishermen, the spatial aspect of dredging operations is particularly important to reduce the potential for conflict between the two sea users. This is largely achieved through regular liaison and the dissemination of accurate information relating to zoning schemes. Codes of Practice for operational liaison are in place. BMAPA and The Crown Estate have voluntarily introduced a national series of zoning charts.

Interaction with other marine interests

The main potential for conflict lies in simple competition for sea space. The nearshore (up to 12 nautical miles from the coastline) environment is particularly heavily used for general navigation, ports, oil and gas, pipelines, cables, fisheries activity and more recently, offshore wind farms.

Marine aggregate dredging may also interact with recreational activity e.g., diving or yachting. More recently, issues associated with our maritime cultural heritage have also arisen – e.g., shipwrecks and prehistoric sites associated with landscapes submerged by rising sea levels – the very process that has preserved many of the aggregate resources themselves (see above). Other concerns include destruction of prehistoric artefacts and cables/pipelines etc.

Liaison and communication between sea-users is very important in order to reduce the potential for conflict between existing aggregate extraction operations and new applications. Marine archaeology has been addressed through the preparation of a Guidance Note by the marine aggregate industry and English Heritage. This is to be followed by a standard protocol to ensure that artefacts recovered through the dredging process are correctly reported.

Where wreck sites are known, they can be avoided, but other artefacts may be damaged or possibly removed and landed at aggregate wharves by dredgers. Where disused and active cables are well documented they can be avoided.


BMAPA

Future trends

If the contribution that marine aggregates make to the construction industry is to be sustained, with all the advantages this brings (see above), new licences will need to be issued to replace those nearing exhaustion.

As sea levels rise over the coming decades, it is likely that marine dredged aggregates will play an increasing role in supplying sand and gravel for soft-engineered beach replenishment and coastal defence projects.