In search of marine sand
– benefits of an European index

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GeoSeas October 9 2012
Content

• Importance of sea bed sediment maps and start of data exchange
• Applications of marine sand and gravel
• How much marine sand Europe needs annually?
• Methods for exploration of the resources
• Benefits of the European indexes
• Sources of marine sand and gravel
  – Mechanisms of supply
  – Sea bed dynamics
Sea bed sediment map of M. Delesse, 1872

Based on hydrographic publications

Sea bed sediment map of the British Fisheries researcher O.T. Olsen, 1883

Based on data of measurements with a leadline ("Soundings") and bottom trawls

Sea bed sediment map of J. Tesch, 1911

Based on map of O.T. Olsen, data from fishermen, the German Navy vessel Drache 1884 and the German research vessel Poseidon, 1902-1905
Sea bed sediment map southern North Sea Jarke (1955)

Based on all available information and data of 3000 sea bed samples

J. Jarke, 1956, Deutsches Hydrografisches Zeitschrift, 1956
EEZ North Sea 1968
Start of marine investigation programmes per country
Applications of marine sand and gravel

- Coastal extensions and islands
- Landfill
- Beach nourishment
- Burial of pipelines
- Industrial use for concrete and mortar sand
Extraction of marine sand: c. 93.5 million m$^3$ (ICES 2012)

<table>
<thead>
<tr>
<th>Country</th>
<th>2011</th>
<th>Industrial</th>
<th>Infill</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>6 990 045</td>
<td>2 778 298</td>
<td></td>
<td>3 477 343</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>2 600 000</td>
<td>2 700 000</td>
<td></td>
<td>7 500 000</td>
</tr>
<tr>
<td>Estonia (2010)</td>
<td>ND</td>
<td></td>
<td>c. 200 000</td>
<td>c. 200 000</td>
</tr>
<tr>
<td>Finland</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>France (2010)</td>
<td>ND</td>
<td>2 595 000</td>
<td>ND</td>
<td>2 595 000</td>
</tr>
<tr>
<td>Germany (North Sea + Baltic Sea)</td>
<td>ND</td>
<td>1 000 972</td>
<td>1 555 598</td>
<td>2 556 570</td>
</tr>
<tr>
<td>Greece</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>ND</td>
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<td>ND</td>
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<tr>
<td>Iceland</td>
<td>ND</td>
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<td>ND</td>
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<td>Italy</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>ND</td>
<td></td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>119 000</td>
<td></td>
<td></td>
<td>119 000</td>
</tr>
<tr>
<td>Netherlands</td>
<td>37 293 360</td>
<td>2 896 273</td>
<td>22 574 299</td>
<td>62 763 932</td>
</tr>
<tr>
<td>Poland (2010)</td>
<td>970 923</td>
<td></td>
<td></td>
<td>970 923</td>
</tr>
<tr>
<td>Portugal + Azores</td>
<td>600 000</td>
<td>126 381</td>
<td></td>
<td>726 381</td>
</tr>
<tr>
<td>Spain (2010)</td>
<td>200 000</td>
<td></td>
<td></td>
<td>200 000</td>
</tr>
<tr>
<td>Sweden</td>
<td>95 562</td>
<td></td>
<td></td>
<td>95 562</td>
</tr>
<tr>
<td>Turkey</td>
<td>ND</td>
<td>c. 3 300 000</td>
<td></td>
<td>3 300 000</td>
</tr>
<tr>
<td>UK</td>
<td>99 585</td>
<td>11 753 015</td>
<td></td>
<td>11 852 600</td>
</tr>
</tbody>
</table>
Example of standards used in The Netherlands

**Beach nourishment:**
No specific standard.
Grain size depending on the natural grain size of the beach

**Infill sand:**
No specific standard.
D50 ± 220 micron

**Concrete sand**

**Mortar sand**
Methods for detecting extractable sand resources
Seismic methods
Sea bed sampling equipment

Boxcorer
Undisturbed sample
0 - 50 cm

Vibrocorer
Undisturbed
Sample 0 - 6 m

Disturbed sample
Van Veen grab
0 - 20 cm
Side scan sonar
Ground truthing with superficial samples

- Sandribbons
- Water depth
- Gravel bed
- Sea bed
Single channel seismic record
Correlation with vibrocores
Single channel seismic record

Record with outcrops of basement in a sand extraction area. Correlation with lithological information of vibrocores
www.eu-seased.net

Your guide to meta-databases:
2.5 million line km of marine seismic information

Operational since 2005

Your guide to seabed samples from the ocean basins and European continental waters, and to seismic lines from the European seas, held at European institutions.

Your guide is a result of the EU supported projects EU-SEASED, EUROSEIS, CONTAIN, and EUROCORES.

This initiative is supported by the European Commission.
GeoSeas 2012

Usefull data for sand search on-line available:

• Geological data: point & gridded
• Grab samples
• Bathymetry: tracking & gridded + swath
• Borehole: images
• Seismics: digital data & scanned images & navigation
• Side scan sonar images
• Maps: data products
Some examples of use of available information for sand search
Sea bed sediment information

Sea bed sediment map of UK, German and Dutch sectors

Folk classification

British Geological Survey

GeoZentrum Hannover

The above classification is based on that of R.L. Folk, 1954, J. Geol., 62 pp344-559.
Detailed Sea bed sediment information Dutch sector

Wentworth classification

<table>
<thead>
<tr>
<th>φ scale</th>
<th>size range</th>
<th>Wentworth name</th>
</tr>
</thead>
<tbody>
<tr>
<td>-8 to -</td>
<td>266 – 64 mm</td>
<td>boulder</td>
</tr>
<tr>
<td>-6 to -6</td>
<td>64 – 256 mm</td>
<td>cobble</td>
</tr>
<tr>
<td>-5 to -6</td>
<td>32 – 64 mm</td>
<td>pebble</td>
</tr>
<tr>
<td>-4 to -5</td>
<td>16 – 32 mm</td>
<td>pebble</td>
</tr>
<tr>
<td>-3 to -4</td>
<td>8 – 16 mm</td>
<td>pebble</td>
</tr>
<tr>
<td>-2 to -3</td>
<td>4 – 8 mm</td>
<td>pebble</td>
</tr>
<tr>
<td>-1 to -2</td>
<td>2 – 4 mm</td>
<td>granule</td>
</tr>
<tr>
<td>0 to -1</td>
<td>1 – 2 mm</td>
<td>very coarse sand</td>
</tr>
<tr>
<td>1 to 0</td>
<td>0.5 – 1 mm</td>
<td>coarse sand</td>
</tr>
<tr>
<td>2 to 1</td>
<td>0.25 – 0.5 mm</td>
<td>medium sand</td>
</tr>
<tr>
<td>3 to 2</td>
<td>0.125 – 0.25 mm</td>
<td>fine sand</td>
</tr>
<tr>
<td>4 to 3</td>
<td>0.0625 – 0.125 mm</td>
<td>very fine sand</td>
</tr>
<tr>
<td>5 to 4</td>
<td>0.03125 – 0.0625 mm</td>
<td>silt</td>
</tr>
<tr>
<td>6 to 8</td>
<td>0.016 – 0.03125 μm</td>
<td>clay</td>
</tr>
<tr>
<td>7 to 10</td>
<td>0.008 – 0.016 μm</td>
<td>colloid</td>
</tr>
</tbody>
</table>

Folk classification

Geological Survey of The Netherlands
Detailed data German and Danish sectors North Sea

Map showing thickness of sand deposits
M. Zeiler, J. Schulz-Ohlberg & K. Figge BHS, Hamburg

Lithological map Danish sector
Leth et al. 2010) Geus

Lithological map Danish sector
Leth et al. 2010) Geus
Morphology of the sea bed based on bathymetric data

The Netherlands

Image of sandwaves by multibeam
Mobility of sand waves based on bathymetric data

Automated method to analyze the morphology and dynamics of bed forms.
Mechanisms transporting sand and gravel into the marine environment
Mechanisms of sediment supply in the North Sea

- Coastal erosion
- Transport by ice (wind)
- Delta Rhine and Meuse

Thickness Quaternary

Eridanos delta
Growing Eridanos delta

Reached the North Sea c. 12 million years ago.
Destroyed by glaciers c. 700,000 years ago
Conclusions:

Benefits of the indexes by:

• Planning of areas for surveying of sand resources
• Preparing preliminary maps of the area by existing data
• Reducing high surveying costs

Recommendation:

• Including grain size and other laboratory analyses
Thank you for your attention