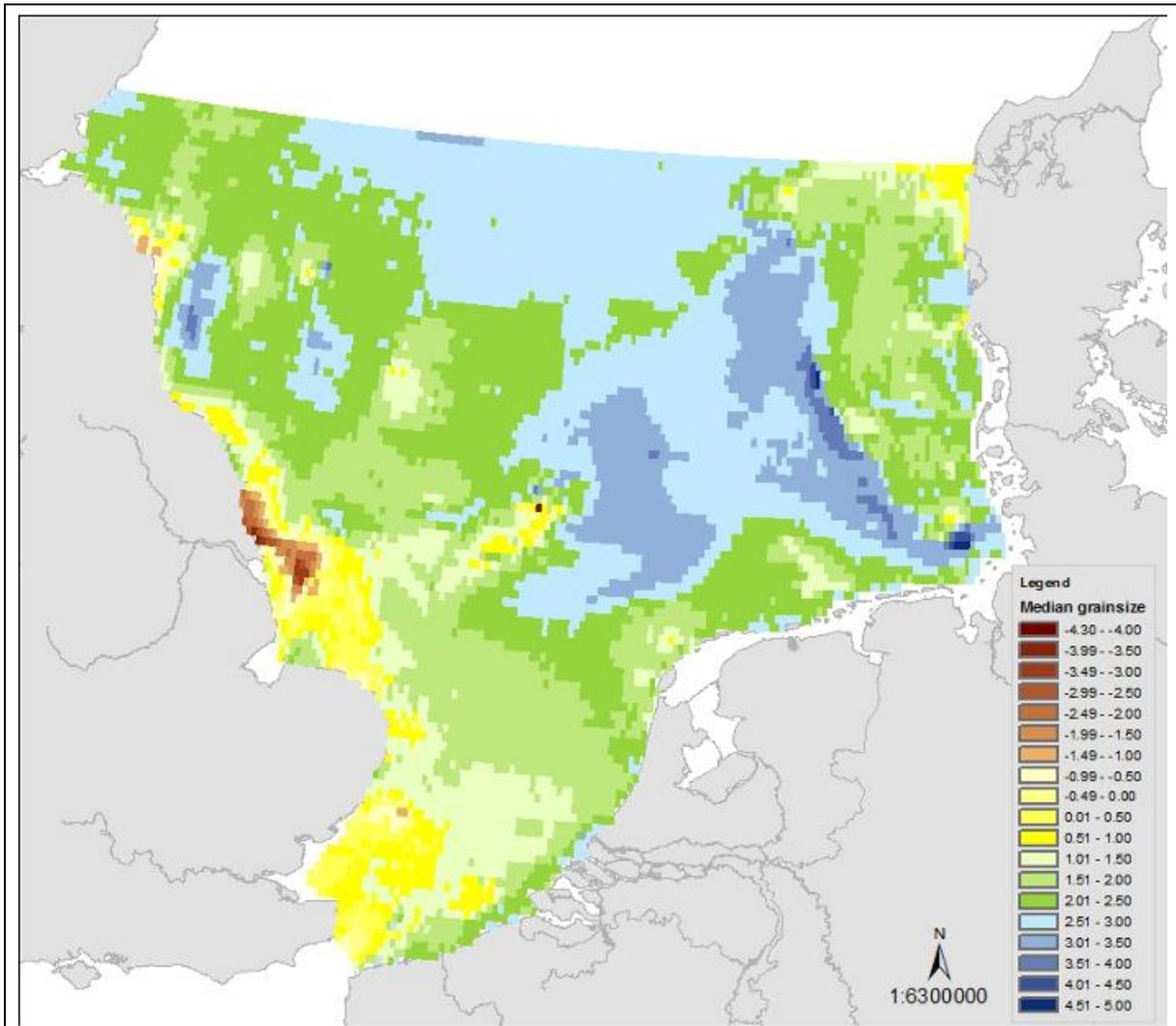


## Median grainsize

GENERAL OVERVIEW	
<b>Dataset name:</b> <i>Grainsize analyses of surface sediments of the North Sea mapped for the median grainsize</i>	
<b>Project:</b> <i>North Sea – Observation and Assessment of Habitats (NOAH)</i>	
<b>Co-Principal Investigator:</b> Walter Puls , Frank Bockelmann, Ulrike Kleeberg (Web Services and Metadata)	
<b>Contact:</b> <i>Helmholtz-Zentrum Geesthacht (HZG), Max-Planck-Straße 1, 21502 Geesthacht, Ulrike.Kleeberg@hzg.de</i>	
DATASET SPECIFICATIONS	
<b>Dataset Parameter(s) and supplied Unit(s):</b> <i>Median Grainsize [Phi scale]</i>	
<b>Date(s) available:</b> --	
<b>Validated:</b> <i>See Notes and Limitations</i>	<b>Version Date:</b> <i>23.05.2014</i>
<b>Current State:</b> <i>final</i>	
<b>Format:</b> <i>Raster (TIFF)</i>	
<b>Citation:</b> <i>Bockelmann, F., W. Puls, U. Kleeberg, D. Müller and K.-C. Emeis (2017). "Mapping mud content and median grain-size of North Sea sediments – a geostatistical approach." Marine Geology 397: 60-71.</i>  <i>Figge, K., (1981). "Sedimentverteilung in der Deutschen Bucht (map)". Deutsches Hydrographisches Institut, Hamburg.</i>	
DATASET DETAILS	
<b>Abstract</b> <i>The map shows the spatial distribution of median grain-sizes (in <math>\phi</math>-scale) of surface sediments in the southern North Sea. The complete surface coverage is predicted by Co-Kriging.</i>  <i>North Sinea data on grain size analyses of surface sediments were compiled from various sources and mapped for the median of the particle size distribution using Kriging technique. The median was used as a covariate to determine habitat substrate type.</i>	



### Acquisition and Processing Description:

#### Acquisition:

The basis for the median grain-size distribution consists of more than 50,000 individual samples whose spatial distribution (in gridded form) is shown in the map. Only samples from the sediment surface (maximum sub-bottom depth 10 cm) were taken into account. The grain-size data were collected from more than 10 institutions and databases. The oldest data were measured in the fifties. All collected data are united into the same data set, disregarding the date of sampling.

#### Processing Description:

The median grain-size (the 50 percentile) is the midpoint of a grain-size distribution. For a given set of grain-size fractions (e.g. obtained by sieving), the median grain-size is determined by a so-called Tauber Fit.

The generation of a map covering the North Sea area of interest is done by Co-Kriging using the R-routine "krige" (R-library "gstat"). The values of the primary variable (median grain-sizes of individual samples) are provided at the original sample locations. The values of the secondary variable are provided at the target grid nodes. The secondary variable (log-converted %mud) is known at all the target grid nodes.

The result of Co-Kriging is a full-coverage estimation of the primary variable at the target grid nodes. Co-Kriging tends to produce a smoothed image. Along with the estimate of the primary

variable (“kriging mean”), kriging gives an estimate of the estimation error (“kriging variance”) at every target grid node.

### Notes and Limitations:

#### Data Quality:

Raw data consists of the grain-size fractions of individual sediment samples. The main difference between data sets is that the grain-size fractions were gained by different methods: wet or dry sieving, laser diffraction analyzer (from different manufacturers), settling test. In addition, sample preparation influences the results quite substantially. There is no way to align the different data sets to one another. Therefore all data were treated equally, regardless of the analytical method. Processed median grain-sizes of a newly added data set were inspected for compatibility with already existing median grain-sizes from the same site. In some cases the new data set was discarded because it did not match the already existing data. Outliers were removed.

Data were inspected for incompatibilities across the borders of EEZs within the North Sea.

Two special aspects which reduce the quality of the median grain-sizes:

(1) A Tauber fit was not applied if a substantial part (e.g. 55 %) of a sample’s sediment mass was not analyzed adequately for grain-size fractions. This was the case if either the coarsest or the finest fraction represents more than 55 % of the sediment mass. The grain-size parameters of that sample are not included in the results list. The consequence is that areas with particularly coarse or fine sediment are not adequately represented in the maps. This means a substantial reduction of data quality.

Along the English North Sea coast, the situation described above is mostly distinct. The percentage of gravel (grain-size > 2 mm) can be above 90 % while the standard grain-size analysis procedure used a coarsest sieve of 2 mm. However, in the case of the English coast sediment samples, a Tauber fit was nevertheless carried out. This could be done because the sediment fraction > 2 mm was artificially split into several sub-fractions. The rule for that artificial splitting was obtained from more adequate grain-size analyses (using sieves of up to 45 mm mesh size) of coarse samples from the same study area.

(2) In the German Bight the dominating grain-size data set is that of Figge (1981). Unfortunately the grain-size fraction > 4 mm was separated from the sediment sample before starting the grain-size analysis. The existence of grains > 4 mm was recorded in the sample protocol, but the percentage mass of grains > 4 mm was not recorded. In German Bight areas with much gravel, the median grain-sizes given in the maps are thus too small. This bias reduces the quality of the Figge data for coarse-grained sediments.

#### Error Estimation:

For individual samples an estimate of the median grain-size error can be obtained from data of CEFAS Lowestoft (2012). At a muddy site (Farnes Deep) the mean and standard deviation of median grain-size (12 sediment surface samples, taken between 1999 and 2010 at the same position) is  $3.91 \pm 0.06$  ( $\varphi$ -scale). At a sandy site (off East Anglia) the mean and standard deviation of median grain-size (11 sediment surface samples between 2000 and 2010) is  $1.57 \pm 0.25$  ( $\varphi$ -scale). The samples were taken at sites where “it is expected there will not be changes in sediment type at these sites over time”.

The standard deviation of the median grain-size  $\varphi_{50}$  as predicted by Co-Kriging is in the order of 0.68 and thus much higher than the above given errors of individual samples. The spatial distribution of the Kriging standard deviation is very uniform. The error is slightly larger where the density of samples is low, e.g. north of 56° latitude.

Instruments/Models:

*Instruments:*

*Surface sediment samples were taken by various types of grab and box core samplers. Grain-size analysis was done by wet or dry sieving, laser diffraction and settling test.*

*Models:*

*Each grain-size distribution is fitted by a logistic function (so-called Tauber fit). The results are the three fit parameters: median grain-size, sorting and skewness.*

*The generation of area-covering maps (on the basis of individual sample data) is done by Co-Kriging using the R-routine "krige" (R-library "gstat").*

Related Datasets:

- *Sorting of the surface sediment grain-size distribution*
- *Skewness of the surface sediment grain-size distribution*
- *Mud content (grain-size fraction < 63 µm) of surface sediment*
- *Gravel content (grain-size fraction > 2000 µm) of surface sediment*
- *Sediment porosity*

## Data Sources

The data for the generation of sediment maps were obtained from the following institutions:

**NAVAL OFFICES and RESEARCH INSTITUTES:**

Forschungs- und Technologiezentrum Büsum, Germany  
 Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg, Germany  
 Senckenberg Institut Wilhelmshaven, Germany  
 Helmholtz Zentrum Geesthacht, Germany  
 Bioconsult Schuchardt & Scholle GbR, Bremen, Germany  
 Deltares, Utrecht, The Netherlands  
 British Geological Survey, Marine Information Project, Edinburgh, UK  
 Marine Scotland, Marine Laboratory, Aberdeen, UK  
 Universität Hamburg, Institut für Geologie und Paläontologie, Hamburg, Germany  
 Royal Netherlands Institute for Sea Research (NIOZ), Texel, The Netherlands  
 Geological Survey of the Netherlands (TNO), Utrecht, The Netherlands  
 School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, UK  
 CEFAS, Lowestoft, UK  
 Geological Survey of Norway (NGU), Trondheim, Norway  
 Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark  
 Bureau de Recherches Géologiques et Minières (brgm), Orléans, France

**PROJECTS:**

Management, Research and Budgeting of Aggregates in Shelf Seas related to End-users (MAREBASSE, 2002-2006), Ghent University, Belgium  
 North Sea Benthos Survey 1987  
 North Sea Benthos Project 2000  
 Zirkulation und Schadstoffumsatz in der Nordsee (ZISCH, 1984-1989), Universität Hamburg  
 Biogeochemistry and Distribution of Suspended Matter in the North Sea and Implications to Fisheries Biology (TOSCH, 1984-1988), Universität Hamburg  
 Geopotenzial Deutsche Nordsee (GPDN, 2009-2013), Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) Hannover, Landesamt für Bergbau, Energie und Geologie (LBEG) Hannover, Bundesamt für Seeschifffahrt und Hydrographie (BSH) Hamburg, Germany

**DATABASES:**

Flanders Marine Institute (VLIZ) Data Centre, Ostend, Belgium



**NOAH**

North Sea Observation and  
Assessment of Habitats

Management Unit of the North Sea Mathematical Models (MUMM), Brussels, Belgium  
International Council for the Exploration of the Sea (ICES), Copenhagen, Denmark  
Publishing Network for Geoscientific & Environmental Data (PANGAEA), Alfred-Wegener-Intitut (AWI),  
Bremerhaven, Germany