Documentation of sedimentological products from the *AufMod* project Functional Seabed Model, data format: Text files (CSV, XYZ)

Valerius J.[a], Feldmann J. [b], van Zoest M. [b], Milbradt P. [b], Zeiler M.[a]

30-06-2013

[a] Federal Maritime and Hydrographic Agency (BSH), Berrnhard-Nocht-Str. 78, 20359 Hamburg, Germany
[b] smile consult GmbH, Vahrenwalder Straße 4, 30165 Hannover, Germany

The Functional Seabed Model is an IT-supported realisation of a dynamic, data-based model which describes the surface of the seabed. It is based on quantities of measurement data, corresponding metadata and interpretation rules (interpolation and approximation methods) and consists of modules for the components:

- Bathymetry: average topography of the seabed, bed forms in parameterised form.
- Sedimentology: Grain distribution of surficial sediments, porosity, organic proportion in sediment.
- Consolidated horizon: holocene basis / basis of holocene marine sands.
- Hydraulic structure and replacement models.

The data are managed in a relational database. Thus the Functional Seabed Model is a combination of a relational database and flexibly adaptable, numerical calculation rules.

It was developed within the framework of the German Coastal Engineering Research Council project ***AufMod*** ("Aufbau integrierter Modellsysteme zur Analyse der langfristigen Morphodynamik in der Deutschen Bucht" ["Development of integrated model systems for the analysis of long-term morphodynamics in the German Bight"], 01.11.2009-31.12.2012).

In the following, the products resulting from Sedimentology Module of the Functional Seabed Model within the ***AufMod*** project will be documented.

Contents

1 Sedimentology Modul 3
1.1 Data input.. 3
1.2 Interpolation method.. 4
2 Sedimentological products of the Functional Seabed Model... 6
2.1 Interpolated grain size distribution 7
2.2 Comprehensive sediment parameters in the German Bight.................................... 7

1 Sedimentology Modul

In the sedimentology module, the surficial sediment of the seabed will, first and foremost, be described with grain size distribution data. A cumulative frequency curve is calculated from the frequency distributions of original data for each sediment sample via a monotonous cubic spline interpolation. Various sedimentological parameters can then be derived.

1.1 Data input

Table 1 displays the grain distribution data entered with a timestamp in the Functional Seabed Model.

Table 1: A list of the grain size distribution data which were integrated into the Functional Seabed Model.

Title	Origin	Amount of samples	Spatial extent	Period
MUDAB - grain size distributions	BSH	25.309	North Sea	1924-2008
WADABA - grain size distributions	Helmholtzzentrum Geesthacht	1.449	German Wadden sea	1987-2003
Grain size distributions Spiekeroog	Forschungsinstitut Senckenberg am Meer, Wilhelmshaven	941	Shoreface Spiekeroog	1986-1989, 2005
Grain size distributions Great Britain	British Geological Survey (BGS), Nottingham, Großbritannien	15.946	North Sea sector Great Britain	
Grain size distributions Netherlands	Geological Survey of the Netherlands (TNO), Utrecht, Niederlande	6.619	North Sea sector Netherlands	1969-2006
Grain size distributions Norway	Norges geologiske undersøkelse (NGU), Trondheim, Norwegen	129	Skagerrak	1992-1994
Grain size distributions Belgium	Royal Belgian Institute of Natural Sciences, Brussels, Belgien	3.468	North Sea sector Belgium	1984-2009
Grain size distributions Danmark	GEUS, Kopenhagen, Dänemark	215	North Sea	2000-2008
Grain size distributions Danmark	Danish Coastal Authority, Ministry of Transport and Energy	215	North Sea sector Danmark	2010
GPDN - grain size distributions	Geopotential Deutsche Nordsee (BSH, BGR, LBEG)	1.363	North Sea sector Germany	2008-2011
SedDB (Küste) – grain size distributions	BfG, Koblenz	4.949	Elbe-, Jade-, Weser-, Ems-estuary	1982-2009

Grain size distributions Sedimentatlas Waddenzee	Waterdienst (Rikswaterstaat, Ministerie van Infrastructuur en Milieu), Lelystadt, NL	7.502	Wadden sea of the Netherlands	1989-1997
Grain size distributions Offshore Windfarms licensing procedures	BSH (confidential)	4.383	North Sea sector Germany	2000-2008
FeDaBa - grain size distributions	BfG, Koblenz	3.163	Elbe-, Jade-, Weser-, Ems-estuary	1980-2012
GROBEKART - grain size distributions	AWI	4.373	Shelf of Schleswig-Holstein	2004-2011

1.2 Interpolation method

The conflated grain size distribution data have different class boundaries. Therefore, in the Functional Seabed Model they are stored via a monotonous cubic spline interpolation as a cumulative curve (cf. Kruger, CJC[1]). In this way, grain size distributions adapted to respective requirements can be generated with uniform class boundaries and corresponding statistical parameters calculated. In addition, there is the possibility of calculating grain size distributions for optional model grids via spatial interpolation procedures integrated into the Functional Seabed Model. In this way, cumulative grain size frequency curves for the area of the German Bight were generated in ***AufMod*** on a 250 m * 250 m grid (cf. Figure1).

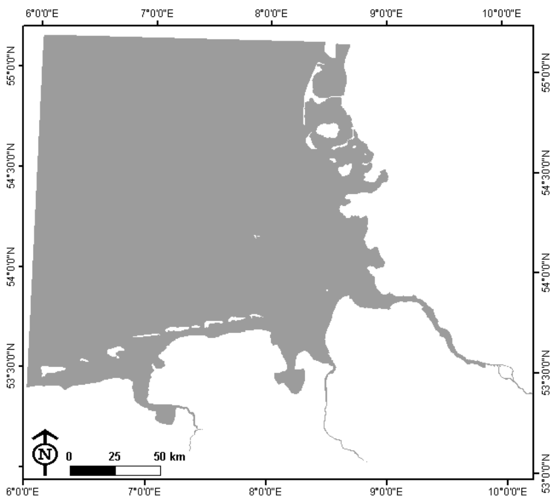

Figure 1: Extent of model grid in the German Bight of all sedimentological products.

For the spatial interpolation, an anisotropic Shepard interpolation oriented to resulting sediment transport vectors was used. Ten survey points within an ellipse around the grid point were considered for the anisotropic inverse distance interpolation. Length and alignment of the main and secondary axes of the ellipse have arised from simulated, residual sediment transports simulated for the year 2006. Figure 2 demonstrates the distribution of

[1] **Kruger, CJC:** Constrained Cubic Spline Interpolation for Chemical Engineering Applications. Quelle: http://www.korf.co.uk/spline.pdf

survey points and vectors of residual sediment transports using the example of the Elbe estuary (figure right) and the alignment of an ellipse using vectors in contrast to a metric search radius (left). Figure 3 shows a comparison of the median grain size diameter which was modelled with an anisotropic (left) and isotropic Shepard interpolation (right) in the zoom in of the Elbe estuary. It is shown that the more coarse sediment in the main channel area of the Elbe seems less mottled by the anisotropic interpolation (left) than is the case with the isotropic interpolation.

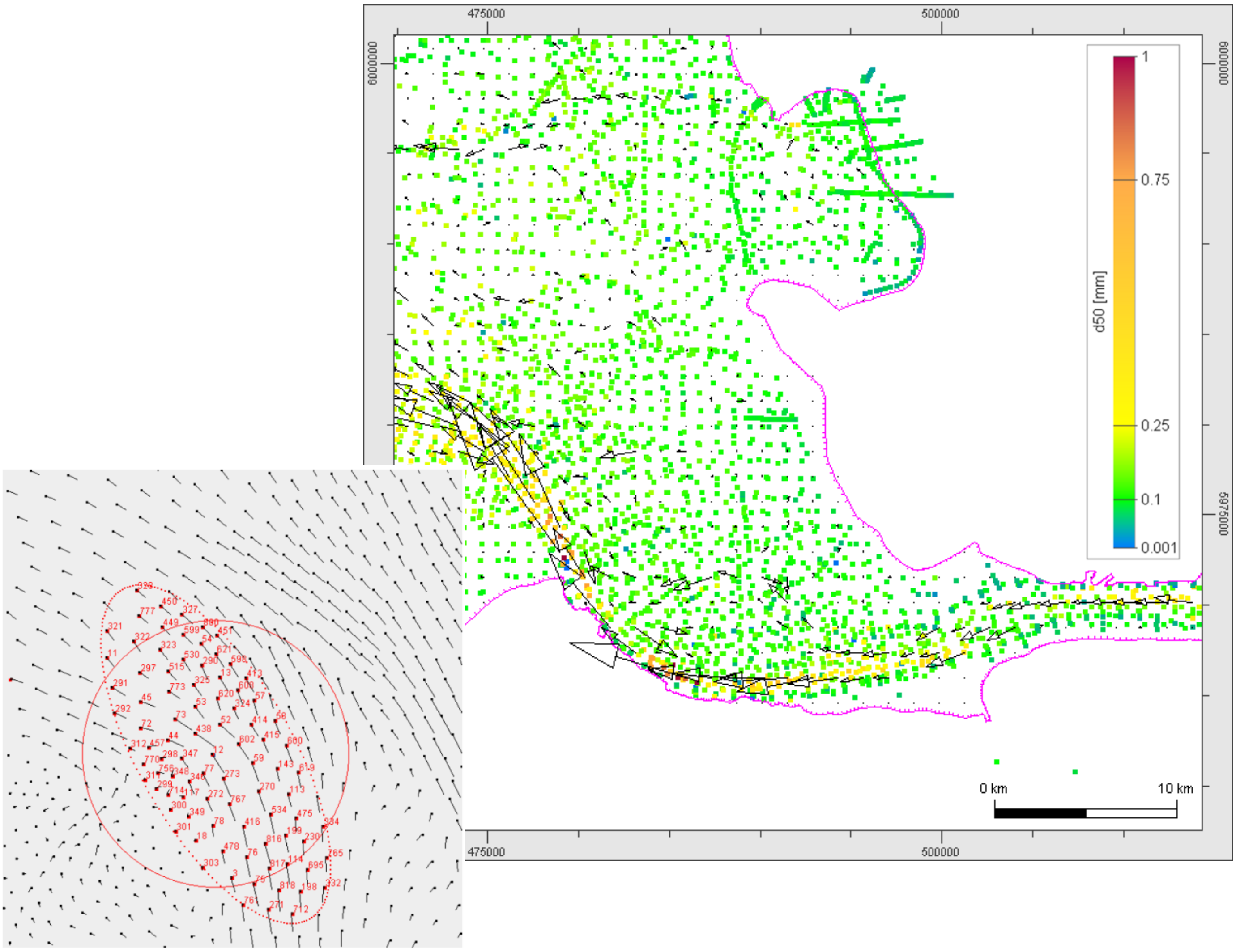

Figure 4: median grain diameter of sediment samples and vectors of residual sediment transports using the example of the Elbe estuary (figure right) and the alignment of an ellipse using vectors in contrast to a metric search radius (left)

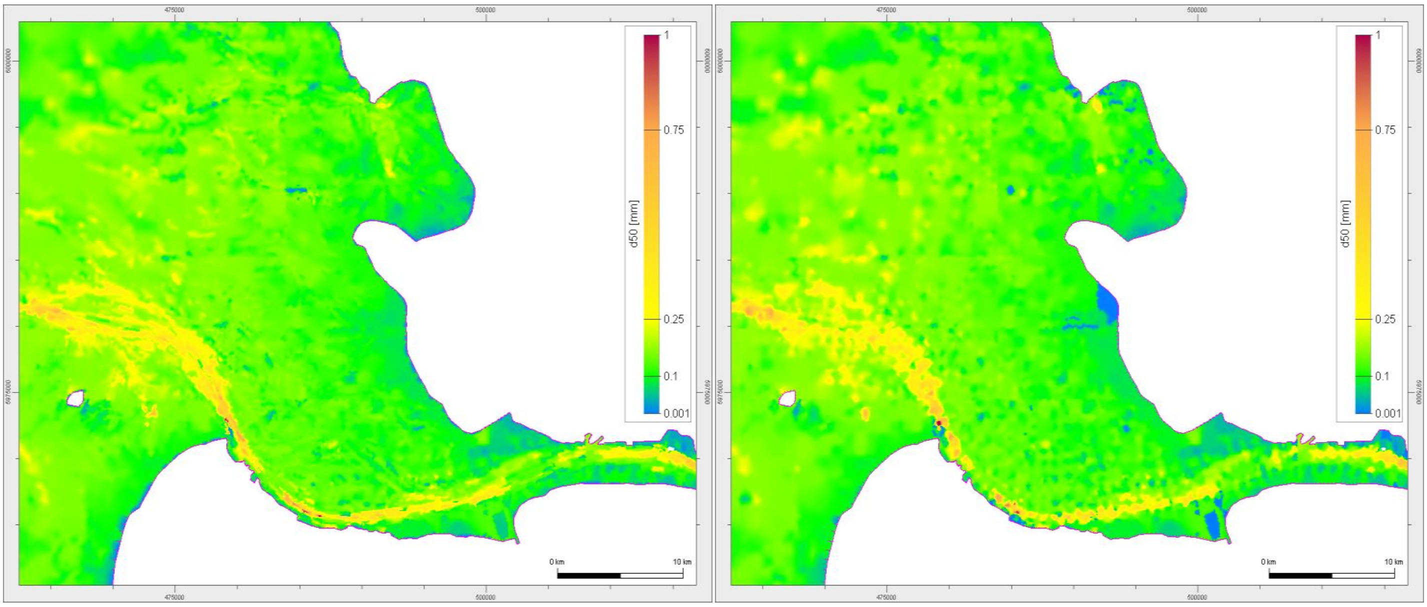

Figure 5: comparison of the median grain size diameter which was modelled with an anisotropic (left) and isotropic Shepard interpolation (right) in the zoom in of the Elbe estuary

2 Sedimentological products of the Functional Seabed Model

Various sedimentological parameters processed as products for the German Bight area were calculated from the interpolated grain size distribution:

- Median grain size diameter of interpolated cumulative grain frequency
- Mean grain size diameter value
- Sorting according to Trask (1932)[2]: $\sqrt{\frac{D75}{D25}}$
- Sorting according to Folk & Ward (1957)[3]: $\sigma_1 = \frac{\Phi84-\Phi16}{4} + \frac{\Phi95-\Phi5}{6,6}$
- Skewness according to Folk & Ward (1957): $Sk_1 = \frac{\Phi16+\Phi84-2\Phi50}{2(\Phi84-\Phi16)} + \frac{\Phi5+\Phi95-2\Phi50}{2(\Phi95-\Phi5)}$
- Kurtosis according to Folk & Ward (1957): $K_G = \frac{\Phi95-\Phi5}{2,44(\Phi75-\Phi25)}$
- Weight percentages of various grain fractions

In the following, content and development of the Functional Seabed Model products, available as text files (ftp://ftp.bsh.de/outgoing/AufMod-Data/ CSV_XYZ_files/ SedimentologicalParametersCSV.zip) will be described.

These data were also processed into classified polygon data and can be downloaded here: ftp://ftp.bsh.de/outgoing/AufMod-Data/FGDB_VectorData/AufModDatabasedModelling.gdb.

---

[2] **Trask, PD. (1932):** Origin and Environment of Source Sediments of Petroleum. *Gulf Publishing Company*, Houston.

[3] **Folk, R.L. & Ward, W.C. (1957):** Brazos River bar: a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, Bd. 27, S. 3-26.

2.1 Interpolated grain size distribution

Download (via ftp): *InterpolatedGSD_GB.csv* in *SedimentologicalParametersCSV.zip*
ftp://ftp.bsh.de/outgoing/AufMod-Data/CSV_XYZ_files/SedimentologicalParametersCSV.zip

Description: Grain size classes derived from the interpolated grain size distributions described in chapter *Interpolation method*.
Identifier: *InterpolatedGSD_GB.csv*
Coordinate system: WGS84 UTM 32 N (EPSG-Code: 32632)
Model grid: 250m*250m grid
File format: CSV (Layout of CSV-file: cl. Table 2:)

Table 2: Layout of CSV-file "*InterpolatedGSD_GB.csv*"

Header	***Content***
x	x-coordinate
y	y-coordinate
<63	Content of grain size < 63 µm [%]
63-88	Content of grain size 63 - 88 µm [%]
88-125	Content of grain size 88 - 125 µm [%]
125-250	Content of grain size 125 - 250 µm [%]
250-500	Content of grain size 250 - 500 µm [%]
500-1000	Content of grain size 500 - 1000 µm [%]
1000-2000	Content of grain size 1000 - 2000 µm [%]
>2000	Content of grain size > 2000 µm [%]

2.2 Comprehensive sediment parameters in the German Bight

Download (via ftp): *SedimentParametersGB.csv* in *SedimentologicalParametersCSV.zip*
ftp://ftp.bsh.de/outgoing/AufMod-Data/CSV_XYZ_files/SedimentologicalParametersCSV.zip

Description: Sediment parameters derived from the interpolated grain size distributions described in chapter *Interpolation method*, such as median grain size diameter or sediment sorting.
Identifier: *SedimentParametersGB.csv*
Coordinate system: WGS84 UTM 32 N (EPSG-Code: 32632)
Model grid: 250m*250m grid

File format: CSV (Layout of CSV-file: cl. **Table** 3)

Table 3: Layout of CSV-file *„SedimentParametersGB“*

Header	***Content***
x	x-coordinate
y	y-coordinate
Median [Phi]	Value of Median [Phi]
Median [mm]	Value of Median [mm]
Mean [mm]	Mean of grain size diameter [mm]
SortingTRASK	Sorting according to Trask (1932)
SortingSigma	Sorting according to Folk & Ward (1957)
Skewness	Skewness according to Folk & Ward (1957)
Kurtosis	Kurtosis according to Folk & Ward (1957)