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A new view on the Elbe

Dynamic and interactive 3D views for public information purposes in news media

An article by TANJA DUFEK, JOHANNES KRÖGER, BRENDON DUNCAN and JOCHEN SCHIEWE

In collaboration with the German newspaper *WELT*, a team of researchers from HafenCity University Hamburg developed new views of the River Elbe, showing the riverbed in a couple of 3D interactive views and videos. These have been integrated into a multimedia special which follows the goal to give people better insights into the complex topic of the fairway adjustment of the Elbe. This contribution describes input data as well as its processing and visualisation.

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Multimedia special of WELT

www.welt.de/lesestueck/2016/elbvertiefung

Long video versions

www.geomatik-hamburg.de/g2lab/research-welt.html

DTM visualisation | dynamic views | interactive 3D views | public participation

1 Introduction

Since 2002 the next – the ninth – stage of the fairway adjustment of the River Elbe in Germany is being planned and discussed by various experts, including politicians and lawyers. The adjustment of the navigational channel shall lead to depths of 15.9 m to 17.1 m below Sea Chart Zero (SKN) so that ships with a draught of 13.5 m (independent of tide) and 14.5 m (dependent of tide) are able to reach the Hamburg Port. This process implies deepening and widening at places where the minimum thresholds are not ensured due to the topography of the riverbed. It is expected that in December 2016 the Federal Administrative Court of Germany finally decides on the legitimacy of the planned process.

As this topic has gained significant public attention not only with people living along the Elbe, the newspaper *WELT* came up with the idea to support their readers with a better impression of the status and the plans. The result is a multimedia special in a so-called storytelling format called »A new view on the Elbe«. Core of this special are several dynamic and interactive 3D views of the Elbe riverbed which have been created by a scientific team of the HafenCity University Hamburg.

In the following the process of merging and visualising the data will be summarised as well as selected results together with first public reactions on it.

2 Data

For this project a digital terrain model of the whole riverbed of the Elbe from Cuxhaven up to the eastern boundary of Hamburg was generated. The underlying data was provided by the Federal Waterways and Shipping Administration (WSA) of Cuxhaven and Hamburg as well as by the Hamburg Port Authority (HPA) in XYZ format. The data sets were collected in 2010 by the responsible authorities. Some of the data sets are available from www.portaltideelbe.de and emodnet-bathymetry.eu. Originally derived from a 2 m grid and cross-lines of 100 m distance, the WSA data was delivered in

1 m resolution. The HPA data set was also obtained at 1 m resolution.

2.1 Videos

For the purpose of creating overview videos in the visualisation software *QPS Fledermaus* the data sets were re-gridded to 3 m resolution in order to increase the manoeuvrability and navigation performance.

A publicly available digital terrain model of the whole of Germany in a 200 m grid, made by the Federal Agency for Cartography and Geodesy (BKG) was used as background data, particularly in order to add some aesthetics to the scenes created.

2.2 Interactive 3D surfaces

The data sets for the interactive 3D surfaces of several locations were obtained from different sources with different properties:

- Wrecks: The wrecks are located in the area of Pagensand close to the city of Stade. This data was recorded by students of HafenCity University Hamburg with the SV »Deepenschriewer II« of HPA in June 2016. This digital terrain model features a horizontal resolution of 25 cm.
- Parkhafen and Turning Basin: These data sets were extracted from the data with 1 m horizontal resolution received from HPA, the same data that was also used for video generation.
- Old Elbtunnel: This data set was also provided by the HPA, but in a higher horizontal resolution (25 cm) than the general data set.

3 Data processing

3.1 Video

The data sets for the Elbe were individually imported into the visualisation software *QPS Fledermaus* where they were transformed to the UTM 32N (WGS 84) coordinate reference system with depths related to NHN (Normalhöhennull). Subsequently the data sets were gridded to a 3 m surface using the »Weighted Moving Average« algorithm. Finally, the single surfaces were merged into one surface depicting the entire sea floor from Cuxhaven to

Hamburg. To prevent data distortion when overlaying the detailed Elbe surface data and the coarse background data, a masking was applied.

A tailor-made colour map was also applied to the scene, illustrating the seabed in a blue colour scheme and the land area in brownish colour. To support the perception of depth and to increase the visibility of small scaled underwater features, a vertical exaggeration of approximately 10 times the horizontal scale was used. Using a 3D mouse, a flight path was created and recorded using the software's camera/video function. The recorded flights were rendered as individual frames in 720p HD resolution before using *ffmpeg* to generate a video in *mp4/H264* format.

3.2 Interactive 3D surfaces

In addition to the videos, HCU also provided interactive views for selected subsets of the bathymetry. The plug-in *Qgis2threejs* for the free desktop GIS software *QGIS* was used to generate *WebGL*-based 3D viewers of the data. *Qgis2threejs* also supports texturing, shading, labels and additional geometries such as lines or points. The result is a HTML-page plus a set of JavaScript files which consist of the application logic for display/interaction and the triangulated 3D data. Default interaction methods include zooming, panning, rotating and orbiting.

Qgis2threejs offers two different resampling approaches when triangulating the elevation grid. While the »simple« mode uses a fixed spacing between vertices, the »advanced« mode uses a quad-tree to increase or decrease the geometric detail in user-defined regions. One disadvantage of *Qgis2threejs* is that it will always ignore the topological details but simply creates a regular mesh of triangulated squares. This limits the possible scale or resolution in the viewers quite severely. For more advanced uses other free and open-source software like *SAGA GIS*, *Blender* or even specialised tools like *Instant Meshes* could be utilised to generate optimised topology.

Qgis2threejs also allows the placement of a texture on the surface. To visually enhance the plain geometries a simple divergent colour scale for land elevation (red) and water (blue) depths with a neutral light grey midpoint was used. For displaying purposes a vertical exaggeration of 3 (Wrecks, Parkhafen, Turning Basin) to 5 (Old Elbtunnel) was chosen.

4 Results

4.1 Videos

The flight of the first video (»Medemrinne«) starts at the Elbe estuary close to Cuxhaven, then proceeds upstream towards Brunsbüttel showing the main fairway as well as the Medemrinne north of it. The flight path has a length of approximately 38 km. The main fairway is only a small part of the Elbe in the south, as shallow water zones and tide ways extend to the northern banks. These features can be very nicely seen in the 3D data set. The original video has a length of 2:39 minutes. Its speed was

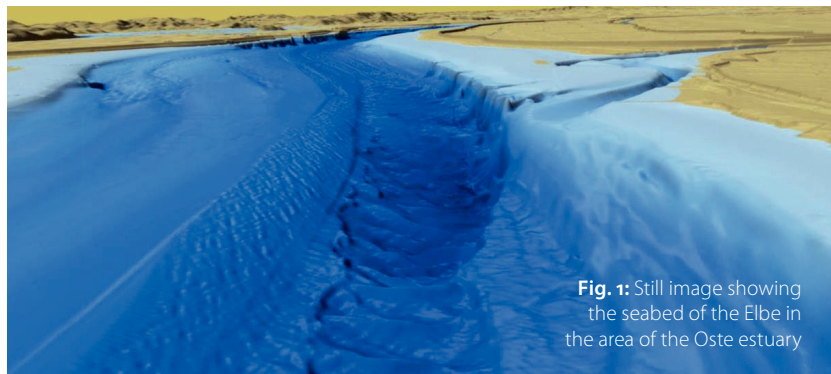


Fig. 1: Still image showing the seabed of the Elbe in the area of the Oste estuary

increased when adding the text by a narrator so that the final length is less than one minute within the multimedia special of WELT. A still image of the video is depicted in Fig. 1.

The second video (»Brunsbüttel to Wittenbergen«) starts in the area of Brunsbüttel and takes the viewer upstream to Wittenbergen. The flight path has a length of approximately 58 km (long video version), leading to a video duration of 2:32 minutes which was reduced to 0:38 minutes within the multimedia special of WELT. A still image of the video in the area of the entrance of the Kiel Canal is depicted in Fig. 2.

Near the end of this video the actual and planned fairways in the area between Wedel and Wittenbergen are visualised by additional vector data (Fig. 3). The respective coordinates were partly provided by the responsible authorities (WSA Hamburg and HPA) and partly derived from the publicly available planning documents (www.fahrrinnenausbau.de). The actual and planned fairway extents were modelled in *AutoCAD Civil 3D*, the resulting DWG files were then imported into *QPS Fledermaus*.

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Furthermore, we would like to thank the WSA Hamburg and Cuxhaven as well as HPA together with the Federal Maritime and Hydrographic Agency of Germany (BSH) for providing the data.

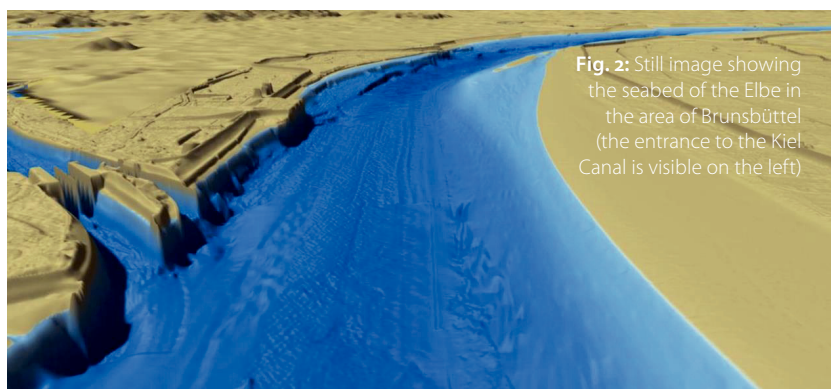


Fig. 2: Still image showing the seabed of the Elbe in the area of Brunsbüttel (the entrance to the Kiel Canal is visible on the left)

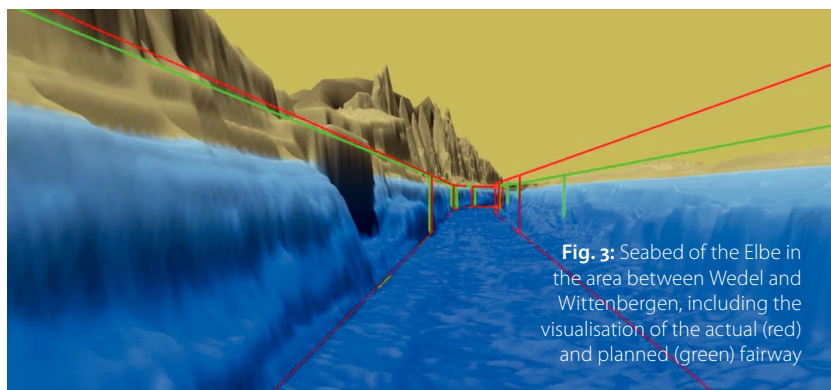


Fig. 3: Seabed of the Elbe in the area between Wedel and Wittenbergen, including the visualisation of the actual (red) and planned (green) fairway

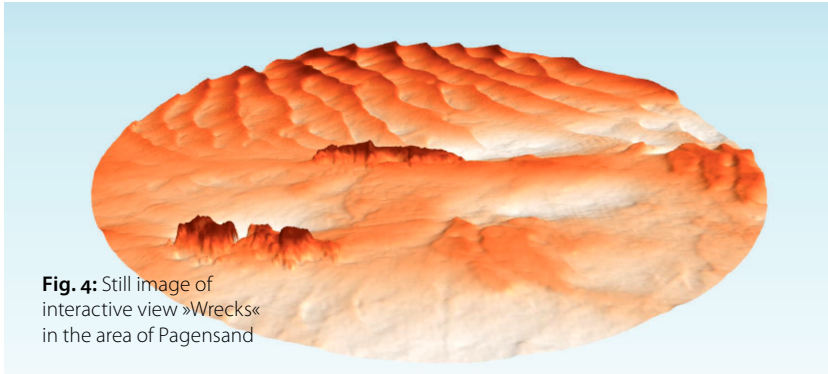


Fig. 4: Still image of interactive view »Wrecks« in the area of Pagensand

4.2 Interactive 3D views

Fig. 4 shows the first interactive prototype focussing on some wrecks. The area was clipped to a circular shape for aesthetic reasons.

The data set »Parkhafen« (Fig. 5) shows the riverbed of the Elbe in the north, the turning circle of Parkhafen in the centre and the entrance to Waltershofer Hafen in the south-east. In the area of the Petroleumhafen dredging scours are visible in the seabed.

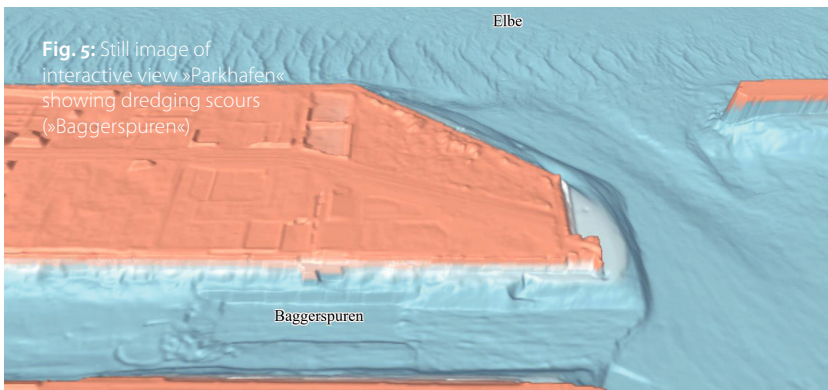


Fig. 5: Still image of interactive view »Parkhafen« showing dredging scours (»Baggerspuren«)

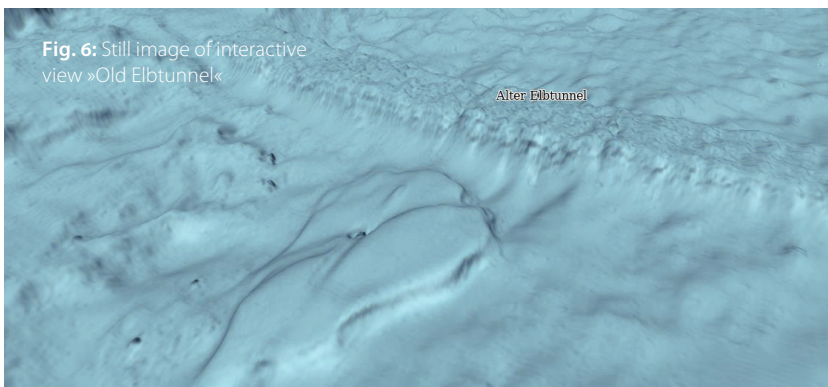


Fig. 6: Still image of interactive view »Old Elbtunnel«

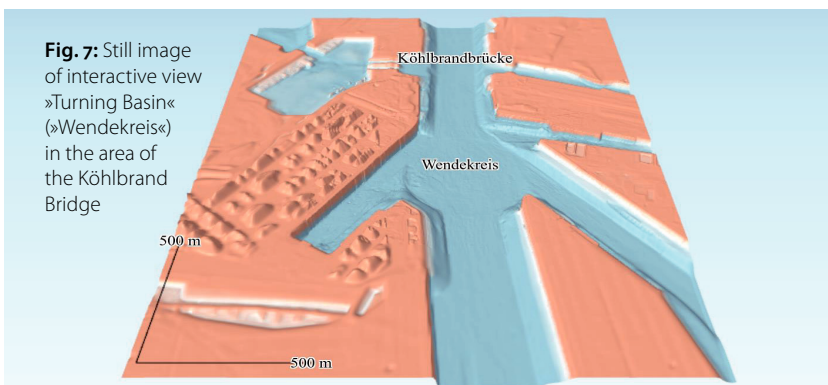


Fig. 7: Still image of interactive view »Turning Basin« (»Wendekreis«) in the area of the Köhlbrand Bridge

As mentioned above, for the area of the »Old Elbtunnel« data of a higher horizontal resolution was used. The selection of an appropriate level of geometric detail in *Qgis2threejs* led to a file size much too big, so a blended hillshade texture based on the high-resolution data was used in combination with a lower-resolution mesh to display the details via the mesh's texture rather than actual geometry (Fig. 6). The viewer shows the material currently placed on top of the Old Elbtunnel to weigh down the structure during ongoing construction works within.

As with the »Parkhafen« example, for the view »Turning Basin« a quad-tree approach was used in order to supply higher geometric resolution for the main area of interest. Looking closely at the »blobs« in the left centre one might be able to see the difference in geometric detail between the high-resolution centre of the image and its borders (Fig. 7). Also shown is a scale bar, simply made of two lines with labels.

4.3 Multimedia special

Finally the WELT team compiled the single elements into the final product, an online multimedia special in a so-called storytelling format. This consists of seven chapters, each of them describing a certain aspect of the adjustment process (like »Elbe without water«, »Elbe upstream«, »Ships' Cemetery«, etc.). These chapters are enriched by the above mentioned videos (with added explanatory narration) and 3D interactive views, together with additional figures and photos. Finally, 360° videos of the Hamburg Port acquired on-board a ship with statements of Jens Meier (Director of HPA) are explaining the importance of the fairway adjustment process.

5 Summary

WELT observed an extraordinary user interest in the resulting multimedia special in terms of visitors. Regarding the impressive impact, Frank Horch, as Senator for Traffic in Hamburg responsible for the Elbe project, stated: »I haven't seen such a representation before. Such 3D views are able to produce a better understanding of infrastructure projects or environmental interventions« (WELT, 01.09.2016).

From a scientific perspective one main challenge within this project was the harmonisation of the huge data sets. In particular, the combination of data with very different horizontal resolutions (in particular, between land and water areas) was not trivial. The second challenge was about the generation of appealing and compact visualisations that should offer both the overview and details like wrecks. Also an appropriate colour scheme had to be chosen, taking into account the fact that some of the areas which are already above the mean sea level (like the Wadden Sea or islands within the Elbe) are widely considered as water area. [↕](#)