Alde-Ore Estuary Bathymetric Model Compilation Report

Report to the

Alde & Ore Estuary Partnership

Commissioned by the Alde and Ore Association

KPAL Report No: 17112
4 February 2015

Kenneth Pye Associates Ltd.
Scientific Research, Consultancy and Investigations

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Report history		
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Contents

1.0 Report scope and purpose

In February 2014 Kenneth Pye Associates Limited (KPAL) was engaged by the Alde & Ore Association (AOA), on behalf of the Alde & Ore Estuary Partnership (AOEP), to undertake an assessment of the future management options at Hazlewood Marshes in terms of their potential geomorphological and hydrodynamic implications for the immediate area and the wider Alde-Ore estuary (Figure 1). As part of this study, a combined digital elevation model of the Alde-Ore estuary was constructed using a combination of LiDAR (flown 17th December 2012 and 2-7 February 2008) and bathymetry (14th July 2013) surveys. One of the recommendations of the study was that additional LiDAR and bathymetric survey data should be obtained to improve the quality of the bathymetric / topographic model as a precursor to further hydrodynamic and sediment transport modelling studies.

On 7th October 2014 a new LiDAR survey of the estuary was flown by the Environment Agency (EA). Unfortunately no new bathymetric data were obtained in 2014. However, the results for a Trinity House survey of the estuary mouth area in April 2014, together with older Seazone data for the offshore area, have been used to extend the bathymetric model seawards. The upstream limits of the digital elevation model (DEM) have also been extended landwards using EA 2008 Lidar data in order that the DEM can be used by JBA Consulting to examine river and tidal flow – controlled water levels in the area upstream of Snape Sluice and around the head of the Butley River. EA profile survey data have also been used to define the channel depths near the head of the Alde and in the Butley River. This report describes the procedures which have been used to construct the updated DEM.

2.0 Data sources

The following data sets have been used to create the updated digital elevation model (DEM) of the estuary:

- EA LiDAR data flown 7th October 2014 at 1.0 m resolution, covering most of the active estuary, but excluding Orford Ness (Figure 2)
- EA LiDAR data flown 17th December 2012 at 1.0 m resolution, covering most of the active estuary and Orford Ness (Figure 3)
- EA LiDAR data flown 2-7 February 2008 at 2 m resolution, covering both the active estuary and the reclaimed areas around the estuary (Figure 4)
- EA swath bathymetry survey of sub-tidal areas on 14th July 2013 at 50 cm resolution (Figure 5). This survey did not cover the Butley River above its confluence with the Ore, or the upper part of the River Alde above Short Reach at Iken (641050E, 257030N)
- Trinity House survey of the River Ore entrance on 1st April 2014, published as a chart with contours and spot heights by Imray Laurie Norie & Wilson Ltd (Figure 6)

- Seazone bathymetric data of the seabed within approximately 6 km of the shoreline, based on Admiralty surveys of various dates, at 20 m resolution (Figure 7)
- EA combined topographic and bathymetric cross-profiles of the upper part of the River Alde above Short Reach at Iken (5 in total) surveyed on 17th August 2006 (Figure 10)
- EA combined topographic and bathymetric cross-profiles of the Butley River (16 in total) surveyed on 15th September 2006 (Figure 11).

3.0 LiDAR and bathymetric data processing methods

3.1 Removing standing water from the LiDAR surveys

Data processing was completed using a combination of Golden Software Surfer™, Golden Software Didger™ and Microsoft Excel™ software packages. The first processing task which was required was to remove areas of standing water from the 2014 LiDAR survey. The tide was at a level of between -0.85 m OD (lower estuary) and -1.0 m OD (upper estuary) at the time of survey. As a first pass, all data in the river channel below these levels were 'blanked' in Surfer. Some areas of the channel had elevations above these values due to waves, and these were manually blanked in Surfer by digitising a shapefile around the perimeter of the river channel using the flat water surface as a guide (4930 points in total prescribed the shape file). The 2008 and 2012 surveys had been processed previously in the same way to remove areas of standing water.

Standing water was also present on two previously-reclaimed marshes: Hazlewood Marshes and Lantern Marshes. The river walls were breached and the marshes flooded during the large storm surge on 5th December 2013. These areas of standing water during the 2014 survey were digitised and 'blanked' and replaced with data from the 17th December 2012 survey.

Small areas of standing water, in puddles and drainage ditches, remained widely across the reclaimed areas of the estuary. The 'grid|mosaic' routine in Surfer was used to fill these areas with data from 2012 or 2008 LiDAR surveys, or from adjacent elevation values.

3.2 Removing vegetation from the LiDAR surveys to produce 'bare earth' DEMs

The 2008 and 2014 LiDAR data were supplied in two formats: unfiltered 'digital surface model' format; and filtered 'digital terrain model' format. The latter format was used for this study, whereby the supplied data had been processed through a supervised classification and filtering routine that attempts to strip out vegetation and buildings from the LiDAR data. The filtering is generally successful at removing large shrubs and trees, but is unable to remove dense stands of vegetation such as reeds and grasses. The 2012 LiDAR data was only supplied in the unfiltered format, and where it was necessary to use this data (i.e. in areas not covered by the 2014 survey) the data was inspected to ensure that large areas of vegetation were not included. In the case of the area immediately west of Snape, including the Snape RSPB reserve, the river walls were rebuilt and large areas of reedbed were created in the period 2008-2012. This area was only covered by the 2008 and 2012 LiDAR surveys. In order to construct the best possible DEM, it was necessary to select the 2012 LiDAR for the new river walls, and for the areas in between to select the 2008 LiDAR data which had the benefit of vegetation filtering and which were acquired at a time when the land-use was agricultural and closer to 'bare-earth' topography (Figure 7).

3.3 Combining the LiDAR and swath bathymetry surveys

The 2013 swath bathymetry data was plotted and inspected to identify any erroneous data spikes. Three were found in the upper estuary: 641050E 257031N; 642539E 257273N; and 644621E 256219N. These spikes were 'blanked' to exclude them from the final digital elevation model.

The 2013 bathymetry and 2014 LiDAR surveys were then combined into a single digital elevation model using the 'grid|mosaic' routine in Surfer, with a common resolution of a 1 metre grid. A gap in the data remained between the bathymetry and the LiDAR data, for elevation between approximately -0.9 m OD and -1.5 m OD which were covered by neither survey. These areas were 'filled' by re-gridding the data using a triangulation with linear interpolation routine in Surfer.

3.4 Extending the bathymetry beyond the extents of the 2013 swath survey

The 2013 swath bathymetry survey in the Alde River did not extend further upstream than Short Reach at Iken. The river above Short Reach, as far as Screw Bridge, was 'filled' by creating a simplified digital elevation model of the river channel using EA bathymetry cross-sections surveyed in 2006 as a guide. Five profiles were available (shown in Figure 7). The profiles were plotted in Excel and the depth of the thalweg found for each profile. The position of the thalweg (taken as the mid-point of water-filled channel visible on the 2014 LiDAR data) was then digitised for the upper river. This line was then transformed into a line of elevations at 1 m spacing using the 'grid|slice' routine in Surfer, with elevations taken from the 2006 cross-sections. The thalweg was assumed to vary linearly in elevation between the cross-sections. It tied in with the 2013 swath bathymetry at an elevation of -2.85 m OD, and was assumed rise linearly between Snape Bridge (at -1.3 m OD) and Screw Bridge (at +1.0 m OD). This single thalweg contour, combined with the edges of the adjacent mudflats from the LiDAR survey, was considered adequate to represent the river channel where the shape of the river cross-section was V-shaped (see Figure 9). Where the river cross-section was U-shaped (along Cliff Reach, and Church Reach), two additional contours were digitised, midway between the thalweg and the channel edges, with the elevations taken from the 2006 cross-section, but generally 0.2 to 0.3 m above the level of the thalweg. The elevation points along these contours were combined with the 2014 LiDAR and the data re-gridded using the triangulation with linear interpolation routine in Surfer to produce a continuous digital elevation model.

The 2013 swath bathymetry survey also did not cover the Butley River. This section was 'filled' in the same way as the upper River Alde, by creating a simplified digital elevation model of the river channel using 16 EA bathymetry cross-sections surveyed in 2006 as a guide. As above, the thalweg was digitised and assigned elevations using the 2006 data; where the channel was U-shaped, additional contours were digitised to either side of the thalweg, again based on the 2006 cross-sections. No data was available for the Butley River entrance, and the depth of this channel was assumed to vary linearly between the 2013 swath bathymetry and 2006 profile A9B_A23A. North of Hill Covert the Butley River has two branches which continue to Mill Road at Butley Mill; it was assumed that the thalweg along both branches rises linearly from -0.75 m OD to -0.50 m OD at Butley Mill.

The 2013 swath bathymetry survey extended as far seawards as North Weir Point. This complex area of banks and channels is surveyed annual by Trinity House. The survey on 1st April 2014 was obtained as a PDF version of a printed navigation chart. The chart was rectified using the WGS84 coordinates on the chart, and the positions of depth contours and spot depths then digitised (a total of 297 data points). Depths in chart datum were converted to Ordnance Datum using a conversion factor of -1.66 m (the Admiralty Tide Tables value for Orford Haven Bar). At the seaward edges of the charted area (638200E and 242000N), spot depths were extracted from a 20 m DEM of the seabed supplied by Seazone. All data points (from the digitised chart, Seazone at the edges, 2014 LiDAR and 2013 swath bathymetry points) were then gridded using a kriging algorithm, at 1 m resolution, covering the area to 638200E and 242000N.

3.5 Extending the LiDAR data coverage

The 2014 and 2012 LiDAR surveys were undertaken mainly to capture the river channels. Some areas of reclaimed marsh were not captured during either of these surveys. The digital elevation model was extended in extent to cover the whole highest astronomical tide contour by combining 2014, 2012 and 2008 LiDAR data, in that order of preference, except in the case of RSPB Snape (see Section 3.2 above) where 2008 data was preferentially selected.

3.6 Conversion to ESRI ASCII grid format

Finally, the resulting combined digital elevation model, which contained data from surveys in 2008, 2012, 2013 and 2014, was exported to ESRI ASCII grid (.asc) format for wider dissemination.

4.0 Conclusions and recommendations

Although the updated DEM described in this report is the most detailed and up-to-date yet produced for the Alde-Ore estuary, and is adequate for presently planned estuary-wide modelling purposes, there are parts of the active intertidal area and reclaimed marshes which have either never been surveyed or for which only low resolution and approximate data is available.

It is recommended that:

(1) All future LiDAR surveys of the estuary should cover the entire area of the estuary below the + 5 m OD contour, including reclaimed former salt, brackish, and fresh water marsh areas behind the current river wall defences. Future surveys should also include the whole of the gravel barrier between Aldeburgh and North Weir Point / Shingle Street. The surveys should be conducted within a period 2 hours either side of low water on a low spring tide to maximise coverage of the intertidal zone and should be acquired at 1 m spatial resolution. In order to maximise available information, the data should be made available both in filtered and unfiltered formats.

(2) Swath bathymetry and/ or single beam echo sounder surveys should be carried out of the Alde estuary above Hazlewood and Iken marshes, and of the Butley River up to its head. The surveys should be undertaken on a high spring tide using a very shallow draught vessel in order to maximise coverage of the intertidal zone and to ensure that there is data overlap with the LIDAR surveys.

(3) A swath bathymetry survey should be undertaken of the nearshore zone between Aldeburgh and East Lane to provide up-to date information about the sea bed topography in this region, and to provide more accurate broad-scale hydrodynamic modelling which can be used to drive the estuary models. This survey should be undertaken as close as possible in time to future Lidar and bathymetry surveys of the estuary. This bathymetric data will also prove useful for further modelling of wave and sediment transport processes on the open coast between Slaughden and North Weir Point.

Figures

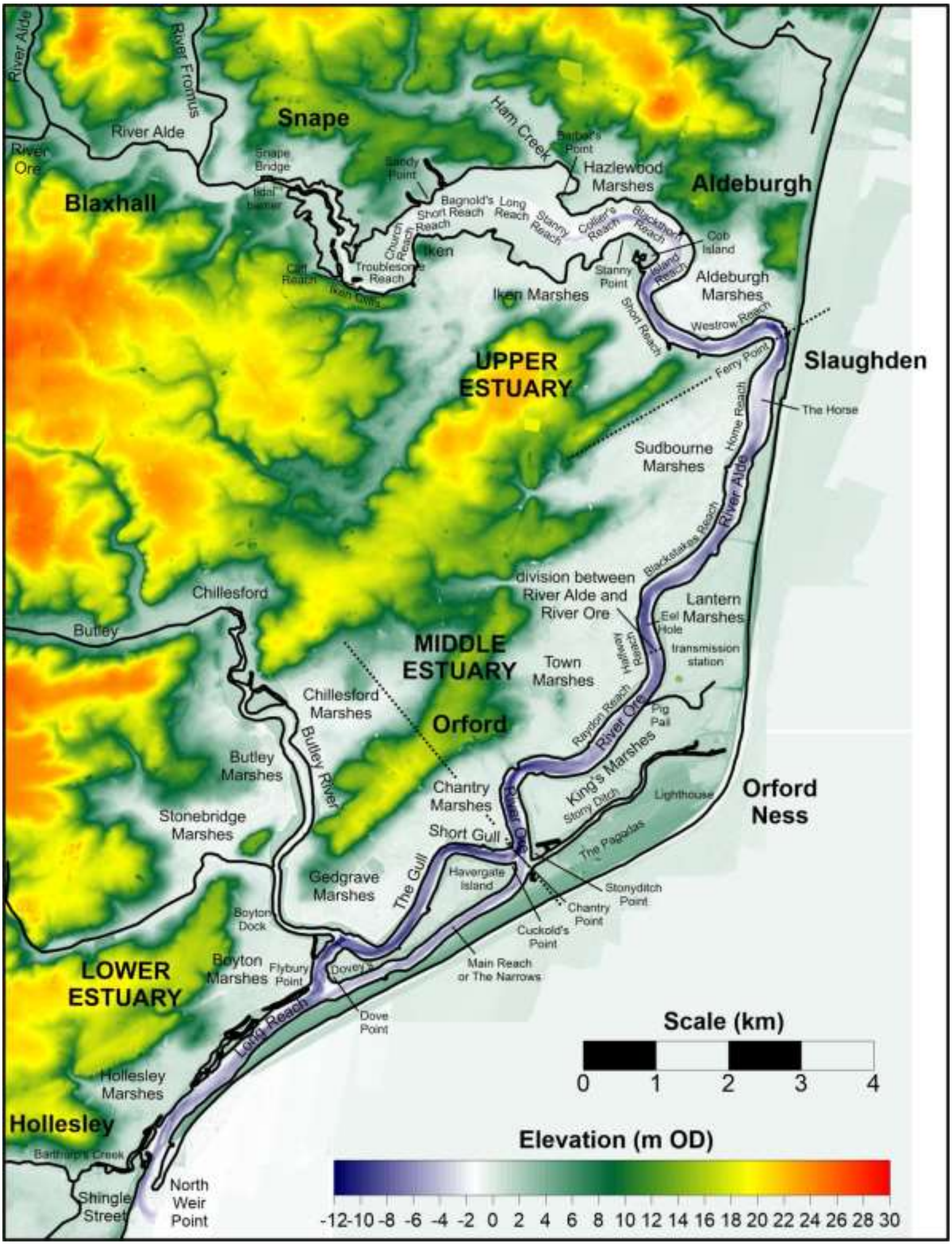


Figure 1. Location map showing the main places mentioned in the text

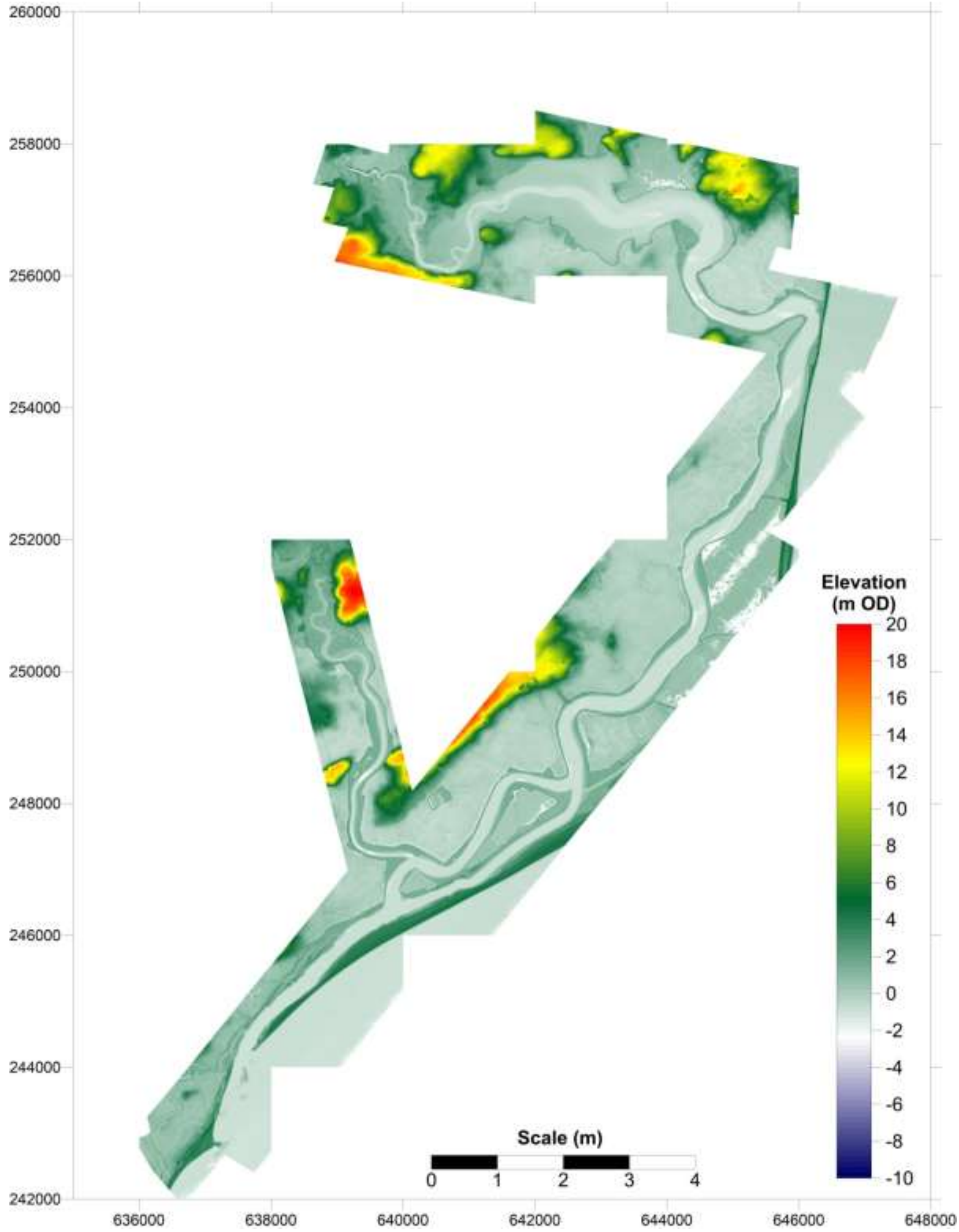


Figure 2. The extent of the 7th October 2014 LiDAR survey provided to KPAL

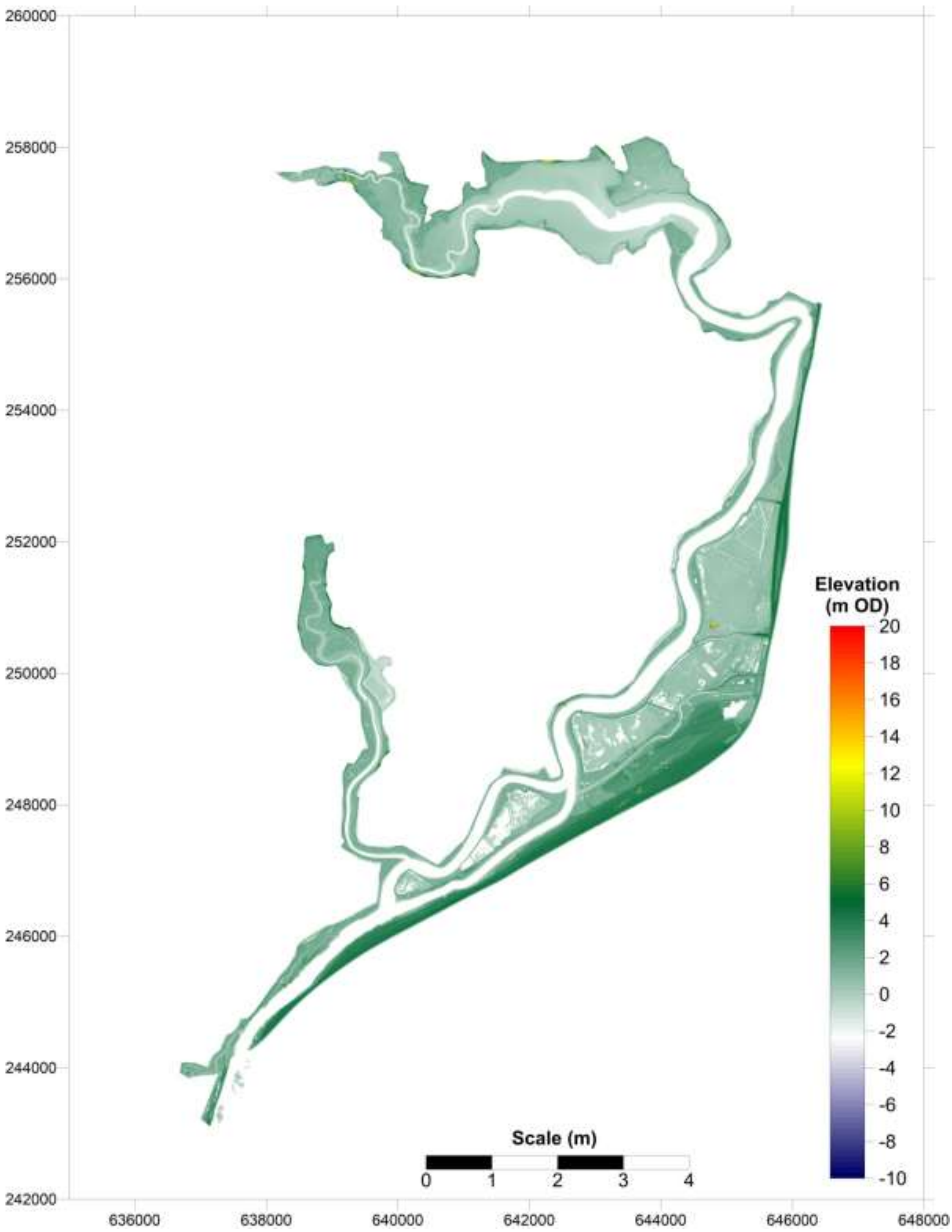


Figure 3. The extent of the 17th December 2012 LiDAR survey data provided to KPAL

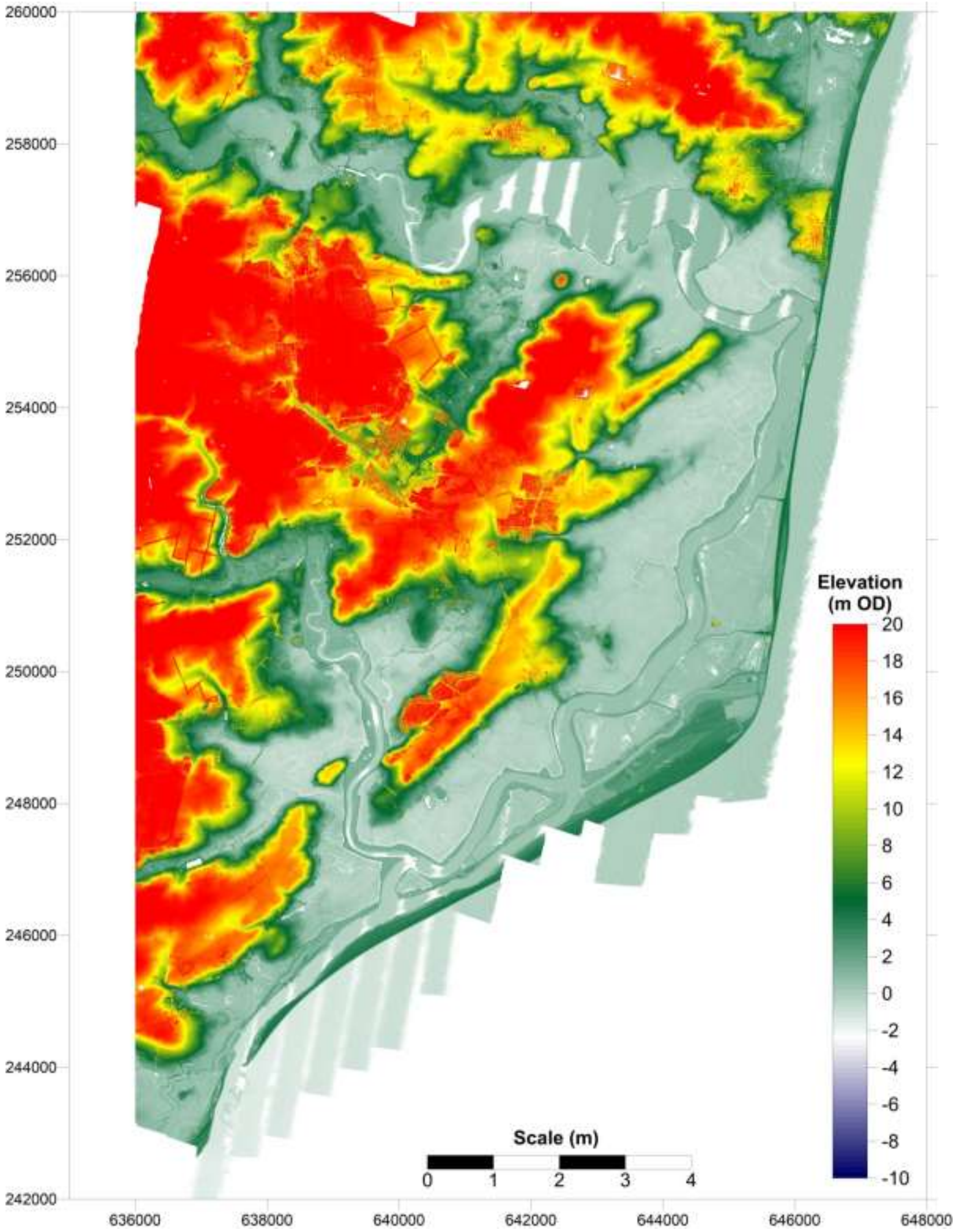


Figure 4. The extent of the 2-7th February 2008 LiDAR survey provided to KPAL

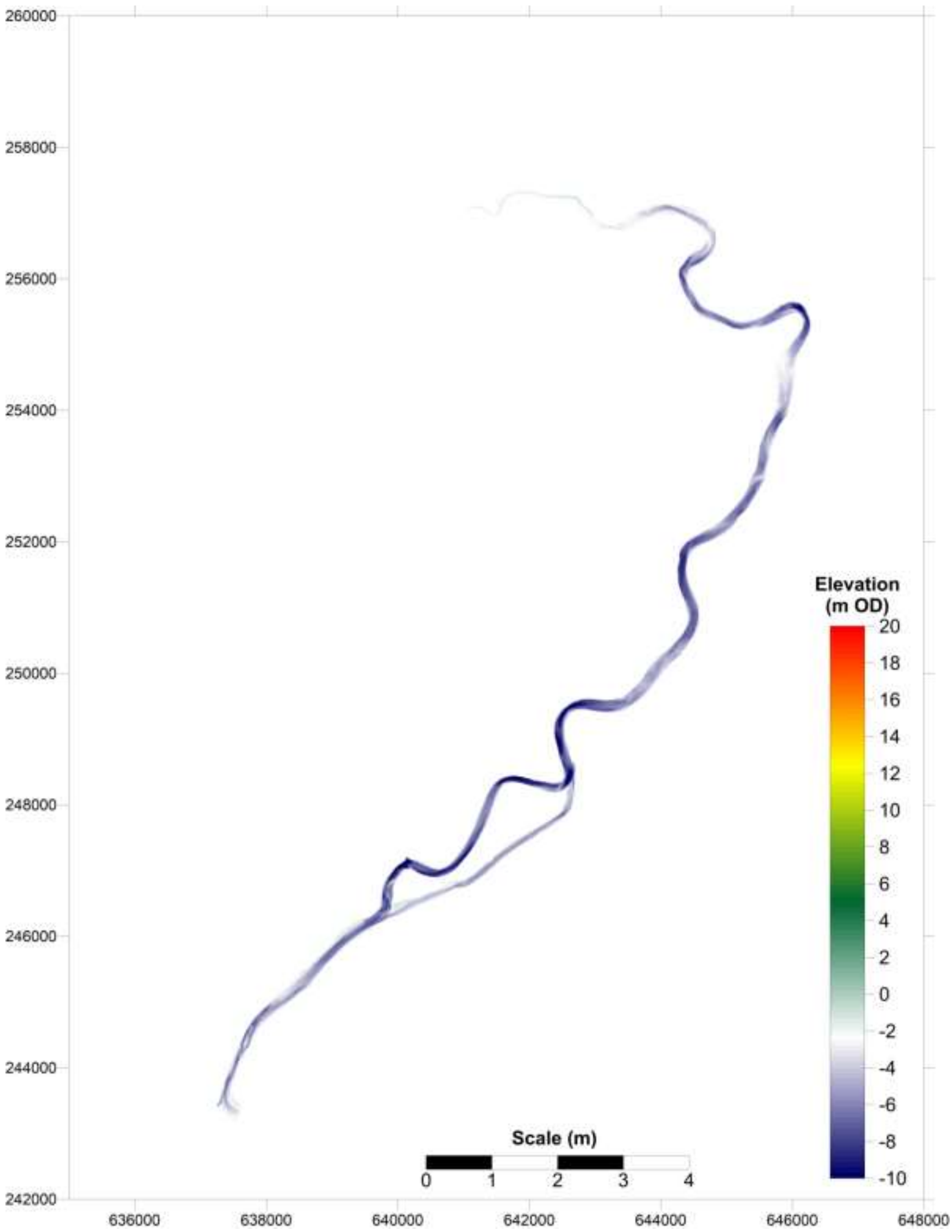


Figure 5. The extent of the 14th July 2013 swath bathymetry survey data provided to KPAL

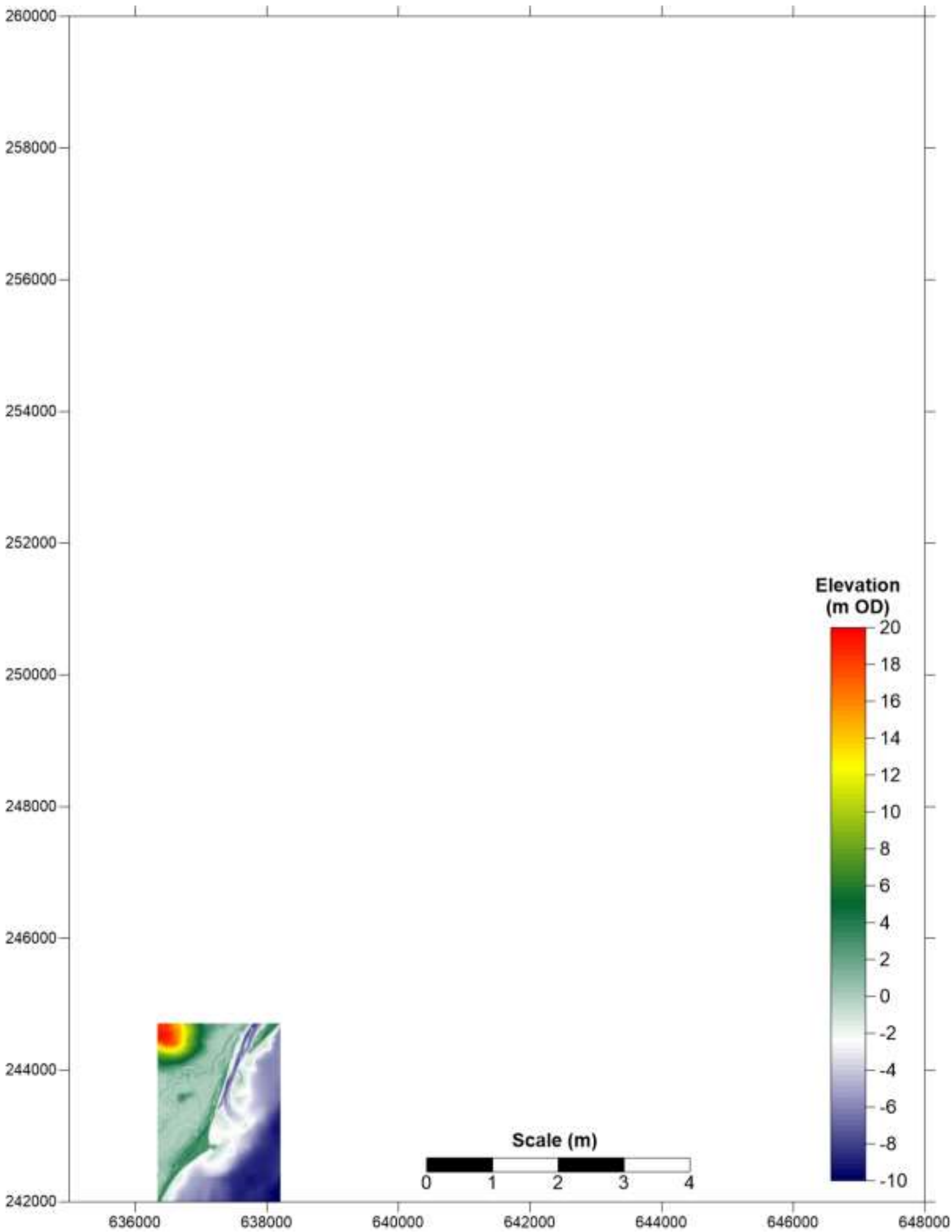


Figure 6. The extent of the 1st April 2014 Trinity House bathymetry survey, extended inland using 2014 LiDAR and 2013 swath bathymetry

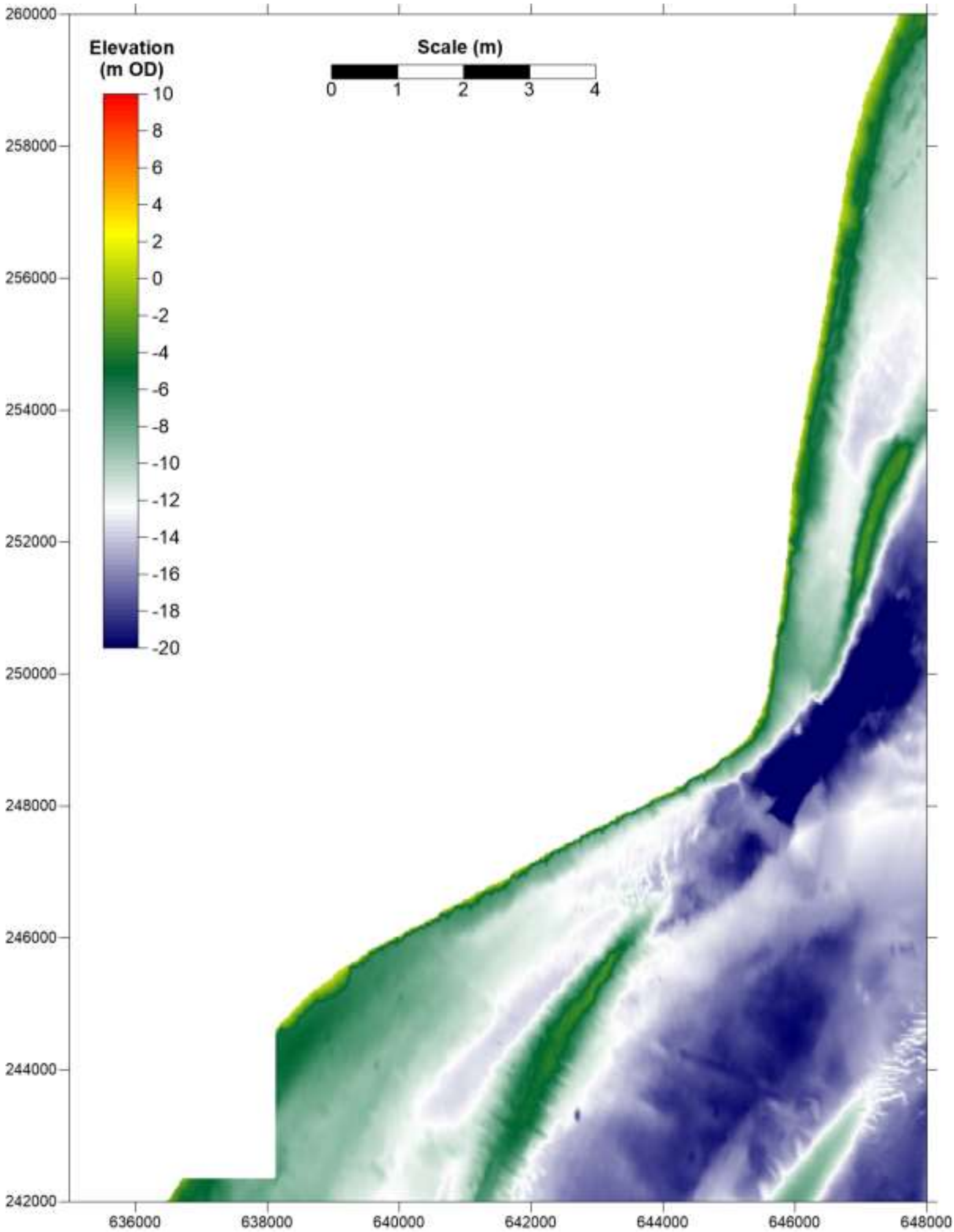


Figure 7. The extent of the Seazone bathymetry data, based on surveys from various dates

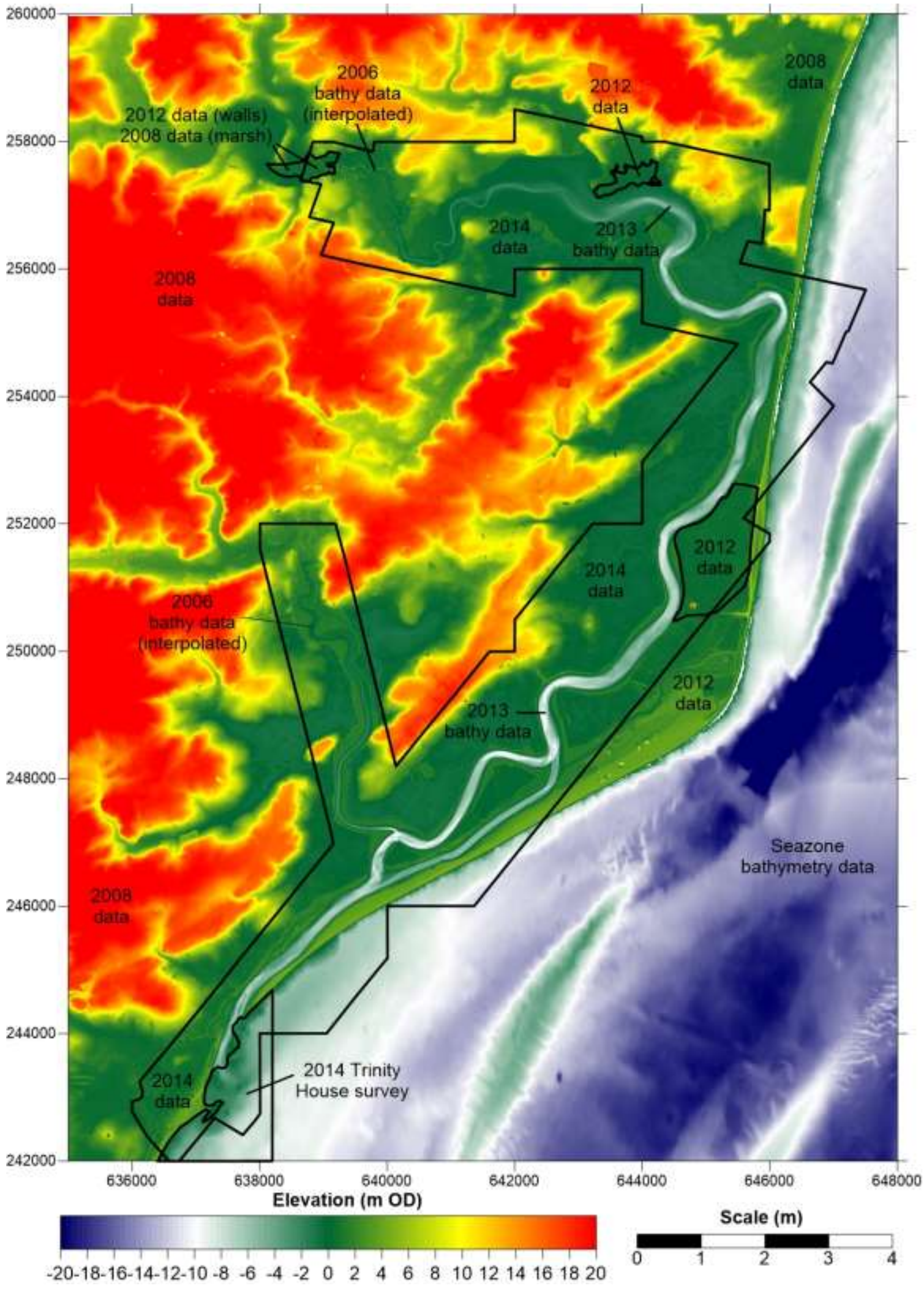


Figure 8. The final combined LiDAR and bathymetric DEM, constructed using data from 2008, 2012 and 2014 LiDAR surveys, 2013 swath bathymetry, 2014 Trinity House survey of the mouth, Seazone bathymetry, and manually inserted bathymetry for the Butley River and upper River Alde using 2006 bathymetry cross-sections as a guide.

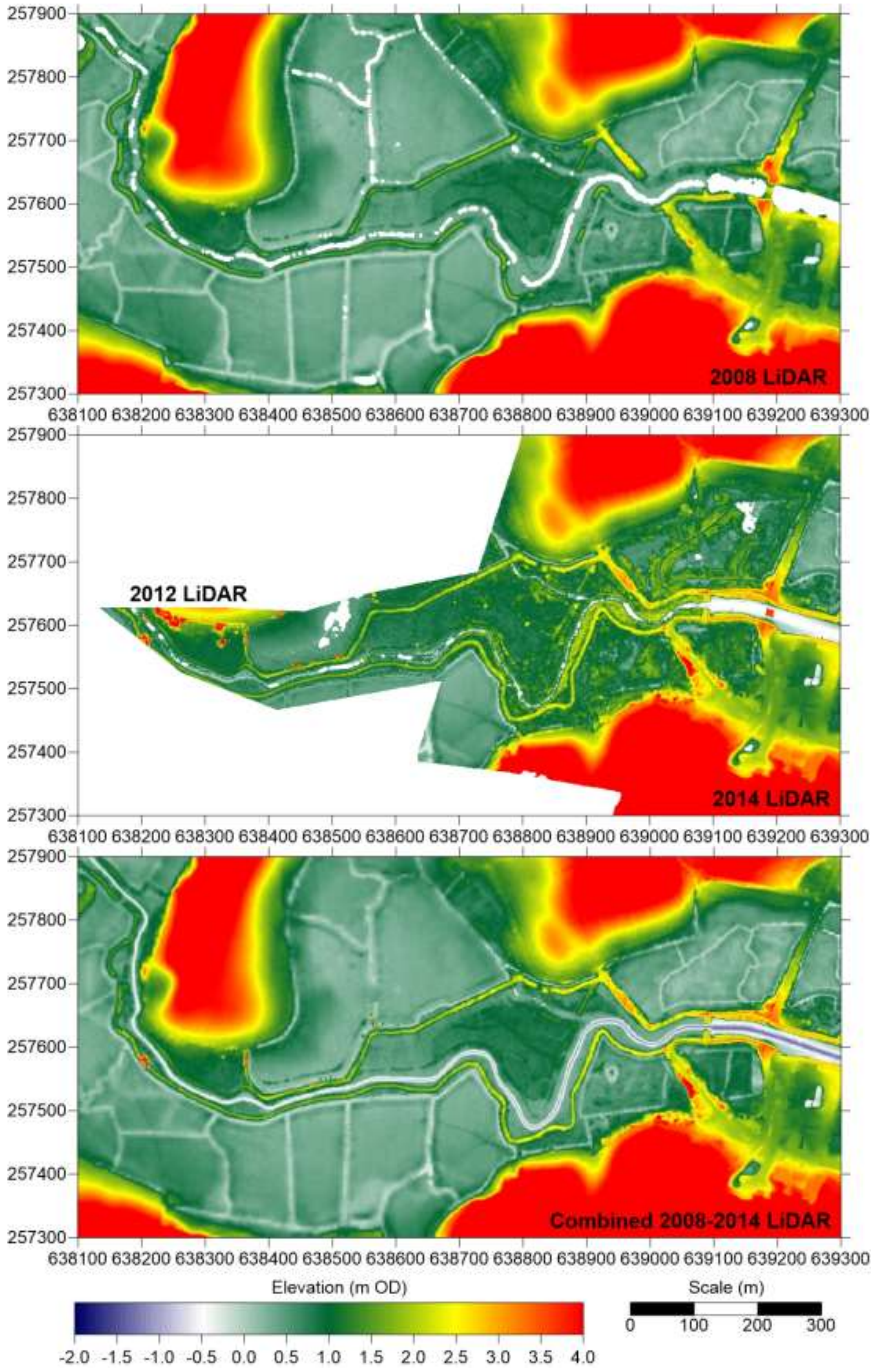


Figure 9. Comparison of 2008, 2012 and 2014 LiDAR above Snape Bridge, and the final combined DEM preferentially selecting 2012-14 data for the rebuilt walls, and 2008 data for the marsh areas.

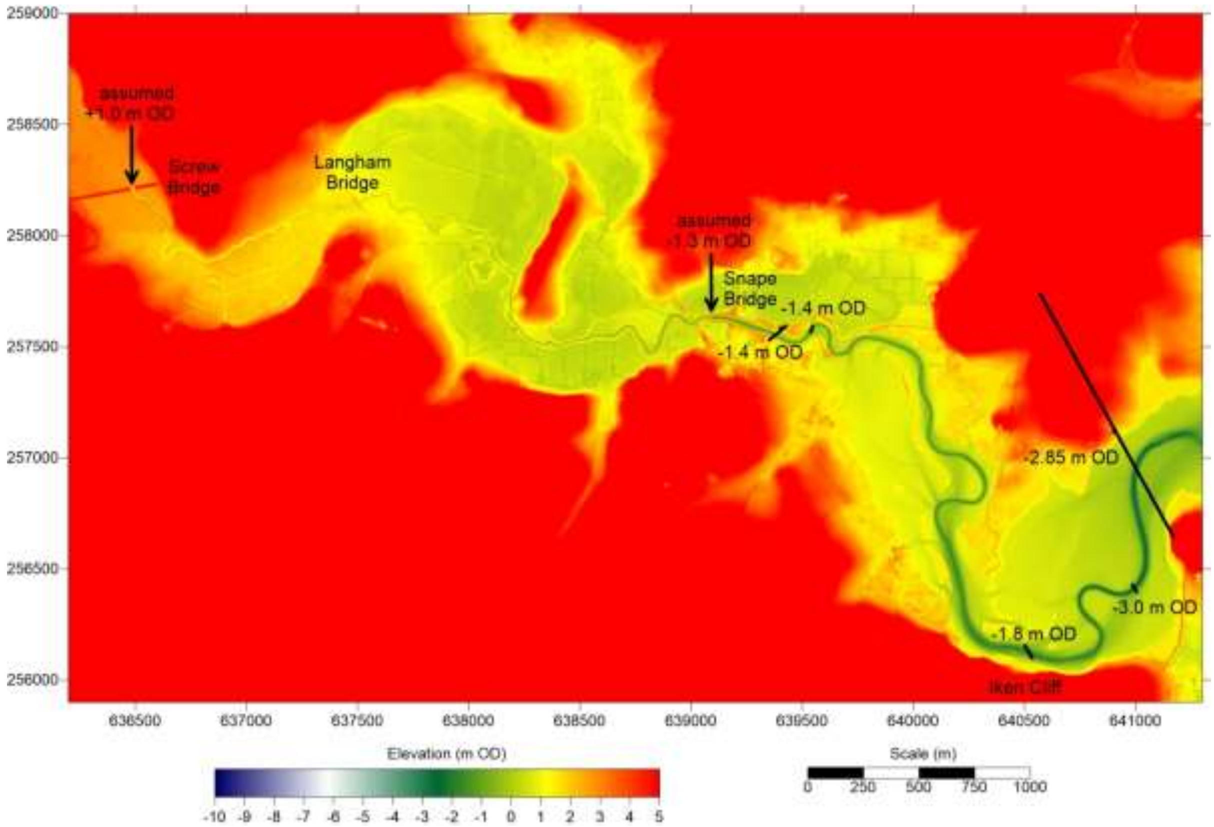


Figure 10. The upper river Alde, showing the locations and depth of the thalweg measured at EA cross-sections surveyed in 2006, and assumed depths at Snape Bridge and Screw Bridge.

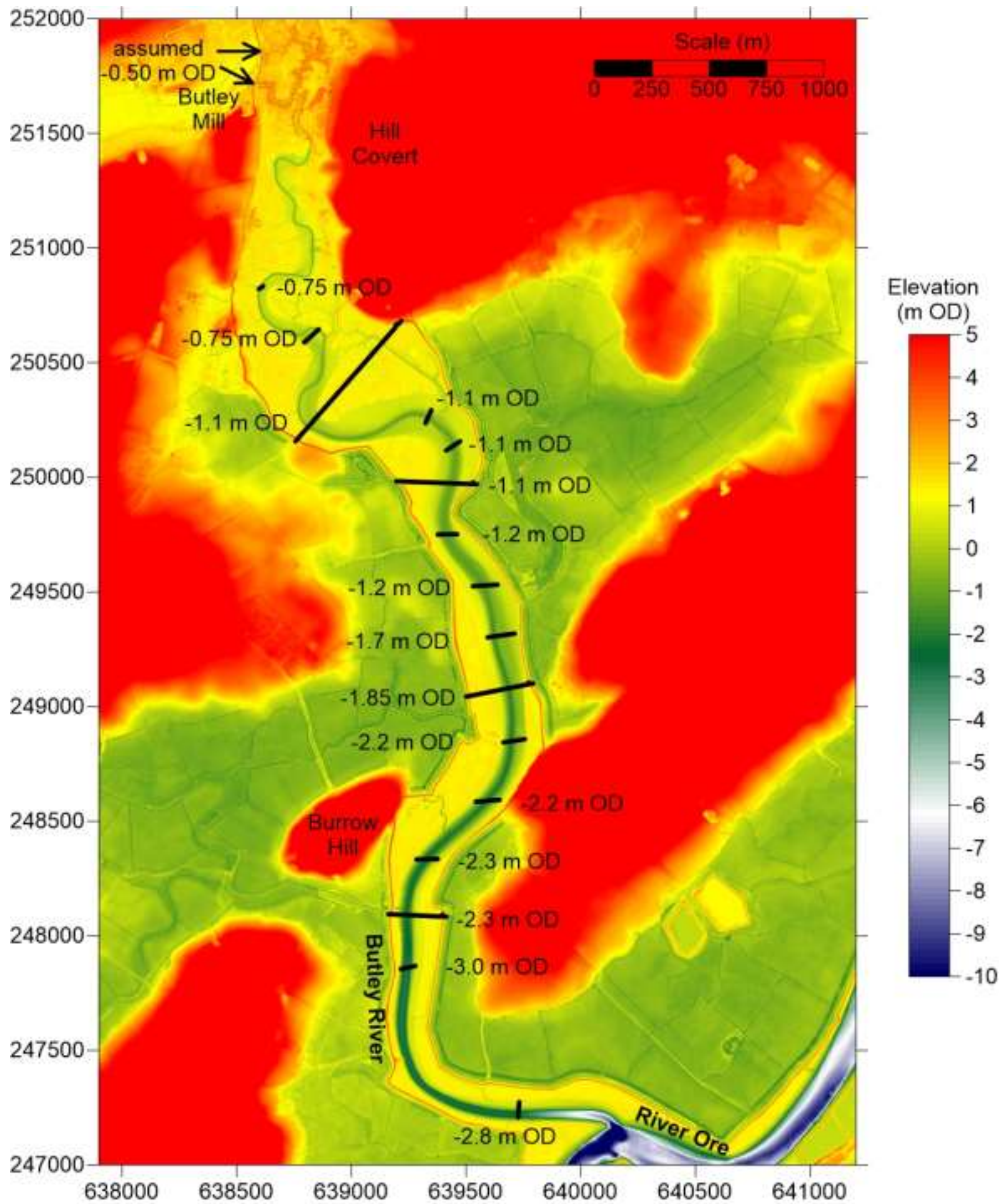
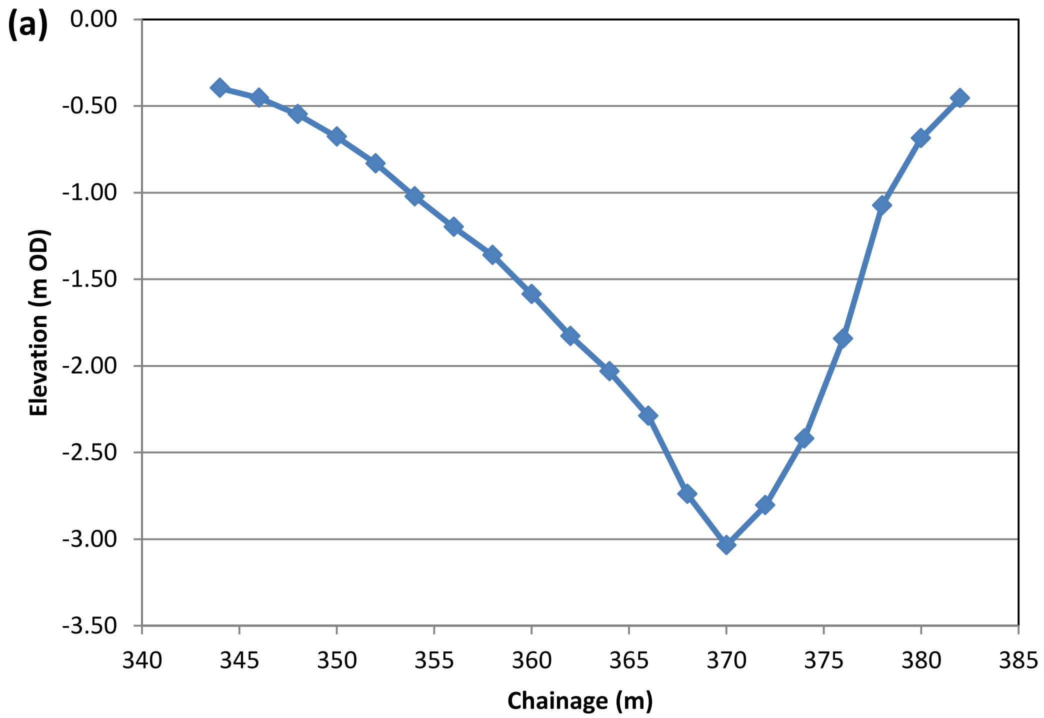


Figure 11. The Butley River, showing the locations and depth of the thalweg measured at EA cross-sections surveyed in 2006, and assumed depth at Butley Mill.



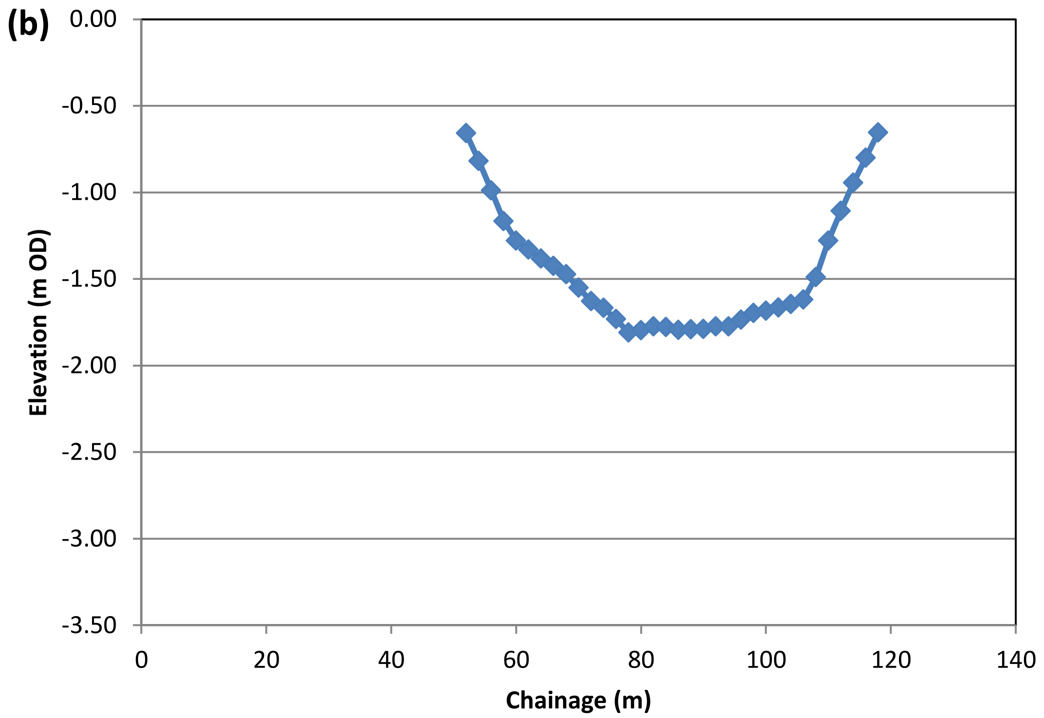


Figure 12. Example EA bathymetry cross-sections of the upper River Alde, surveyed in 2006: (a) a V-shaped cross-section (Profile 73A-74A); and (b) and U-shaped cross-section (Profile 75A to 76A).

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