BLUE Coast
Physical and biological dynamic coastal processes and their role in coastal recovery

Contemporary Challenges for Shoreline Change Analysis

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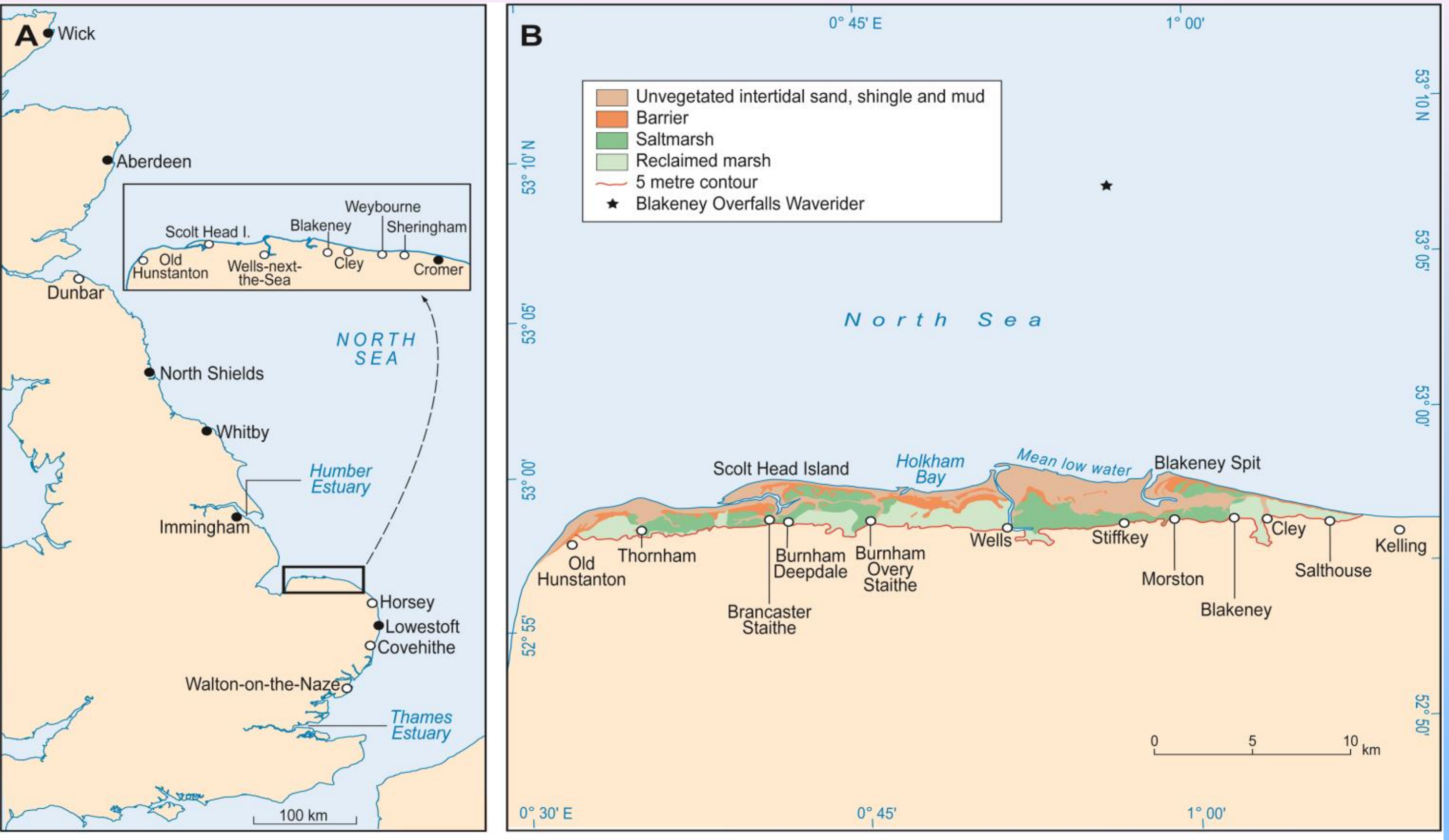
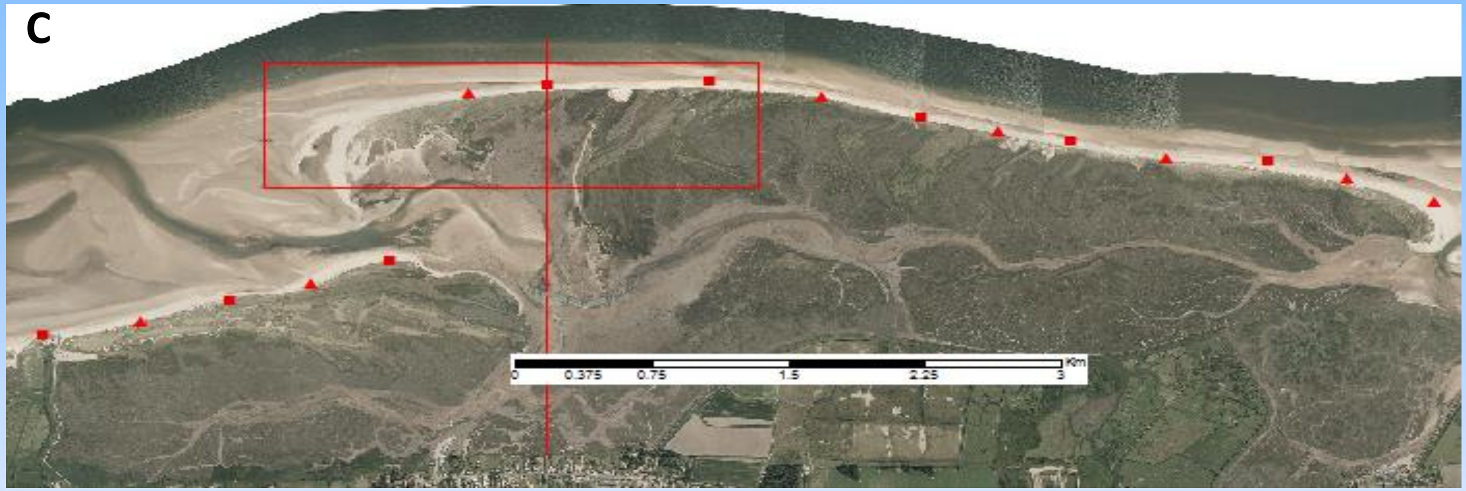


Figure 1: Study site location on the North Norfolk coast, UK. A) General setting within the UK, B) landuse settings along the barrier coast of North Norfolk and C) detail of the Scolt Head Island field site locations of cross-shore profiles from the UK Environment Agency database. Note: cross shore profile used in this study identified by red line and detailed area of analysis shown by red bounded box



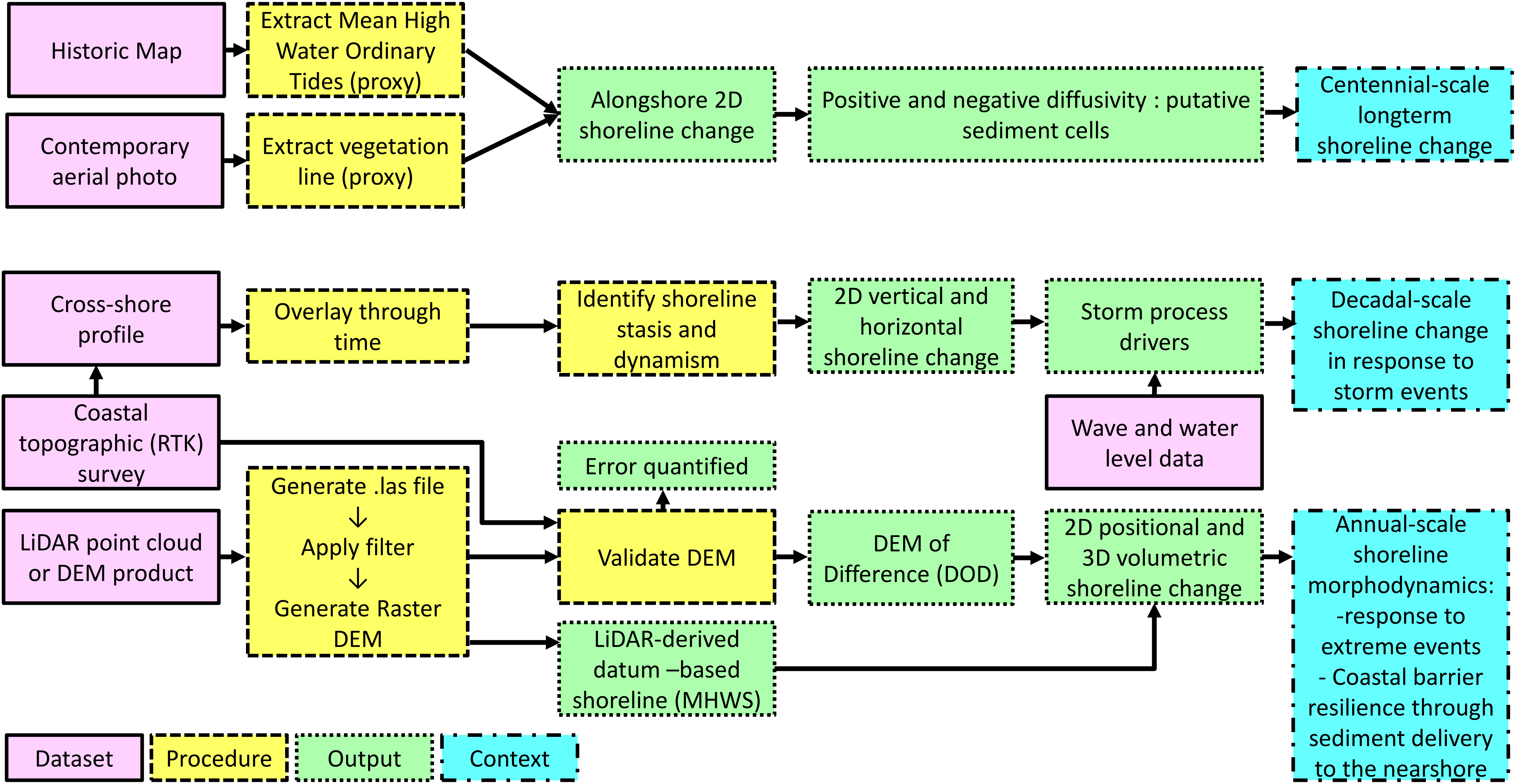
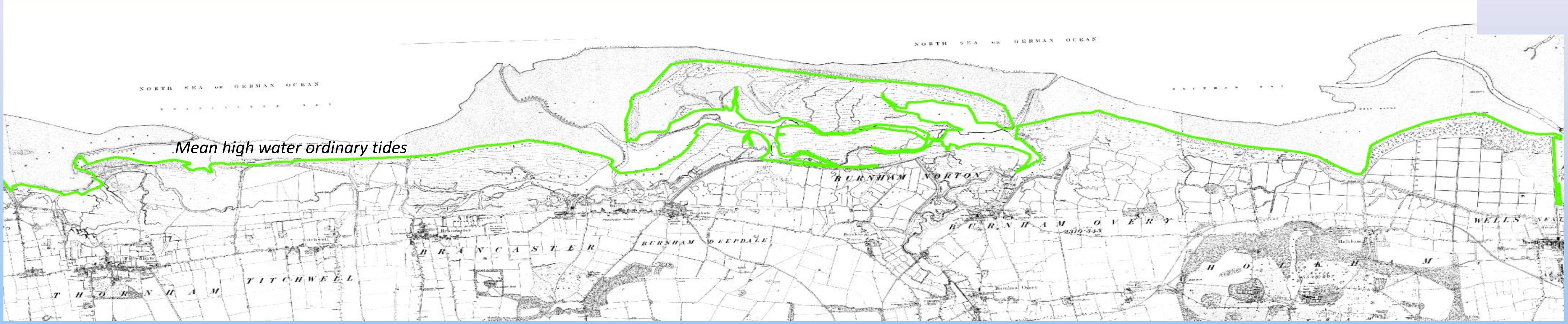


Figure 2: Workflow diagram for datasets, procedures, outputs and context

Figure 3: North Norfolk Coast in 1885 (1 :10 560) and 2010 (aerial photo) showing centennial-scale change and identifying areas of positive and negative sediment diffusivity along the coast



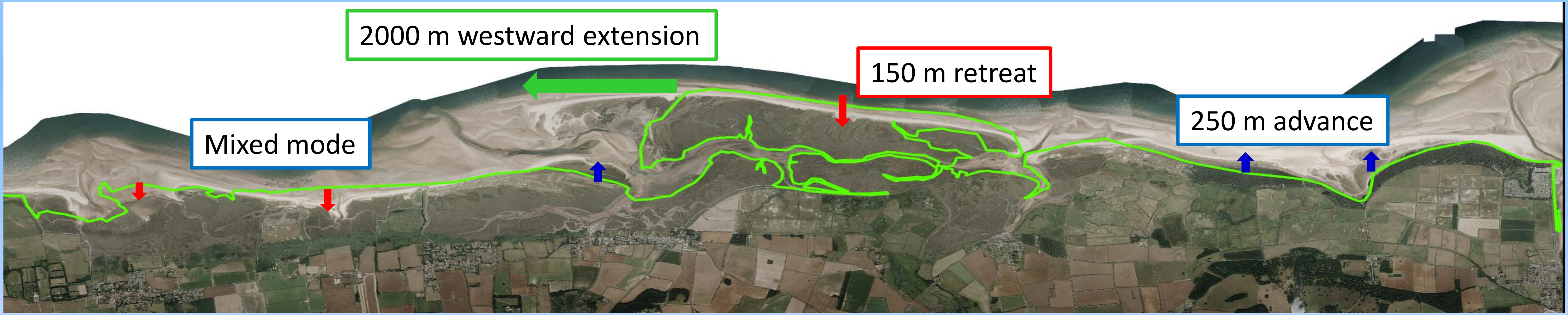
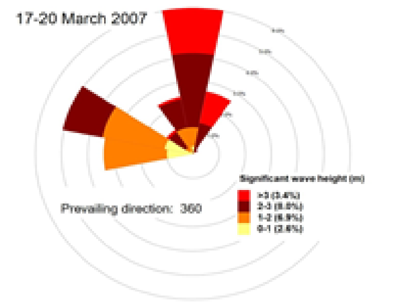
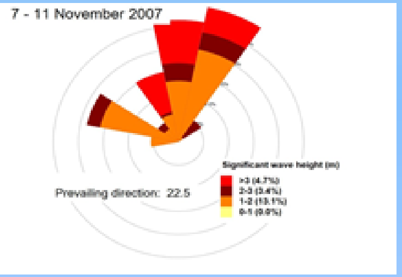
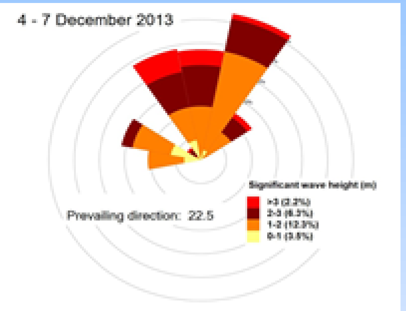


Figure 4: Cross-shore profile analysis for Scolt Head Island, 2008-2014 revealing stasis (2008-2013) and dynamism (2006-2007; 2007-2008; 2013-2014) in shoreline change on decadal timescales. Storm forcing conditions from waves recorded 17-20 March, 2007; 7-11 November, 2007; and 4-7 December, 2013

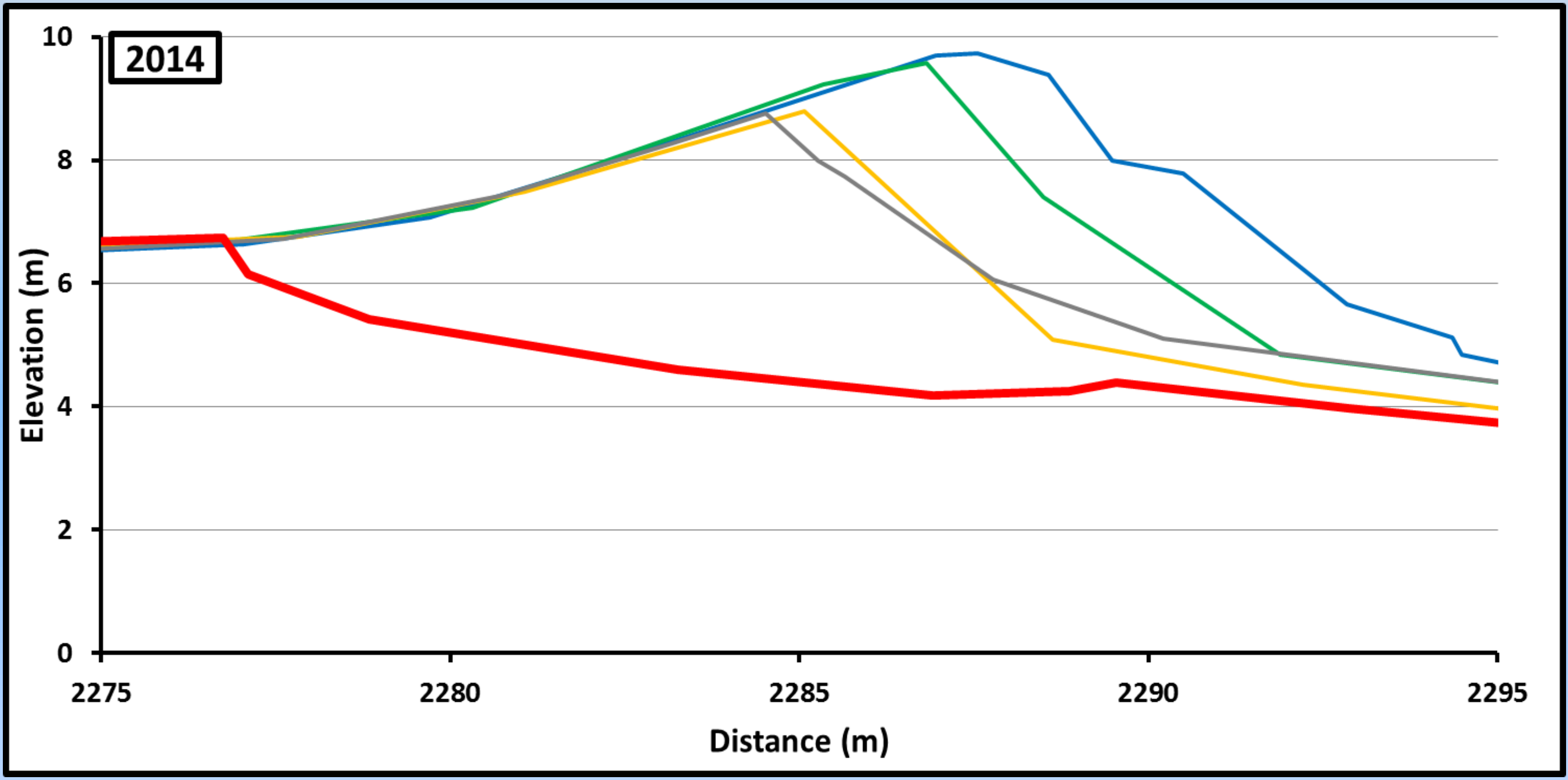
The photo above shows an extensive washover and the cross-shore profile location on the higher dunes behind. The barrier has lost elevation (3 m) and retreated (13 m) inland. Each storm can be matched to the forcing conditions from the Blakeney Overfalls Wave Rider (figure 1) for wave height and direction.





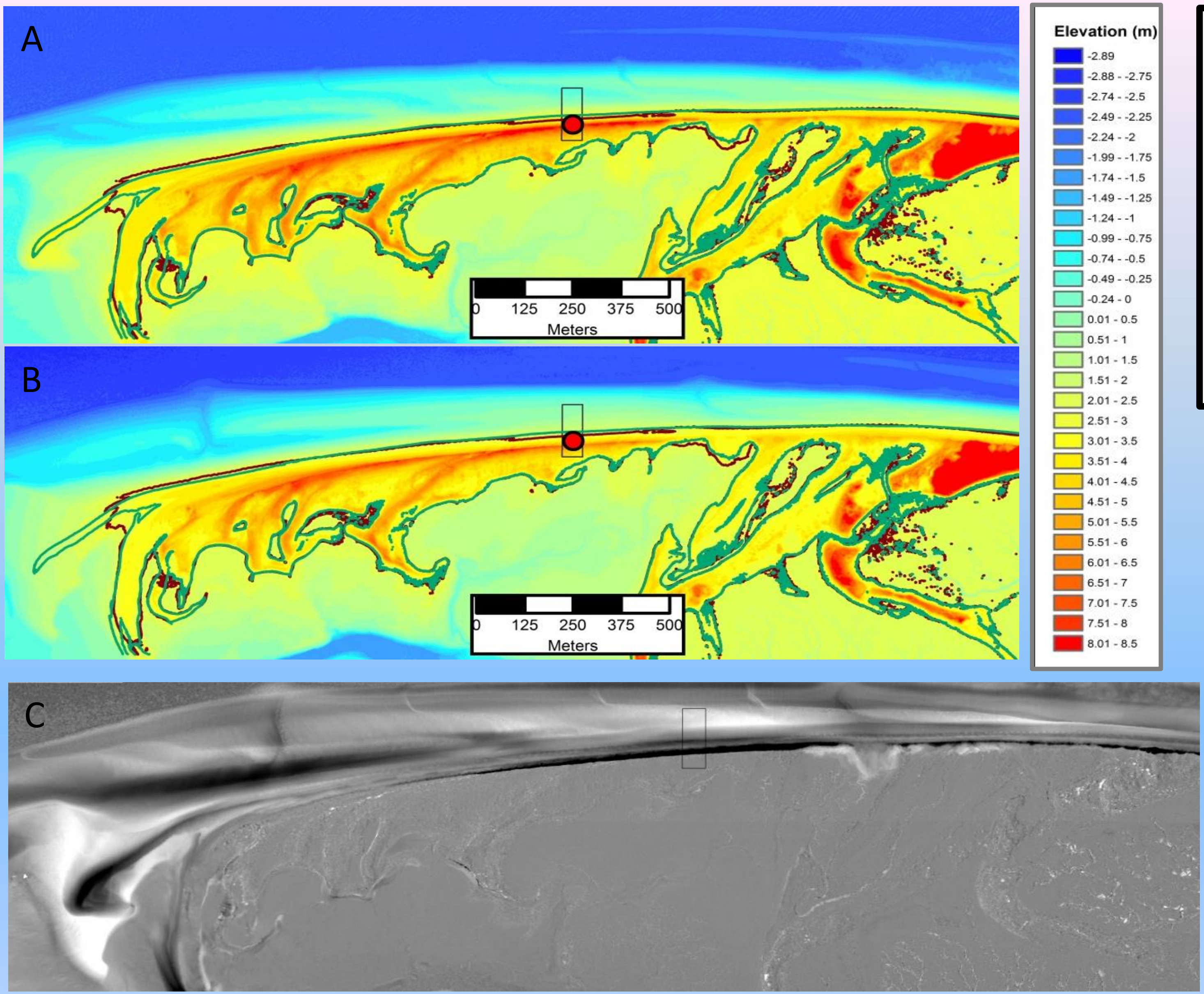


Blue: 2006 Green: 2007 Gold:2008 Grey: 2013 Red: 2014



Cross-shore profiles courtesy of the UK Environment Agency

Figure 5: Use of LiDAR for shoreline change analysis allows datum based shorelines to build upon proxy based information. Here, airborne LiDAR point clouds from 28th January 2013 (A) and 28th February 2014 (B) were processed to develop a 1 m resolution DEM and a DEM of Difference (DOD) (C) was derived for an area depicted by the bounding box in figure 1c.

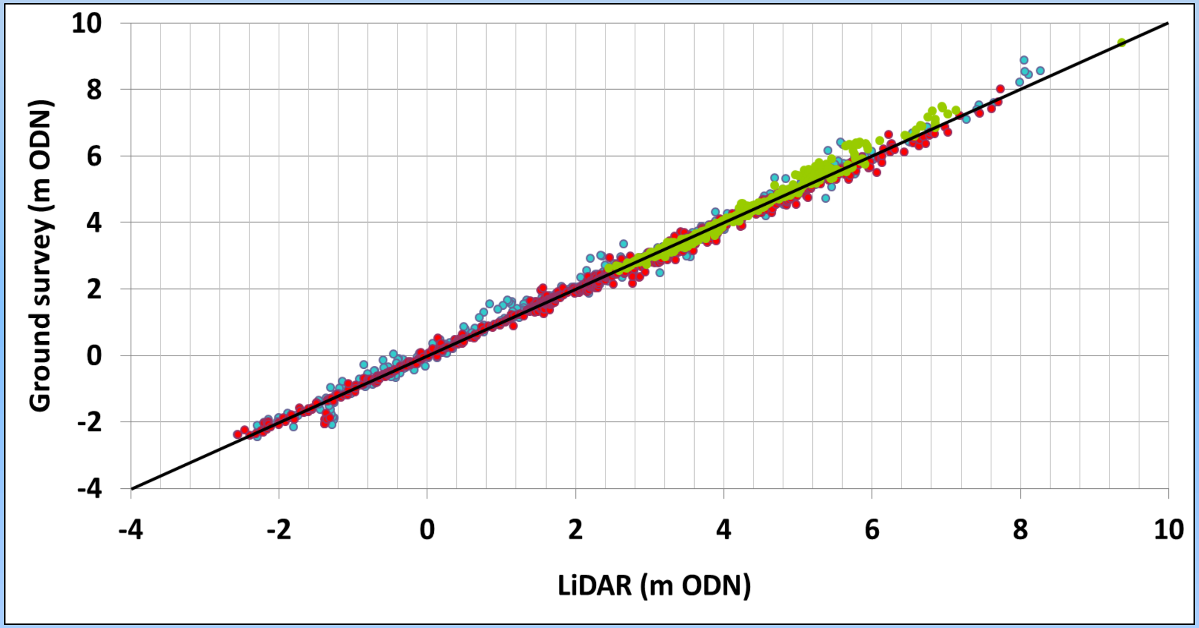


Stretched raster from -4.7 m (height loss - dark) to 2.3 m (height gain – light)

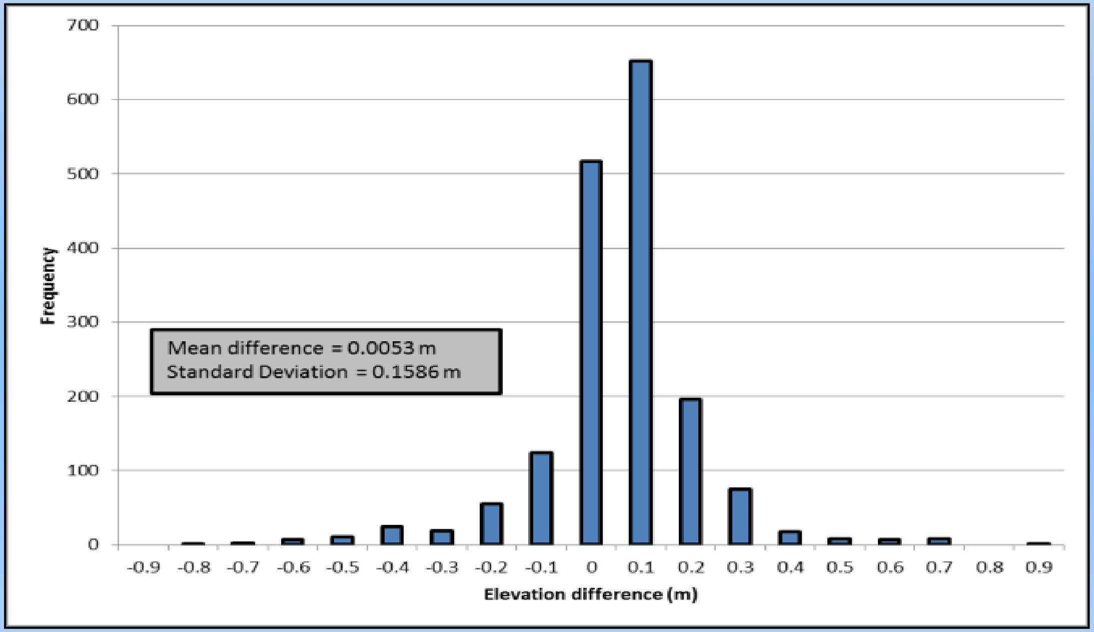
Clearly seen are the locations of barrier erosion (retreat) where elevations have fallen by up to 4.7 m, and erosion around the western end of the barrier. However, elevation gains are evident at the western end as it continues to expand, the intertidal bars on the beach are developing and areas around the washover and laterals have also gained in elevation.

Figure 6: LiDAR product accuracy as verified by RTK ground survey for points along the shoreline of the area shown in figure 5. (A) Ground surface elevations from RTK surveys and LiDAR for the western end of the barrier at Scolt Head Island (28th January 2013 LiDAR elevations are plotted against EA cross-shore surveys on 8th March 2013 (blue); 28th February 2014 LiDAR elevations are plotted against EA cross-shore surveys on 3rd March 2014 (red) and ground survey on 31st January 2014 (green) for the eroded edge of the shoreline barrier. The 1:1 line is shown in black. In all cases r2 > 0.98. (B) Frequency distribution plot of mean error calculated in 6A.

A



B



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Conclusions

- Proxy-based and datum-based shorelines are used to develop a picture of shoreline change at centennial, decadal, annual and event scales
- Methodological developments include working with historic maps, aerial photos, ground-based survey and LiDAR to assess magnitude and location of shoreline change
- Linked process drivers are contained in wave and water level data sets
- LiDAR products are 1 m pixel resolution and give accuracy to within ±10 cm, which for shoreline change of 13 m is within 0.7%
- Higher frequency satellite imagery is available from mid-1980s but at pixel resolutions of 30 m – currently too coarse to provide accurate proxy-based shoreline information and unable to provide datum-based shoreline information
- Combination of maps, aerial photos, cross-shore profiles and ground RTK surveys as well as LiDAR is suitable for providing regional to local scale analysis of contemporary and historic shoreline change at a range of scales

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Further Information:

- Pollard J.A., Spencer, T., Brooks, S.M., Christie, E.K. and Möller, I. (2020) Understanding spatio-temporal barrier dynamics through the use of multiple shoreline proxies. Geomorphology (https://doi.org/10.1016/j.geomorph.2020.107058)
- Pollard J.A., Brooks, S.M. and Spencer, T. (2019) Harmonising topographic & remotely sensed datasets, a reference dataset for shoreline and beach change analysis. Nature Scientific Data, 6:42 (https://doi.org/10.1038/s41597-019-0044-3)