Linking nearshore morphological change to long term observed sand loss from a mixed sediment beach

University of Southampton

D.Townsend@soton.ac.uk
@snuffleapagus

Authors: Dominique Townsend[1], Dr Julian Leyland[2], Dr Hachem Kassem[1], Dr Charlie Thompson[1,3], Prof. Ian Townend[1]

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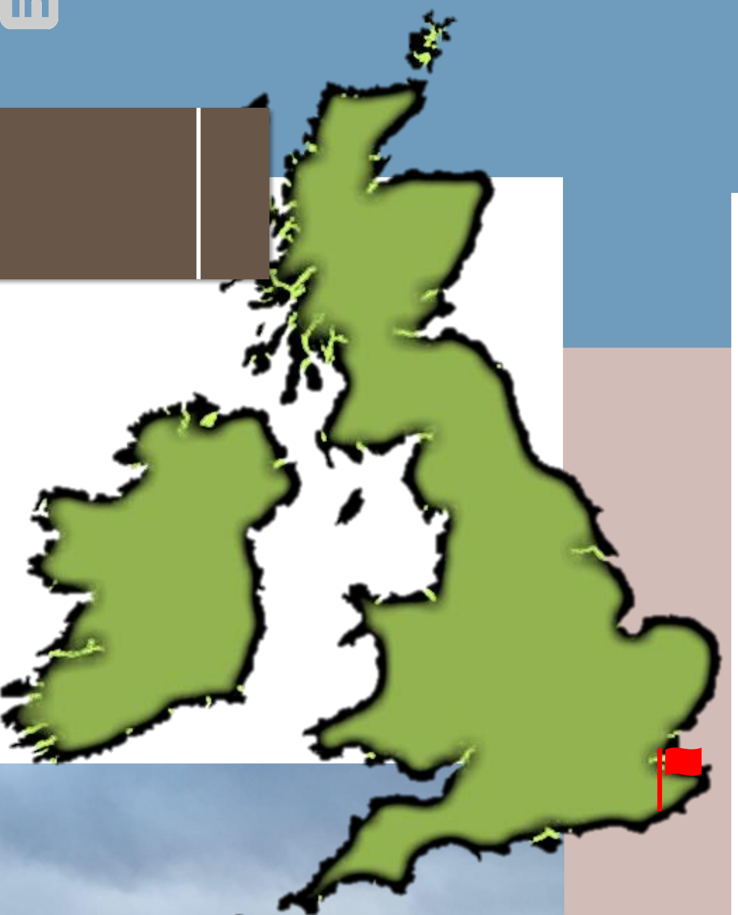
QR to abstract

CONTEXT



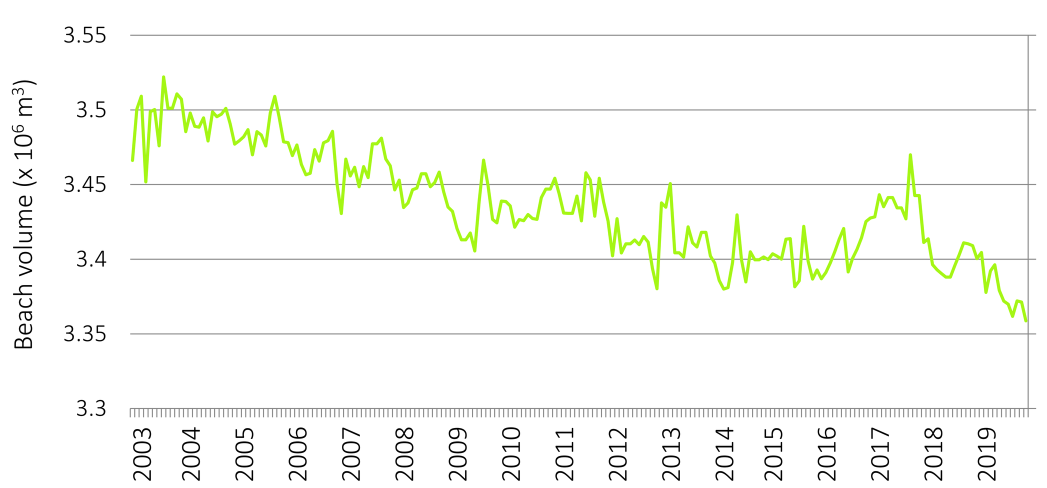
NEARSHORE ZONE OF MIXED SEDIMENT BEACHES

Few studies focus on the changing morphology of the nearshore zone of mixed sediment beaches, despite the fact that these beaches are found across the world. In the UK, these beaches make up ~25% of the coastline (Scott *et al.*, 2011), and are often utilised as a first line of defence against coastal flooding.

THE BEACH AS A DEFENCE

In Pevensey Bay, East Sussex, active beach management (sediment recycling and recharge) maintains the mixed gravel barrier beach to protect around 10,000 properties, culturally significant landmarks and internationally important wildlife sites (Sutherland and Thomas, 2011). During the past 25 years, this management approach has successfully maintained the volume of the upper shingle part of the beach. However, the sandy foreshore area is experiencing a continuing loss of 8000 m^3 of sediment *per annum* (Thomas, 2015).

This study seeks to understand the drivers behind the sustained loss of volume.

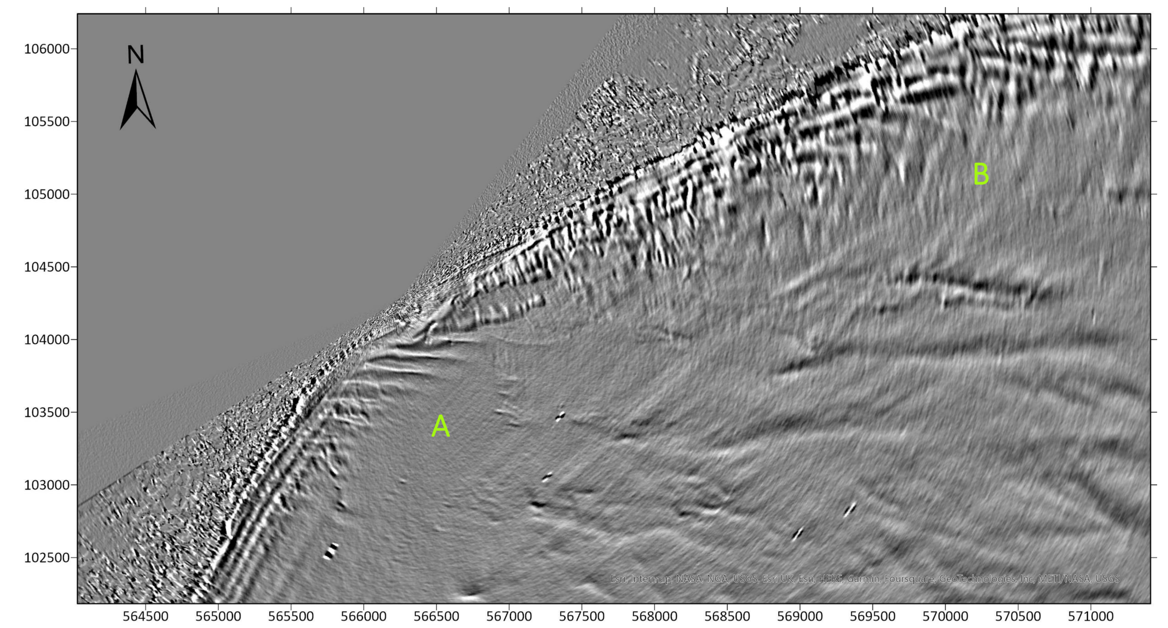


Pevensey Bay beach volume calculated above a datum of -2.0mOD (Thomas, 2013)

OUR STUDY

TRANSVERSE FINGER BARS

Examination of multibeam bathymetry data revealed the presence of transverse finger bars with a wavelength of approximately 80 – 120 m, orientated at 45 degrees from the shoreline in the subtidal zone extending between the -2.0 to -5.0 mOD contours, across the study site. Using X-band radar imagery, we show that in the west of the site, the bars were a permanent feature over the 18-month period of observation, whilst to the east there were bars that disappeared after sustained periods of easterly waves.



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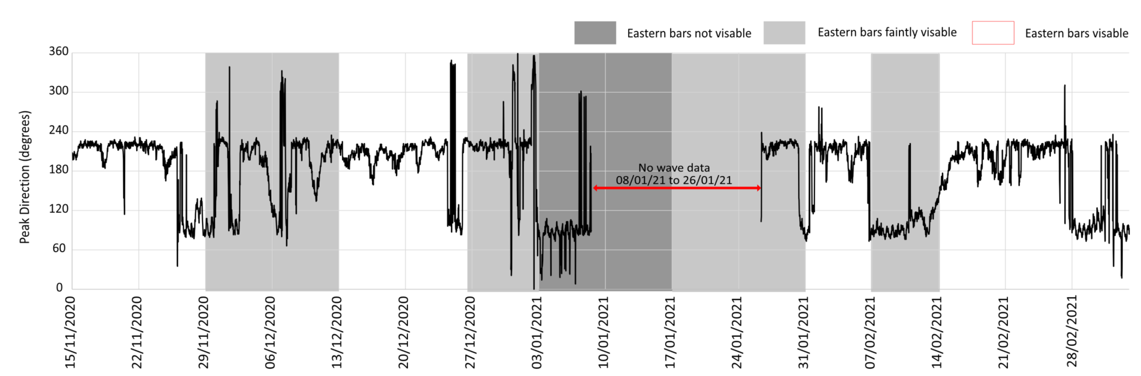
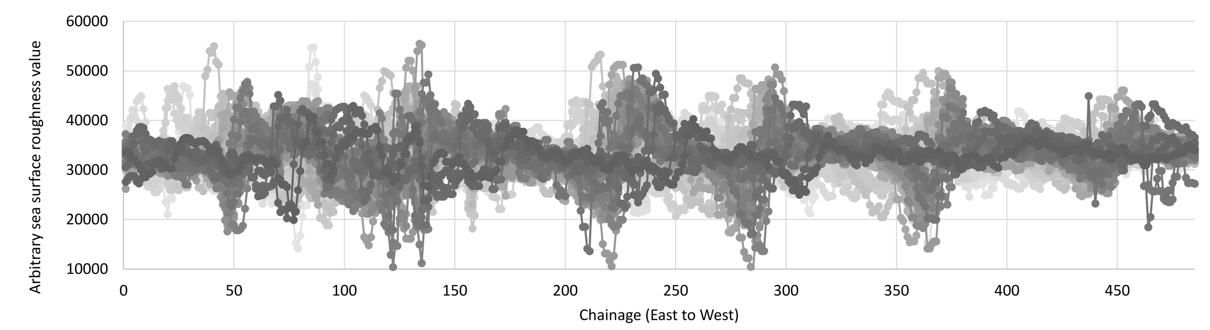
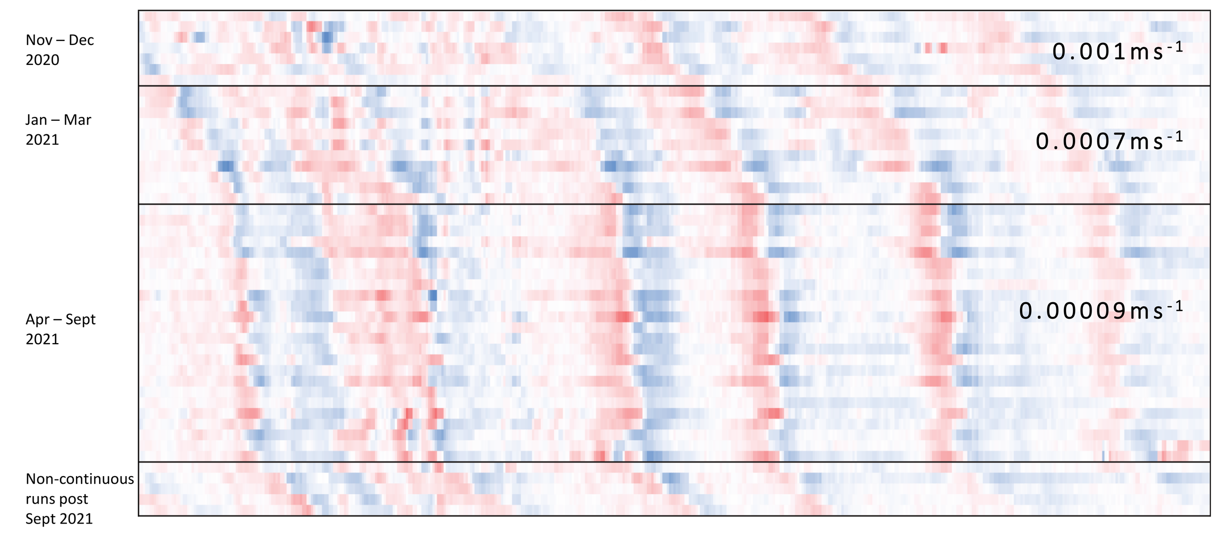
(Above) transverse finger bars seen in the west (A) and east (B).
(Below) the eastern group of transverse finger bars were not permanent features, appearing clearly 11/47 weeks, appearing faintly 25.47 weeks and not visible for 11/47 weeks.

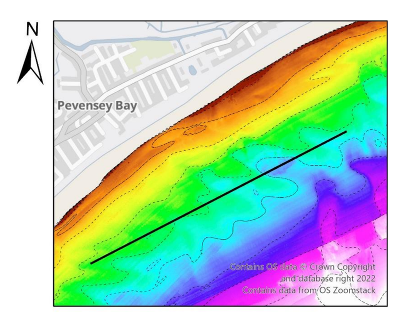


DRIVING FORCES

This novel approach of studying mobile sea bed features provided an indicative migration rate of approximately one wavelength a year of the features to the east. A steady migration rate during the winter months, and virtually no movement during the summer period, suggests that the movement of the bars is driven by relatively higher energy south westerly waves.







(Top panel) a cross section of the weekly surface roughness dataset, taken parallel to the shore, and oblique to the bar crests closest to the radar tower.

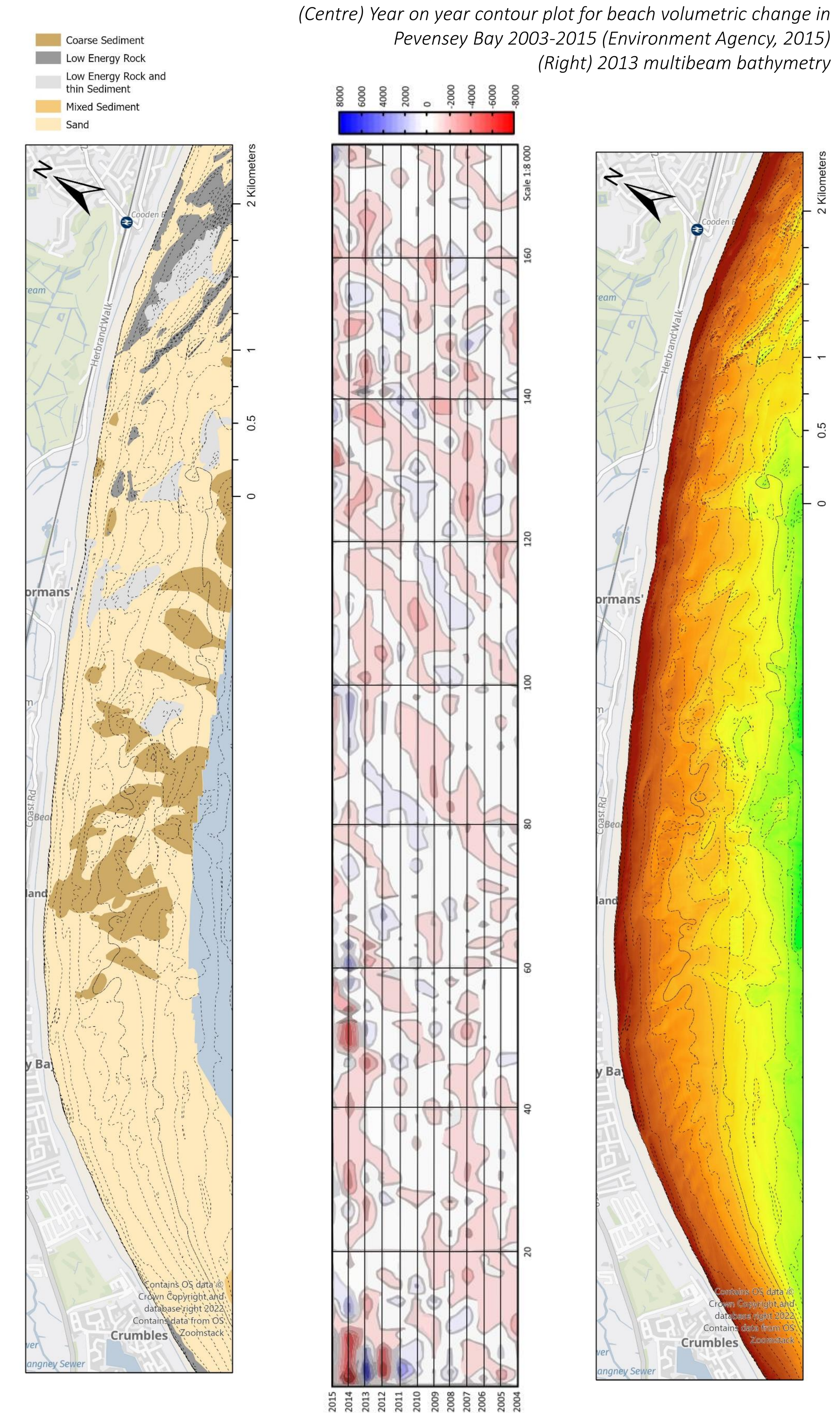
(Bottom panel) The cross sections plotted through time, with red indicating the lowest values and blue the highest.

(Left) location of the cross section in relation to the 2013 multibeam bathymetry data.

MAKING THE LINK

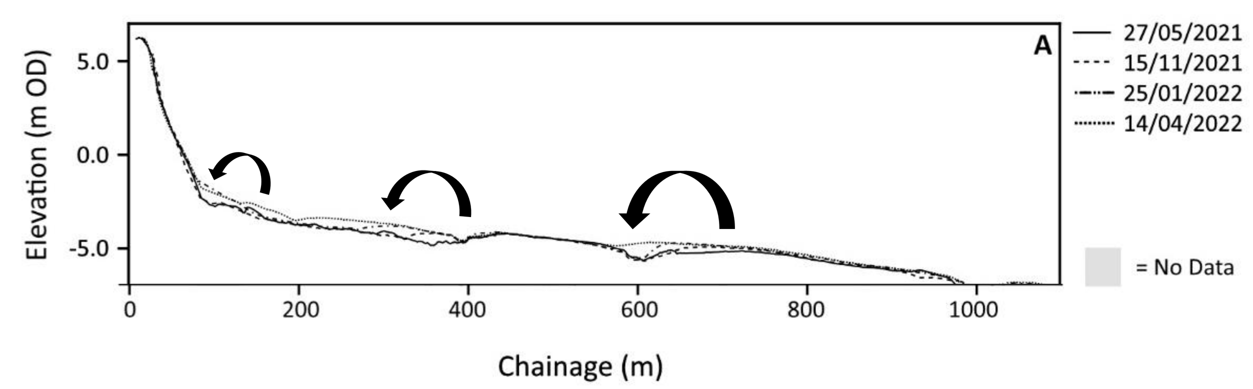
It is thought that the movement of these bars may be linked to erosive and accretive pulses which move easterly across the bay on the upper beach face. Understanding the process dynamics and broader role within the bay-wide sediment budget of these features is essential in comprehending the loss of sediment from the bay and will contribute to the future sustainable management of the site, where the management strategy for the next 100 years is currently under review.

(Left) surficial sediments based on 2013 Bathymetry
(Centre) Year on year contour plot for beach volumetric change in Pevensey Bay 2003-2015 (Environment Agency, 2015)
(Right) 2013 multibeam bathymetry



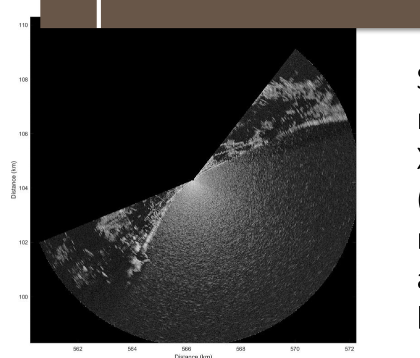
VALIDATION

Repeat bathymetric surveying of a cross shore profile located at the centre of the site showed defined bars, moving in an apparent 'onshore' movement over winter periods and no change during summer periods (Townsend *et al.* in prep).

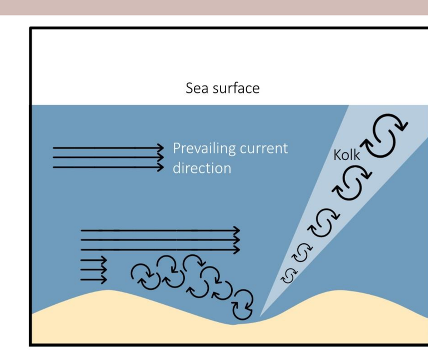


Cross shore profile located in the centre of the bay, dissecting two transverse finger bars, lying at approximately 45° to the shoreline

X-BAND RADAR METHOD



Strong tidal currents flowing over bed features modulate the sea surface roughness, forming turbulent kolks (see right) which can be detected in the X-band radar reflectance imagery (Bell *et al.* 2015). X-band radar images (see left) were captured with each antenna rotation of 0.86 seconds. This raw imagery was translated from polar into cartesian space and then averaged over a one week period to give a sea surface roughness map, locating the areas of undulating bathymetry.



Adapted from Slingsby et al. (2021)

THANKS

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INSPIRE DOCTORAL TRAINING PARTNERSHIP

[1]School of Ocean and Earth Science, University of Southampton, National Oceanographic Centre, European Way, Southampton, SO14 3ZH, UK
[2]School of Geography and Environmental Science, University of Southampton, Shackleton Building, University Rd, Southampton SO17 1BJ, UK
[3]Channel Coastal Observatory, National Oceanographic Centre, European Way, Southampton, SO14 3ZH, UK

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