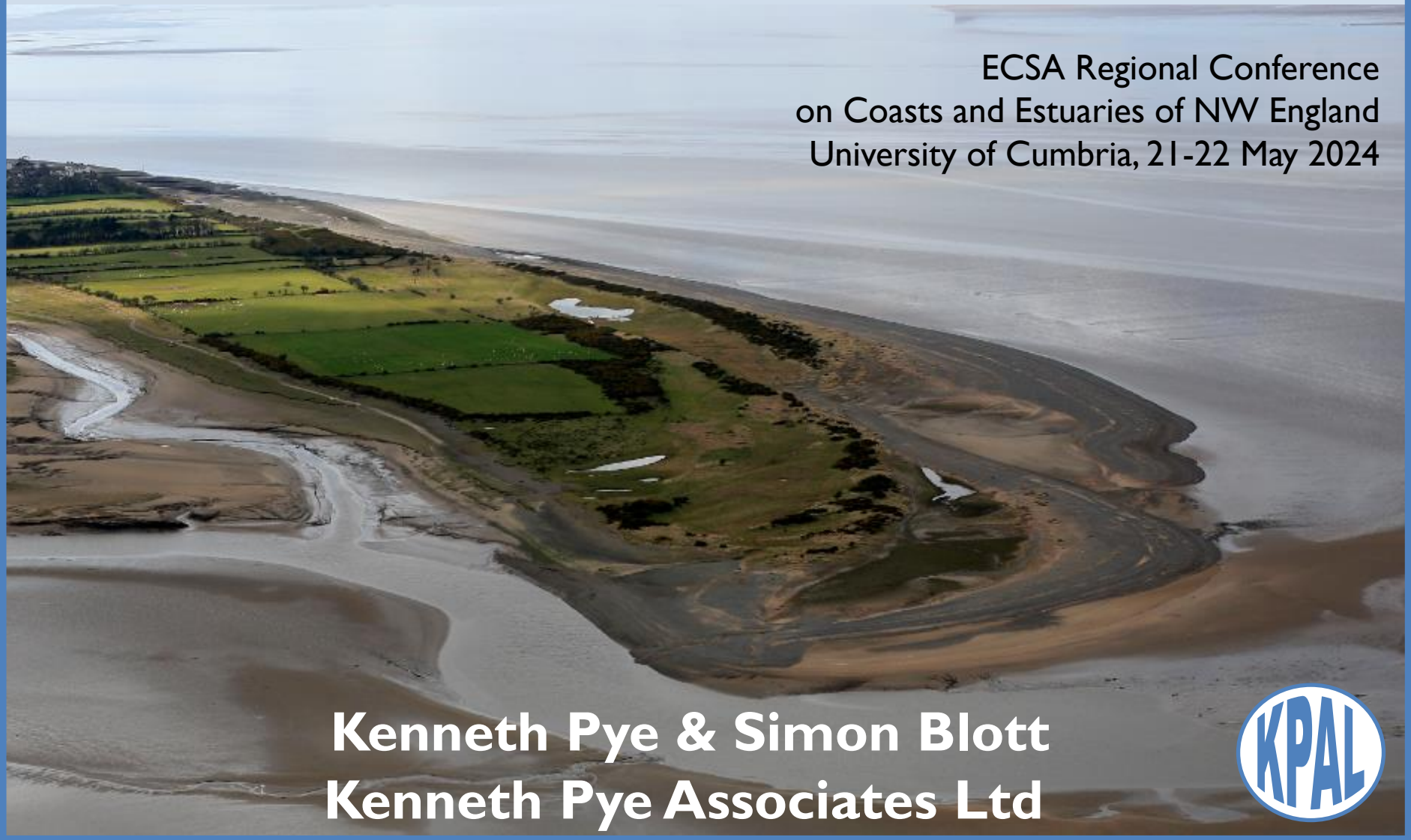
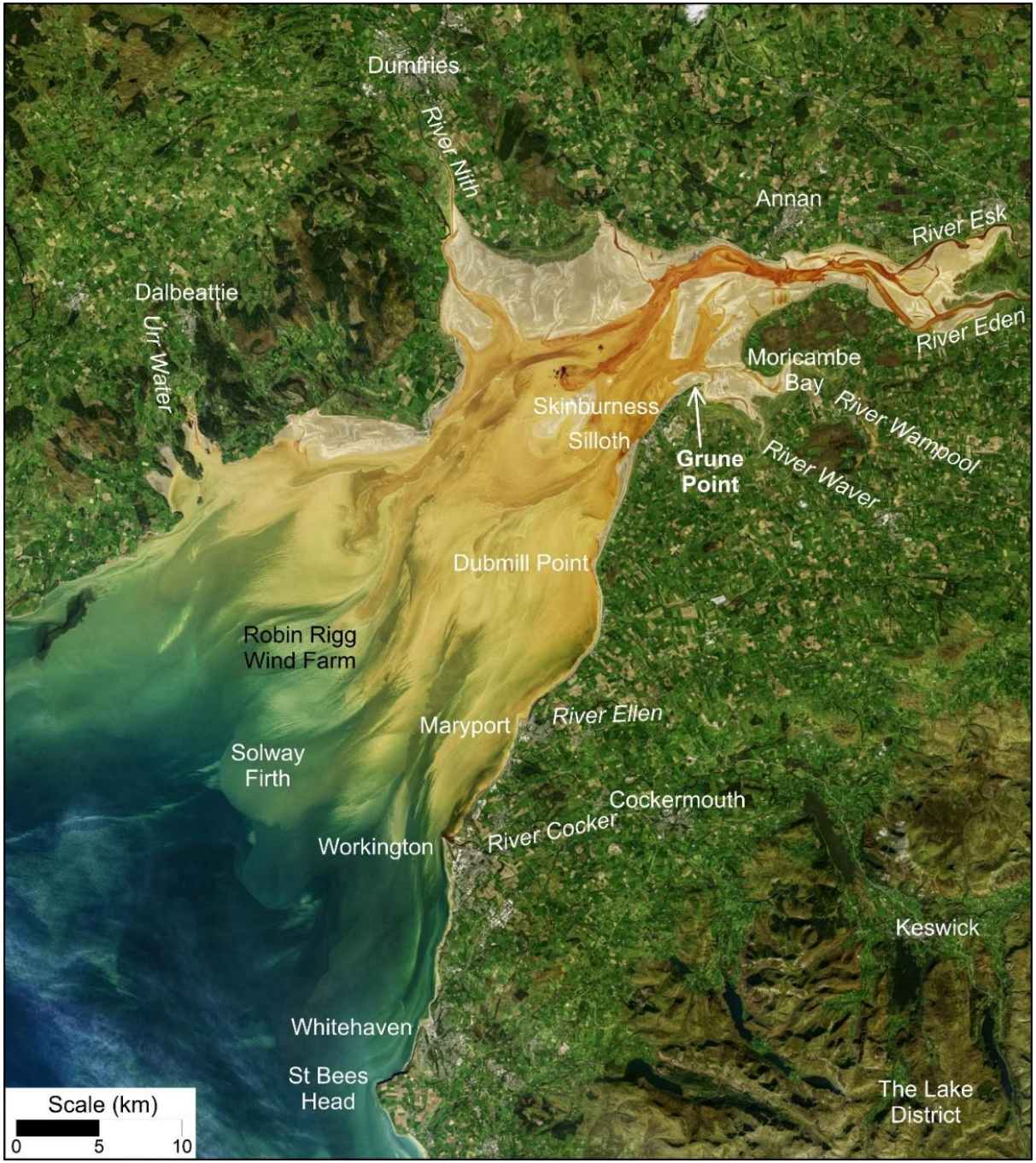
Morphodynamics of Grune Point, Solway Firth



ECSA Regional Conference
on Coasts and Estuaries of NW England
University of Cumbria, 21-22 May 2024

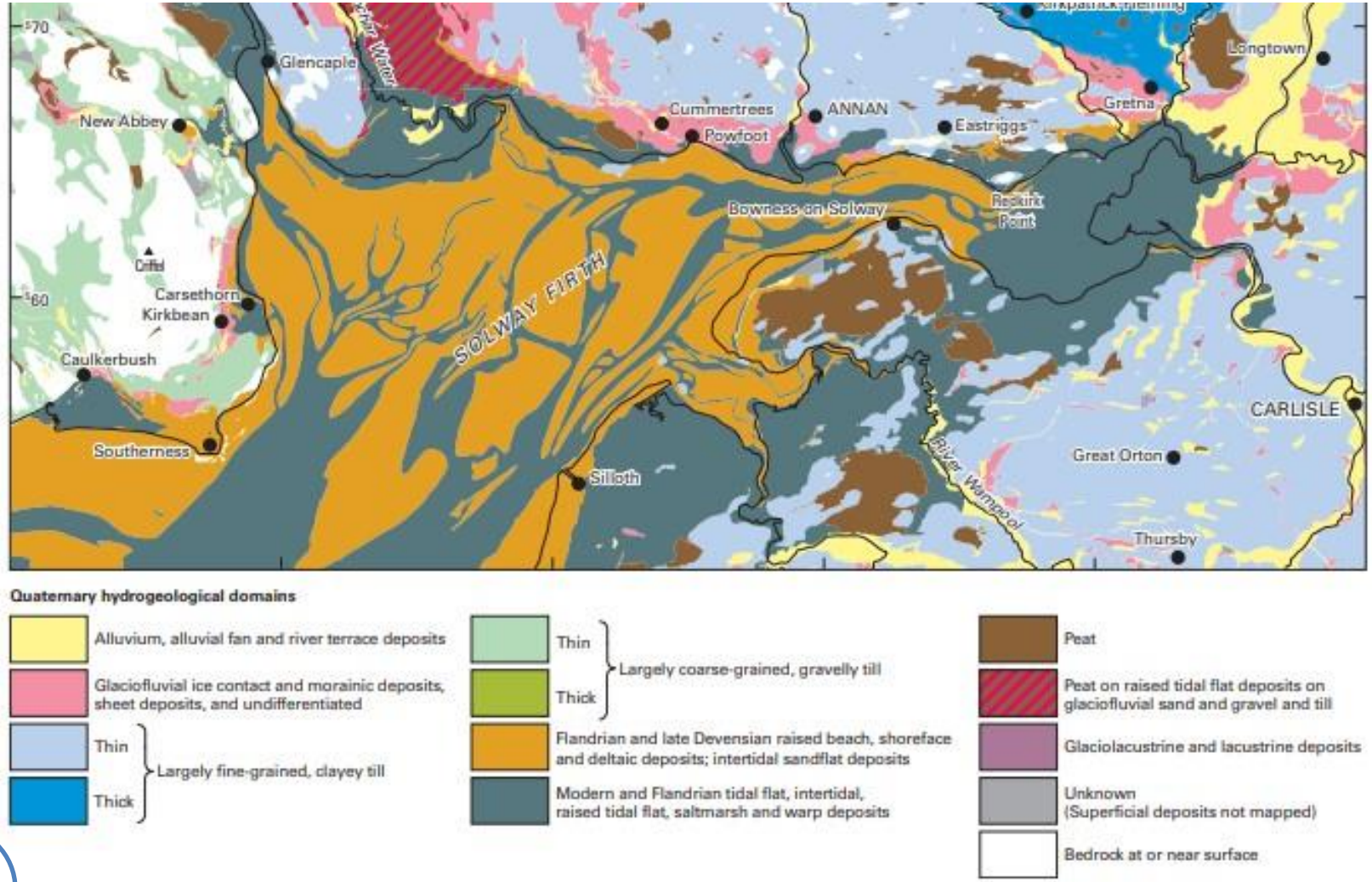
Kenneth Pye & Simon Blott
Kenneth Pye Associates Ltd

The Solway Firth (Landsat false colour image 2019)

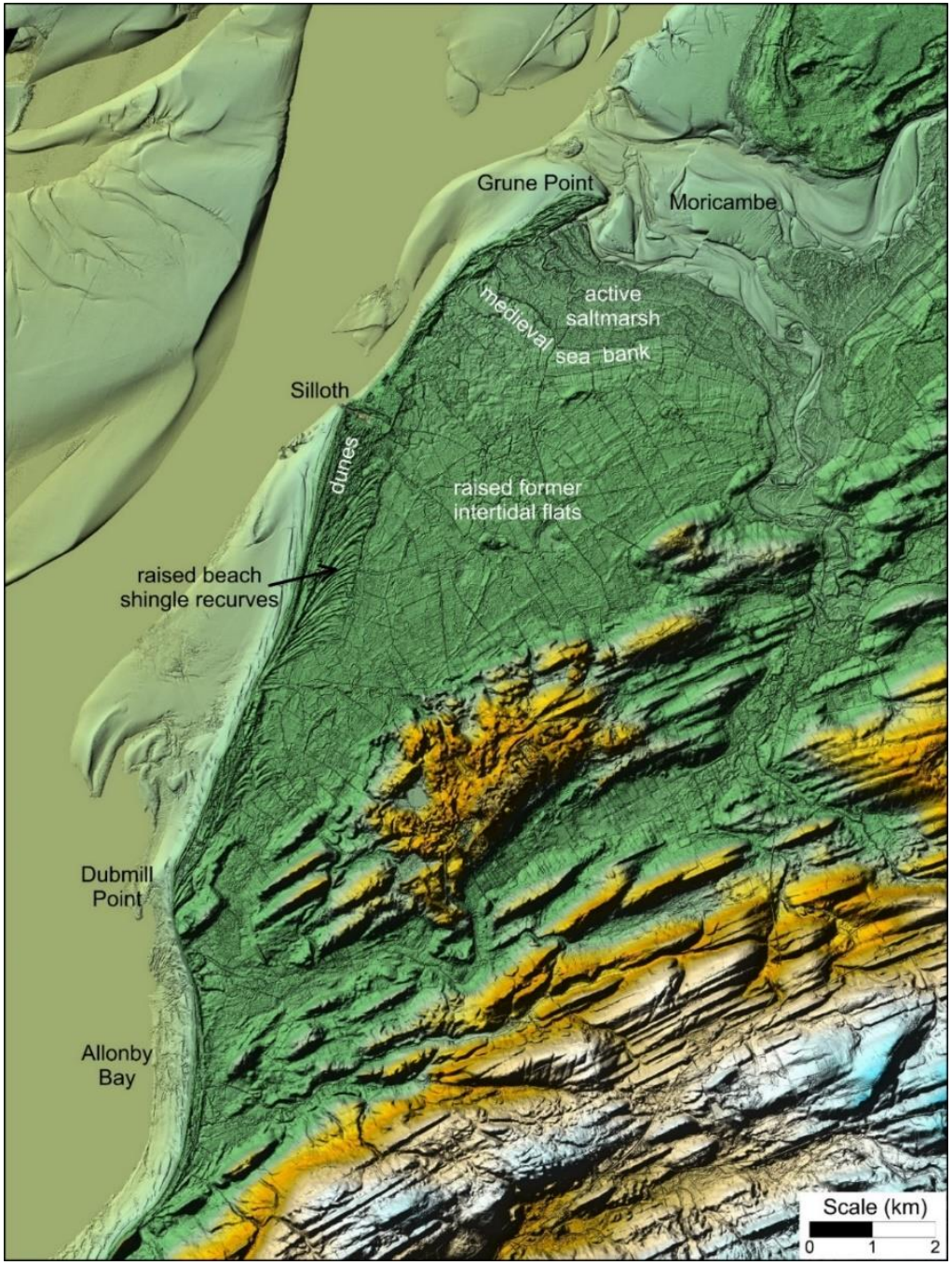


Quaternary hydrogeological domains of the Solway Firth

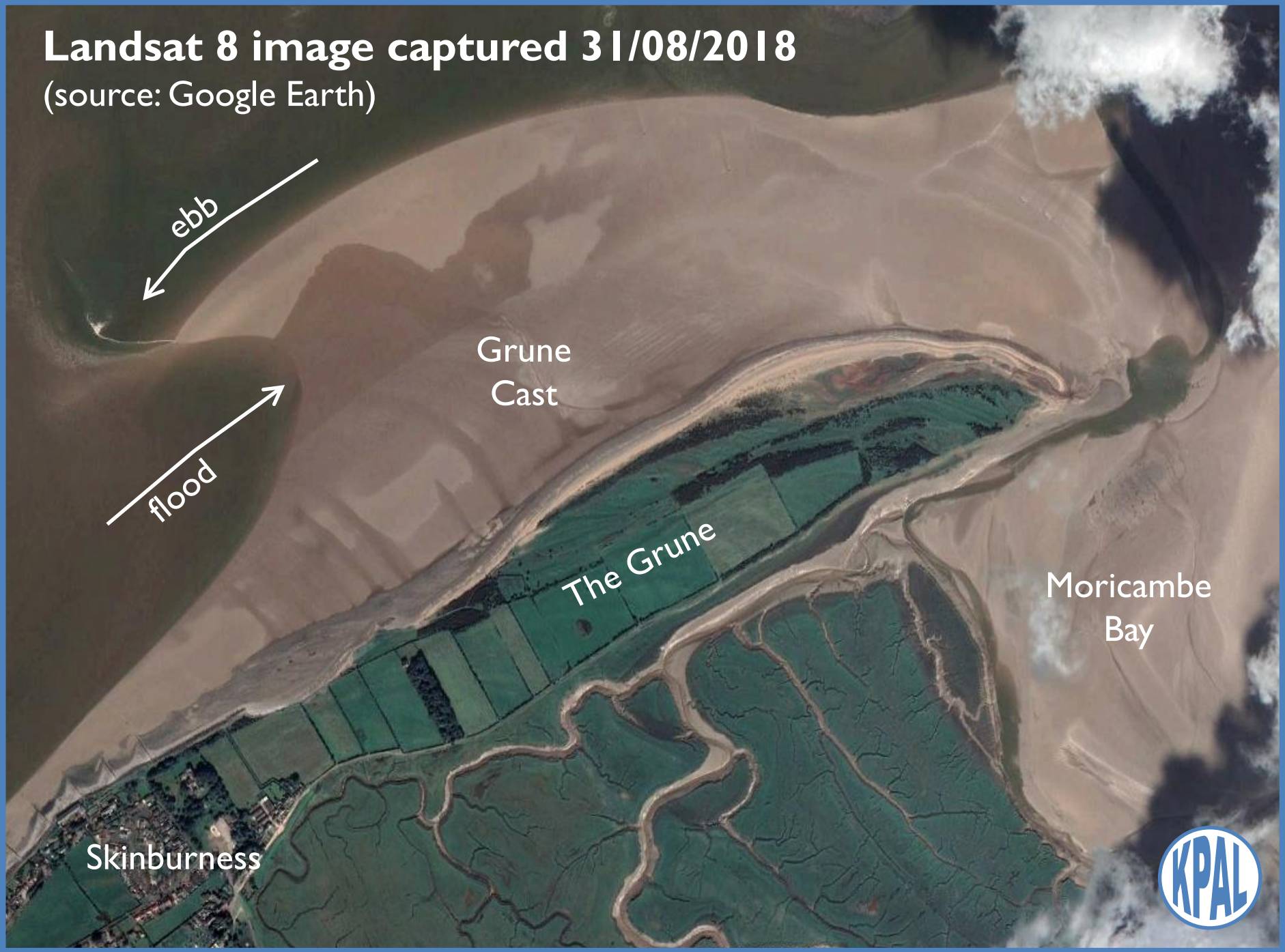
(source: McMillan et al, 2011)



Coloured shaded relief map showing the general topography of the region



Composite LiDAR DTM flown in 2022.
Source: DEFRA Data Service Platform


Landsat 8 image captured 31/08/2018
(source: Google Earth)
ebb
flood
Grune
Cast
The Grune
Moricambe
Bay
Skinburness
KPAL

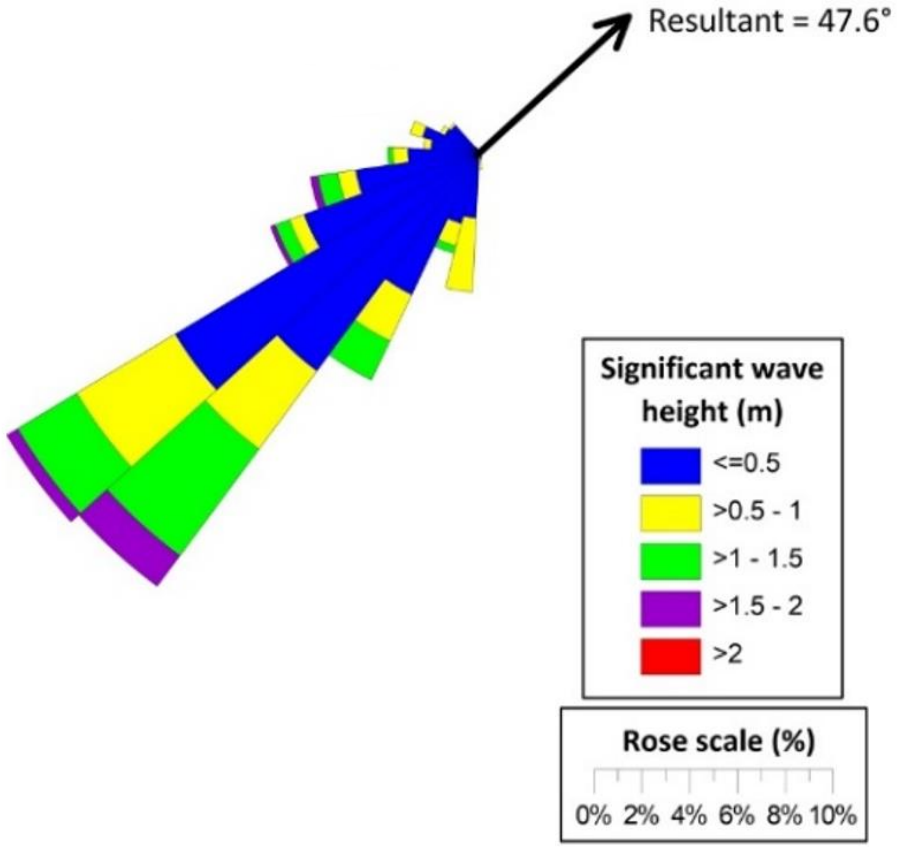
Tides and Waves in the Solway / NW England

Mean and extreme levels at Grune Point (sources: Admiralty Tide Tables and McMillan et al. 2019)

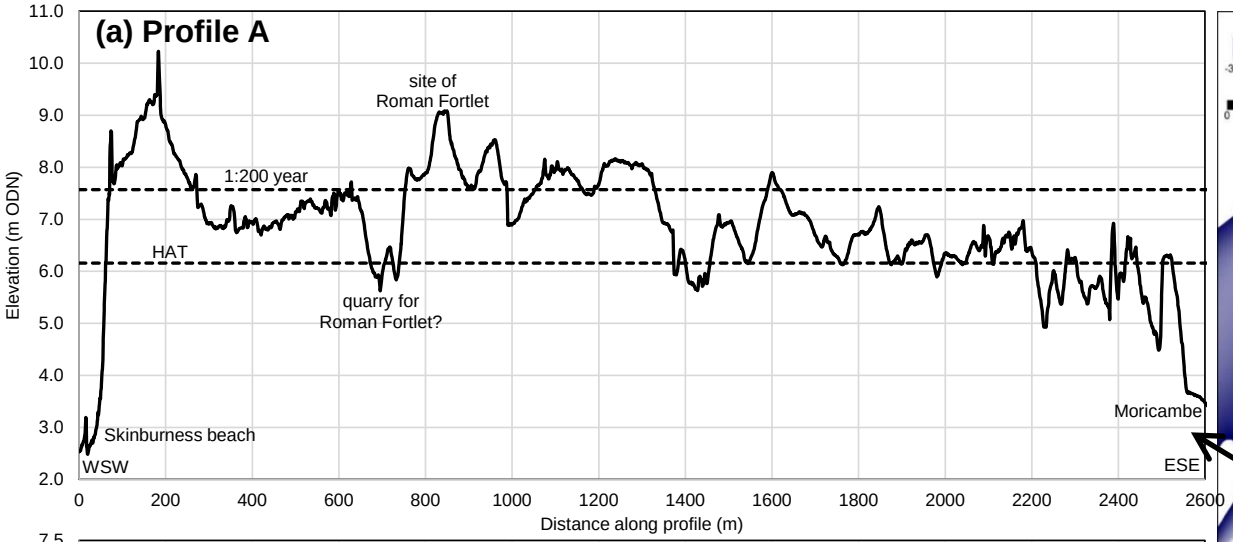
Level	m AODN
1:10000	9.48
1:200 year extreme	7.57
1:20 year extreme	6.72
HAT	6.16
MHWS	4.96
MHW	3.75
MHWN	2.70
MSL	nd
MLWN	-2.10
MLW	-2.85
MLWS	-3.60
LAT	nd
CD	-4.40
MTR	6.60
MSR	8.40
MNR	4.80

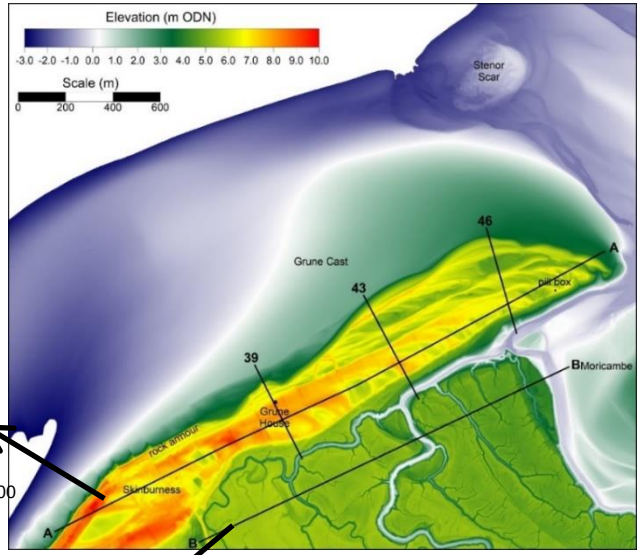
Wave Rose for St Bees South AWAC

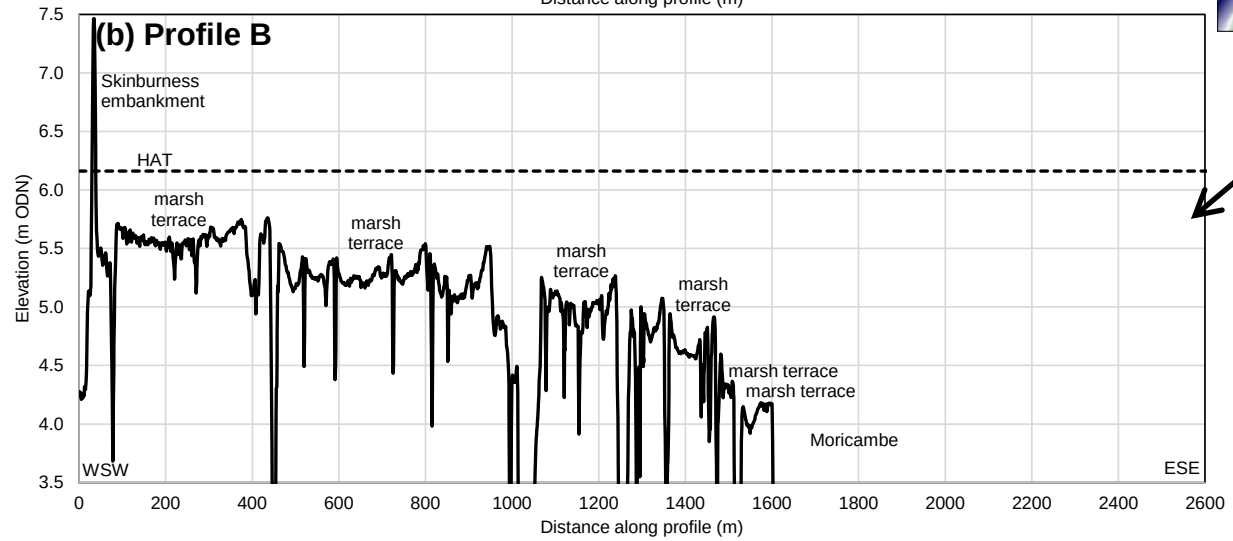
(April-May 2014, source: Sefton MBC)



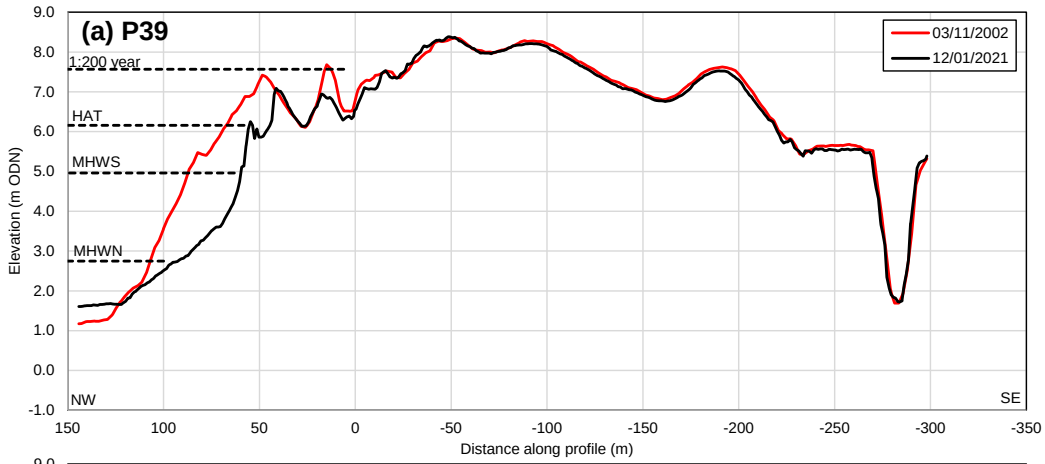
Topographic profiles along Grune Point extracted from the LiDAR DTM flown 12/01/2021

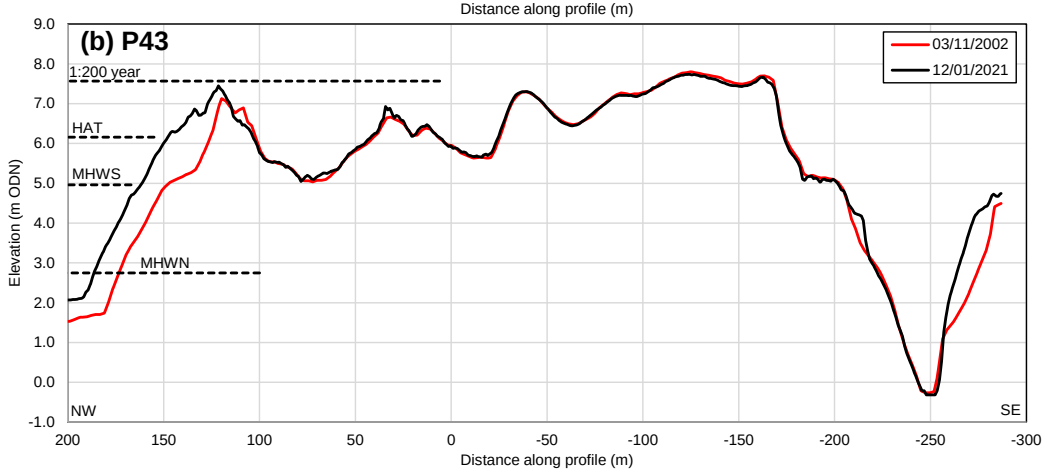


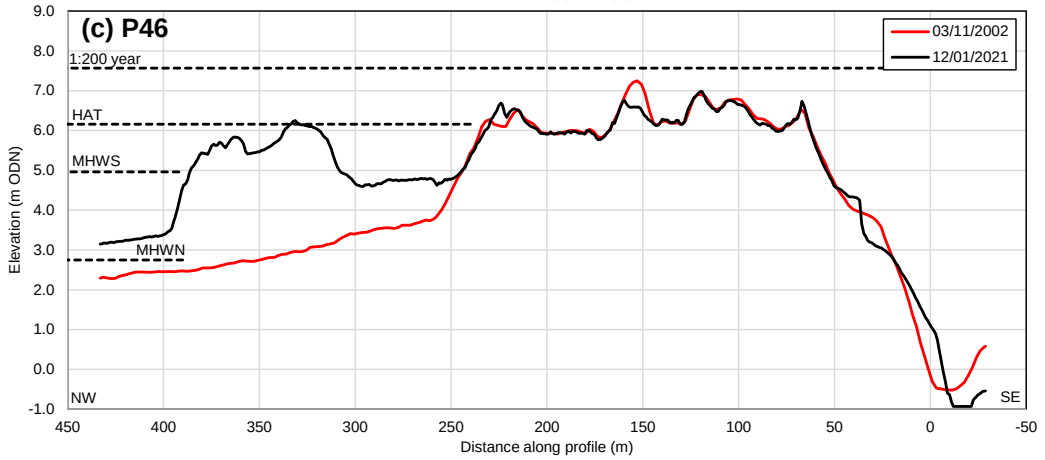




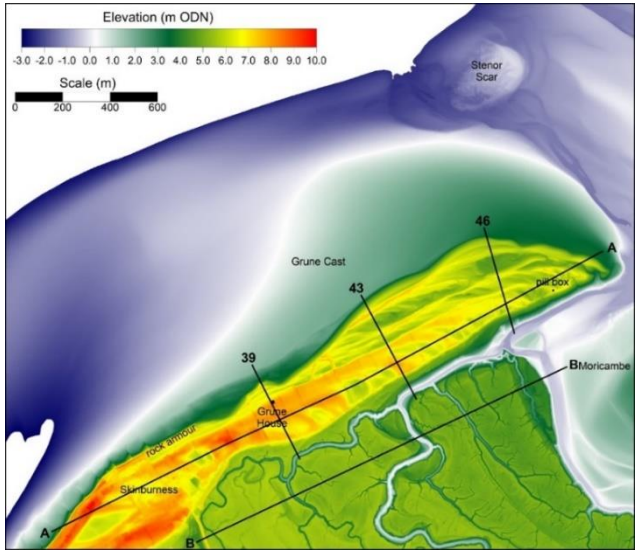
(Source: DEFRA Data Service Platform)







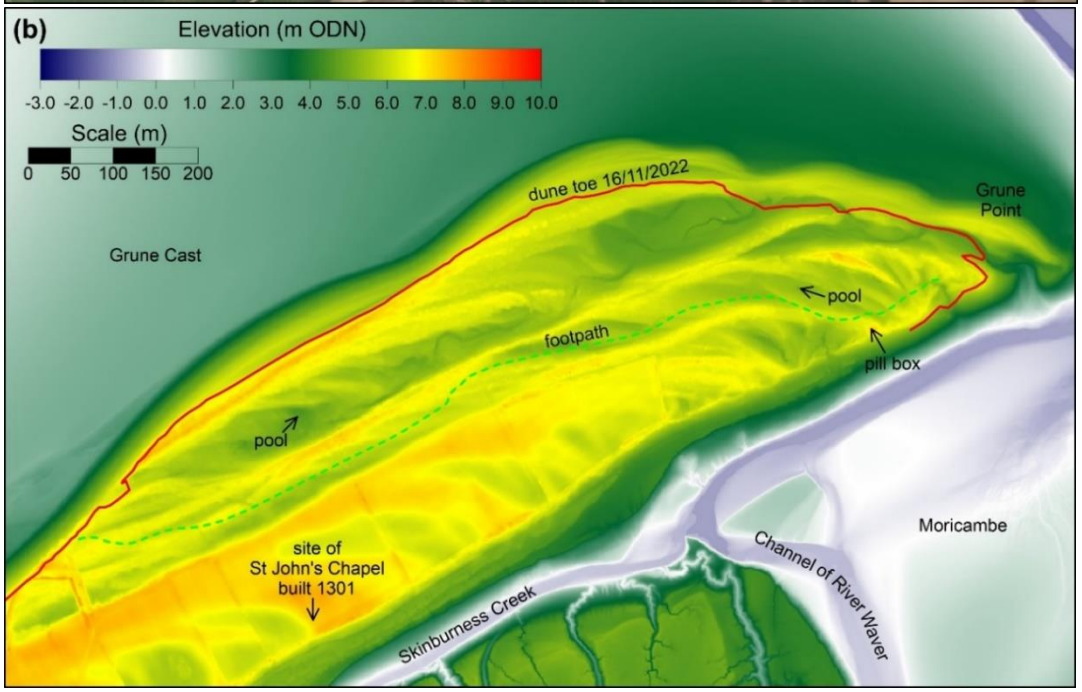
Topographic profiles across Grune Point extracted from the LiDAR DTM flown 12/01/2021



(Source: DEFRA Data Service Platform)

The Grune

Aerial photograph flown June 2019

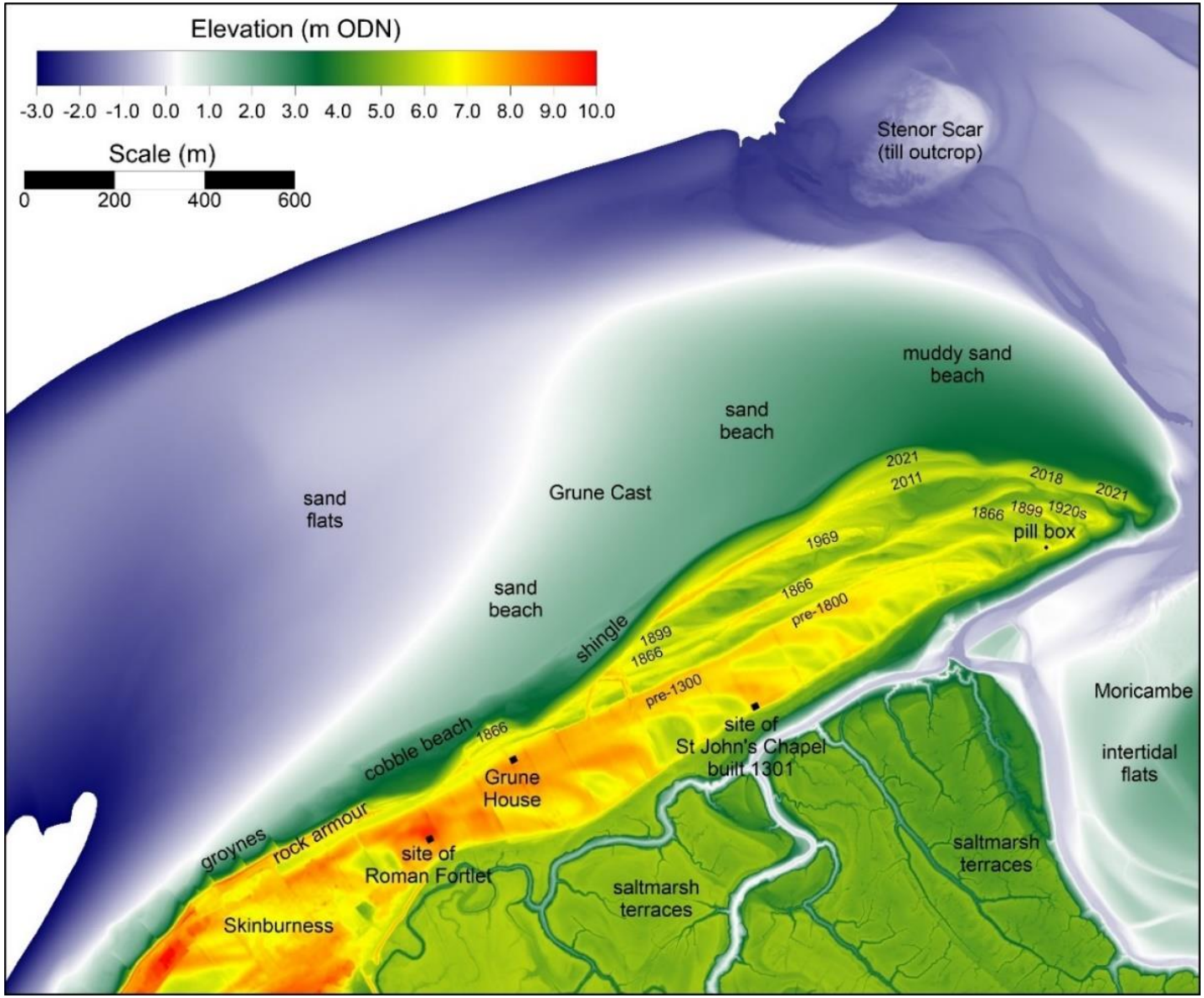


LIDAR DTM flown January 2021

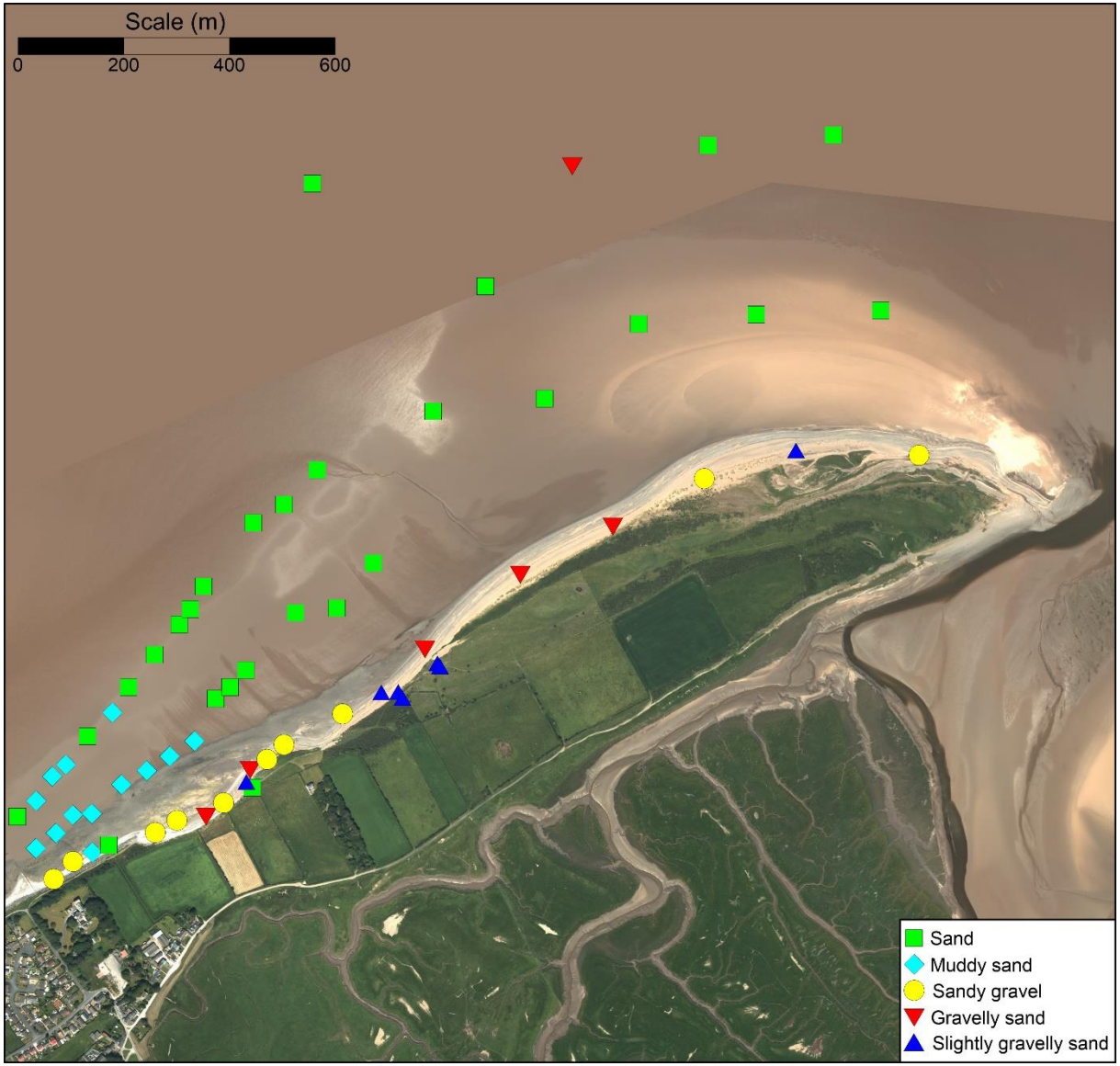
(Source: DEFRA Data Service Platform)

Coloured LiDAR DTM flown 12/01/2021

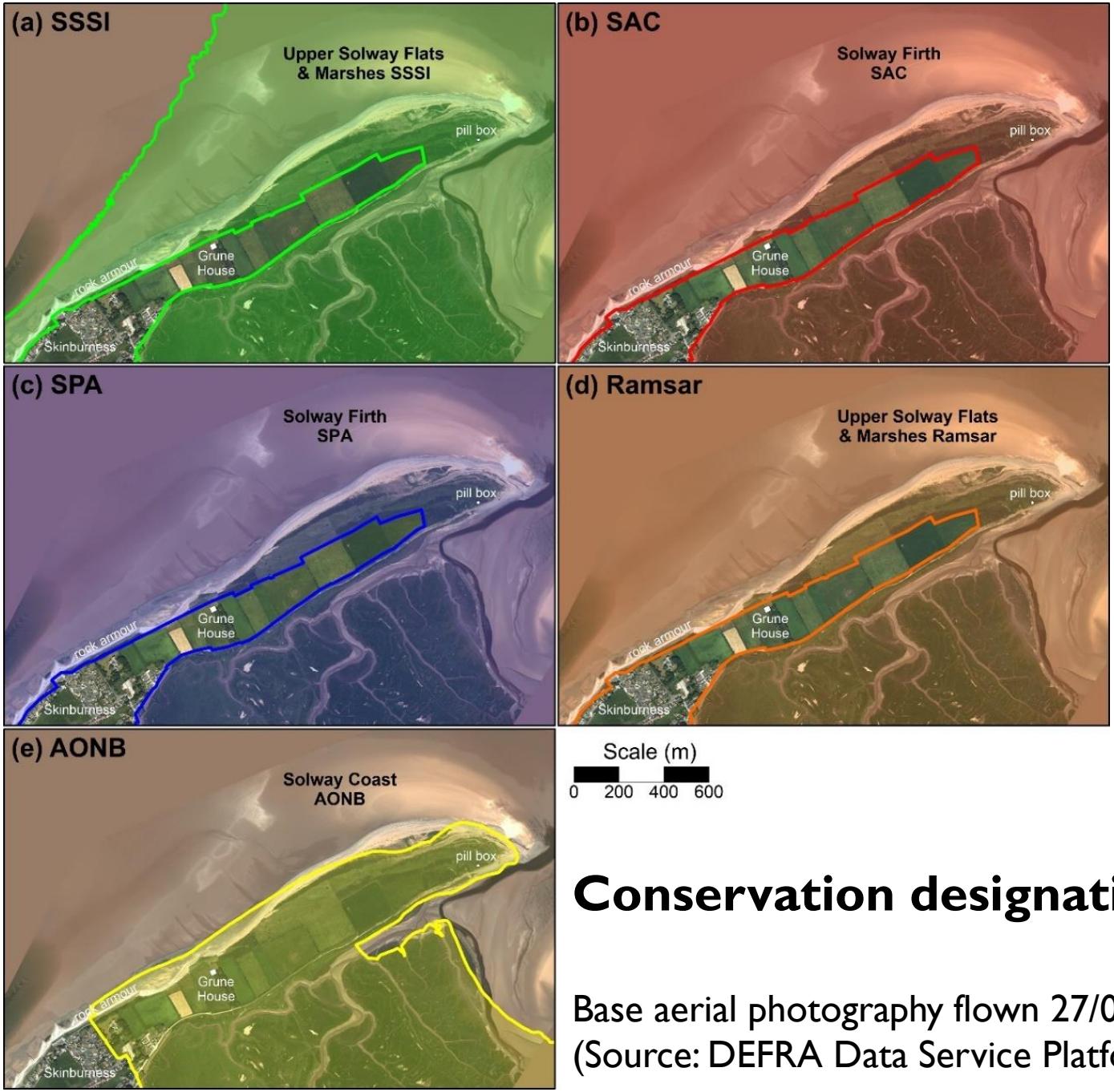
(Source: DEFRA Data Service Platform)



Folk (1954) textural classification of sediment samples collected from the beach and dunes



(samples collected by NW Regional Monitoring Programme and KPAL)



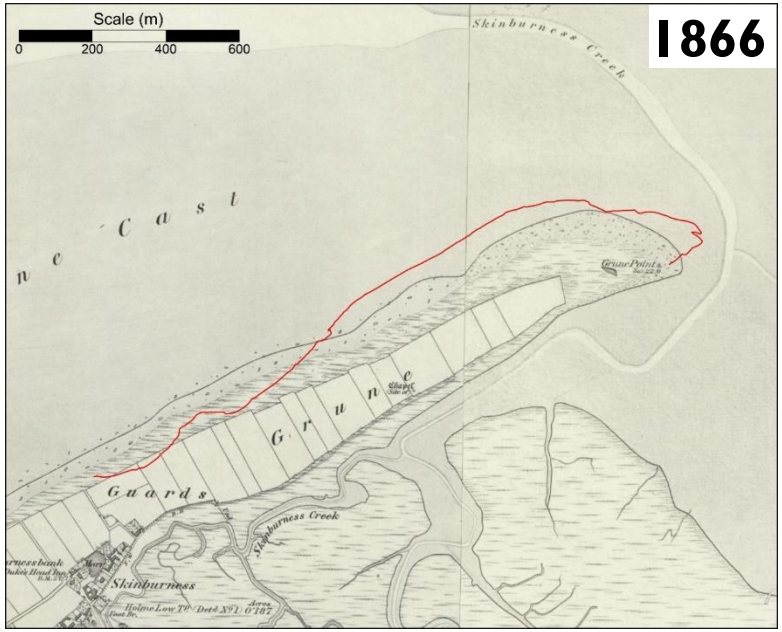
Conservation designations

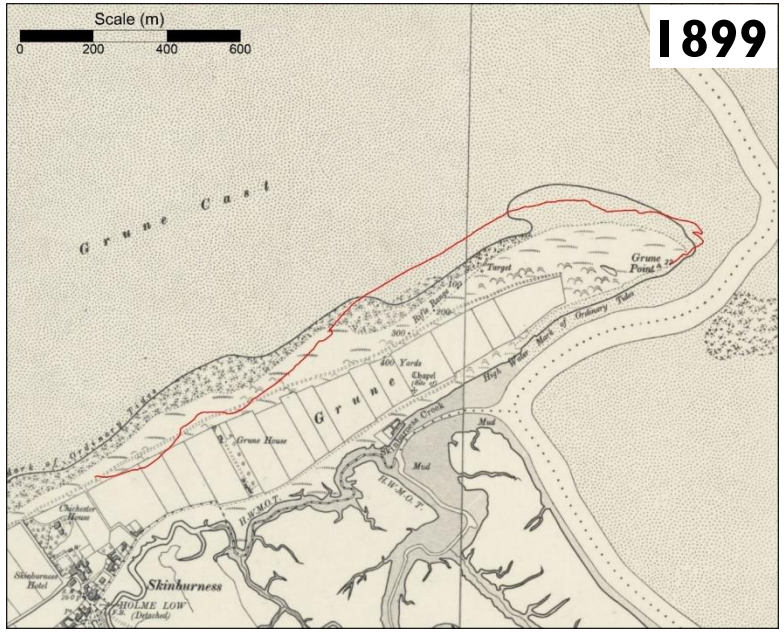
Base aerial photography flown 27/06/2019
(Source: DEFRA Data Service Platform)

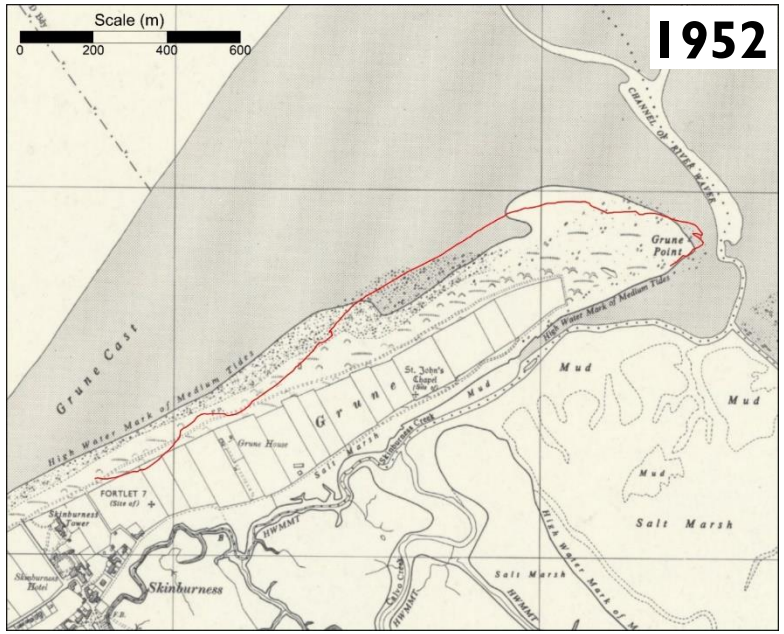
Admiralty Chart of the Firth of Solway surveyed by Lieutenant C.G Robinson R.N. in 1837-1840

(Source: National Library of Scotland)

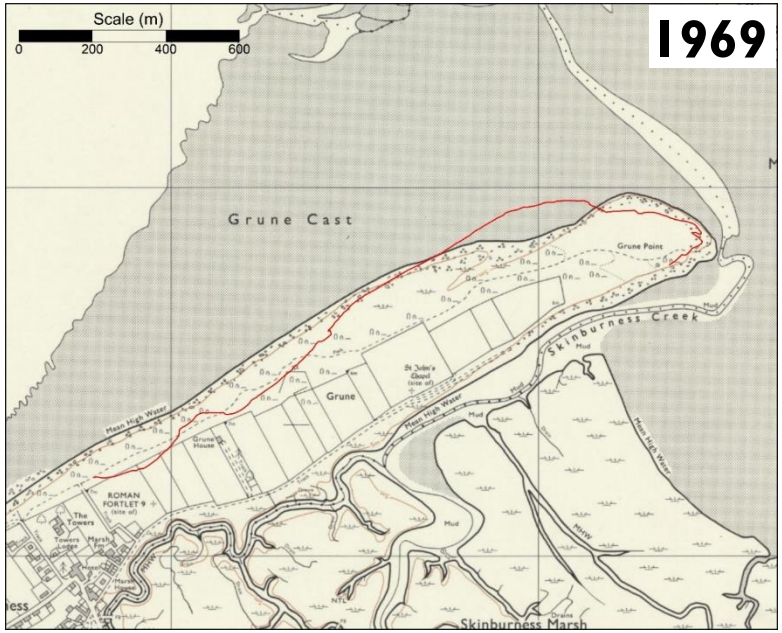
Historical OS maps with surveyed dune toe on 16/11/2022

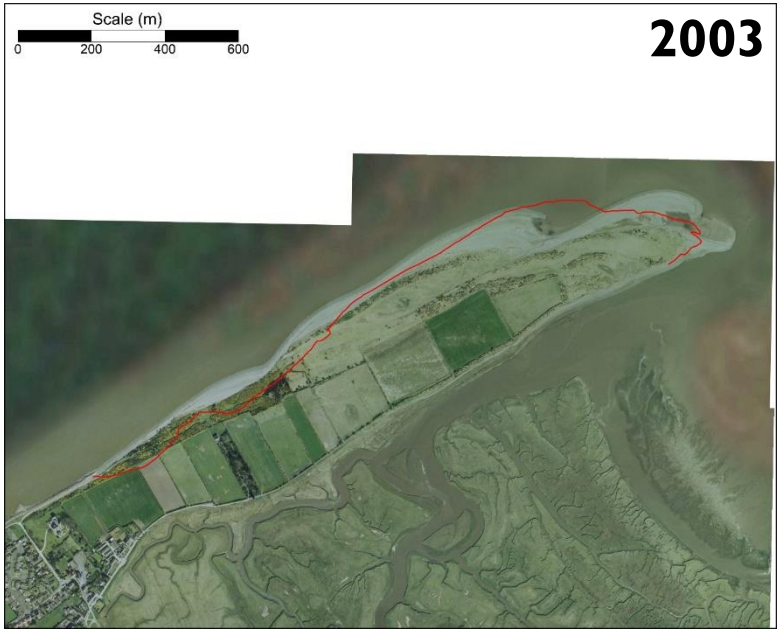


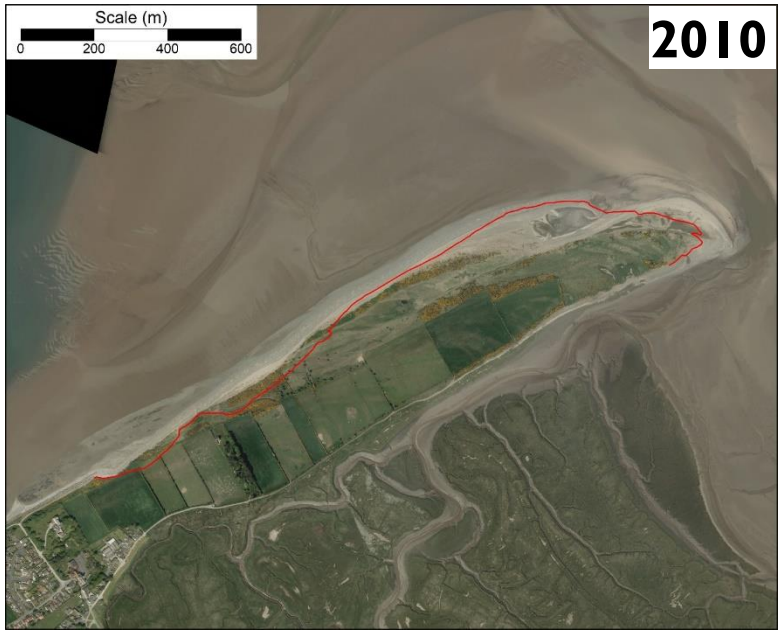




Historical map and photos with dune toe on 16/11/2022

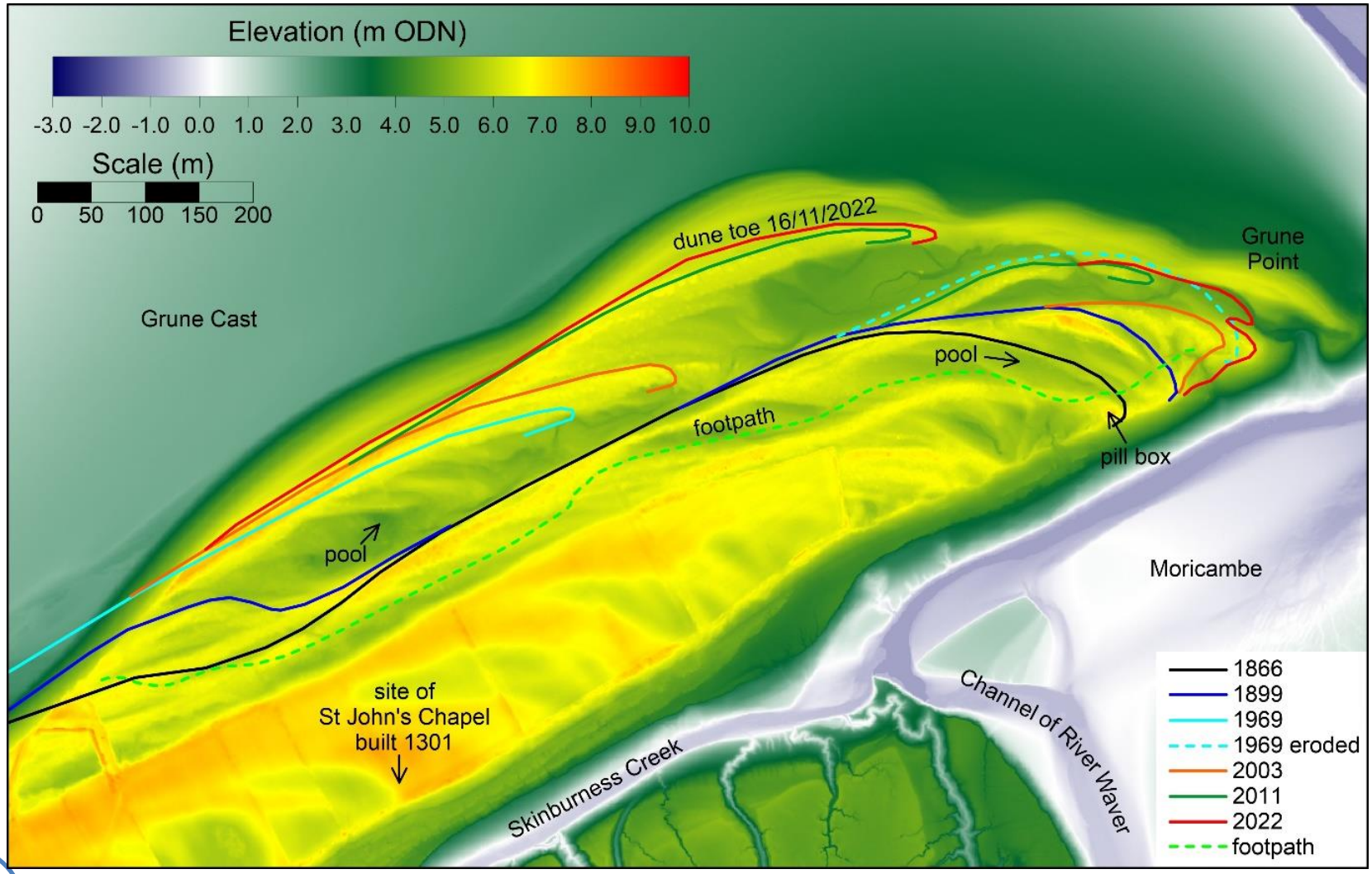






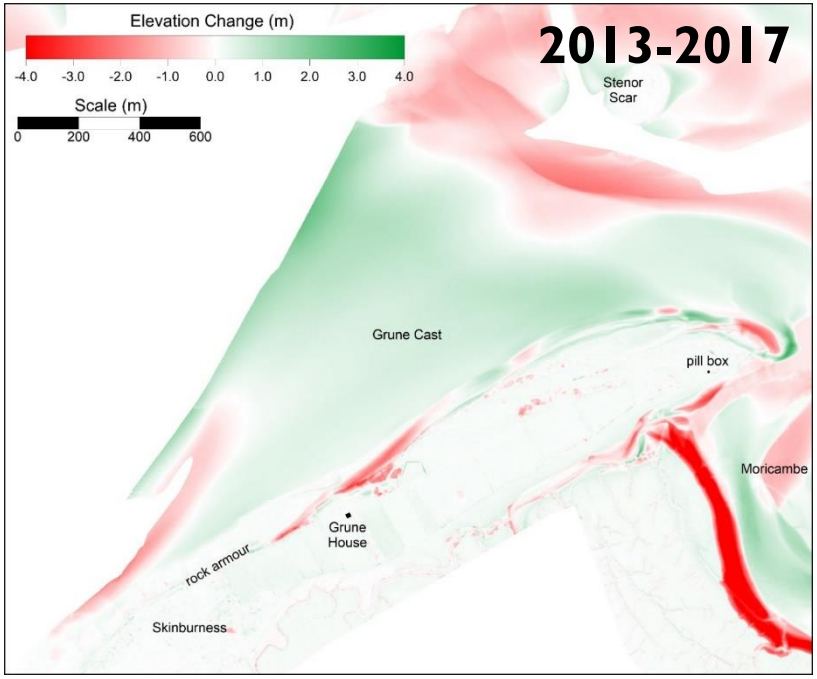
Coloured LiDAR DTM flown 12/01/2021

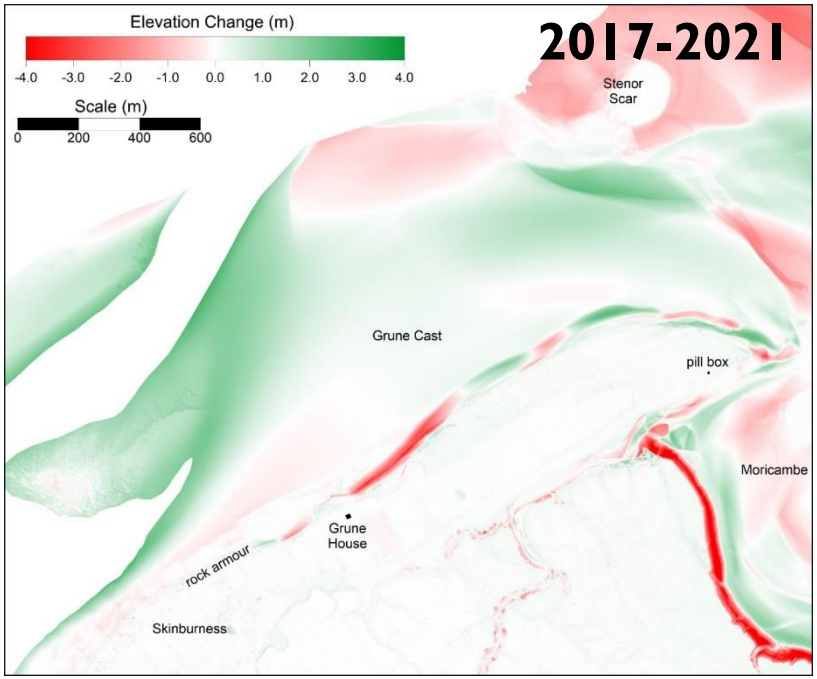
(Source: DEFRA Data Service Platform)

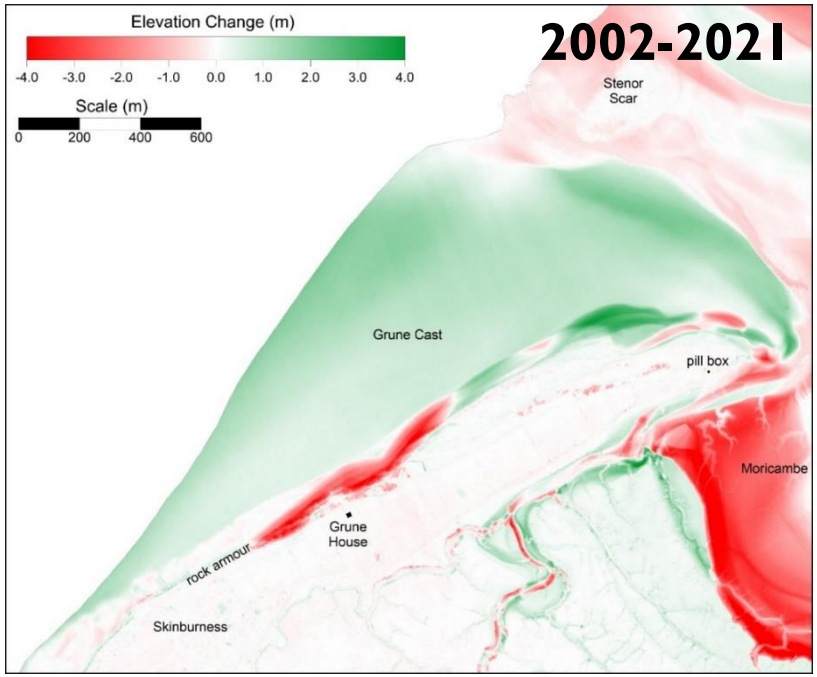


Change in elevation between LiDAR DTMs

(Source: DEFRA Data Service Platform)

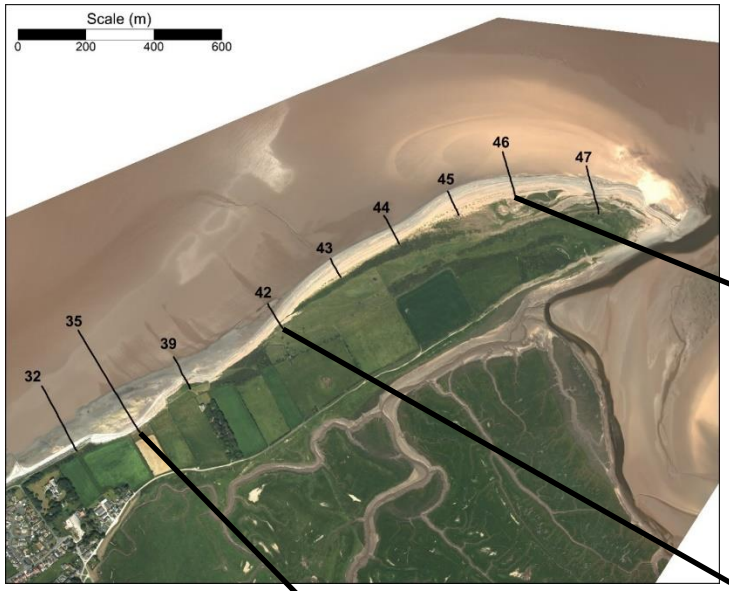


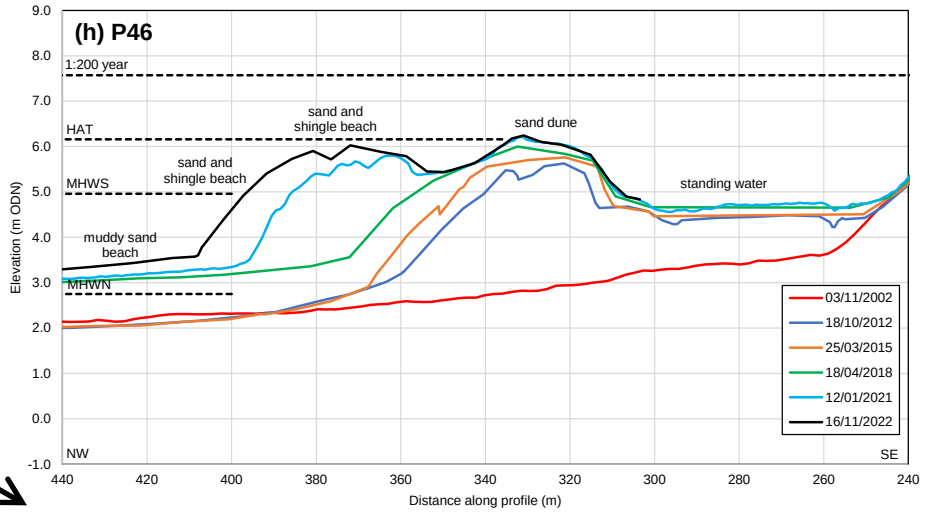


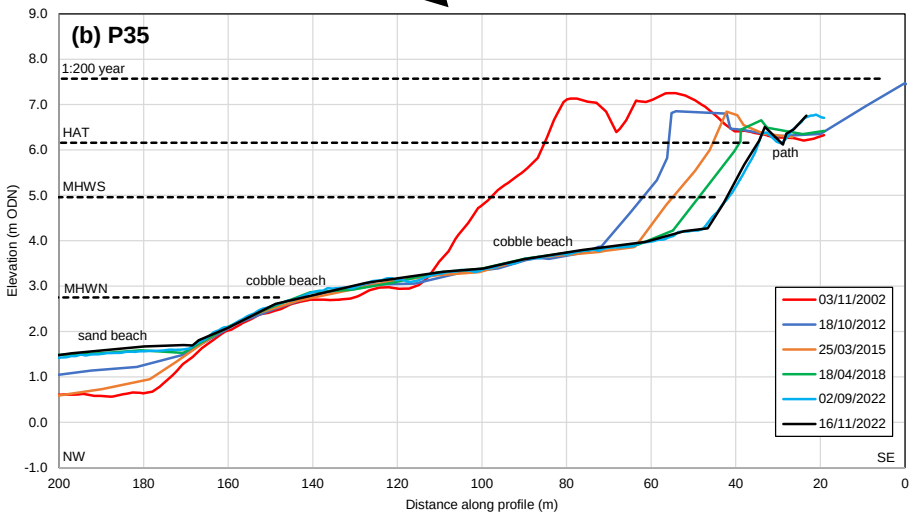


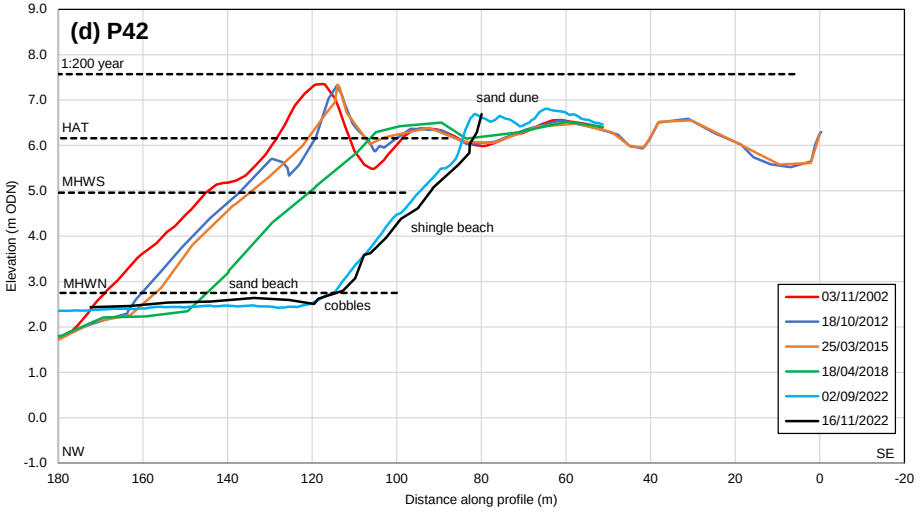
Topographic cross-sections from LiDAR and ground surveys

(Sources: DEFRA Data Service Platform and KPAL)









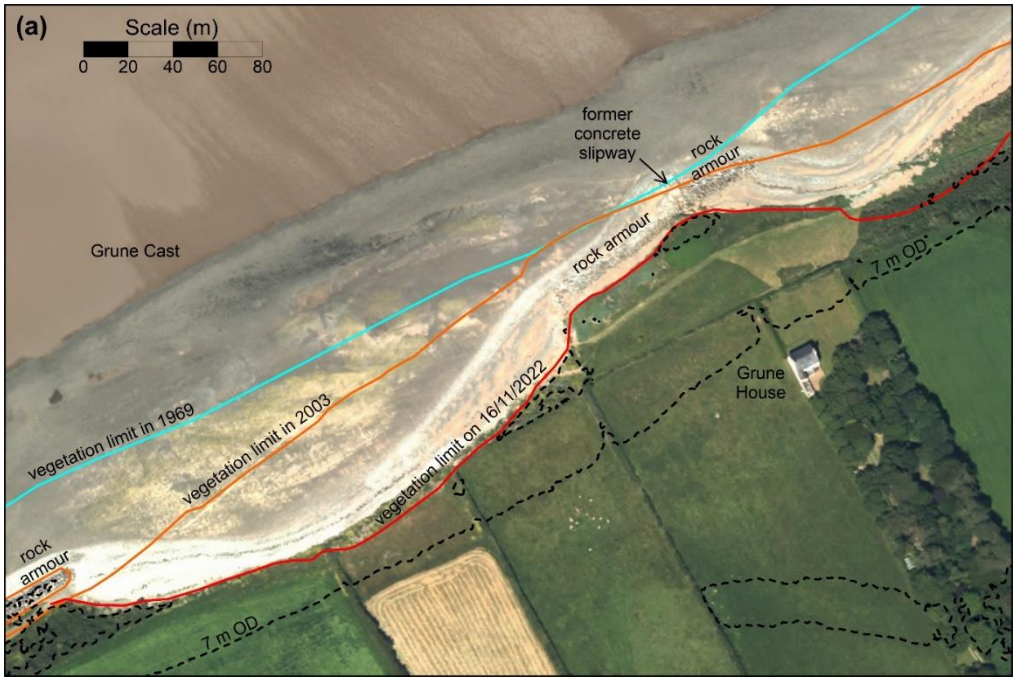

Erosion, SW Grune Point

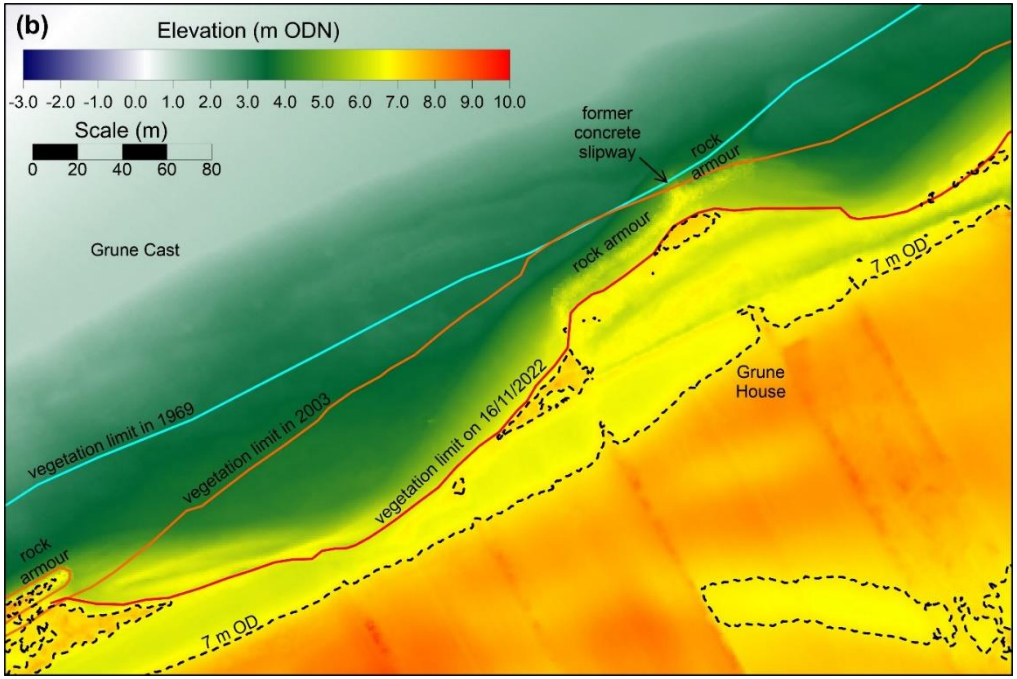

Erosion, SW Grune Point
KPAL


Accretion, NW Grune Point


Moricambe Bay shore

Grune House



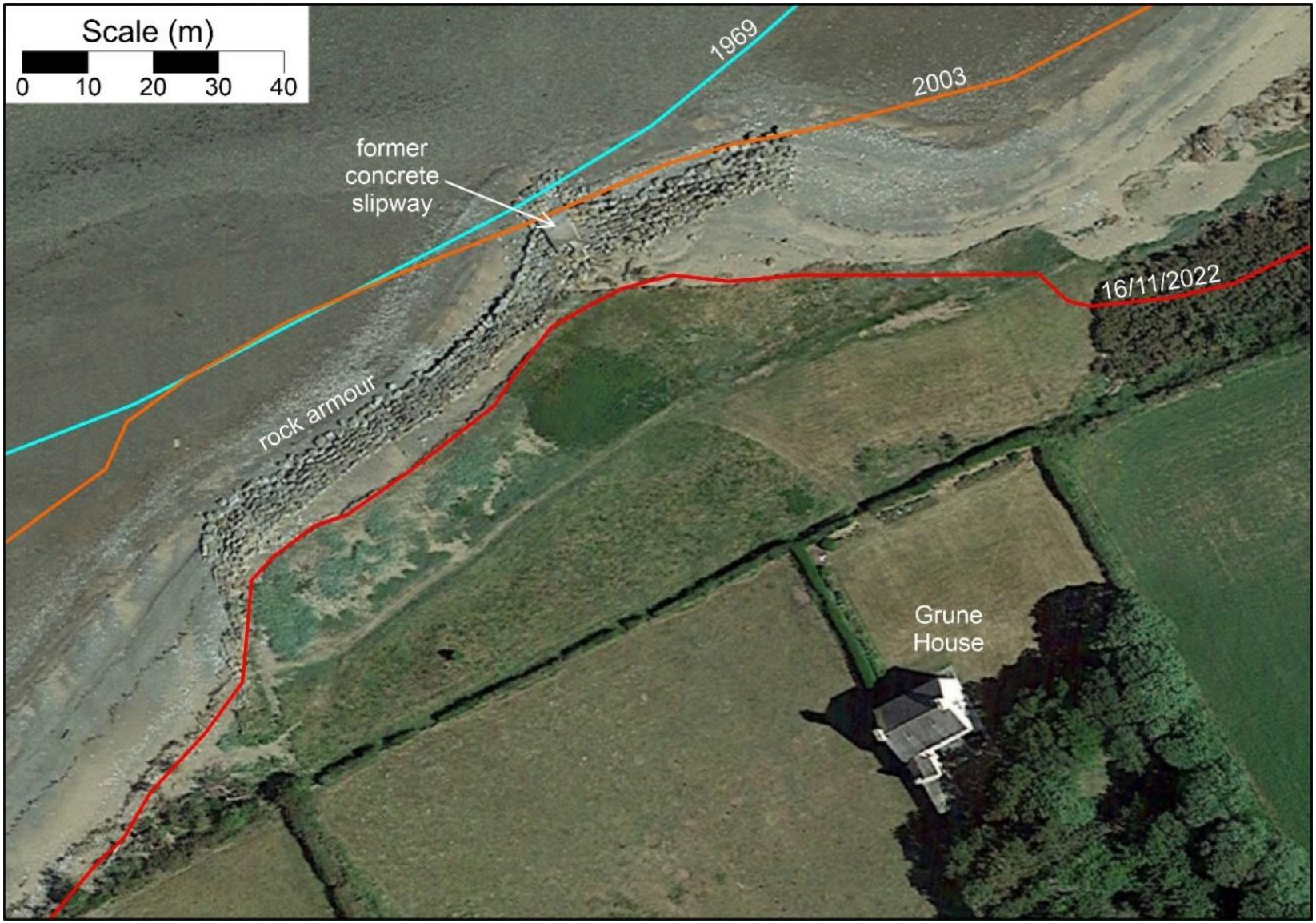


Aerial photograph flown June 2019

LIDAR DTM flown January 2021

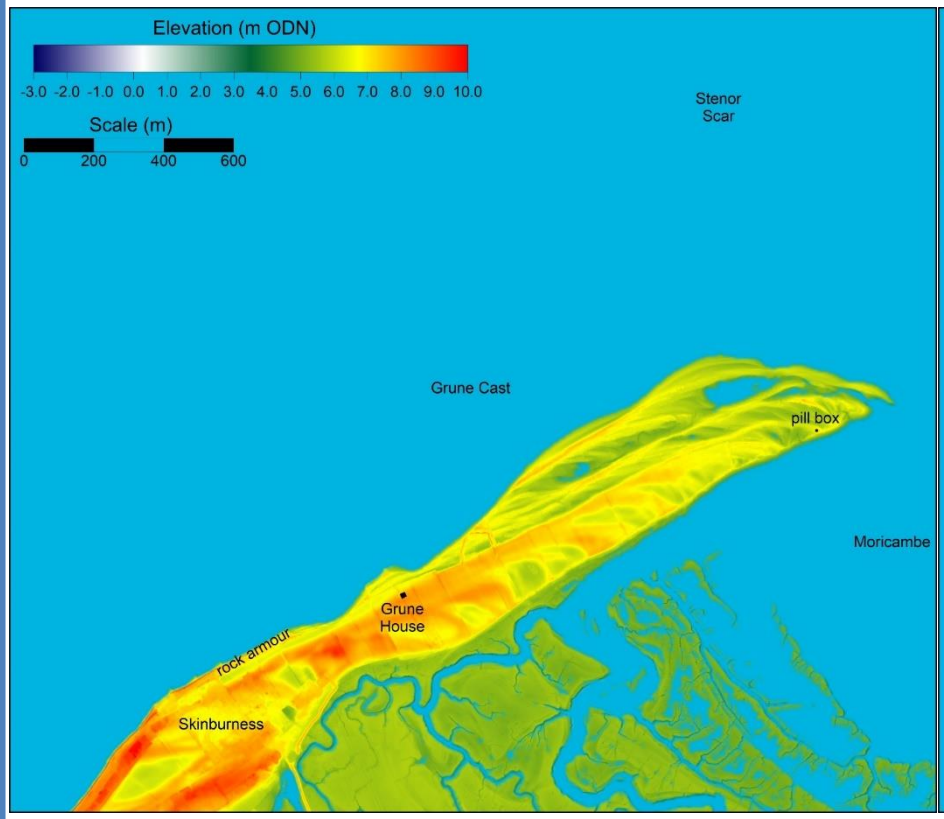
(Source: DEFRA Data Service Platform)

Enlargement of Grune House area flown 30/06/2018, with historical positions of the edge of vegetation

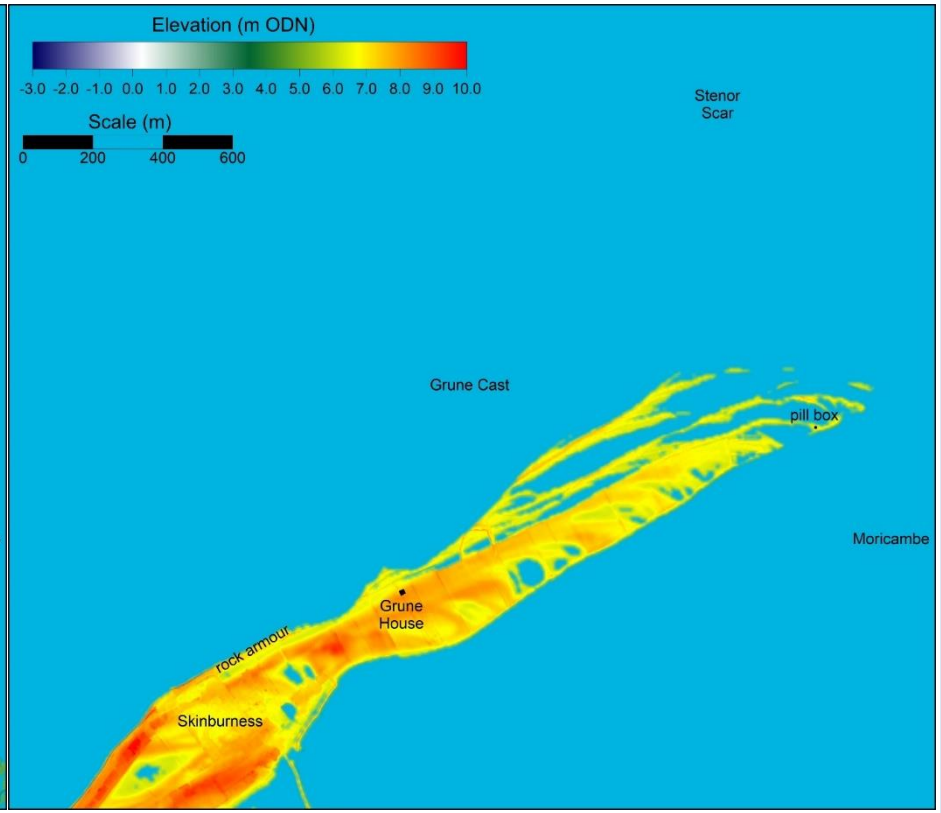


Areas potentially flooded at high tide levels

(calculated from LiDAR DTM flown 12/01/2021)



Water level at 4.96 m OD (MHWS)



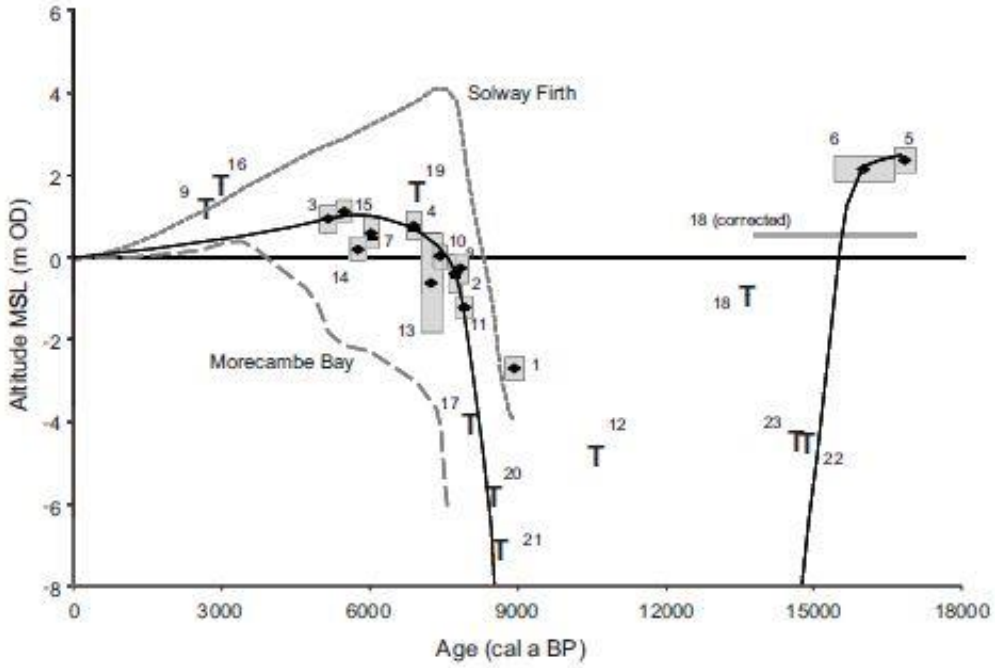
Water level at 6.72 m OD (1:20 year extreme)

KPAL

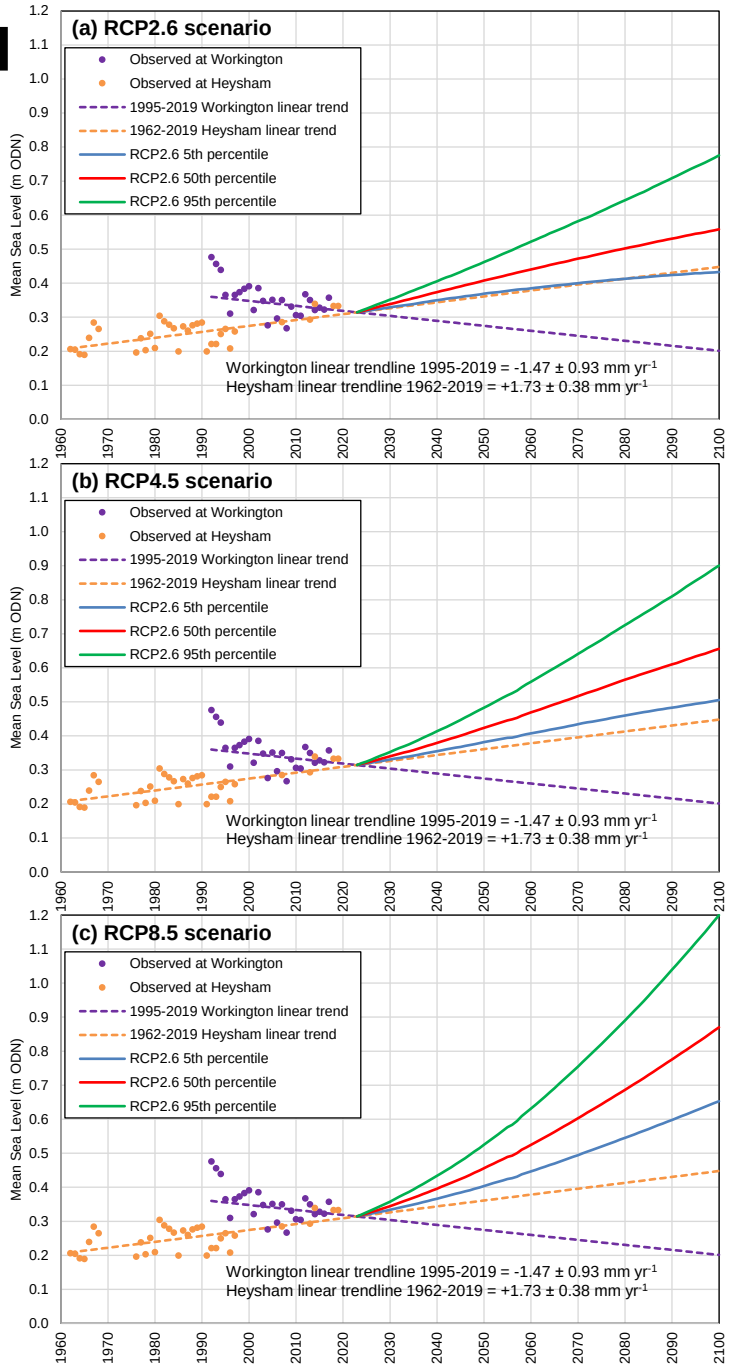
Past and Future MSL in NW England

(sources: Lloyd et al. 2012, NTSLF and UKCP18)

Mean sea level in the last 18,000 years in the Solway Firth



Workington and Heysham historical and UKCP18 projections



Conclusions

The Grune is a composite and partially relict spit feature formed in the mid to late Holocene under conditions of falling relative sea level

The 'core' consists of a series of raised shingle and sand recurved which have been truncated on both sides by erosion linked to historical shifts in low water channel position

Since the mid 19th century the seaward side has experienced a spatially varying pattern of erosion and accretion but with long-term net erosion at the southwest end and net progradation at the northeastern end

Erosion at the southeastern end has been caused by a combination of landward movement of the Skinburness Channel and the impact of coastal defences at Skinburness which have interrupted the alongshore sediment supply; private defences in front of Grune House have also had an effect

The distal end of the spit is highly dynamic but further net extension and/or seaward progradation is limited by the position of Skinburness Creek where it enters Moricambe Bay

Conclusions (continued)

The 'core' of The Grune currently lies above extreme still water storm surge level but evidence indicates that the historical trend of falling relative sea level has now ended and has started to reverse; hence flood risk due to storm surge tides and wave overtopping will increase in the future

Consideration of UKCP climate and sea level change projections suggests that in the coming decades more frequent flooding and increased wave action is likely and may cause shortening at the lower lying northern end of the spit

Shortening and/ or relative lowering of the northern end of the spit would have significant implications for the stability of active saltmarshes and tidal flats within Moricambe Bay

Although coastal defences have had a negative impact on the seaward side of The Grune since their construction their removal would lead to a sudden increase in the rate of erosion; the remaining beach and low dune sediments which formed in front of a low cliff cut in the early to mid Holocene raised beach deposits after the mid 19th century would be entirely eroded, threatening Grune House and other assets