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Advice on Options for Sand Dune Management for Flood and Coastal Defence Volume 2: Site Summaries

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Report No 207

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1. Introduction

1.1 Scope and purpose

This document represents Volume 2 of the report *Advice on Options for Sand Dune Management for Flood and Coastal Defence*. Volume 1 (the Main Report) provides a summary of the main findings, while this volume provides individual summaries for each of the 87 dune sites shown in Figure 1 and listed in Table 1.

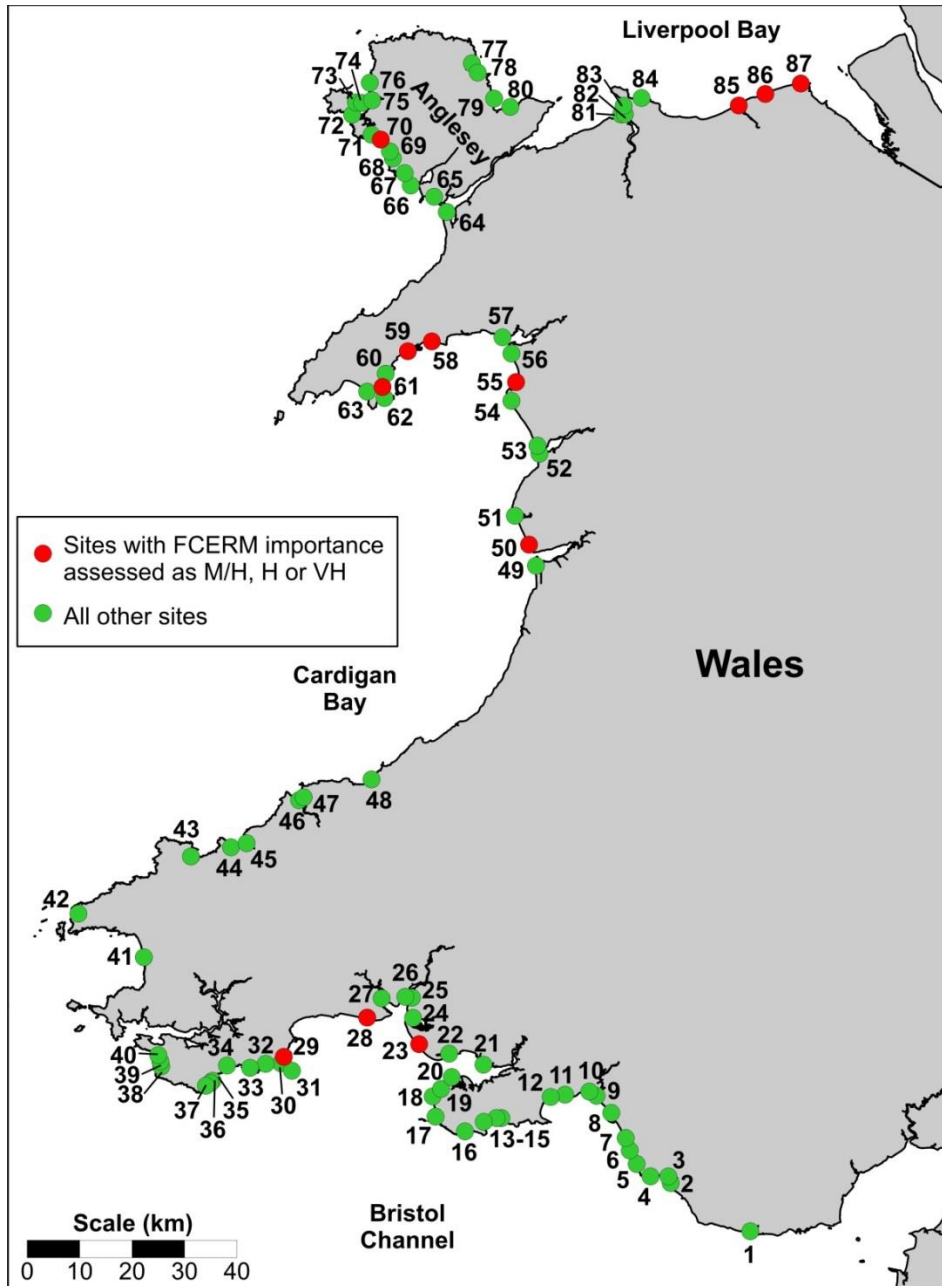


Figure 1. The locations of dune sites referred to in this report

Table 1. List of dune sites, together with classification of dune site importance, and SMP2 policies: L = Low, M = Medium, H = High, VH = Very High, N = None; HTL = Hold the Line, MR = Managed Realignment, NAI = No Active Intervention. Hyperlinks are active in the electronic version.

No.	Site Name	Flood and Coastal Erosion Risk Management (FCERM)	Nature Conservation Designation	Geomorphological Features	Recreation	Economic / Military	Historical / Archaeological	SMP2 Policy: Epoch 1	SMP2 Policy: Epoch 2	SMP2 Policy: Epoch 3
1	Aberthaw	L	L	L	L	L	L	NAI	NAI	NAI
2	Ogmore Dunes	N	L	L	L	L	L	MR	MR	MR
3	Merthyr-mawr Warren and Newton Burrows	M	VH	H	M	L	H	MR	MR	MR
4	Sandy Bay, Porthcawl	L	L	L	M	L	L	HTL	HTL	HTL
5	Porthcawl to Sker Point	L	L	L	L	L/M	L	NAI	NAI	NAI
6	Kenfig Burrows	L	VH	H	M	L	H	MR	MR	MR
7	Margam Burrows	M	L	L	L	L	M	HTL	HTL	HTL
8	Aberavon	N	L	L	L	L	L	HTL	HTL	HTL
9	Baglan Burrows	M	L/M	M	M	L	L	MR	MR	MR
10	Crymlyn Burrows and Earlswood Golf Club	L/M	H	M	L/M	L	L	MR	MR	MR
11	Spontex Dunes, Swansea	L/M	L/M	L	M	L	L	HTL	HTL	HTL
12	Swansea Beach and Black Pill Burrows	M	L/M	L	M/H	L	M	HTL	HTL	HTL
13	Pennard Burrows	N	H	VH	M	L	H	NAI	NAI	NAI
14	Penmaen Burrows	N	H	VH	M	L	H	NAI	NAI	NAI
15	Oxwich and Nicholaston Burrows	L/M	H	VH	M	L	M	MR	MR	MR
16	Port-Eynon and Horton Dunes	L	M	L	M	L	L	MR	MR	MR
17	Rhossilli Bay South	N	VH	L	L	L	L	NAI	NAI	NAI
18	Llangennith, Hillend and Broughton Burrows	L	L/M	H	M	M	M	MR	MR	MR
19	Delvid Burrows and Hills Burrows	N	L	VH	M	L	M	MR	MR	MR
20	Whiteford Burrows	L/M	VH	VH	M	L	M	MR	MR	MR
21	Machynys and Llanelli	L/M	L	L	M	M	L	HTL	HTL	HTL
22	Burry Port	L/M	L	L	M	L	L	HTL	MR	MR
23	Pembrey Burrows	M/H	VH	VH	H	VH	H	MR	MR	MR
24	Gwendraeth Estuary North Shore	L	L	L	M	L	L	NAI	NAI	NAI
25	Ferry side to Morfa Uchaf, River Towy	L	L	L	L	L	L	HTL	HTL	HTL
26	Llansteffan and Ferry Point, River Towy	L	L	L	L	L	L	HTL	HTL	HTL
27	Pentowyn, River Taf	L	L	L	L	L	L	NAI	NAI	NAI
28	Pendine and Laugharne Burrows	H	VH	VH	L/M	VH	H	MR	MR	MR
29	Tenby Burrows	M/H	H	M	H	M	L/M	MR	MR	MR
30	Giltar Point	N	VH	L	L	L	L	MR	MR	MR
31	Priory Bay, Caldey Island	N	L	L	L	L	L	NAI	NAI	NAI
32	Lydstep Haven	L	L	L	L	L	L	HTL	NAI	NAI
33	Manorbier Bay	N	H	L	M	L	L	NAI	NAI	NAI
34	Freshwater East	L/M	L	M	M	L	L	MR	MR	MR
35	Barafundle Bay	L	VH	M	L	L	M	NAI	NAI	NAI
36	Stackpole Warren	N	VH	M	M	L/M	H	NAI	NAI	NAI
37	Broad Haven	L	VH	M	M	L	L	NAI	NAI	NAI
38	Brownslade and Linney Burrows	L	VH	H	L	H	L	MR	MR	MR
39	Gupton Burrows	N	M	L	L	L	H	MR	MR	MR
40	Broomhill, Kilpaison and Newton Burrows	L	VH	H	H	L/M	H	NAI	MR	MR
41	Nolton Haven	N	VH	L	L	L	L	HTL	MR	MR
42	The Burrows, Whitesands Bay	N	L	M	L	L	H	HTL	MR	MR
43	The Parrog, Fishguard	L	L	L	M	L	L	HTL	MR	MR
44	Aber Forest	N	L	L	M	L	L	NAI	NAI	NAI
45a	Newport Bay: The Bennet	L	L	M	M	M	L	NAI	NAI	NAI
45b	Newport Bay: Newport Sands North	N	L	L	M	M	L	HTL	MR	NAI

Table 1. continued

No.	Site Name	Flood and Coastal Erosion Risk Management (FCERM)	Nature Conservation Designation	Geomorphological Features	Recreation	Economic / Military	Historical / Archaeological	SMP2 Policy: Epoch 1	SMP2 Policy: Epoch 2	SMP2 Policy: Epoch 3
46	Poppit Sands	L/M	VH	M	M	L	L	MR	MR	MR
47	Towyn Warren	L/M	H	L	M	L	L	HTL	HTL	MR
48	Traeth Penbryn	N	VH	L	L	L	L	NAI	NAI	NAI
49a	Borth to Ynyslas: Ynyslas South	M	H	L	M	L	L	HTL	MR	MR
49b	Borth to Ynyslas: Ynyslas North	M	VH	VH	H	L	L	MR	NAI	NAI
50	Aberdovey to Tywyn	M/H	VH	M	H	M	L	MR	MR	MR
51	Aber Dysynni	L	H	L	L	L	L	HTL	MR	MR
52	Fairbourne spit	M	VH	L	H	L	L	MR	MR	NAI
53	Barmouth	M	H	L	H	L	L	HTL	HTL	HTL
54	Morfa Dyffryn	M	VH	VH	H	H	M	NAI	NAI	NAI
55	Llandanwg	M/H	VH	L	M	L	H	MR	MR	MR
56	Morfa Harlech	L/M	VH	VH	H	L/M	L	NAI	NAI	NAI
57	Morfa Bychan	L/M	VH	M	H	M	L	MR	MR	MR
58a	Morfa Abererch to Pwllheli: Abererch East	VH	M	M	M	L	L	NAI	NAI	NAI
58b	Morfa Abererch to Pwllheli: Abererch West	VH	L	L	H	M	L	HTL	MR	MR
58c	Morfa Abererch to Pwllheli: Glan y Don	VH	L	L	L	L	L	HTL	HTL	HTL
59a	Pwllheli and Traeth Crugan: Pwllheli South Beach	H	H	L	H	M	L	HTL	HTL	HTL
59b	Pwllheli and Traeth Crugan: Pwllheli Golf Club	H	H	L	H	M	L	HTL	MR	MR
59c	Pwllheli and Traeth Crugan: Traeth Crugan	H	H	L	L	L	L	HTL	MR	MR
60	The Warren, Abersoch	L	L	L	M	M	L	HTL	MR	MR
61	Morfa Gors, Abersoch	M/H	L	L	M	L/M	L	HTL	MR	NAI
62	Tywyn yr Wylfa, Abersoch	N	H	L	L	L	L	NAI	NAI	NAI
63	Tai Morfa, Porth Neigwl	L	VH	L	M	L	L	NAI	NAI	NAI
64	Morfa Dinlle	L/M	VH	VH	L	M	M	MR	MR	NAI
65	Newborough	M	VH	VH	M	M	M	NAI	NAI	NAI
66	Porth Twyn-mawr and Porth Gro	N	H	L	L	L	L	NAI	NAI	NAI
67	Tywyn Aberffraw	L	VH	VH	M	L/M	L/M	NAI	NAI	NAI
68	Porth Trecastell	L	L	L	M	L	L	NAI	NAI	NAI
69	Tywyn Fferam and Tywyn Llyn	L	L	M	M	L	L	MR	MR	NAI
70	Tywyn Trewan	M/H	L	M	M	VH	L	NAI	NAI	NAI
71	Tywyn Bryn-y-Bar, Holy Island	L	L	L	M	L	L	MR	MR	MR
72	Treaddur Bay, Holy Island	L/M	L	L	M	L	L	HTL	HTL	HTL
73	Traeth Penrhos, Holy Island	L	L	L	M	L	L	MR	MR	MR
74	Gorsedd-y-penrhyn, Holy Island	L	L	L	M	L	L	NAI	NAI	NAI
75	Tywyn-gwynn	L/M	M	L	M	L	L	MR	MR	MR
76	Tywyn-mawr	L	L	L	M	L	L	NAI	NAI	NAI
77	Traeth Dulas	L	H	L	L	L	L	NAI	NAI	NAI
78	Traeth Ligwy	L	H	L	H	L	L	NAI	NAI	NAI
79	Benllech Sand	N	L	L	M	L	L	HTL	HTL	MR
80	Red Wharf Bay	L	L	L	M	L	L	NAI	NAI	NAI
81	Conwy Morfa	M	L	M	M	L	L	HTL	HTL	MR
82	Deganwy South	L/M	L	L	L	L	L	HTL	HTL	MR
83	Deganwy North and Llandudno West Shore	L/M	L	L	M	L	L	HTL	HTL	MR
84	Llandudno East Shore	L	H	L	L	L	L	HTL	HTL	HTL
85	Kinmel Dunes	M/H	L/M	L	H	L	L	HTL	HTL	HTL
86a	Rhyl East	M	L	L	H	M	L	HTL	HTL	HTL
86b	Ffrith Beach, Prestatyn	H	L	L	H	L	L	HTL	HTL	HTL
87	Barkby Beach, Gronant Dunes and Talacre Warren	H	H	H	H	M	L	MR	MR	MR

1.2 Explanation of site descriptions

1.2.1 Morphological setting

This heading relates to the location the site within its wider regional setting, and particularly with regard to exposure to open ocean, embayment or estuarine processes. Most of the sand dune sites in Wales are described as being situated either within a bay, or at the mouth of an estuary. A small number are described as being situated on the open coast, although very few if any of the sites are completely open coast in nature. Many sites are composite, having parts which could be described as embayment, or estuarine, or transitional to open coast. For this reason, a written description of the setting has been preferred to a simple ternary classification.

1.2.2 Morphological type

This heading relates to the broad-scale form of the dune system, and its relationship to adjoining physical features. Again, a written description is provided since many sites are a composite of several different types. The description is based on that described in Pye et al. 2007, and broadly classifies sites as barrier, fringing or transgressive types. Barrier dune systems generally separate the sea from a lagoon, estuary, or low-lying coastal plain. Fringing dune systems generally form a relatively narrow ridge, or group of ridges around the coastal boundary, behind which lies land which is high enough to avoid marine flooding. Transgressive dune systems are relatively wide and are formed of dunes which have migrated inland across level or climbed up rising ground; in some instances former climbing dunes have become isolated from the sea by erosion and have been left as cliff-top dunes.

1.2.3 Erosion/progradation status

This heading relates to whether the frontal dunes show net evidence (over the past 10 - 20 years) of seaward advance (progradation), erosion, or little/ no net change (stability). In some instances the dune systems lie behind coastal defence structures or, in the case of some climbing and cliff-top systems, are now detached from the beach. Again, many sites are composite, showing alongshore variation. The status has been determined through a combination of site visits, analysis of historical maps and aerial photographs, and beach profile survey data.

1.2.4 Defence structures

A summary is provided of the main hard defence structures which exist at each site, determined by site visits and analysis of 2013-14 aerial photographs.

1.2.5 Hinterland type

This heading refers to the nature and major land use types on ground behind the dune system; categories include agriculture, golf courses, housing, forestry, caravan parks, recreational facilities and airfields / military ranges.

1.2.6 Typical hinterland level

Indicative elevations are provided for the land immediately behind the dune system, ignoring any slacks or pools within the dune system itself. This usually represents the level of land liable to flooding behind the dunes, or is described as 'rising ground'

where the land continues to rise behind the dunes to levels which cannot be flooded. This has been determined using the most recently available LiDAR data (up to 2015).

1.2.7 Conservation designations

Statutory and non-statutory designations are indicated where they cover any part of the sand dune system, within the blown sand boundary, or occur immediately adjacent to the site, either alongshore, in front of (usually below MHW or MLW), or behind the dune system. The designations considered are: Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site, Site of Special Scientific Interest (SSSI), Biosphere Reserve, National Nature Reserve (NNR), Local Nature Reserve (LNR), National Park, Area of Outstanding Natural Beauty (AONB), Heritage Coast, Site of Interest for Nature Conservation (SINC) and Environmentally Sensitive Area (ESA). Most of these designations are taken from the www.magic.gov.uk website (last accessed January 2017). Also provided is information about whether the dune system falls within a Geological Conservation Review (GCR) site, whether it forms part of a Wildlife Trust Reserve or RSPB Reserve, or is in the ownership of the National Trust.

1.2.8 Notable Features

Any additional features of note are mentioned, such as the presence of scheduled monuments, military ranges or airfields within the dune system.

1.3 Explanation of key water level and dune crest level parameters

1.3.1 Highest Astronomical Tide (HAT)

The HAT for a site has been determined by interpolation with distance from the nearest Standard or Secondary Ports listed in the 2017 Admiralty Tide Tables (UKHO, 2016), converted to metres above Ordnance Datum Newlyn.

1.3.2 1 in 200 year storm surge level

An indication of an extreme flood level is taken as the 1 in 200 year flood level given at the nearest calculation point determined by McMillan et al. (2011), which are spaced at 2 km intervals around the open coast. For large sites, a value closest to the centre of the site has been taken.

1.3.3 Maximum and minimum crest level

For those sites which have a defined frontal dune ridge crest, the maximum and minimum levels have given, taken from a watershed profile across the most recently available LiDAR data (up to 2015). Sites without a defined crest are indicated as n/a.

1.3.4 LiDAR survey date

The date of the most recent LiDAR survey which covers all or the majority of the site.

1.3.5 Principal aspect of the dune frontage

The principal aspect (orientation with respect to the sea, and hence highest wind and wave exposure) of the dune frontage is stated. In a few instances, dune systems are exposed to the sea on more than one side.

1.3.6 Frontal dune morphological parameters

For those dune systems which perform a significant marine flood defence function the morphological character of the most seaward dune ridges has been quantified along selected shore-normal cross-sections through the most recent LiDAR digital Terrain model (DTM). In each case, the width and sediment volume per metre length of the dune system at HAT level and the 1 in 200 year storm surge level have been calculated

1.4 Explanation of nearshore wind and wave parameters

1.4.1 Wavenet Hindcast data

Selected wind and wave parameters are reported based on analysis of hindcast data for the closest nearshore calculation point in the WaveNet Hindcast database maintained by CEFAS (<http://wavenet.cefas.co.uk/hindcast>). This is an Environment Agency-funded platform, which uses the UK Met Office nearshore wave model to hindcast wind and wave parameters at a grid of points spaced at intervals of approximately 8.9 km around the British Isles. Fifty-six points around the coast of Wales were selected, including those points closest to each dune site. Location coordinates and distance offshore are stated for each point in the summary tables. In each case the complete available data record was analysed, comprising three-hourly hindcasts during the period 1st January 1980 to 31st December 2000, and hourly hindcasts during the period 1st January 2001 to 31st December 2016 (201624 records for each point). For the purposes of averaging, the three-hourly data were transformed into hourly data, with the intervening hours assumed to have the same wind and wave parameters as the first hour (producing 324360 hourly records for each point). The following parameters were extracted from the WaveNet Hindcast database: Eastward Wind (U10, in m/s), Northward Wind (V10, in m/s), Wave Mean Direction (dir, in degrees), Wave Peak Frequency (fp, in s⁻¹), Significant Wave Height (H_s, in metres), Zero Up-crossing Period (T_z, in seconds), and Energy Period (T_e, in seconds). The following parameters were then computed for inclusion in the dune site summaries:

1.4.2 Mean wind speed

The mean wind speed, at a height of 10 m from the ground, is included in the hindcast database split into eastward (U10) and northward (V10) components, expressed in metres per second. These components were converted into a resultant mean wind speed using Pythagoras theorem, $\sqrt{U10^2+V10^2}$, and then converted to knots using a conversion factor of 1.94384. The mean of all 324360 records was taken as the mean wind speed.

1.4.3 Mean wind direction

The mean wind direction was calculated by summing all eastward and northward winds, and using the right-angled trigonometric formula: $\tan^{-1} (U_{10}/V_{10})$. An If...Then... formula within Microsoft Excel ensured that negative U₁₀ or V₁₀ values were represented as winds from the east or north respectively, and converted the result into the direction from which winds were blowing.

1.4.4 Resultant Drift Direction (RDD)

The rate of sand drift, q , was determined for each data record using a modification of the formula proposed by Lettau & Lettau (1978), $q = V^2 (V - V_T)$, where V is the wind speed at 10 m, and V_T is the impact threshold velocity at 10 m, which equates to the minimum velocity at 10 m to keep sand in saltation. Following Fryberger & Dean (1979), V_T was taken as 11 knots for this study. The eastward and northward components of sand drift were then summed for the period of record, and right-angled trigonometry used to calculate the resultant direction of the rate of sand drift, termed the Resultant Drift Direction (RDD) by Fryberger & Dean (1979). Data for this parameter are not included in the Volume 2 summary tables but can be found in the Volume 1.

1.4.5 Drift Potential (DP)

A modified version of the method proposed by Fryberger & Dean (1979) was used to calculate the drift potential at each site. The rates of sand drift, q , for each data record were summed for the period of record, and then divided by the number of years of observations (37) and the number of hours in each year (8760 or 8784), the Drift Potential (DP) in effect becoming the average value of $V^2 (V - V_T)$ for the period of record. Data for this parameter also are not included in the Volume 2 summary tables but can be found in the Volume 1.

1.4.6 Resultant Drift Potential (RDP)

A modified version of the method proposed by Fryberger & Dean (1979) was used to calculate the drift potential in the resultant direction at each site. The drift potential for each data record was split into easterly and northerly components, and summed for the period of record. These components were then converted into a resultant using Pythagoras theorem, $\sqrt{(DP_{east}^2 + DP_{north}^2)}$, and again divided by the number of years of observations (37) and the number of hours in each year (8760 or 8784). Data for this parameter also are not included in the Volume 2 summary tables but can be found in the Volume 1.

1.4.7 RDP / DP Ratio

The RDP / DP ratio was calculated for each data record, and averaged for the period of record. The ratio is an index of directional variability of the wind, proposed by Fryberger & Dean (1979). Data for this parameter also are not included in the Volume 2 summary tables but can be found in the Volume 1.

1.4.8 Mean significant wave height, H_s

The significant wave height, modelled from the wave spectrum of combined wind and swell waves, and approximately equivalent to the highest third of all waves. The average H_s from all waves in the record (1980-2016) has been determined.

1.4.9 Mean zero up-crossing period, T_z

The mean zero up-crossing period (in seconds) from all waves in the record (1980-2016) has been determined.

1.4.10 Mean peak wave period, T_p

Peak wave period (in seconds) has been calculated as the inverse of the wave peak frequency (sec^{-1}). The mean T_p from all waves in the record (1980-2016) has been determined.

1.4.11 Mean energy period, T_e

The mean energy period (in seconds) from all waves in the record (1980-2016) has been determined.

1.4.12 Mean wave power

The wave power for each data record has been calculated using the equation: $P = (\rho g^2 / 64\pi) \times H_s^2 \times T_e$, where P is the wave power (in W m^{-1}), ρ is the water density (assumed to be 1000 kg m^{-3}), g is the acceleration due to gravity (9.81 m s^{-2}), H_s is the significant wave height (in metres) and T_e is the wave energy period (in seconds). The mean wave power for the whole period of record has then been calculated and expressed in kW m^{-1} .

1.4.13 Mean wave direction

The mean wave direction for each data record has been used to derive an E-W and N-S vector, these being summed over the period of record (1980-2016). The direction of the total vector is the mean wave direction.

1.4.14 Mean wave direction scaled for wave power

The E-W and N-S vectors calculated for each data record were multiplied by the wave power for each record, and these weighted vectors then summed over the period of record (1980-2016). The direction of the total vector is the mean wave direction weighted for wave power.

1.5 Explanation of dune sediment characteristics

1.5.1 Mean particle size

Where determined, the range and average mean sediment particle size of dune sediment is given, based either on laser diffraction (LD) analysis or dry sieve (DS) analysis of sediment samples collected from the dune sites. The number of samples taken (N) is indicated. Some of the data are reproduced from Pye et al. (2007) while others represent the results of new analyses.

1.5.2 Calcium carbonate content

The calcium carbonate content is taken from values published in Pye et al. 2007. Calcium carbonate content was estimated from the calcium oxide (CaO) content determined by X-ray fluorescence (XRF), using a conversion factor of 1.78. The number of samples taken (N) is indicated.

1.5.3 Silica content

The silica (SiO₂) content is taken from values published in Pye et al. 2007, also determined by XRF. The number of samples taken (N) is indicated.

1.6 Explanation of site importance and SMP2 Policy

1.6.1 Qualitative dune site importance

A qualitative classification scheme has been used to indicate the degree of importance of dunes at each site in terms of six attributes: flood and coastal erosion risk management (FCERM), nature conservation, geomorphological features, recreation, economic/military and historical/archaeological importance. Each has a five-fold classification: Very High, High, Medium, Low and None.

1.6.2 Flood and coastal erosion risk management (FCERM)

A Very High description is given for those sites where the dune forms the only form of defence and the hinterland is below the level of the 1 in 200 year storm level, and contains infrastructure, properties or other assets of high economic value. Conversely a 'none' description is given for sites where the hinterland rises well above the 1 in 200 year flood level, and for climbing and cliff-top dune sites. Other sites are scaled between low and high on the basis of hinterland level and the dune height and width.

1.6.3 Nature conservation

A Very High description is given for those sites with international designations (SAC or SPA), while sites with only national designations (such as SSSI) are assigned a lower level of significance.

1.6.4 Geomorphological features

A Very High description is given for sites described in the Geological Conservation Review (GCR). Sites with only a narrow coastal barrier, or which have been levelled or urbanised, are assigned Low significance. Other sites are scaled between High and Low on the basis of the quality and importance of geomorphological features present, as determined from site visits, analysis of aerial photographs and LiDAR data, and published literature.

1.6.5 Recreation

Site significance is classified based on the role the sand dunes play for recreational activities, such as a golf course, camping or picnicking, and whether they principally have local amenity value or attract visitors from other parts of Wales or overseas. Sites which are largely fenced to keep out visitors are given a Low score.

1.6.6 Economic/ military

Site significance is classified on the basis of their importance for economic or military activities. The presence of internationally renowned golf courses, military training ranges or air fields have been assigned a High or Very High score.

1.6.7 Historical/archaeological

Site significance is classified on the basis of the presence of scheduled monuments or other features of historical interest.

1.6.8 Overall significance score

The qualitative significance descriptions have been assigned a numerical value as follows: Very High = 4, High = 3, Medium/High = 2.5, Medium = 2, Low/Medium = 1.5, Low = 1, None = 0. The combined numerical value for the six attributes listed above provides an overall significance score for a site. The maximum score would be 24 if the significance was Very High in all six categories.

1.6.9 SMP2 Policy

The policy stated in the second generation Shoreline Management Plans is given as either Hold The Line (HTL), Managed Realignment (MR) or No Active Intervention (NAI). Policies are stated for each of the three epochs in the SMPs. Where a dune site spans more than one policy unit, and where the policy differs along the frontage, the site is subdivided into two or three sub-sites (labelled a,b,c...) and policies are given for each unit.

1.7 Present and past dune and beach management measures

Where identified, present and past dune and beach management measures have been identified. The main dune management measures include sand fencing, surface stabilization using brushwood, marram planting, construction of boardwalks, tree / scrub planting, dune sediment nourishment, scrub clearance, tree-felling and grazing. More recent intervention measures to increase sand mobility include turf stripping, the cutting of notches in frontal dunes, and dune re-profiling. The principal beach management measures which have had an impact on dune systems include toe protection works, groynes and beach nourishment.

1.8 Further information

One or more key references which provide further information are cited, where available.

2. References

Fryberger SG, Dean G. 1979. Dune forms and wind regime. In McKee ED (ed.) *A Study of Global Sand Seas*. United States Geological Survey Professional Paper 1052, 137-169.

Lettau K, Lettau H. 1978. Experimental and micrometeorological field studies of dune migration. In: Lettau HH & Lettau K (eds.) *Exploring the World's Driest Climate*. Center for Climatic Research, University of Wisconsin, pp. 110-147.

McMillan A, Batstone C, Worth D, Tawn J, Horsburgh K, Lawless M. 2011. *Coastal Flood Boundary Conditions for UK Mainland and Islands. Project SC060064/TR2: Design sea levels*. Bristol: Environment Agency.

Pye K, Saye S, Blott S. 2007. *Sand dune processes and management for flood and coastal defence* (Parts 1-5, with Part 4 focusing on techniques for sand dune management, funded by Joint Defra/EA Flood & Coastal Erosion Risk Management R&D Programme).

UKHO 2016. *Admiralty Tide Tables 2017*. Taunton: United Kingdom Hydrographic Office.

Site summaries

Site 1: Aberthaw

Site description

Morphological setting	Shallow bay (Limpert Bay, north shore of Bristol Channel)
Morphological type	Low fringing dune and sand sheet behind shingle barrier
Erosion/progradation status	Stable shingle ridge
Defence structures	Wall of WWII anti-tank blocks at eastern end
Hinterland type	Agricultural land / former marsh
Typical hinterland level	4.5 to 5.5 m OD on agricultural land
Conservation designations	Heritage Coast
Notable features	Aberthaw Power Station immediately to the east

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	6.70 m OD
1:200 year storm surge level	7.33 ± 0.4 m OD
Maximum crest level	9.8 m OD
Minimum crest level	7.2 m OD
LiDAR survey date	09/01/2000 and 23/03/2006
Principal aspect of dune frontage	south-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	582 (297213E 157344N)
Distance offshore	9.3 km
Mean wind speed	11.36 knots
Mean wind direction	255.8 ° (WSW)
Mean significant wave height (Hs)	0.86 m
Mean zero up-crossing period (Tz)	4.52 sec
Mean peak wave period (Tp)	7.74 sec
Mean wave direction	269.6 ° (W)
Mean wave direction scaled for wave power	268.6 ° (W)
Mean annual wave power	27.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

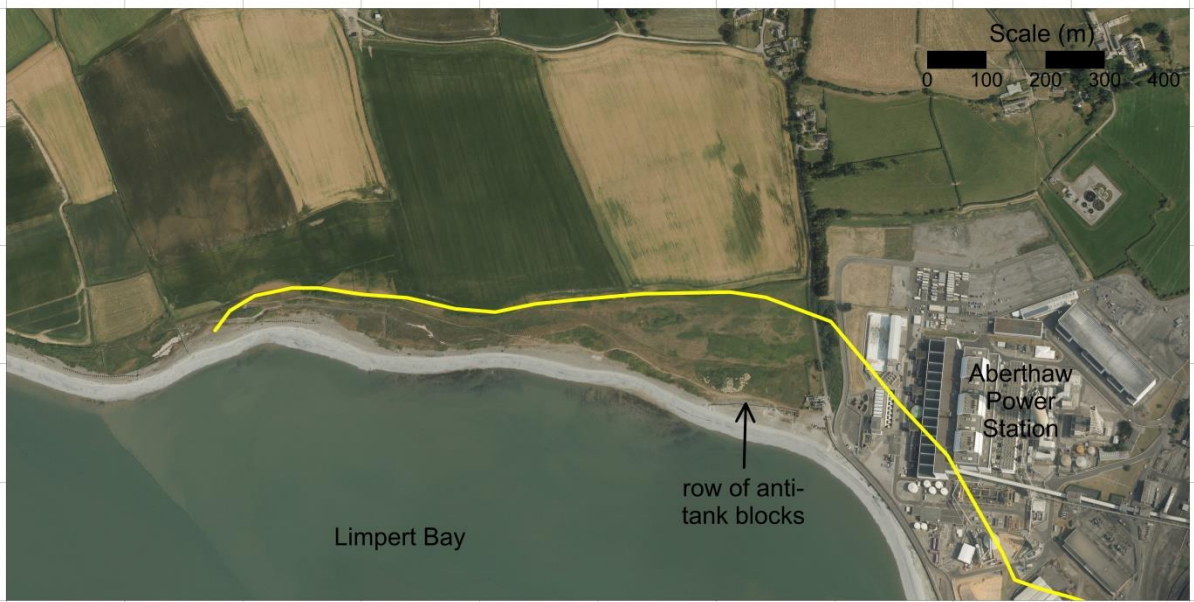
Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

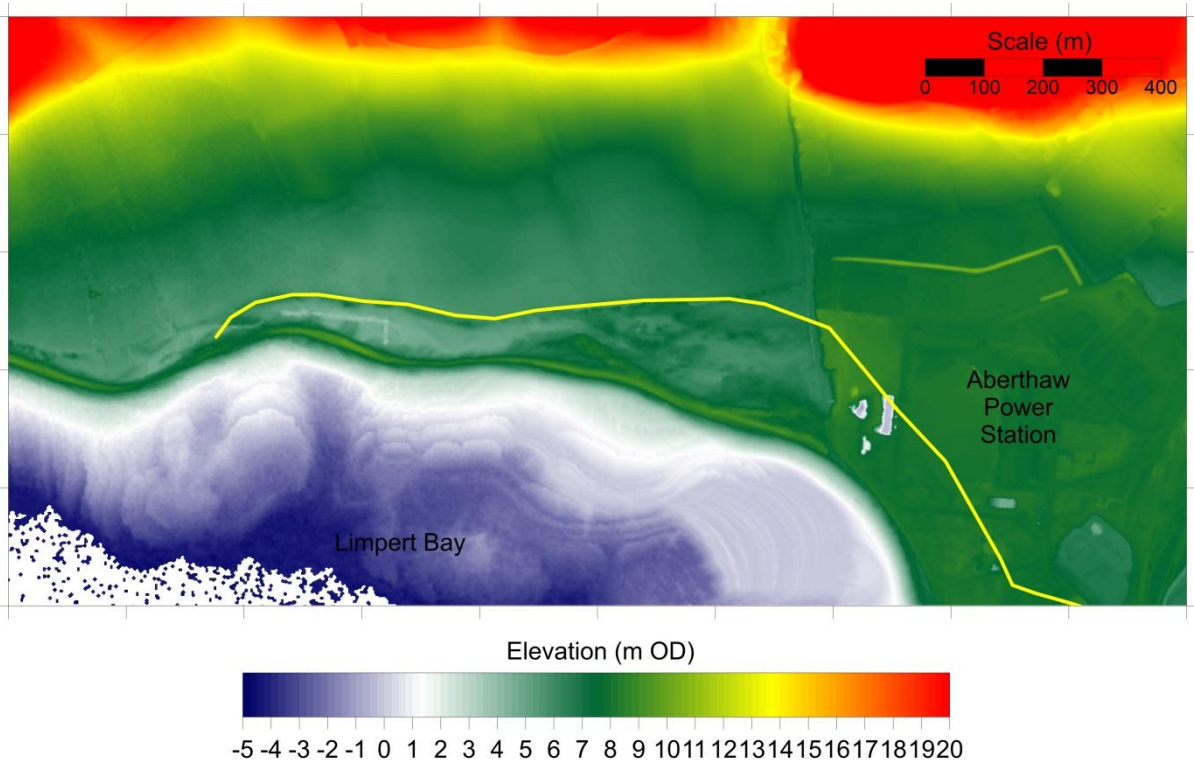
None identified	
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Further information

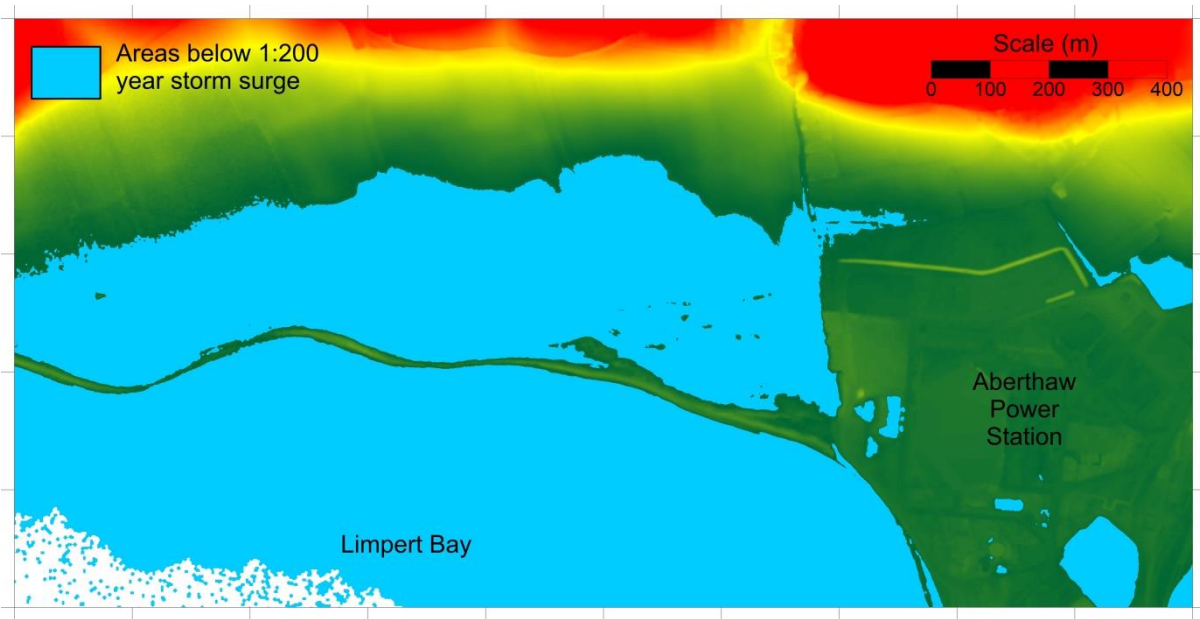
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand taken from BGS 1:50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand taken from BGS 1:50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 2: Ogmores Dunes

Site description

Morphological setting	Estuarine margin (south / east side of the Ogmores River, adjacent to shallow bay south of Porthcawl, north shore of the Bristol Channel); related to the Merthyr Mawr dune system on the west side of the Ogmores River
Morphological type	Mainly climbing dunes, now stabilised by vegetation
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Ogmores-by-Sea village to the west, golf course extension and agricultural fields to the south and east
Typical hinterland level	Rising land
Conservation designations	Southerndown Coast SSSI; Heritage Coast
Notable features	Southerndown Golf Club

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.80 m OD
1:200 year storm surge level	6.42 ± 0.3 m OD
Maximum crest level	n/a
Minimum crest level	n/a
Lidar survey data	02/05/15 (50 cm data)
Principal aspect of dune frontage	n/a

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	665 (279505E 175255N)
Distance offshore	2.5 km
Mean wind speed	11.80 knots
Mean wind direction	248.9 ° (WSW)
Mean significant wave height (Hs)	0.94 m
Mean zero up-crossing period (Tz)	4.77 sec
Mean peak wave period (Tp)	8.20 sec
Mean wave direction	244.0 ° (WSW)
Mean wave direction scaled for wave power	243.2 ° (WSW)
Mean annual wave power	36.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

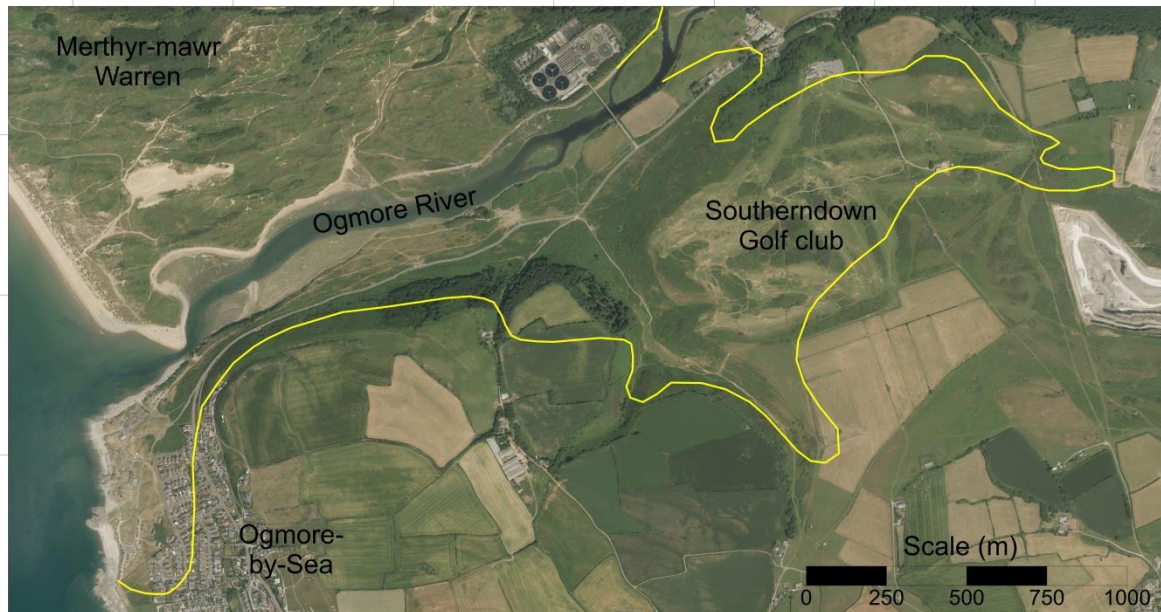
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

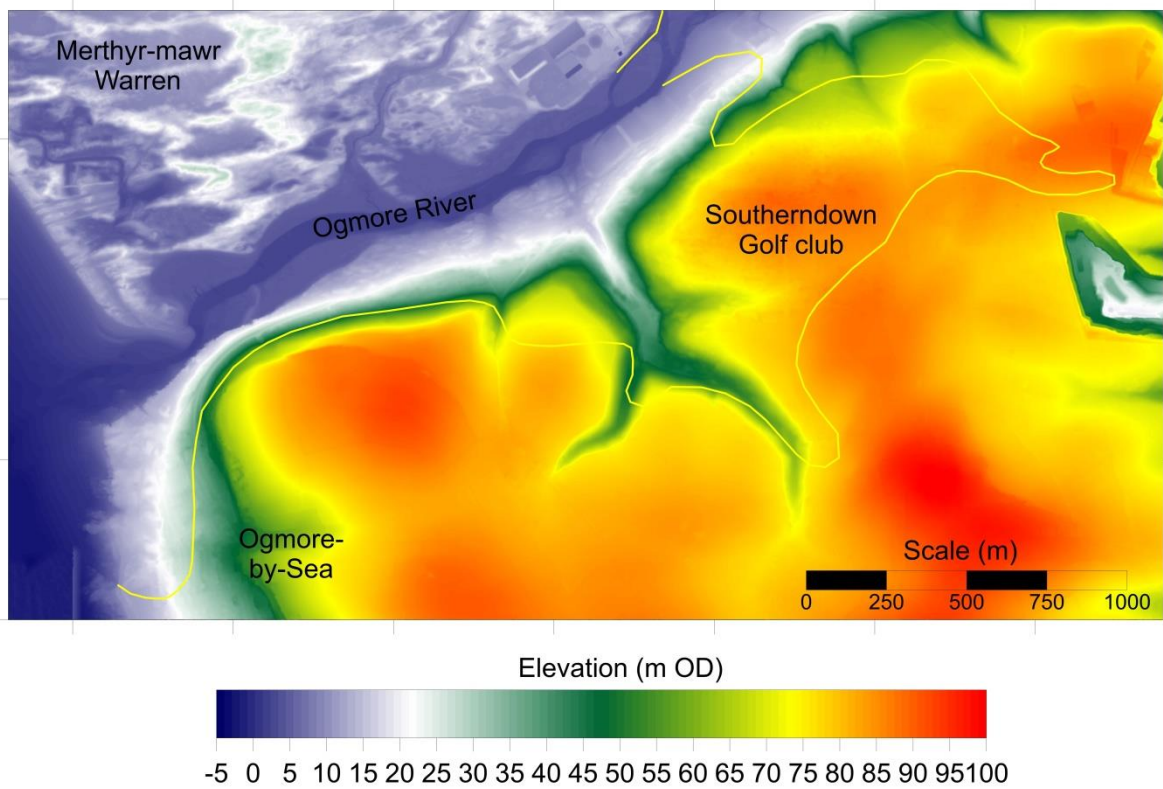
None identified	
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Further information

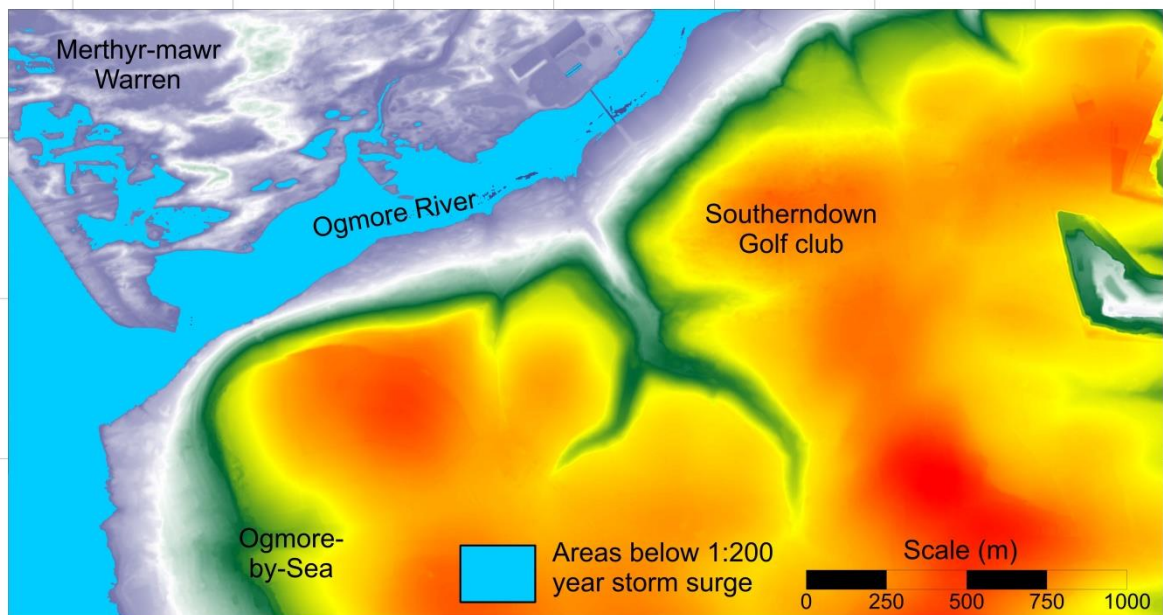
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1:50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand taken from BGS 1:50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 3: Merthyr-mawr Warren and Newton Burrows

Site description

Morphological setting	Bay (unnamed bay between Porthcawl and River Ogmore, north shore of Bristol Channel)
Morphological type	Composite: Transgressive, climbing and fringing
Erosion/progradation status	Progradation at E end, stable to eroding at W end
Defence structures	Rock armour and groynes at the extreme western end
Hinterland type	Wooded rock ridge, estuarine alluvium, urban development at western end
Typical hinterland level	5.5 to 6.0 m OD in Porthcawl housing areas, rising ground behind most of frontage
Conservation designations	Merthyr Mawr SSSI, SAC, NNR, Heritage Coast
Notable features	NRW dune rejuvenation site, Candleston Castle Scheduled Monument; extensive former sand and gravel workings now form slack habitat

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.80 m OD
1:200 year storm surge level	6.36 ± 0.3 m OD
Maximum crest level	20.6 m OD
Minimum crest level	c. 7.0 m OD
LiDAR survey date	05/02/2015 (50 cm)
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	665 (279505E 175255N)
Distance offshore	2.5 km
Mean wind speed	11.80 knots
Mean wind direction	248.9 ° (WSW)
Mean significant wave height (Hs)	0.94 m
Mean zero up-crossing period (Tz)	4.77 sec
Mean peak wave period (Tp)	8.20 sec
Mean wave direction	244.0 ° (WSW)
Mean wave direction scaled for wave power	243.2 ° (WSW)
Mean annual wave power	36.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 11; LD)	206-347 µm (average: 265 µm)
Calcium carbonate content (%) (N= 3)	4.27-8.62% (average: 6.16%)
Silica content (%) (N= 3)	84.7-90.0% (average: 87.7%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Very High
Geomorphological Features	High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	15
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

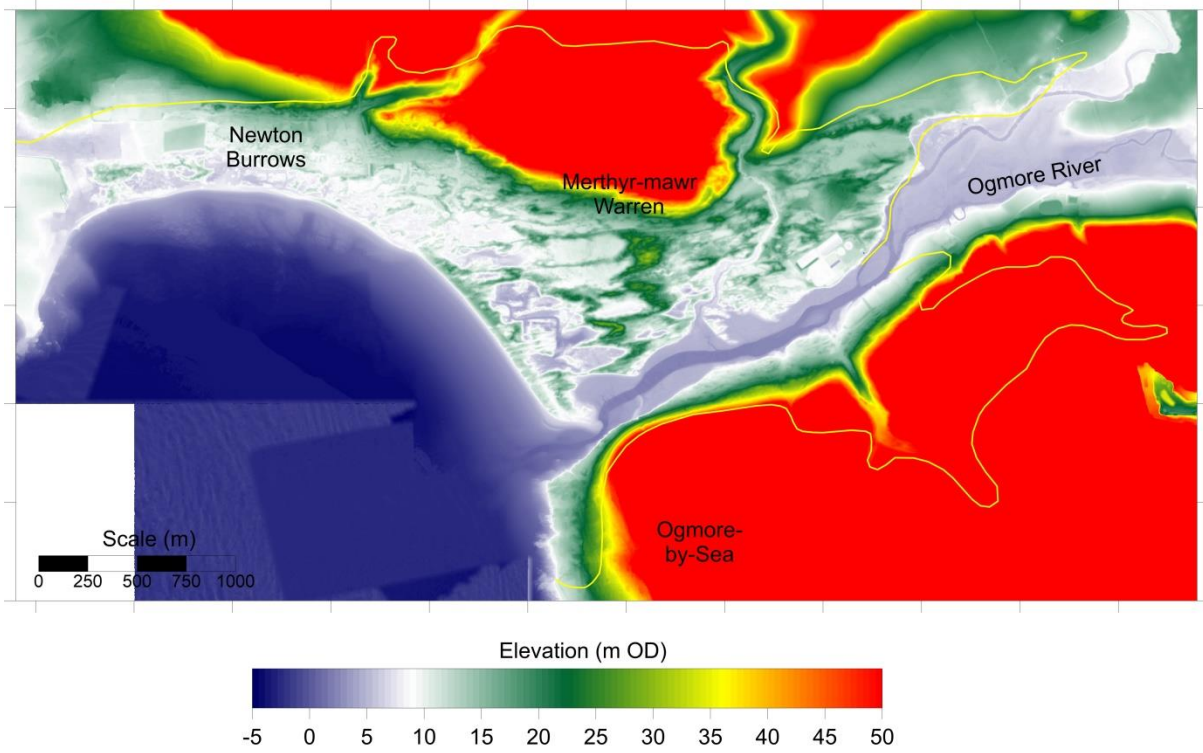
Sand fencing	Minor
Scrub control	Major
Stock grazing	Major in hind dune area
Turf stripping	Significant
Excavation of notches in frontal dunes	Significant
Excavation to deepen blowouts and create slacks	Significant
Translocation of sand to modify dune morphology	Significant

Further information

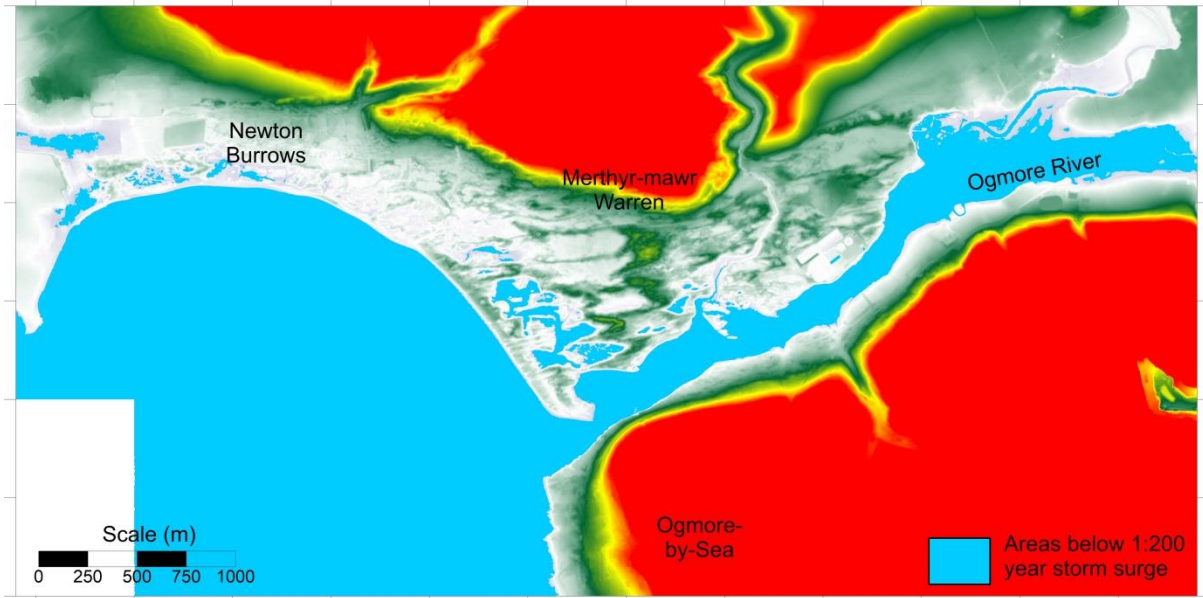
Pye K, Blott SJ. 2011. *Merthyr Mawr Warren – Potential for Dune Reactivation*. CCW Science Report No. 978, Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand taken from BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1:200 year storm surge level.

Site 4: Sandy Bay, Porthcawl

Site description

Morphological setting	Bay between artificial breakwaters / natural rock outcrop, Porthcawl, north shore of Bristol Channel
Morphological type	Fringing and transgressive
Erosion/progradation status	Stable
Defence structures	Rock armour beneath the frontal dunes
Hinterland type	Caravans, Holiday park / recreational area
Typical hinterland level	>9.2 m OD behind dune area
Conservation designations	None
Notable features	Significant area of bare, mobile sand

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.70 m OD
1:200 year storm surge level	6.31 ± 0.3 m OD
Maximum crest level	16.2 m OD
Minimum crest level	11.6 m OD
LiDAR survey date	28/02/2011
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	665 (279505E 175255N)
Distance offshore	2.5 km
Mean wind speed	11.80 knots
Mean wind direction	248.9 ° (WSW)
Mean significant wave height (Hs)	0.94 m
Mean zero up-crossing period (Tz)	4.77 sec
Mean peak wave period (Tp)	8.20 sec
Mean wave direction	244.0 ° (WSW)
Mean wave direction scaled for wave power	243.2 ° (WSW)
Mean annual wave power	36.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; LD)	199 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

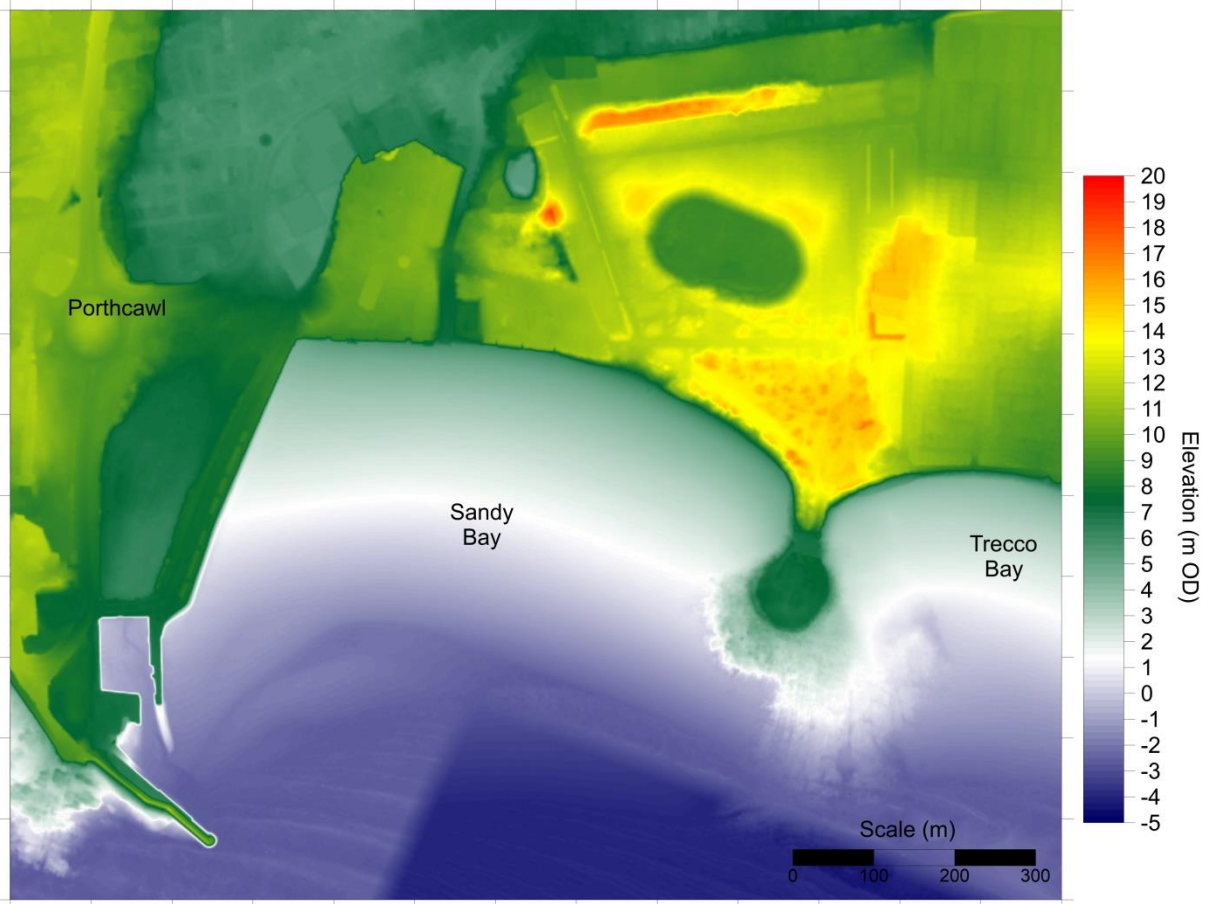
Sand fencing	Minor
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Further information

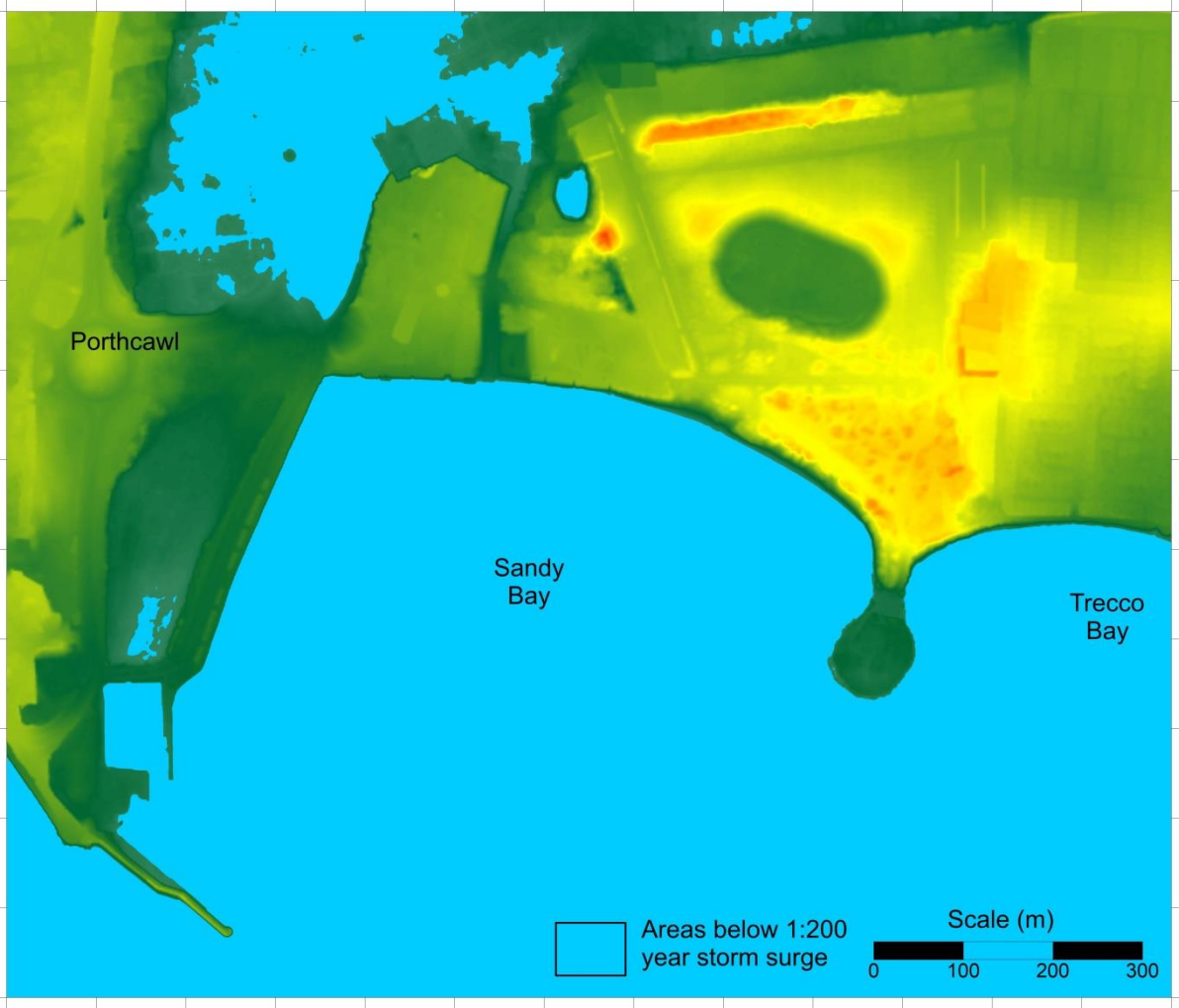
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The whole land area of the image is covered by blown sand, according to BGS 1: 50 000 scale geological maps, although the only active dunes occur at the eastern end of Sandy Bay.



LiDAR digital terrain model, flown 28 February 2011.



Areas below the estimated 1 in 200 year storm surge level.

Site 5: Porthcawl to Sker Point

Site description

Morphological setting	Open coast north of Porthcawl, north shore of Bristol Channel
Morphological type	Climbing and cliff top low dunes and sand sheets, localised areas of low ground protected principally by shingle barriers
Erosion/progradation status	Stable
Defence structures	Rock armour beneath the dune
Hinterland type	Caravans, Holiday park
Typical hinterland level	>9.2 m OD behind dune area
Conservation designations	None
Notable features	Royal Porthcawl Golf Club

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.70 m OD
1:200 year storm surge level	6.26 ± 0.3 m OD
Maximum crest level	n/a
Minimum crest level	n/a
LiDAR survey date	31/03/2014 and 01/04/2015
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	665 (279505E 175255N)
Distance offshore	2.5 km
Mean wind speed	11.80 knots
Mean wind direction	248.9 ° (WSW)
Mean significant wave height (Hs)	0.94 m
Mean zero up-crossing period (Tz)	4.77 sec
Mean peak wave period (Tp)	8.20 sec
Mean wave direction	244.0 ° (WSW)
Mean wave direction scaled for wave power	243.2 ° (WSW)
Mean annual wave power	36.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low / Medium
Historical / Archaeological	Low
Overall significance score	6.5
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

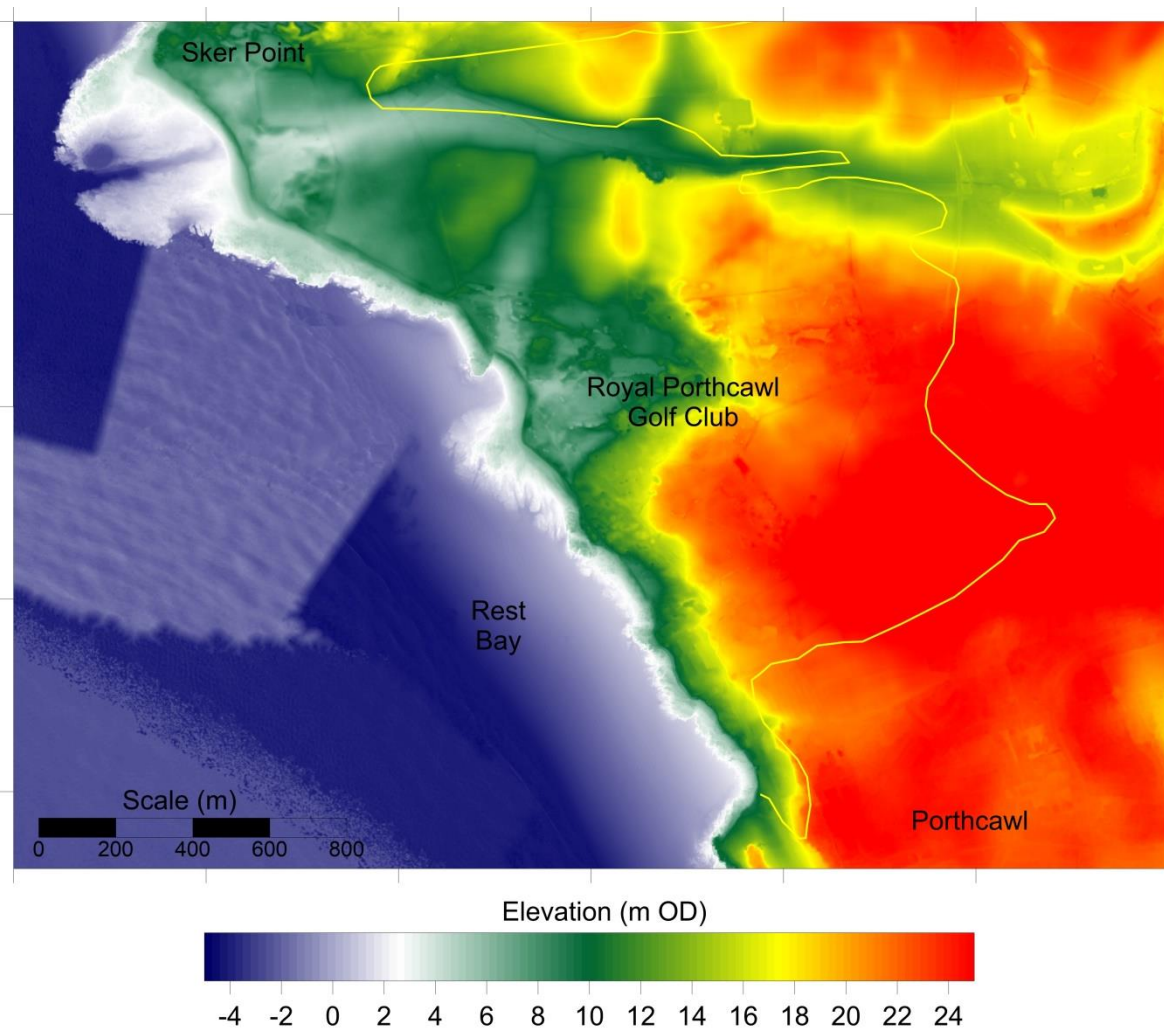
Sand fencing	Minor
Stock grazing	Minor

Further information

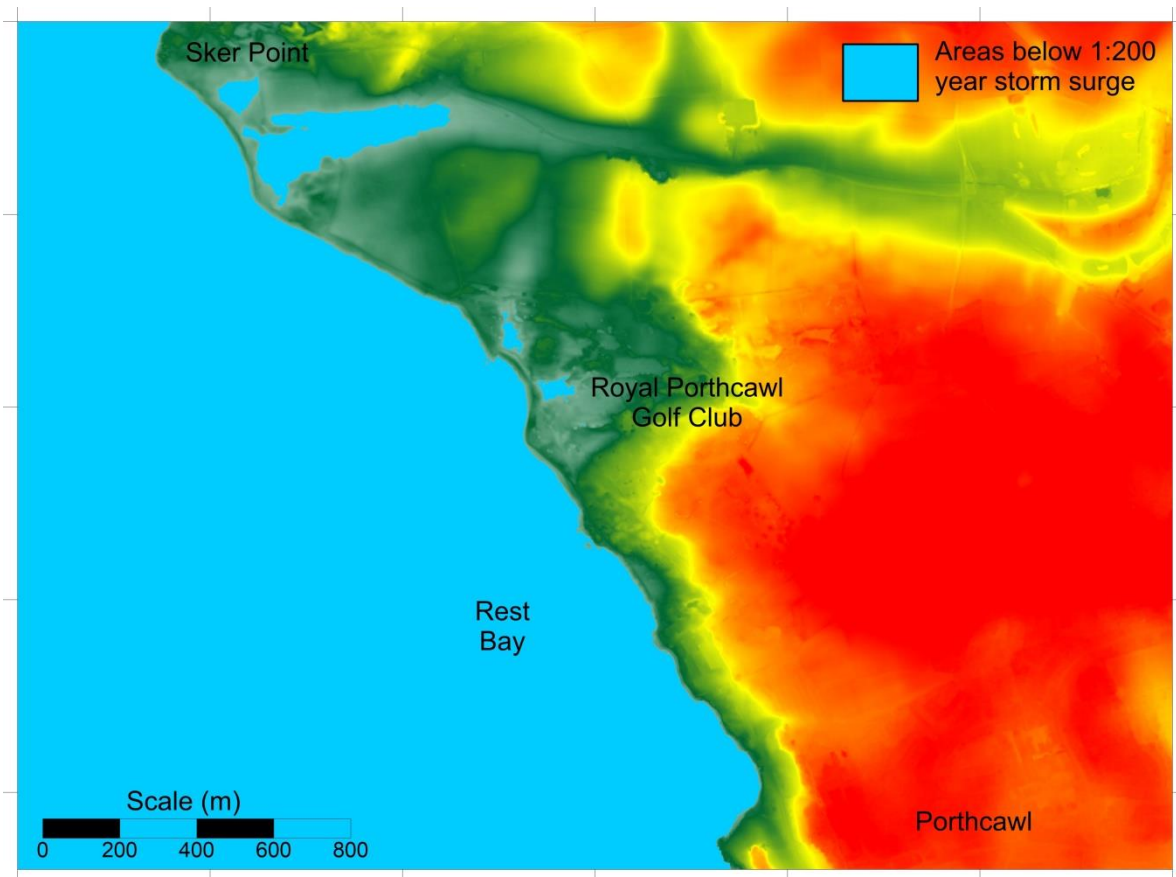
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography, flown 2013-14. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model, flown 28 February 2011. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 6: Kenfig Burrows

Site description

Morphological setting	Bay, southeast corner of Swansea Bay, north side of the Bristol Channel
Morphological type	Composite: Transgressive, climbing inland, barrier spit at mouth of Kenfig River with low foredune platform
Erosion/progradation status	Slowly eroding in S, stable in centre, slowly prograding in N
Defence structures	None
Hinterland type	Alluvial plain, M4 motorway, urban area, rock ridge, golf club
Typical hinterland level	6.8 to 7.8 m OD on Margam industrial area, rising ground >9.2 m OD to east of dunes
Conservation designations	Cynffig/Kenfig SSSI, SAC, NNR, LNR
Notable features	NRW dune rejuvenation trial area; artificial scrapes / slacks created by Plantlife; former sand and gravel workings provide significant slack habitat; Kenfig castle and town scheduled monument

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.65 m OD
1:200 year storm surge level	6.22 ± 0.3 m OD
Maximum crest level	22.4 m OD
Minimum crest level	7.3 m OD
LiDAR survey date	01/04/2014
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	716 (270629E 184219N)
Distance offshore	6.6 km
Mean wind speed	10.99 knots
Mean wind direction	244.8 ° (WSW)
Mean significant wave height (Hs)	0.83 m
Mean zero up-crossing period (Tz)	4.65 sec
Mean peak wave period (Tp)	8.13 sec
Mean wave direction	240.0 ° (WSW)
Mean wave direction scaled for wave power	239.0 ° (WSW)
Mean annual wave power	28.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 15; LD)	227-675 µm (average: 362 µm)
Calcium carbonate content (%) (N= 5)	3.44-6.55% (average: 4.91%)
Silica content (%) (N= 5)	88.0-94.6% (average: 89.0%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	14
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Sand fencing	Minor
Vegetation planting	Minor
Scrub removal	Significant
Stock grazing	Major
Turf stripping	Significant
Notch cutting in frontal dunes	Significant
Excavation to create slacks	Significant
Movement of sand to reform dunes	Significant
Beach nourishment	Minor

Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

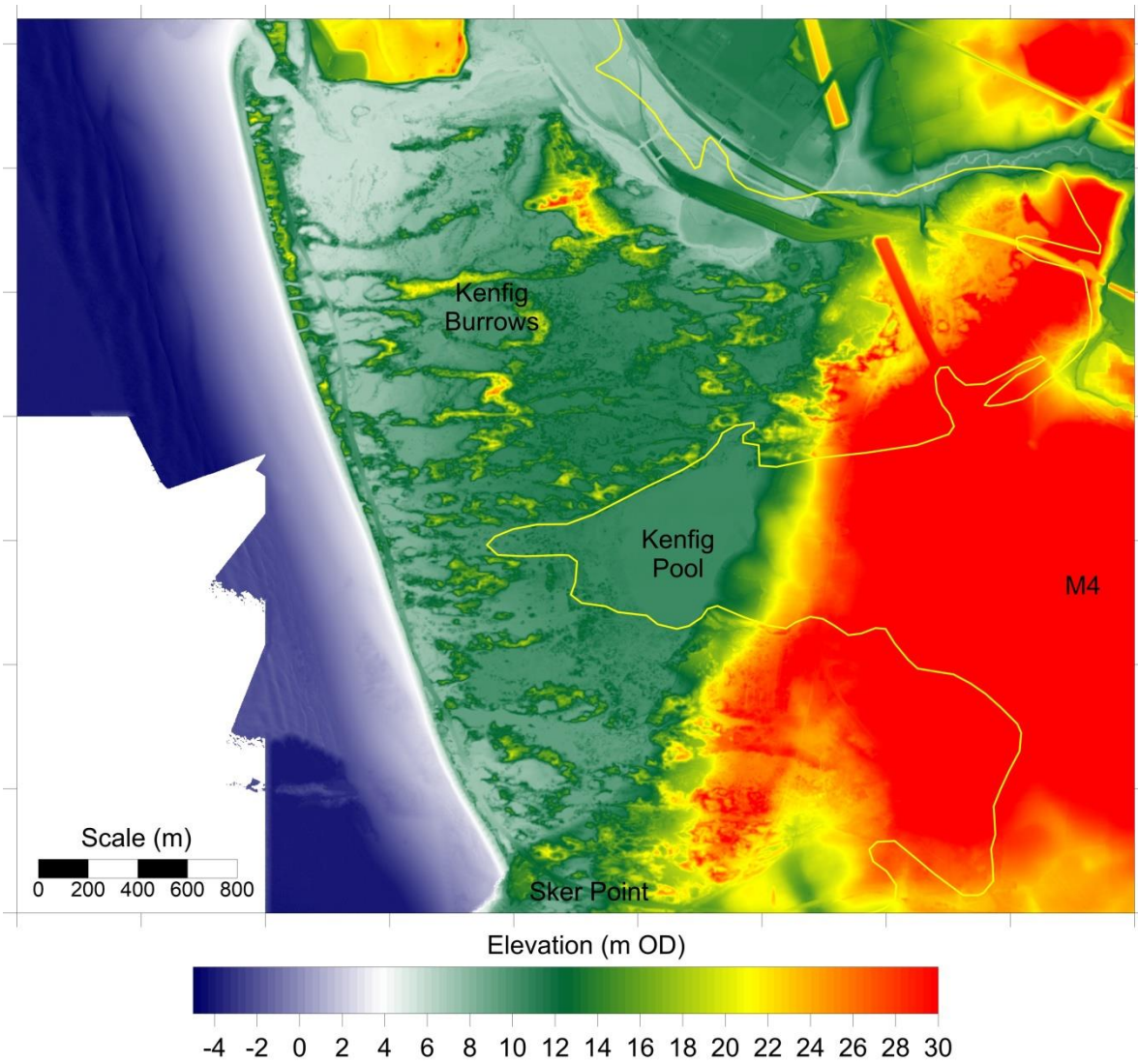
Pye K, Blott SJ. 2011. *Kenfig sand Dunes – Potential for Dune Rejuvenation*. CCW Science Report 970, Countryside Council for Wales, Bangor.

Pye K, Blott SJ. 2017. Evolution of a sediment-starved, over-stabilized coastal dunefield: Kenfig Burrows, South Wales, UK. *Journal of Coastal Conservation* (published online April 2017)

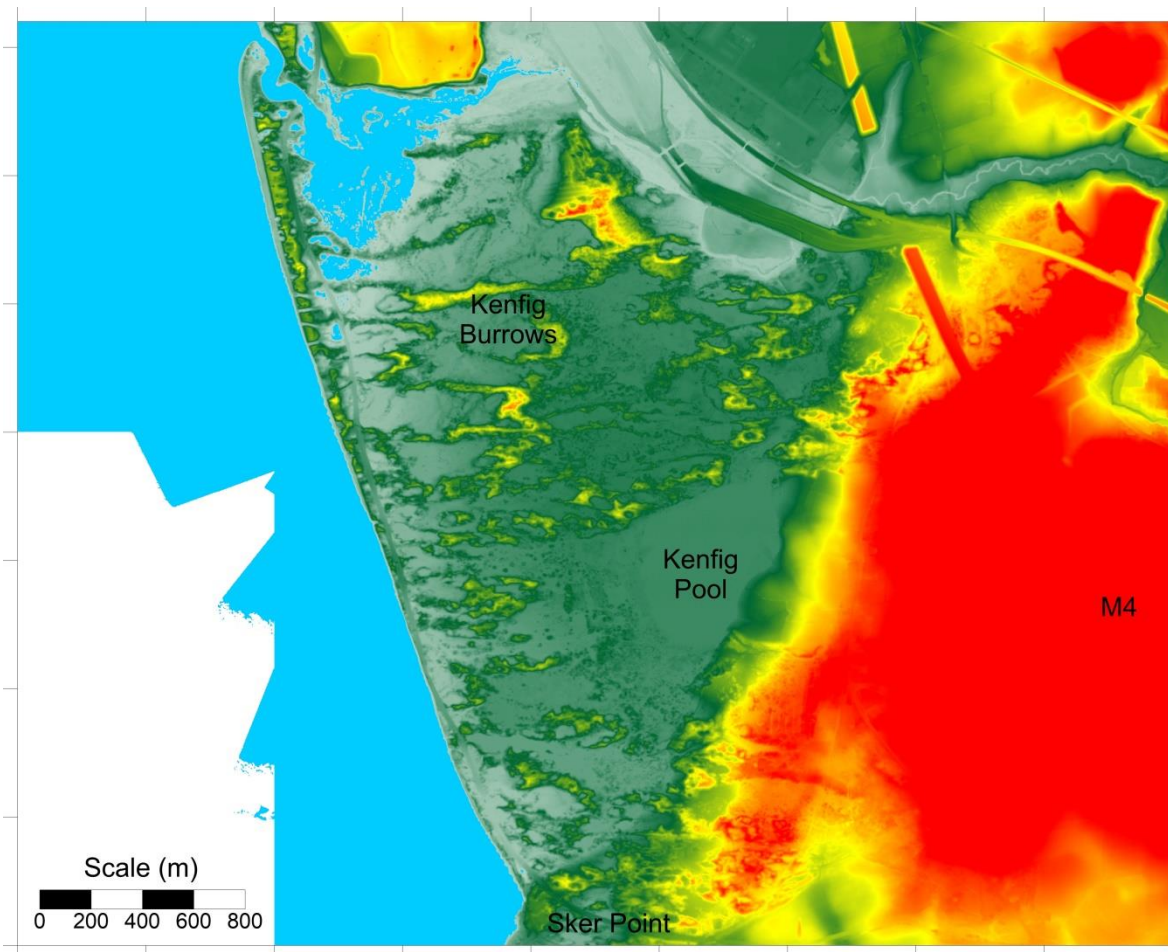
Saye SE, van der Wal D, Pye K, Blott SJ .2005. Beach – dune morphological relationships and erosion / accretion: an investigation at five sites in England and Wales using LIDAR. *Geomorphology* 72, 128-158.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 7: Margam Burrows

Site description

Morphological setting	Bay, eastern side of Swansea Bay
Morphological type	Fringing and transgressive barrier, now largely stabilized
Erosion/progradation status	Slowly eroding in S, defended in N; active blowouts in S
Defence structures	None on the remaining dune frontage, rock armour and sea wall on the former dune areas to the north along Port Talbot steel works frontage
Hinterland type	Reclaimed marsh (Margam Moors) and reservoir
Typical hinterland level	3.6 to 4.5 m OD on Margam Moors
Conservation designations	None, but adjacent to Kenfig SSSI, SAC and NNR
Notable features	Port Talbot steel works immediately to the north

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.65 m OD
1:200 year storm surge level	6.21 ± 0.3 m OD
Maximum crest level	n/d
Minimum crest level	n/d
Maximum cross-sectional area above HAT	
Minimum cross-sectional area above HAT	
LiDAR survey date	31/03/2014
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	716 (270629E 184219N)
Distance offshore	6.6 km
Mean wind speed	10.99 knots
Mean wind direction	244.8 ° (WSW)
Mean significant wave height (Hs)	0.83 m
Mean zero up-crossing period (Tz)	4.65 sec
Mean peak wave period (Tp)	8.13 sec
Mean wave direction	240.0 ° (WSW)
Mean wave direction scaled for wave power	239.0 ° (WSW)
Mean annual wave power	28.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	234-256 µm (average: 242 µm)
Calcium carbonate content (%) (N= 3)	4.03-5.41% (average: 4.82%)
Silica content (%) (N= 3)	89.1-89.7% (average: 89.3%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

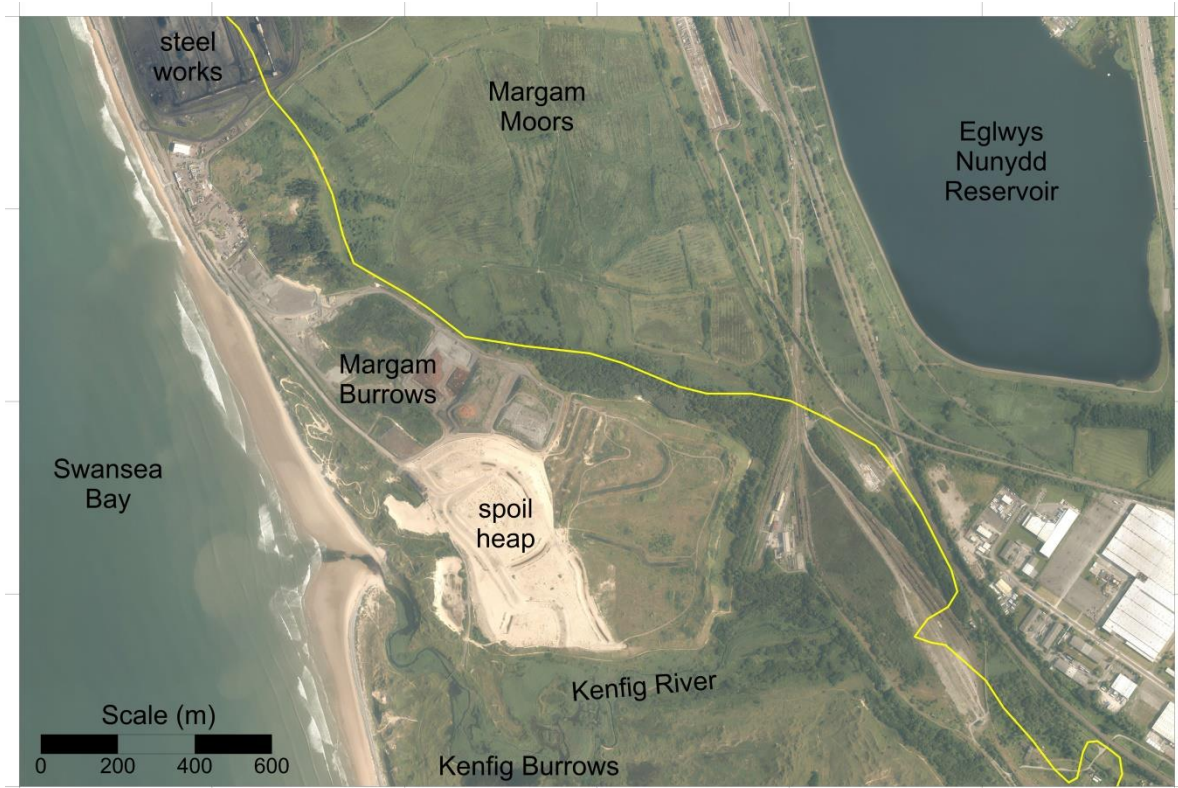
Present and past dune and beach management measures

Sand fencing	Minor
Vegetation planting	Minor
Artificial dune landscaping on steelworks spoil heap	Significant

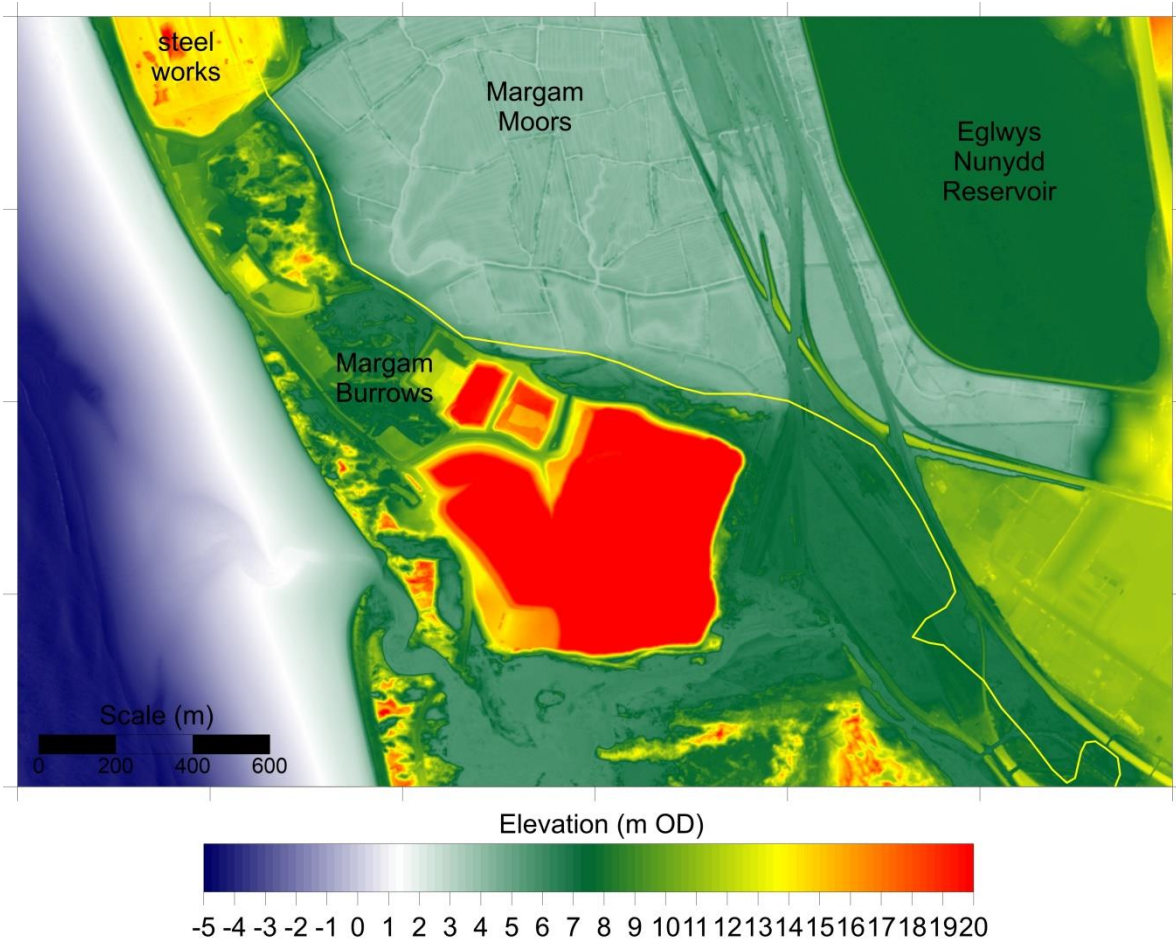
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

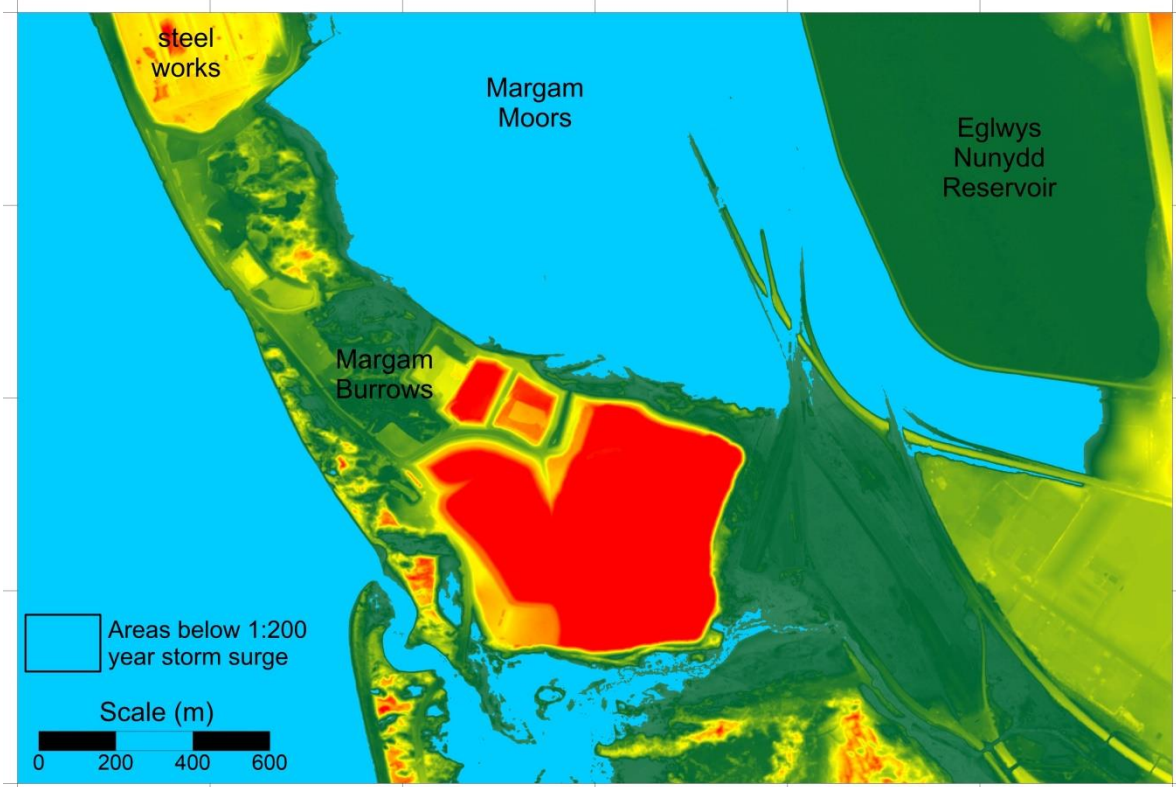
Pye K, Blott SJ. 2017. Evolution of a sediment-starved, over-stabilized coastal dunefield: Kenfig Burrows, South Wales, UK. *Journal of Coastal Conservation* (published online April 2017)



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps. The high area (red) is a spoil heap linked to the steelworks. Note the area of sand excavation between the spoil heap and coast-fringing dunes.



Areas below the estimated 1 in 200 year storm surge level.

Site 8: Aberavon

Site description

Morphological setting	Artificial bay between artificial breakwaters, north side of River Avon, eastern side of Swansea Bay
Morphological type	Fringing in front of sea wall, relict dune system behind the promenade
Erosion/progradation status	Stable / slowly prograding in front of sea wall / stable behind promenade
Defence structures	Sea wall, breakwaters at either end
Hinterland type	Housing
Typical hinterland level	>10 m OD
Conservation designations	None
Notable features	Adjacent to River Avon and Port Talbot Old Harbour

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.60 m OD
1:200 year storm surge level	6.18 ± 0.3 m OD
Maximum crest level	15.3 m OD
Minimum crest level	10.6 m OD
LiDAR survey date	31/03/2014
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	716 (270629E 184219N)
Distance offshore	6.6 km
Mean wind speed	10.99 knots
Mean wind direction	244.8 ° (WSW)
Mean significant wave height (Hs)	0.83 m
Mean zero up-crossing period (Tz)	4.65 sec
Mean peak wave period (Tp)	8.13 sec
Mean wave direction	240.0 ° (WSW)
Mean wave direction scaled for wave power	239.0 ° (WSW)
Mean annual wave power	28.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 3; LD)	257-260 µm (average: 259 µm)
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

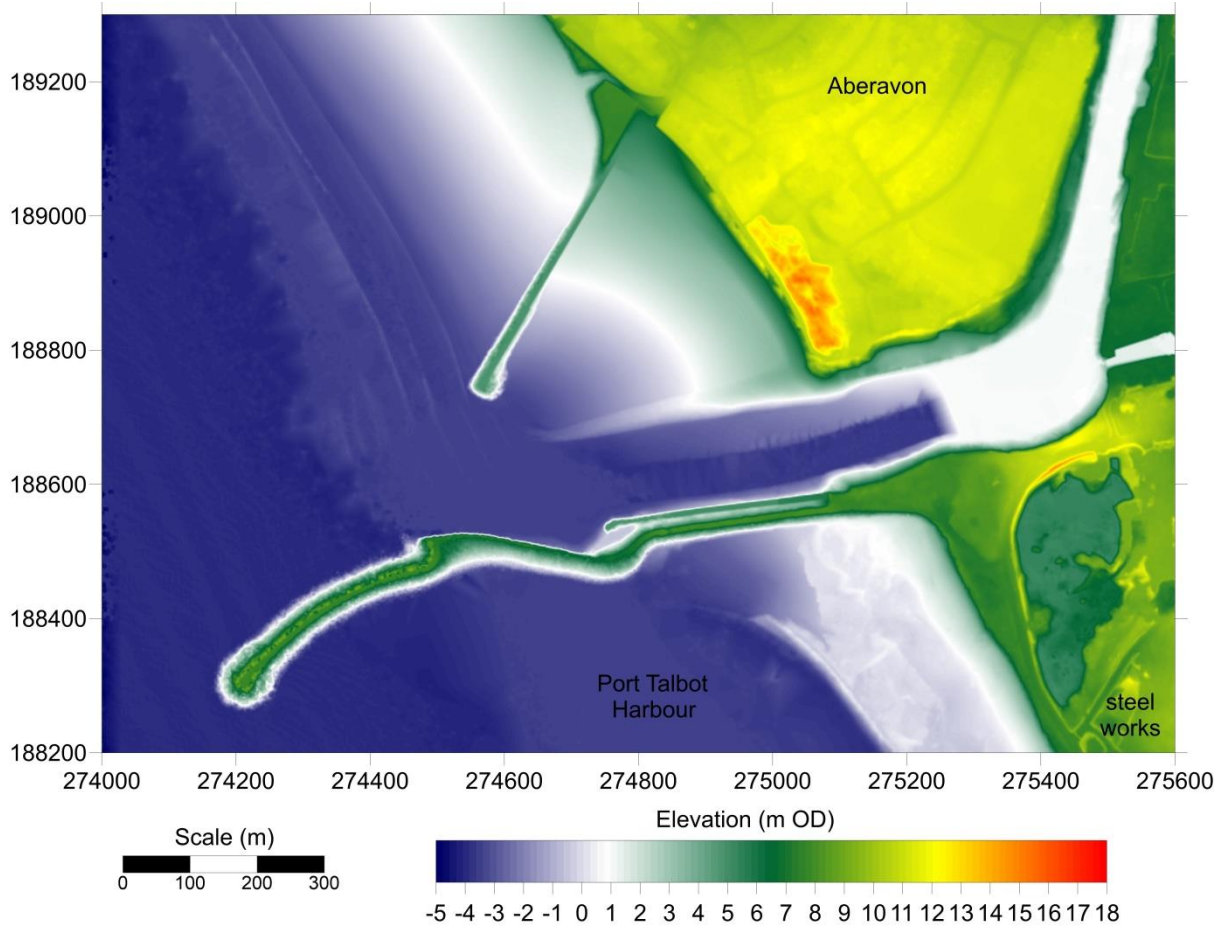
Sand fencing	Minor
Vegetation planting	Minor

Further information

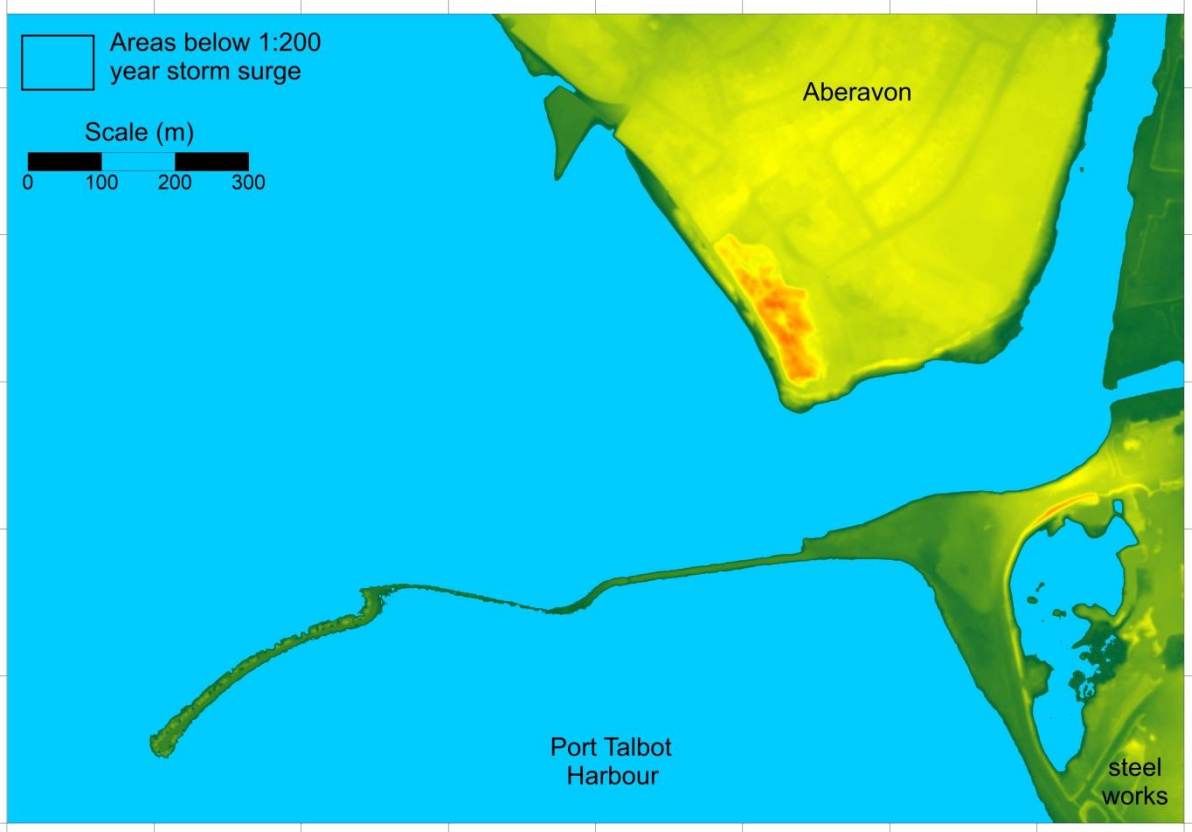
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The whole land area of the image is underlain with blown sand, according to BGS 1: 50 000 scale geological maps, but significant dune forms (largely vegetated by marram) are present only behind and in front of the promenade on the north side of the river mouth (indicated by yellow lines)



LiDAR digital terrain model, flown 31 March 2014. The whole land area of the image is underlain with blown sand, according to BGS 1: 50,000 scale geological maps. The main area of higher relief dunes is shown in red.



Areas below the estimated 1 in 200 year storm surge level.

Site 9: Baglan Burrows

Site description

Morphological setting	Bay and estuary margin (NE corner of Swansea Bay, south side of Neath estuary)
Morphological type	Bay fringing, with estuarine mouth spit recurves at northern end
Erosion/progradation status	Slowly eroding at southern end, prograding at northern end
Defence structures	River Neath training wall at northern end, rip rap toe protection and minor rock armour at the southern (Aberavon) end
Hinterland type	Industrial / former industrial
Typical hinterland level	Active estuarine areas in the north, 7.8 to 10.0 m OD on industrial areas to the south
Conservation designations	None
Notable features	Deposition site for dredge arisings from Neath Estuary; significant areas of bare, mobile sand present

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.80 m OD
1:200 year storm surge level	6.17 ± 0.3 m OD
Maximum crest level	22.0 m OD
Minimum crest level	Intertidal at N end
LiDAR survey date	20/01/2011
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	716 (270629E 184219N)
Distance offshore	6.6 km
Mean wind speed	10.99 knots
Mean wind direction	244.8 ° (WSW)
Mean significant wave height (Hs)	0.83 m
Mean zero up-crossing period (Tz)	4.65 sec
Mean peak wave period (Tp)	8.13 sec
Mean wave direction	240.0 ° (WSW)
Mean wave direction scaled for wave power	239.0 ° (WSW)
Mean annual wave power	28.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 10; LD)	232-291 µm (average: 261 µm)
Calcium carbonate content (%) (N=4)	4.21-7.16% (average: 5.87%)
Silica content (%) (N= 4)	86.2-91.4% (average: 88.7%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Low / Medium
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	9.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Sand fencing	Minor
Vegetation planting	Minor
Placement of dredging arisings to create artificial dune mounds	Significant
Placement of gravel on blowout surfaces to limit deflation	Minor
Placement of rip rap along part of dune toe	Minor

Further information

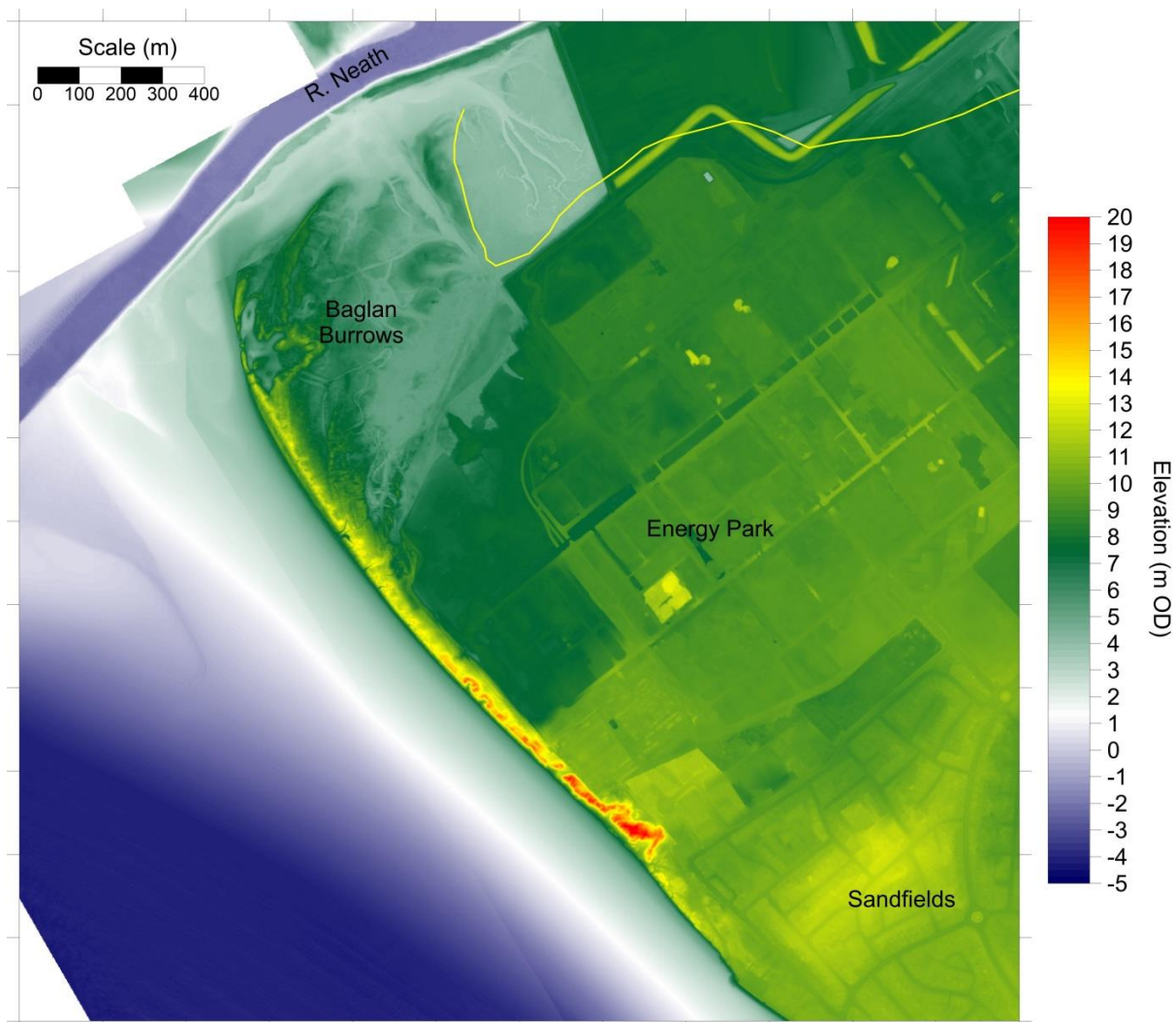
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2014. *Crymlyn Burrows and Baglan Burrows Geomorphological Assessment Report*. Report to Neath Port Talbot Council. Report No. EX1283, Kenneth Pye Associates Ltd, Solihull.

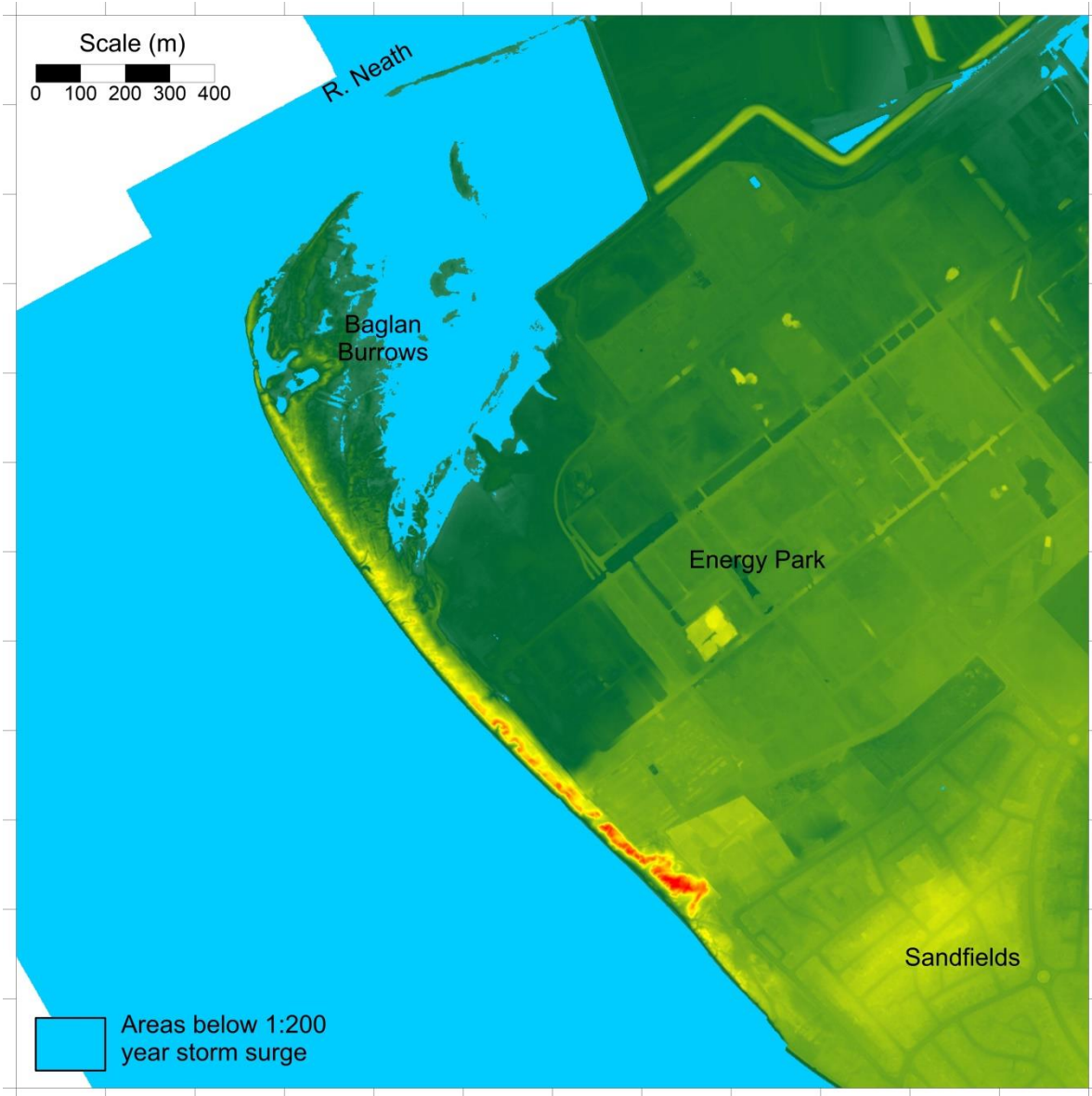
Pye K, Blott SJ. 2015. *Proposed Dune Habitat Enhancement Works at Baglan Burrows*. Report to Neath Port Talbot Council. Report No. EX17007, Kenneth Pye Associates Ltd, Solihull.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model, flown 20 January 2011. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 10: Crymlyn Burrows and Earlswood Golf Club

Site description

Morphological setting	Bay and estuary (NE corner of Swansea Bay, west side of Neath estuary)
Morphological type	Bay-head barrier, with estuarine mouth spit recurves at eastern end, estuarine fringing and climbing dunes inland
Erosion/progradation status	Temporally and spatially variable in response to intertidal morphological change
Defence structures	Neath training wall at eastern end, rock armour at western end
Hinterland type	Industrial, golf club on high ground inland
Typical hinterland level	>7.2 m OD on main road and industrial areas, >6.0 m OD on Earlswood Golf Club
Conservation designations	Crymlyn Burrows SSSI
Notable features	Swansea University Bay Campus adjacent to W end, Earlswood Golf Club on climbing dunes; adjacent to Swansea Bay Tidal Lagoon planned to southwest of the site

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.80 m OD
1:200 year storm surge level	6.17 ± 0.3 m OD
Maximum crest level	13.6 m OD
Minimum crest level	Intertidal at E end
LiDAR survey date	30/11/2013
Principal aspect of dune frontage	south

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	716 (270629E 184219N)
Distance offshore	6.6 km
Mean wind speed	10.99 knots
Mean wind direction	244.8 ° (WSW)
Mean significant wave height (Hs)	0.83 m
Mean zero up-crossing period (Tz)	4.65 sec
Mean peak wave period (Tp)	8.13 sec
Mean wave direction	240.0 ° (WSW)
Mean wave direction scaled for wave power	239.0 ° (WSW)
Mean annual wave power	28.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	242-301 µm (average: 270 µm)
Calcium carbonate content (%) (N= 3)	5.69-6.34% (average: 5.94%)
Silica content (%) (N= 3)	86.3-88.4% (average: 87.4%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	High
Geomorphological Features	Medium
Recreation	Low / Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	10
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

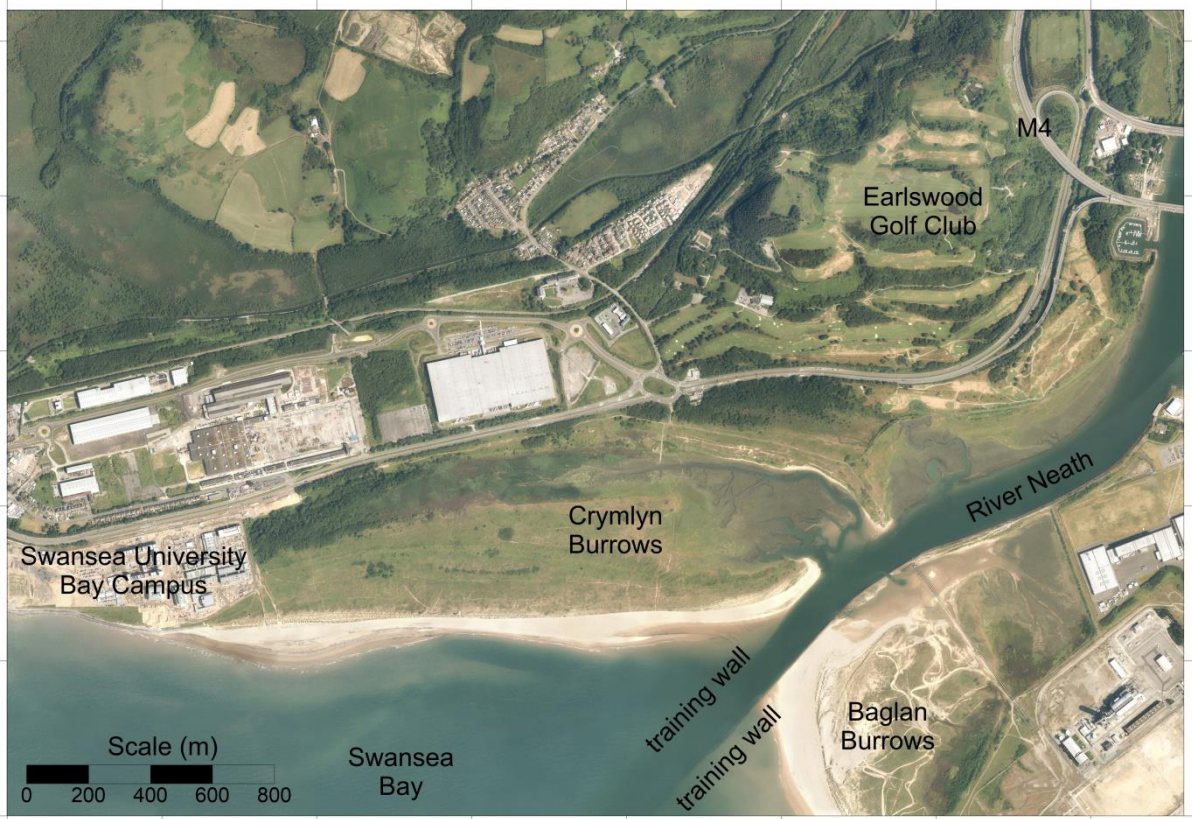
Sand fencing	Minor
Vegetation planting	Minor
Scrub clearance	Minor
Placement of rock armour along western end of dune toe	Minor

Further information

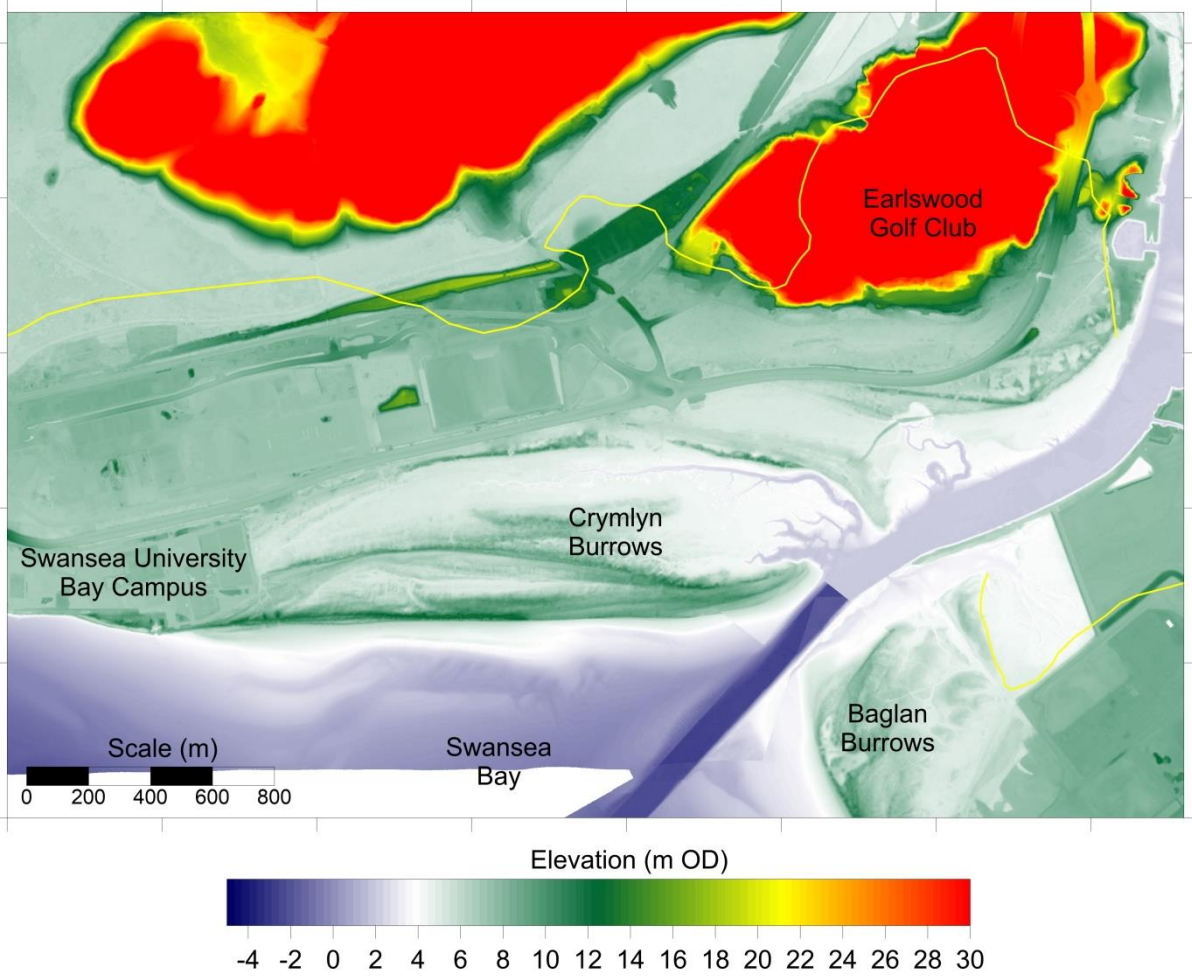
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2014. *Crymlyn Burrows and Baglan Burrows Geomorphological Assessment Report*. Report to Neath Port Talbot Council. Report No. EX1283, Kenneth Pye Associates Ltd, Solihull.

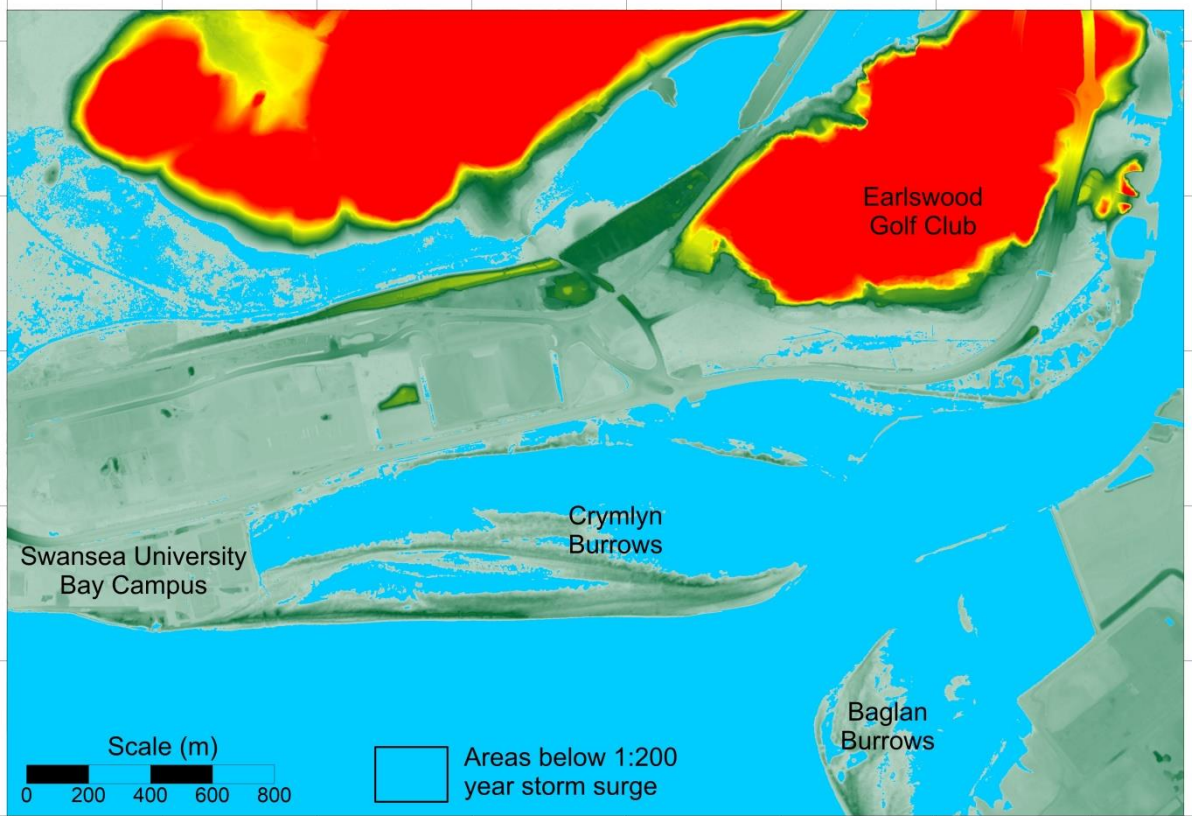
Pye K, Blott SJ. 2014. *Crymlyn Burrows SSSI Geomorphological Assessment Report*. Report to Natural Resources Wales. Report No. 160906, Kenneth Pye Associates Ltd, Solihull.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model, flown 30 November 2013. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 11: Spontex Dunes, Swansea

Site description

Morphological setting	Artificial bay formed between Swansea Harbour west breakwater and the old Swansea Observatory, northwest Swansea Bay
Morphological type	Fringing
Erosion/progradation status	Slowly prograding and vertically accreting
Defence structures	Tawe training wall at eastern end, sea wall at western end and behind the dunes
Hinterland type	Housing, marina
Typical hinterland level	9.5 to 10.5 m OD on housing areas
Conservation designations	Site of Interest for Nature Conservation (SINC)
Notable features	Swansea Point and Maritime Quarter urban development behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.50 m OD
1:200 year storm surge level	6.15 ± 0.3 m OD
Maximum crest level	12.5 m OD
Minimum crest level	9.0 m OD
LiDAR survey date	31/03/2014
Principal aspect of dune frontage	south-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	717 (261748E 184276N)
Distance offshore	2.7 km
Mean wind speed	11.70 knots
Mean wind direction	243.7 ° (WSW)
Mean significant wave height (Hs)	0.85 m
Mean zero up-crossing period (Tz)	4.48 sec
Mean peak wave period (Tp)	7.86 sec
Mean wave direction	236.4 ° (WSW)
Mean wave direction scaled for wave power	234.8 ° (SW)
Mean annual wave power	28.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low / Medium
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

Sand fencing	Significant
Vegetation planting	Significant
Scrub clearance	Minor
Board walks	Significant

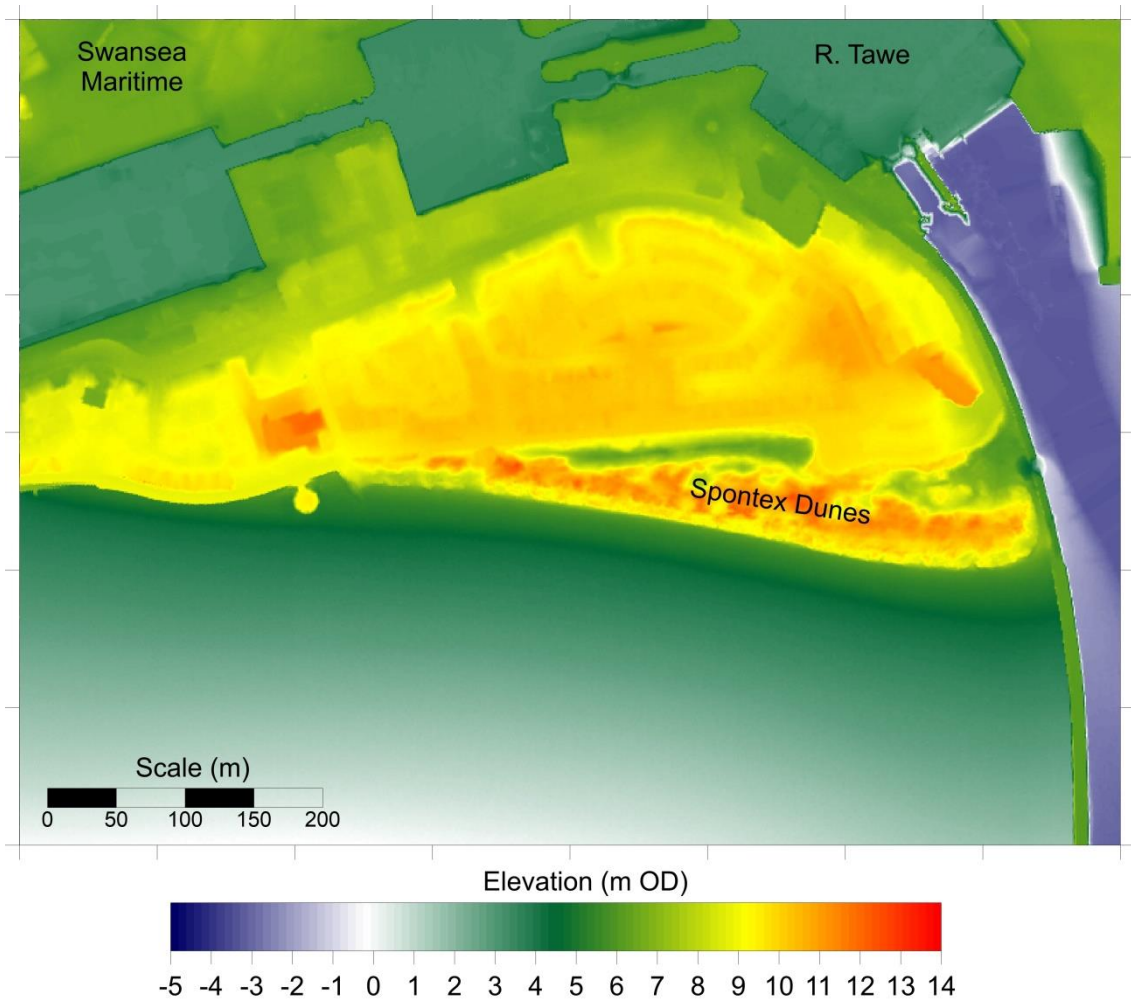
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

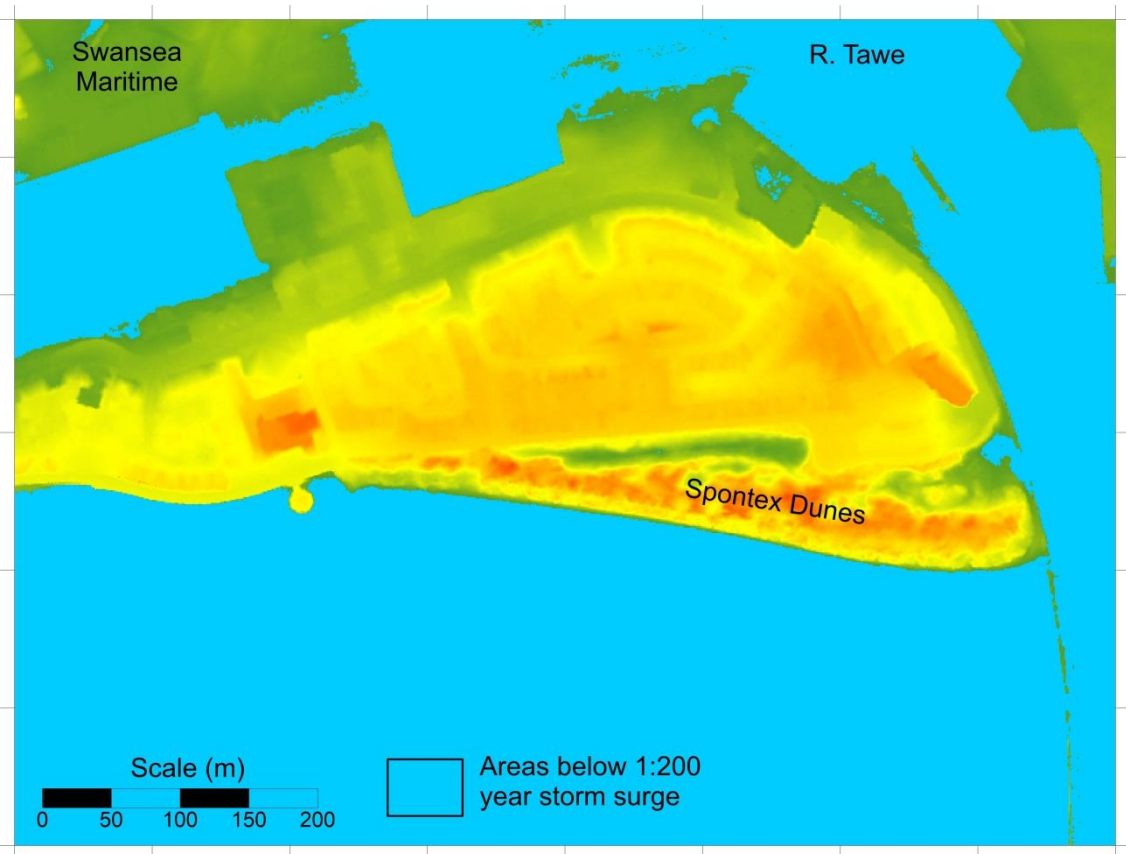
Phillips M. 2013. *An Assessment of the Swansea Point Dune System*. Report to the City and County of Swansea. University of Wales Trinity St David.



2013-14 aerial photography. The whole land area of the image is underlain with blown sand, according to BGS 1: 50 000 scale geological maps, but the older dunes have been largely levelled and built on



LiDAR digital terrain model, flown 31 March 2014. The whole land area of the image is underlain with blown sand, according to BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 12: Swansea Beach and Black Pill Burrows

Site description

Morphological setting	Bay (northwest Swansea Bay)
Morphological type	Bay-head barrier, fringing dunes on seaward side of promenade
Erosion/progradation status	Stabilised behind promenade, dunes in front of promenade are stable in W and slowly prograding / vertically accreting in E, though vulnerable to periodic storm erosion
Defence structures	Sea wall, dunes in front of or behind the wall
Hinterland type	Housing, recreation
Typical hinterland level	>6.2 m OD on most housing areas, small area between 5.5 and 6.2 m OD at the eastern end
Conservation designations	Blackpill SSSI, Heritage Coast (western part of dune system)
Notable features	Main coastal road behind subject to blown sand incursion, Swansea Council/NRW dune creation trial in E

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.50 m OD
1:200 year storm surge level	6.15 ± 0.3 m OD
Maximum crest level	13.4 m OD
Minimum crest level	6.5 m OD
LiDAR survey date	31/03/2014
Principal aspect of dune frontage	south-southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	717 (261748E 184276N)
Distance offshore	2.7 km
Mean wind speed	11.70 knots
Mean wind direction	243.7 ° (WSW)
Mean significant wave height (Hs)	0.85 m
Mean zero up-crossing period (Tz)	4.48 sec
Mean peak wave period (Tp)	7.86 sec
Mean wave direction	236.4 ° (WSW)
Mean wave direction scaled for wave power	234.8 ° (SW)
Mean annual wave power	28.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	225-300 µm (average: 280 µm)
Calcium carbonate content (%) (N= 3)	6.01-6.94% (average: 6.57%)
Silica content (%) (N= 3)	87.2-89% (average: 87.9%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Low / Medium
Geomorphological Features	Low
Recreation	Medium / High
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	10
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

Sand fencing	Significant
Vegetation planting	Significant
Scrub clearance	Minor
Sand placement and dune reprofiling	Significant

Further information

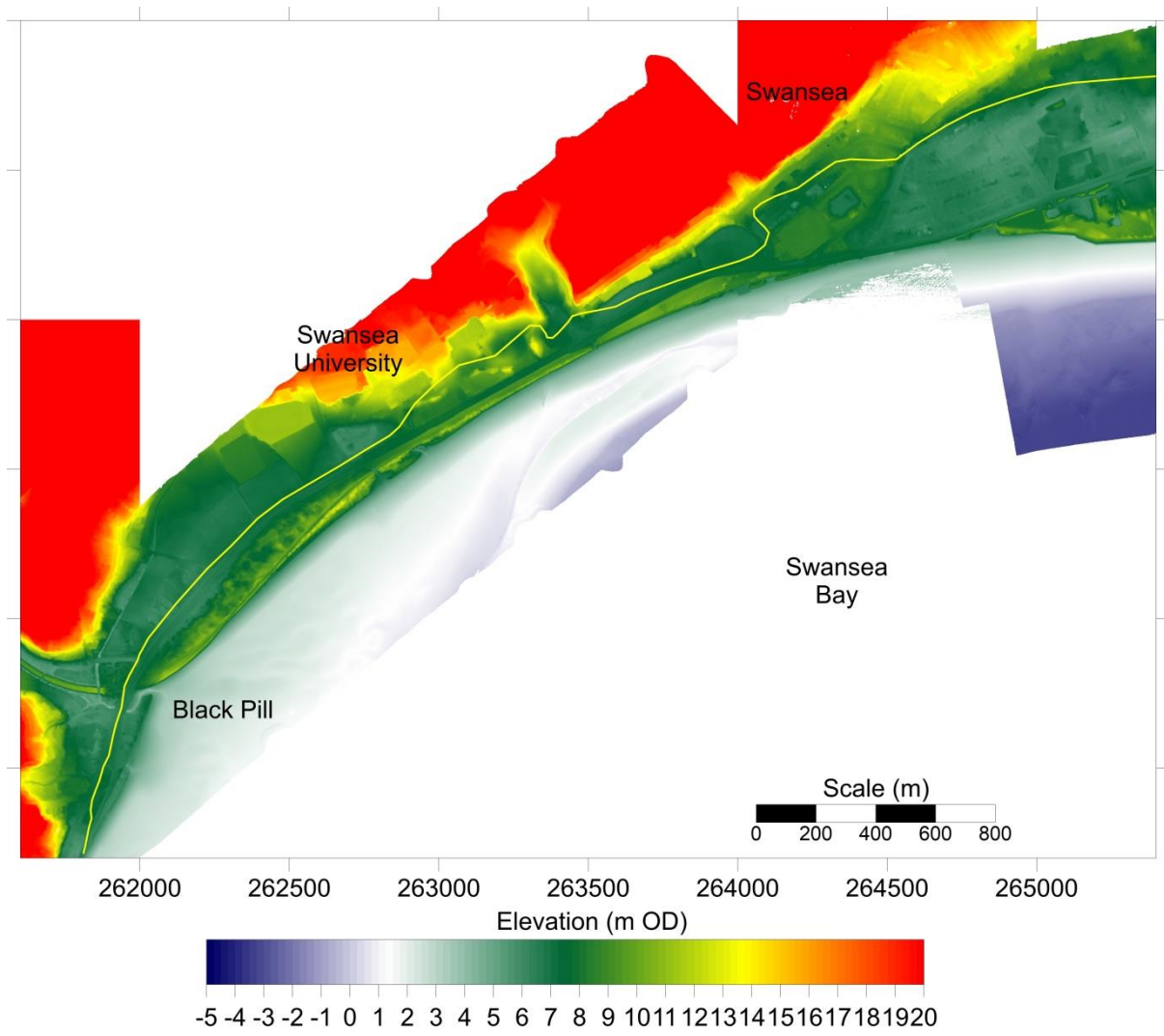
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2014. *Tidal Lagoon Swansea Bay. Background Information Relating to Blackpill SSSI and Adjoining Areas of Swansea Bay*. Report to Natural Resources Wales. Report No. 16098, Kenneth Pye Associates Ltd, Solihull.

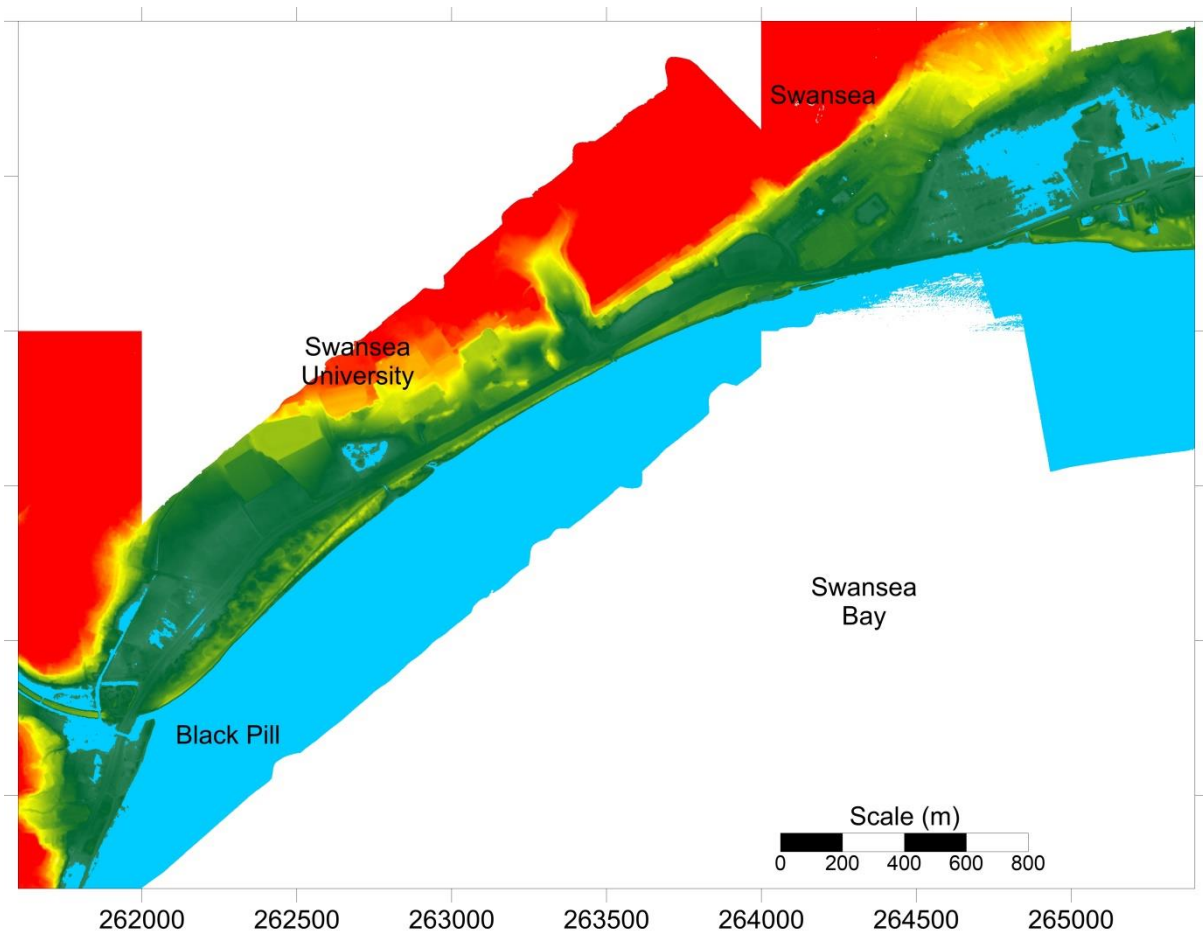
Pye K, Blott SJ. 2015. *Revised Proposals for Dune Restoration and Windblown Sand Control Works on Eastern Swansea Beach*. Report to City and County of Swansea and Natural Resources Wales. Report No. 1387, Kenneth Pye Associates Ltd., Solihull.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model, flown 31 March 2014. The yellow line indicates the limit of blown sand based on BGS1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 13: Pennard Burrows

Site description

Morphological setting	Bay (Three Cliff Bay, southern Gower Peninsula)
Morphological type	Bay-head barriers, climbing dunes behind
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Golf course, agricultural
Typical hinterland level	Rising ground
Conservation designations	Pennard Valley SSSI, AONB, Heritage Coast, National Trust
Notable features	Three Cliff Bay to seaward Pennard Castle

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	6.02 ± 0.3 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	29/03/2007 and 21/08/2005
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	718 (252798E 184339N)
Distance offshore	1.7 km
Mean wind speed	12.52 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	0.77 m
Mean zero up-crossing period (Tz)	4.23 sec
Mean peak wave period (Tp)	7.35 sec
Mean wave direction	232.1 ° (SW)
Mean wave direction scaled for wave power	227.7 ° (SW)
Mean annual wave power	21.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	251-319 µm (average: 290 µm)
Calcium carbonate content (%) (N= 4)	0.52-6.76% (average: 2.87%)
Silica content (%) (N= 4)	85-93.8% (average: 90.4%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	12
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

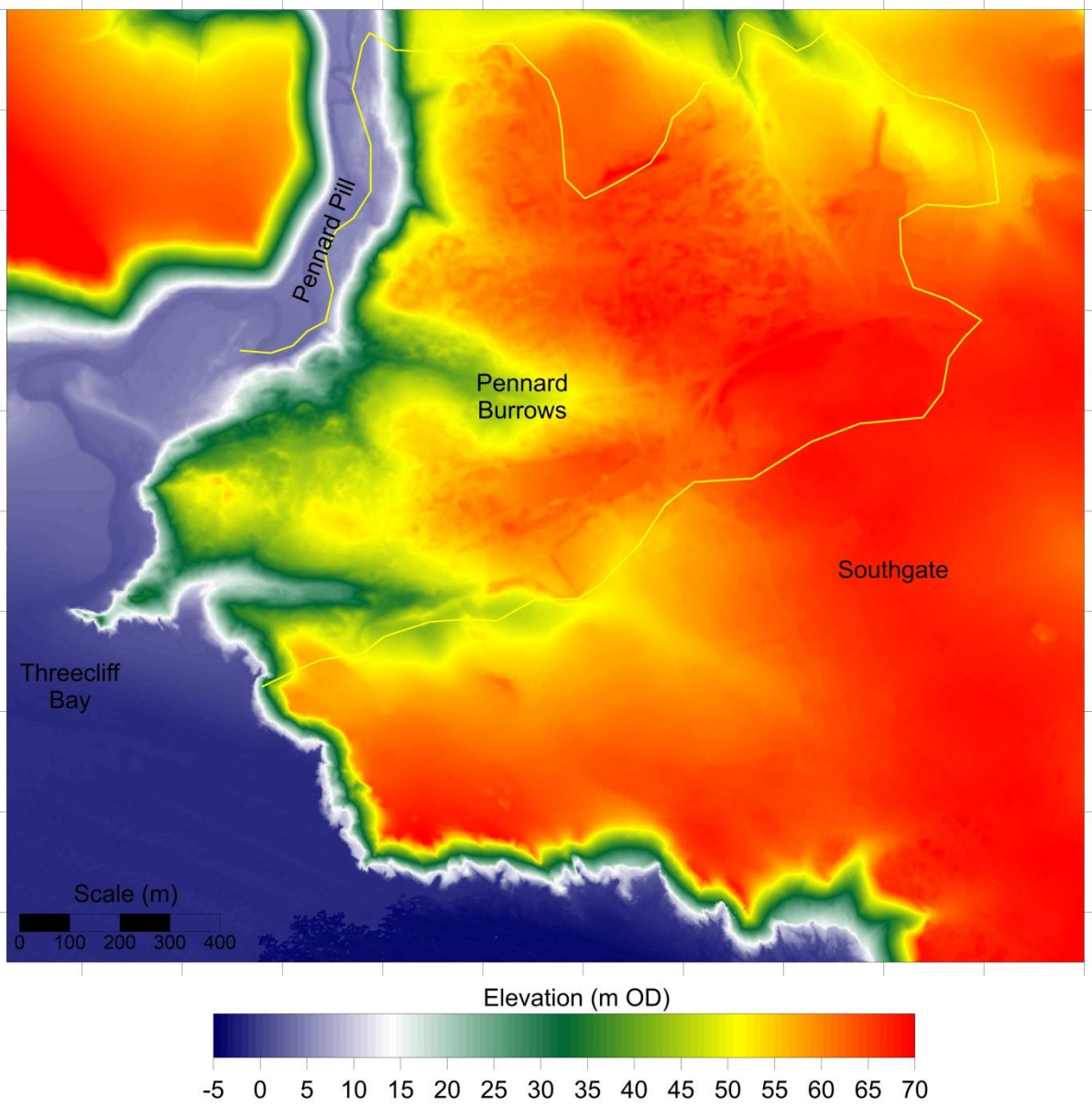
Sand fencing	Minor
Vegetation planting	Minor
Scrub clearance	Minor
Grazing	Minor

Further information sources

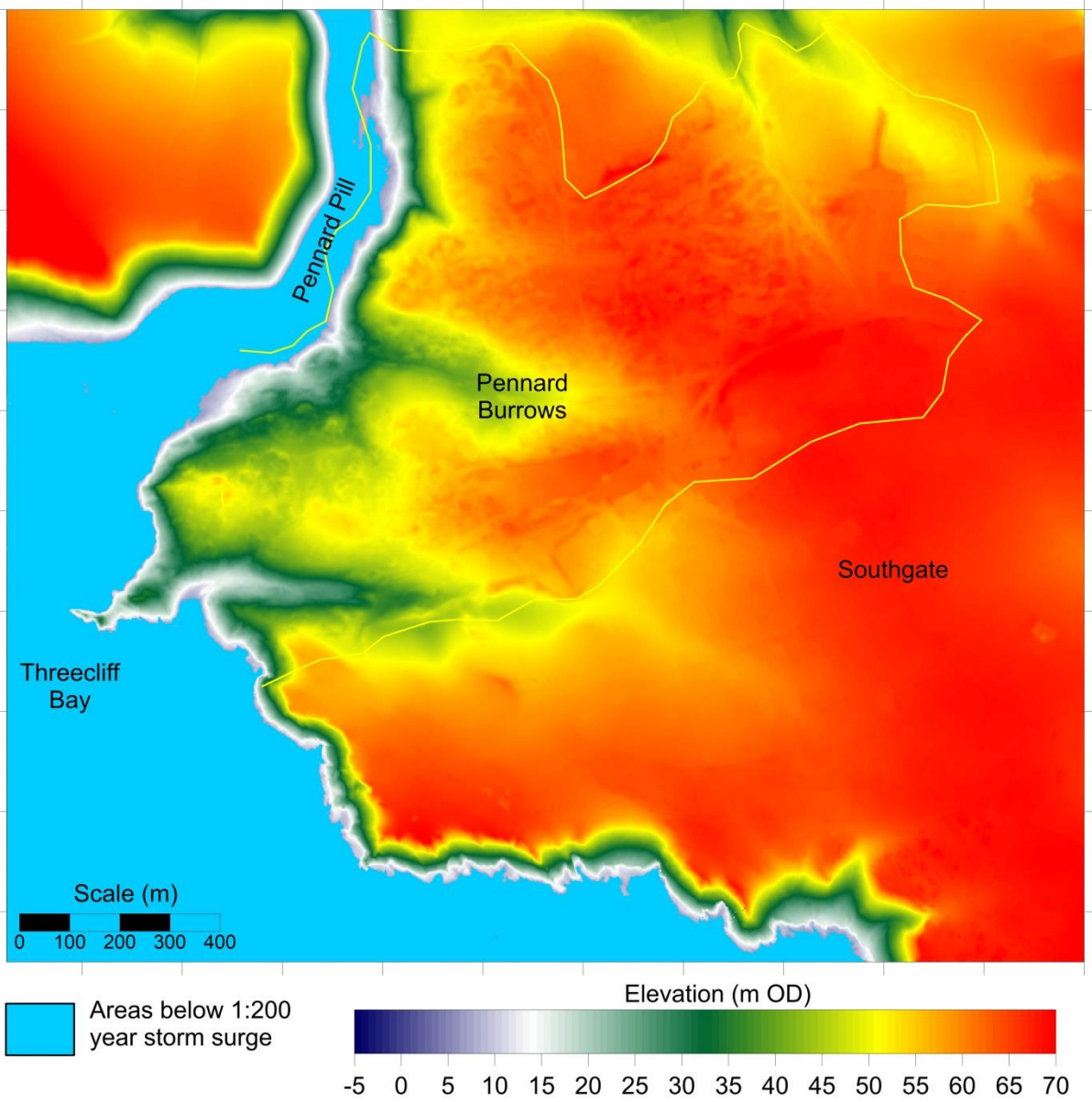
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 14: Penmaen Burrows

Site description

Morphological setting	Bay (Three Cliff Bay, southern Gower Peninsula)
Morphological type	Bay-head barriers, climbing dunes behind
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Woodland, agricultural
Typical hinterland level	Rising ground
Conservation designations	Great Tor (Three Cliff Bay) SSSI, AONB, Heritage Coast, National Trust
Notable features	Three Cliff Bay to seaward Burial chamber on Penmaen Burrows

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	6.02 ± 0.3 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	29/03/2007 and 21/08/2005
Principal aspect of dune frontage	southwest and southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	718 (252798E 184339N)
Distance offshore	1.7 km
Mean wind speed	12.52 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	0.77 m
Mean zero up-crossing period (Tz)	4.23 sec
Mean peak wave period (Tp)	7.35 sec
Mean wave direction	232.1 ° (SW)
Mean wave direction scaled for wave power	227.7 ° (SW)
Mean annual wave power	21.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	270-292 µm (average: 281 µm)
Calcium carbonate content (%) (N= 3)	2.75-7.35% (average: 4.41%)
Silica content (%) (N= 3)	86.4-92.4% (average: 90.1%)

Dune site importance and SMP2 Policy

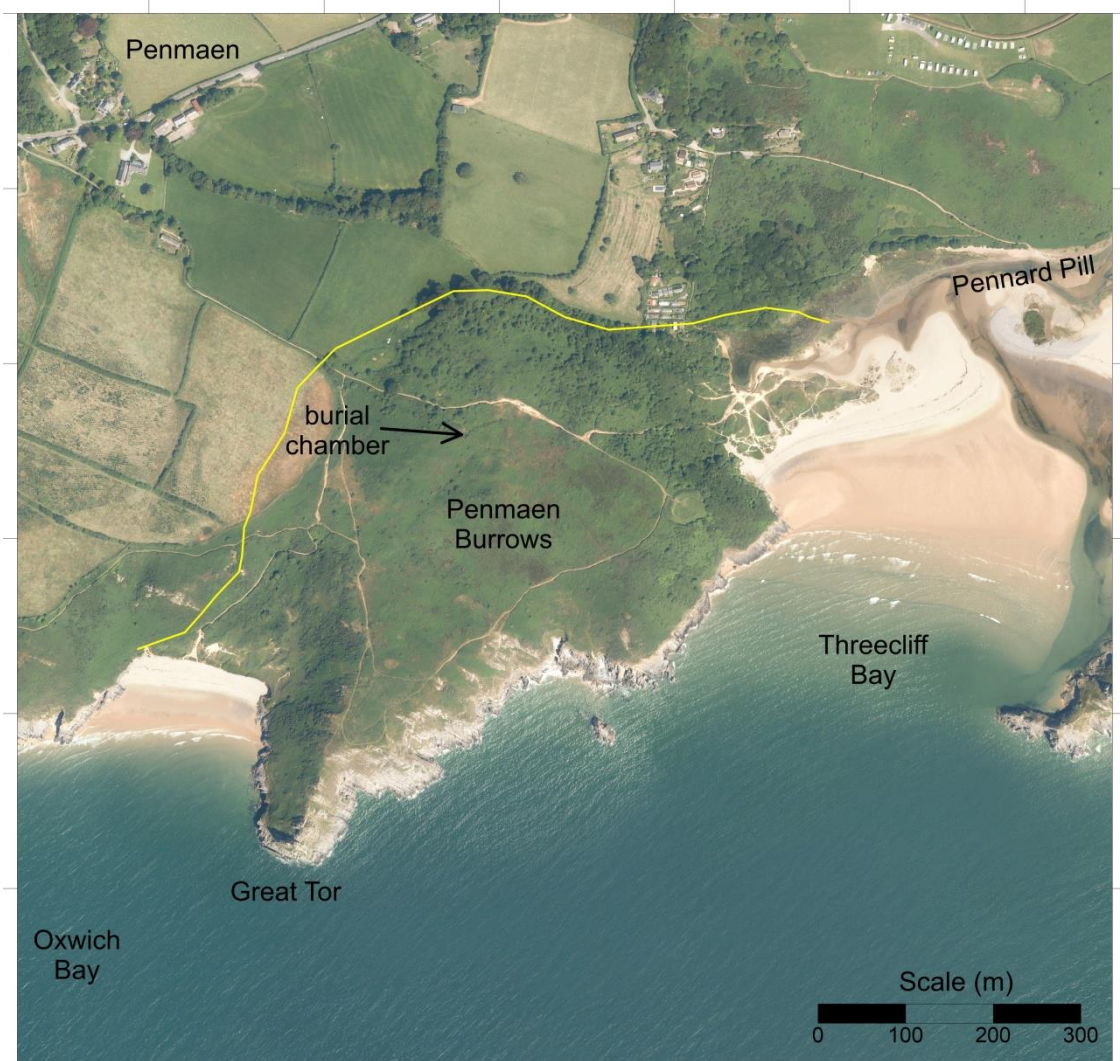
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	13
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

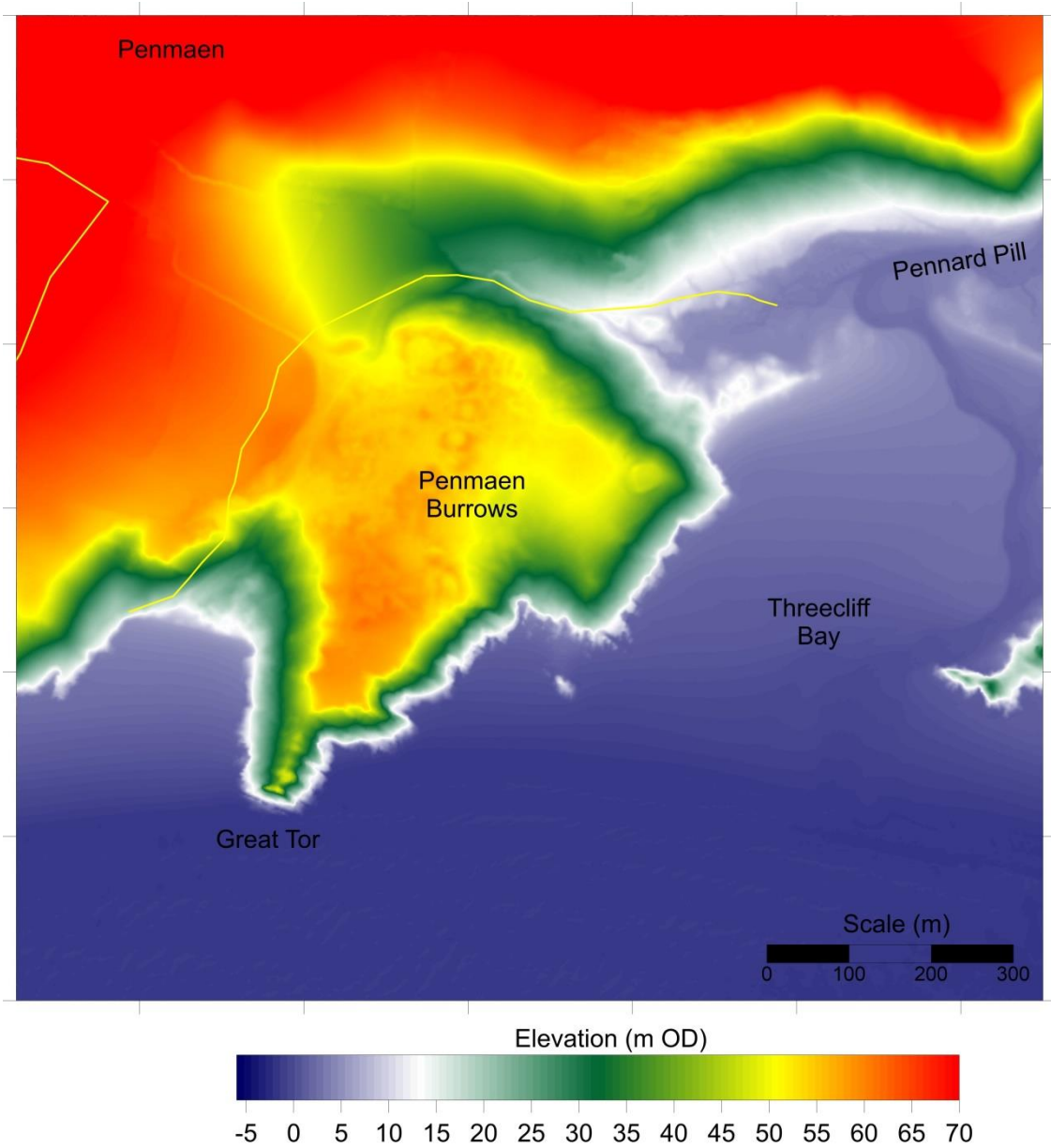
Sand fencing	Minor
Vegetation planting	Minor
Scrub clearance	Minor
Grazing	Minor

Further information

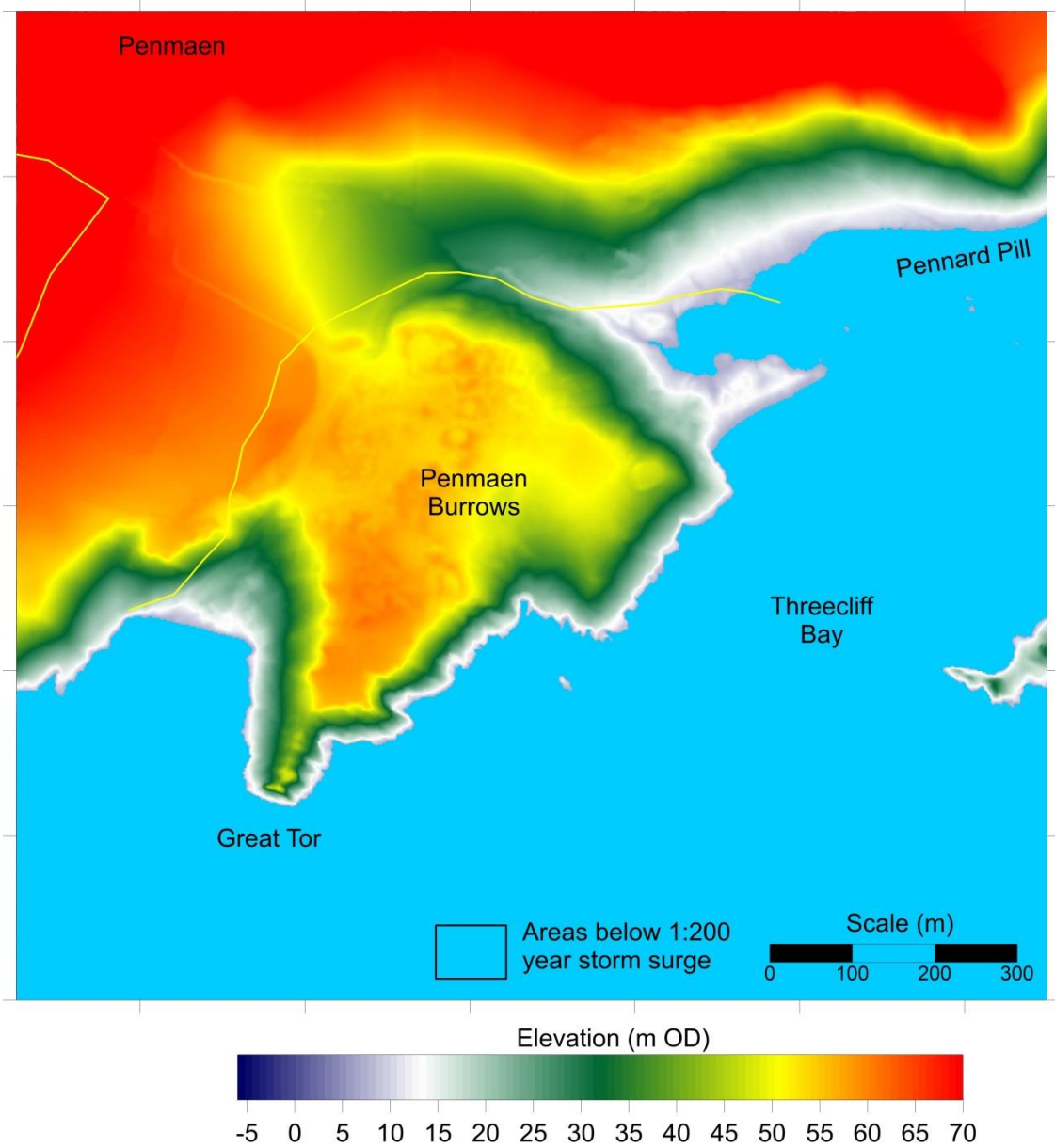
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



Air photograph, flown 2013-14. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 15: Oxwich and Nicholaston Burrows

Site description

Morphological setting	Bay (Oxwich Bay, southern Gower Peninsula)
Morphological type	Bay-head barriers, climbing behind Nicholaston Burrows
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agricultural
Typical hinterland level	4.4 to 4.6 m OD on agricultural areas
Conservation designations	Oxwich Bay SSSI, NNR, AONB, GCR, Heritage Coast , National Trust
Notable features	Important surfing beach

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	6.00 ± 0.3 m OD
Maximum crest level	22.5 m OD
Minimum crest level	7.6 m OD and intertidal at E end
LiDAR survey date	29/03/2007 and 21/08/2005
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	718 (252798E 184339N)
Distance offshore	1.7 km
Mean wind speed	12.52 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	0.77 m
Mean zero up-crossing period (Tz)	4.23 sec
Mean peak wave period (Tp)	7.35 sec
Mean wave direction	232.1 ° (SW)
Mean wave direction scaled for wave power	227.7 ° (SW)
Mean annual wave power	21.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	234-309 µm (average: 252 µm)
Calcium carbonate content (%) (N= 4)	8.51-10.35% (average: 9.46%)
Silica content (%) (N= 4)	83.1-92.3% (average: 86.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	13.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Sand fencing	Minor
Vegetation planting	Minor
Scrub clearance	Significant
Grazing	Significant

Further information

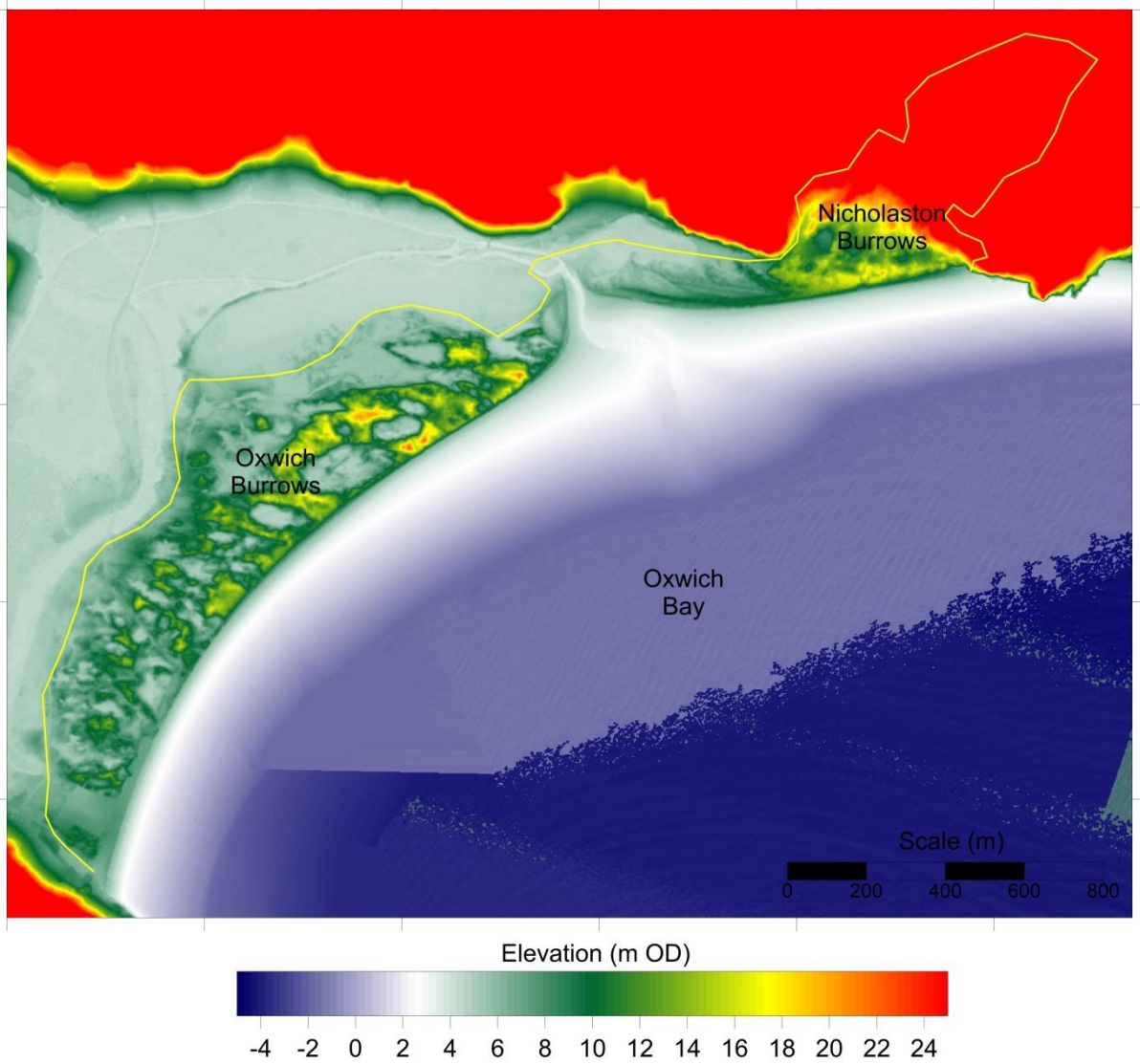
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Harris C. 1974. Oxwich Burrows. *Gower* 25, 48-56.

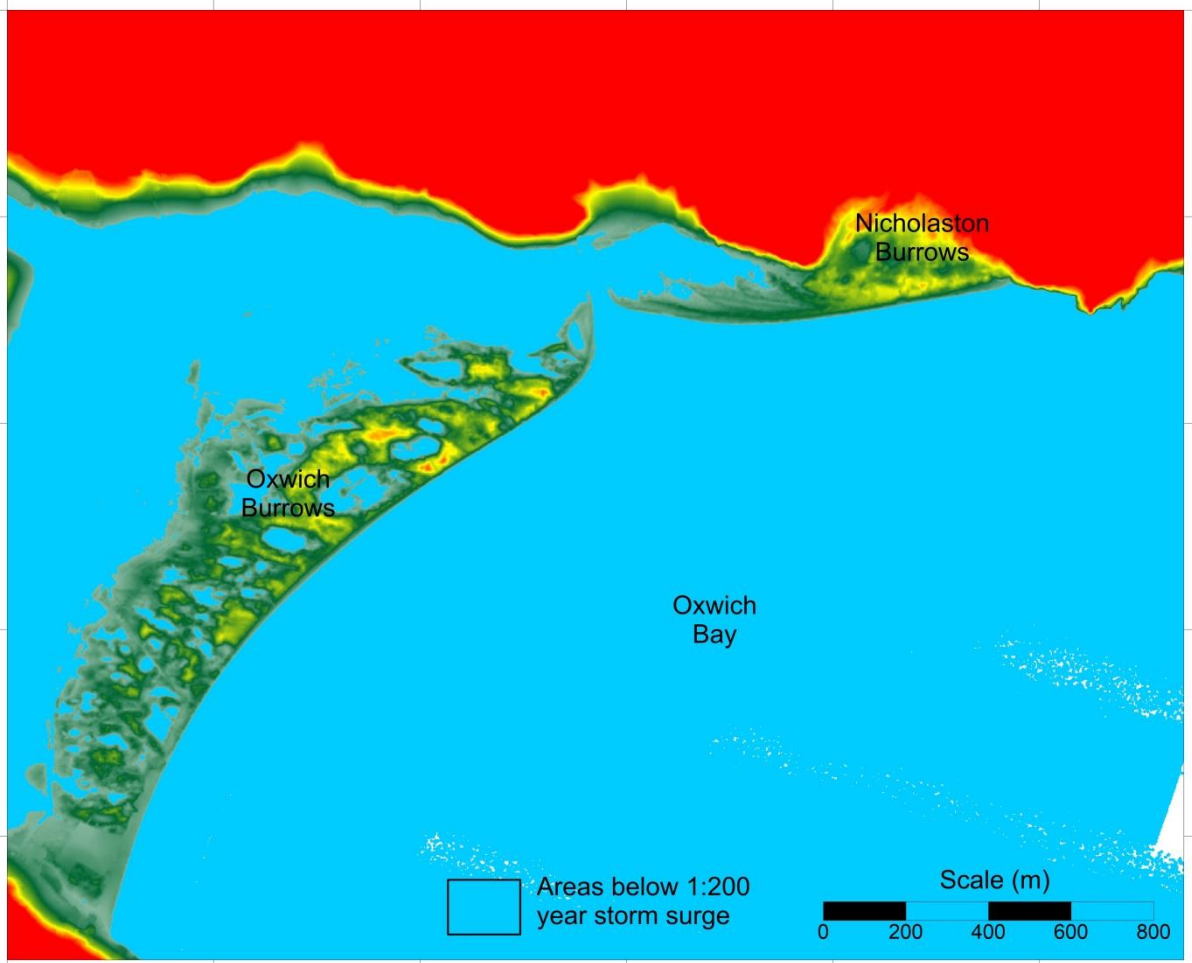
May VJ. 2001. Oxwich Bay, Glamorgan (SS 510 870). In May VJ, Hansom JD (eds) *Coastal Geomorphology of Great Britain*. Geological Conservation Review No. 28. Joint Nature Conservation Committee, Peterborough, 354-356.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 16: Port-Eynon and Horton dunes

Site description

Morphological setting	Bay (Port Eynon Bay, southern Gower)
Morphological type	Bay-head barrier, climbing, fringing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Caravans, housing
Typical hinterland level	>8.5 m OD
Conservation designations	Gower Coast: Rhossili to Porteynon SSSI, SAC, AONB, Heritage Coast Wildlife Trust,
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.15 m OD
1:200 year storm surge level	5.95 ± 0.3 m OD
Maximum crest level	22.0 m OD
Minimum crest level	8.0 m OD
LiDAR survey date	19/08/2005
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	719 (243915E 184393N)
Distance offshore	1.1 km
Mean wind speed	13.22 knots
Mean wind direction	243.8 ° (WSW)
Mean significant wave height (Hs)	1.22 m
Mean zero up-crossing period (Tz)	4.89 sec
Mean peak wave period (Tp)	8.21 sec
Mean wave direction	237.7 ° (WSW)
Mean wave direction scaled for wave power	234.3 ° (SW)
Mean annual wave power	64.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	257-368 µm (average: 309 µm)
Calcium carbonate content (%) (N= 3)	5.59-8.53% (average: 7.01%)
Silica content (%) (N= 3)	86-88.8% (average: 87%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Medium
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

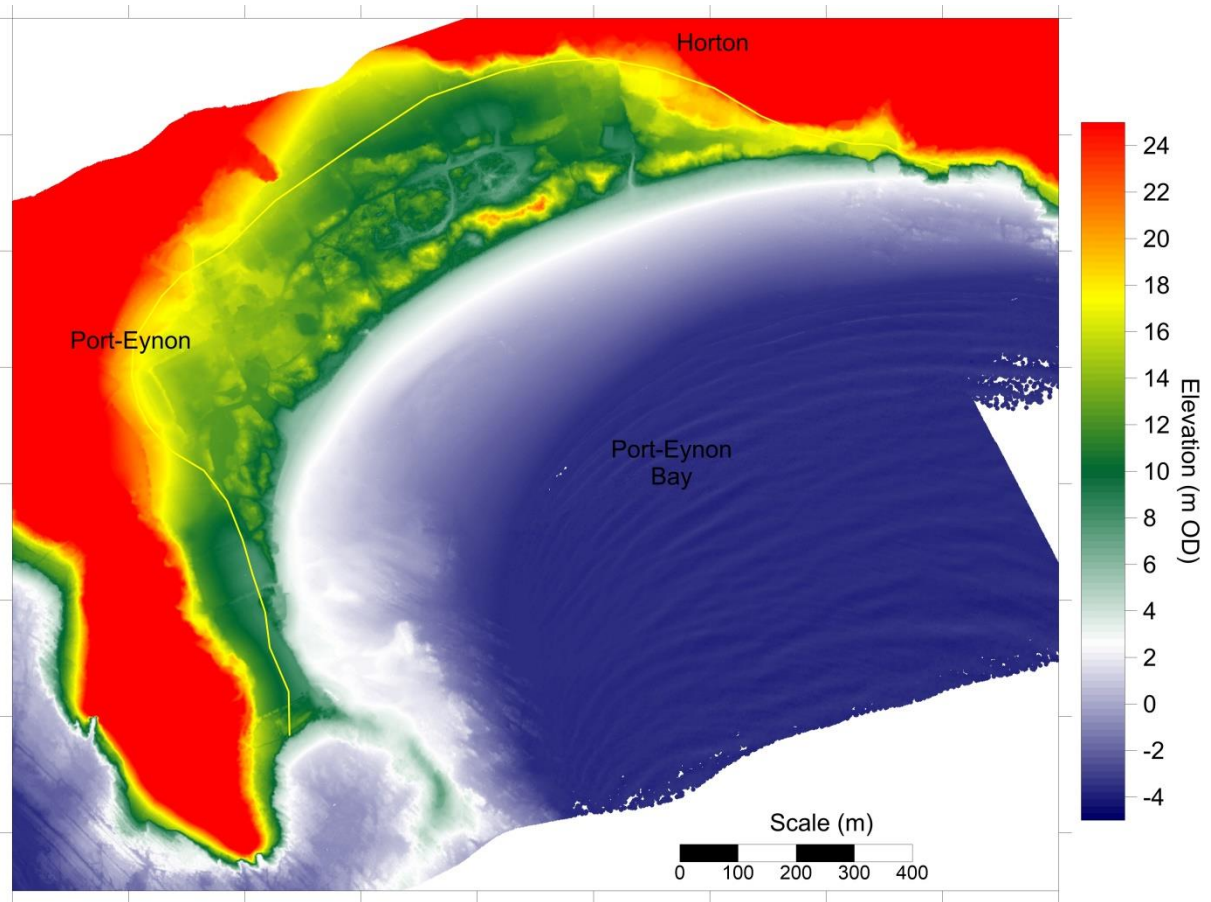
Sand fencing	Minor
Vegetation planting	Minor
Scrub clearance	Minor
Grazing	

Further information

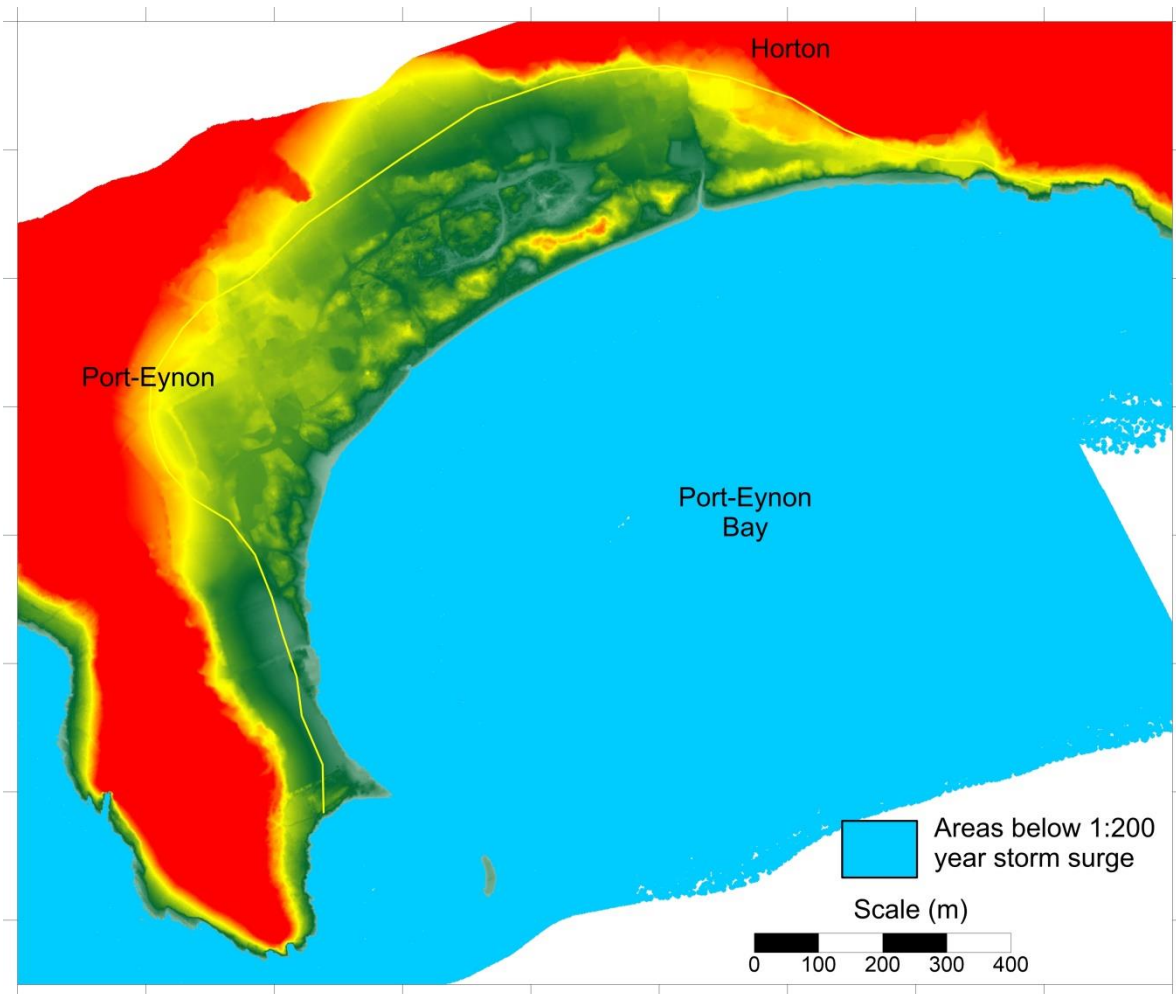
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 17: Rhossili Bay south

Site description

Morphological setting	Shallow bay (Rhossili Bay, western Gower Peninsula)
Morphological type	Climbing and cliff top
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agricultural, housing
Typical hinterland level	Rising ground
Conservation designations	Gower Coast: Rhossili to Porteynon SSSI, Rhossili Down SSSI, SAC, AONB; part of Carmarthen Bay GCR coastal assemblage, National Trust
Notable features	Rhossili Down to the north and east; Rhossili village to S; blown sand partly overlies periglacial head and fluvioglacial deposits

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.00 m OD
1:200 year storm surge level	5.82 ± 0.3 m OD
Maximum crest level	n/a
Minimum crest level	n/a
LiDAR survey date	01/08/2005
Principal aspect of dune frontage	west

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	708 (234962E 184454N)
Distance offshore	5.9 km
Mean wind speed	13.65 knots
Mean wind direction	243.5 ° (WSW)
Mean significant wave height (Hs)	1.29 m
Mean zero up-crossing period (Tz)	4.77 sec
Mean peak wave period (Tp)	8.01 sec
Mean wave direction	240.9 ° (WSW)
Mean wave direction scaled for wave power	237.3 ° (WSW)
Mean annual wave power	71.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

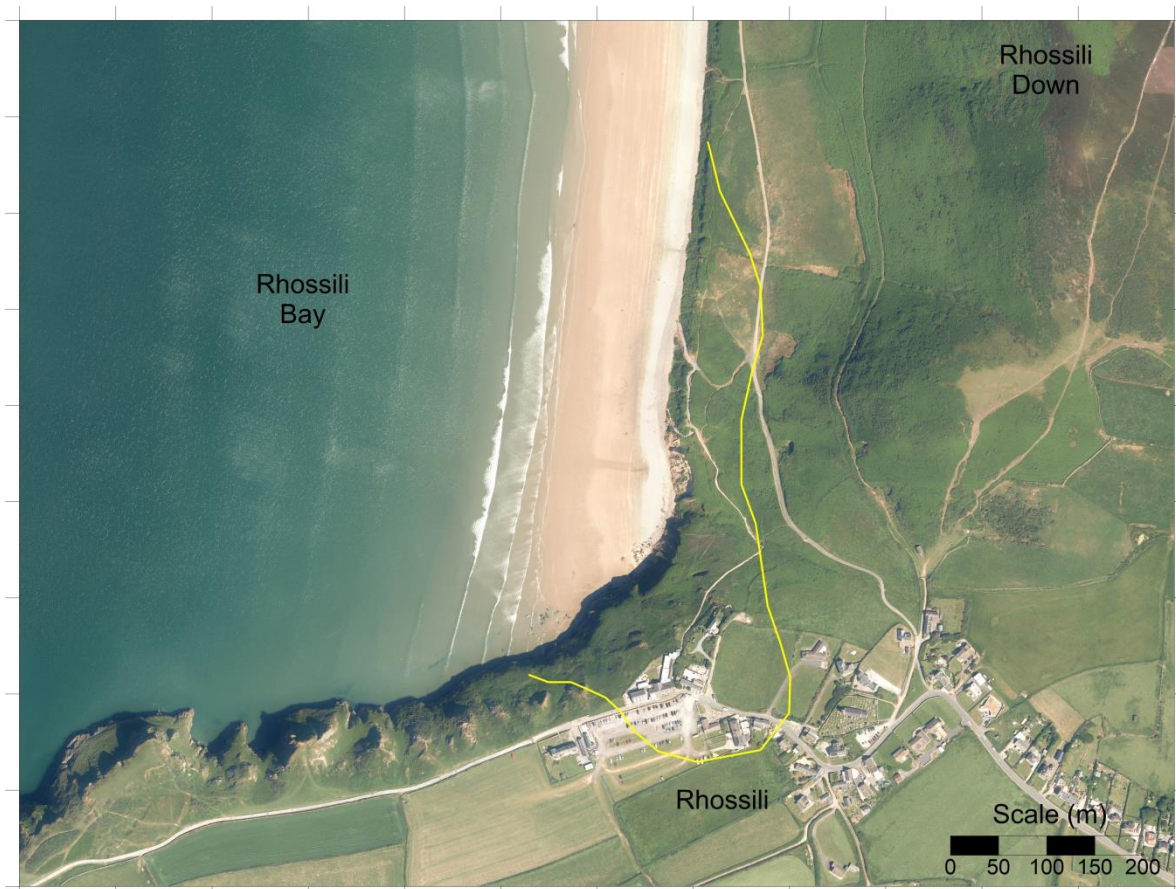
Present and past dune and beach management measures

None identified	
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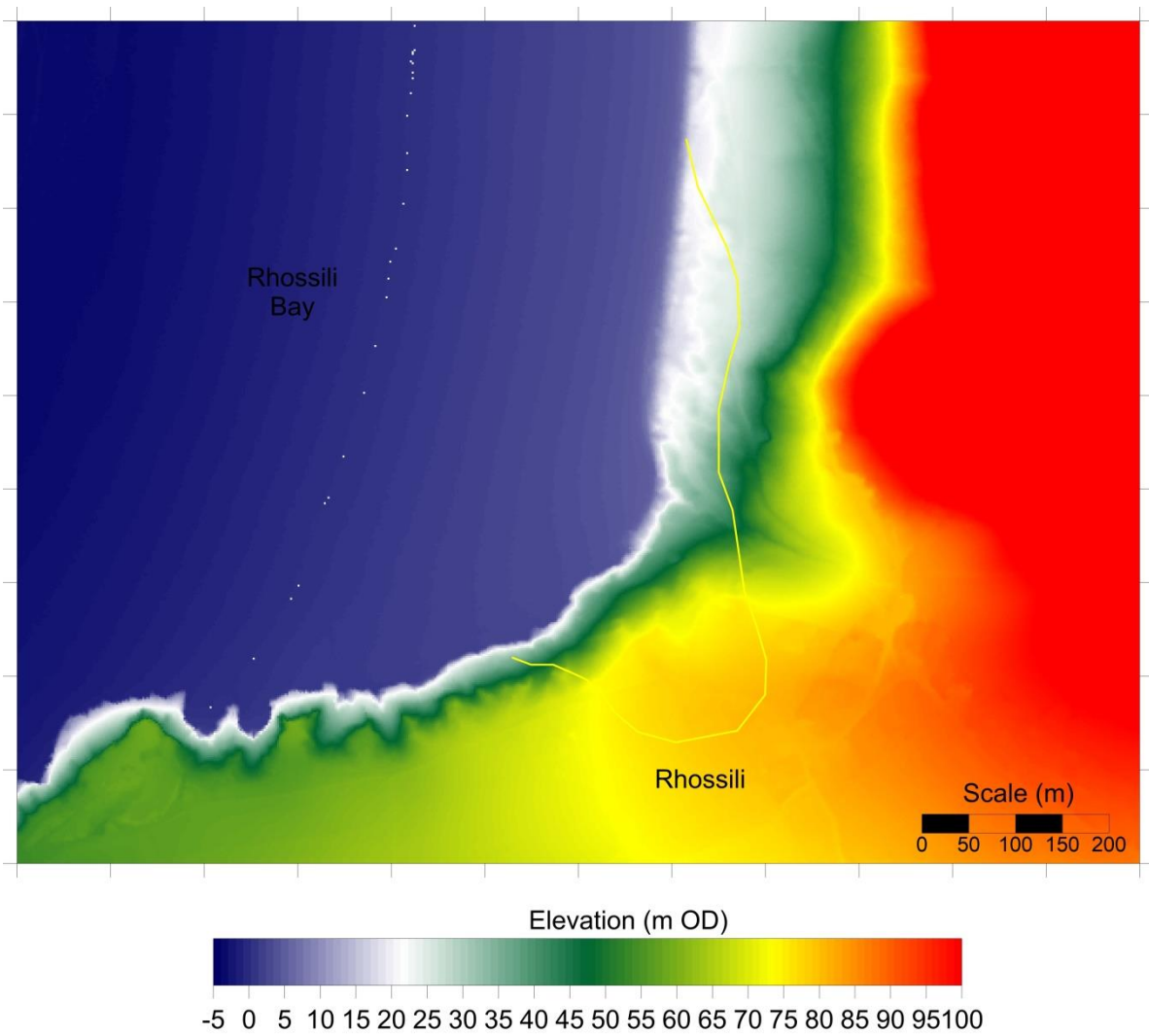
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

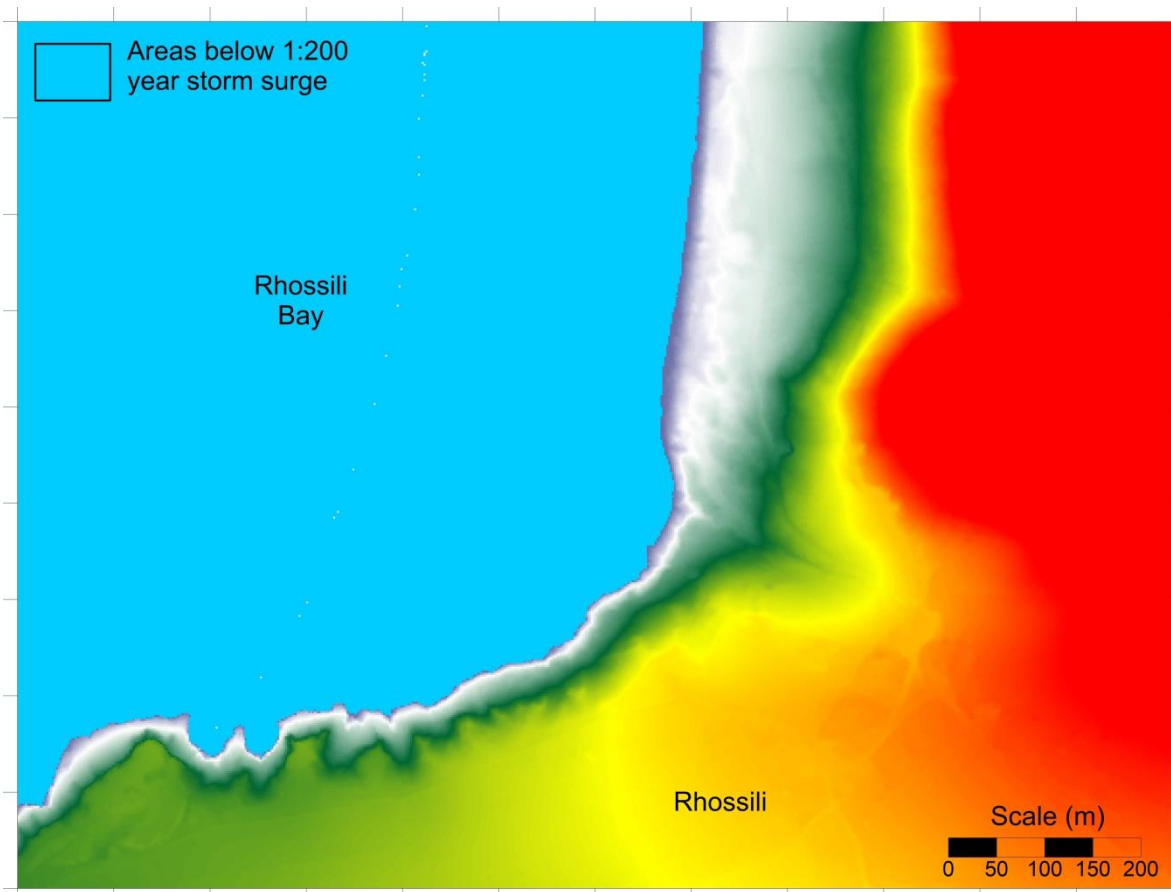
May VJ. 2001. Carmarthen Bay (SS 510 870). In: May VJ, Hansom JD (eds) *Coastal Geomorphology of Great Britain*. Geological Conservation Review No. 28. Joint Nature Conservation Committee, Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 18: Llangennith, Hillend and Broughton Burrows

Site description

Morphological setting	Shallow bay (Rhossili Bay, western Gower Peninsula)
Morphological type	Transgressive and climbing
Erosion/progradation status	Stable / slowly eroding
Defence structures	None
Hinterland type	Grazing land, arable fields, caravan sites
Typical hinterland level	6.2 to 7.4 m OD
Conservation designations	AONB, Heritage Coast, adjacent to SAC, SPA, SSSI, Carmarthen Bay GCR site, National Trust
Notable features	Some parabolic dunes remain partially active

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.00 m OD
1:200 year storm surge level	5.79 ± 0.3 m OD
Maximum crest level	c. 6.0 m OD
Minimum crest level	6.0 m OD
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	756 (235044E 193345N)
Distance offshore	4.9 km
Mean wind speed	12.75 knots
Mean wind direction	241.1 ° (WSW)
Mean significant wave height (Hs)	1.08 m
Mean zero up-crossing period (Tz)	4.63 sec
Mean peak wave period (Tp)	7.99 sec
Mean wave direction	235.9 ° (SW)
Mean wave direction scaled for wave power	232.1 ° (SW)
Mean annual wave power	50.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 12; LD)	197-293 µm (average: 246 µm)
Calcium carbonate content (%) (N= 5)	7.25-11.6% (average: 9.32%)
Silica content (%) (N= 5)	78.7-84.9% (average: 82.1%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low / Medium
Geomorphological Features	High
Recreation	Medium
Economic / Military	Medium
Historical / Archaeological	Medium
Overall significance score	11.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Fencing	Significant
Vegetation planting	Minor
Boardwalks	Minor
Grazing	Significant

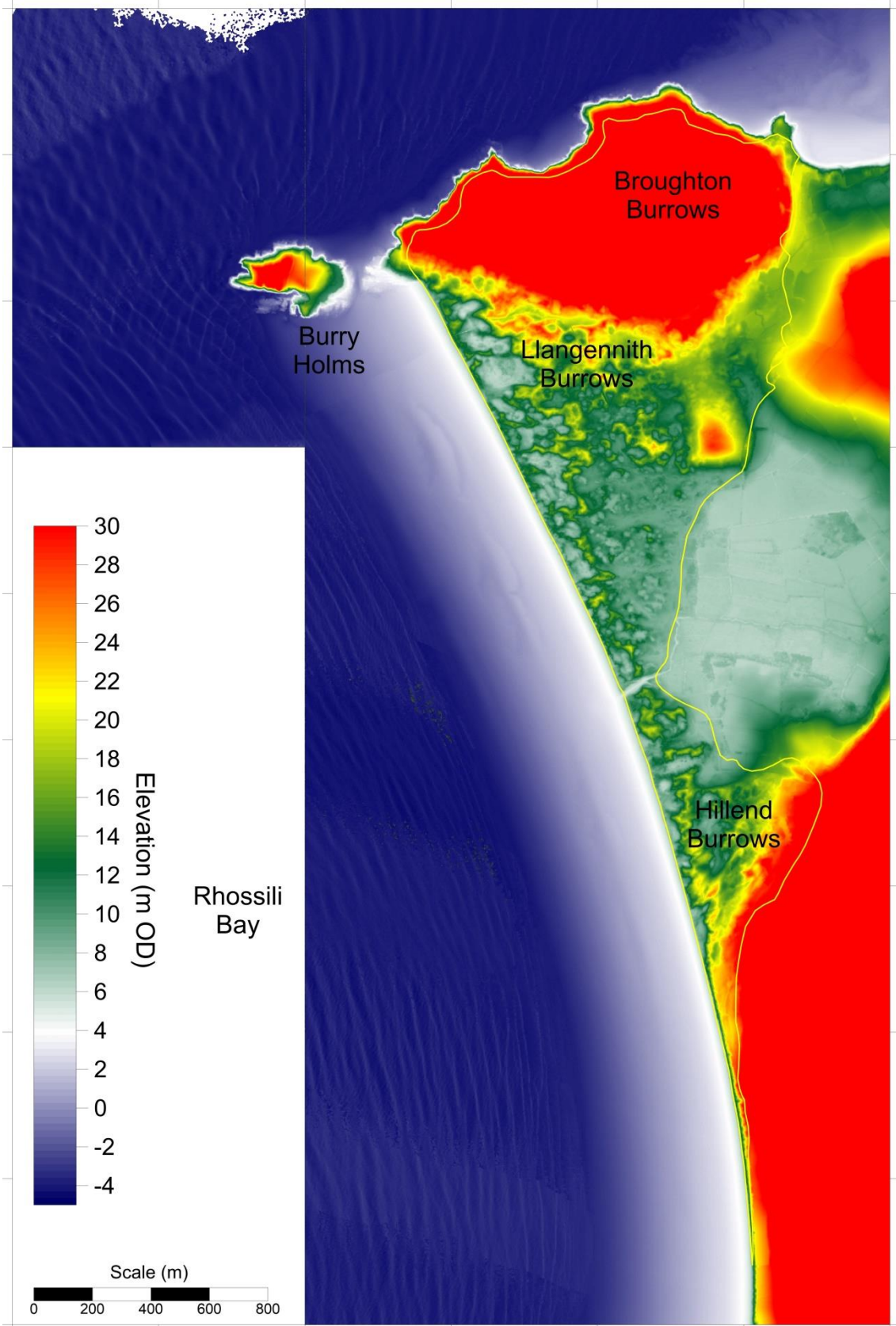
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

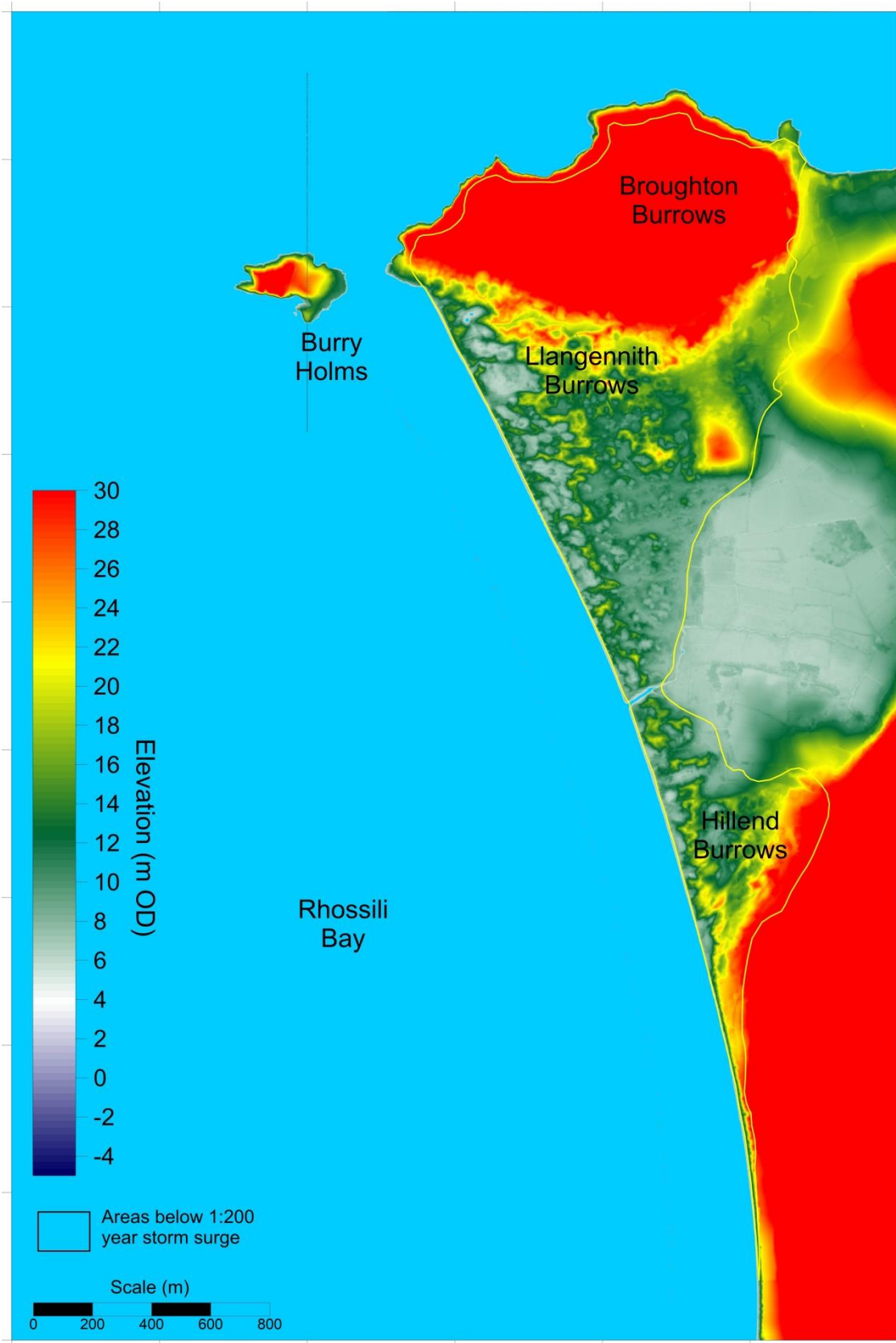
Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 10 Llangennith Burrows*. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the level of 1:200 year storm surge.

Site 19: Delvid Burrows and Hills Burrows

Site description

Morphological setting	Shallow bay (Broughton Bay, western Gower Peninsula)
Morphological type	Fringing, climbing, cliff-top
Erosion/progradation status	slowly eroding
Defence structures	None
Hinterland type	Grazing land, arable fields, caravan sites
Typical hinterland level	Rising ground
Conservation designations	Twyni Chwitfordd, Morfa Landimor a Bae Brychdwn/Whiteford Burrows, Landimore Marsh and Broughton Bay SSSI, SAC, AONB, Heritage Coast, Carmarthen Bay GCR site, adjacent to SPA
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.75 ± 0.3 m OD
Maximum crest level	54 m OD
Minimum crest level	6.0 m OD
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	756 (235044E 193345N)
Distance offshore	4.9 km
Mean wind speed	12.75 knots
Mean wind direction	241.1 ° (WSW)
Mean significant wave height (Hs)	1.08 m
Mean zero up-crossing period (Tz)	4.63 sec
Mean peak wave period (Tp)	7.99 sec
Mean wave direction	235.9 ° (SW)
Mean wave direction scaled for wave power	232.1 ° (SW)
Mean annual wave power	50.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	231-244 µm (average: 237 µm)
Calcium carbonate content (%) (N= 3)	9.44-10.71% (average: 9.89%)
Silica content (%) (N= 3)	79.2-81.3% (average: 80.1%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	10
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Fencing	Minor
Vegetation planting	Minor
Grazing	Minor

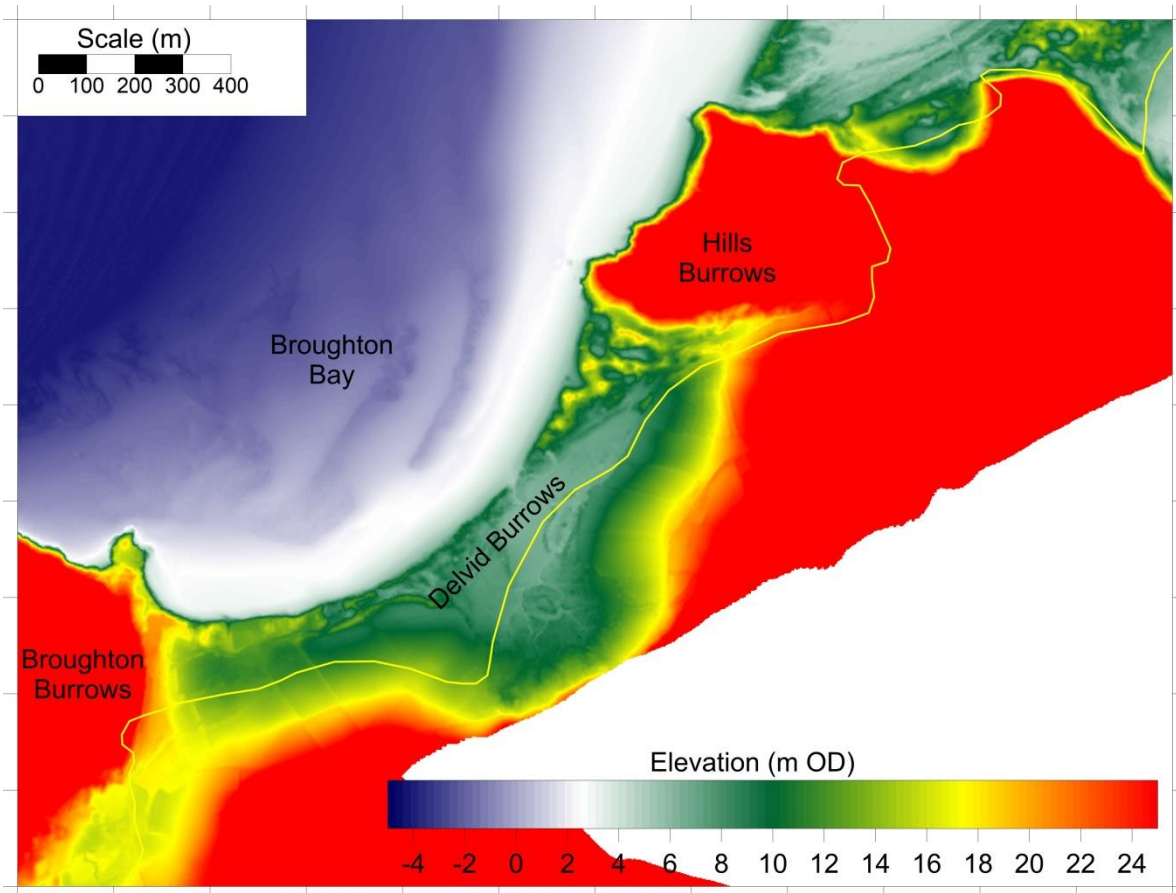
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

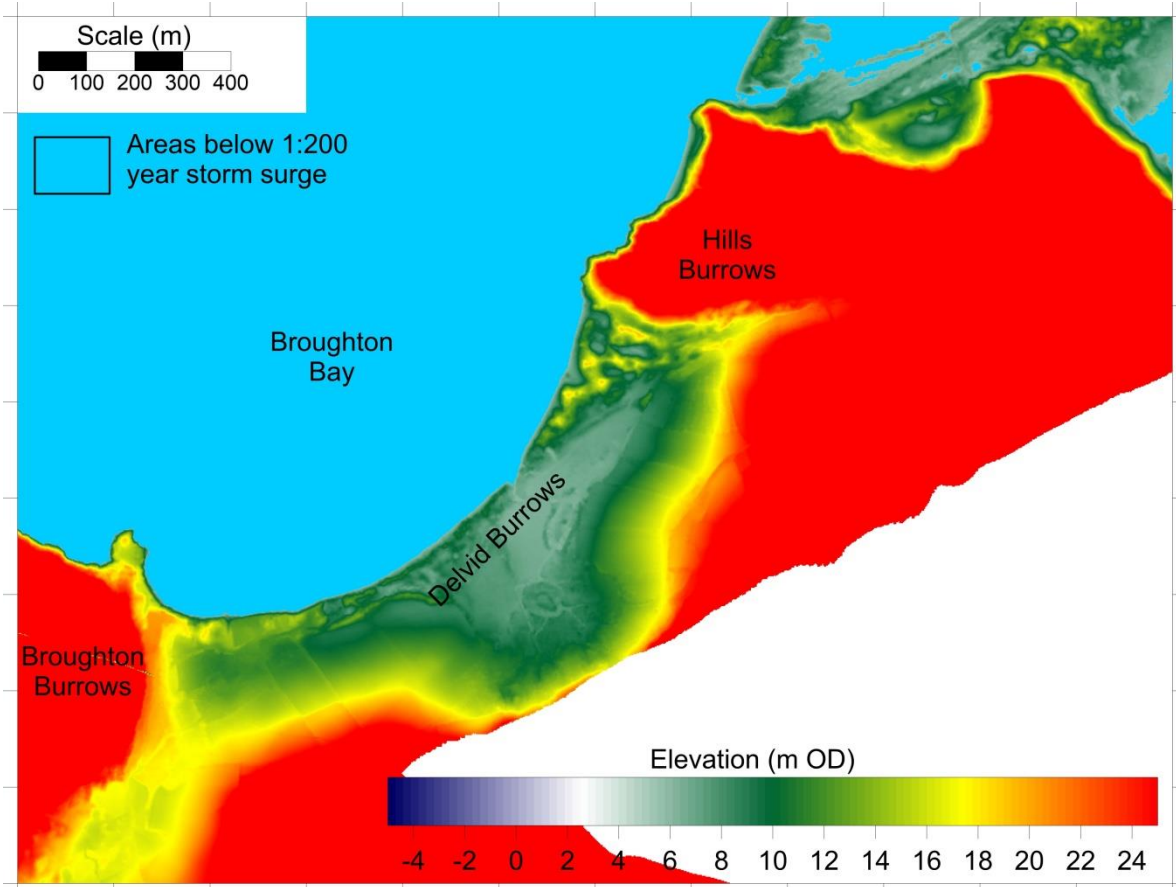
May VJ. 2001. Carmarthen Bay (SN 220 070 – SN 421 868). In May VJ, Hansom JD (eds) *Coastal Geomorphology of Great Britain*. Geological Conservation Review No. 28. Joint Nature Conservation Committee, Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 20: Whiteford Burrows

Site description

Morphological setting	Bay / Estuary mouth
Morphological type	Barrier spit anchored by glacial moraine core
Erosion/progradation status	Stable in N, eroding in centre, stable / prograding in S
Defence structures	None
Hinterland type	Mostly grazed saltmarsh
Typical hinterland level	Rising ground in south, active saltmarsh in centre and tidal flats in north
Conservation designations	Twyni Chwitffordd, Morfa Landimor a Bae Brychdwn/Whiteford Burrows, Landimore Marsh and Broughton Bay SSSI, SAC, SPA, Ramsar, AONB, Heritage Coast, Carmarthen Bay GCR site, National Trust
Notable features	Hazard from buried WWII ordnance and chemicals; large active blowout and mobile dune at northern end; significant young dune ridge and slack at southern end

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.73 ± 0.3 m OD
Maximum crest level	16.2 m OD
Minimum crest level	6.5 m OD
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	756 (235044E 193345N)
Distance offshore	4.9 km
Mean wind speed	12.75 knots
Mean wind direction	241.1 ° (WSW)
Mean significant wave height (Hs)	1.08 m
Mean zero up-crossing period (Tz)	4.63 sec
Mean peak wave period (Tp)	7.99 sec
Mean wave direction	235.9 ° (SW)
Mean wave direction scaled for wave power	232.1 ° (SW)
Mean annual wave power	50.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 11; LD)	211-282 µm (average: 238 µm)
Calcium carbonate content (%) (N= 5)	5.5-9.3% (average: 7.6%)
Silica content (%) (N= 5)	84.4-89.7% (average: 86.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	14.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Fencing	Minor
Scrub clearance and tree felling	Significant
Grazing	Significant
Notch creation in frontal dunes	Minor
Sand re-profiling	Minor

Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

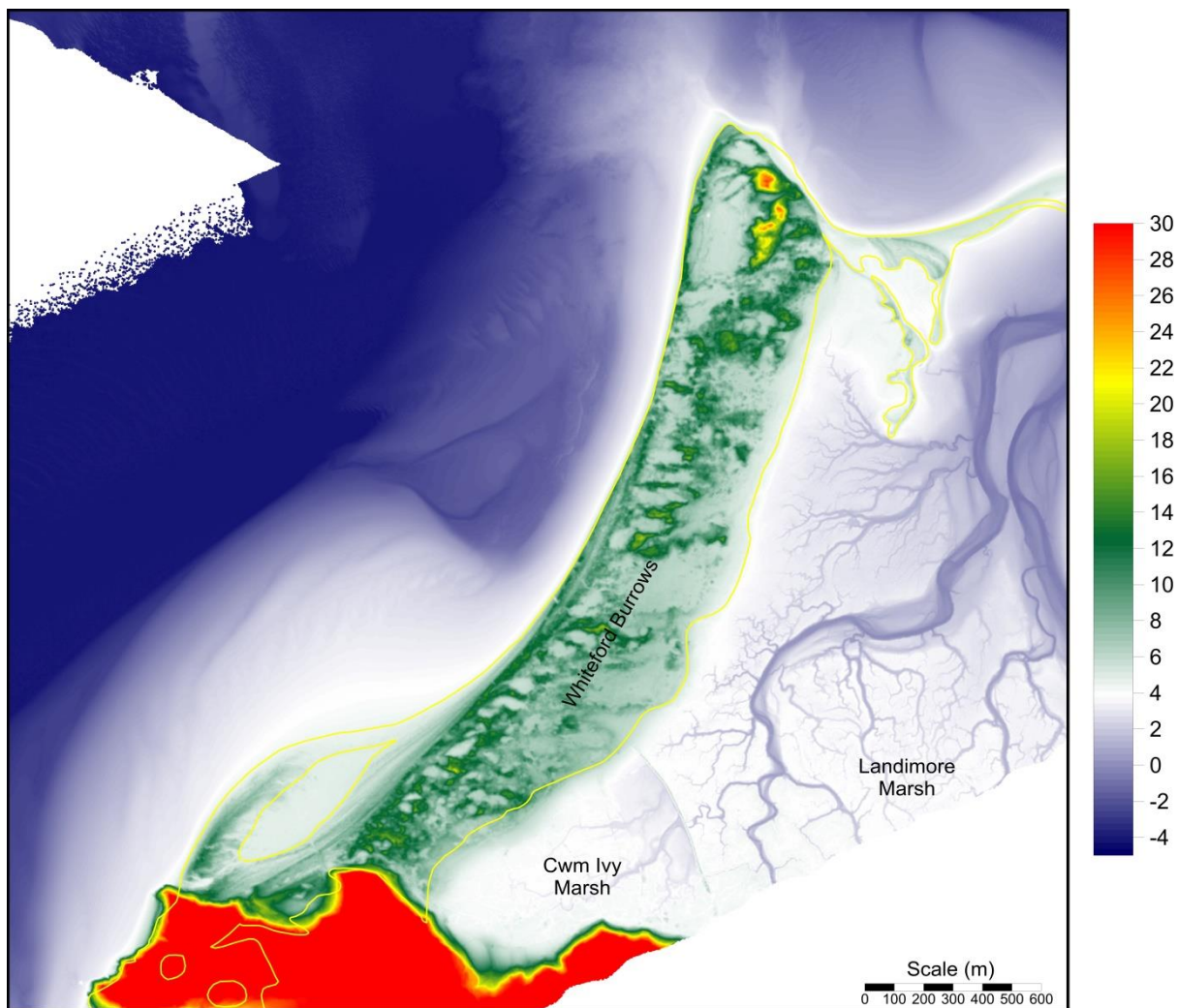
May VJ. 2001. Carmarthen Bay (SN 2200 070 – SN 421 868). In May VJ, Hansom JD (eds) *Coastal Geomorphology of Great Britain*. Geological Conservation Review No. 28. Joint Nature Conservation Committee, Peterborough.

Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 9 Whiteford Burrows*. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.

Pye K, Blott SJ. 2016. *A Geomorphological Appraisal of Whiteford Burrows to Inform Habitat Management and Restoration*. Report to Plantlife Wales. Report No. 20123, Kenneth Pye Associates Ltd., Solihull.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps and KPAL ground surveys.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps and KPAL ground surveys.



Areas below the estimated 1 in 200 year storm surge level.

Site 21: Machynys and Llanelli

Site description

Morphological setting	Estuary (north shore of Burry Inlet)
Morphological type	Barrier spits and tombolos, some formed between fishtail groynes (Machynys), transgressive over slag bank (Llanelli North Dock)
Erosion/progradation status	Largely stabilised by defences; progradation in front of sea wall west of Llanelli North Dock
Defence structures	Sea wall, rock armour, breakwaters, fishtail groynes, slag bank
Hinterland type	Housing, industrial, golf course, dock
Typical hinterland level	3.4 to 4.4 m OD at Machynys, 5.8 to 6.6 m OD at Llanelli
Conservation designations	Burry Inlet and Loughor Estuary SSSI, SAC, SPA
Notable features	Llanelli town and harbour behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.14 m OD
1:200 year storm surge level	5.73 ± 0.3 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters – N.B. data are for a point outside the estuary

CEFAS WaveNet Hindcast Point	756 (235044E 193345N)
Distance offshore	4.9 km
Mean wind speed	12.75 knots
Mean wind direction	241.1 ° (WSW)
Mean significant wave height (Hs)	1.08 m
Mean zero up-crossing period (Tz)	4.63 sec
Mean peak wave period (Tp)	7.99 sec
Mean wave direction	235.9 ° (SW)
Mean wave direction scaled for wave power	232.1 ° (SW)
Mean annual wave power	50.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 3; DS)	187-369 µm (average: 300 µm)
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Medium
Historical / Archaeological	Low
Overall significance score	8.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

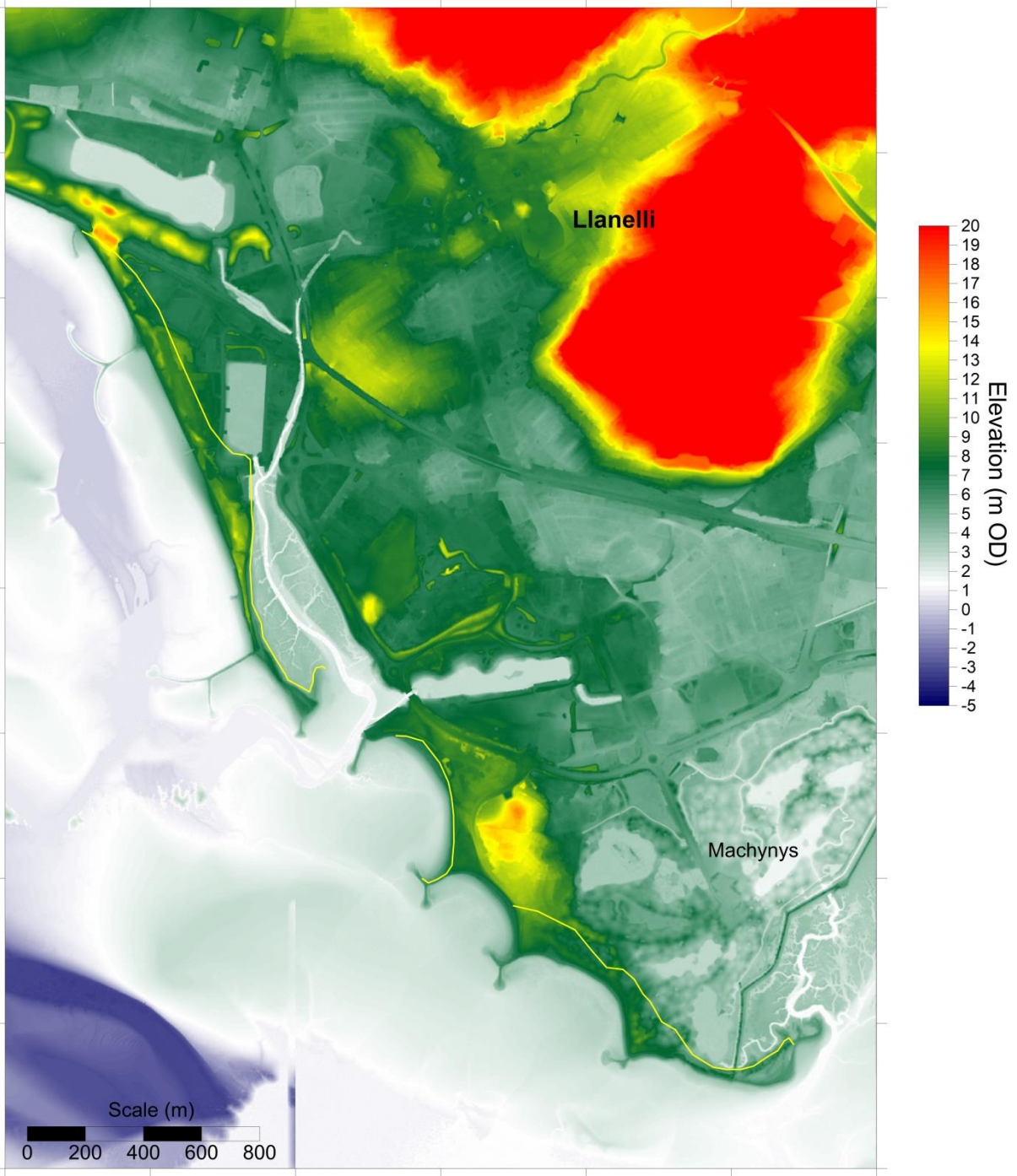
None identified	
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Sources of further information

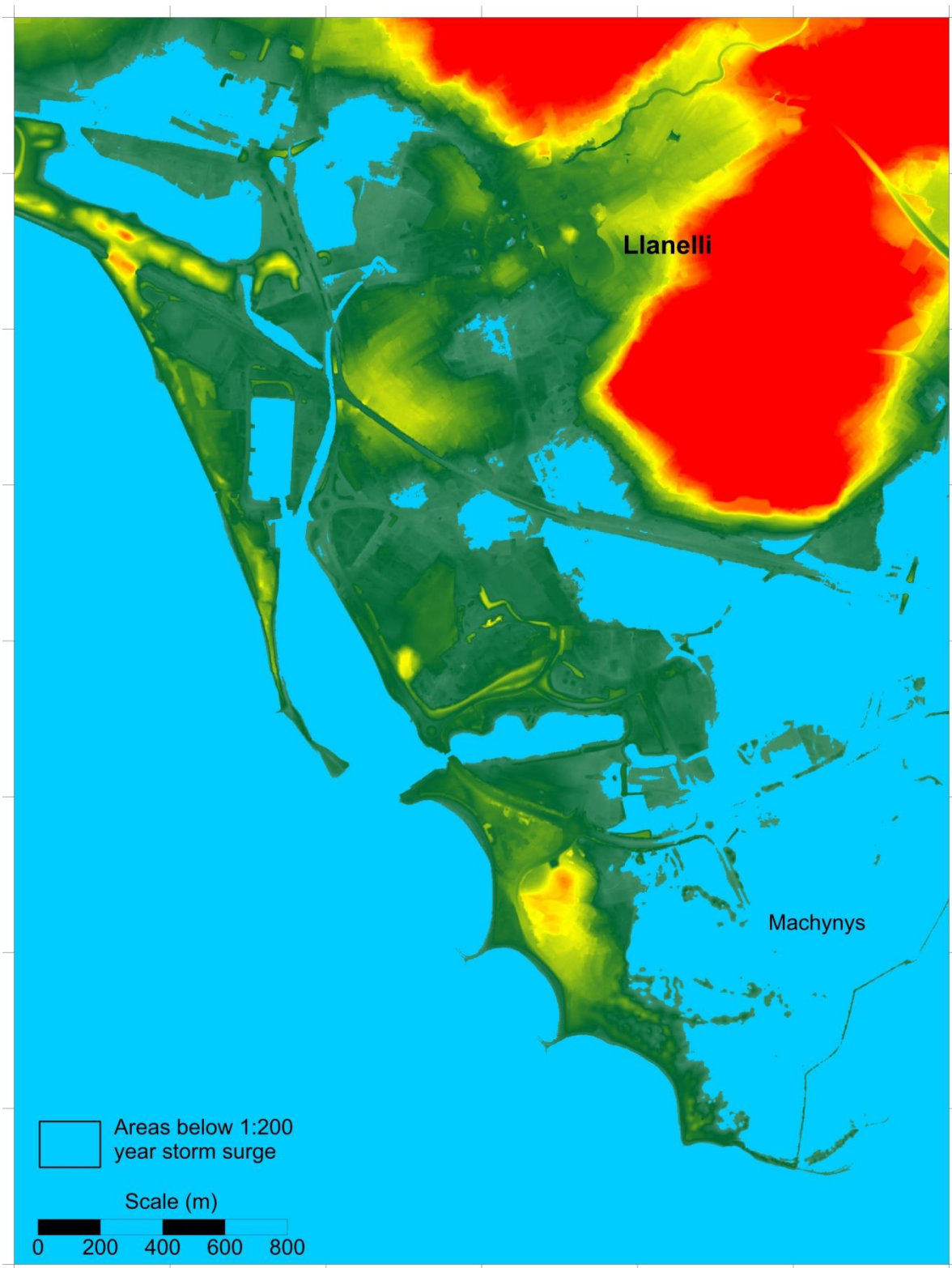
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan
SMP2. Halcrow Group Ltd., Swindon.



2006 and 2013-14 composite aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 22: Burry Port

Site description

Morphological setting	Estuary (north shore of Burry Inlet)
Morphological type	Fringing, transgressive sand sheets and locally small transgressive dunes, much of former blown sand area now levelled and built on; sand excavated for Burry Port Harbour and locally for aggregate
Erosion/progradation status	Largely stabilised by defences and waste tips; small area of prograding embryo dunes east of the new harbour
Defence structures	Rock armour, breakwaters
Hinterland type	Housing, industrial, golf course
Typical hinterland level	5.4 to 6.6 m OD
Conservation designations	Burry Inlet and Loughor Estuary SSSI, SAC, SPA
Notable features	Partially active blowouts in dunes to the east and west of the old harbour

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.73 ± 0.3 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	south

Nearshore wind and wave parameters – N.B. data are for a point outside the estuary

CEFAS WaveNet Hindcast Point	756 (235044E 193345N)
Distance offshore	4.9 km
Mean wind speed	12.75 knots
Mean wind direction	241.1 ° (WSW)
Mean significant wave height (Hs)	1.08 m
Mean zero up-crossing period (Tz)	4.63 sec
Mean peak wave period (Tp)	7.99 sec
Mean wave direction	235.9 ° (SW)
Mean wave direction scaled for wave power	232.1 ° (SW)
Mean annual wave power	50.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N=2; LD)	187-197 µm (average: 192 µm)
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

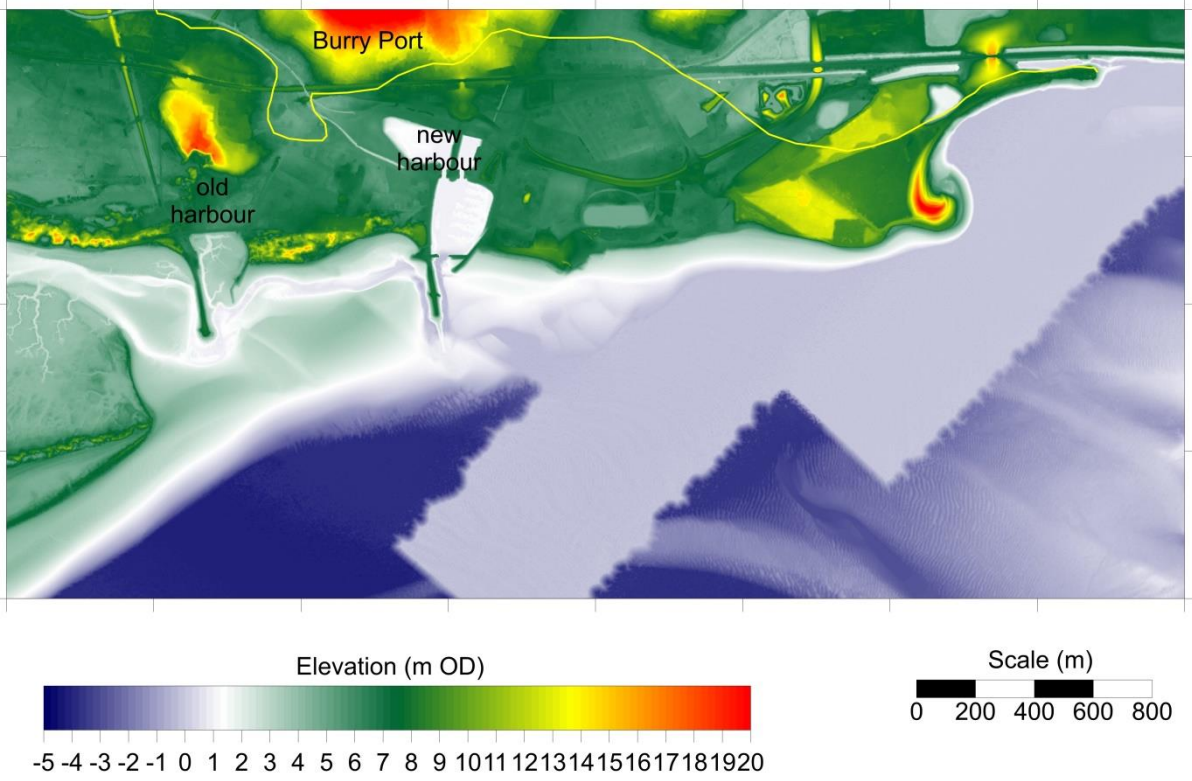
None identified	
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Further information

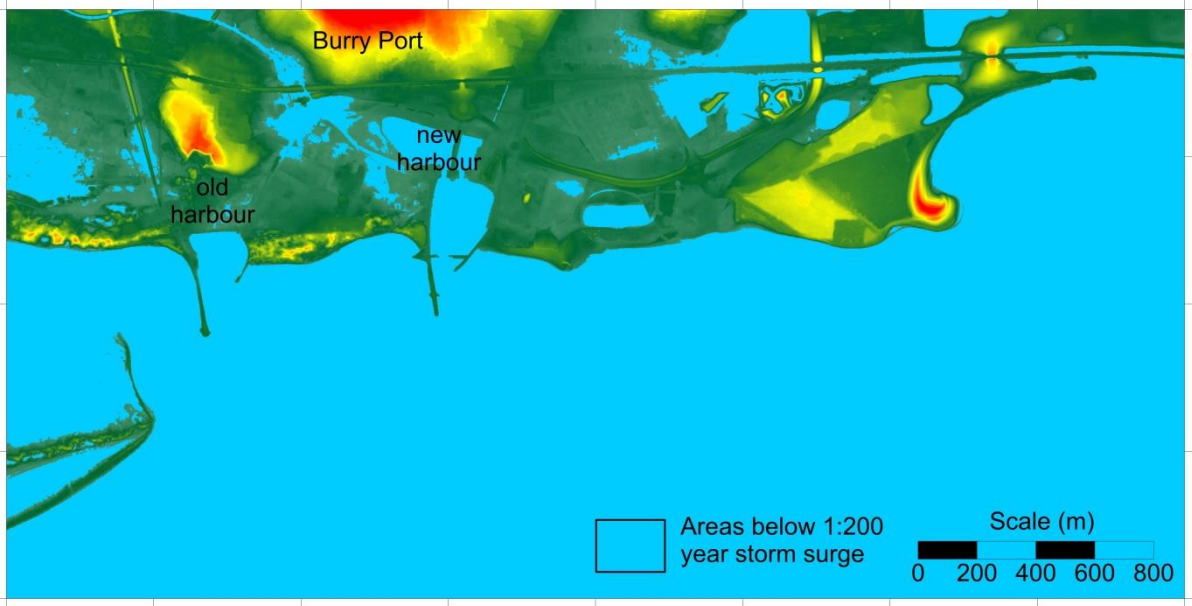
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 23: Pembrey Burrows

Site description

Morphological setting	Large embayment (Carmarthen Bay)
Morphological type	Former barrier island, now shore attached with barrier spits at each end
Erosion/progradation status	Bay-facing dunes are slowly prograding in extreme N but at Tywyn Point dunes are eroding due to landward channels movement, slowly eroding along the central section an slow variable pattern of progradation and erosion in the south due to variable channel position
Defence structures	Rock armour and rock groynes near Pembrey Air Weapons Range control tower
Hinterland type	Forestry, airfield, agricultural, urban development, railway
Typical hinterland level	4.6 to 7.6 m OD
Conservation designations	Arfordir Pen-Bre / Pembrey Coast SSSI, SAC, SPA, Ramsar, LNR; Carmarthen Bay GCR site
Notable features	Pembrey Air Weapons Range, Pembrey Forest, Pembrey Country Park; extensive WWII buildings; old explosive works

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.69 ± 0.3 m OD
Maximum crest level	17.70 m OD
Minimum crest level	6.75 m OD
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	southwest

Dune barrier parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	9.43	Above HAT	119	Above HAT	144
Profile 2	18.75	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 3	20.51	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 4	22.97	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 5	10.04	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 6	9.60	616	502	1238	786

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	790 (235058E 202250N)
Distance offshore	2.2 km
Mean wind speed	11.60 knots
Mean wind direction	237.6 ° (WSW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.69 sec
Mean wave direction	224.4 ° (SW)
Mean wave direction scaled for wave power	220.7 ° (SW)
Mean annual wave power	27.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 21; LD)	150-225 µm (average: 178 µm)
Calcium carbonate content (%) (N= 6)	7.05-11.1% (average: 9.6%)
Silica content (%) (N= 6)	81.2-85.7% (average: 82.7%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	High
Economic / Military	Very High
Historical / Archaeological	High
Overall significance score	19.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

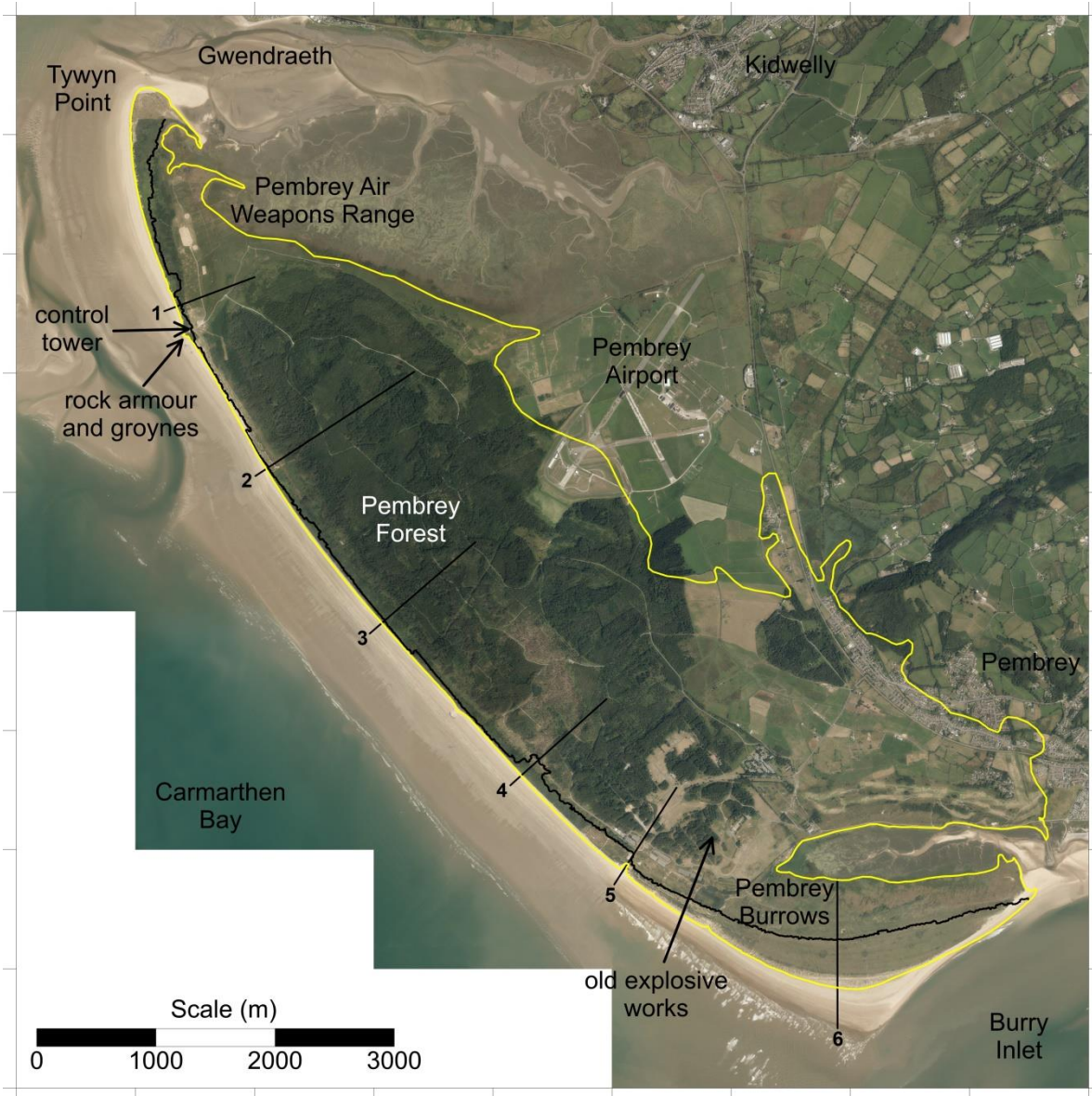
Dune fencing	Significant
Marram planting	Significant
Tree planting	Significant
Grazing	Significant
Scrub clearance	Major
Sand excavation to create pools and slacks	Significant
Turf stripping	Minor
Tree felling	Significant
Detached rock breakwaters to control dune erosion	Minor

Further information

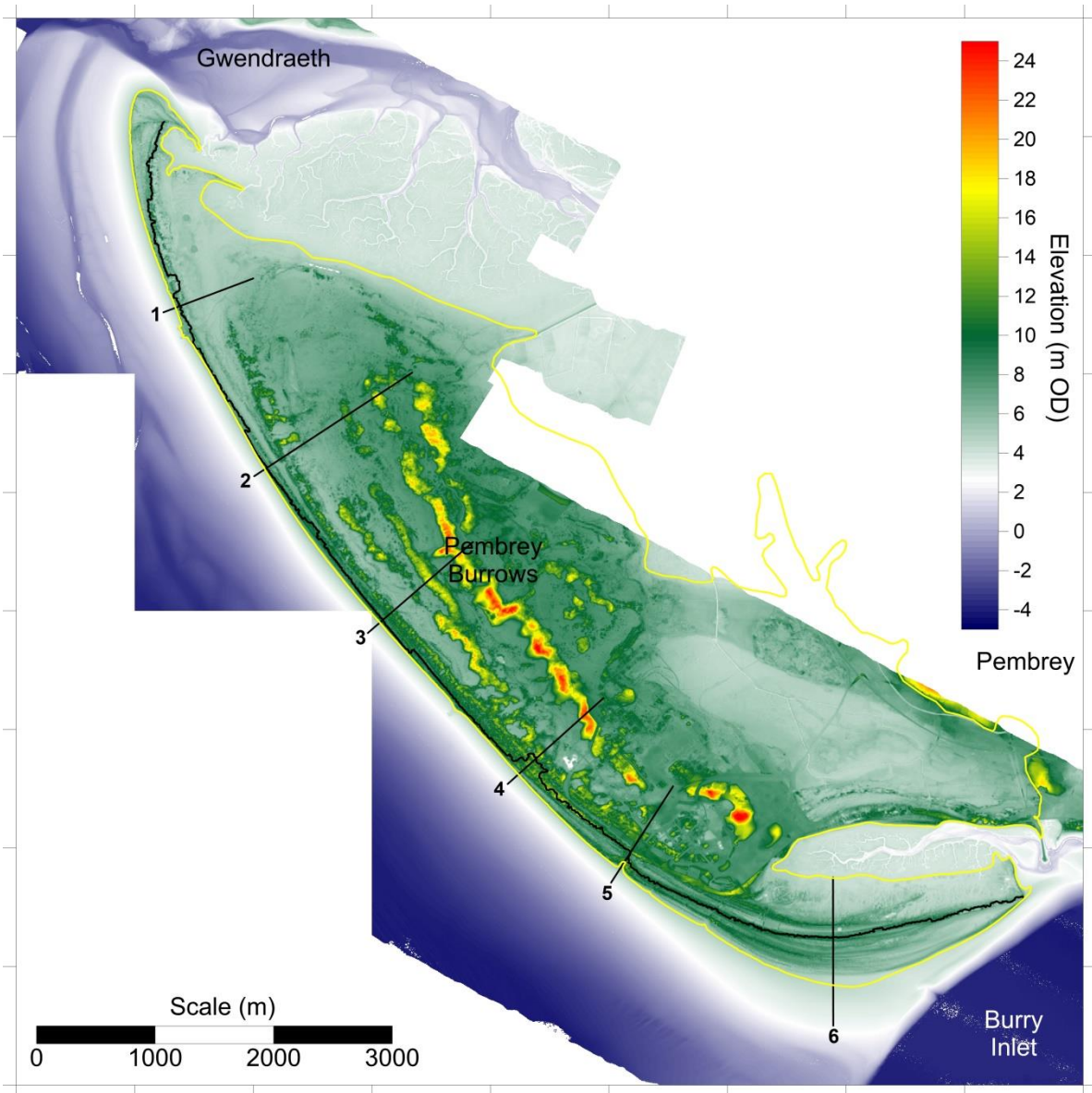
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2014. *Pembrey Burrows – A Geomorphological Appraisal and Options for Dune Rejuvenation*. NRW Evidence Report No. 42, Natural resources Wales, Bangor.

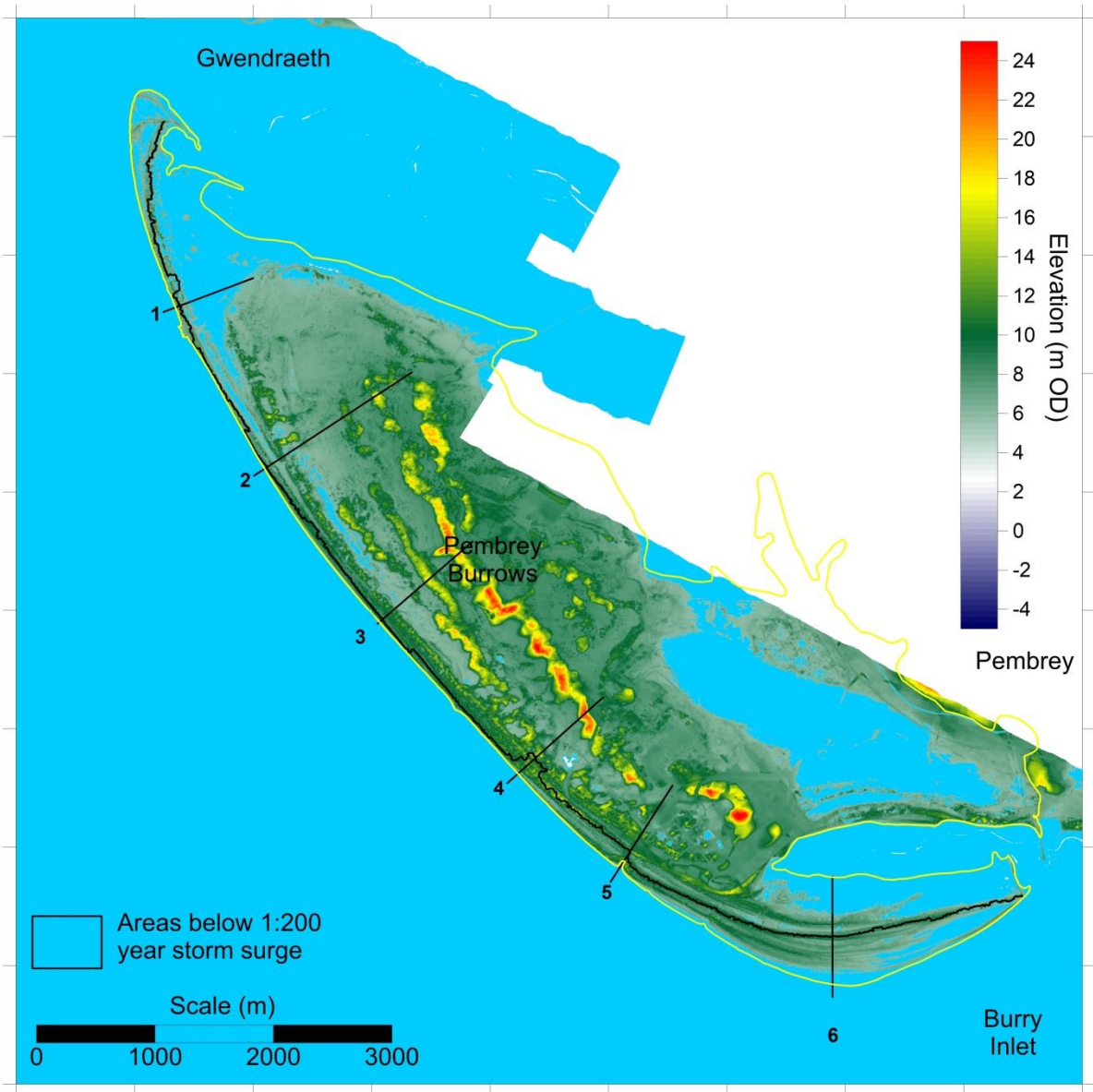
Pye K, Blott SJ. 2015. *Coastal Erosion and Scrub Management at Pembrey Sands Air Weapons Range, Carmarthenshire*. Report to Defence Training Estates. Report EX151201, Kenneth Pye Associates Ltd., Solihull.



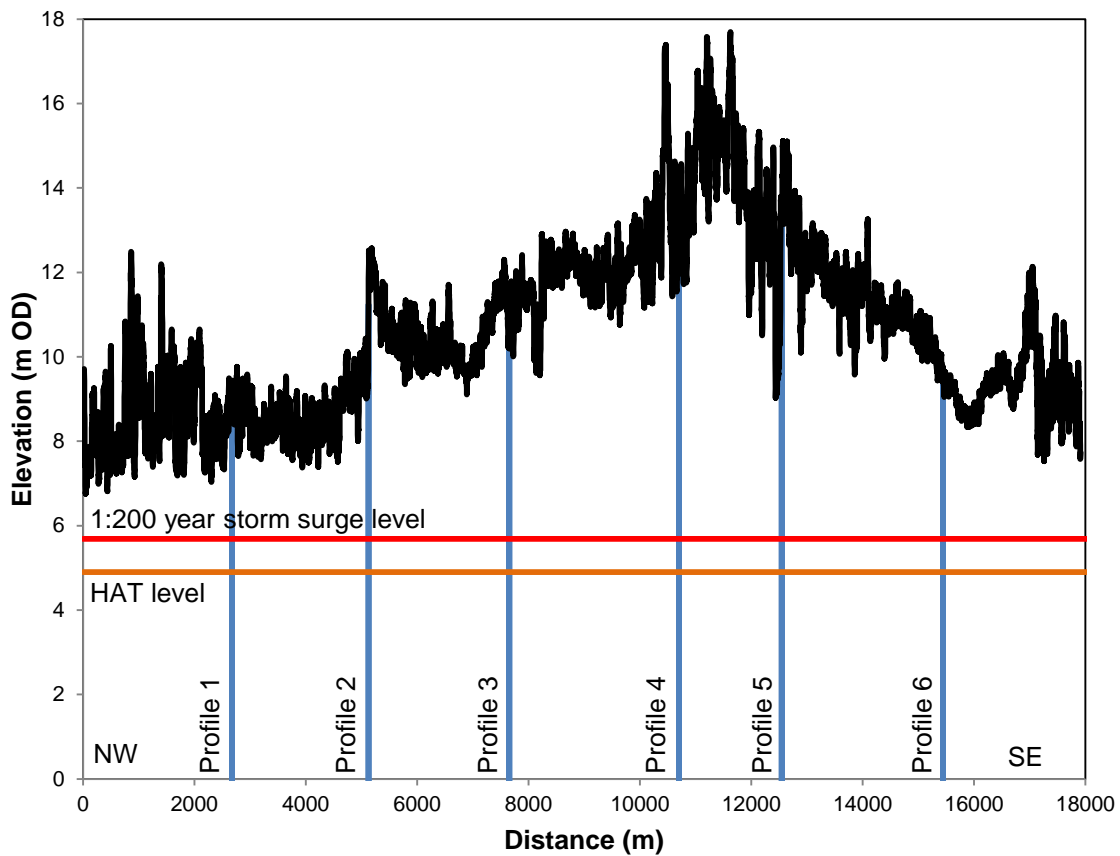
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps. Locations of profiles 1 to 6 are also shown.



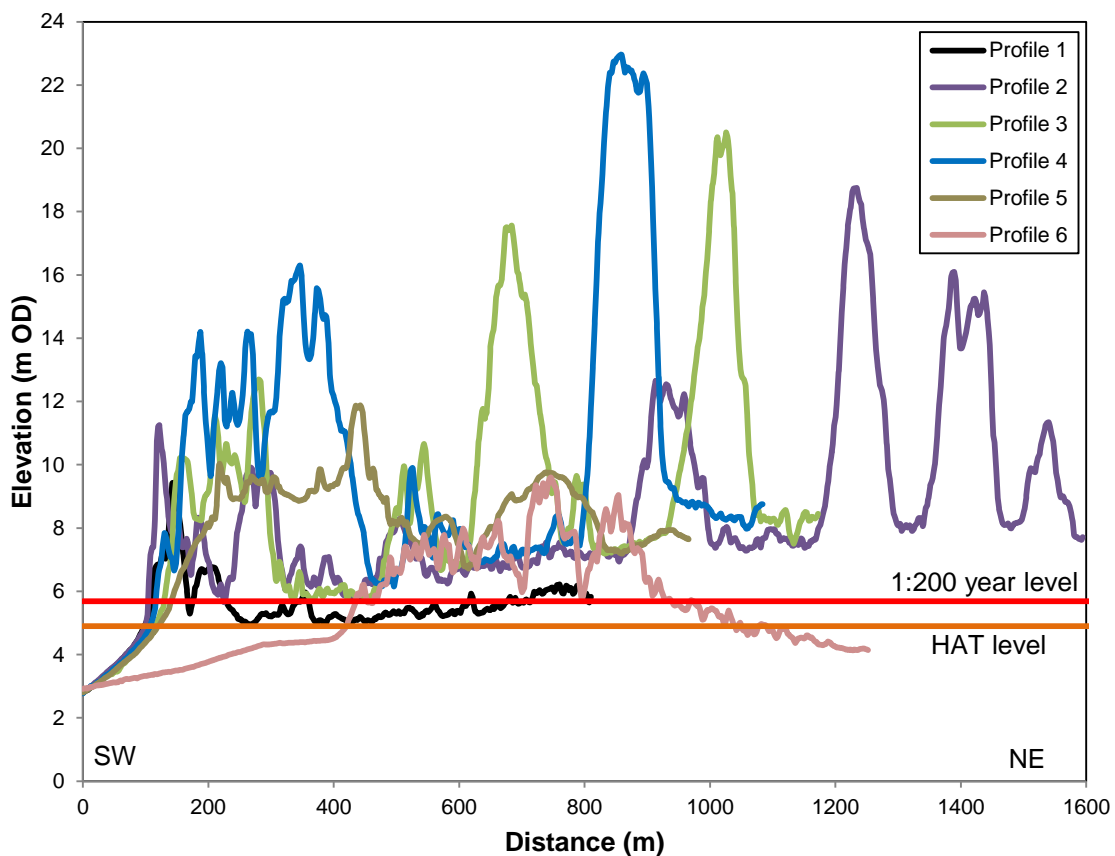
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps. Locations of profiles 1 to 6 are also shown.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 24: Gwendraeth Estuary North Shore

Site description

Morphological setting	Estuary (Gwendraeth)
Morphological type	low fringing and former transgressive sand sheets, now stabilized and protected by shingle beaches and spits
Erosion/progradation status	Slowly eroding where defences are absent
Defence structures	Rock armour
Hinterland type	Caravans, railway, agricultural land
Typical hinterland level	3.2 to 5.6 m OD
Conservation designations	Arfordir Pen-Bre / Pembrey Coast SSSI, SAC; Carmarthen Bay GCR site
Notable features	Caravan park and associated buildings, railway immediately behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.00 m OD
1:200 year storm surge level	5.58 ± 0.4 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	south

Nearshore wind and wave parameters – N.B. data are for a point outside the estuary

CEFAS WaveNet Hindcast Point	790 (235058E 202250N)
Distance offshore	2.2 km
Mean wind speed	11.60 knots
Mean wind direction	237.6 ° (WSW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.69 sec
Mean wave direction	224.4 ° (SW)
Mean wave direction scaled for wave power	220.7 ° (SW)
Mean annual wave power	27.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; DS)	166 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

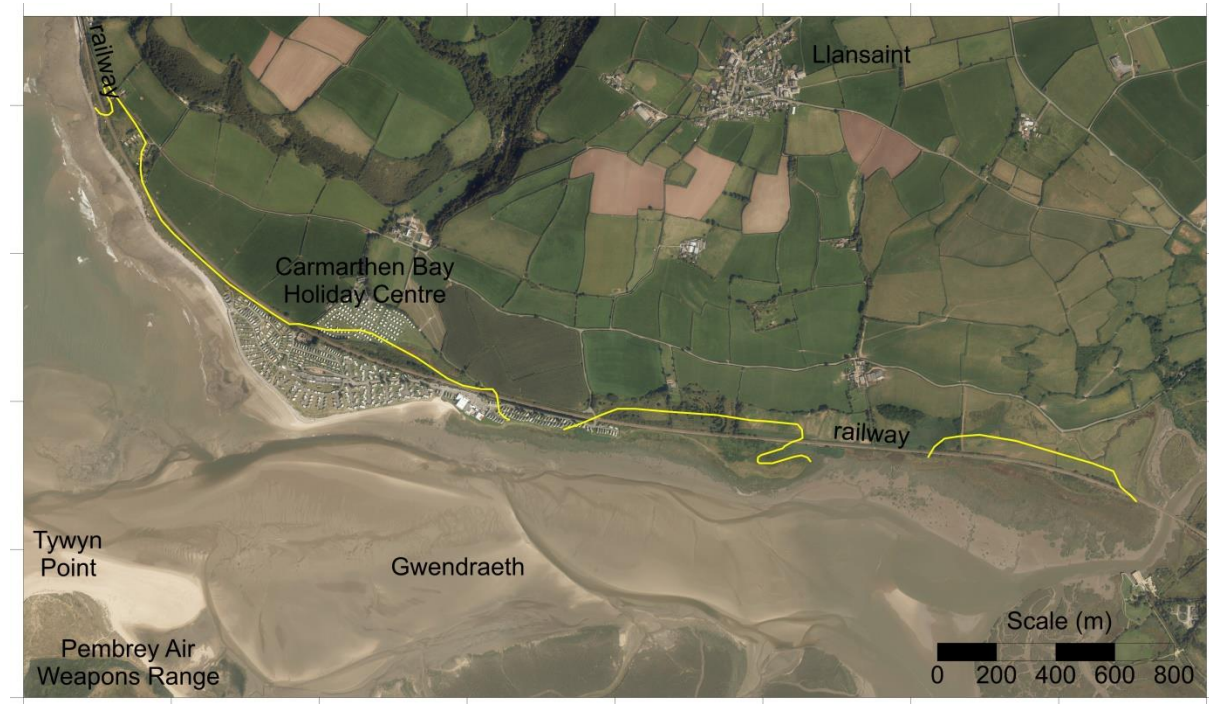
Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

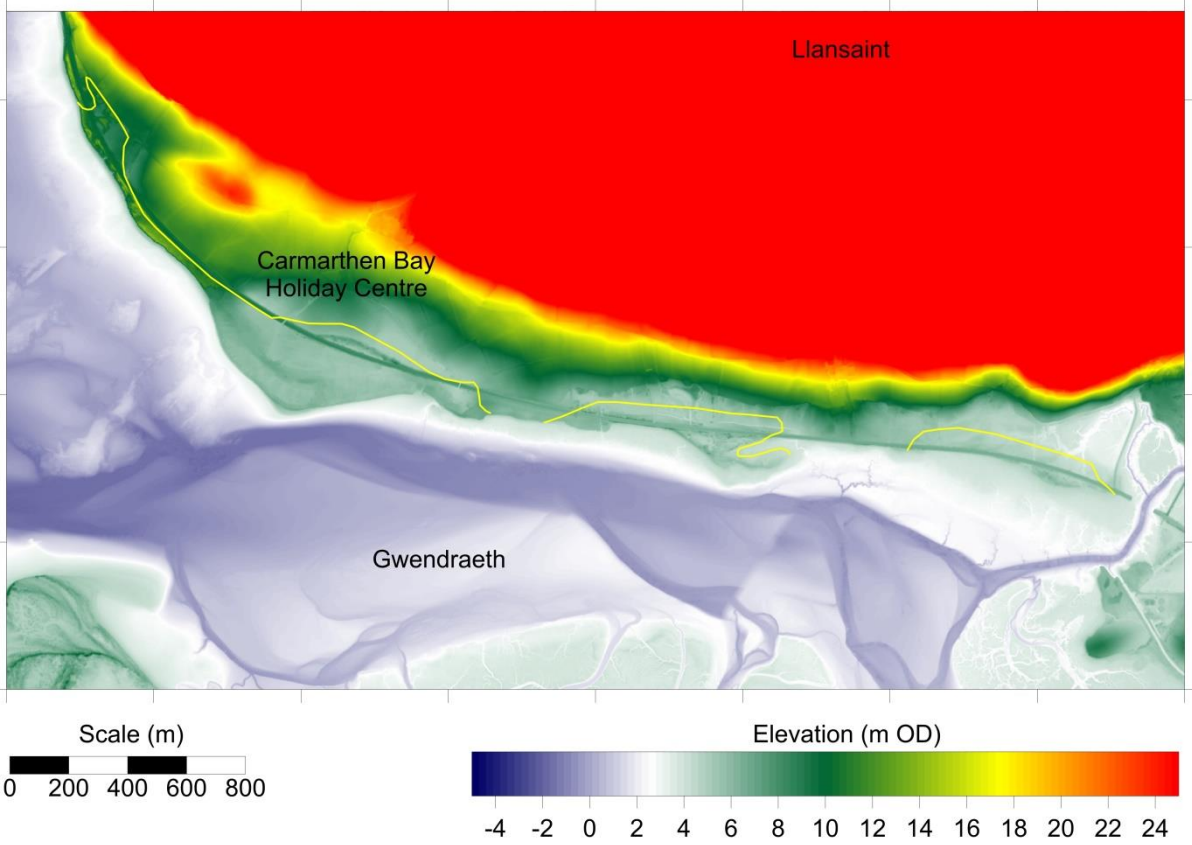
None identified	
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Further information

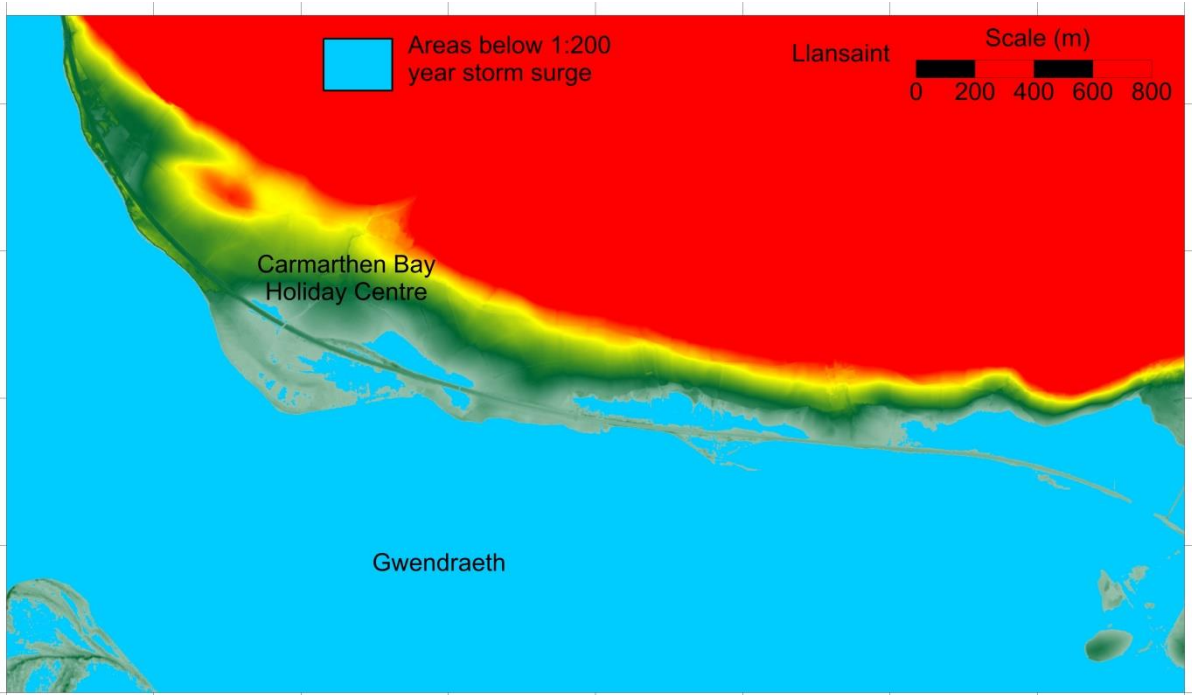
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 25: Ferryside to Morfa Uchaf, River Towy

Site description

Morphological setting	Estuary (Towy east shore)
Morphological type	Fringing, locally formerly transgressive but now stabilised
Erosion/progradation status	Slowly eroding where not protected
Defence structures	Rock armour, groynes
Hinterland type	Housing, railway, agricultural land
Typical hinterland level	4.0 to 5.5 m OD
Conservation designations	Afon Tywi SSSI, SAC; part of the Carmarthen Bay GCR coastal assemblage
Notable features	Railway immediately behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	5.58 ± 0.4 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters – N.B. data area for a point outside the estuary

CEFAS WaveNet Hindcast Point	790 (235058E 202250N)
Distance offshore	2.2 km
Mean wind speed	11.60 knots
Mean wind direction	237.6 ° (WSW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.69 sec
Mean wave direction	224.4 ° (SW)
Mean wave direction scaled for wave power	220.7 ° (SW)
Mean annual wave power	27.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; LD)	166 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

Partial rock armour dune toe protection	Significant
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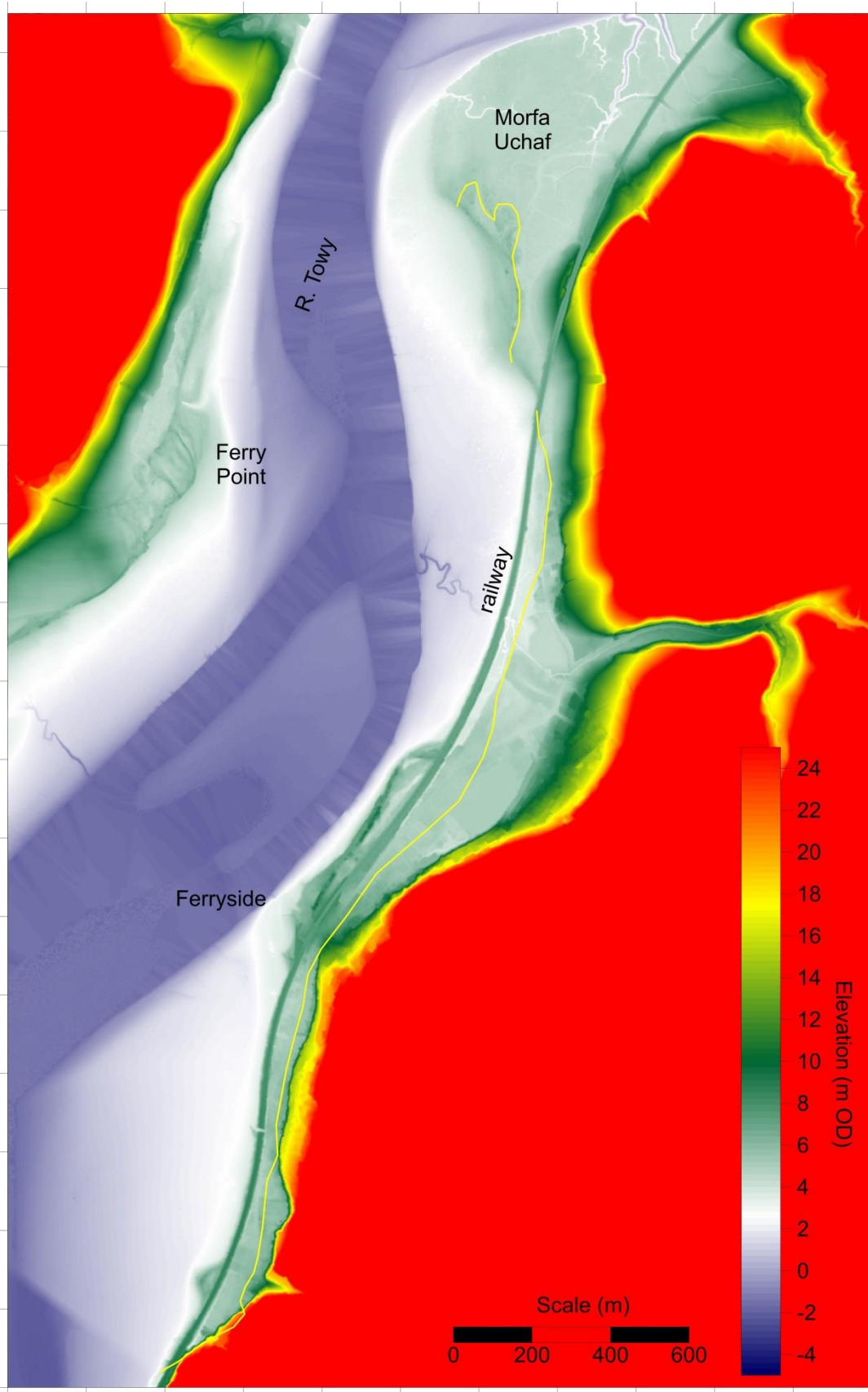
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

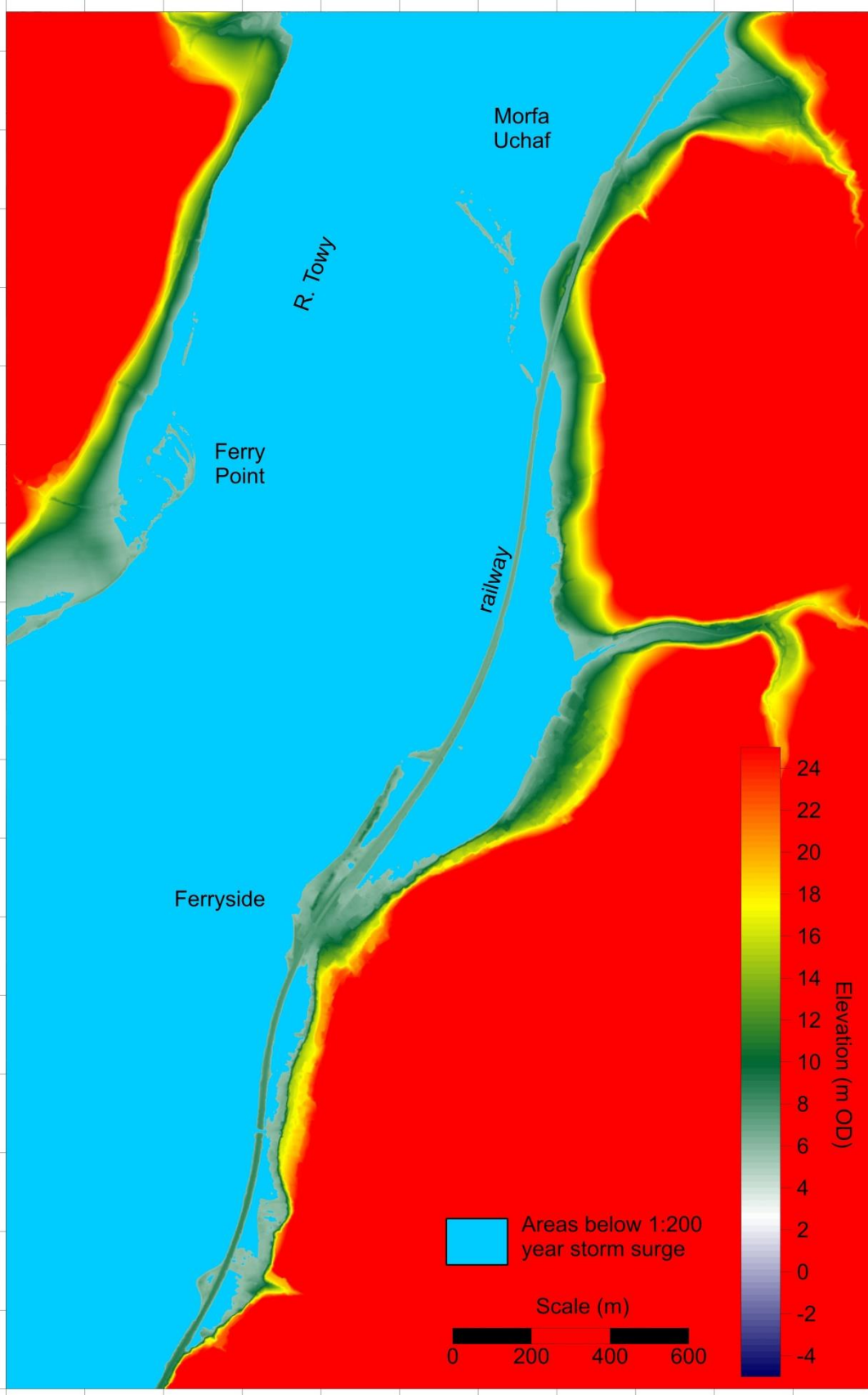
Pye K, Blott SJ. 2010. *Morphological Change in Carmarthen Bay and Adjoining Estuaries: Further Analysis*. Annex A2 in Halcrow (2010) Swansea Bay and Carmarthen Bay Shoreline Management Plan, Appendix C, Baseline Processes Understanding. Halcrow Group, Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 26: Llansteffan and Ferry Point, River Towy

Site description

Morphological setting	Estuary (Towy west shore)
Morphological type	Fringing, low barrier spit with dune capping
Erosion/progradation status	Currently stable / slowly prograding, but temporally and spatially variable in response to channel movements
Defence structures	Sea wall behind and buried below dunes, outfall on the beach acts as a groyne
Hinterland type	Housing, agricultural land
Typical hinterland level	4.6 to 6.4 m OD
Conservation designations	Afon Tywi SSSI, SAC; part of the Carmarthen Bay GCR coastal assemblage
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	5.58 ± 0.4 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters – N.B. data area for a point outside the estuary

CEFAS WaveNet Hindcast Point	790 (235058E 202250N)
Distance offshore	2.2 km
Mean wind speed	11.60 knots
Mean wind direction	237.6 ° (WSW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.69 sec
Mean wave direction	224.4 ° (SW)
Mean wave direction scaled for wave power	220.7 ° (SW)
Mean annual wave power	27.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; LD)	168 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Present and past dune and beach management measures

None identified	
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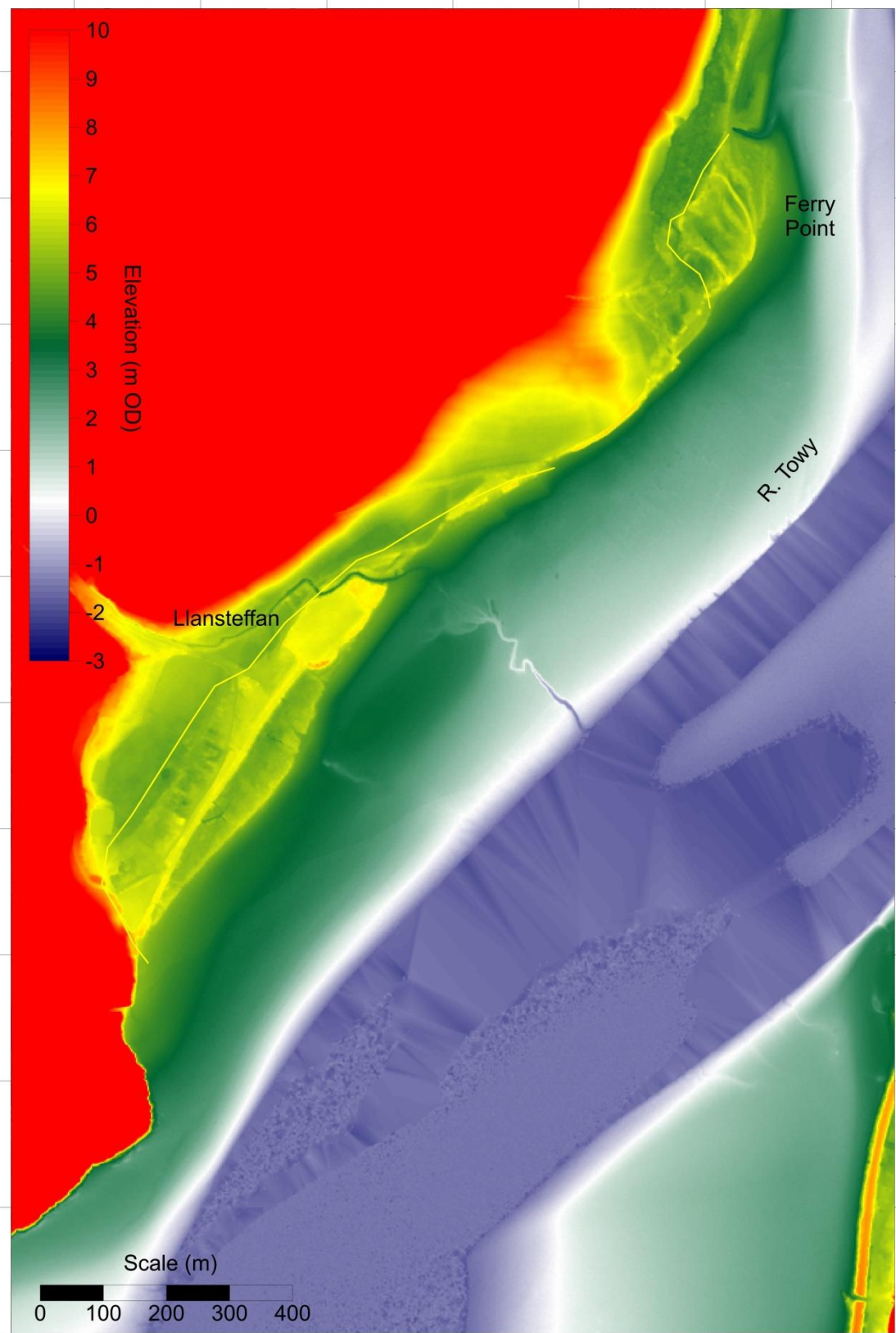
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

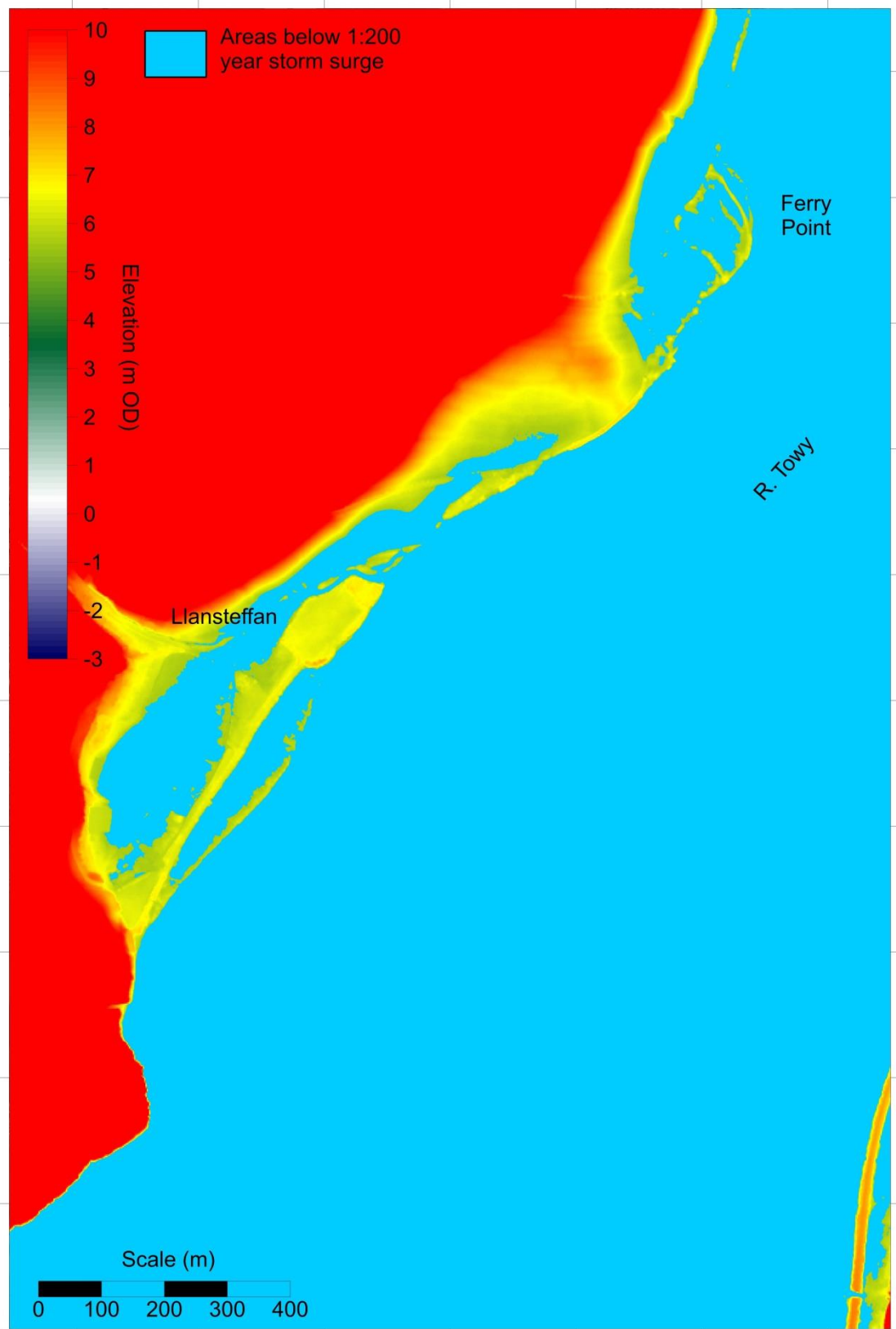
Pye K, Blott SJ. 2010. *Morphological Change in Carmarthen Bay and Adjoining Estuaries: Further Analysis*. Annex A2 in Halcrow (2010) Swansea Bay and Carmarthen Bay Shoreline Management Plan, Appendix C, Baseline Processes Understanding. Halcrow Group, Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 27: Pentowyn, River Taf

Site description

Morphological setting	Estuary (Taf)
Morphological type	Climbing and cliff top low dunes and sand sheet
Erosion/progradation status	Stabilised low dunes now cut off from active sand source by saltmarsh development
Defence structures	None
Hinterland type	Agricultural land
Typical hinterland level	Rising ground
Conservation designations	Aber Taf / Taf Estuary SSSI, SAC; Carmarthen Bay GCR site, National Trust
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.30 m OD
1:200 year storm surge level	5.58 ± 0.4 m OD (outside estuary)
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2006
Principal aspect of dune frontage	southwest and northeast

Nearshore wind and wave parameters – N.B. data area for a point outside the estuary

CEFAS WaveNet Hindcast Point	790 (235058E 202250N)
Distance offshore	2.2 km
Mean wind speed	11.60 knots
Mean wind direction	237.6 ° (WSW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.69 sec
Mean wave direction	224.4 ° (SW)
Mean wave direction scaled for wave power	220.7 ° (SW)
Mean annual wave power	27.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

None identified	
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Further information

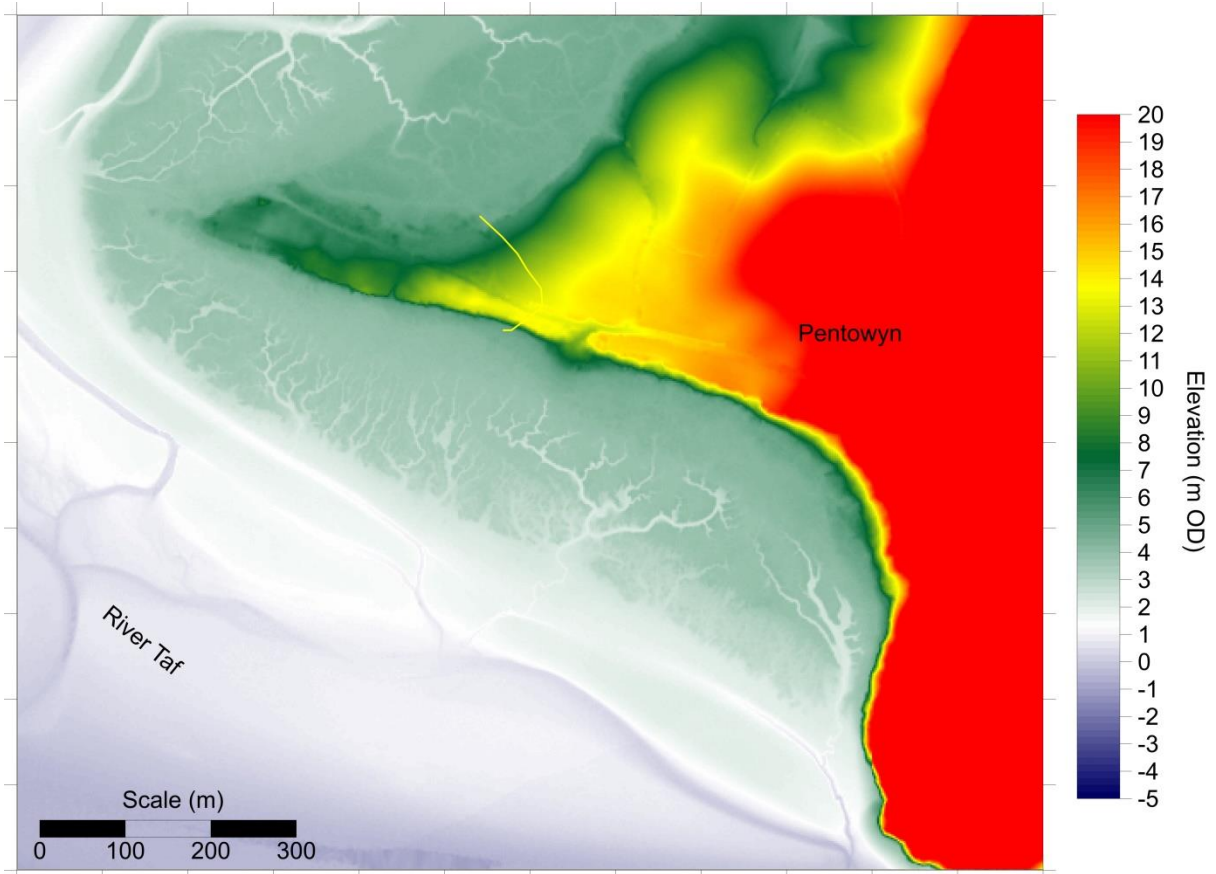
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2010. *Morphological Change in Carmarthen Bay and Adjoining Estuaries: Further Analysis*. Annex A2 in Halcrow (2010) Swansea Bay and Carmarthen Bay Shoreline Management Plan, Appendix C, Baseline Processes Understanding. Halcrow Group, Swindon.

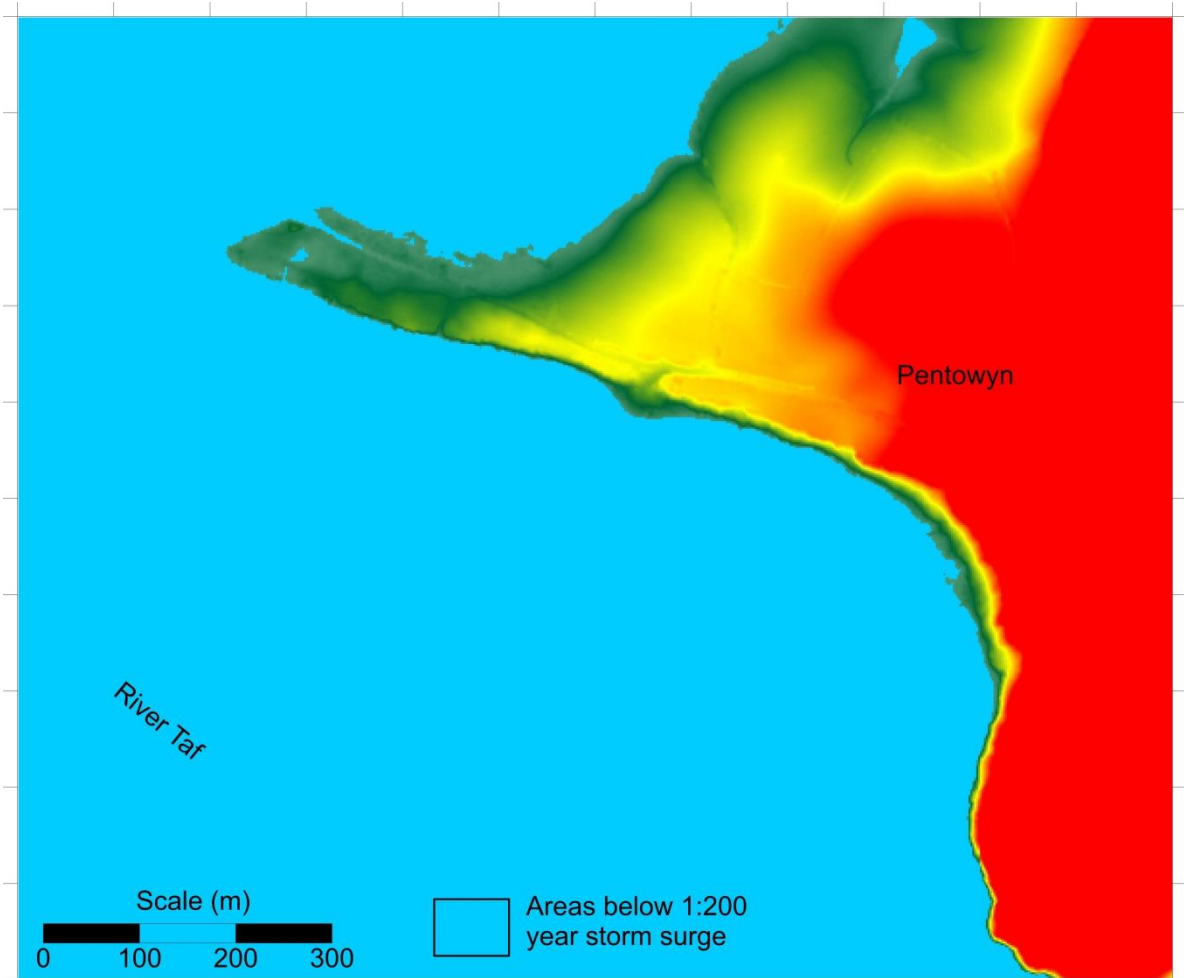
Pye K, Blott, SJ. 2010. *Geomorphological Assessment of the Taf Estuary, Carmarthen shire, with Particular Reference to Sea Defence Management at Mwche and Pentowyn*. Report to the National Trust. Report No. EX1222, Kenneth Pye Associates Ltd., Crowthorne.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 28: Pendine and Laugharne Burrows

Site description

Morphological setting	Bay (Carmarthen Bay)
Morphological type	Barrier spit on west side of Three Rivers estuarine complex
Erosion/progradation status	Stable or slowly eroding at We end and in centre, locally prograding near Ginst Point, but spatially and temporally variable in response to channel movements
Defence structures	Seawall and revetment at western end (Pendine), rock buttresses at intervals along DTE testing range, concrete wall west of Ginst Point
Hinterland type	Urban development at Pendine, military testing range, grazing land (reclaimed marshland)
Typical hinterland level	3.4 to 4.5 m OD
Conservation designations	Twyni Lacharn - Pentywyn / Laugharne - Pendine Burrows SSSI, SAC; Carmarthen Bay GCR site
Notable features	Pendine Range (MOD)

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.56 ± 0.4 m OD
Maximum crest level	21.44 m OD
Minimum crest level	5.07 m OD
LiDAR survey date	19/04/2009
Principal aspect of dune frontage	south-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	791 (226136E 202316N)
Distance offshore	5.1 km
Mean wind speed	11.84 knots
Mean wind direction	237.0 ° (WSW)
Mean significant wave height (Hs)	0.80 m
Mean zero up-crossing period (Tz)	4.17 sec
Mean peak wave period (Tp)	7.41 sec
Mean wave direction	216.2 ° (SW)
Mean wave direction scaled for wave power	211.6 ° (SSW)
Mean annual wave power	26.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 17; LD)	171-201 µm (average: 182 µm)
Calcium carbonate content (%) (N= 5)	7.57-10.94% (average: 8.71%)
Silica content (%) (N= 5)	80.4-86.7% (average: 83.9%)

Frontal dune morphological parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	13.08	Above HAT	460	Above HAT	1173
Profile 2	19.64	540	513	3015	2674
Profile 3	11.96	456	223	953	527
Profile 4	8.47	238	75	260	78
Profile 5	0.00	120	0	44	0
Profile 6	21.39	421	303	1783	1403

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	High
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	Low / Medium
Economic / Military	Very High
Historical / Archaeological	High
Overall significance score	19.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

Dune fencing	Significant
Scrub clearance	Major
Excavation of shallow pools	Minor
Rip rap along parts of the dune toe	Significant
Rock armour buttresses around beach access points	Significant
Planting of sea buckthorn	Significant

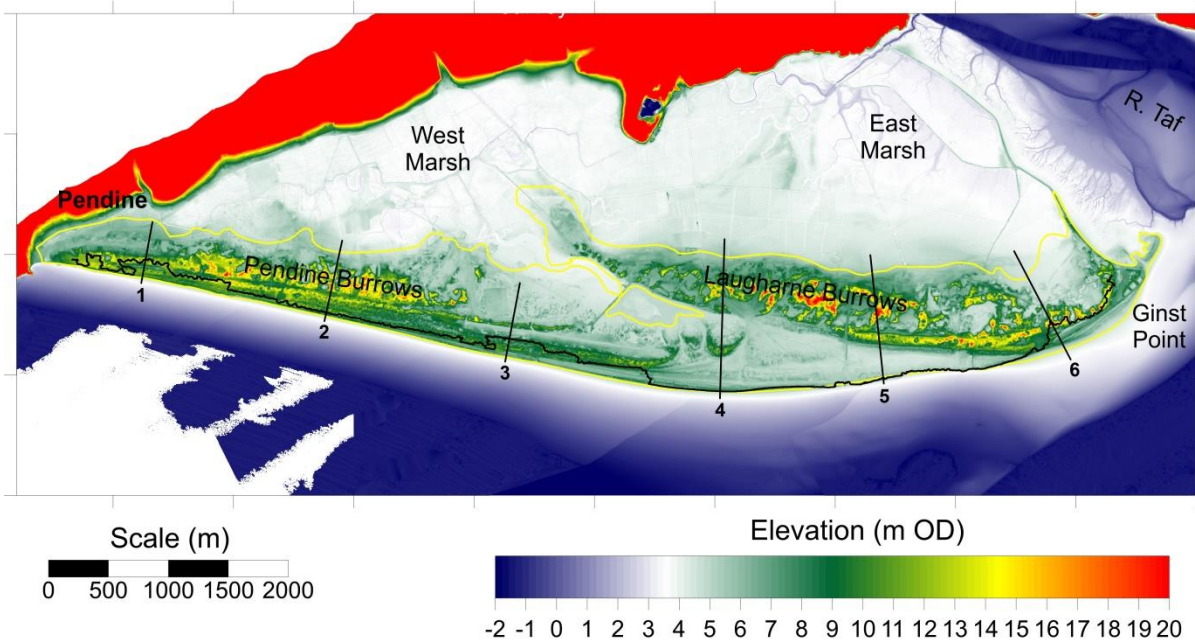
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

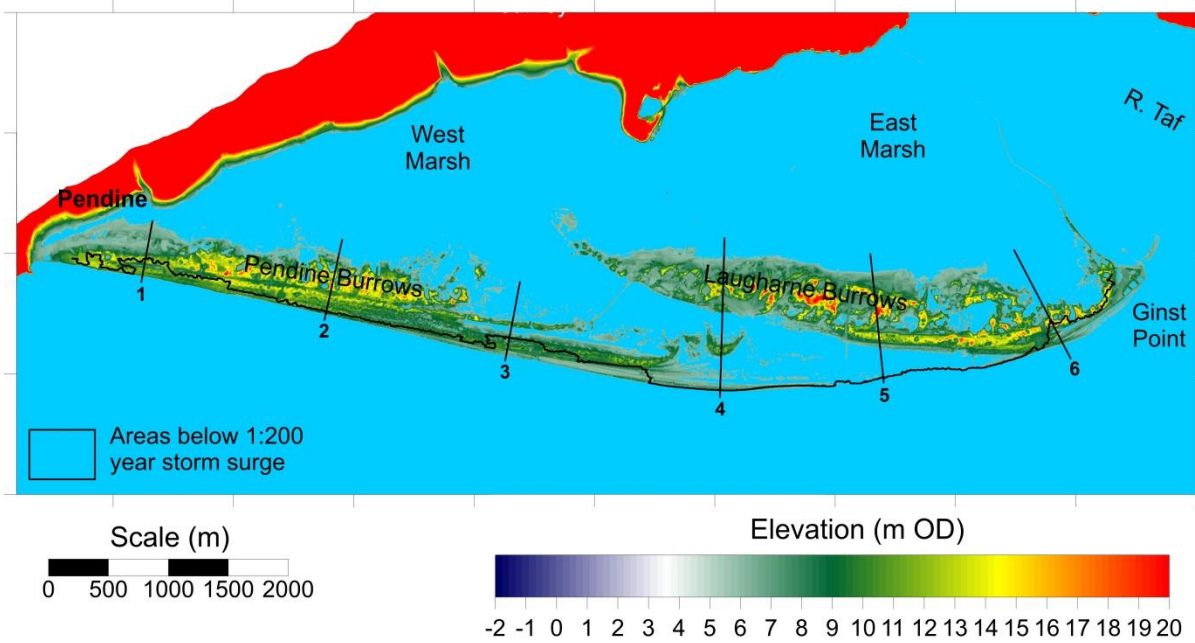
Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 8 Laugharne & Pendine Burrows*. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



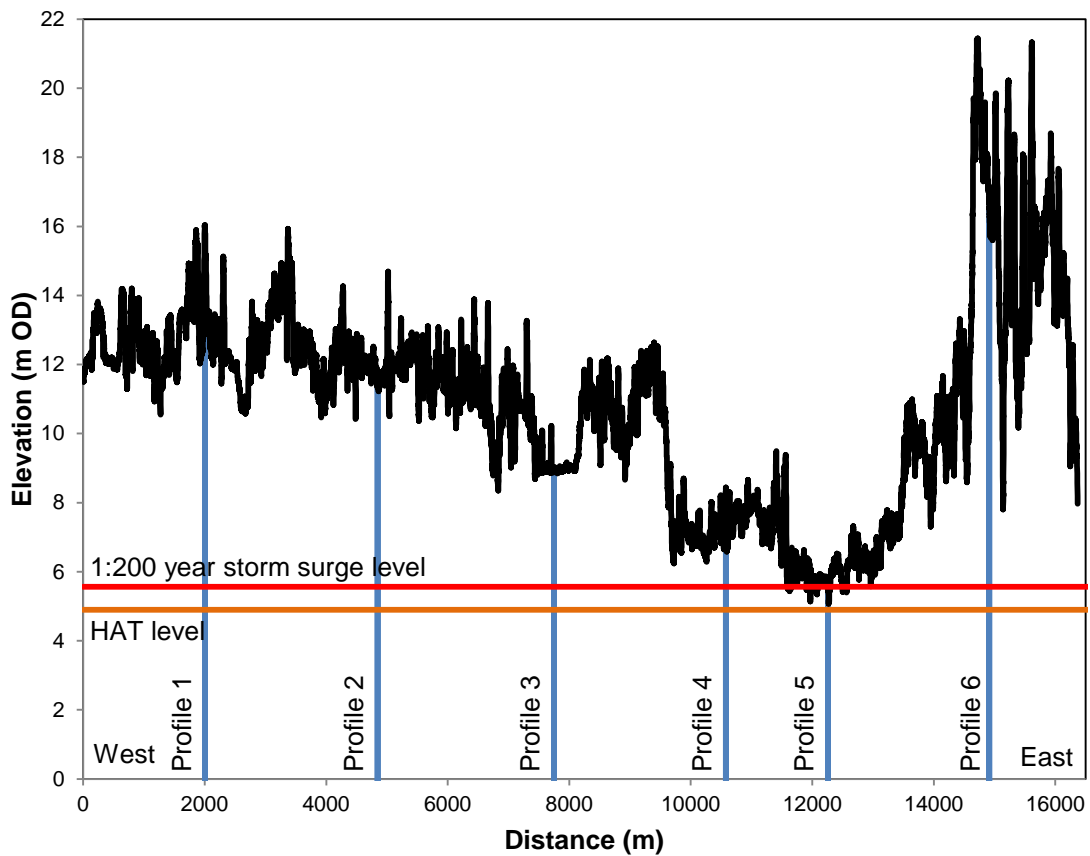
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps. Locations of cross profiles 1 to 6 are also shown.



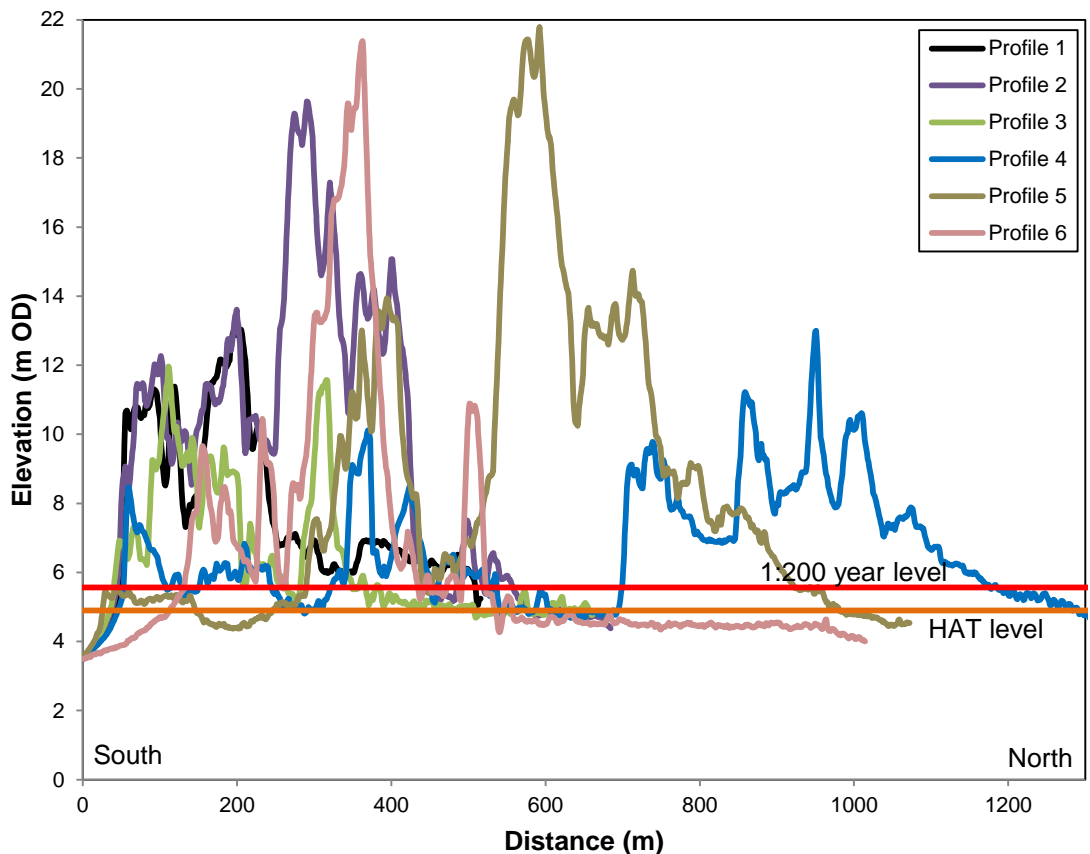
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps. Locations of cross profiles 1 to 6 are also shown.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 29: Tenby Burrows

Site description

Morphological setting	Shallow SE-facing bay, north shore of outer Bristol Channel
Morphological type	Bay mouth barrier (originally a spit, now a tombolo with reclaimed land behind)
Erosion/progradation status	Slowly eroding at SW end, stable in centre and at N (Tenby) end
Defence structures	Detached gabion wall at SW end
Hinterland type	Golf course, railway, housing
Typical hinterland level	3.8 to 5.2 m OD
Conservation designations	Lydstep Head to Tenby Burrows SSSI, National Park
Notable features	Tenby Golf Club, railway behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level	5.30 ± 0.2 m OD
Maximum crest level	27.43 m OD
Minimum crest level	6.34 m OD
LiDAR survey date	31/03/2013
Principal aspect of dune frontage	southeast

Dune barrier parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	13.08	Above HAT	460	Above HAT	1173
Profile 2	19.64	540	513	3015	2674
Profile 3	11.96	456	223	953	527
Profile 4	8.47	238	75	260	78
Profile 5	0.00	120	0	44	0
Profile 6	21.39	421	303	1783	1403

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	792 (217281E 202373N)
Distance offshore	2.5 km
Mean wind speed	14.00 knots
Mean wind direction	243.3 ° (WSW)
Mean significant wave height (Hs)	0.69 m
Mean zero up-crossing period (Tz)	3.97 sec
Mean peak wave period (Tp)	6.82 sec
Mean wave direction	205.8 ° (SSW)
Mean wave direction scaled for wave power	199.3 ° (SSW)
Mean annual wave power	18.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	227-296 µm (average: 253 µm)
Calcium carbonate content (%) (N= 3)	9.03-11.78% (average: 10.74%)
Silica content (%) (N= 3)	82.3-87.9% (average: 84.2%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	High
Geomorphological Features	Medium
Recreation	High
Economic / Military	Medium
Historical / Archaeological	Low / Medium
Overall significance score	14
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

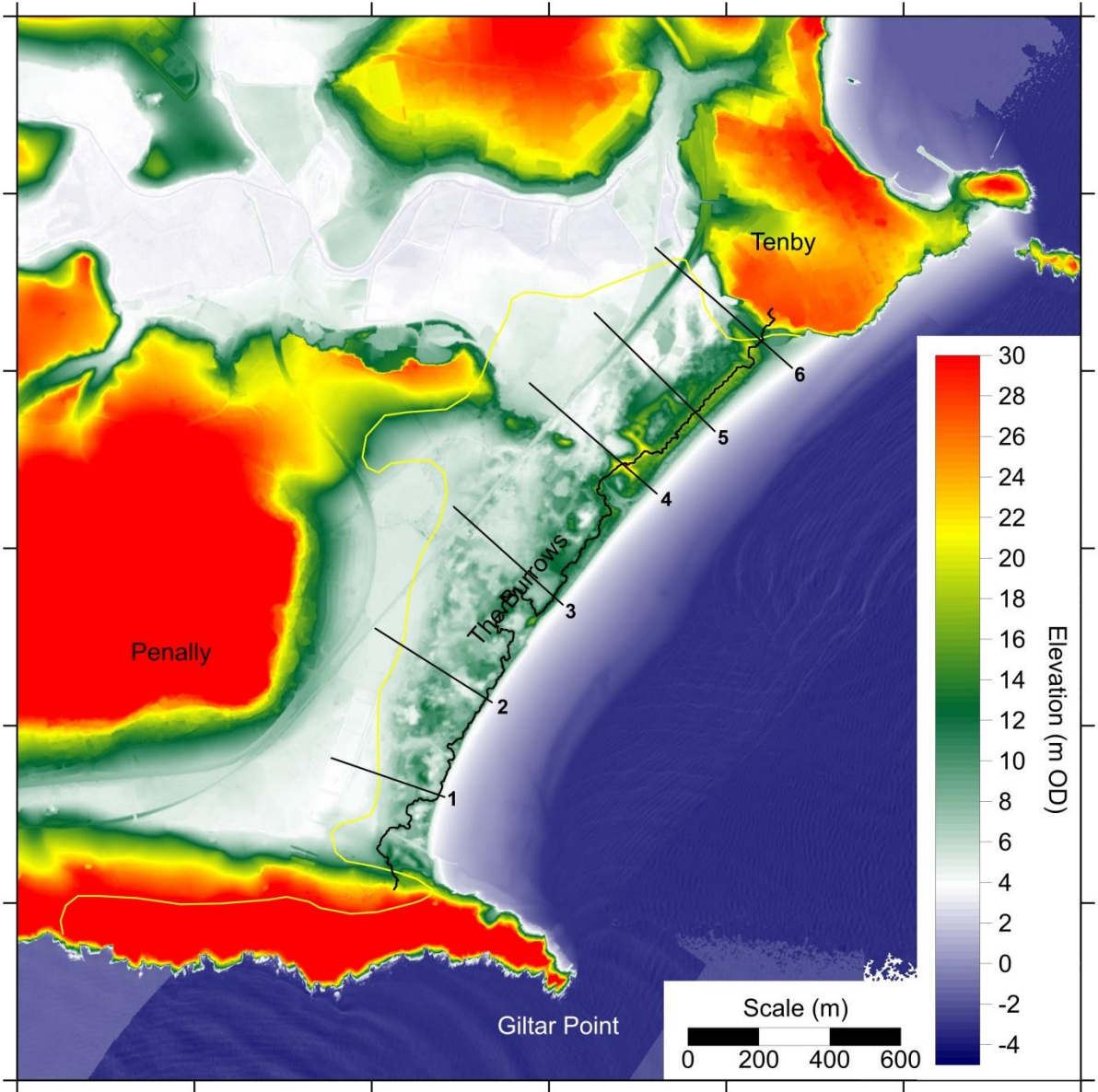
Dune fencing	Significant
Scrub clearance	Minor
Gabions wave protection to dune toe	Significant

Further information

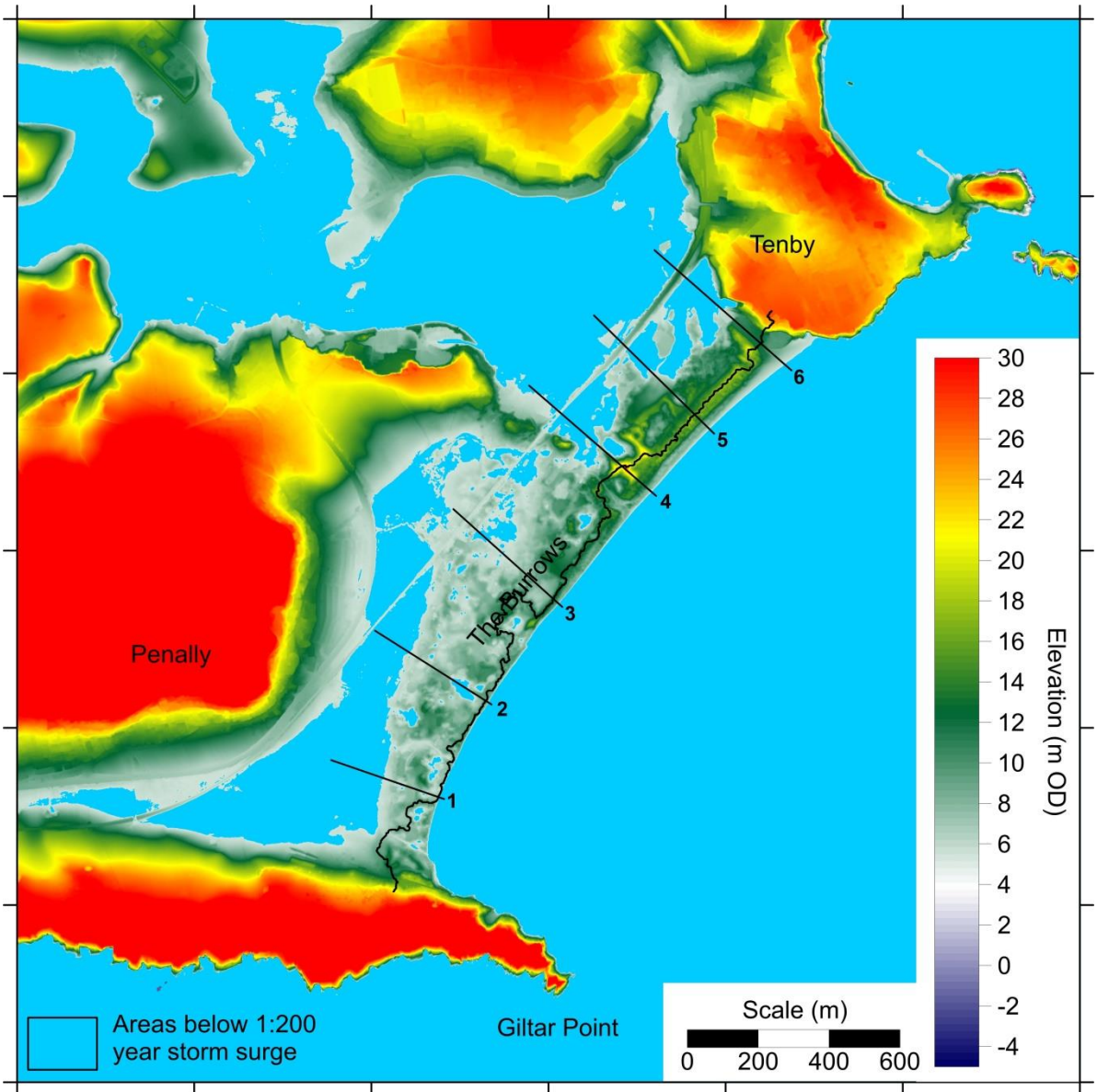
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



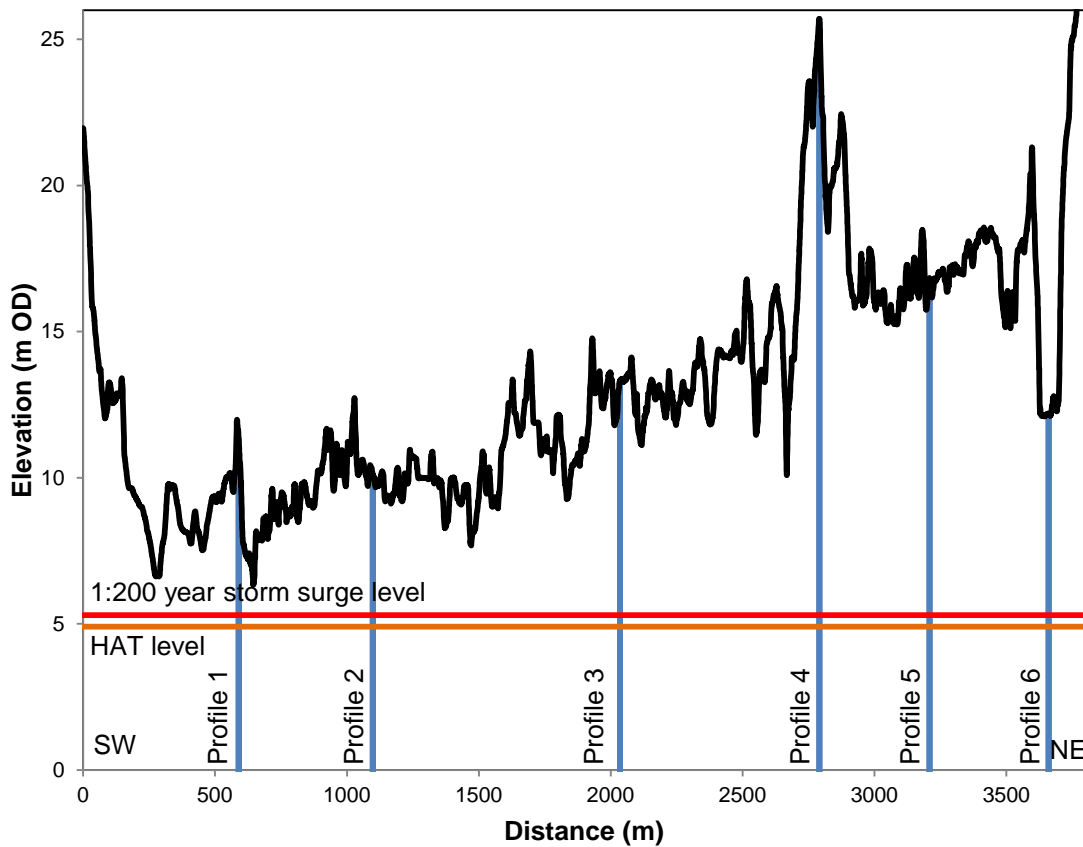
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



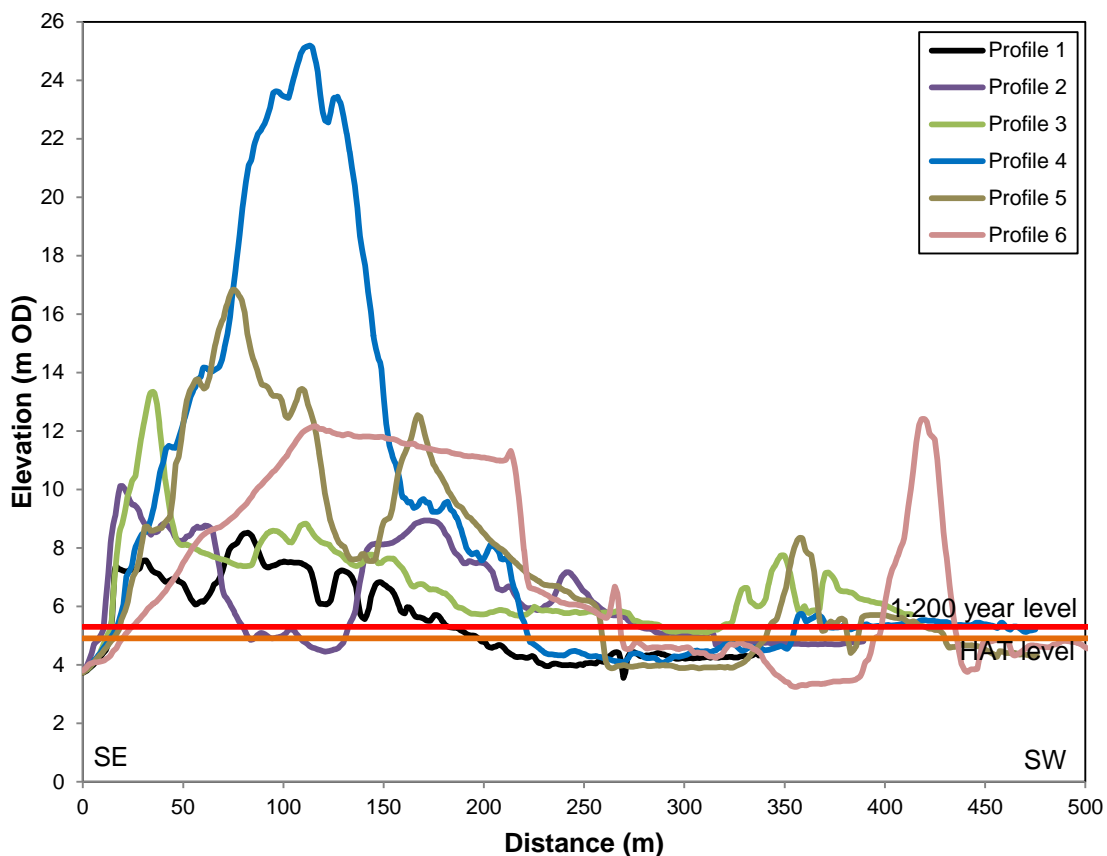
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 30: Giltar Point

Site description

Morphological setting	Open coast (north shore of Bristol Channel)
Morphological type	Cliff-top sand sheets and low hummock dunes, now isolated from sand source
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agricultural land
Typical hinterland level	Rising ground
Conservation designations	Lydstep Head to Tenby Burrows SSSI, SAC, National Park, Heritage Coast
Notable features	Penally Gallery Range

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.85 m OD
1:200 year storm surge level	5.27 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	31/03/2013
Principal aspect of dune frontage	n/a

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	792 (217281E 202373N)
Distance offshore	2.5 km
Mean wind speed	14.00 knots
Mean wind direction	243.3 ° (WSW)
Mean significant wave height (Hs)	0.69 m
Mean zero up-crossing period (Tz)	3.97 sec
Mean peak wave period (Tp)	6.82 sec
Mean wave direction	205.8 ° (SSW)
Mean wave direction scaled for wave power	199.3 ° (SSW)
Mean annual wave power	18.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

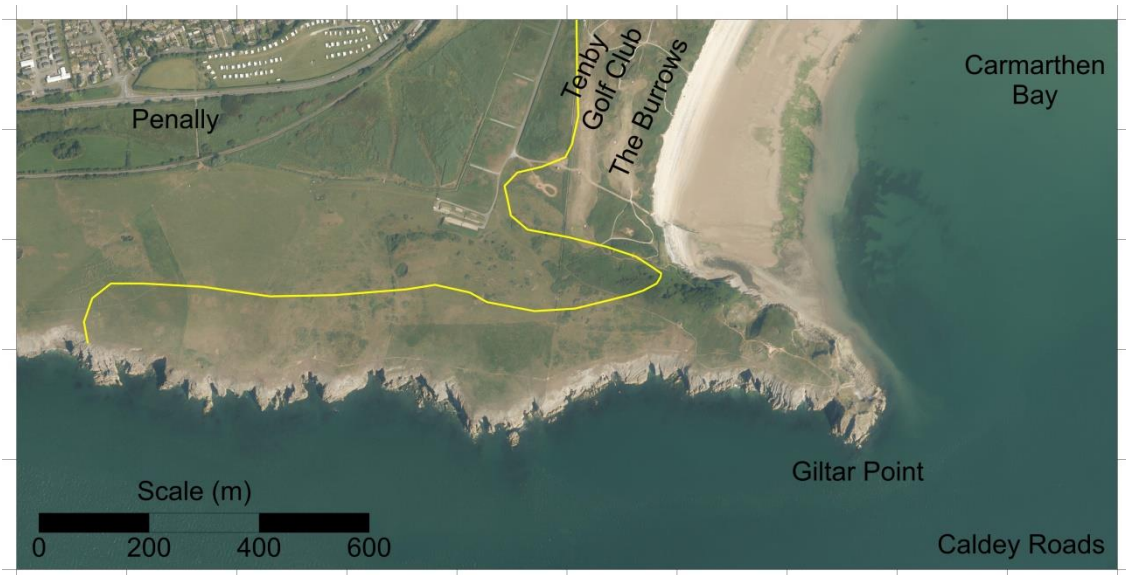
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

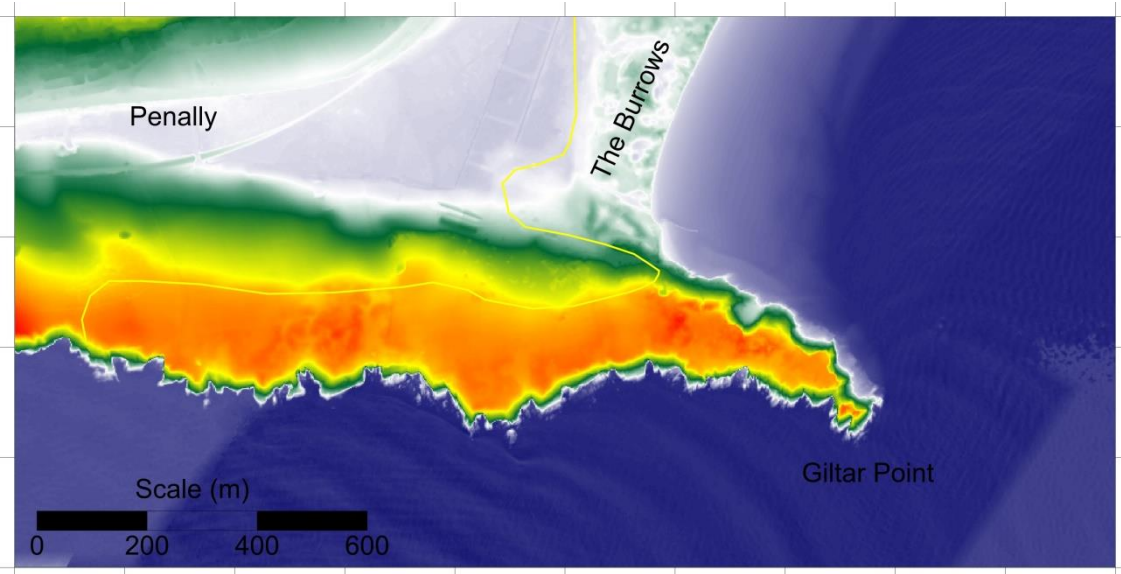
None identified	
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Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.

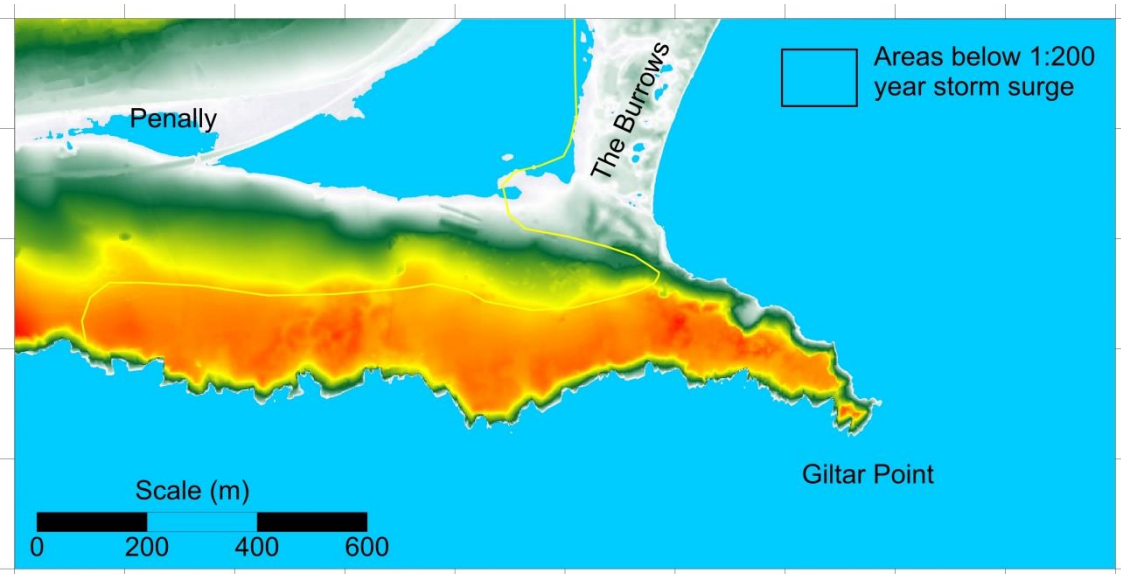


Elevation (m OD)



-4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps



Elevation (m OD)



-4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Areas below the estimated 1 in 200 year storm surge level.

Site 31: Priory Bay, Caldey Island

Site description

Morphological setting	Bay (Priory Bay, north side of Caldey Island, north side of Bristol Channel)
Morphological type	Fringing and climbing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Woodland
Typical hinterland level	Rising ground
Conservation designations	National Park, Heritage Coast, adjacent to SAC
Notable features	Benedictine Priory inland

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.85 m OD
1:200 year storm surge level	5.27 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	No LiDAR surveys undertaken
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters – N.B. data for a point south of Caldey Island

CEFAS WaveNet Hindcast Point	792 (217281E 202373N)
Distance offshore	2.5 km
Mean wind speed	14.00 knots
Mean wind direction	243.3 ° (WSW)
Mean significant wave height (Hs)	0.69 m
Mean zero up-crossing period (Tz)	3.97 sec
Mean peak wave period (Tp)	6.82 sec
Mean wave direction	205.8 ° (SSW)
Mean wave direction scaled for wave power	199.3 ° (SSW)
Mean annual wave power	18.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	5
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

None identified	
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Sources of further information

Halcrow (2012) Lavernock Point to St. Ann’s Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.

Site 32: Lydstep Haven

Site description

Morphological setting	Bay (Lydstep Haven, north shore of Bristol Channel)
Morphological type	Fringing and climbing, levelled for caravan parks and other urban development
Erosion/progradation status	Stable
Defence structures	Rock armour, concrete wall
Hinterland type	Caravans, golf course, agricultural fields
Typical hinterland level	Rising ground
Conservation designations	Lydstep Head to Tenby Burrows SSSI, Pembrokeshire Coast National Park, Heritage Coast
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.80 m OD
1:200 year storm surge level	5.19 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	28/03/2013
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	759 (208295E 193532N)
Distance offshore	3.2 km
Mean wind speed	13.52 knots
Mean wind direction	241.7 ° (WSW)
Mean significant wave height (Hs)	1.00 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.49 sec
Mean wave direction	220.9 ° (SW)
Mean wave direction scaled for wave power	214.0 ° (SW)
Mean annual wave power	41.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 3; LD)	215-236 µm (average: 225 µm)
Calcium carbonate content (%) (N= 3)	15.62-22.27% (average: 18.29%)
Silica content (%) (N= 3)	72.8-79.8% (average: 77%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

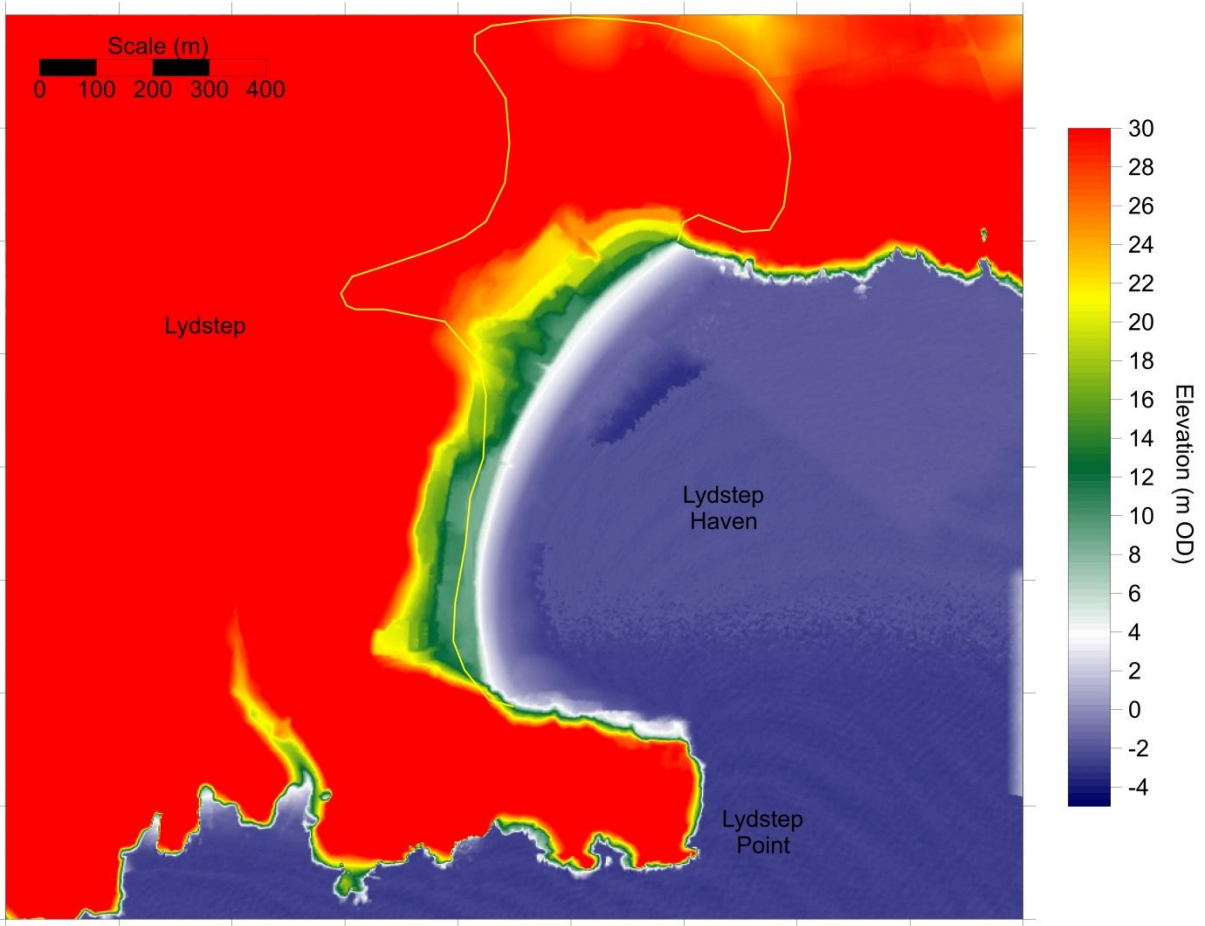
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Further information

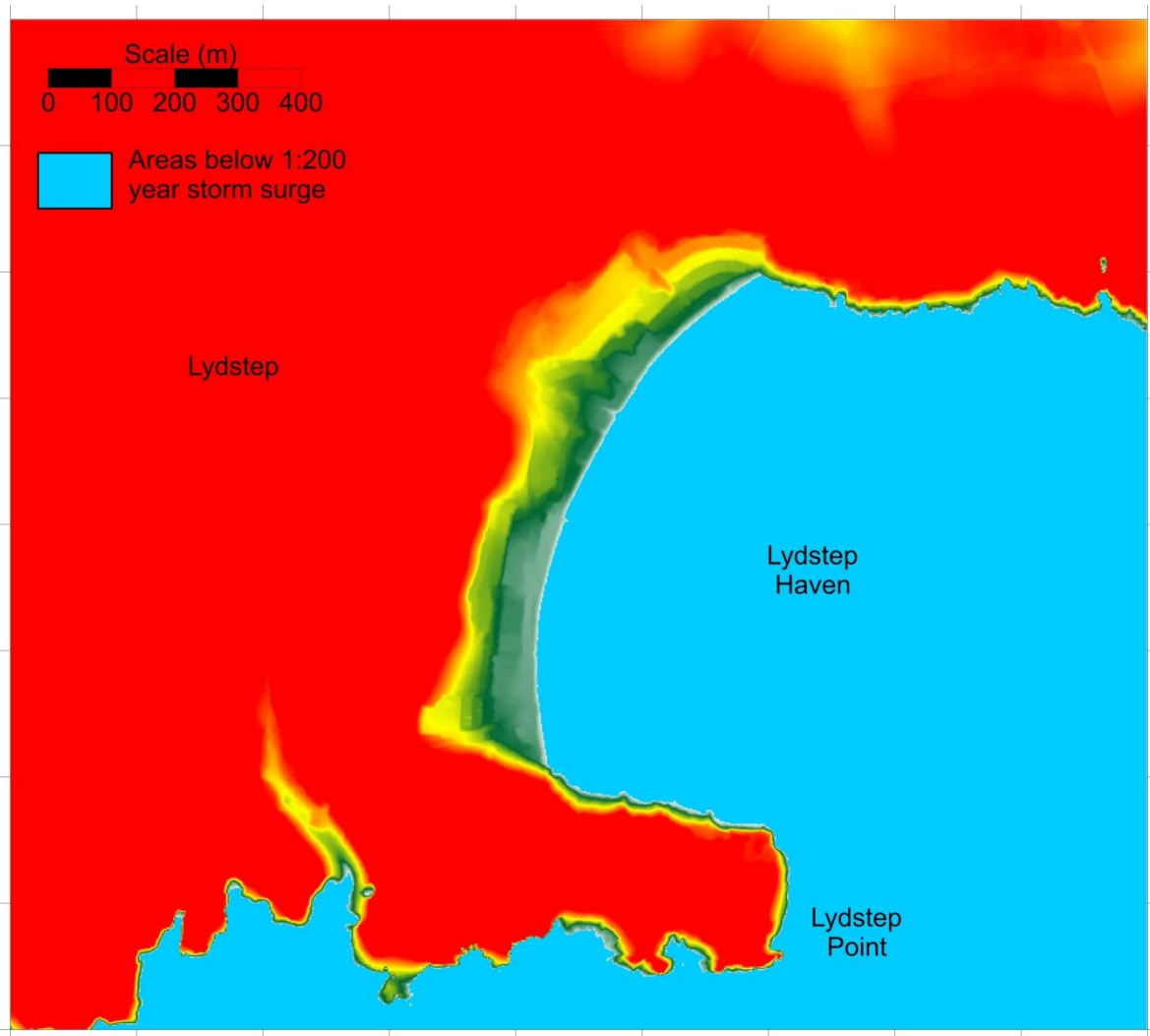
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 33: Manorbier Bay

Site description

Morphological setting	Bay Manorbier Bay, north shore of Bristol Channel)
Morphological type	Fringing and climbing
Erosion/progradation status	Stable; small area of frontal dunes behind central part of beach subject to high visitor pressure
Defence structures	Concrete wall and promenade, partly buried by sand
Hinterland type	Agricultural land
Typical hinterland level	Rising ground
Conservation designations	Freshwater East Cliffs To Skrinkle Haven SSSI, Pembrokeshire Coast National Park, Heritage Coast
Notable features	Manorbier Castle just inland

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.70 m OD
1:200 year storm surge level	5.06 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	28/03/2013
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	759 (208295E 193532N)
Distance offshore	3.2 km
Mean wind speed	13.52 knots
Mean wind direction	241.7 ° (WSW)
Mean significant wave height (Hs)	1.00 m
Mean zero up-crossing period (Tz)	4.33 sec
Mean peak wave period (Tp)	7.49 sec
Mean wave direction	220.9 ° (SW)
Mean wave direction scaled for wave power	214.0 ° (SW)
Mean annual wave power	41.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	308-574 µm (average: 392 µm)
Calcium carbonate content (%) (N= 3)	12.14-17.51% (average: 14.56%)
Silica content (%) (N= 3)	69.8-76.5% (average: 74.1%)

Dune site importance and SMP2 Policy

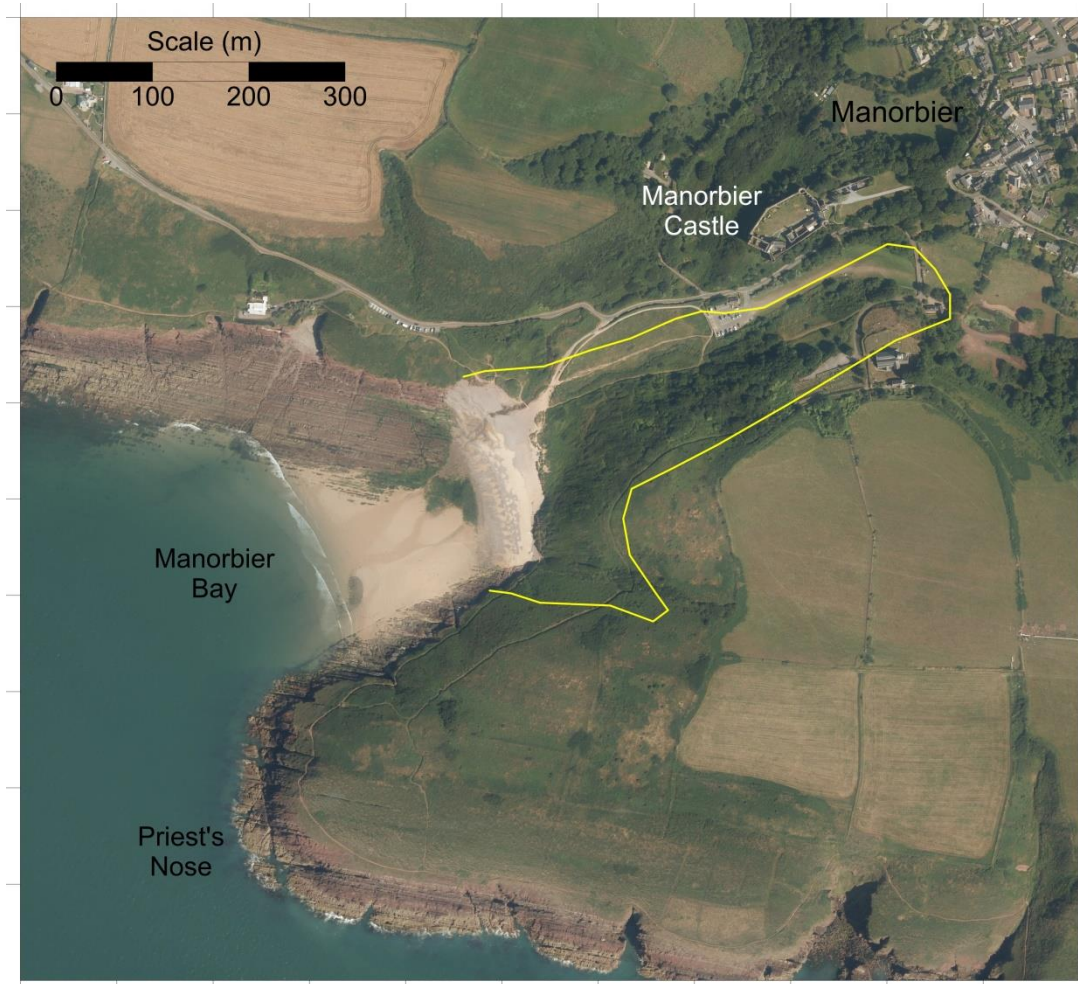
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

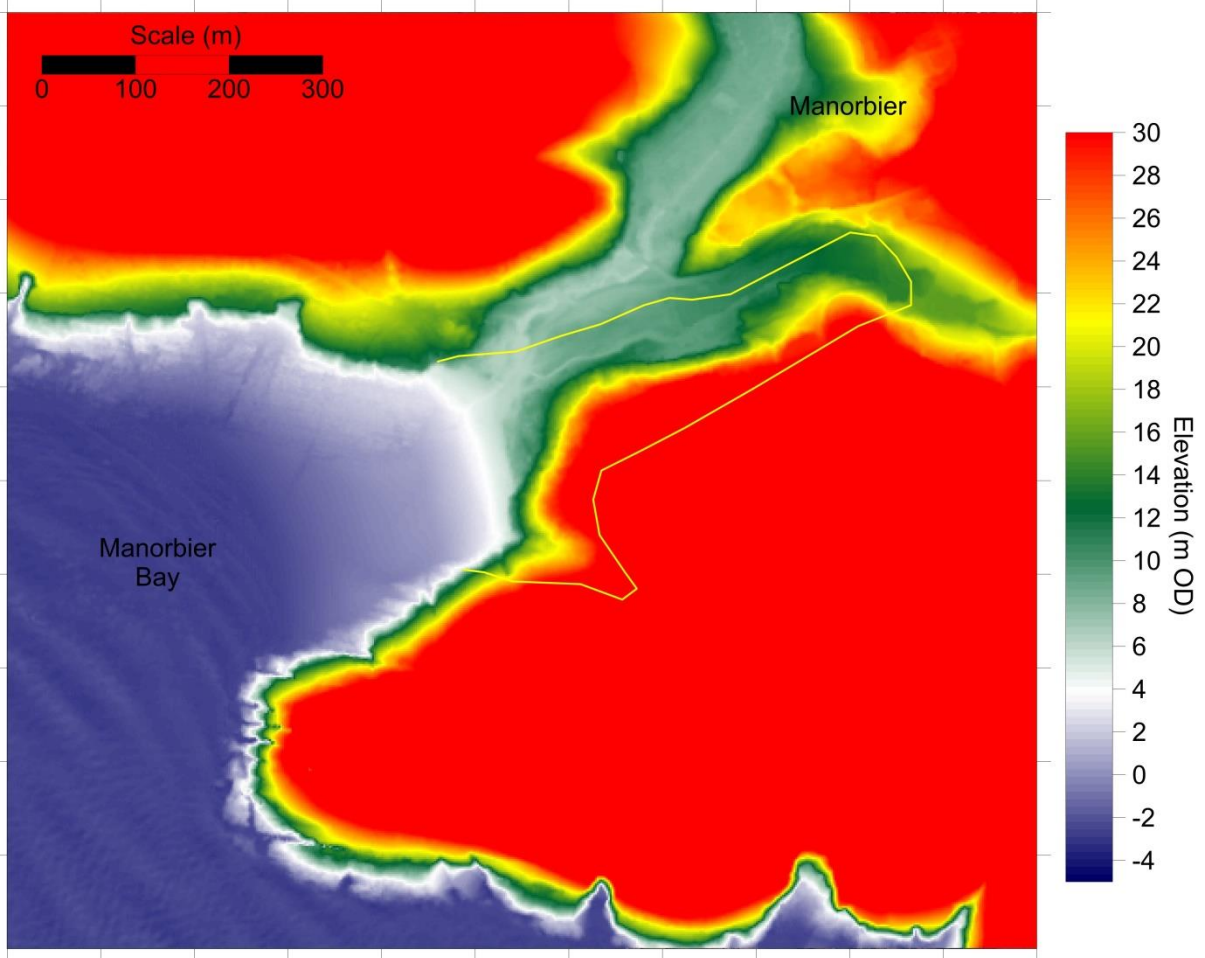
None identified	
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Further information

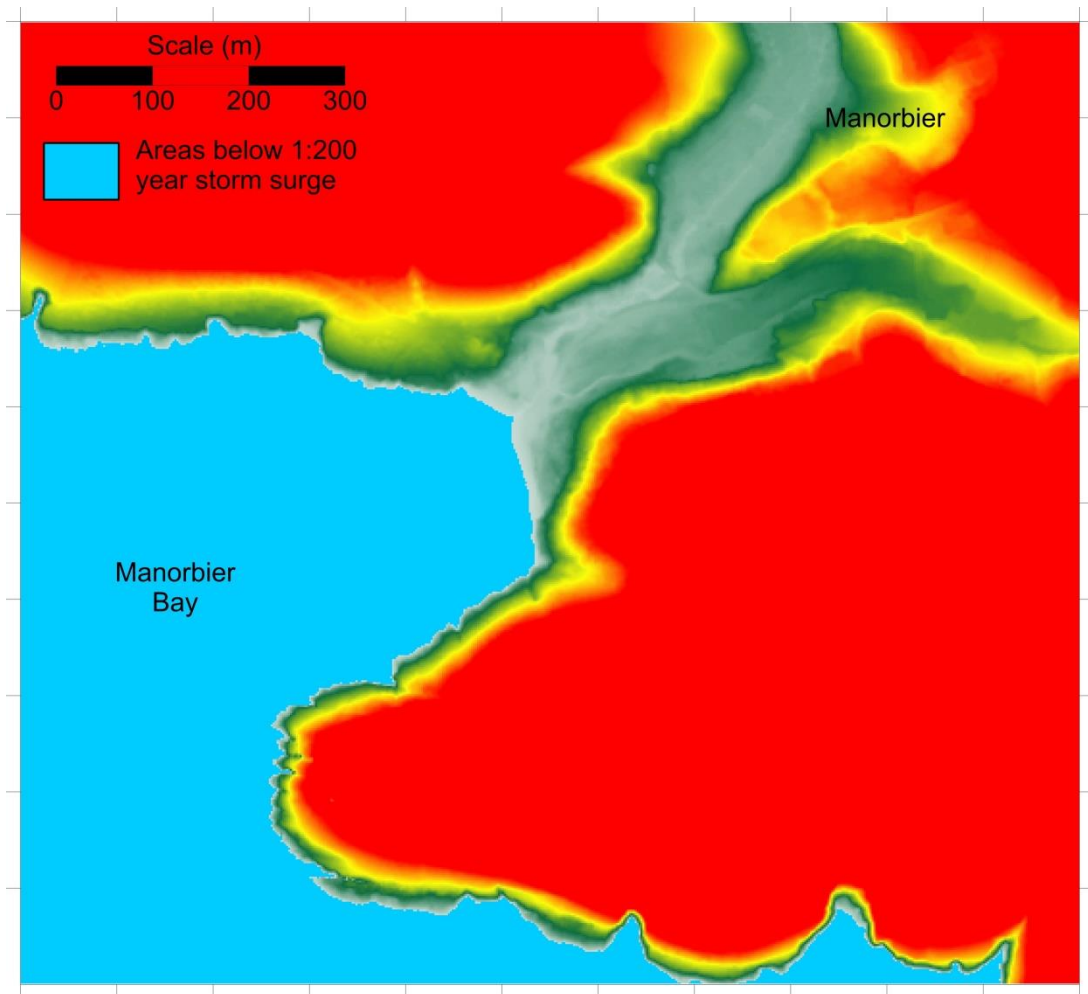
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1:50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1:50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 34: Freshwater East

Site description

Morphological setting	Bay (Freshwater East, north shore of Bristol Channel)
Morphological type	Fringing, valley mouth barrier and climbing
Erosion/progradation status	Generally stable
Defence structures	Short section of wall at SW end
Hinterland type	Caravans, grazing land
Typical hinterland level	5.4 to 6.4 m OD on marsh area, >8.0 m OD on caravan site
Conservation designations	Freshwater East Cliffs To Skrinkle Haven SSSI, Stackpole Quay - Trewent Point SSSI, SAC, Pembrokeshire Coast National Park, Heritage Coast
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.65 m OD
1:200 year storm surge level	5.06 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	15/03/2016
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	760 (199353E 193589N)
Distance offshore	1.0 km
Mean wind speed	14.10 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	1.13 m
Mean zero up-crossing period (Tz)	4.64 sec
Mean peak wave period (Tp)	8.04 sec
Mean wave direction	224.8 ° (SW)
Mean wave direction scaled for wave power	218.8 ° (SW)
Mean annual wave power	56.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	253-368 µm (average: 313 µm)
Calcium carbonate content (%) (N= 4)	13.97-24.43% (average: 20.38%)
Silica content (%) (N= 4)	67-80.7% (average: 73.1%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Present and past dune and beach management measures

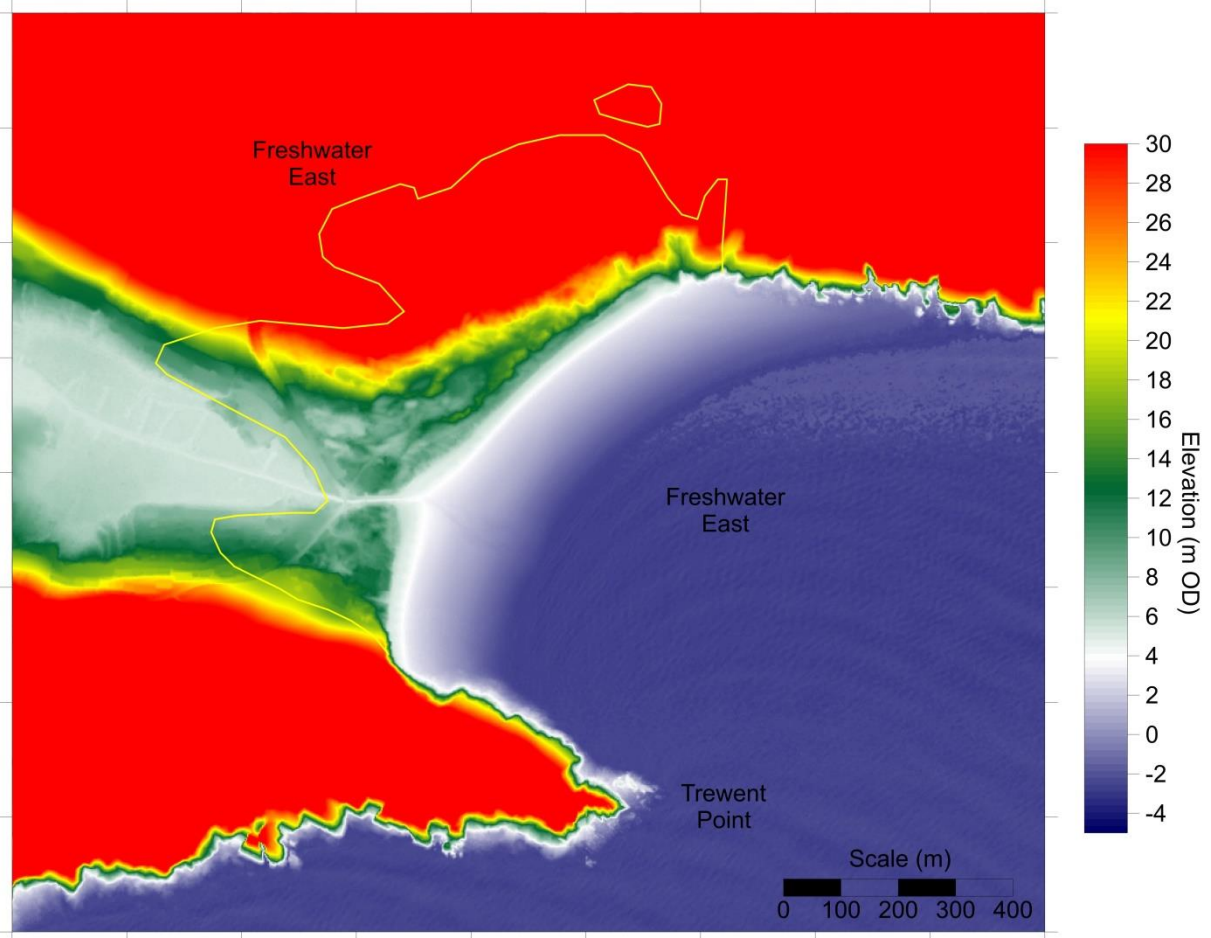
Fencing	Significant
Boardwalks	Minor
Grazing	Significant

Further information

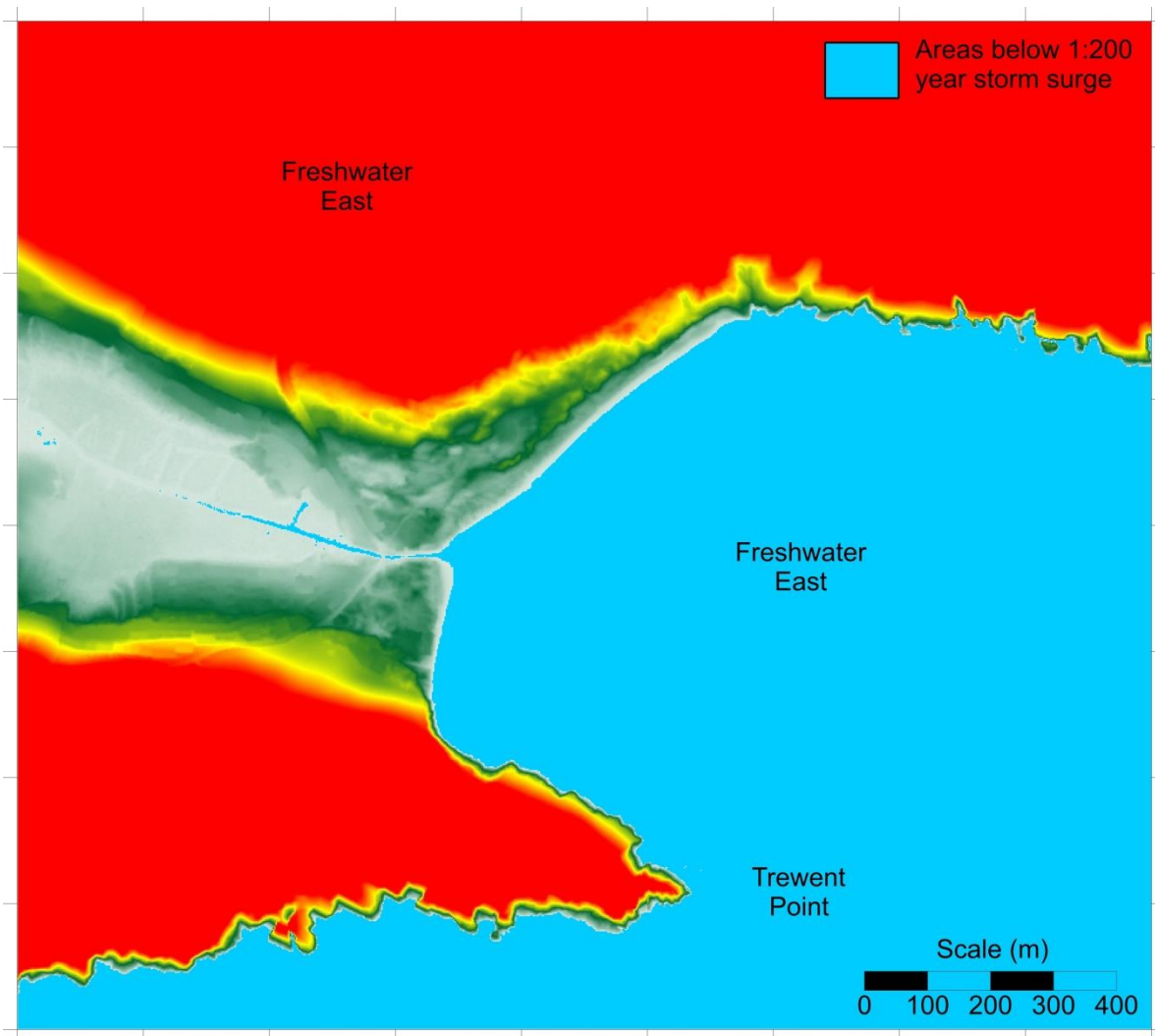
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



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LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 150 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 35: Barafundle Bay

Site description

Morphological setting	Bay (Barafundle Bay, north shore of Bristol Channel)
Morphological type	Transgressive parabolic, foredunes, infilling valley
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Woodland, agriculture
Typical hinterland level	Rising ground
Conservation designations	Stackpole SSSI, SAC, SPA, NNR, National Park, Heritage Coast, National Trust
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.60 m OD
1:200 year storm surge level	4.99 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	07/03/2004
Principal aspect of dune frontage	East-southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	760 (199353E 193589N)
Distance offshore	1.0 km
Mean wind speed	14.10 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	1.13 m
Mean zero up-crossing period (Tz)	4.64 sec
Mean peak wave period (Tp)	8.04 sec
Mean wave direction	224.8 ° (SW)
Mean wave direction scaled for wave power	218.8 ° (SW)
Mean annual wave power	56.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 4; LD)	316-354 µm (average: 329 µm)
Calcium carbonate content (%) (N= 3)	21.69-32.72% (average: 27.45%)
Silica content (%) (N= 3)	62.9-73.4% (average: 67.7%)

Dune site importance and SMP2 Policy

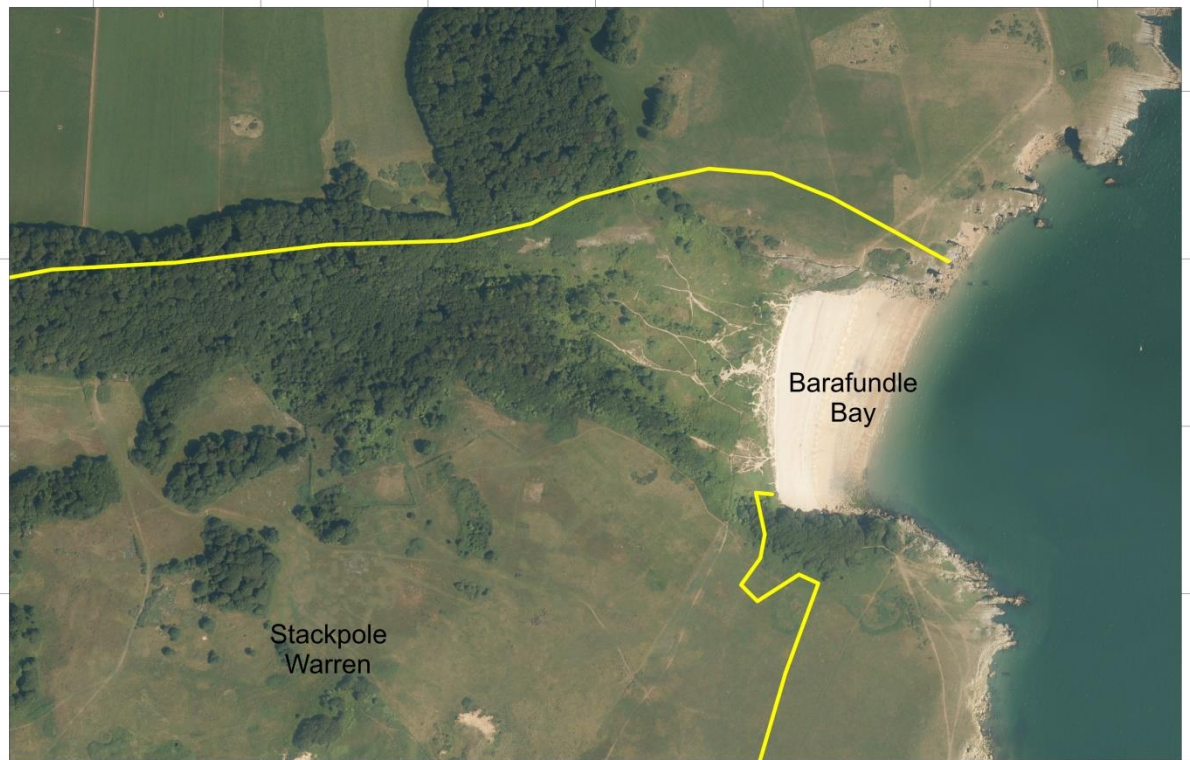
Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Medium
Overall significance score	
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

None identified	
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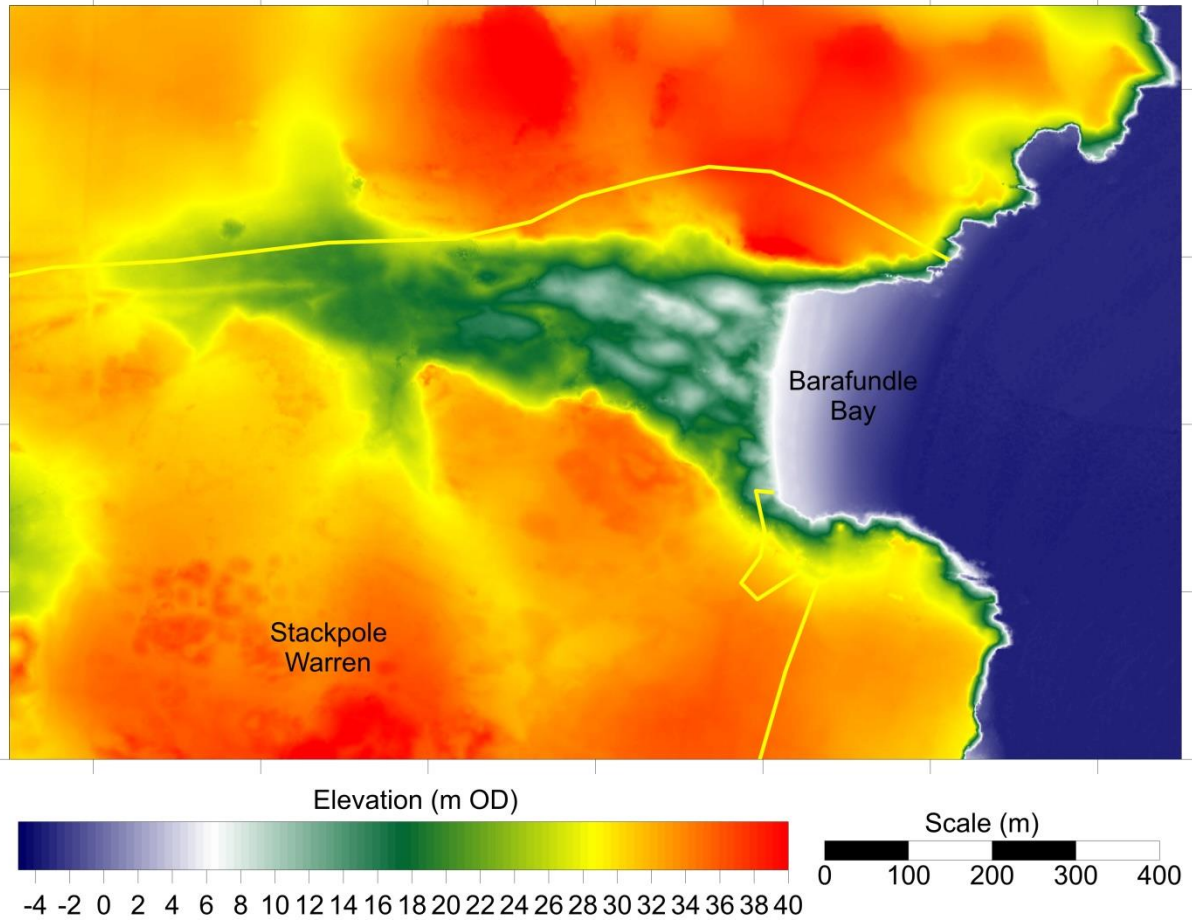
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

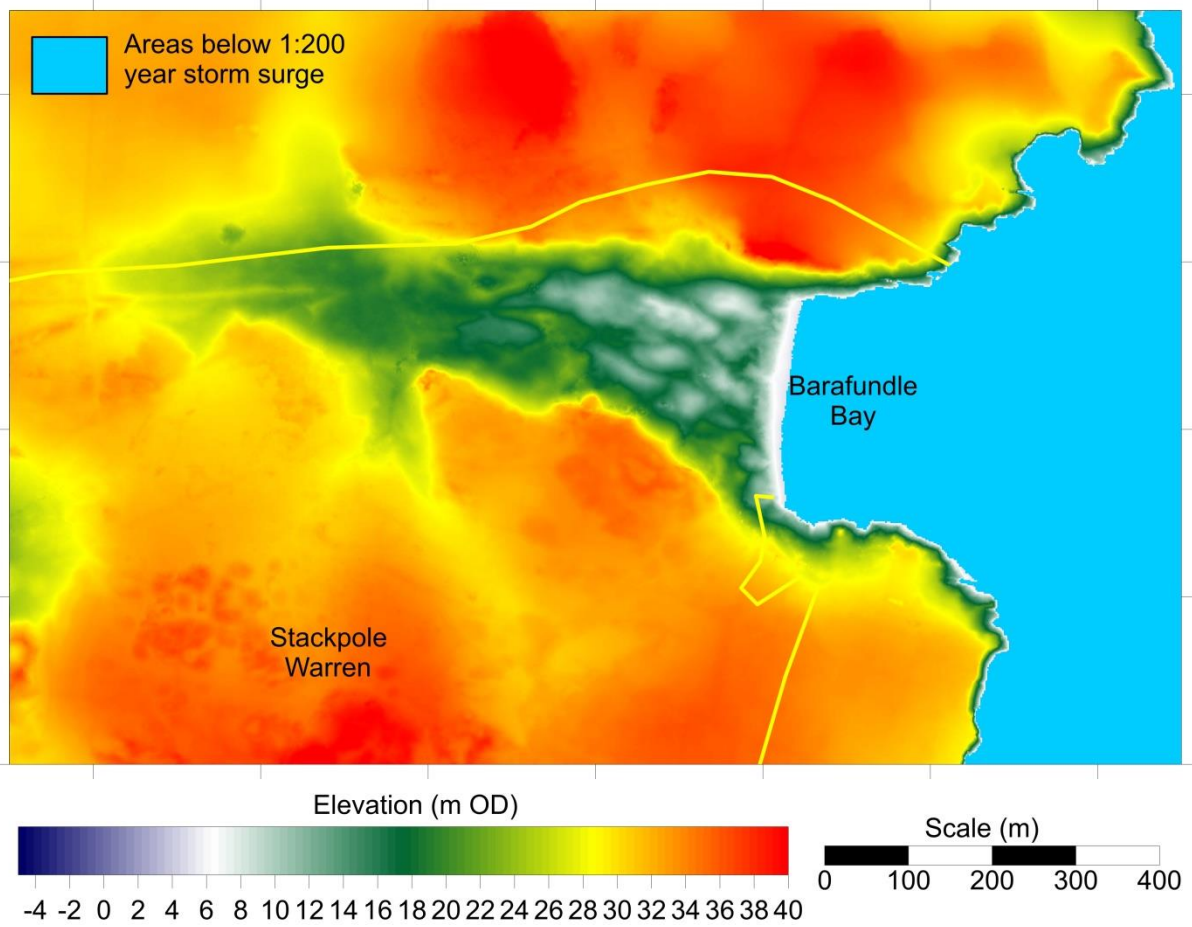


Scale (m)
0 100 200 300 400

2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 36: Stackpole Warren

Site description

Morphological setting	Open coast (north shore of Bristol Channel)
Morphological type	Cliff-top, minor climbing (now largely cut off from sand source)
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agriculture, natural moorland
Typical hinterland level	Rising ground and cliff-top
Conservation designations	Stackpole SSSI, SAC, SPA, NNR, National Park, Heritage Coast, National Trust
Notable features	numerous archaeological sites, some active blowouts due to grazing

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.60 m OD
1:200 year storm surge level	4.99 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	07/03/2004
Principal aspect of dune frontage	n/a

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	760 (199353E 193589N)
Distance offshore	1.0 km
Mean wind speed	14.10 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	1.13 m
Mean zero up-crossing period (Tz)	4.64 sec
Mean peak wave period (Tp)	8.04 sec
Mean wave direction	224.8 ° (SW)
Mean wave direction scaled for wave power	218.8 ° (SW)
Mean annual wave power	56.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 6; LD)	257-362 µm (average: 306 µm)
Calcium carbonate content (%) (N= 3)	14.65-17.97% (average: 16.33%)
Silica content (%) (N= 3)	78.2-79% (average: 78.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low /Medium
Historical / Archaeological	High
Overall significance score	12.5
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

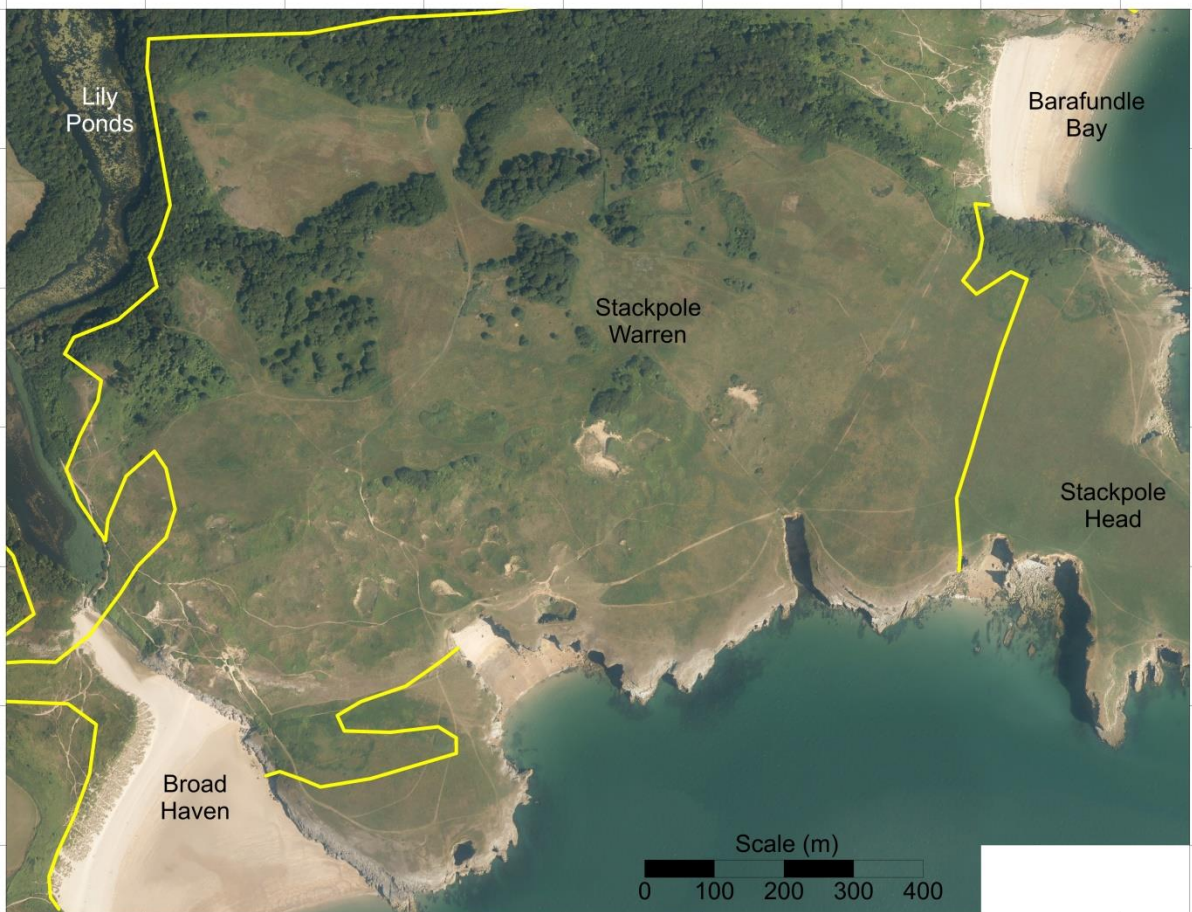
Present and past dune and beach management measures

Grazing

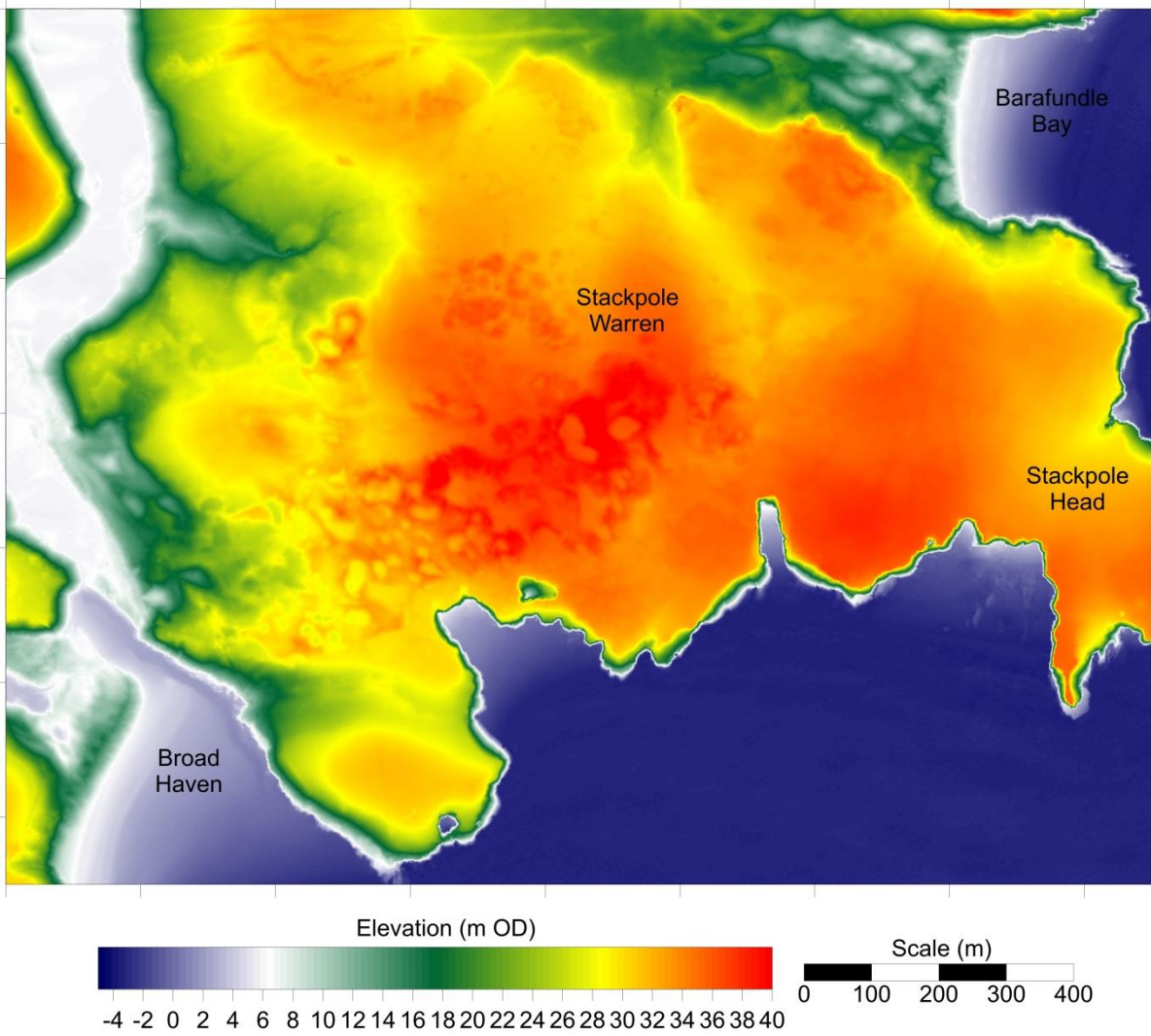
Significant

Further information

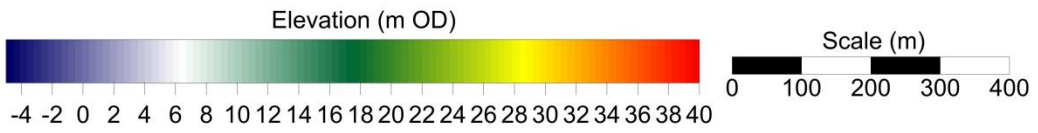
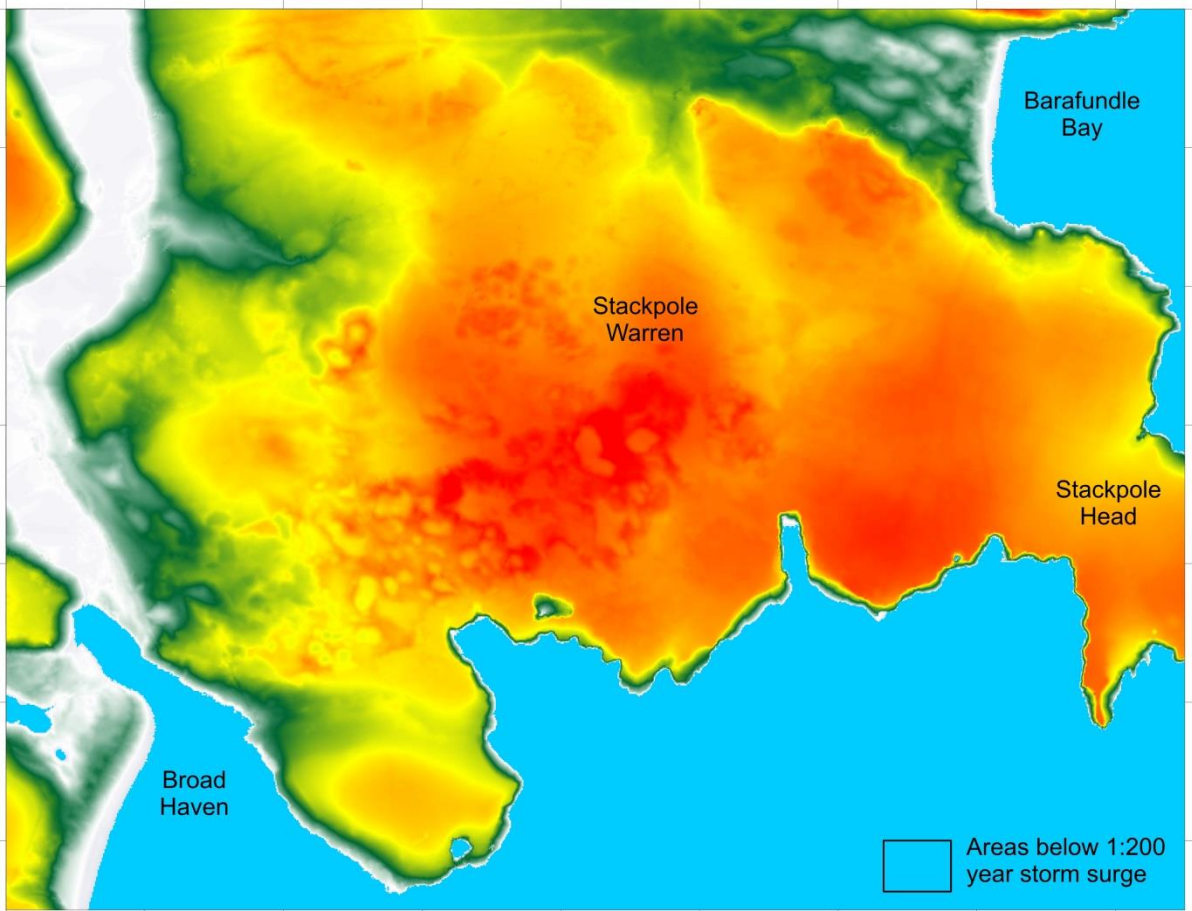
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps



Areas below the estimated 1 in 200 year storm surge level.

Site 37: Broad Haven

Site description

Morphological setting	Bay
Morphological type	Bay-head barrier and climbing
Erosion/progradation status	Slowly Prograding and vertically accreting
Defence structures	None
Hinterland type	Marsh, artificial lakes, high ground
Typical hinterland level	3.4 to 5.8 m OD on marsh and artificial lakes
Conservation designations	Stackpole SSSI, SAC, SPA, NNR, National Park
Notable features	Lily Ponds freshwater lakes behind dam

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.55 m OD
1:200 year storm surge level	4.96 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	07/03/2004
Principal aspect of dune frontage	southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	760 (199353E 193589N)
Distance offshore	1.0 km
Mean wind speed	14.10 knots
Mean wind direction	243.4 ° (WSW)
Mean significant wave height (Hs)	1.13 m
Mean zero up-crossing period (Tz)	4.64 sec
Mean peak wave period (Tp)	8.04 sec
Mean wave direction	224.8 ° (SW)
Mean wave direction scaled for wave power	218.8 ° (SW)
Mean annual wave power	56.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	333-380 µm (average: 352 µm)
Calcium carbonate content (%) (N= 3)	17.08-22.93% (average: 19.99%)
Silica content (%) (N= 3)	71.8-77.8% (average: 74.9%)

Dune site importance and SMP2 Policy

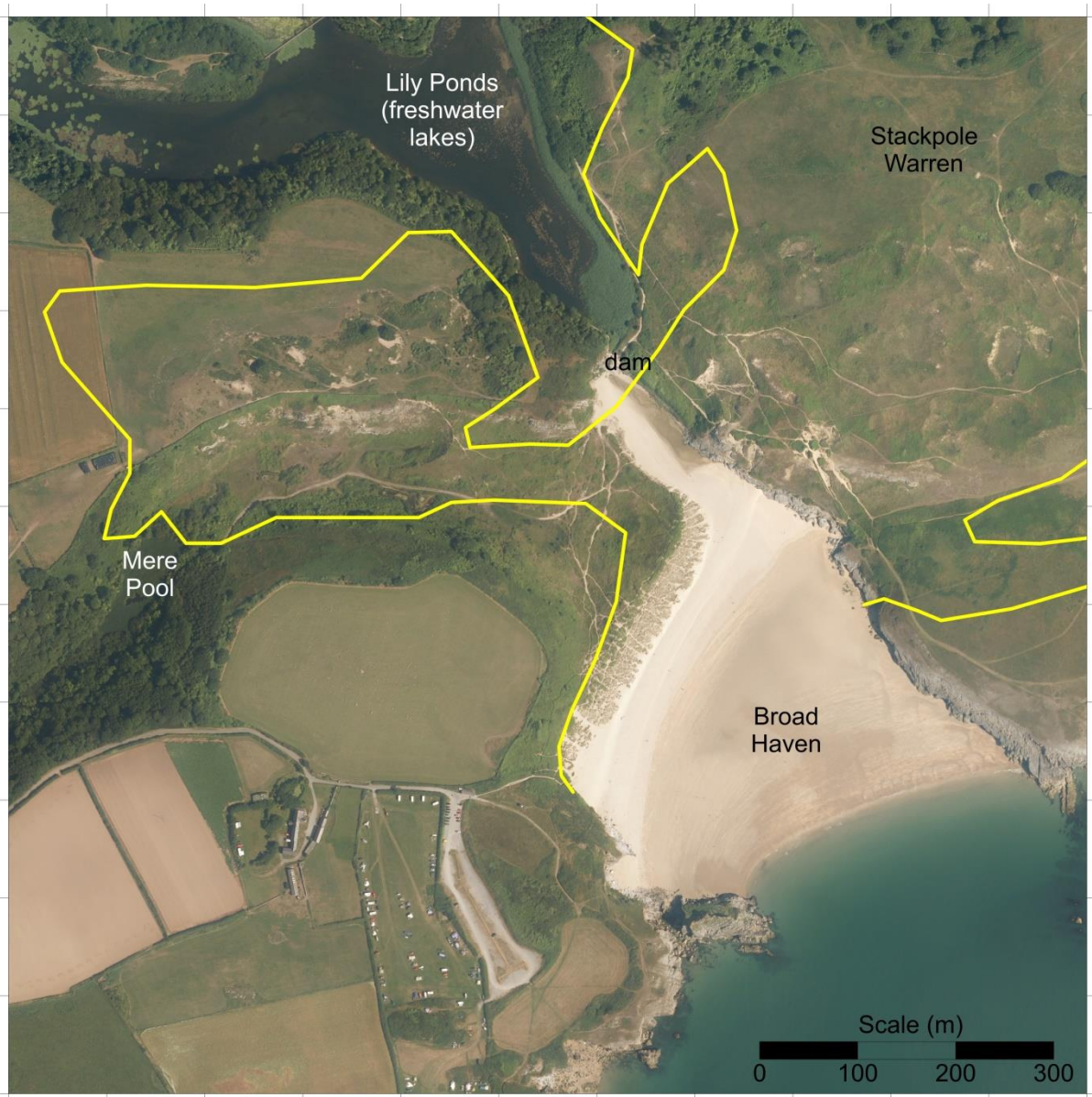
Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	11
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Present and past dune and beach management measures

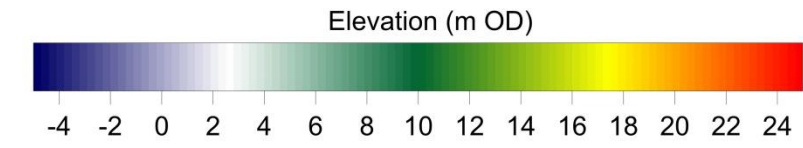
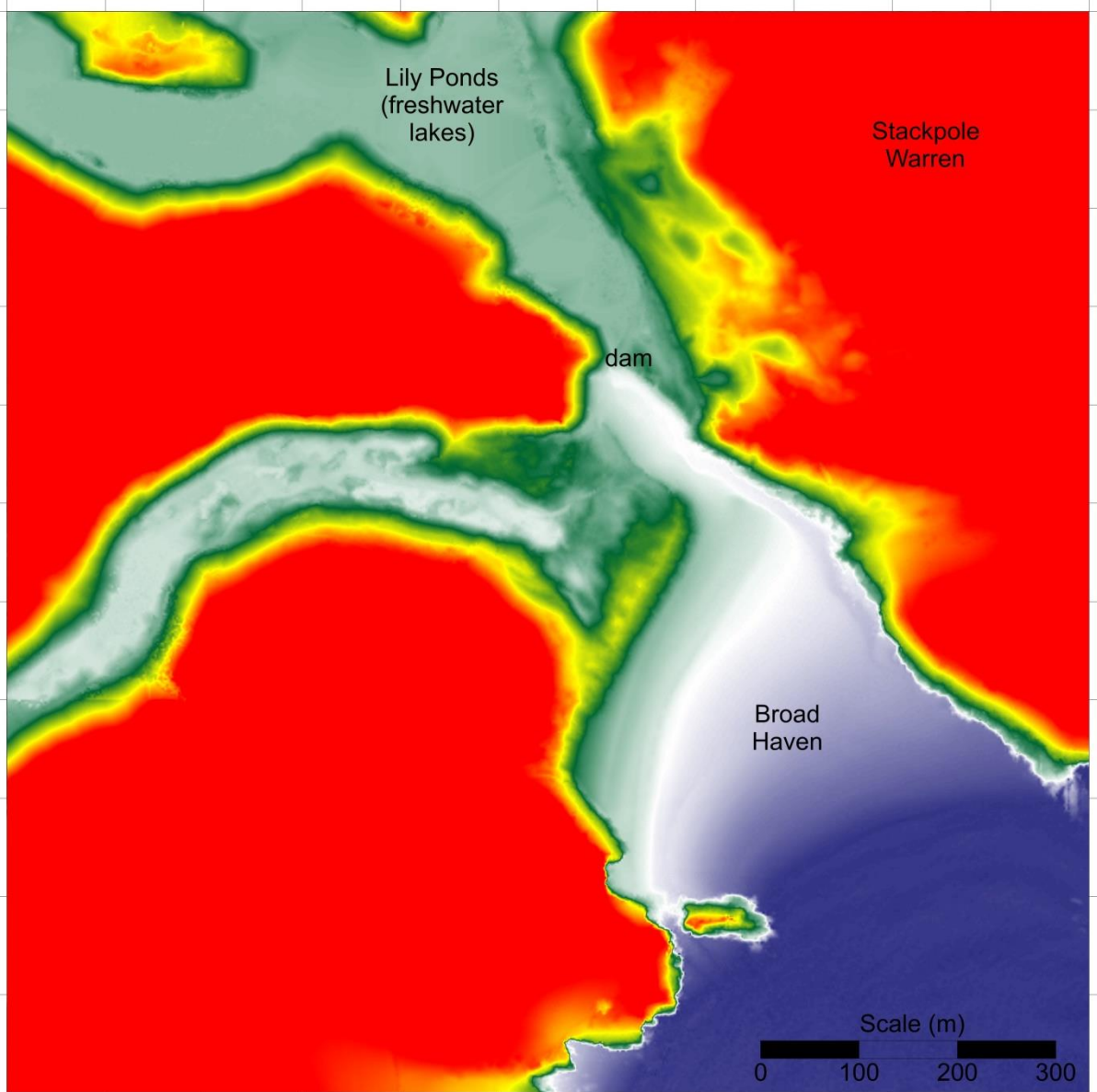
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Further information

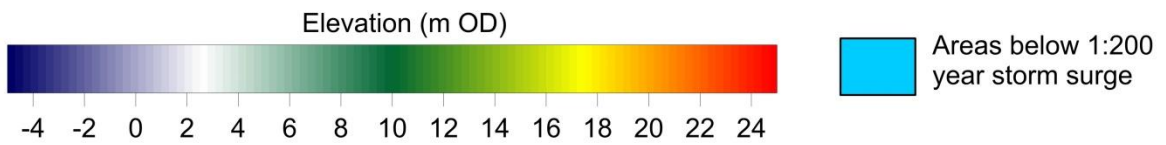
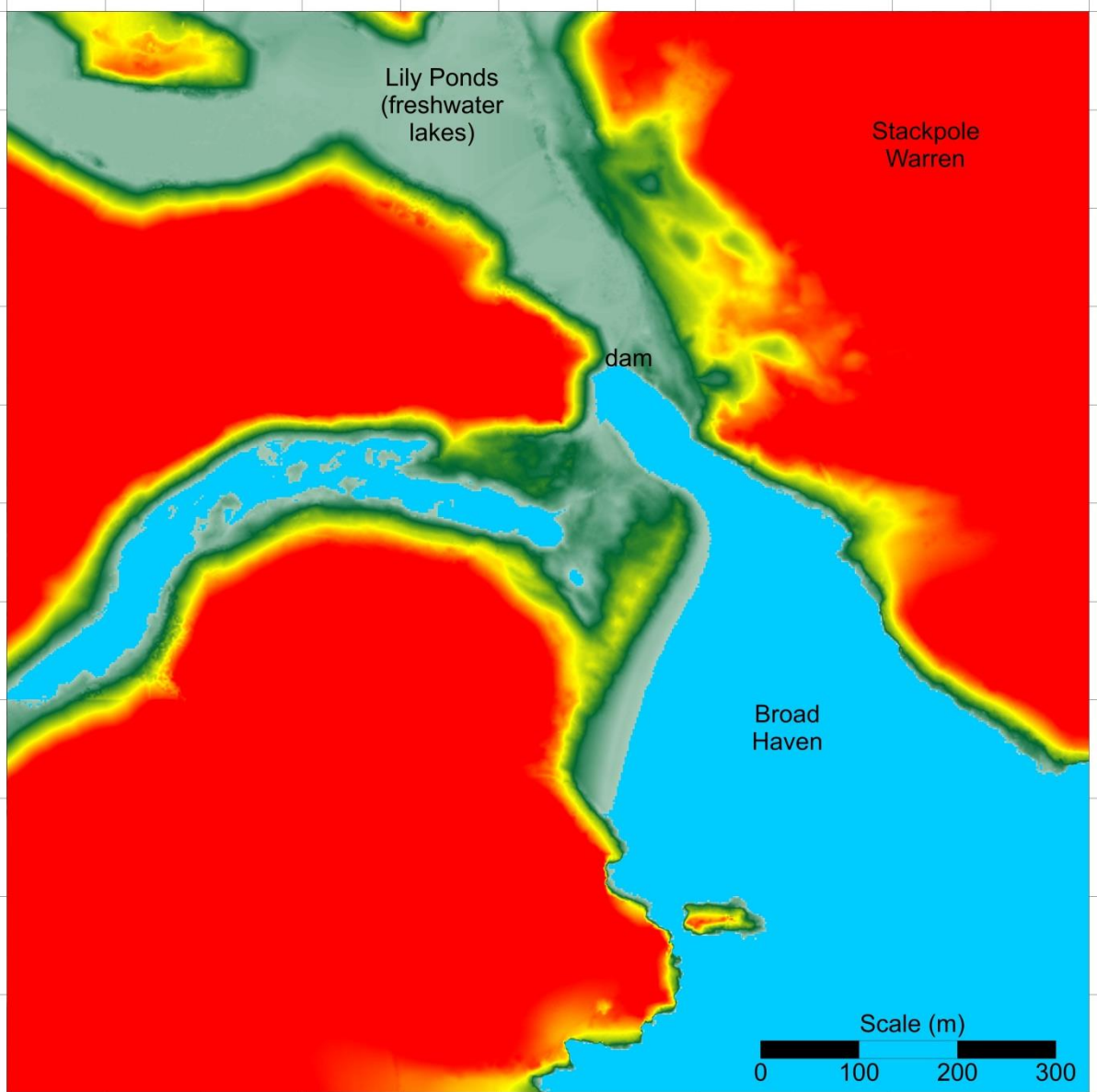
Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 38: Brownslade and Linney Burrows

Site description

Morphological setting	Bay (un-named, Atlantic-facing)
Morphological type	Transgressive climbing, cliff top, fringing, small section of shingle barrier with dune capping; cliff top and climbing dune snow largely cut off from sand source
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agriculture, military range
Typical hinterland level	7.9 to 9.0 m OD on Lady Castle Valley, 8.2 to 9.4 m OD on Frains Lake, rising ground elsewhere
Conservation designations	Castlemartin Range SSSI, SAC, SPA, National Park, Heritage Coast
Notable features	Castlemartin Artillery Range; extensive former sand quarries within Brownhill Burrows now important slack habitat; some small-scale dune rejuvenation trial works undertaken by NRW

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.35 m OD
1:200 year storm surge level	4.78 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	28/04/2006
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	751 (181534E 193704N)
Distance offshore	7.0 km
Mean wind speed	15.19 knots
Mean wind direction	245.8 ° (WSW)
Mean significant wave height (Hs)	1.59 m
Mean zero up-crossing period (Tz)	5.04 sec
Mean peak wave period (Tp)	8.38 sec
Mean wave direction	242.7 ° (WSW)
Mean wave direction scaled for wave power	238.5 ° (WSW)
Mean annual wave power	119.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 21; LD)	278-531 µm (average: 408 µm)
Calcium carbonate content (%) (N= 7)	11.6-21.79% (average: 16.9%)
Silica content (%) (N= 7)	70.2-82.7% (average: 76.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	High
Recreation	Low
Economic / Military	High
Historical / Archaeological	Low
Overall significance score	13
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

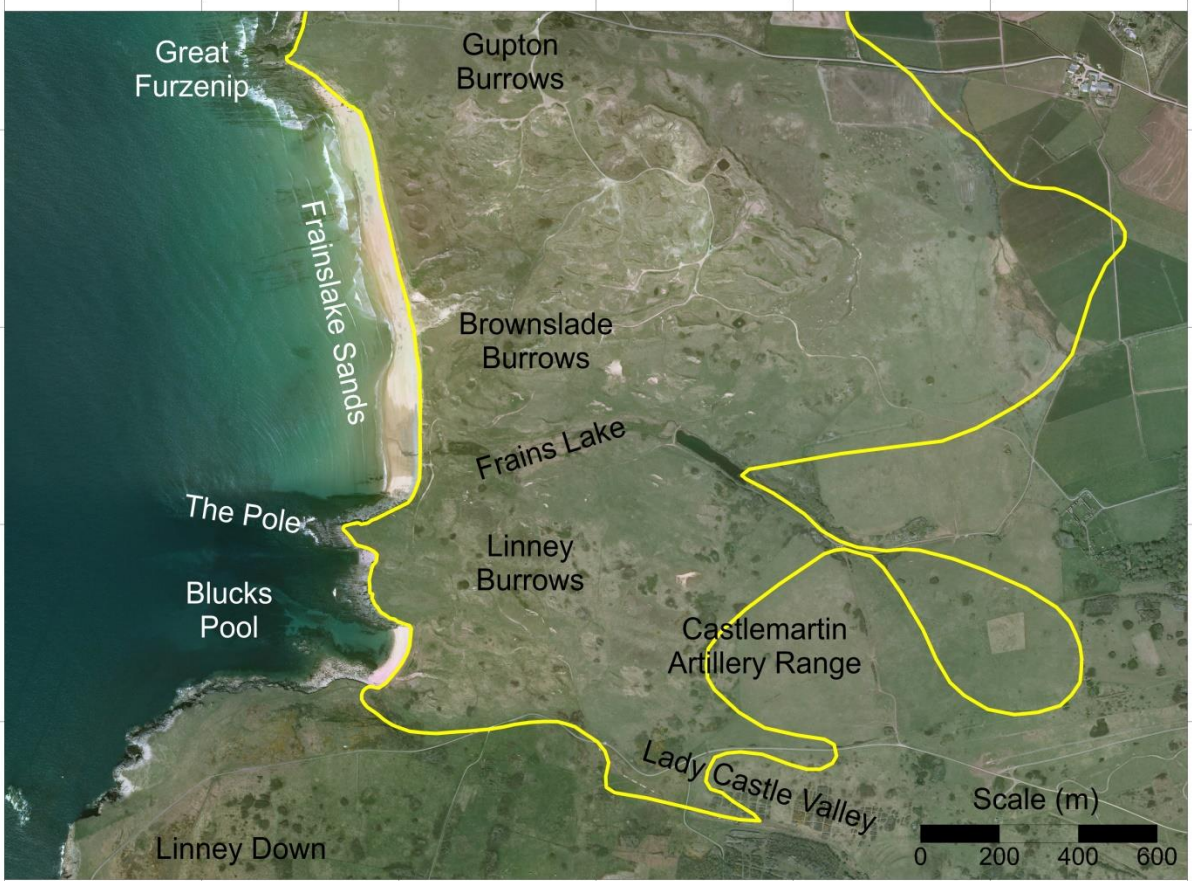
Present and past dune and beach management measures

Grazing	Significant
Scrub clearance	Significant
Turf stripping to remobilise sand surface	Significant

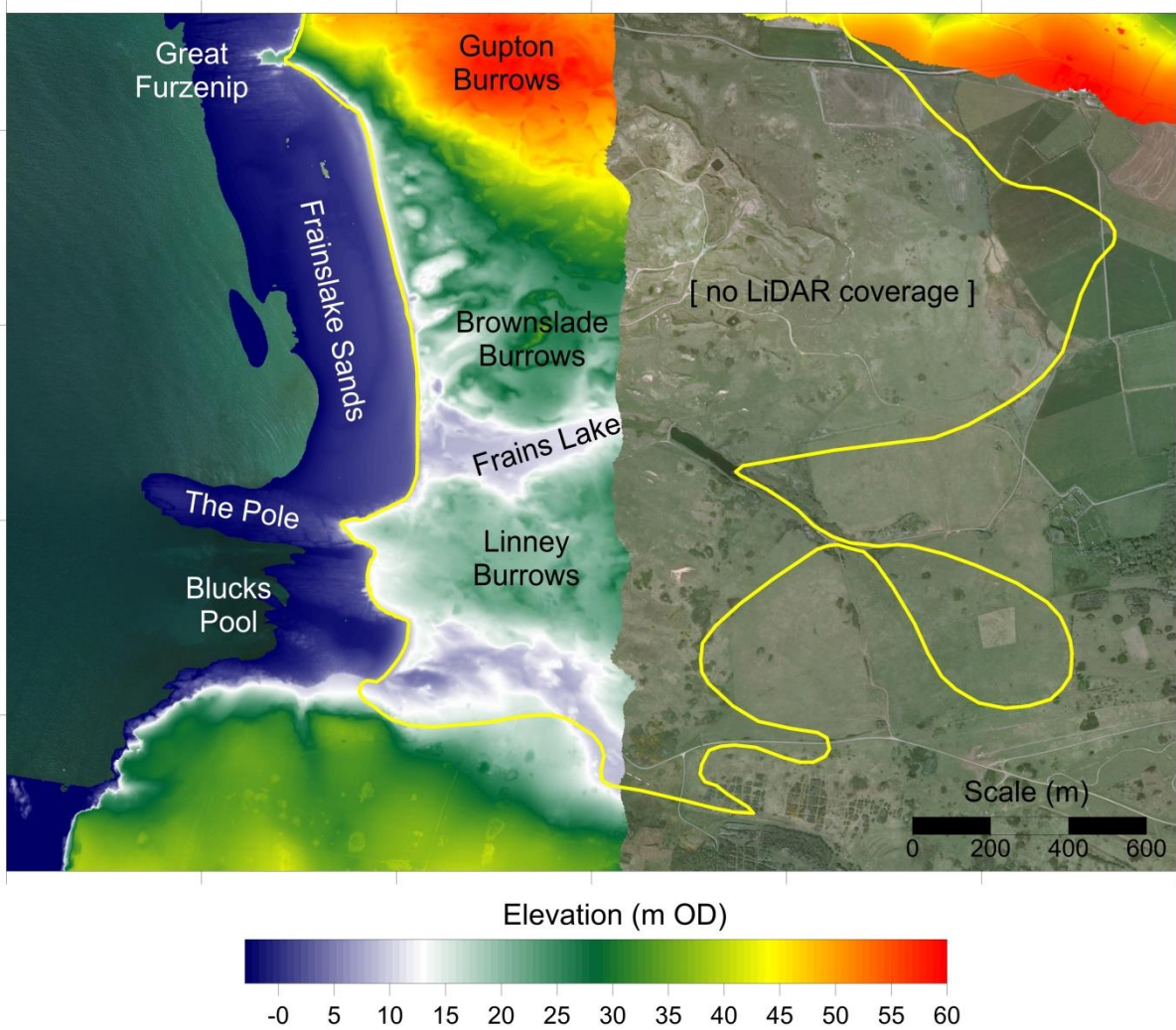
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

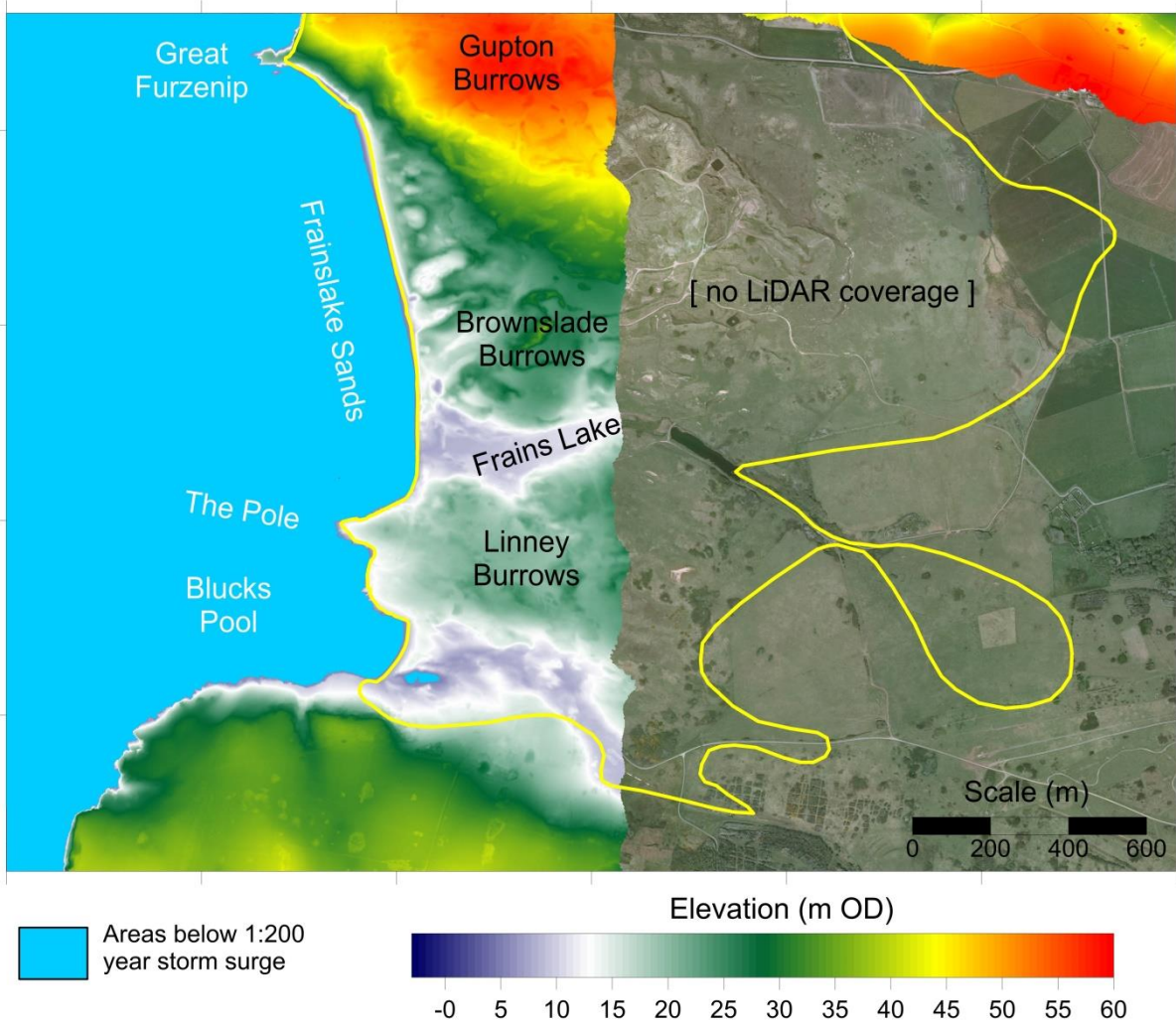
Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 7. Bownslade and Linney Burrows*. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below estimated 1 in 200 year storm surge level.

Site 39: Gupton Burrows

Site description

Morphological setting	Bay – un-named, Atlantic facing
Morphological type	Climbing, cliff top sand sheets and low hummocky dunes
Erosion/progradation status	Stable, now cut off from active sand source
Defence structures	None
Hinterland type	Grazing, arable fields
Typical hinterland level	Rising ground
Conservation designations	Castlemartin Range SSSI, SAC, SPA, National Park, Heritage Coast (covering parts of the site)
Notable features	

Key water level and dun crest level parameters

Highest astronomical tide (HAT) level	4.35 m OD
1:200 year storm surge level	4.78 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	28/04/2006
Principal aspect of dune frontage	n/a

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	751 (181534E 193704N)
Distance offshore	7.0 km
Mean wind speed	15.19 knots
Mean wind direction	245.8 ° (WSW)
Mean significant wave height (Hs)	1.59 m
Mean zero up-crossing period (Tz)	5.04 sec
Mean peak wave period (Tp)	8.38 sec
Mean wave direction	242.7 ° (WSW)
Mean wave direction scaled for wave power	238.5 ° (WSW)
Mean annual wave power	119.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; LD)	382 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Medium
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	8
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

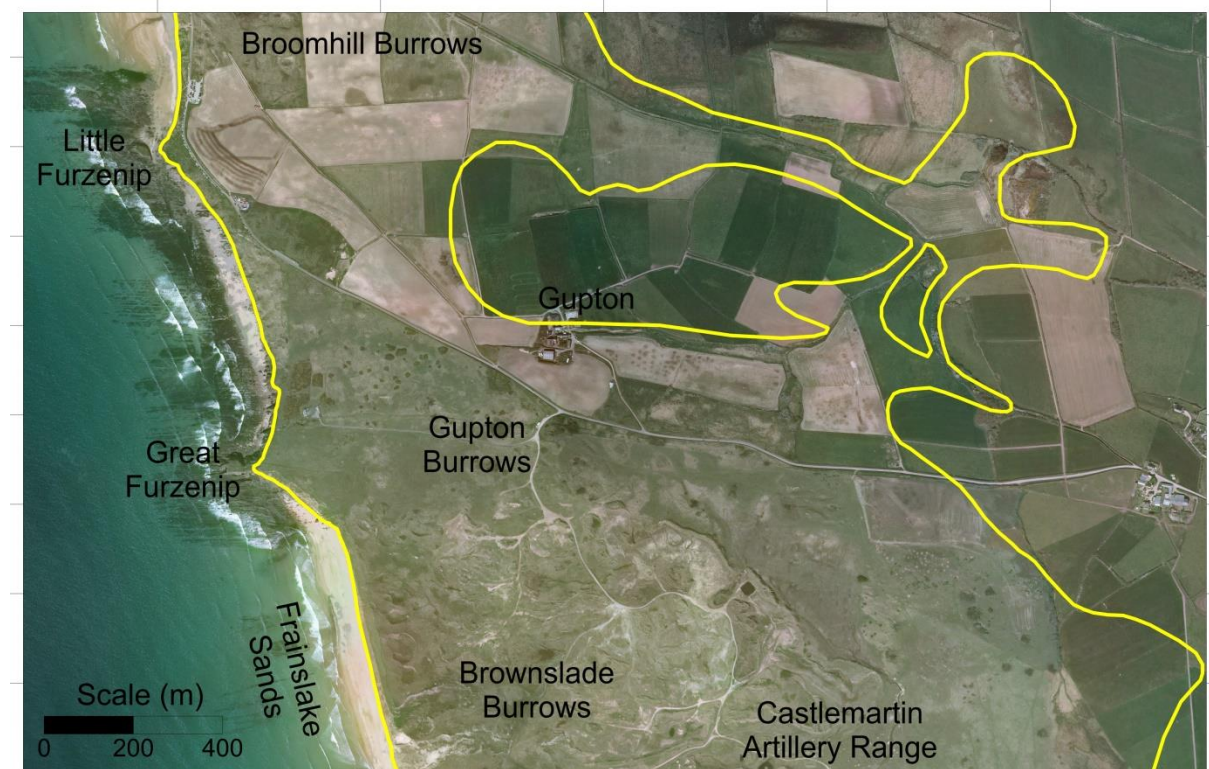
Current and past dune and beach management measures

Grazing	Significant
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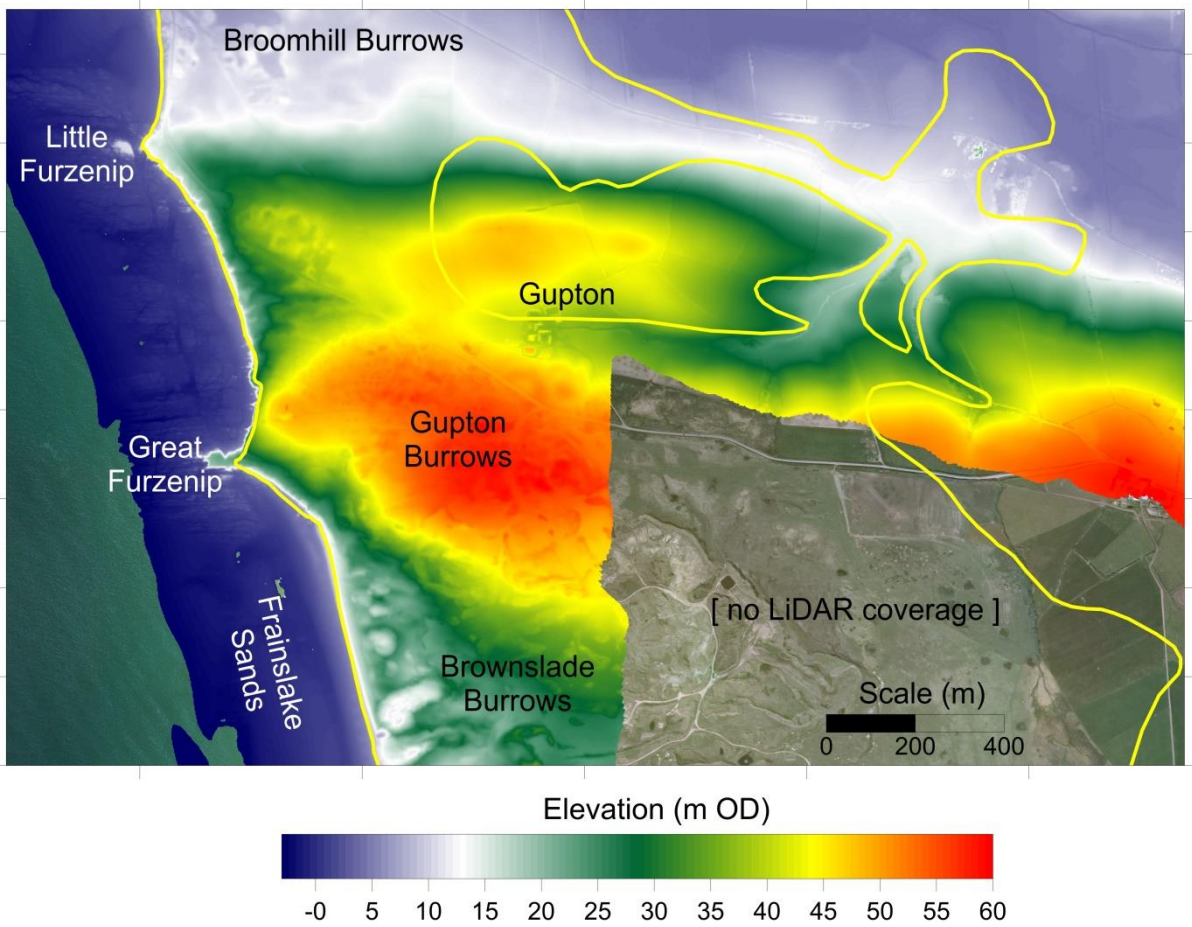
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

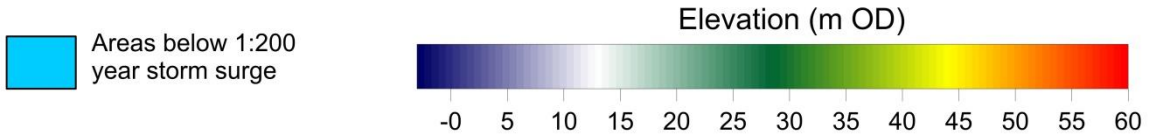
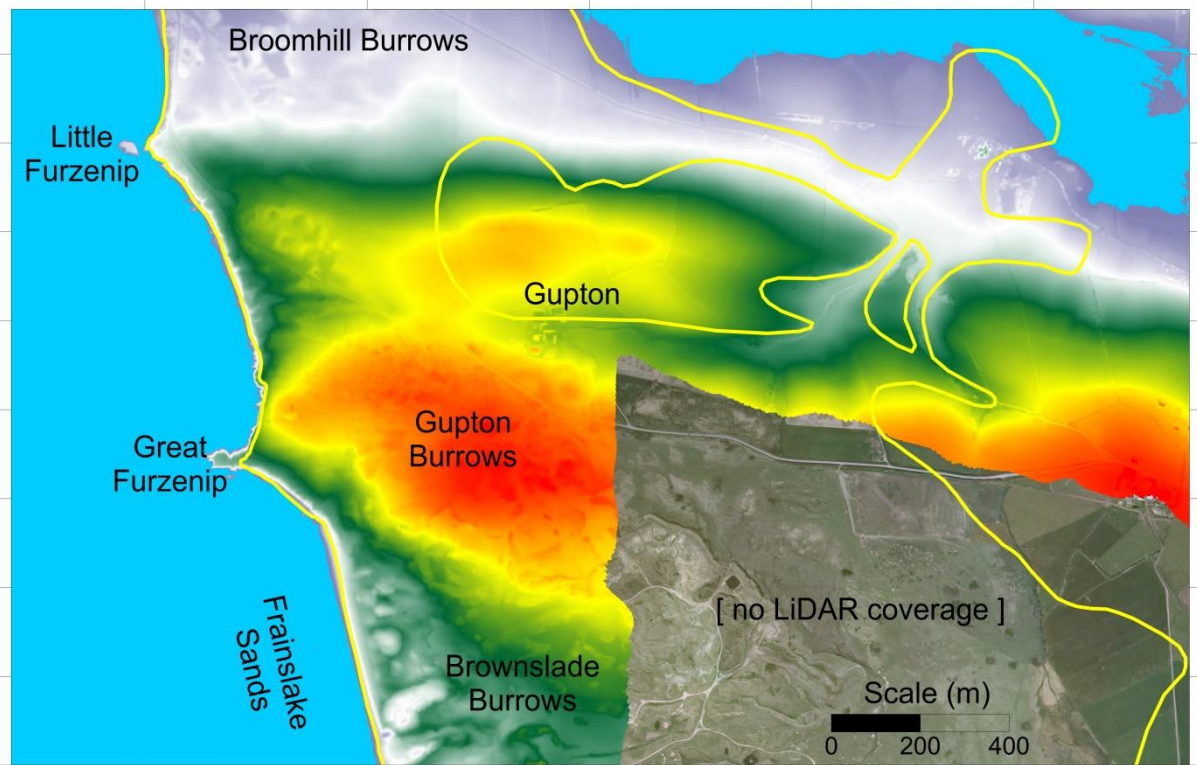
Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 7. Bownslade and Linney Burrows.* CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1:50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 40: Broomhill, Kilpaison and Newton Burrows

Site description

Morphological setting	Bay (un-named, Atlantic facing)
Morphological type	Barrier tombolo, transgressive valley-filling (Broomhill Burrows), climbing (Kilpaison and Newton Burrows)
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Wetland, grazing land,
Typical hinterland level	3.8 to 4.5 m OD on marsh (Castlemartin Corse)
Conservation designations	Broomhill Burrows SSSI, SAC, SPA, National Park, Heritage Coast
Notable features	Several active blowouts due to heavy visitor pressure, B-road behind dune subject to periodic blown sand incursion, extensive former sand and gravel workings in hind dune area at Broomhill Burrows now important slack habitat

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.35 m OD
1:200 year storm surge level	4.78 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	28/04/2006
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	751 (181534E 193704N)
Distance offshore	7.0 km
Mean wind speed	15.19 knots
Mean wind direction	245.8 ° (WSW)
Mean significant wave height (Hs)	1.59 m
Mean zero up-crossing period (Tz)	5.04 sec
Mean peak wave period (Tp)	8.38 sec
Mean wave direction	242.7 ° (WSW)
Mean wave direction scaled for wave power	238.5 ° (WSW)
Mean annual wave power	119.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	252-298 µm (average: 282 µm)
Calcium carbonate content (%) (N= 3)	18.9-20.61% (average: 19.99%)
Silica content (%) (N= 3)	74-75.7% (average: 74.8%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	High
Recreation	High
Economic / Military	Low / Medium
Historical / Archaeological	High
Overall significance score	15.5
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

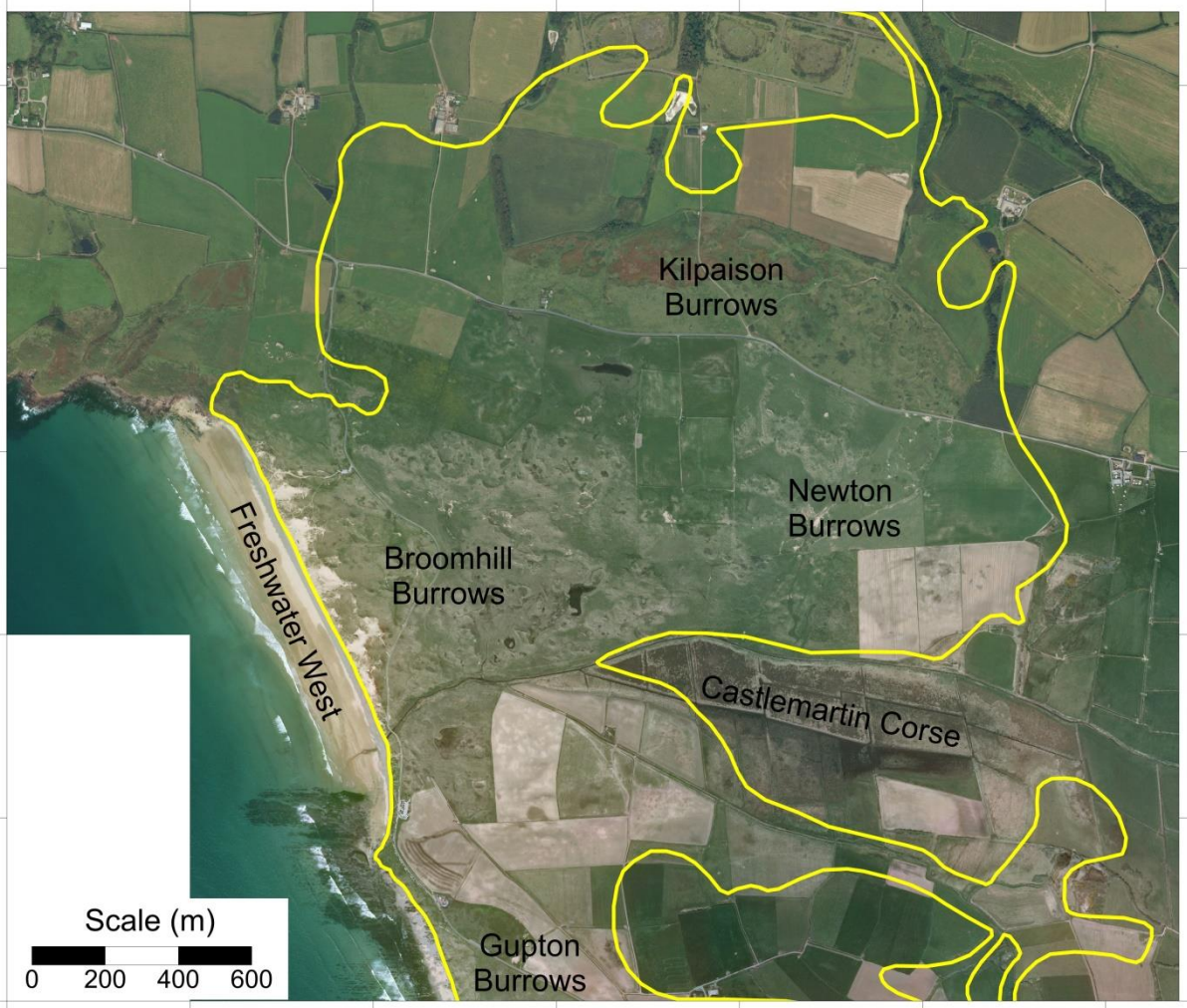
Current and past dune and beach management measures

Fencing	Significant
Marram planting	Significant
Scrub clearance	Significant
Grazing	Significant

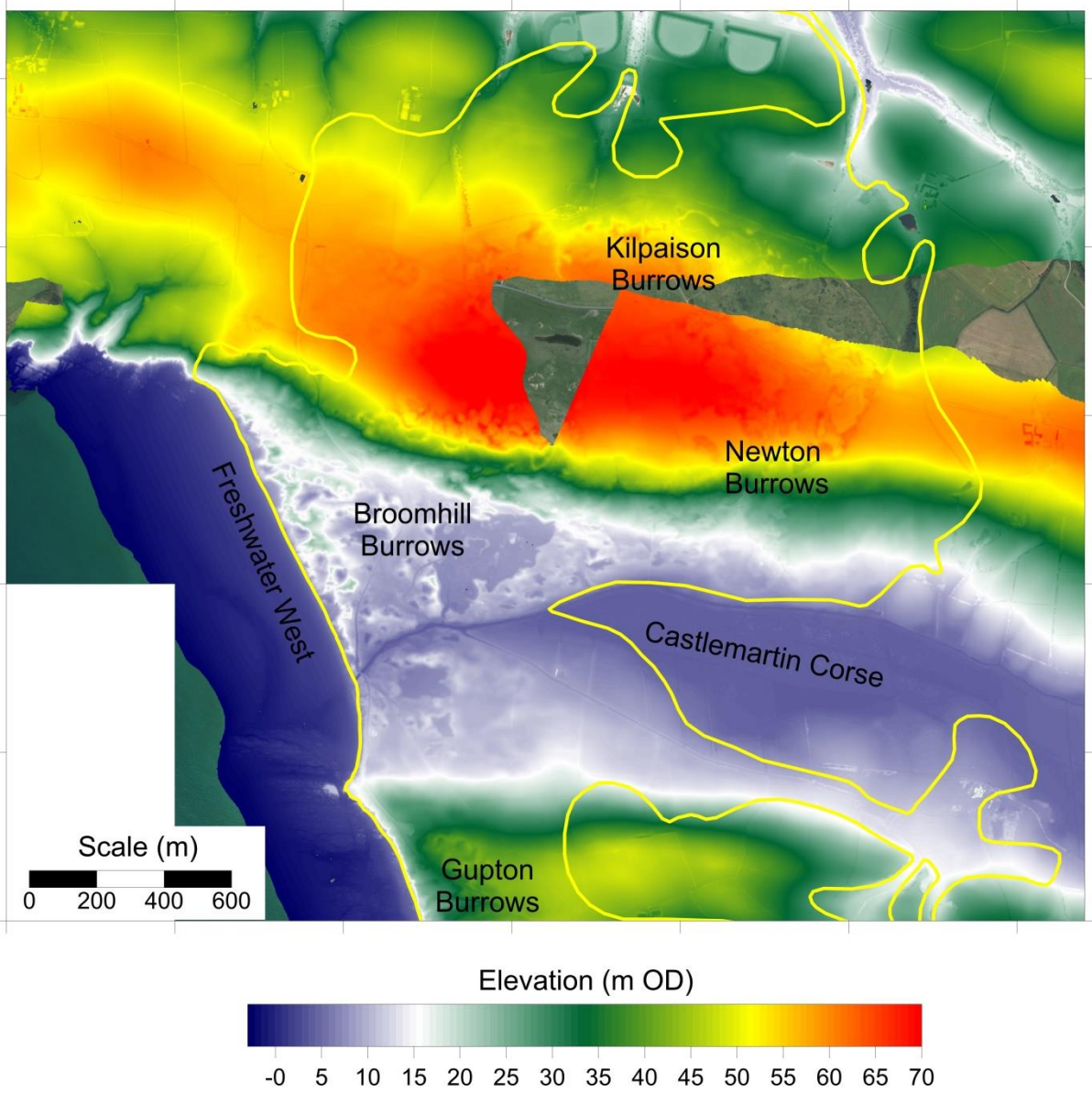
Further information

Halcrow (2012) Lavernock Point to St. Ann's Head Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

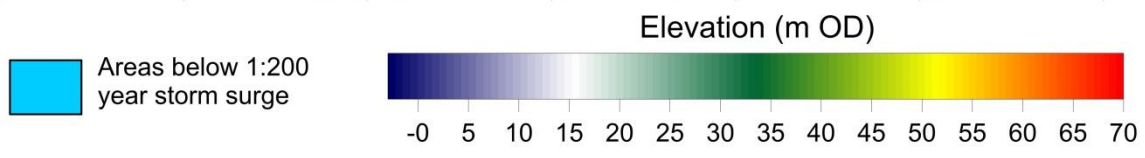
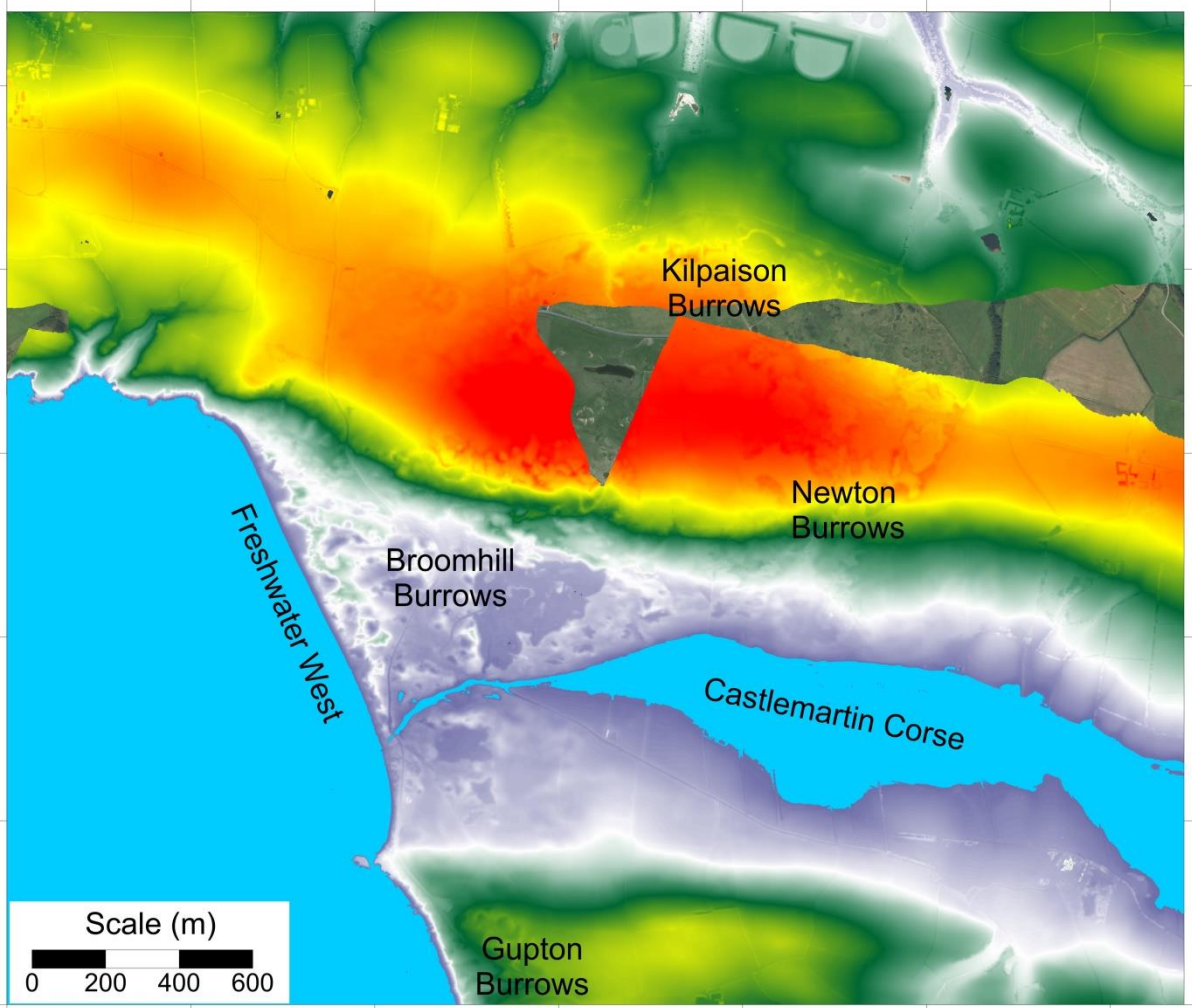
Pye K, Blott SJ. 2012. *A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 6. Broomhill & Kilpaison Burrows*. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 41: Nolton Haven

Site description

Morphological setting	Bay (St Bride's Bay, Atlantic-facing)
Morphological type	Fringing
Erosion/progradation status	Stable, but with blown sand a problem locally blowing onto the road behind
Defence structures	None
Hinterland type	Houses, park, natural heathland, agriculture
Typical hinterland level	Rising ground
Conservation designations	Arfordir Niwgwyl - Aber Bach / Newgale to Little Haven Coast SSSI, SAC, National Park, Heritage Coast
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.30 m OD
1:200 year storm surge level	4.08 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	May 2006
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	842 (181655E 220410N)
Distance offshore	3.5 km
Mean wind speed	14.45 knots
Mean wind direction	242.8 ° (WSW)
Mean significant wave height (Hs)	1.11 m
Mean zero up-crossing period (Tz)	5.06 sec
Mean peak wave period (Tp)	8.35 sec
Mean wave direction	252.6 ° (WSW)
Mean wave direction scaled for wave power	250.9 ° (WSW)
Mean annual wave power	62.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Very high
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

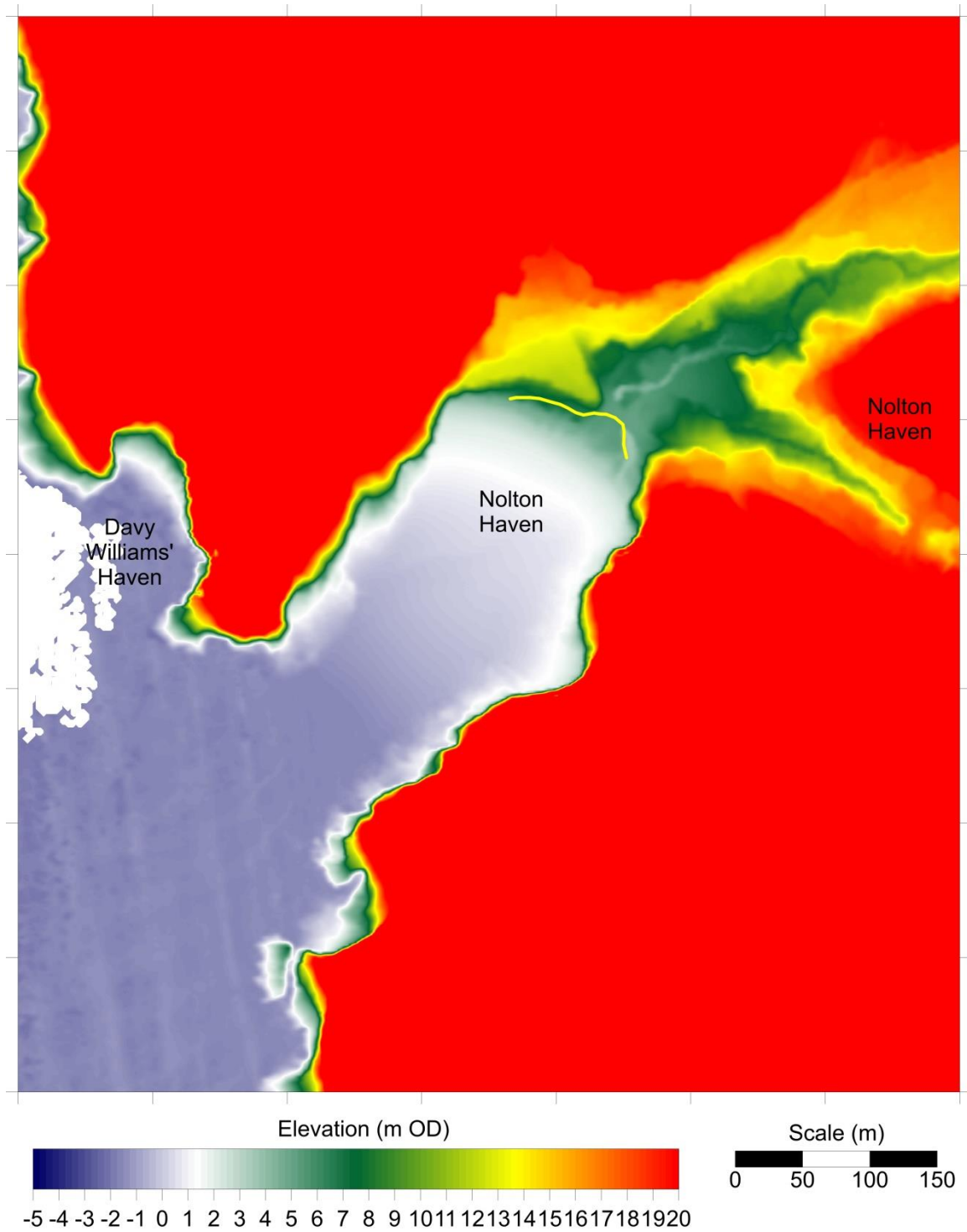
Fencing	Minor
Marram planting	Minor

Further information

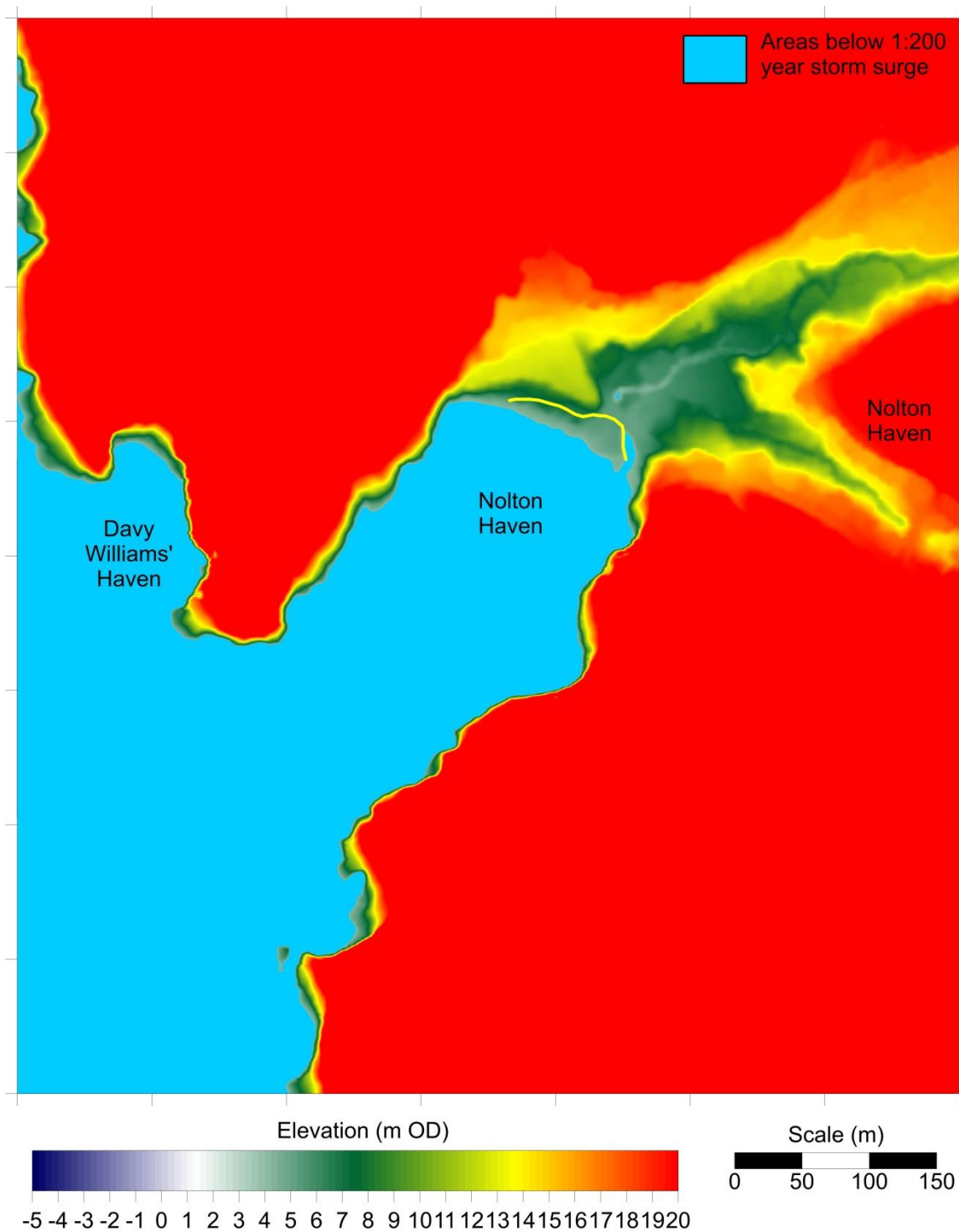
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 42: The Burrows, Whitesands Bay

Site description

Morphological setting	Bay (Whitesands Bay, Atlantic-facing)
Morphological type	Climbing, cliff top
Erosion/progradation status	Stable; no dunes now present at high water level due to erosion; till cliff exposed and dunes largely cut off from active sand source
Defence structures	Rock armour and sea wall protecting the car park / beach access
Hinterland type	Grazing land, golf course
Typical hinterland level	Rising ground
Conservation designations	St. David's Peninsula Coast SSSI, SAC, SPA, SSSI, National Park, Heritage Coast, Environmentally Sensitive Area
Notable features	St. Patrick's Chapel scheduled monument, St David's Golf Club

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.80 m OD
1:200 year storm surge level	3.68 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
Principal Aspect of dune frontage	west

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	869 (163860E 229428N)
Distance offshore	8.5 km
Mean wind speed	15.46 knots
Mean wind direction	242.6 ° (WSW)
Mean significant wave height (Hs)	1.59 m
Mean zero up-crossing period (Tz)	4.78 sec
Mean peak wave period (Tp)	7.68 sec
Mean wave direction	252.7 ° (WSW)
Mean wave direction scaled for wave power	245.5 ° (WSW)
Mean annual wave power	108.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	224-295 µm (average: 254 µm)
Calcium carbonate content (%) (N= 3)	6.26-8.21% (average: 7.48%)
Silica content (%) (N= 3)	81.2-81.7% (average: 81.5%)

Dune site importance and SMP2 Policy

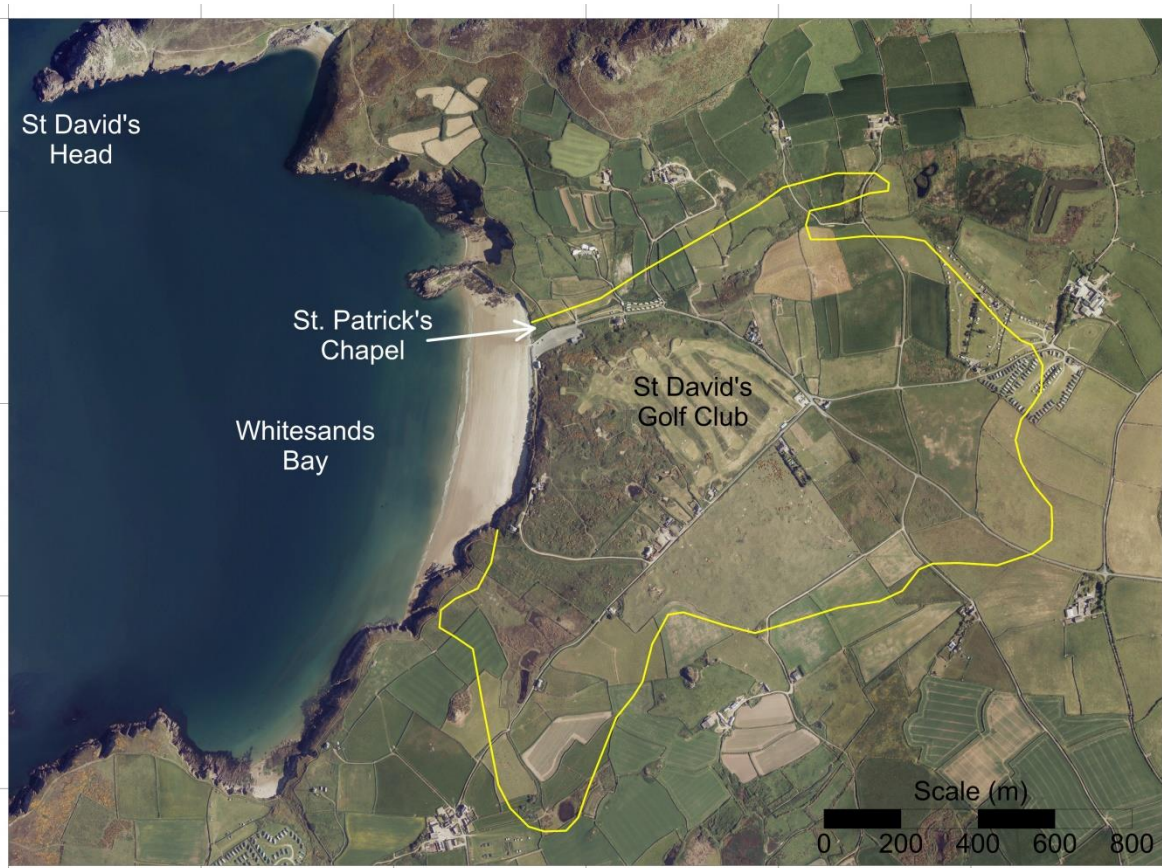
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Medium
Recreation	Low
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

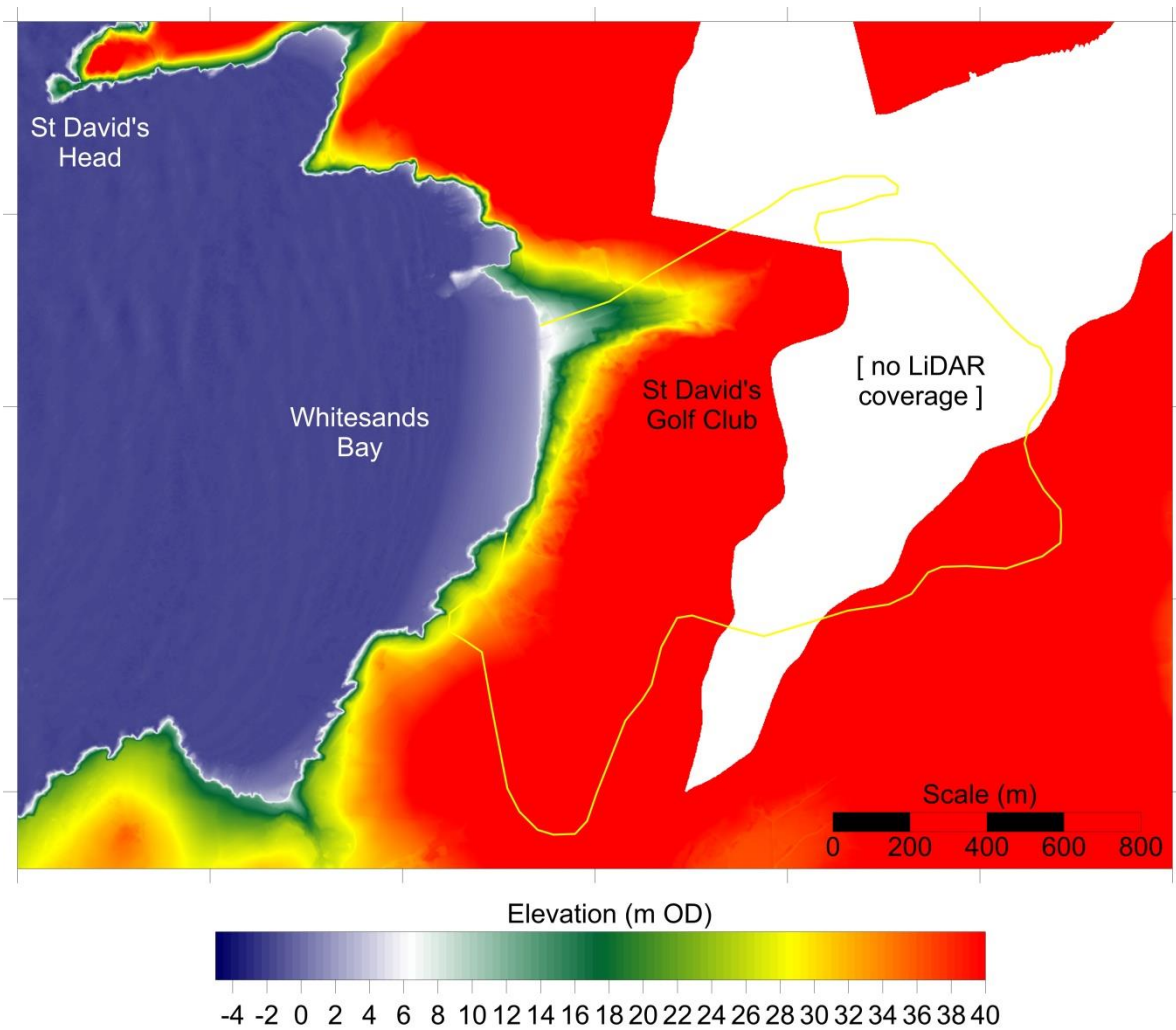
Fencing	Significant
Marram planting	Minor

Further information

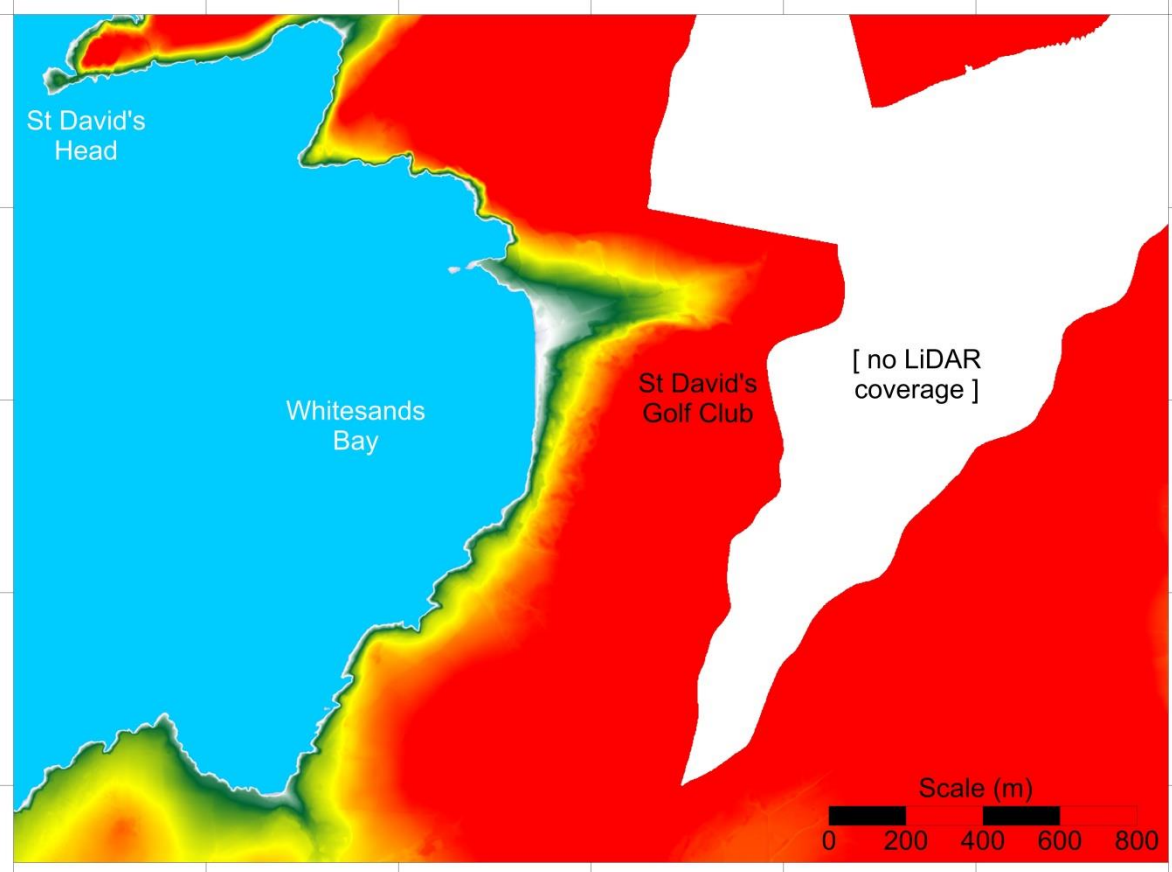
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 43: The Parrog, Fishguard

Site description

Morphological setting	Bay (Fishguard Harbour)
Morphological type	Fringing
Erosion/progradation status	Stable
Defence structures	Rock armour, sea wall and groynes protecting the road and low lying ground behind (Goodwick Moor)
Hinterland type	Marsh, recreation, houses
Typical hinterland level	2.2 to 2.7 m OD on Goodwick Moor 2.4 to 3.5 m OD on recreation areas
Conservation designations	None
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.06 m OD
1:200 year storm surge level	3.58 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	02/04/2013
Principal aspect of dune frontage	northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	935 (190778E 247053N)
Distance offshore	6.1 km
Mean wind speed	14.38 knots
Mean wind direction	240.4 ° (WSW)
Mean significant wave height (Hs)	1.13 m
Mean zero up-crossing period (Tz)	4.34 sec
Mean peak wave period (Tp)	7.17 sec
Mean wave direction	271.4 ° (W)
Mean wave direction scaled for wave power	269.7 ° (W)
Mean annual wave power	49.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

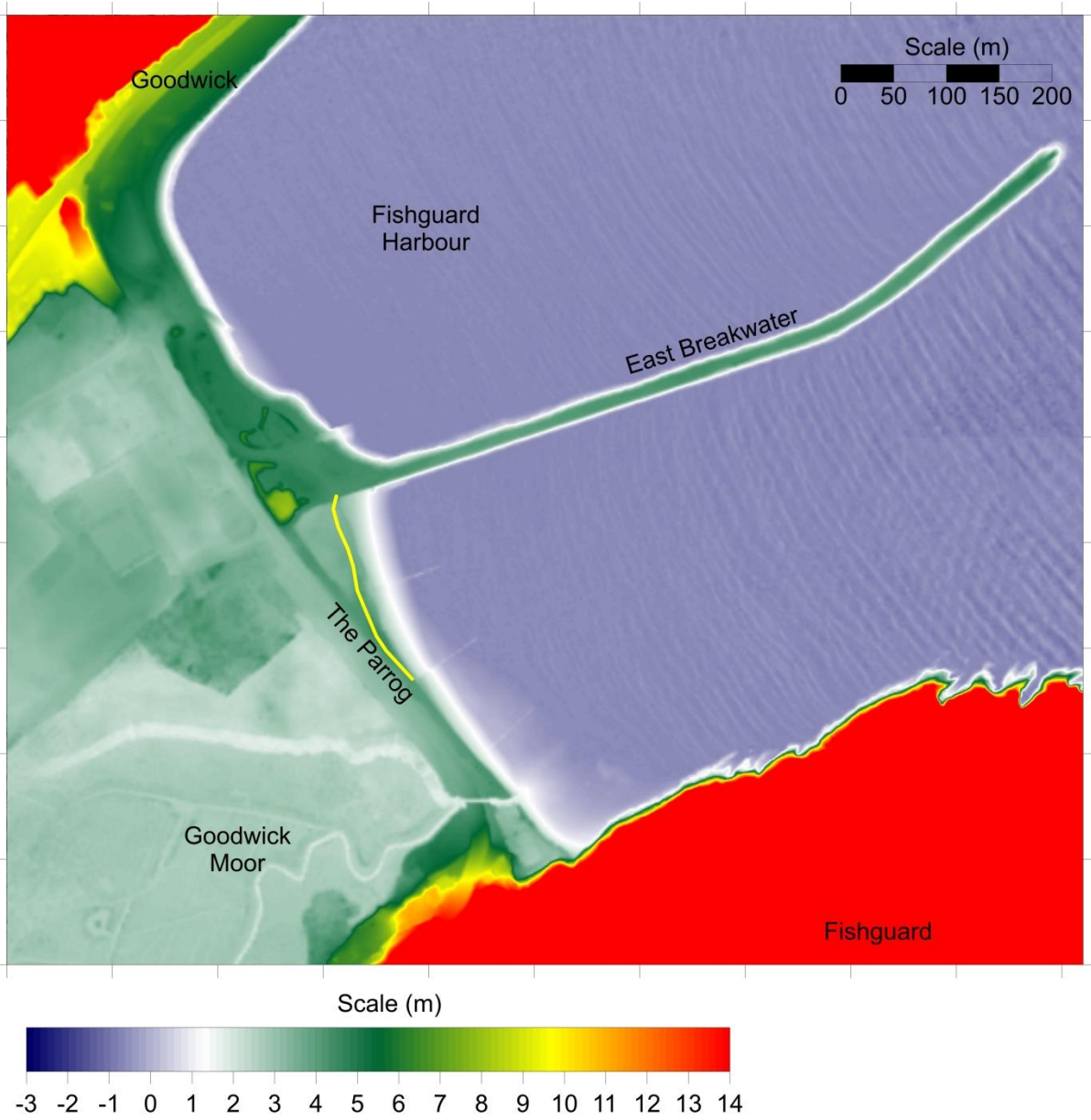
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Further information

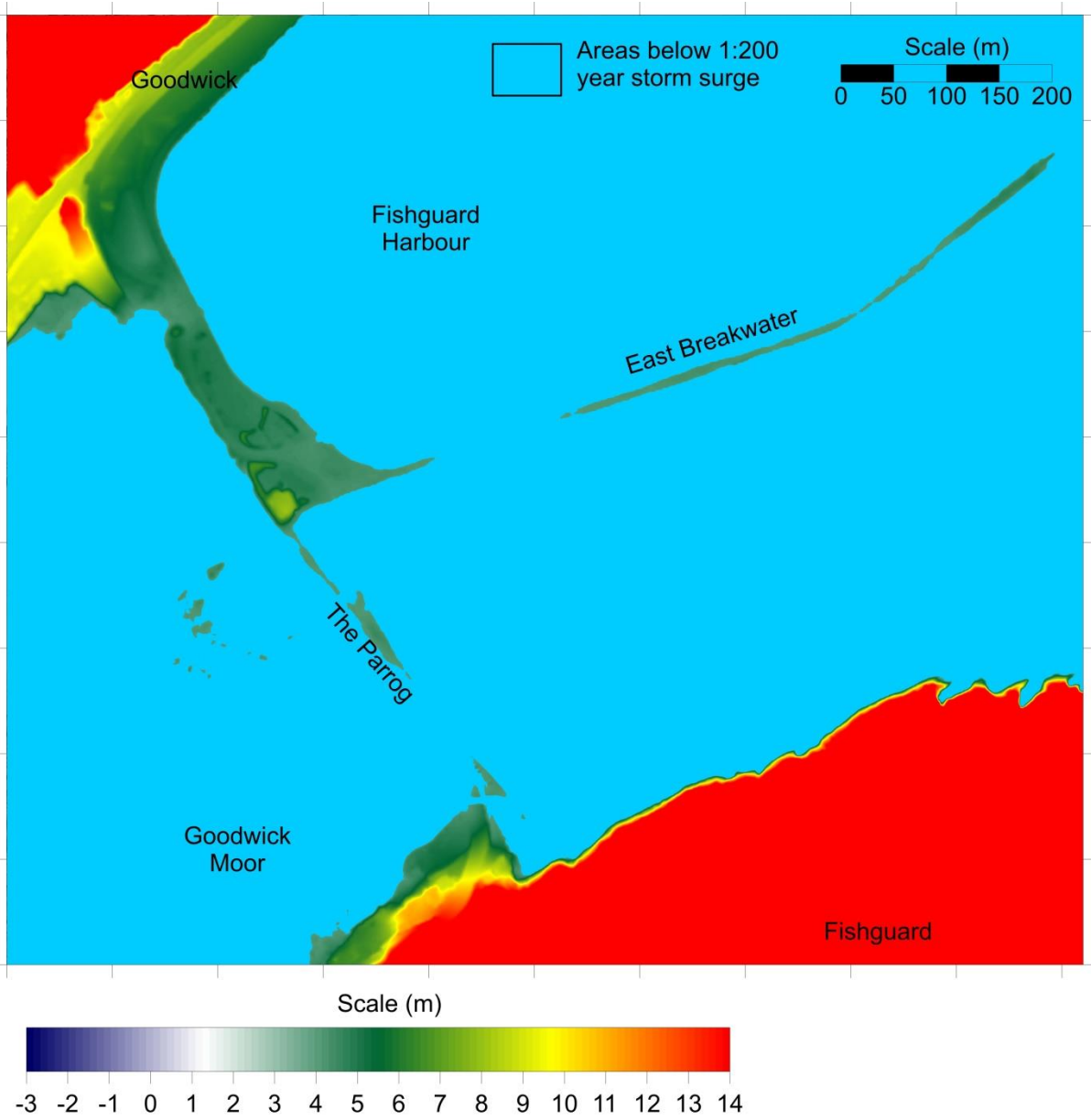
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



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LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 44: Aber Fforest

Site description

Morphological setting	Bay (Aber Fforest)
Morphological type	Fringing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Houses, agriculture, wooded valley
Typical hinterland level	Rising ground
Conservation designations	National Park, Heritage Coast
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.00 m OD
1:200 year storm surge level	3.59 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	02/04/2013
Principal aspect of dune frontage	north-northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	934 (199696E 246997N)
Distance offshore	5.9 km
Mean wind speed	13.71 knots
Mean wind direction	241.3 ° (WSW)
Mean significant wave height (Hs)	1.00 m
Mean zero up-crossing period (Tz)	4.20 sec
Mean peak wave period (Tp)	7.10 sec
Mean wave direction	279.2 ° (W)
Mean wave direction scaled for wave power	279.7 ° (W)
Mean annual wave power	38.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

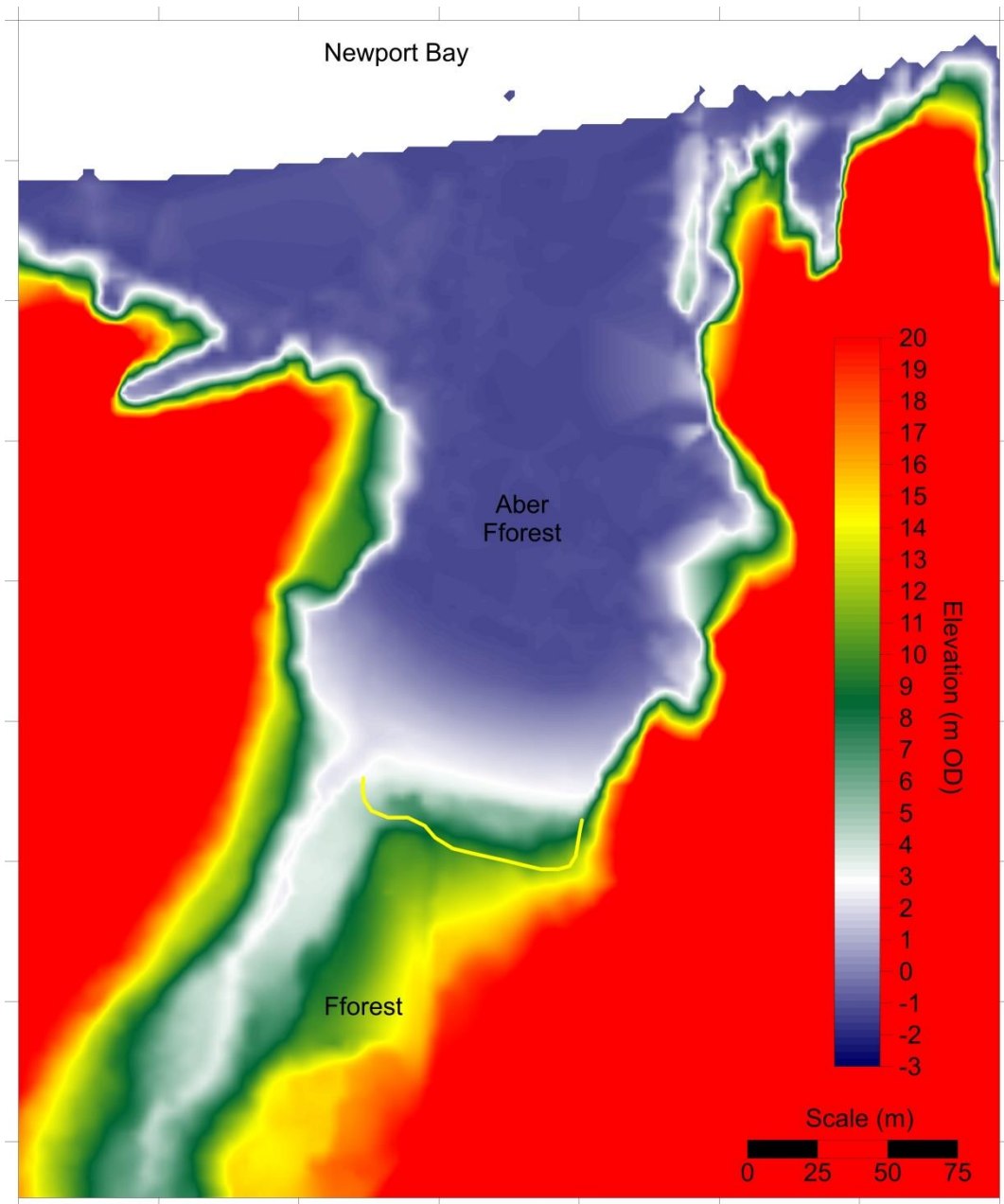
None identified	
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Further information

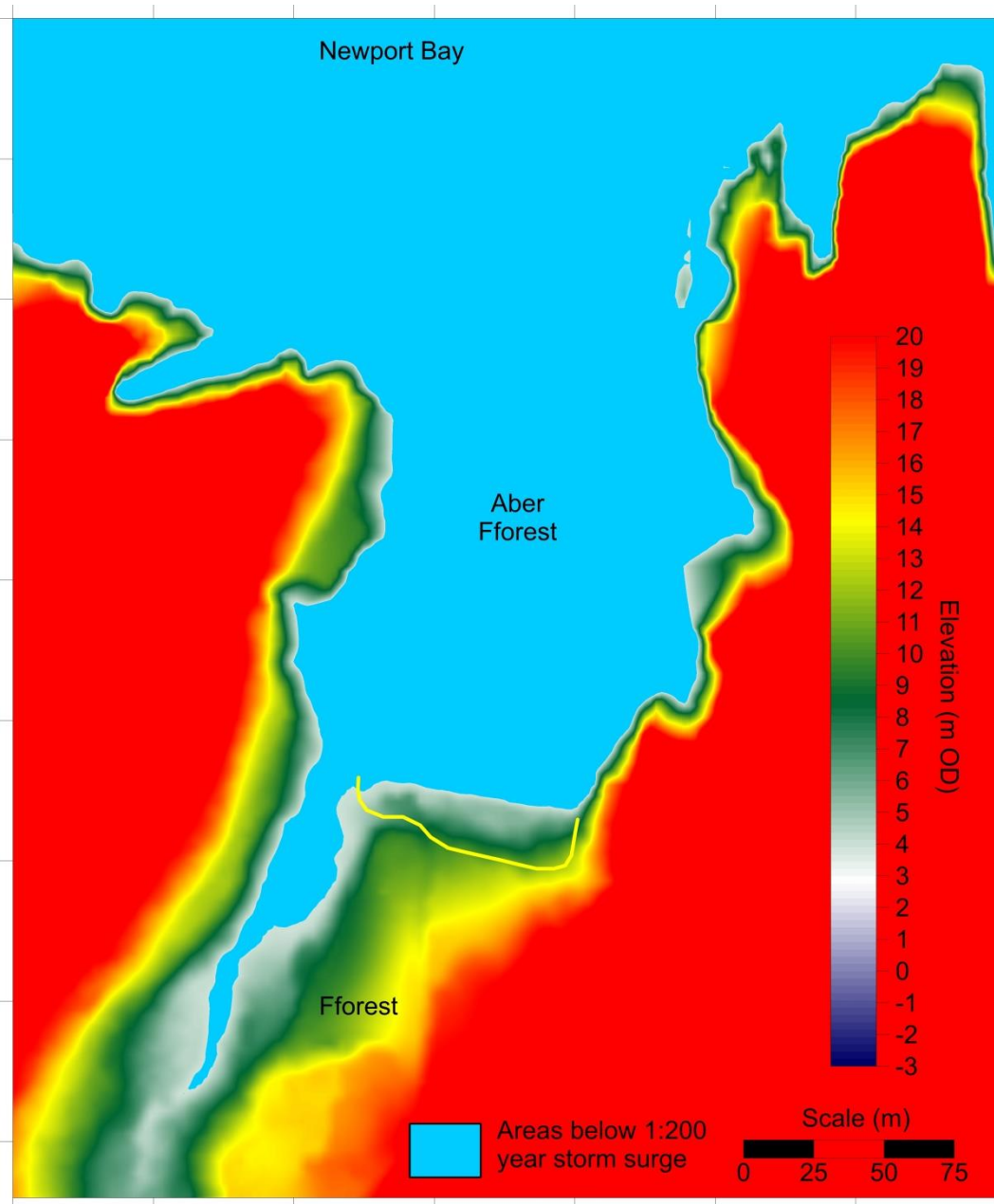
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



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LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 45: Newport Bay: The Bennet and Newport Sands

Site description

Morphological setting	Bay (Newport Bay), adjacent to estuary of the River Nevern
Morphological type	Barrier spit with hummock dunes and small parabolics, transgressive / climbing sand sheets and low dunes behind
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Golf course, grazing land, arable fields
Typical hinterland level	Rising ground
Conservation designations	National Park, Environmentally Sensitive Area
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.00 m OD
1:200 year storm surge level	3.59 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	02/04/2013
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	934 (199696E 246997N)
Distance offshore	5.9 km
Mean wind speed	13.71 knots
Mean wind direction	241.3 ° (WSW)
Mean significant wave height (Hs)	1.00 m
Mean zero up-crossing period (Tz)	4.20 sec
Mean peak wave period (Tp)	7.10 sec
Mean wave direction	279.2 ° (W)
Mean wave direction scaled for wave power	279.7 ° (W)
Mean annual wave power	38.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 8; LD)	183-232 µm (average: 204 µm)
Calcium carbonate content (%) (N= 3)	0.66-2.45% (average: 1.8%)
Silica content (%) (N= 3)	85.6-89.1% (average: 87.6%)

Dune site importance and SMP2 Policy

	45a (PU14.7)	45b (PU14.8)
Flood and Coastal Erosion Risk Management (FCERM)	Low	None
Nature Conservation Designation	Low	Low
Geomorphological Features	Medium	Low
Recreation	Medium	Medium
Economic / Military	Medium	Medium
Historical / Archaeological	Low	Low
Overall significance score	8	7
SMP2 Policy in Epoch 1	NAI	HTL
SMP2 Policy in Epoch 2	NAI	MR
SMP2 Policy in Epoch 3	NAI	NAI

Current and past dune and beach management measures

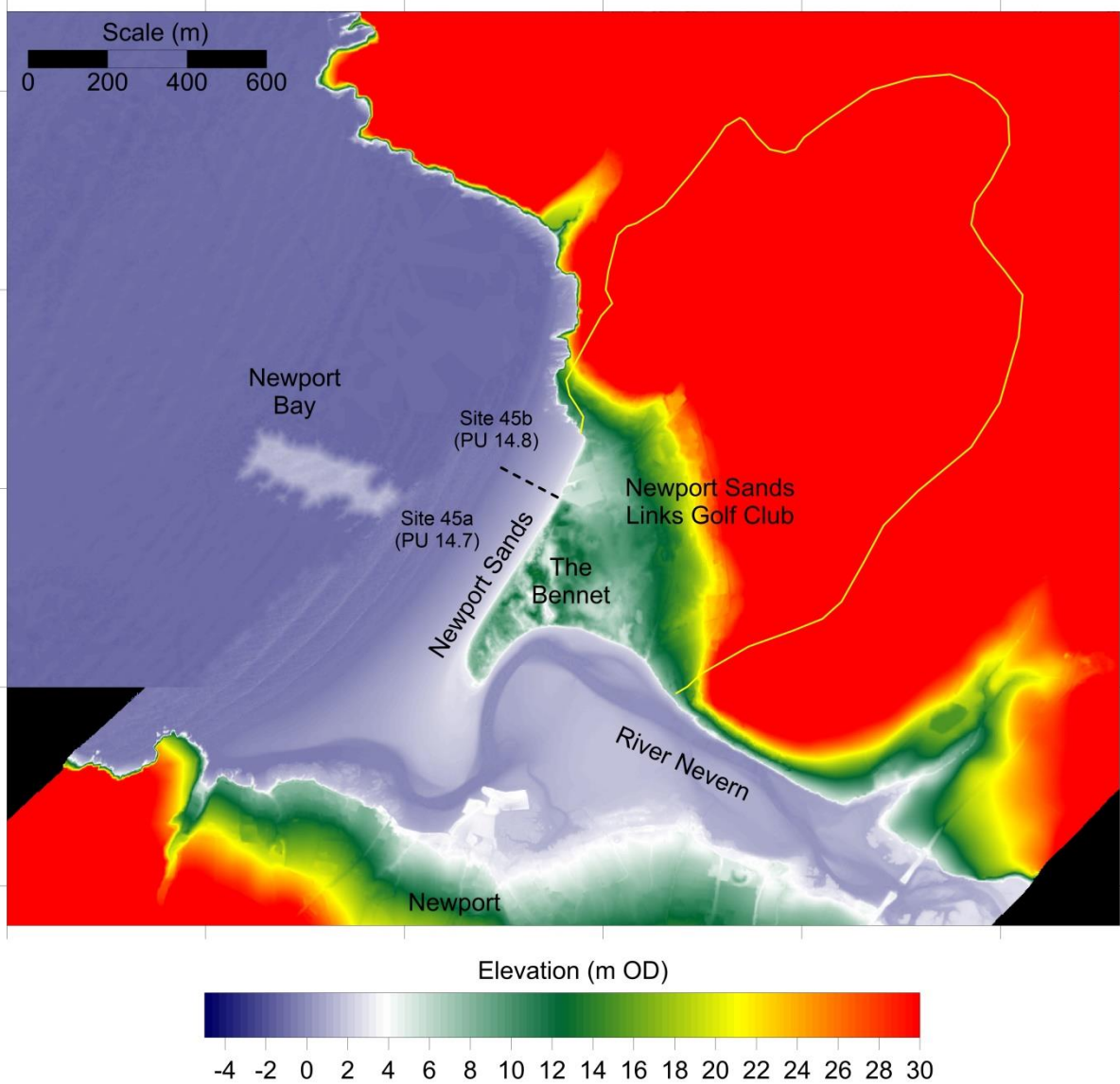
Fencing	Significant
Beach barrier for motor vehicles	Significant

Further information

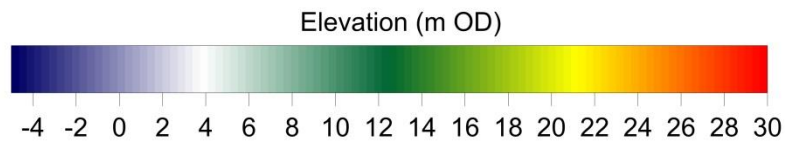
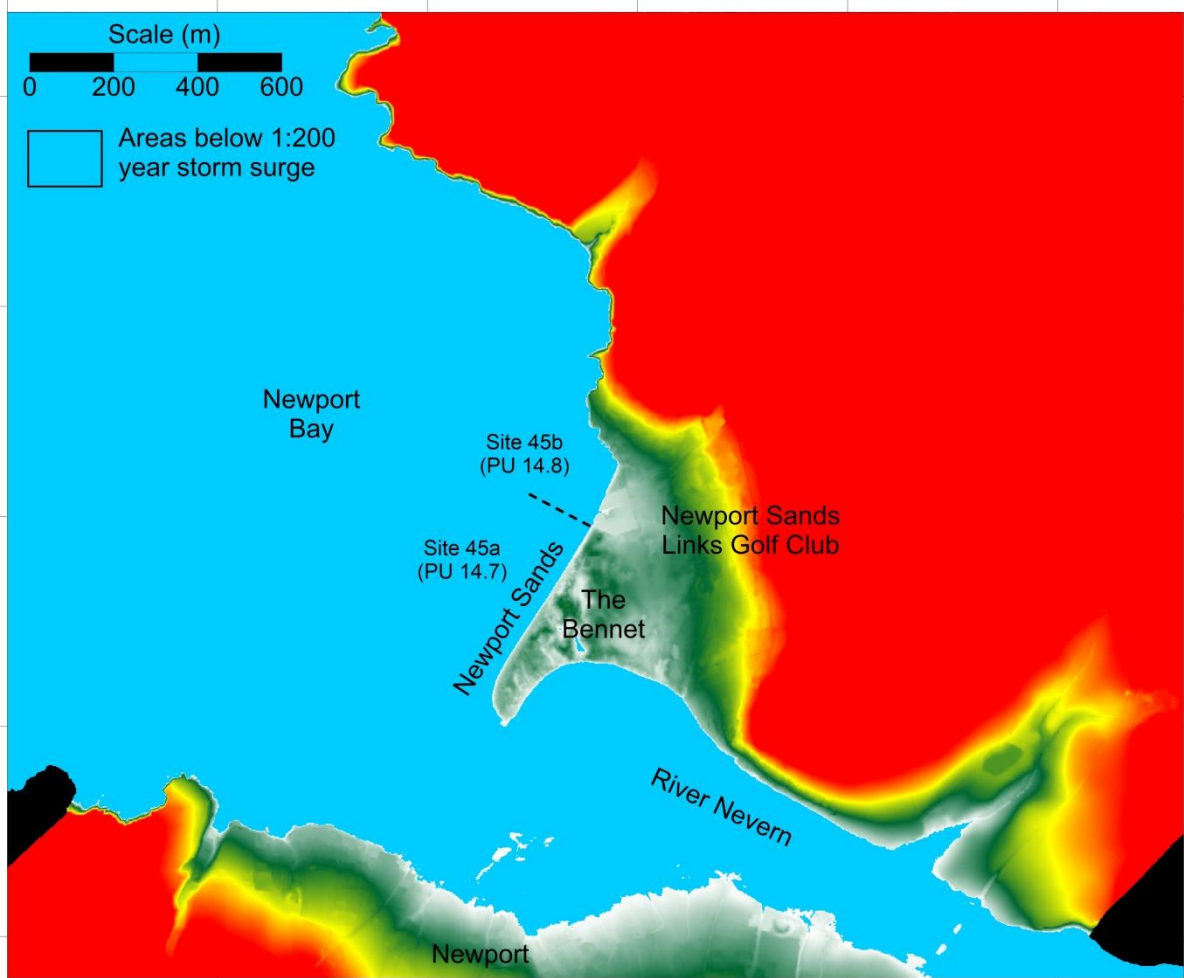
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 46: Poppit Sands

Site description

Morphological setting	Estuary
Morphological type	Estuary mouth fringing
Erosion/progradation status	Prograding
Defence structures	Short length of rock armour at SE corner
Hinterland type	Car park, woodland, agricultural fields
Typical hinterland level	3.7 to 4.4 m OD on car park and woodland
Conservation designations	Afon Teifi SSSI, Aberarth - Carreg Wylan SSSI, SAC, National Park, Heritage Coast, Environmentally Sensitive Area
Notable features	RNLI station

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.86 m OD
1:200 year storm surge level	3.60 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	01/05/2015
Principal aspect of dune frontage	northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	976 (208682E 255841N)
Distance offshore	7.2 km
Mean wind speed	13.79 knots
Mean wind direction	240.5 ° (WSW)
Mean significant wave height (Hs)	1.05 m
Mean zero up-crossing period (Tz)	4.10 sec
Mean peak wave period (Tp)	6.78 sec
Mean wave direction	272.0 ° (W)
Mean wave direction scaled for wave power	270.8 ° (W)
Mean annual wave power	40.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 4; LD)	172-199 µm (average: 186 µm)
Calcium carbonate content (%) (N= 3)	1.73-2.48% (average: 2.21%)
Silica content (%) (N= 3)	89.3-90.5% (average: 90%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	11.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

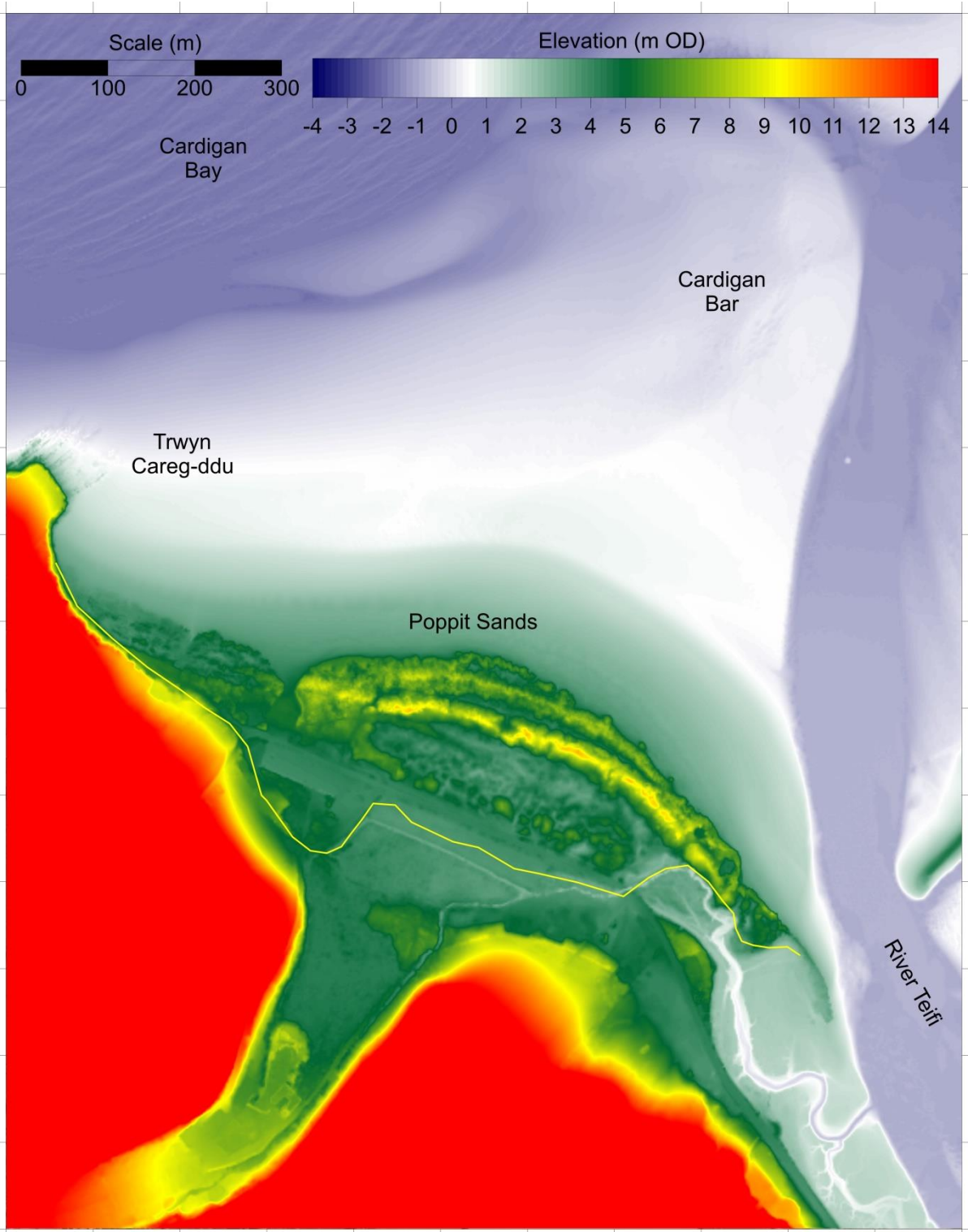
Fencing	Minor
Rock armour to part of dune toe	Minor

Further information

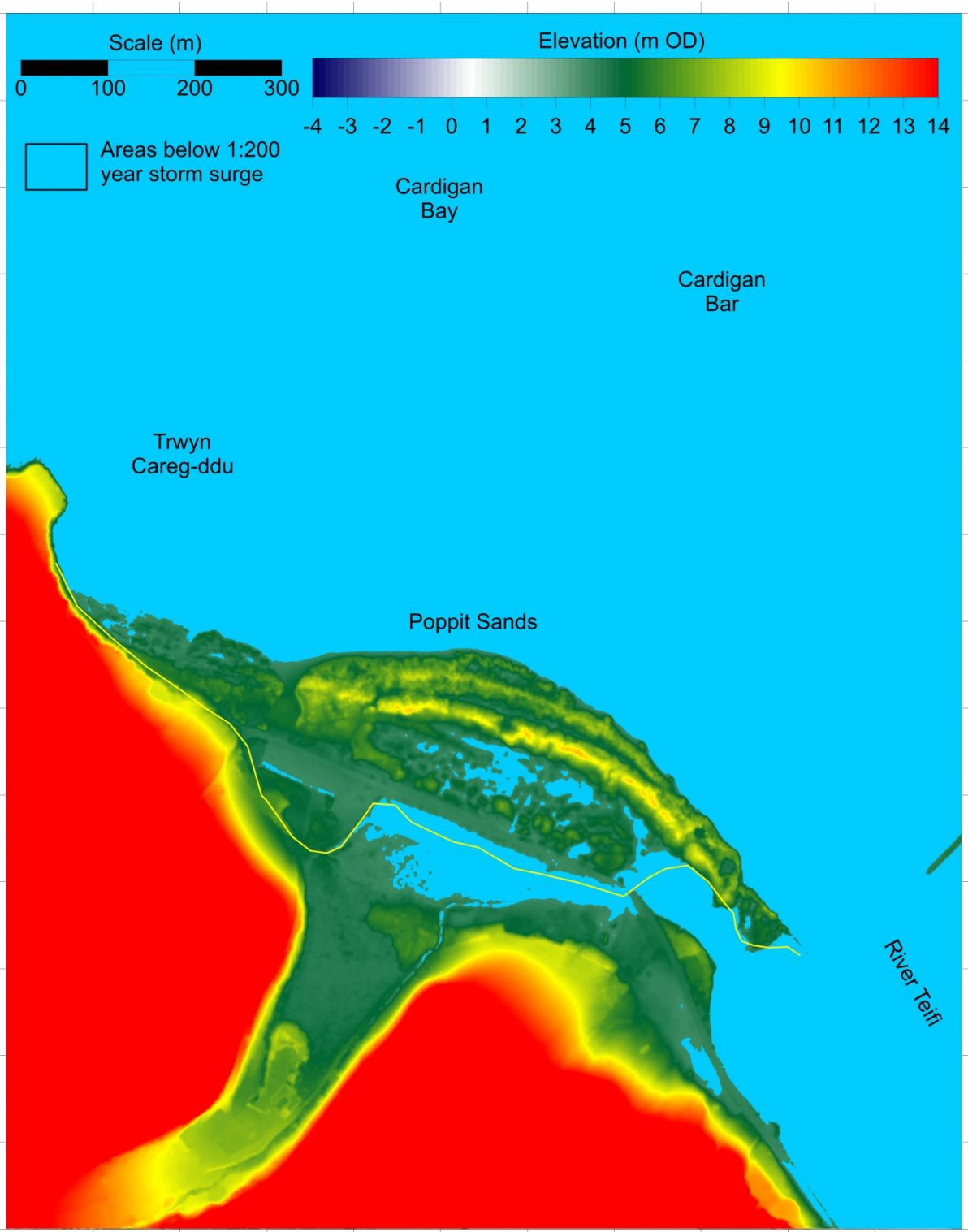
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 47: Towyn Warren

Site description

Morphological setting	Estuary
Morphological type	Barrier spit and climbing
Erosion/progradation status	Stable (protected)
Defence structures	Rock armour, rock groynes, masonry wall
Hinterland type	Caravans, golf course, grazing land, boat moorings
Typical hinterland level	Rising ground on east side, active estuary on River Teifi side
Conservation designations	Aberarth - Carreg Wylan SSSI, SAC, National Park, Heritage Coast, Environmentally Sensitive Area
Notable features	Cardigan Golf Club; Teifi Boat Club and mooring area of fishing boats behind barrier; Craft Caravan Park on barrier; active blowouts due to rabbit activity in climbing dunes west of golf club

Key water level and dune crest parameters

Highest astronomical tide (HAT) level	2.86 m OD
1:200 year storm surge level	3.60 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	01/05/2015
Principal aspect of due frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	976 (208682E 255841N)
Distance offshore	7.2 km
Mean wind speed	13.79 knots
Mean wind direction	240.5 ° (WSW)
Mean significant wave height (Hs)	1.05 m
Mean zero up-crossing period (Tz)	4.10 sec
Mean peak wave period (Tp)	6.78 sec
Mean wave direction	272.0 ° (W)
Mean wave direction scaled for wave power	270.8 ° (W)
Mean annual wave power	40.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 3; LD)	200-224 µm (average: 210 µm)
Calcium carbonate content (%) (N= 3)	1.21-1.89% (average: 1.53%)
Silica content (%) (N= 3)	87.5-89.2% (average: 88.2%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	9.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Fencing	Significant
Grazing of upper dune slopes above road	Significant
Groynes, rock armour, stone wall protection to part of dune toe	Major

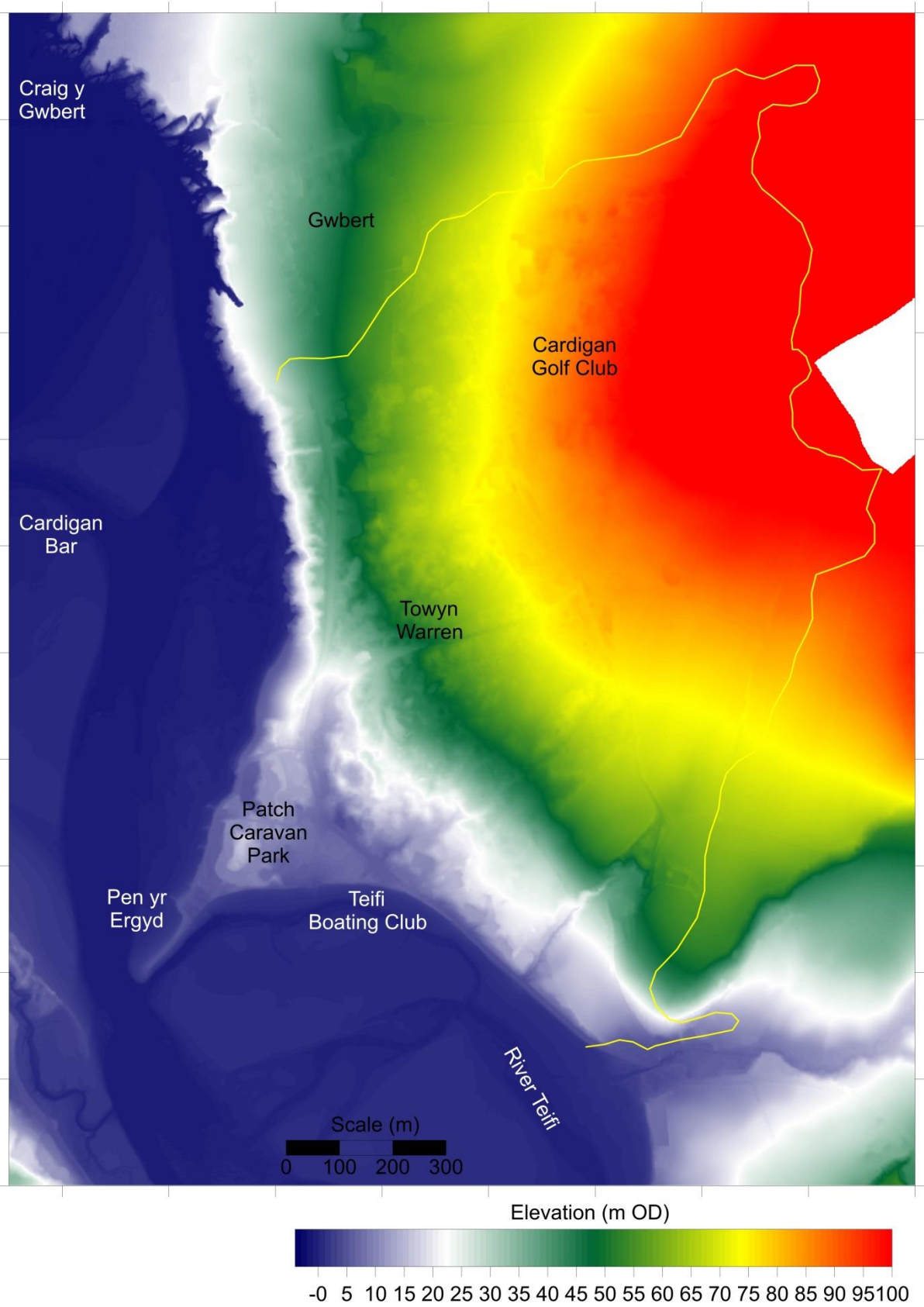
Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

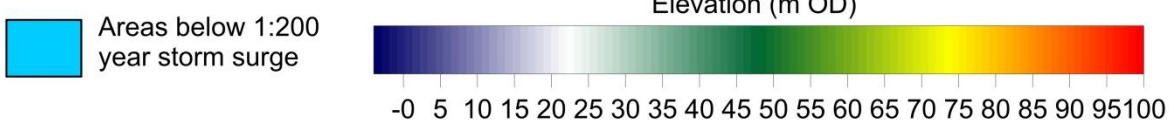
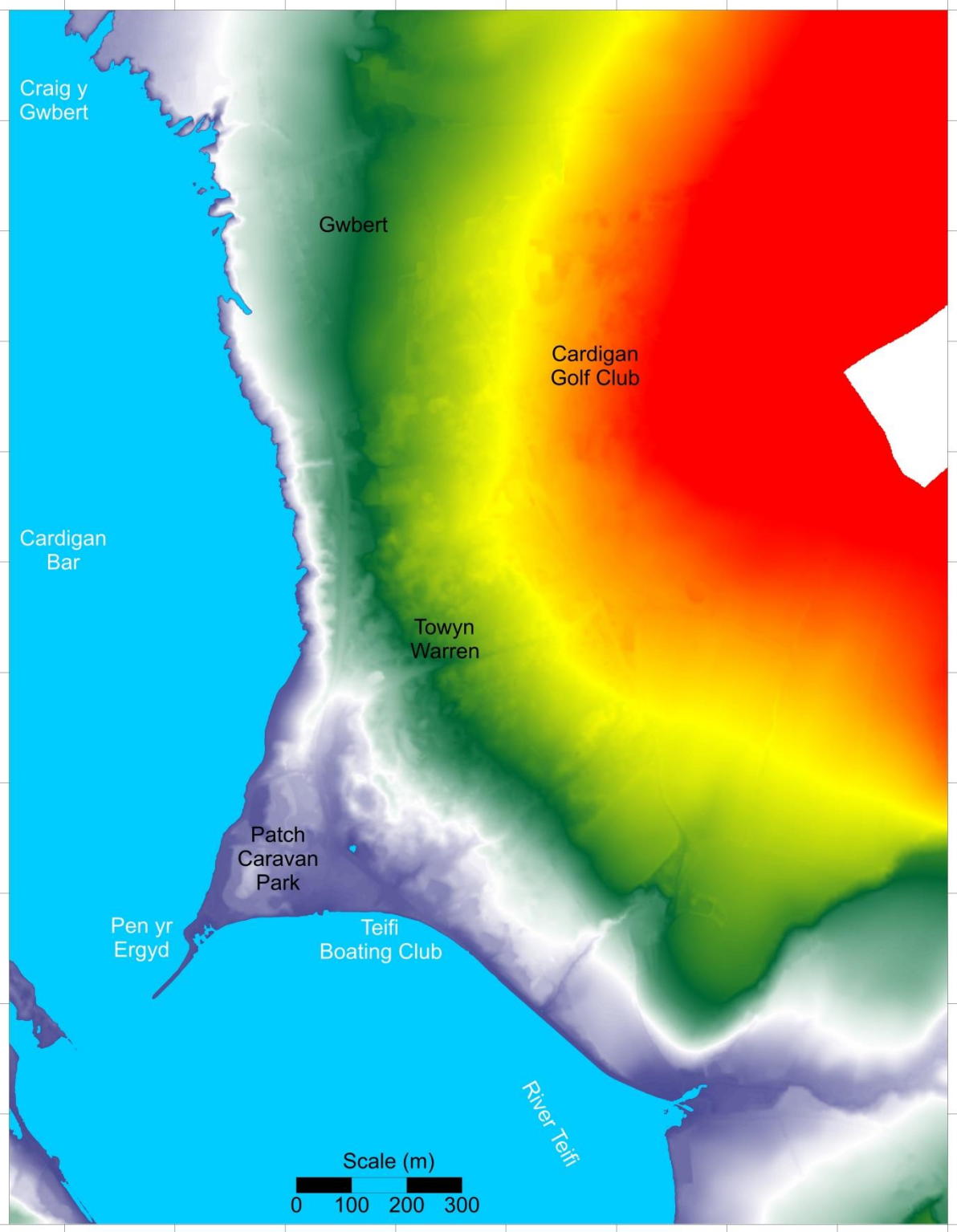
Pye K, Saye SE. 2005. The Geomorphological Response of Welsh Sand Dunes to Sea Level Rise over the Next 100 Years and the Management Implications for SAC and SSSI Sites. CCW Contract Science Report No 670, Countryside Council for Wales, Bangor.



2013-14 photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 48: Traeth Penbryn

Site description

Morphological setting	Bay (Cardigan Bay)
Morphological type	Fringing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Car park, wooded valley, agricultural land
Typical hinterland level	Rising ground
Conservation designations	Aberarth - Carreg Wylan SSSI, SAC, Heritage Coast, National Trust
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.00 m OD
1:200 year storm surge level	3.68 ± 0.2 m OD
Maximum crest level	n/a
Minimum crest level	n/a
LiDAR survey date	May 2006
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	974 (226478E 255721N)
Distance offshore	4.3 km
Mean wind speed	12.32 knots
Mean wind direction	241.7 ° (WSW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.91 sec
Mean peak wave period (Tp)	6.65 sec
Mean wave direction	283.1 ° (WNW)
Mean wave direction scaled for wave power	284.6 ° (WNW)
Mean annual wave power	23.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

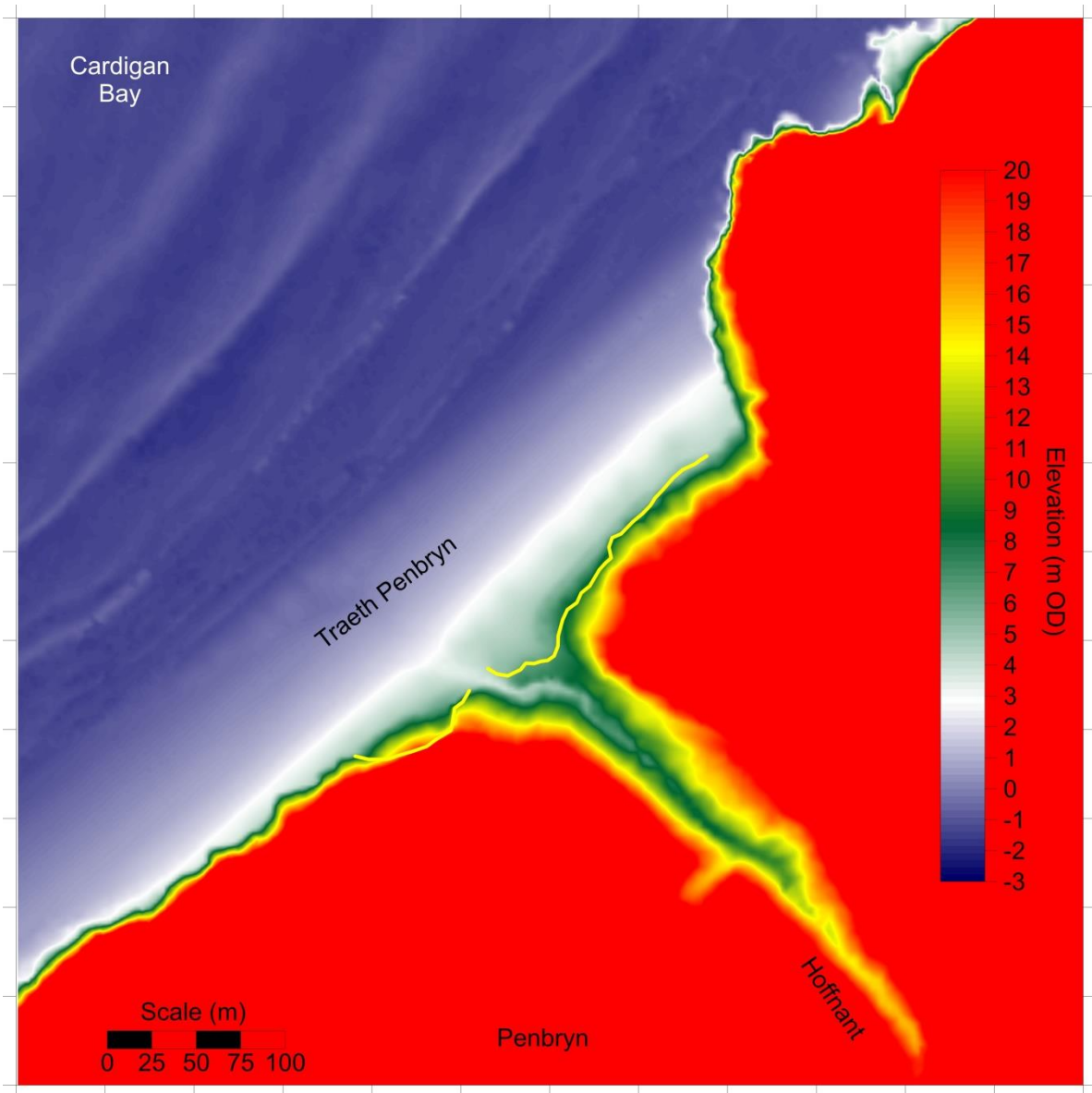
Fencing	Minor
Grazing	Minor

Further information

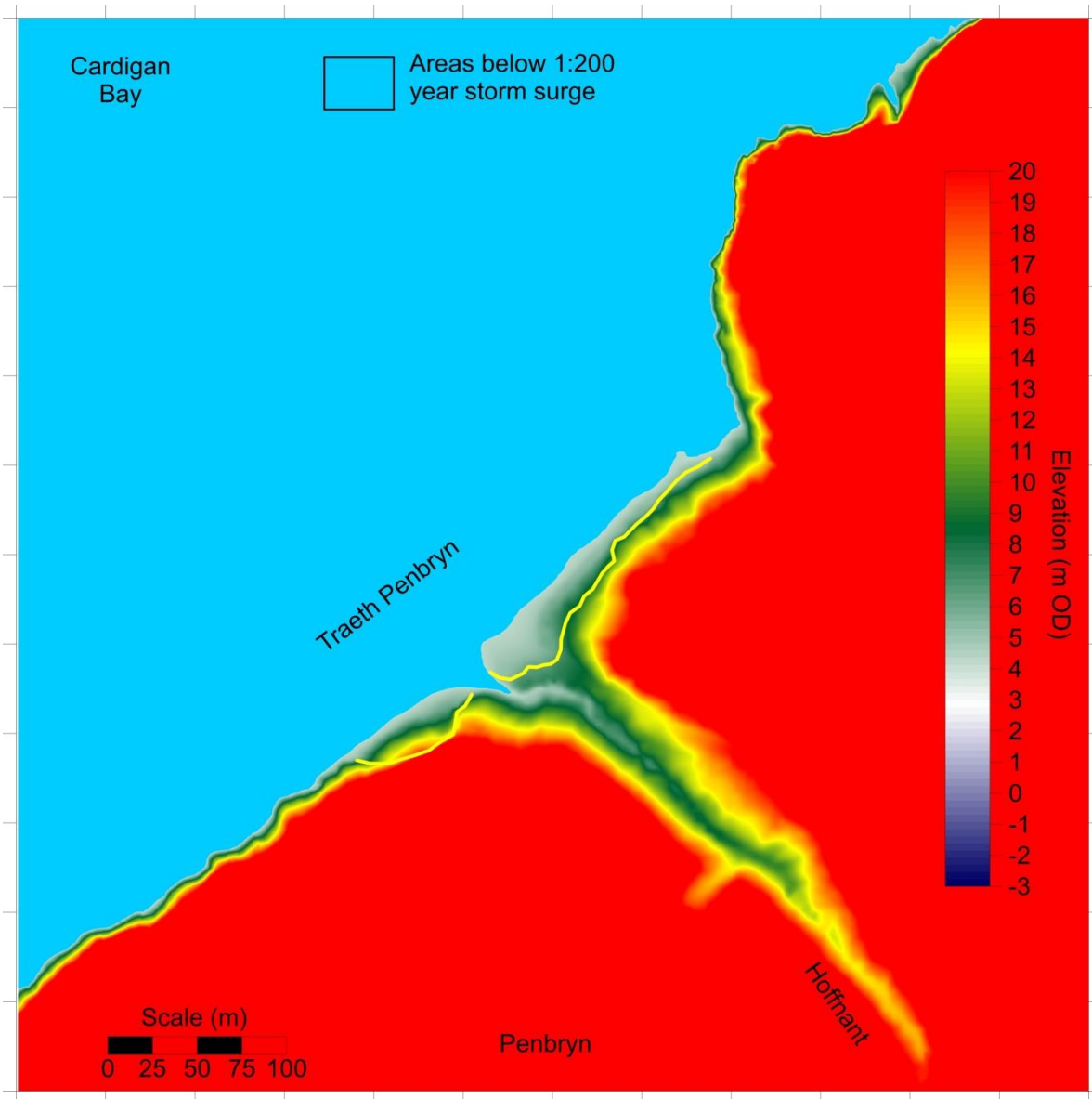
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 49: Borth to Ynyslas

Site description

Morphological setting	Open coast (facing Cardigan Bay)
Morphological type	Estuary mouth Barrier spit (south side of the Dovey estuary);
Erosion/progradation status	Eroding along southern section, episodic erosion and accretion on the northern section; south of Ynyslas village the barrier is mainly composed of shingle, with a thin, discontinuous capping of windblown sand which extends onto the back barrier area; north of Ynyslas the barrier consists mainly of higher sand dunes which overlie lower shingle ridges and intervening sandy swales
Defence structures	Sea wall, rock armour and groynes along the Borth frontage
Hinterland type	Houses, caravans, golf course, road, grazing land, agricultural fields, active saltmarsh and sandy tidal flats at the northern end
Typical hinterland level	1.2 to 3.6 m OD on marsh and agricultural land
Conservation designations	Dyfi SSSI, SAC, Biosphere Reserve, Ramsar, NNR (adjacent to SPA), GCR
Notable features	Cardigan Golf Club; dynamic processes at the northern end, with embryo dune development and episodes of dune erosion/cliffing; a number of significant active blowouts are present

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.06 m OD
1:200 year storm surge level	3.94 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/02/2015
Principal aspect of dune frontage	west-southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1095 (253542E 291133N)
Distance offshore	7.1 km
Mean wind speed	12.91 knots
Mean wind direction	237.2 ° (WSW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.77 sec
Mean peak wave period (Tp)	6.04 sec
Mean wave direction	260.5 ° (W)
Mean wave direction scaled for wave power	259.3 ° (W)
Mean annual wave power	23.8 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	193-235 µm (average: 210 µm)
Calcium carbonate content (%) (N= 3)	2.59-3.27% (average: 3.02%)
Silica content (%) (N= 3)	87.7-90.3% (average: 89.2%)

Dune site importance and SMP2 Policy

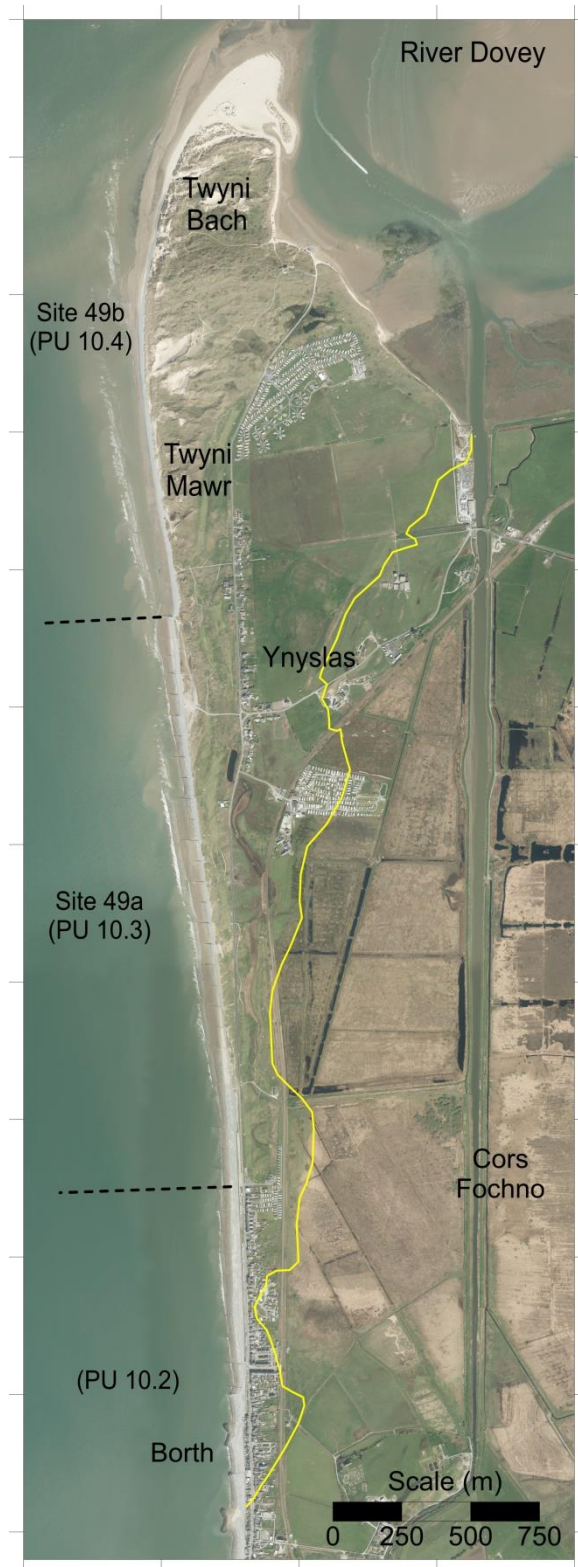
	Site 49a	Site 49b
Flood and Coastal Erosion Risk Management (FCERM)	Medium	Medium
Nature Conservation Designation	High	Very High
Geomorphological Features	Low	Very High
Recreation	Medium	High
Economic / Military	Low	Low
Historical / Archaeological	Low	Low
Overall significance score	10	15
SMP2 Policy in Epoch 1	HTL	MR
SMP2 Policy in Epoch 2	MR	NAI
SMP2 Policy in Epoch 3	MR	NAI

Current and past dune and beach management measures

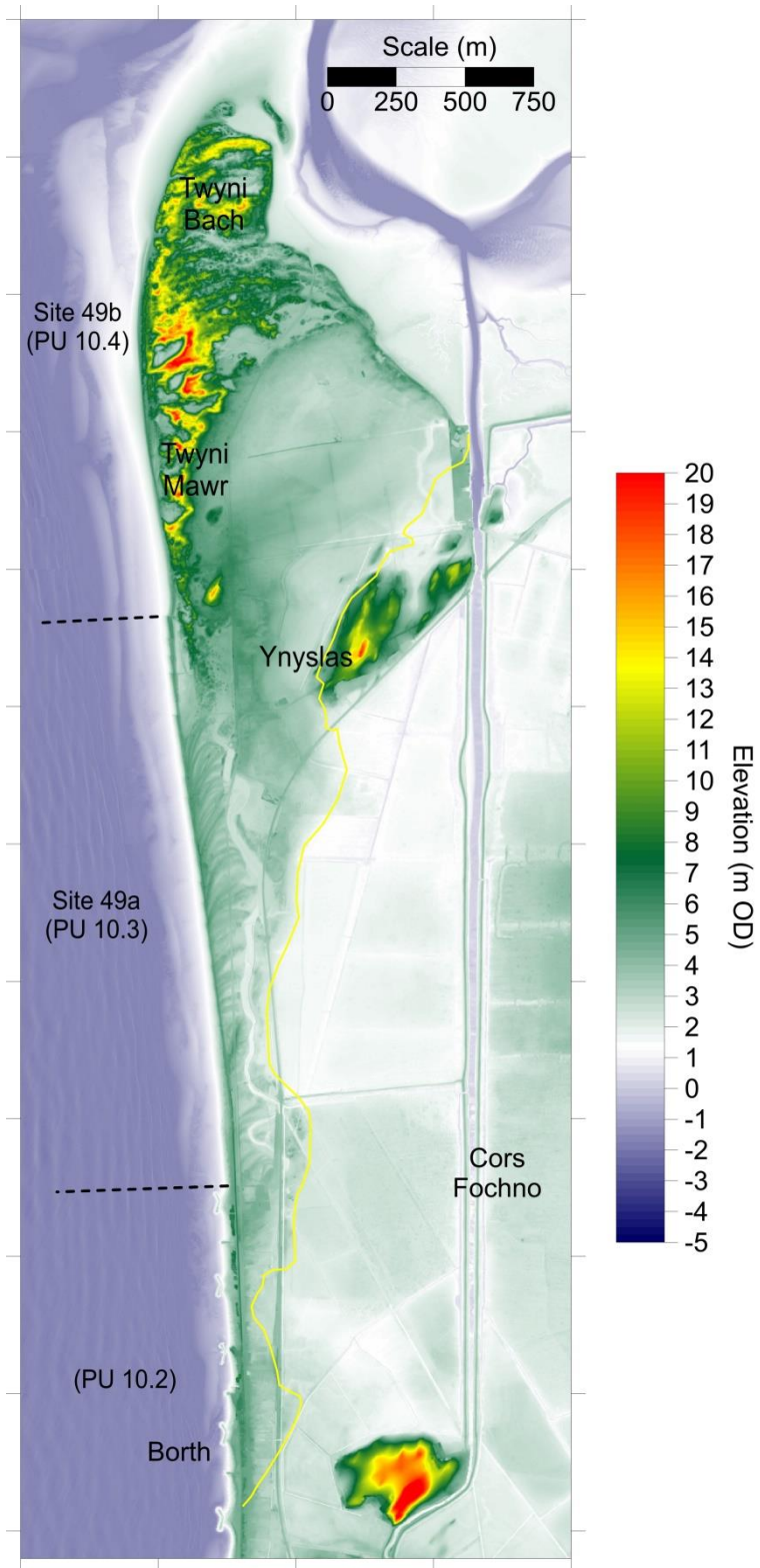
Grazing	Significant
Groynes	Major
Wooden barrier along part of beach	Major

Further information

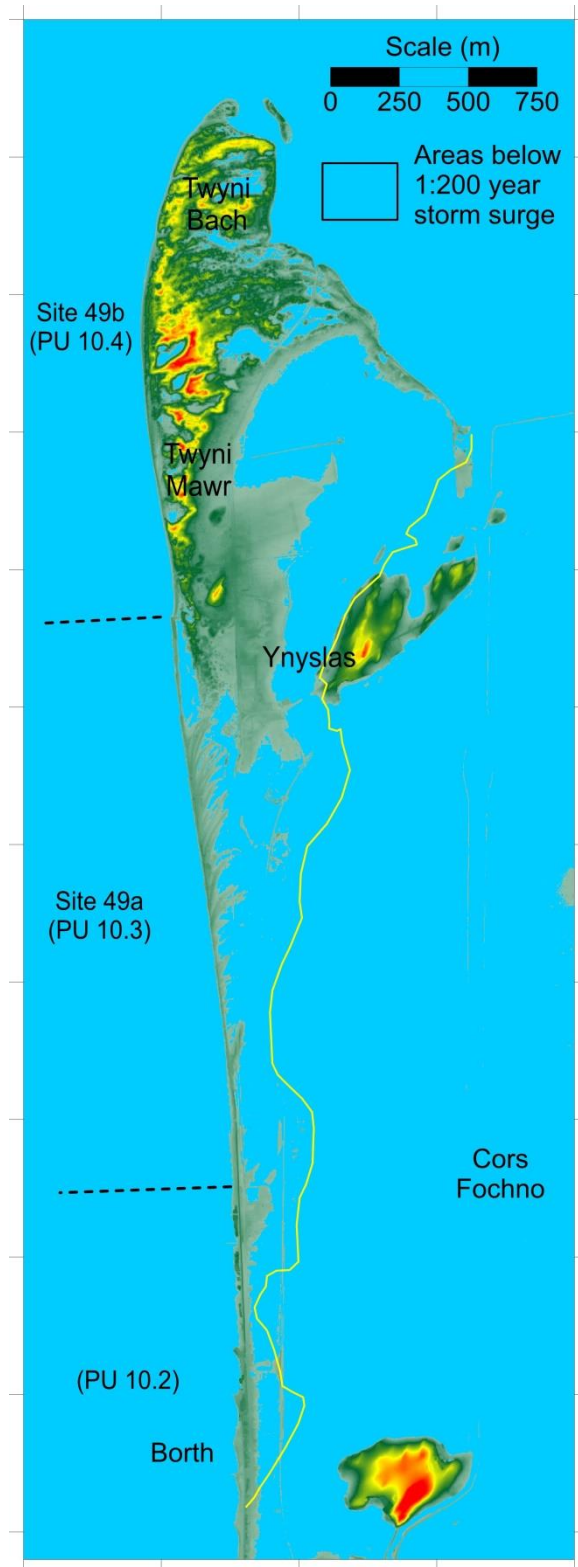
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 geological scale maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 50: Aberdovey to Tywyn

Site description

Morphological setting	Open coast and estuary mouth (facing Cardigan Bay and Dovey Estuary)
Morphological type	Fringing and barrier spit
Erosion/progradation status	Eroding along most of the open coast section site, temporally and spatially variable in the south in response to movement of banks and channels in the Dovey estuary
Defence structures	Sand- filled geotextiles fronting part of the golf course; slate blocks within the frontal dune / shingle ridge between the golf course northern boundary and Towyn
Hinterland type	Caravans, golf course, wetland, grazing land
Typical hinterland level	2.7 to 3.6 m OD on Aberdovey Golf Club 1.4 to 2.8 m OD on marsh further inland and in N
Conservation designations	Dyfi SSSI, SAC, National Park (adjacent to SPA and Ramsar)
Notable features	Aberdovey Golf Club

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.06 m OD
1:200 year storm surge level	3.93 ± 0.2 m OD
Maximum crest level	17.39
Minimum crest level	5.21
LiDAR survey date	03/02/2015
Principal aspect of dune frontage	west

Frontal dune morphological parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	7.36	98	54	148	82
Profile 2	7.33	234	82	228	118
Profile 3	5.44	191	40	124	30
Profile 4	6.35	371	32	252	33
Profile 5	8.60	79	48	143	89
Profile 6	12.93	151	135	694	569
Profile 7	9.74	94	73	233	161

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1095 (253542E 291133N)
Distance offshore	7.1 km
Mean wind speed	12.91 knots
Mean wind direction	237.2 ° (WSW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.77 sec
Mean peak wave period (Tp)	6.04 sec
Mean wave direction	260.5 ° (W)
Mean wave direction scaled for wave power	259.3 ° (W)
Mean annual wave power	23.8 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 8; LD)	227-312 µm (average: 254 µm)
Calcium carbonate content (%) (N= 3)	1.53-2.09% (average: 1.84%)
Silica content (%) (N= 3)	94.5-94.9% (average: 94.8%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	High
Economic / Military	Medium
Historical / Archaeological	Low
Overall significance score	14.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Grazing	Significant
Fencing	Significant
Marram planting	Significant
Dune reprofiling	Significant
Dune nourishment	Significant
Surface stabilization using brushwood	Significant
Protection of dune face using sandbags	Significant
Slate block reinforcement of frontal dune toe	Significant

Further information

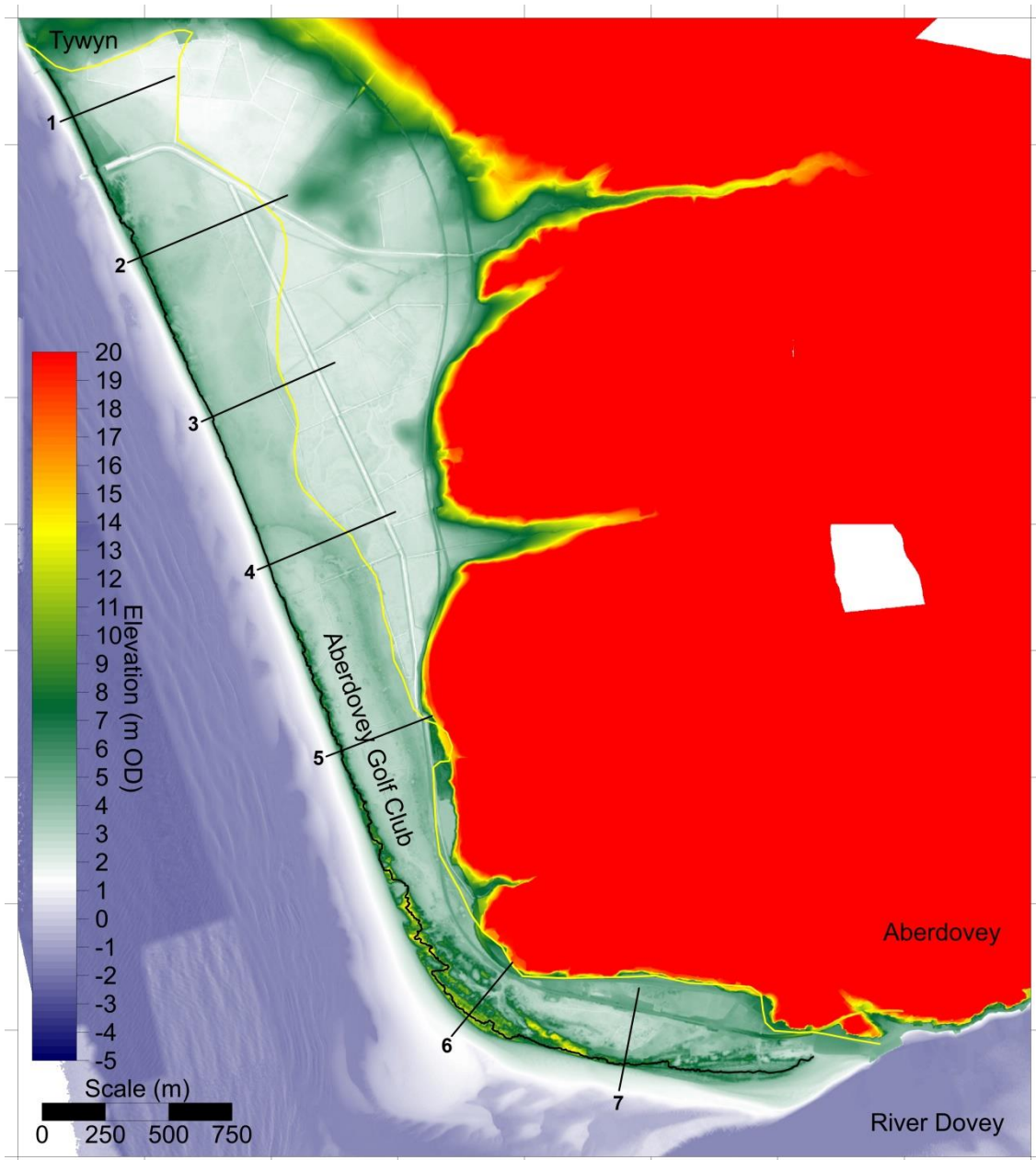
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

Pye K, Blott SJ. 2006. The Geomorphology and Environmental Context of the Aberdovey Coastal Dune System, Report to Aberdovey Golf Club. Report, No. 604, Kenneth Pye Associates Ltd, Crowthorne.

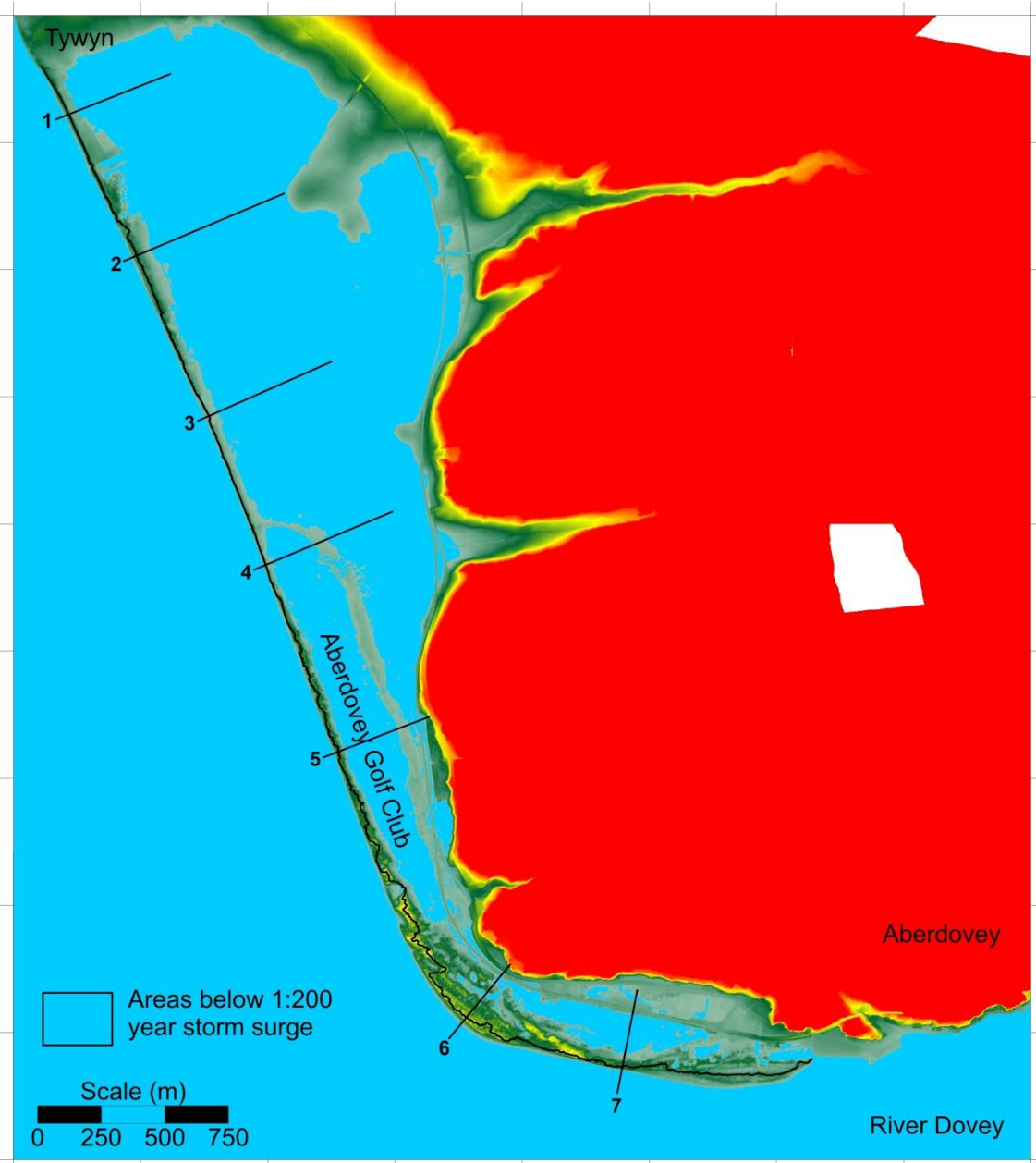
Pye K, Blott SJ. 2014. Aberdovey Golf Club: Dune Erosion and Management Options. Report to Natural Resources Wales. Report No. 160726, Kenneth Pye Associates Ltd., Solihull.



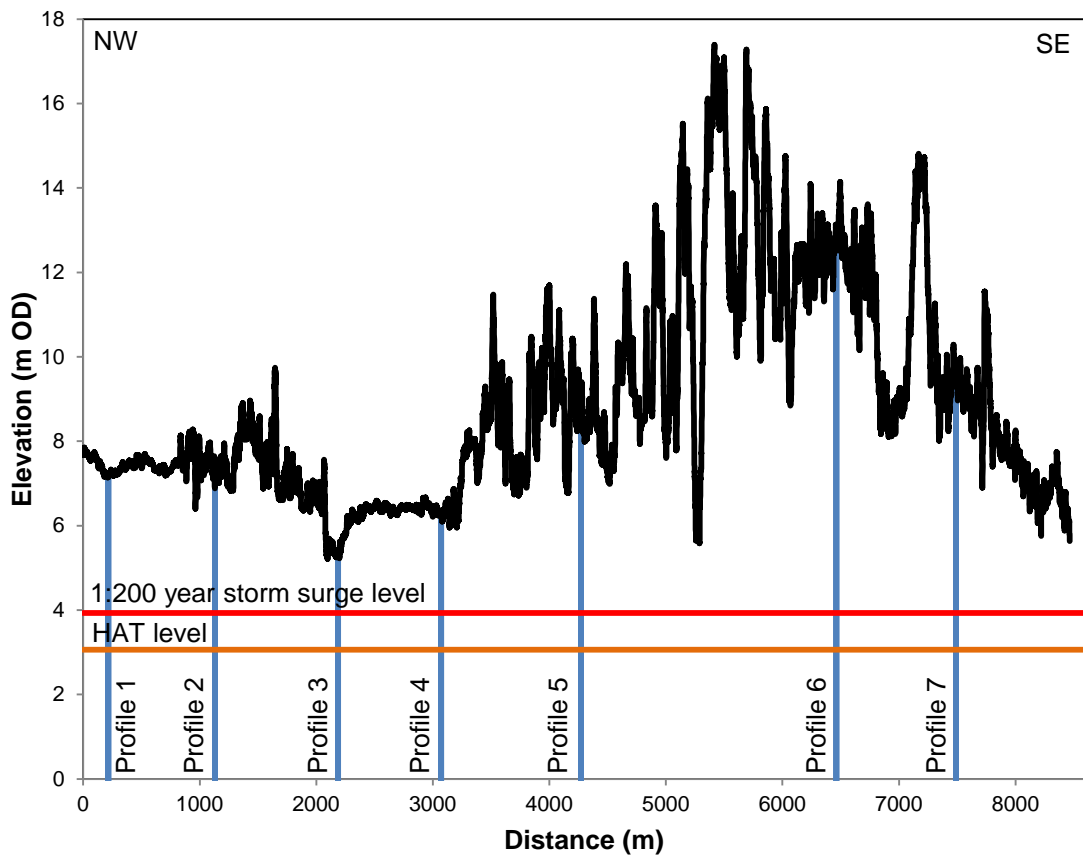
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



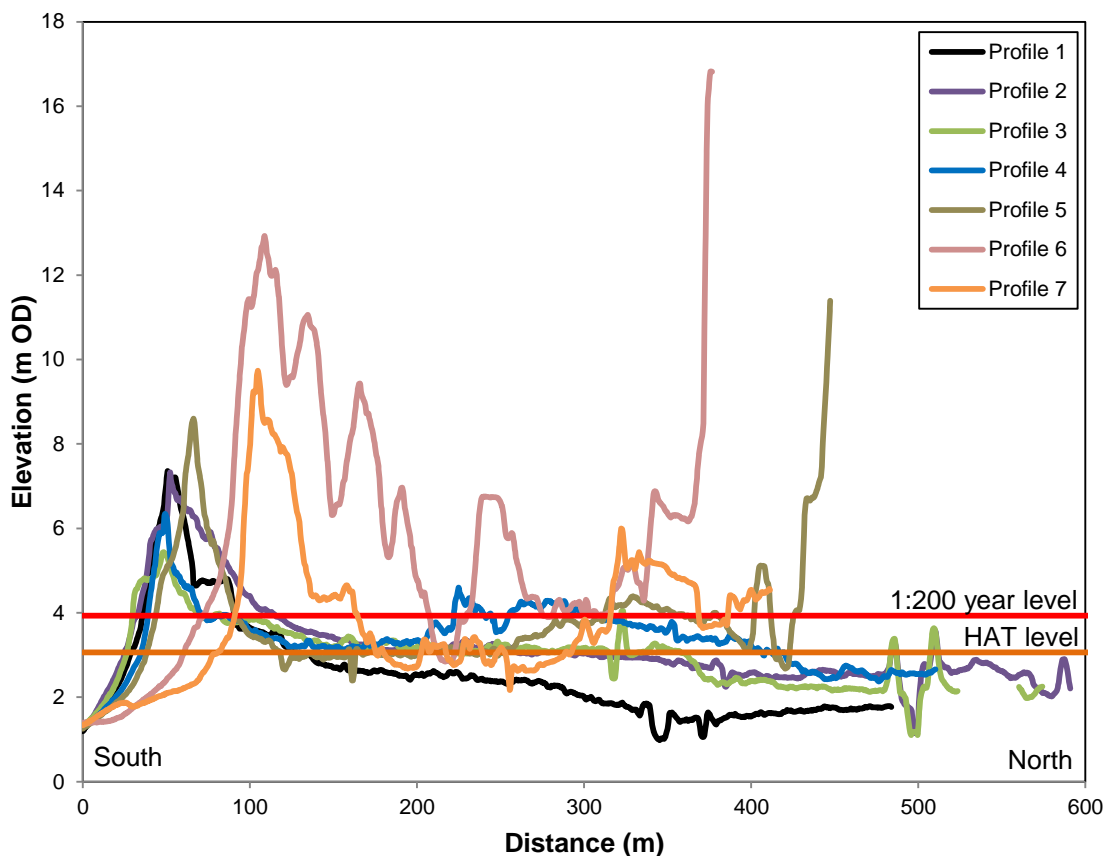
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 51: Aber Dysynni

Site description

Morphological setting	Open coast and estuary (facing cardigan Bay, adjacent to Dysynni estuary)
Morphological type	Barrier spit, with low dunes on multiple shingle recurves; shingle barrier beach to seaward
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Grazing land on reclaimed marsh, active marsh and tidal flats; Cambrian coast railway line runs along the seaward edge of the dunes, adjacent to the shingle ridge
Typical hinterland level	1.8 to 2.2 m OD on marsh
Conservation designations	Broadwater SSSI, National Park
Notable features	Broad Water behind

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.15 m OD
1:200 year storm surge level	3.91 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2014
Principal aspect of dune frontage	west southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1124 (253605E 300036N)
Distance offshore	4.1 km
Mean wind speed	13.01 knots
Mean wind direction	235.8 ° (SW)
Mean significant wave height (Hs)	0.81 m
Mean zero up-crossing period (Tz)	3.83 sec
Mean peak wave period (Tp)	6.09 sec
Mean wave direction	253.7 ° (WSW)
Mean wave direction scaled for wave power	251.9 ° (WSW)
Mean annual wave power	25.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

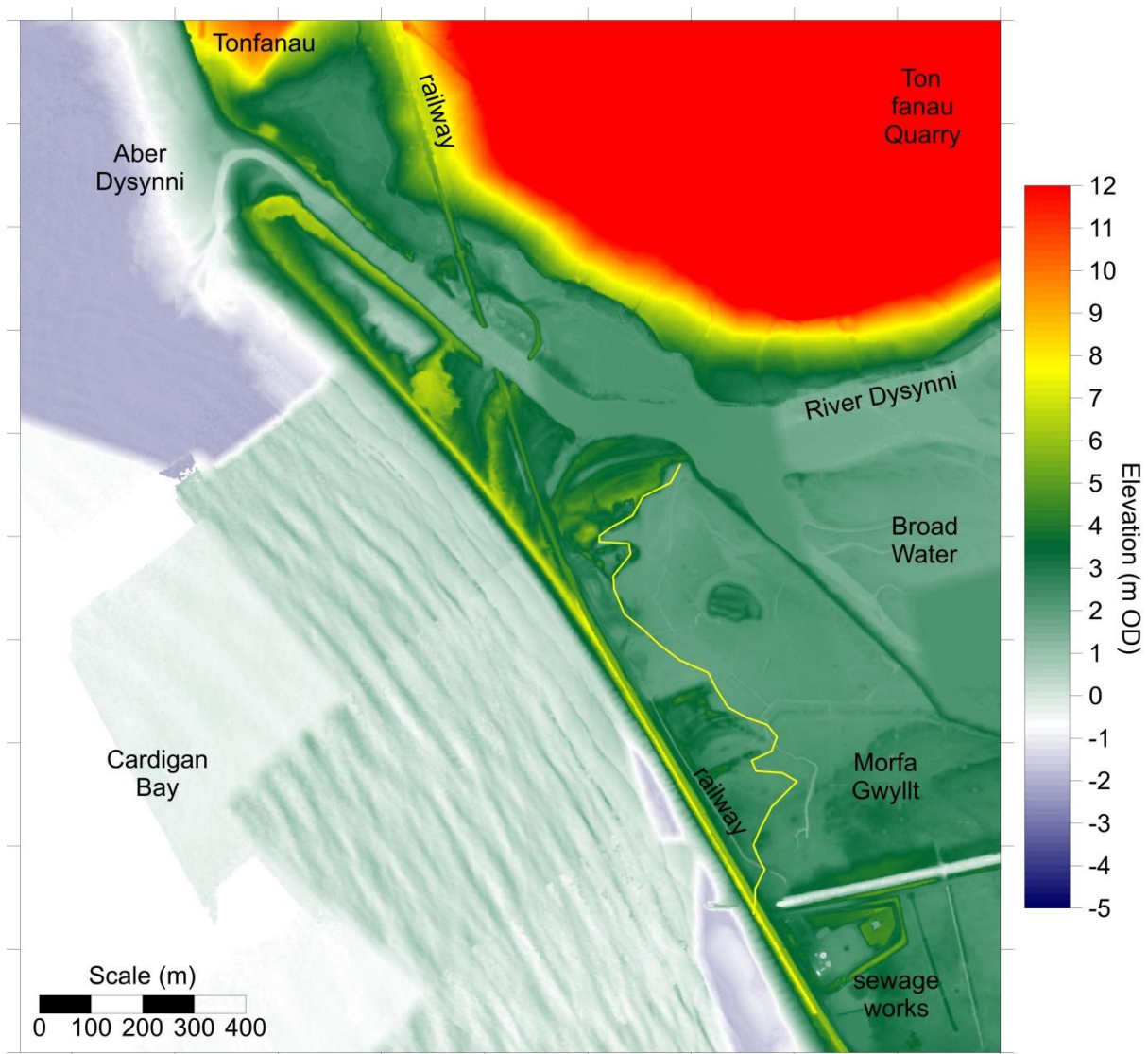
Grazing	Significant
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Further information

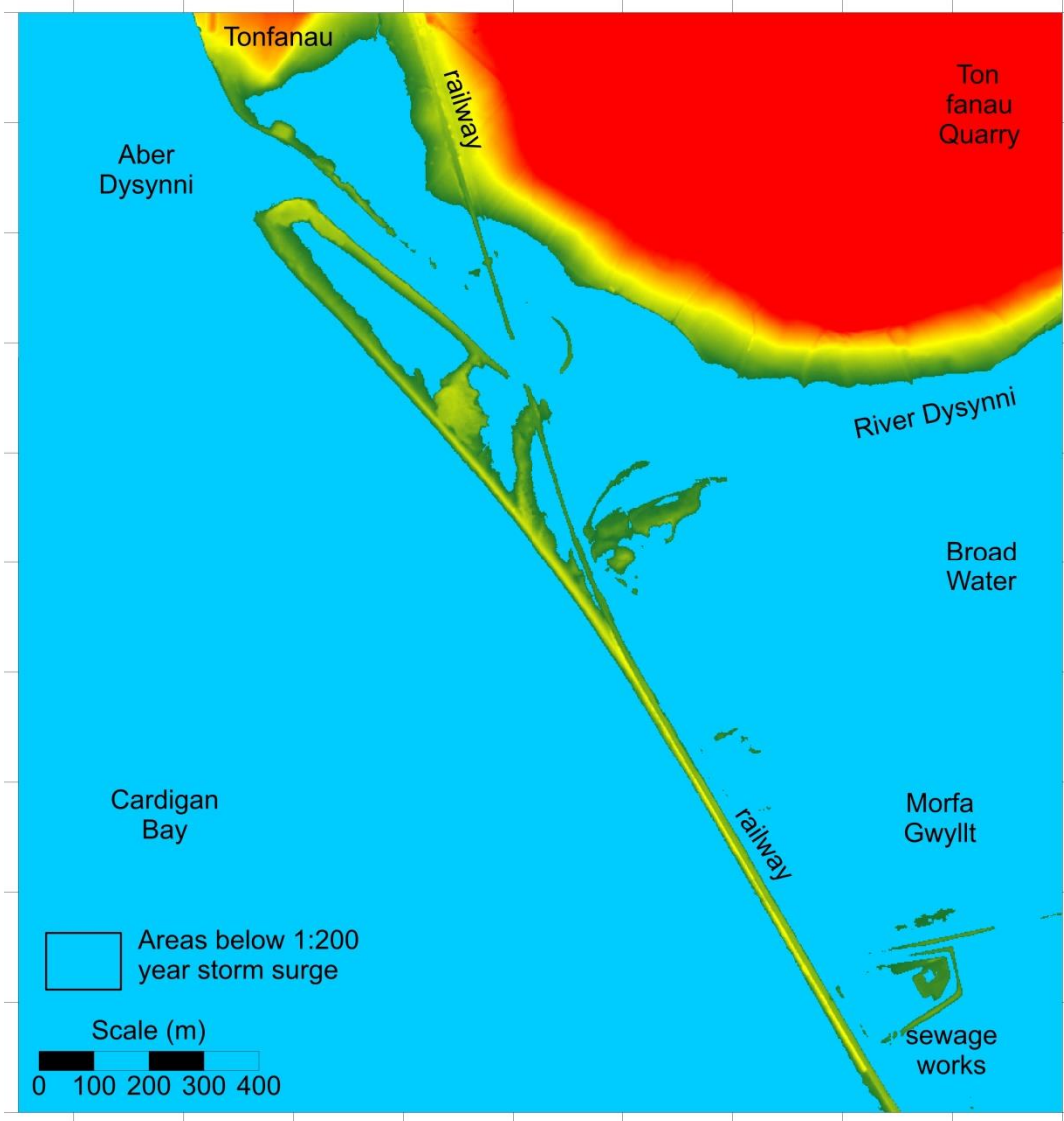
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 52: Fairbourne Spit

Site description

Morphological setting	Open coast and estuary (Cardigan Bay and Mawddach estuary)
Morphological type	Barrier spit on southern side of the entrance to the Mawddach estuary, with dunes developed on shingle ridges at the northern end
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Intertidal flats and saltmarsh
Typical hinterland level	Intertidal on both sides of site
Conservation designations	Aber Mawddach/Mawddach Estuary SSSI, SAC, National Park
Notable features	Fairbourne miniature railway and road run through the dunes; foot ferry to Barmouth at the northern end

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.26 m OD
1:200 year storm surge level (McMillan et al., 2011)	4.22 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2014
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1175 (253733E 317832N)
Distance offshore	5.4 km
Mean wind speed	12.18 knots
Mean wind direction	231.7 ° (SW)
Mean significant wave height (Hs)	0.77 m
Mean zero up-crossing period (Tz)	3.92 sec
Mean peak wave period (Tp)	6.11 sec
Mean wave direction	243.4 ° (WSW)
Mean wave direction scaled for wave power	240.8 ° (WSW)
Mean annual wave power	24.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 4; LD)	203-233 µm (average: 214 µm)
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	High
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	12
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

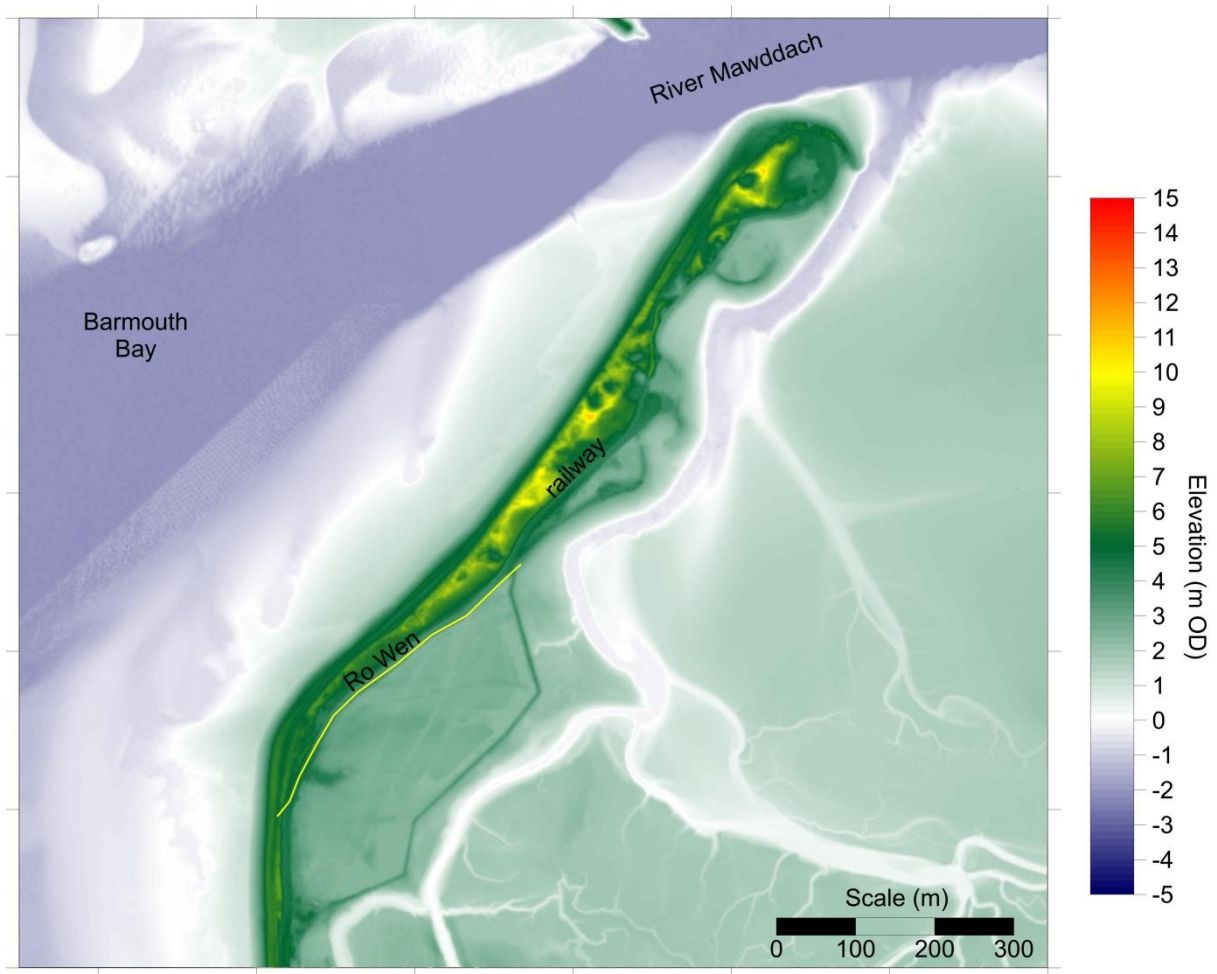
Fencing	Significant
Marram planting	Minor

Further information

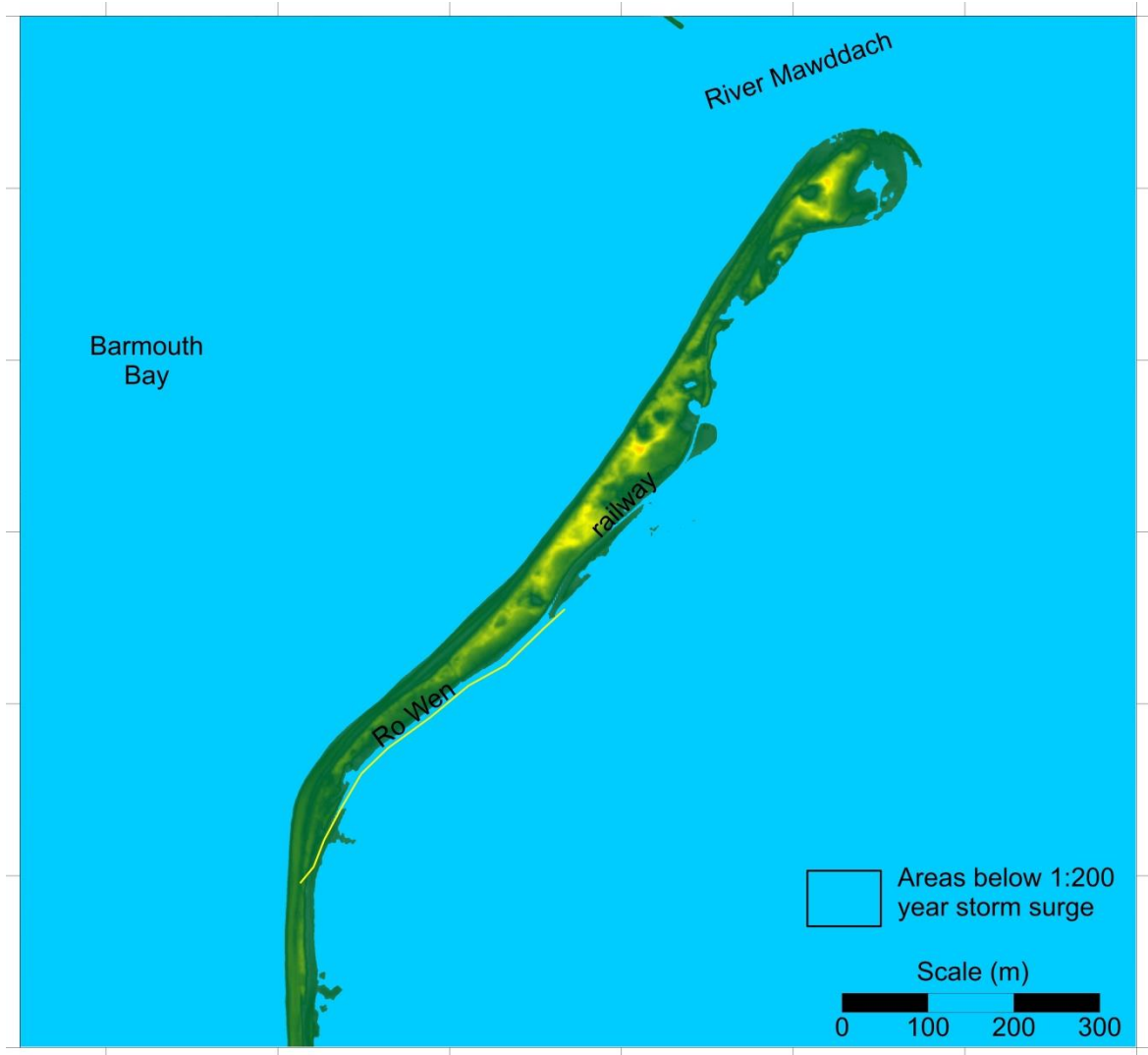
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimate 1 in 200 year storm surge level.

Site 53: Barmouth

Site description

Morphological setting	Open coast and estuary (Cardigan Bay and Mawddach estuary)
Morphological type	Fringing and barrier dunes in front of seawall at Barmouth and adjacent to the Ynys Brawd causeway, with relict dunes and sand sheets behind the sea wall
Erosion/progradation status	Prograding / vertically accreting in front of the defences, stable behind
Defence structures	Sea wall, groynes, causeway at S end
Hinterland type	Housing, industry, recreational facilities, road, railway
Typical hinterland level	3.5 to 6.4 m OD in urban area 2.5 to 3.2 m OD to E of railway in N
Conservation designations	None
Notable features	Significant area of bare, partially mobile blown sand, which periodically extends into Barmouth town and on to the Cambrian Coast railway; lateral extension of the dunes currently controlled by Gwynedd Council

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.26 m OD
1:200 year storm surge level	4.22 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	03/03/2014
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1175 (253733E 317832N)
Distance offshore	5.4 km
Mean wind speed	12.18 knots
Mean wind direction	231.7 ° (SW)
Mean significant wave height (Hs)	0.77 m
Mean zero up-crossing period (Tz)	3.92 sec
Mean peak wave period (Tp)	6.11 sec
Mean wave direction	243.4 ° (WSW)
Mean wave direction scaled for wave power	240.8 ° (WSW)
Mean annual wave power	24.5 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 4; LD)	205-231 µm (average: 220 µm)
Calcium carbonate content (%) (N= 3)	0.91-2.37% (average: 1.62%)
Silica content (%) (N= 3)	92.4-94.7% (average: 93.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	High
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	11
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

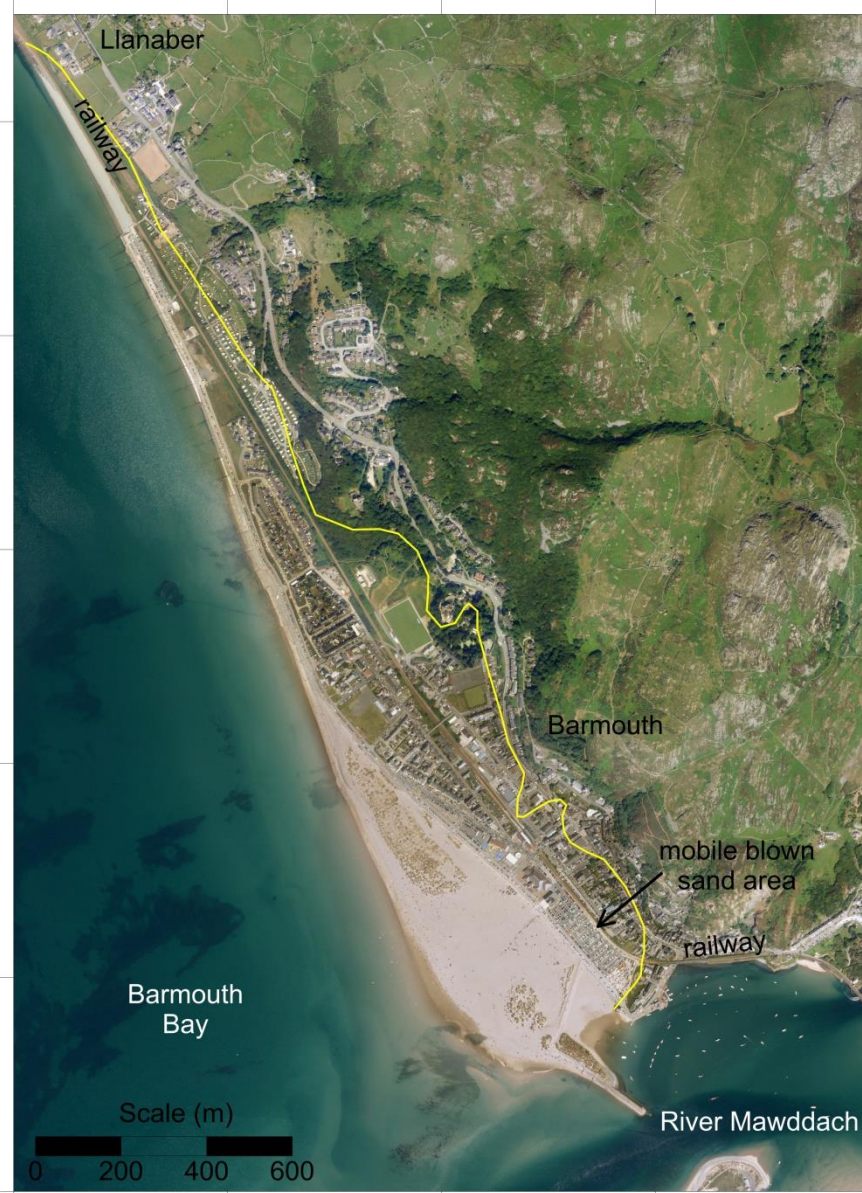
Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Annual sand shift of windblow sand to the lower beach	Significant

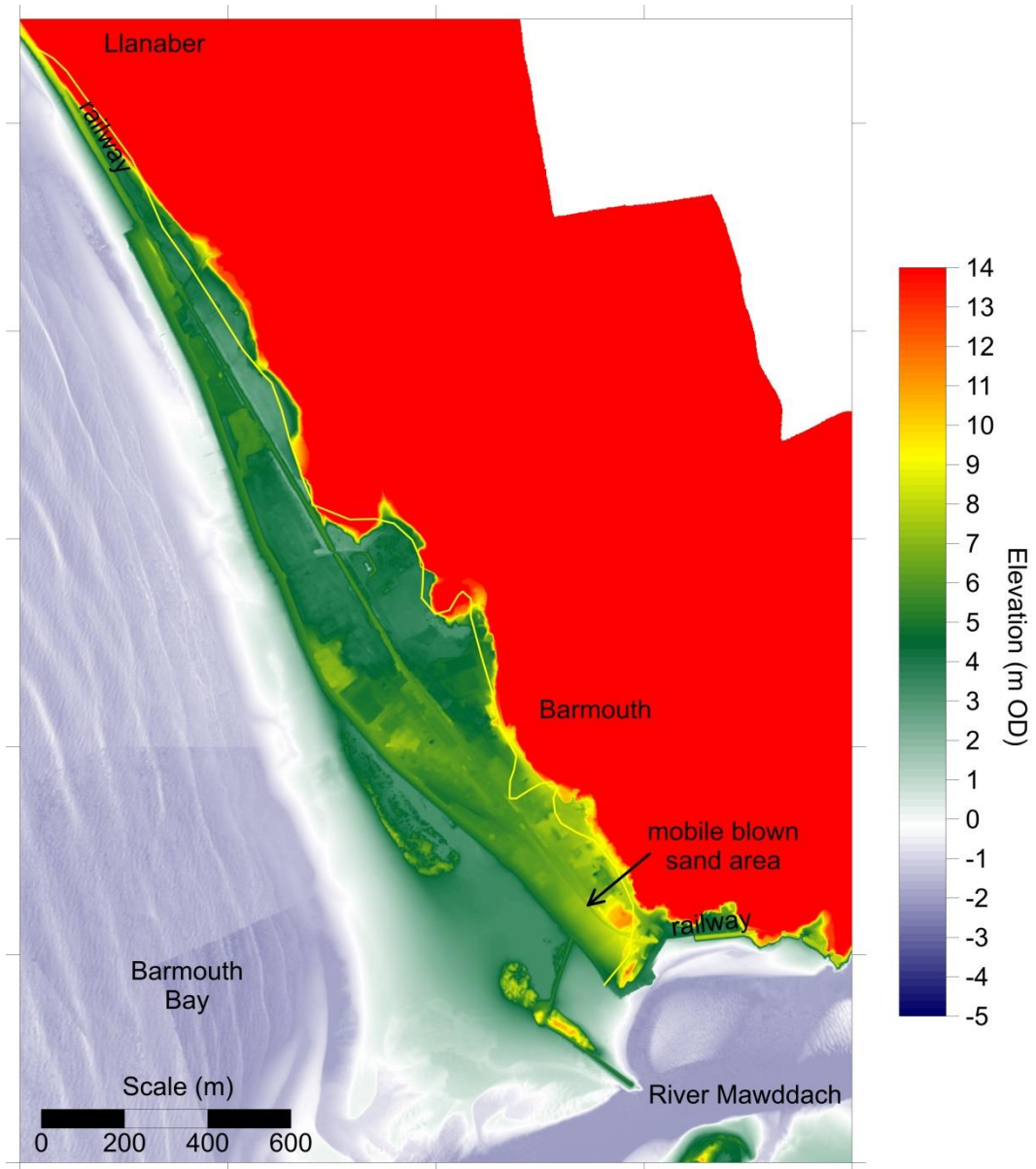
Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

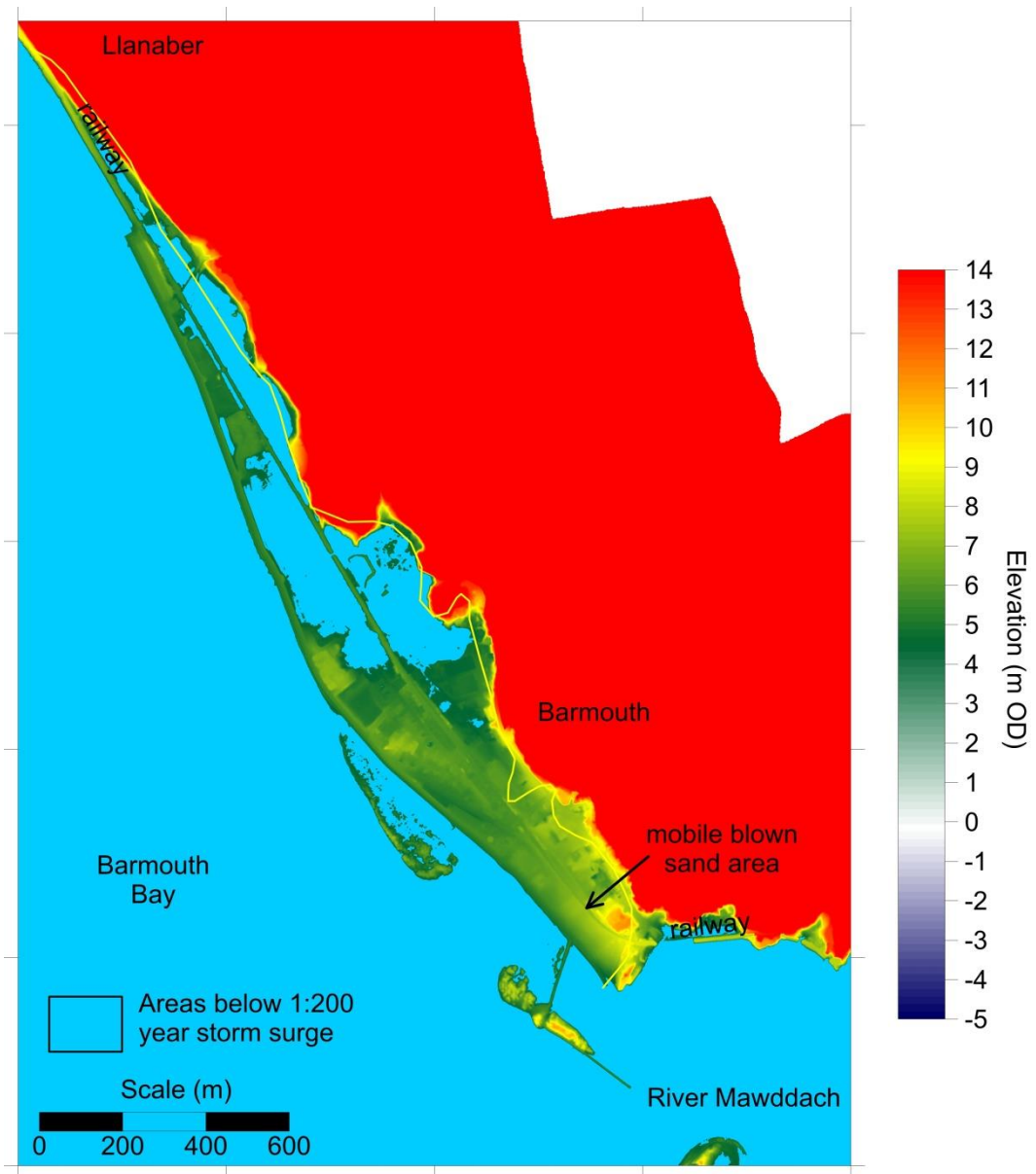
Pye K, Blott SJ. 2016. Barmouth Beach: Blown Sand Management Options. Report to Gwynedd Council. Report No. 19100, Kenneth Pye Associates Ltd., Solihull.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 54: Morfa Dyffryn

Site description

Morphological setting	Open coast (Cardigan Bay)
Morphological type	Barrier tombolo linking mainland near Tal-y-Bont with Shell Island, transgressive compound parabolic dunes, foredunes, sandsheets and low hummocky dunes behind main dune ridges
Erosion/progradation status	Largely stable
Defence structures	Rock armour protecting caravan site in S
Hinterland type	Llanbedr airfield, caravan sites and holiday village, grazing land and agricultural fields on reclaimed marshland
Typical hinterland level	5.9 to 8.5 m OD on Llanbedr Airfield and caravan site 1.2 to 3.0 m OD on agricultural land to E of airfield
Conservation designations	Morfa Dyffryn SSSI, SAC, NNR, National Park
Notable features	Llanbedr Airfield, Mochras (Shell Island) campsite to N; former tidal channel south of Shell Island; the most mobile dune system in Wales

Key water level and dune crest parameters

Highest astronomical tide (HAT) level	3.30 m OD
1:200 year storm surge level	4.14 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	West southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1199 (253800E 326735N)
Distance offshore	1.4 km
Mean wind speed	11.34 knots
Mean wind direction	228.9 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	3.82 sec
Mean peak wave period (Tp)	5.94 sec
Mean wave direction	242.0 ° (WSW)
Mean wave direction scaled for wave power	239.8 ° (WSW)
Mean annual wave power	16.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 15; LD)	210-283 µm (average: 238 µm)
Calcium carbonate content (%) (N= 4)	1.66-2.66% (average: 2.14%)
Silica content (%) (N= 4)	92.8-94.2% (average: 93.4%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	High
Economic / Military	High
Historical / Archaeological	Medium
Overall significance score	18
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Grazing	Significant
Scrub clearance	Significant
Rock protection to dune toe	Minor

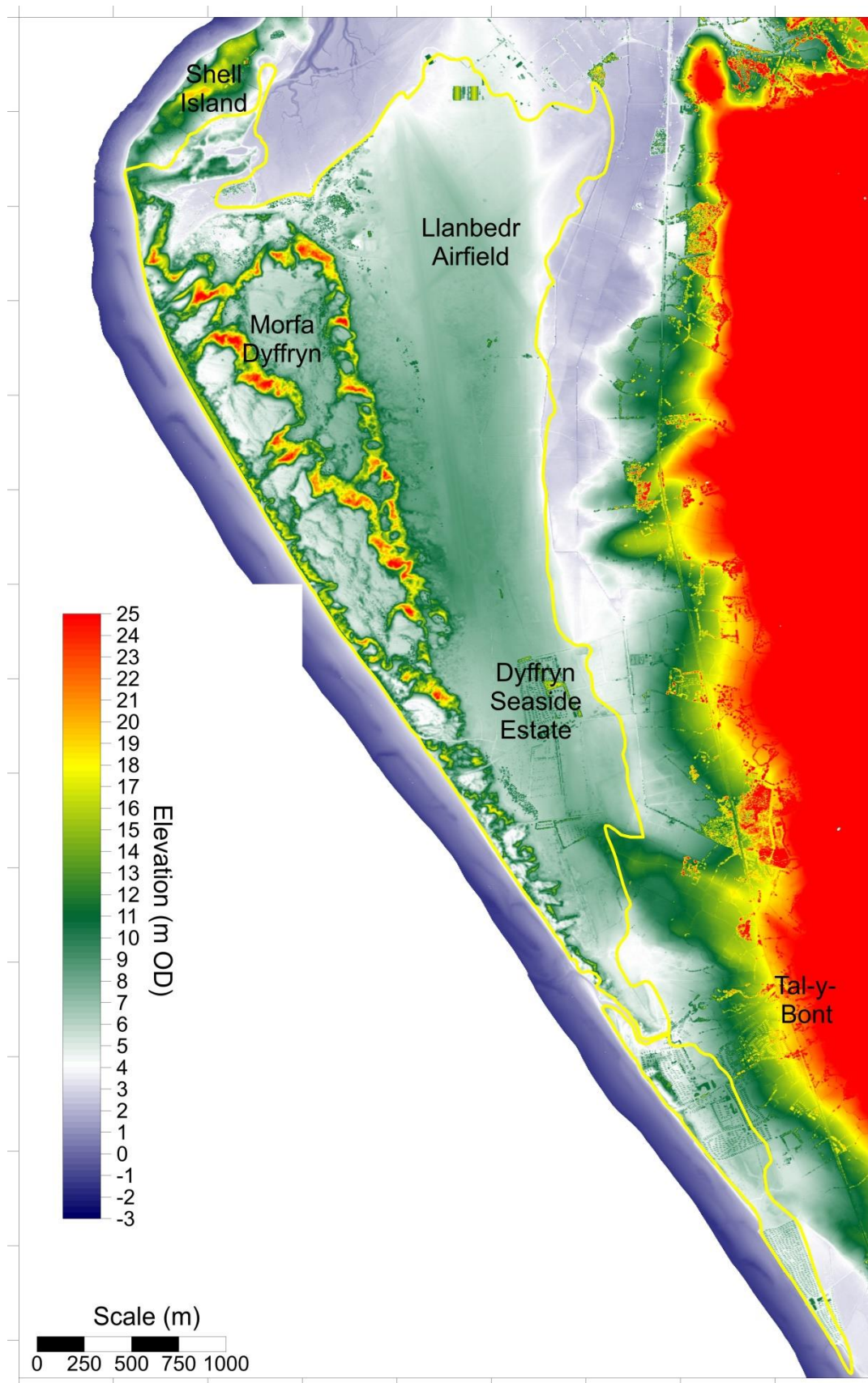
Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

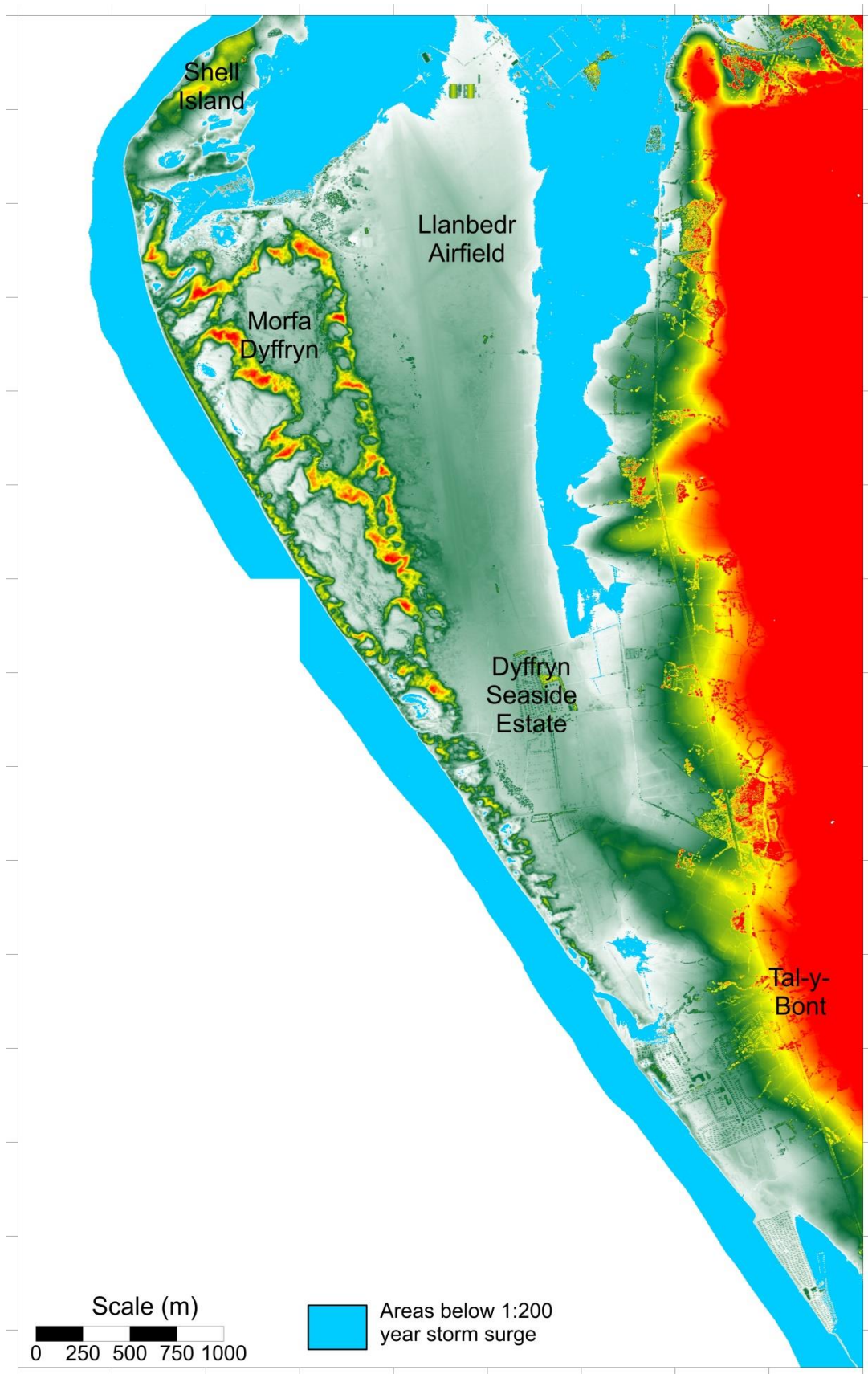
Pye K, Blott SJ. 2012. A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 5. Morfa Dyffryn. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps



Areas below the estimated 1 in 200 year storm surge level.

Site 55: Llandanwg

Site description

Morphological setting	Open coast and estuary mouth (facing Cardigan Bay, on north site of the Artro estuary)
Morphological type	Barrier spit; hummocky dunes, parabolic dunes and transgressive sand sheet with low hummocky dunes behind
Erosion/progradation status	Slowly eroding, stable where defended
Defence structures	Sea wall and sheet piling at the southern end
Hinterland type	Reclaimed marsh in north, active marsh and estuarine tidal flats in the south
Typical hinterland level	2.0 to 2.3 m OD on reclaimed marsh
Conservation designations	Morfa Dyffryn SSSI, SAC
Notable features	Parish Church of St Tanwyg and graveyard (Grade II listed building) within the dunes

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.36 m OD
1:200 year storm surge level	4.09 ± 0.2 m OD
Maximum crest level	11.36 m OD
Minimum crest level	6.17 m OD
LiDAR survey date	04/02/2015 (50 cm)
Principal aspect of dune frontage	west northwest

Frontal dune morphological parameters at selected cross-sections

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	7.77	186	177	505	373
Profile 2	6.17	174	136	229	122
Profile 3	9.04	158	149	291	183
Profile 4	11.36	176	119	381	270
Profile 5	8.99	28	22	80	61

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1199 (253800E 326735N)
Distance offshore	1.4 km
Mean wind speed	11.34 knots
Mean wind direction	228.9 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	3.82 sec
Mean peak wave period (Tp)	5.94 sec
Mean wave direction	242.0 ° (WSW)
Mean wave direction scaled for wave power	239.8 ° (WSW)
Mean annual wave power	16.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	High
Overall significance score	13.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Grazing	Minor
Rock protection to dune toe	Significant
Steel revetment to part of dune toe	Significant

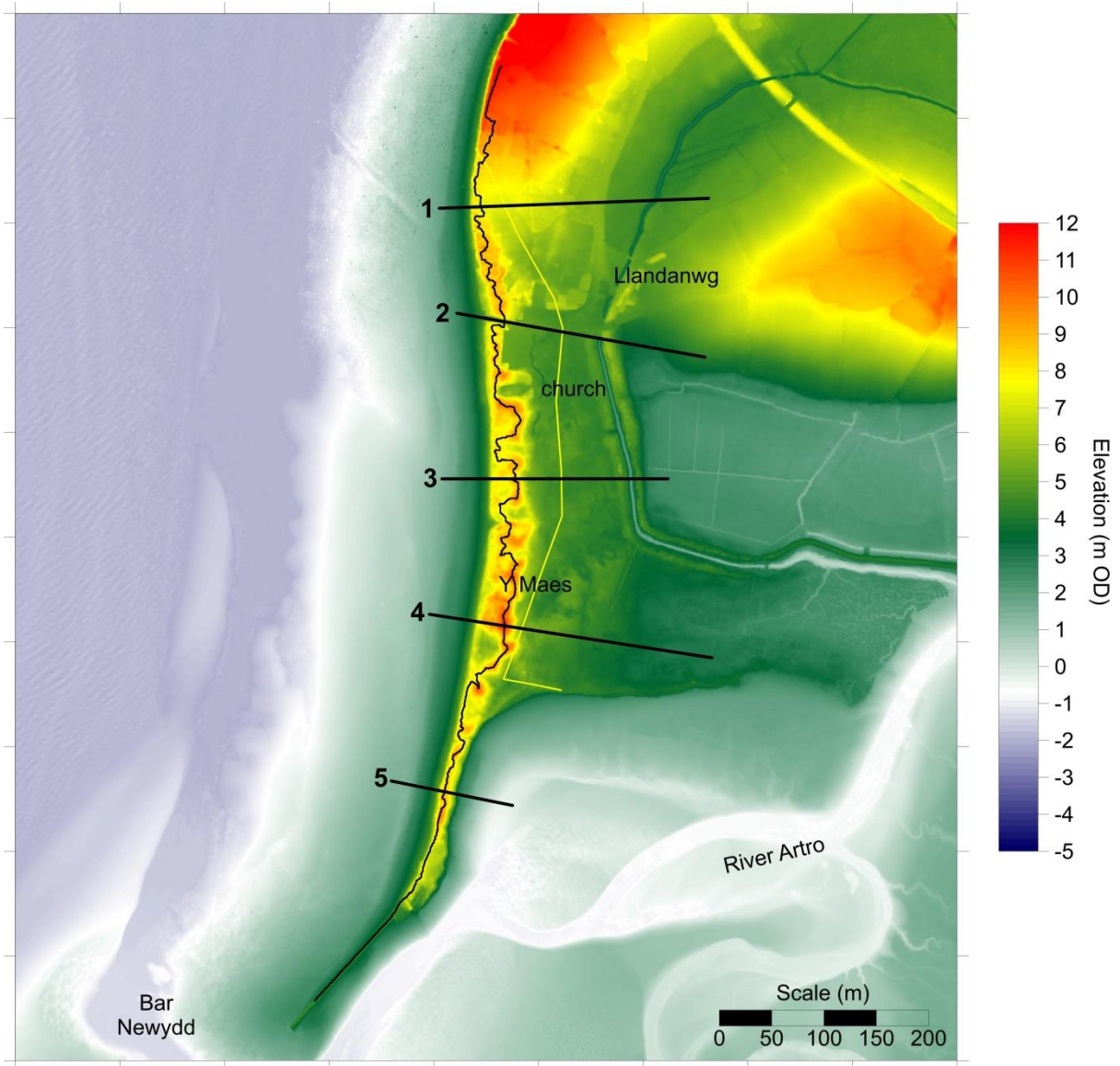
Further information

Gwynedd Council Coast Protection Unit (2003) North Cardigan Shoreline Management Plan (CD Version)

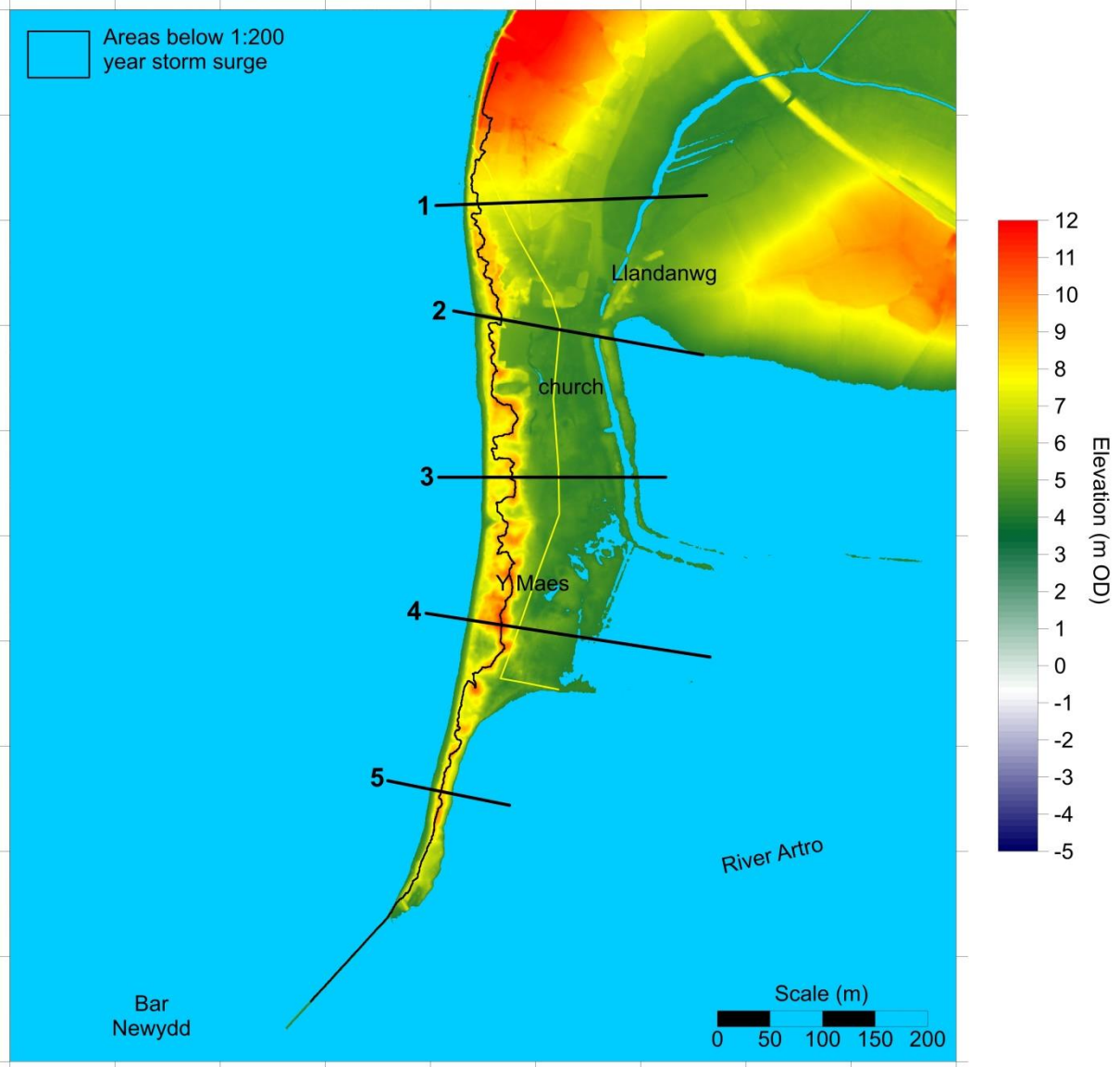
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



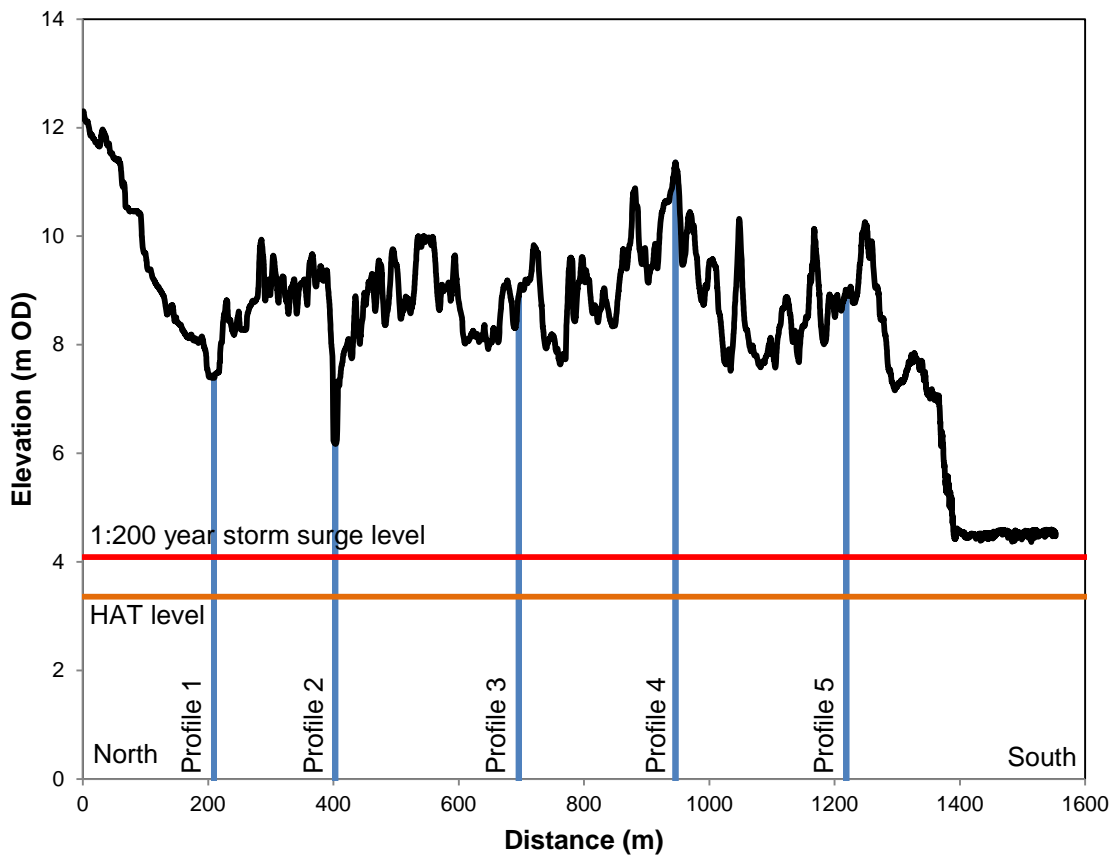
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



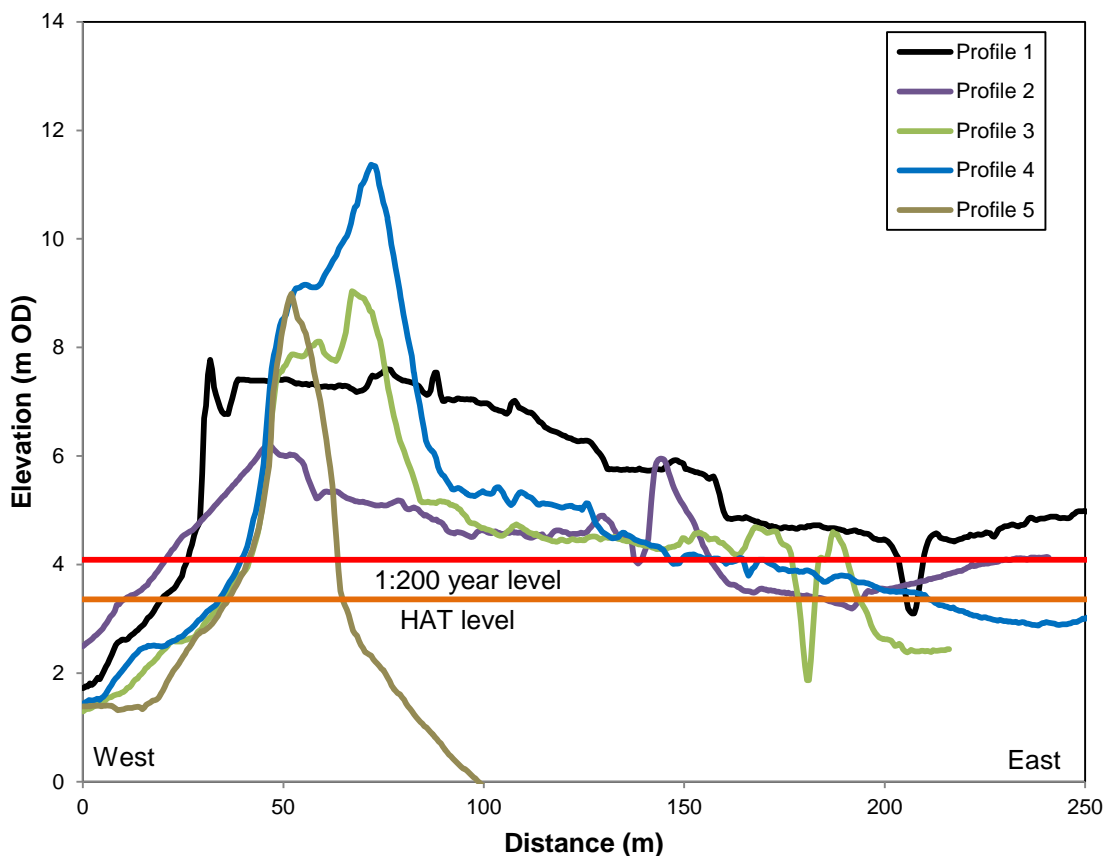
LiDAR digital terrain model, flown 4 February 2015. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 56: Morfa Harlech

Site description

Morphological setting	Bay and estuary (Tremadoc Bay, adjacent to Glaslyn – Dwyrdd estuary)
Morphological type	Estuary mouth barrier spit; foredune ridges and small parabolic dunes on multiple shingle ridges, large transgressive long-walled parabolic dune, transgressive sand sheets with low hummocky dunes behind
Erosion/progradation status	Largely stable in S, prograding in centre and N
Defence structures	None
Hinterland type	Golf course, managed forest, grazing land and agricultural fields on reclaimed marshland, caravan site, waste management facility, road, railway, adjoin buildings and shops
Typical hinterland level	6-8 m on reclaimed marshland
Conservation designations	Morfa Harlech SSSI, SAC, NNR, National Park
Notable features	Royal St David's Golf Club, Harlech Castle

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.40 m OD
1:200 year storm surge level	4.08 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1199 (253800E 326735N)
Distance offshore	1.4 km
Mean wind speed	11.34 knots
Mean wind direction	228.9 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	3.82 sec
Mean peak wave period (Tp)	5.94 sec
Mean wave direction	242.0 ° (WSW)
Mean wave direction scaled for wave power	239.8 ° (WSW)
Mean annual wave power	16.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 17; LD)	172-246 µm (average: 206 µm)
Calcium carbonate content (%) (N= 5)	1.98-3.03% (average: 2.39%)
Silica content (%) (N= 5)	90.4-92.5% (average: 91.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	High
Economic / Military	Low / Medium
Historical / Archaeological	Low
Overall significance score	15
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

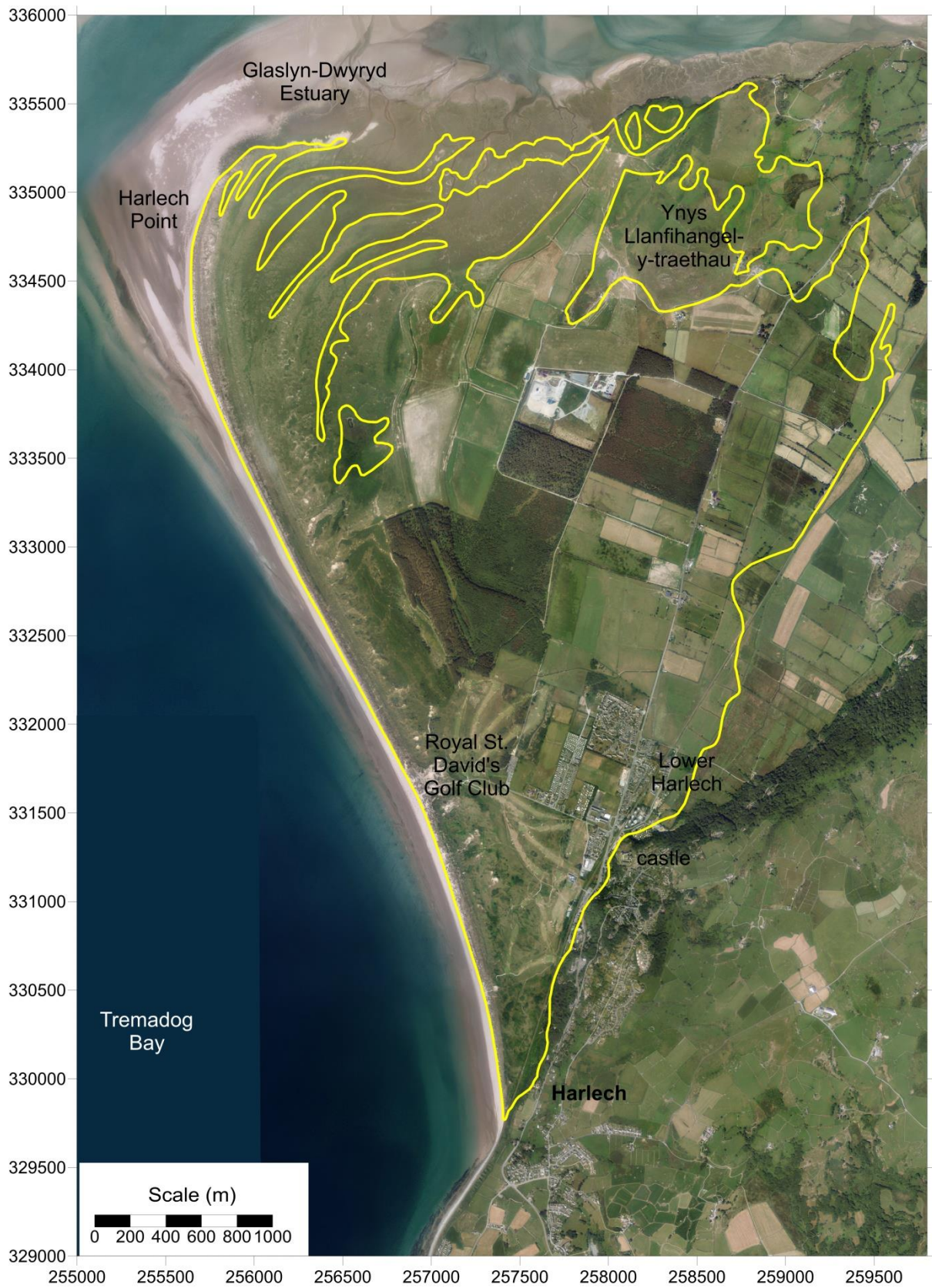
Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Boardwalks	Minor
Grazing	Significant
Scrub clearance	Significant
Tree felling	Significant

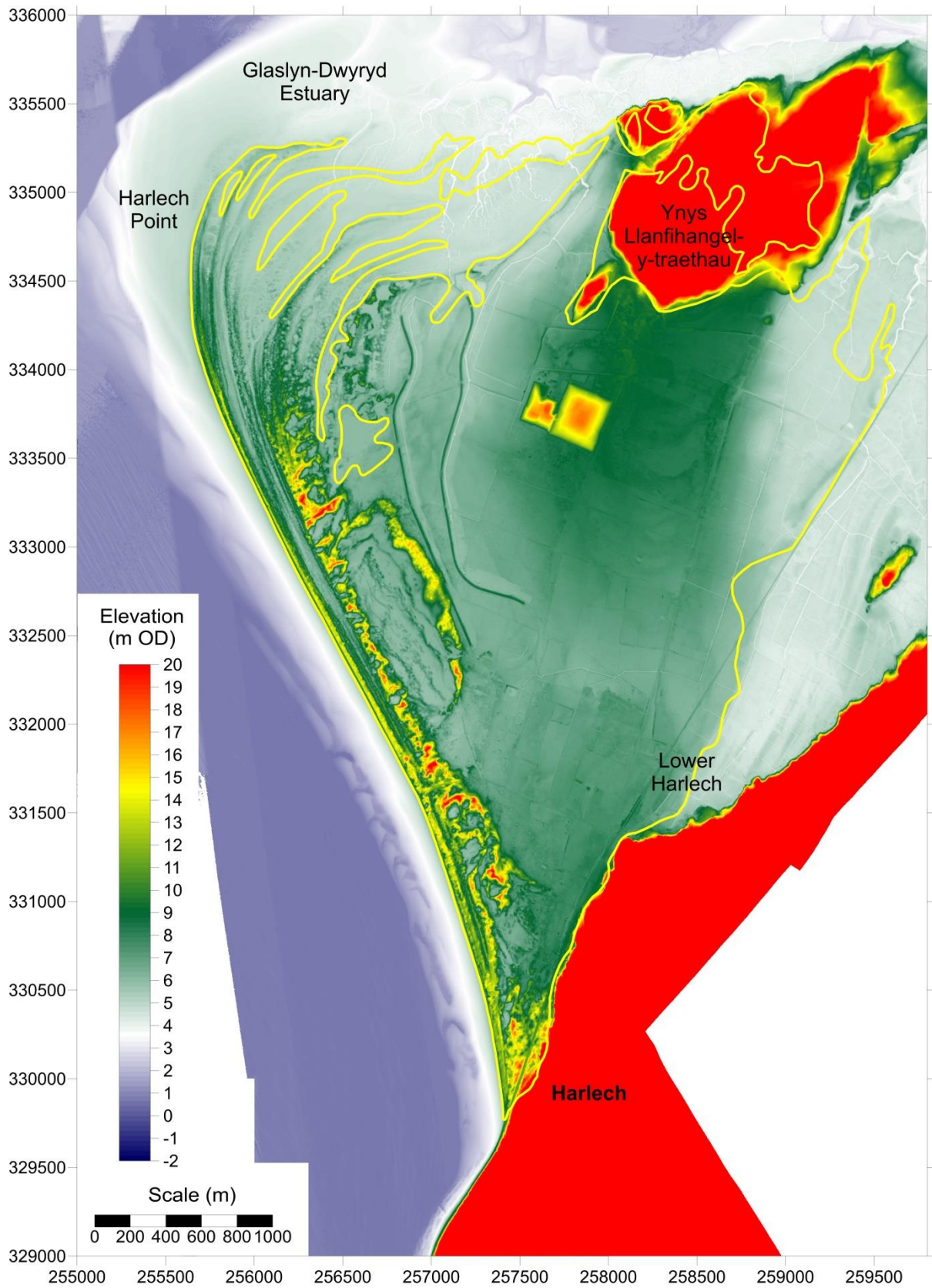
Sources of further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

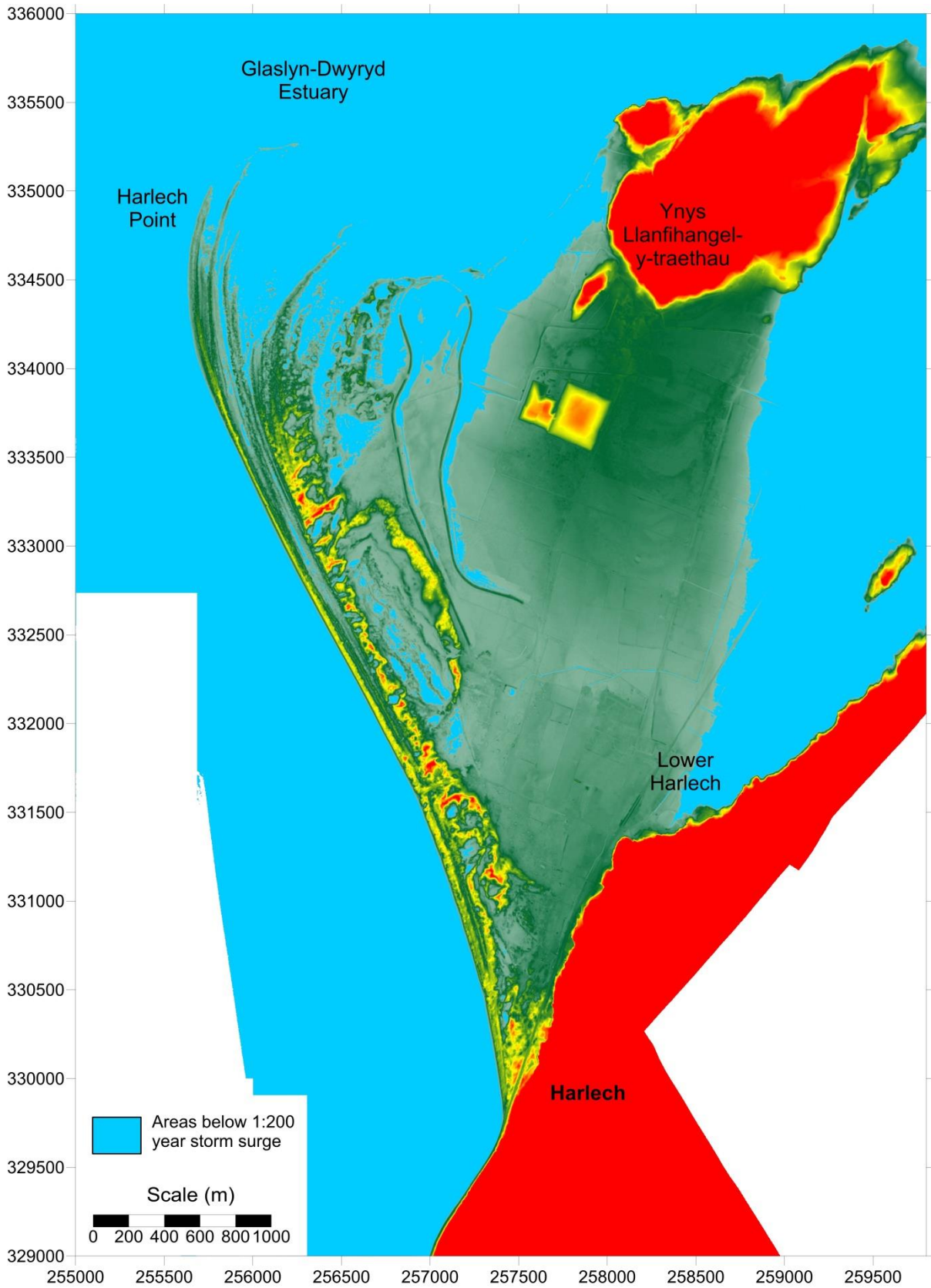
Pye K, Blott SJ. 2012. A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 4. Morfa Harlech. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 57: Morfa Bychan

Site description

Morphological setting	Bay and estuary (Tremadoc Bay, adjacent to Glaslyn – Dyrwyd estuary)
Morphological type	Multiple foredune ridges overlying shingle ridges / spits which have formed within a rock-bound sub-embayment; thin sandsheet with low hummocky dunes comprising the Morfa behind the frontal dunes; one large parabolic dune at eastern end of the system, north of the Ynys Cyngar islet, formed by easterly winds blowing down the Glaslyn valley
Erosion/progradation status	Long-term net accretion, now net stable / slowly prograding but temporally and spatially variable in response to fluctuations in storminess which affect Black Rock Sands beach
Defence structures	None
Hinterland type	Caravan site, golf course, agriculture
Typical hinterland level	3.6 to 4.7 m OD
Conservation designations	Tiroedd A Glannau Rhwng Cricieth Ac Afon Glaslyn SSSI, SAC, National Park
Notable features	Morfa Bychan Holiday park; Black Rock Sands holiday and Camping Ground; large stabilised parabolic dune at eastern end of system

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.40 m OD
1:200 year storm surge level	4.07 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	South southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1199 (253800E 326735N)
Distance offshore	1.4 km
Mean wind speed	11.34 knots
Mean wind direction	228.9 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	3.82 sec
Mean peak wave period (Tp)	5.94 sec
Mean wave direction	242.0 ° (WSW)
Mean wave direction scaled for wave power	239.8 ° (WSW)
Mean annual wave power	16.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 12; LD)	159-196 µm (average: 175 µm)
Calcium carbonate content (%) (N= 3)	0.55-1.55% (average: 1.05%)
Silica content (%) (N= 3)	90.9-93.3% (average: 92.1%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Very High
Geomorphological Features	Medium
Recreation	High
Economic / Military	Medium
Historical / Archaeological	Low
Overall significance score	13.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

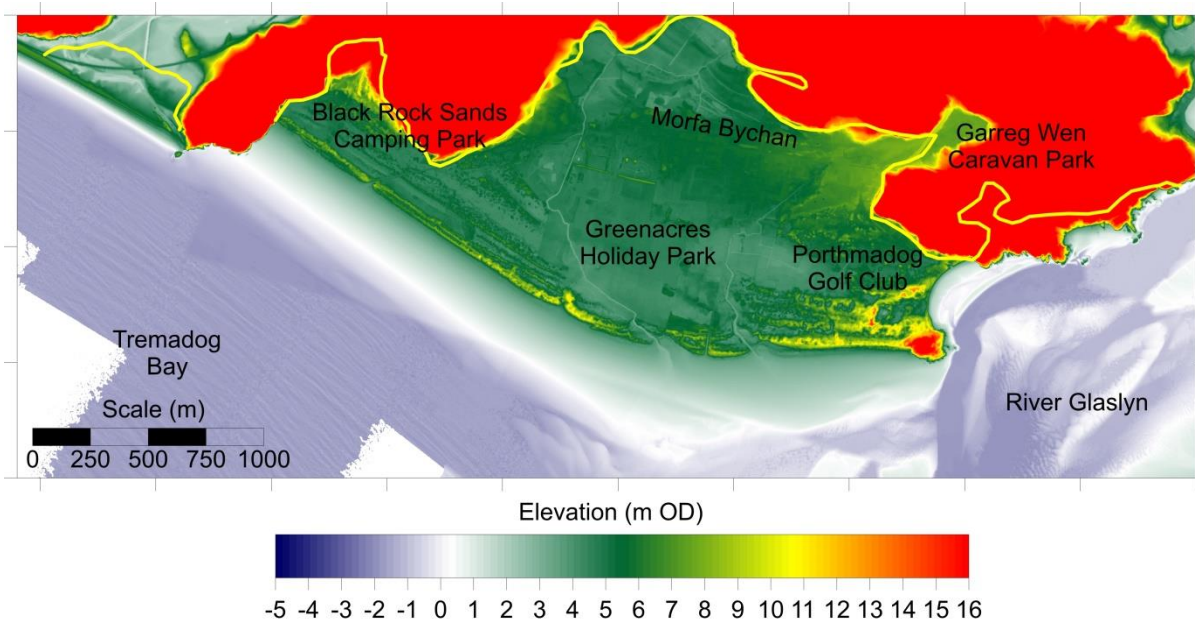
Fencing	Significant
Marram planting	Minor
Grazing	Significant
Scrub clearance	Minor

Further information

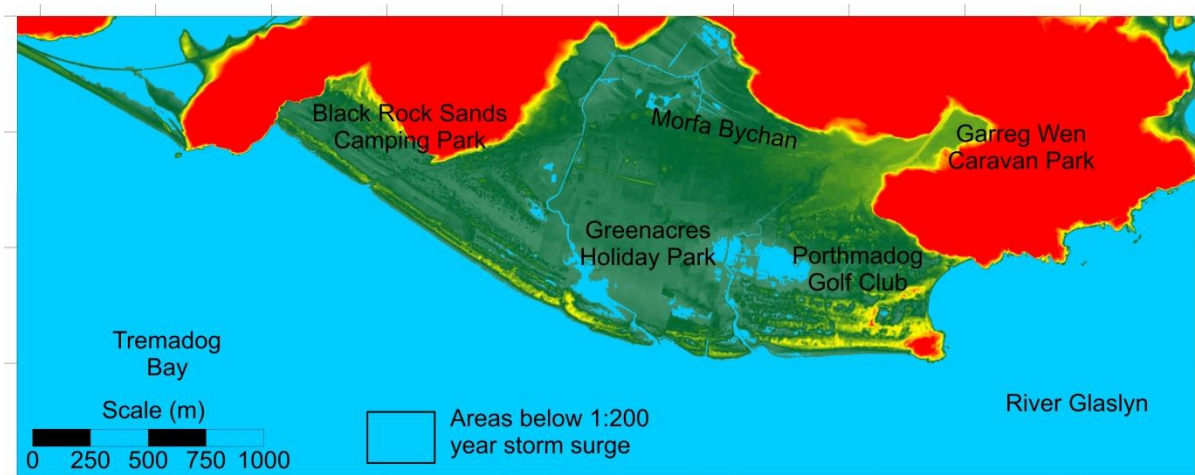
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 58: Morfa Abererch to Pwllheli

Site description

Morphological setting	Bay (Tremadoc Bay)
Morphological type	Fringing, climbing, cliff top to east of Abererch, barrier spits around mouth of Dwyfor River, fringing east of Pwllheli
Erosion/progradation status	Stable (mainly where defended), slowly eroding where undefended
Defence structures	Rock armour, sand fencing; sea walls and groynes at Criccieth
Hinterland type	Reclaimed marshland, Cambrian Coast railway, car parks and industrial use at Pwllheli and Criccieth, caravan parks
Typical hinterland level	0.8 to 2.2 m OD on reclaimed marsh
Conservation designations	Abererch SSSI, (SAC below MLW)
Notable features	Haven Caravan Holiday Park east of Pwllheli

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.36 m OD
1:200 year storm surge level	4.05 ± 0.2 m OD
Maximum crest level	12.81 m OD
Minimum crest level	4.78 m OD
LiDAR survey date	04/02/2015 (50 cm)
Principal aspect of dune frontage	south-southwest

Dune barrier parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	11.15	219	210	770	623
Profile 2	9.61	43	26	89	63
Profile 3	12.81	104	83	208	148
Profile 4	4.78	49	19	37	11
Profile 5	10.75	318	296	1417	1204
Profile 6	7.36	Above HAT	196	Above HAT	286

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1200 (244831E 326803N)
Distance offshore	8.8 km
Mean wind speed	12.38 knots
Mean wind direction	230.5 ° (SW)
Mean significant wave height (Hs)	0.67 m
Mean zero up-crossing period (Tz)	3.67 sec
Mean peak wave period (Tp)	5.62 sec
Mean wave direction	234.5 ° (SW)
Mean wave direction scaled for wave power	229.9 ° (SW)
Mean annual wave power	16.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 13; LD)	202-476 µm (average: 373 µm)
Calcium carbonate content (%) (N= 3)	0.27-0.91% (average: 0.64%)
Silica content (%) (N= 3)	92-96.2% (average: 93.8%)

Dune site importance and SMP2 Policy

	Site 58a	Site 58b	Site 58c
Flood and Coastal Erosion Risk Management	Very High	Very High	Very High
Nature Conservation Designation	Medium	Low	Low
Geomorphological Features	Medium	Low	Low
Recreation	Medium	High	Low
Economic / Military	Low	Medium	Low
Historical / Archaeological	Low	Low	Low
Overall significance score	12	12	9
SMP2 Policy in Epoch 1	NAI	HTL	HTL
SMP2 Policy in Epoch 2	NAI	MR	HTL
SMP2 Policy in Epoch 3	NAI	MR	HTL

Current and past dune and beach management measures

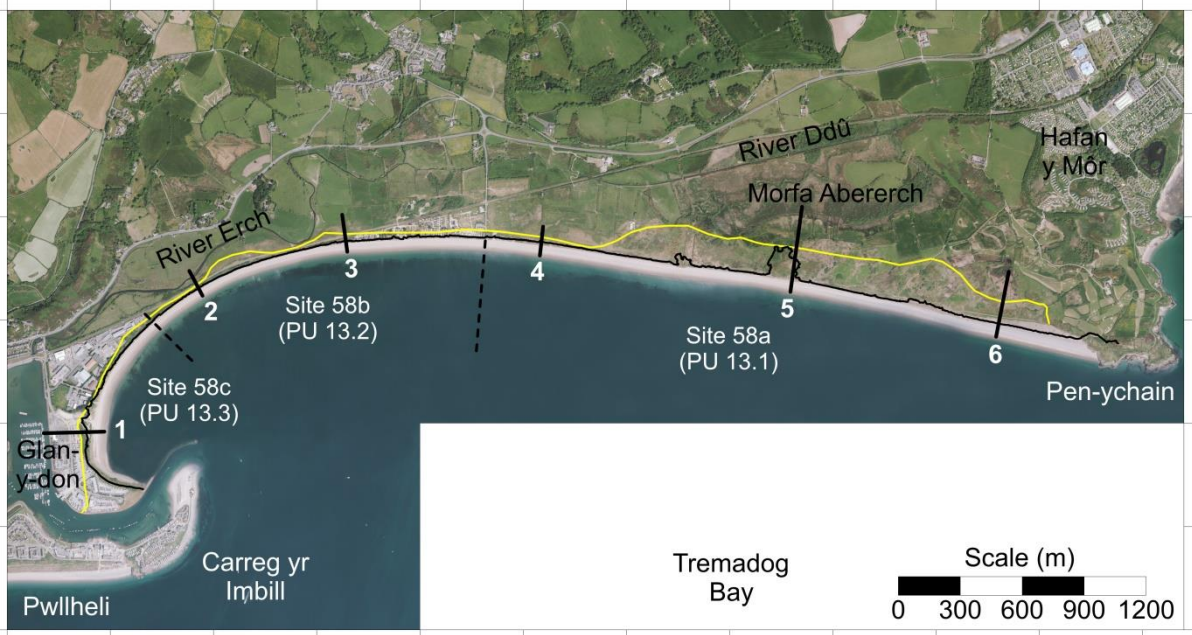
Fencing	Significant
Marram planting	Minor
Grazing	Significant
Rock armour protection to dune toe	Significant
Steel / plastic bulkhead protection to dune toe	Significant
Beach and dune nourishment	Significant

Further information

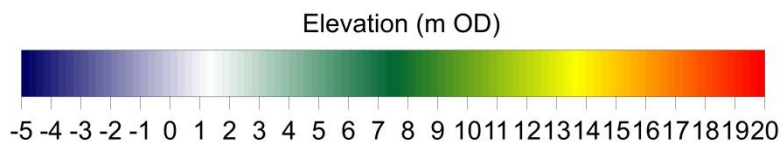
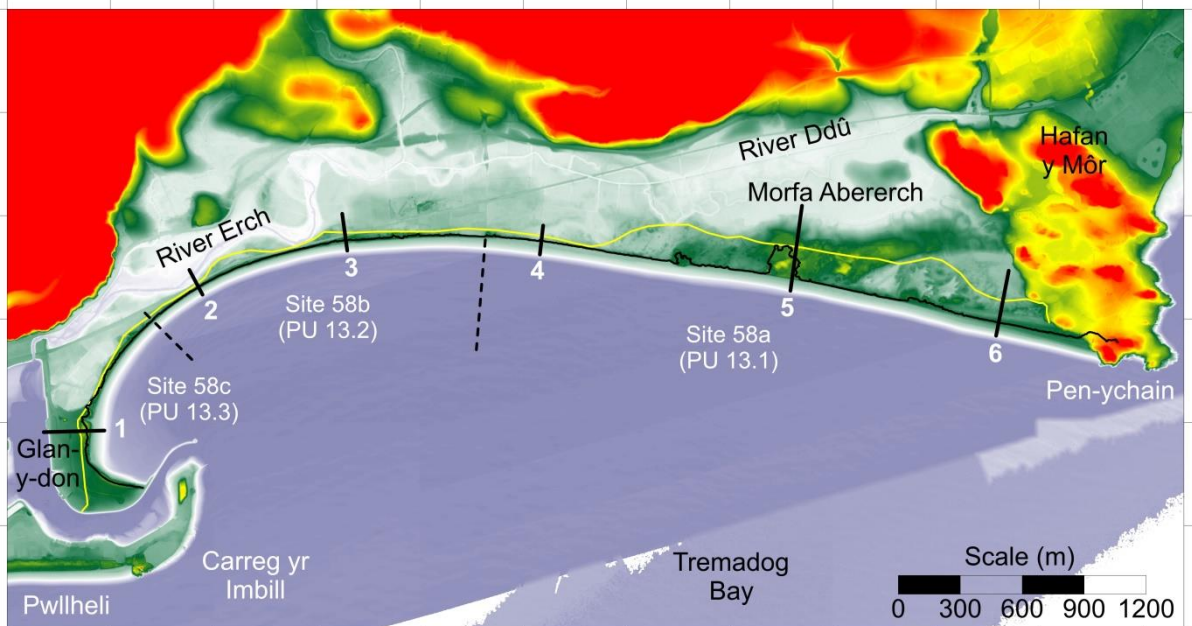
Halcrow. 2005. Abererch Feasibility Study Conceptual Model Report. Report to the Environment Agency Wales, Halcrow Group, Exeter.

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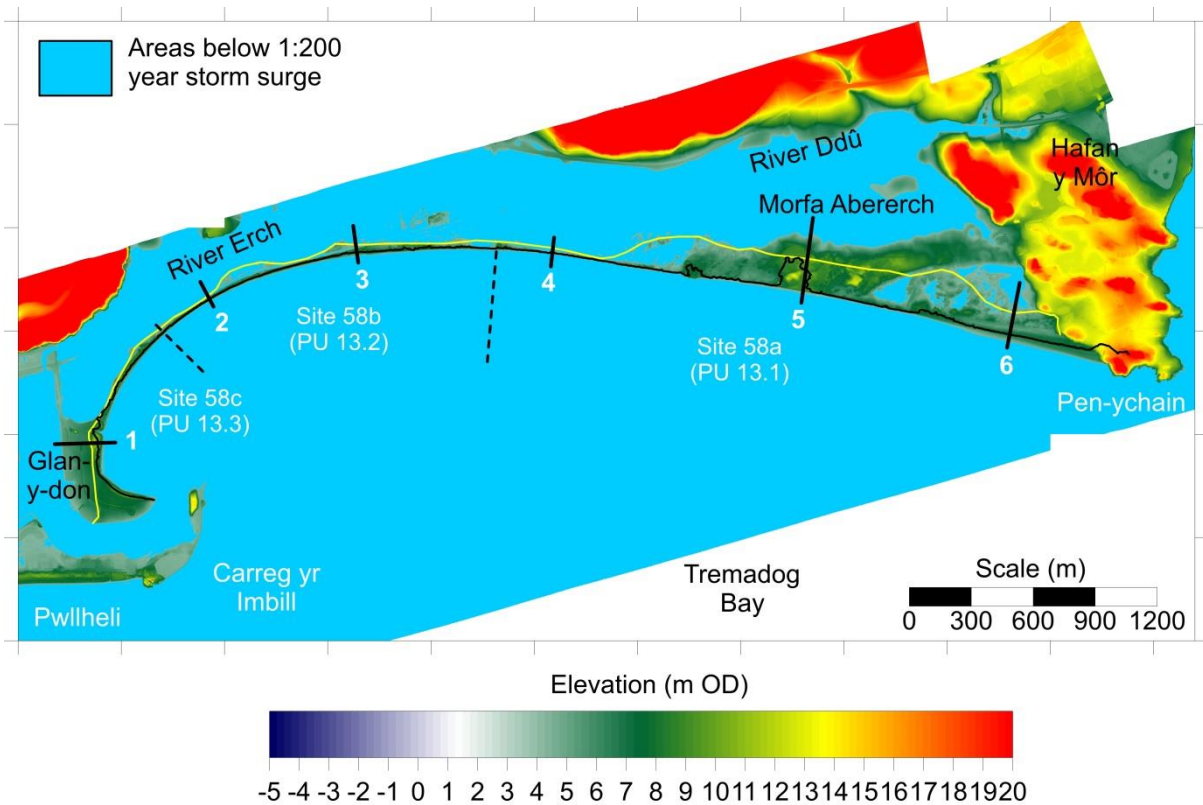
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



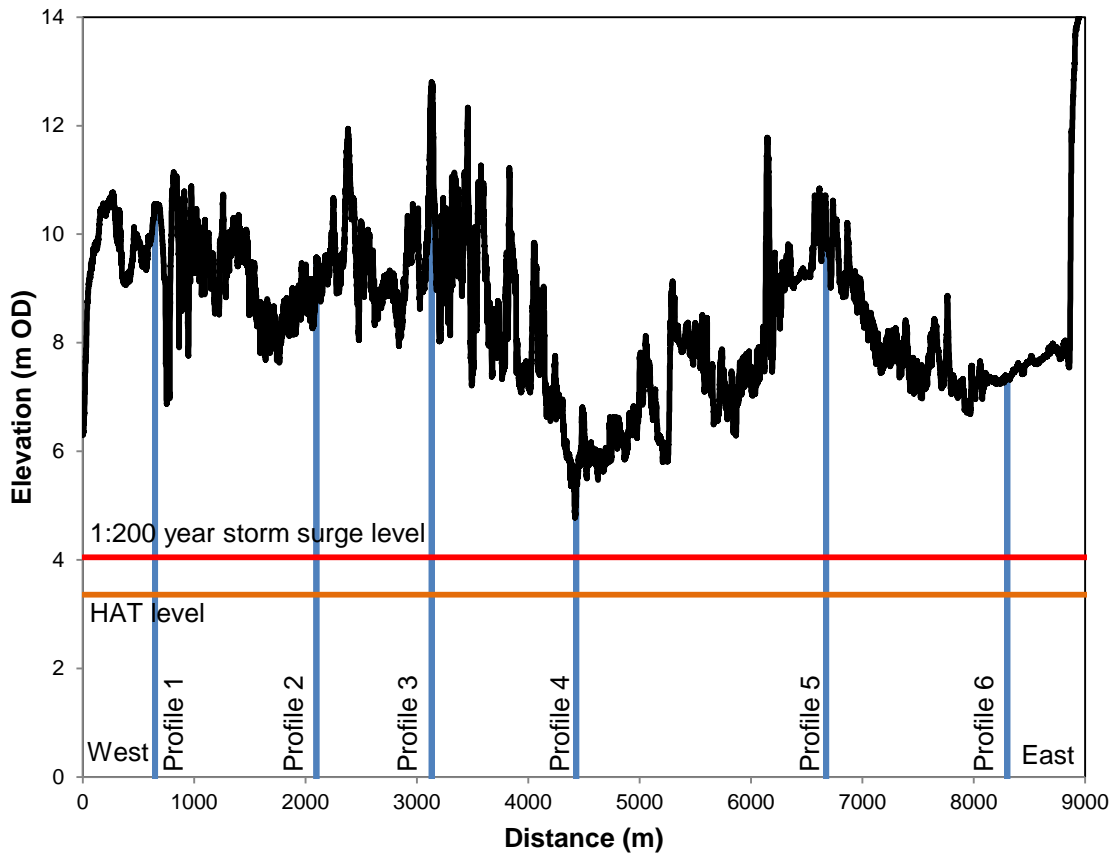
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



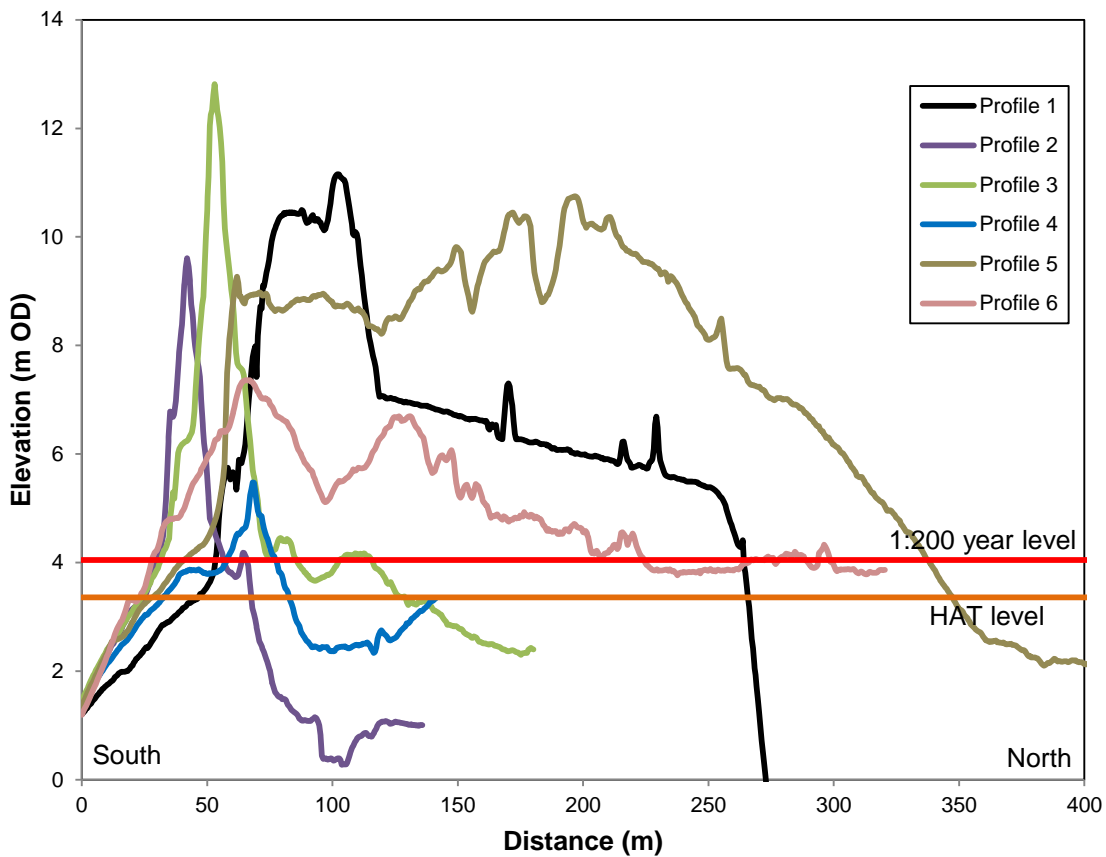
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 59: Pwllheli and Traeth Crugan

Site description

Morphological setting	Bay (Tremadoc Bay)
Morphological type	Dune-capped barrier tombolo linking Carreg y Ibill (Gimlet Rock) with the headland at the western end of Traeth Crugan
Erosion/progradation status	Stable (mostly defended)
Defence structures	Rock armour in the centre and at western end of the site, sheet piling at the eastern end; dune creation works in front of West End promenade
Hinterland type	Golf course, grazing land and arable fields behind western half of the barrier, housing, hotels, marina and industrial units behind the eastern half
Typical hinterland level	1.5 to 2.2 m OD on reclaimed marsh 2.5 to 4.2 m OD in housing areas
Conservation designations	Mynydd Tir Y Cwmwd A'r Glannau At Garreg Yr Imbill SSSI, SAC
Notable features	Pwllheli Golf Club, West End Promenade, Pwllheli Marina

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.36 m OD
1:200 year storm surge level	4.03 ± 0.2 m OD
Maximum crest level	11.30 m OD
Minimum crest level	5.89 m OD
LiDAR survey date	04/02/2015 (50 cm)
Principal aspect of dune frontage	South southeast

Frontal dune morphological parameters at selected cross-sectional profiles, calculated from LiDAR survey flown 04/02/2015

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	5.89	17	12	27	17
Profile 2	7.85	121	50	127	66
Profile 3	8.43	135	85	203	132
Profile 4	7.43	169	153	342	234
Profile 5	11.30	263	252	532	359
Profile 6	7.58	115	101	209	135

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1195 (235929E 326863N)
Distance offshore	4.8 km
Mean wind speed	14.84 knots
Mean wind direction	234.5 ° (SW)
Mean significant wave height (Hs)	0.62 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.25 sec
Mean wave direction	218.4 ° (SW)
Mean wave direction scaled for wave power	210.5 ° (SSW)
Mean annual wave power	13.6 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 12; LD)	387-513 µm (average: 438 µm)
Calcium carbonate content (%) (N= 3)	0.57-0.98% (average: 0.79%)
Silica content (%) (N= 3)	93.3-94.8% (average: 94.2%)

Dune site importance and SMP2 Policy

	Site 59a	Site 59b	Site 59c
Flood and Coastal Erosion Risk Management (FCERM)	High	High	High
Nature Conservation Designation	High	High	High
Geomorphological Features	Low	Low	Low
Recreation	High	High	Low
Economic / Military	Medium	Medium	Low
Historical / Archaeological	Low	Low	Low
Overall significance score	13	13	10
SMP2 Policy in Epoch 1	HTL	HTL	HTL
SMP2 Policy in Epoch 2	HTL	MR	MR
SMP2 Policy in Epoch 3	HTL	MR	MR

Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Grazing	Minor
Scrub clearance	Minor
Rock armour protection to dune toe	Significant
Beach and dune nourishment	Significant

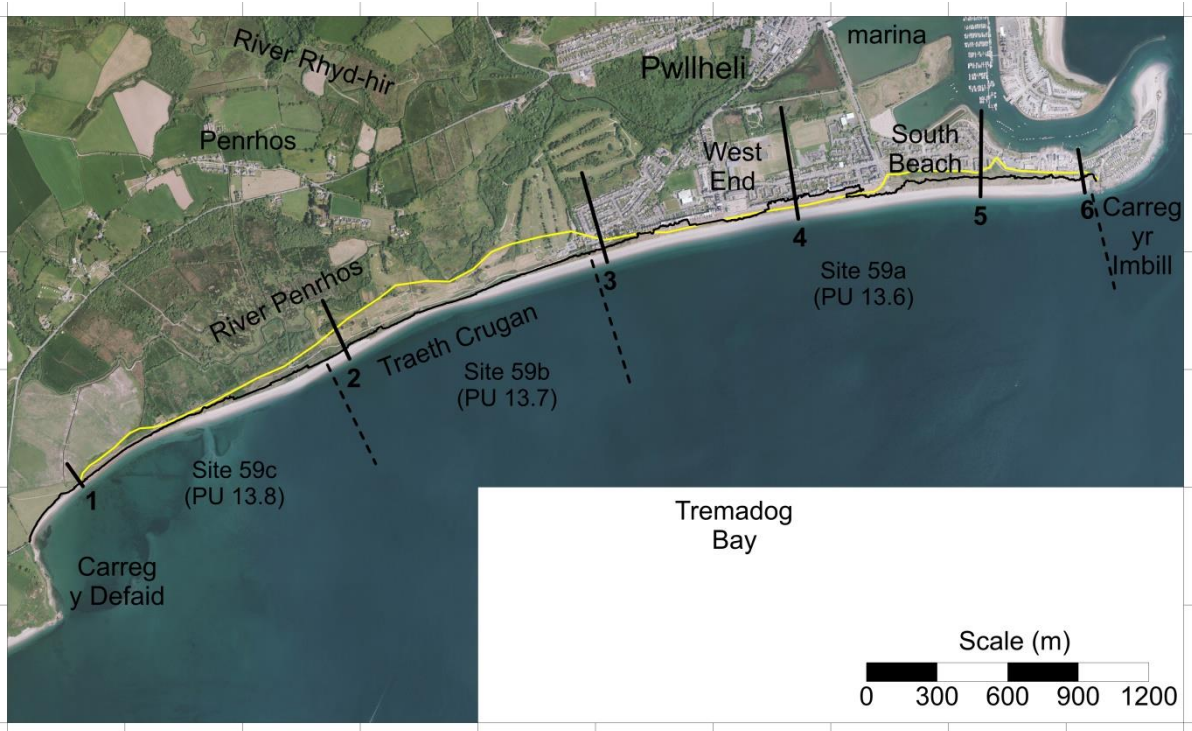
Further information

Faber Maunsell (2008) Traeth Crugan – Pwllheli Coastal Defence. Options Study. Final Report. Birkenhead.

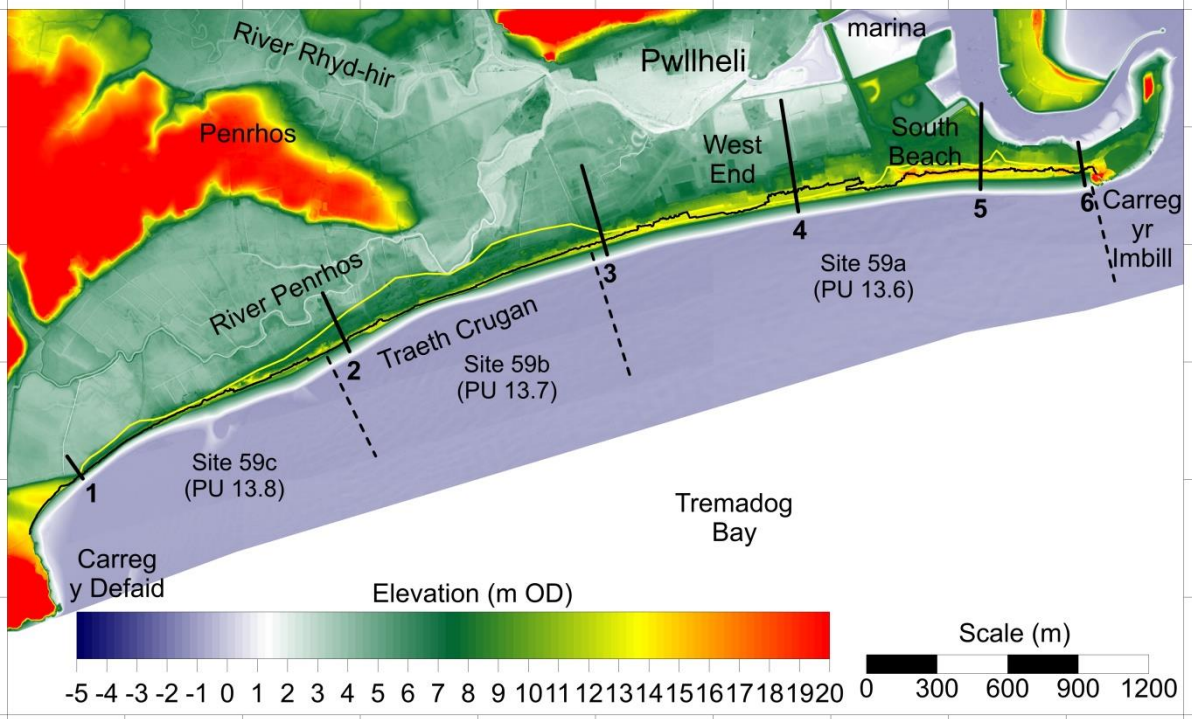
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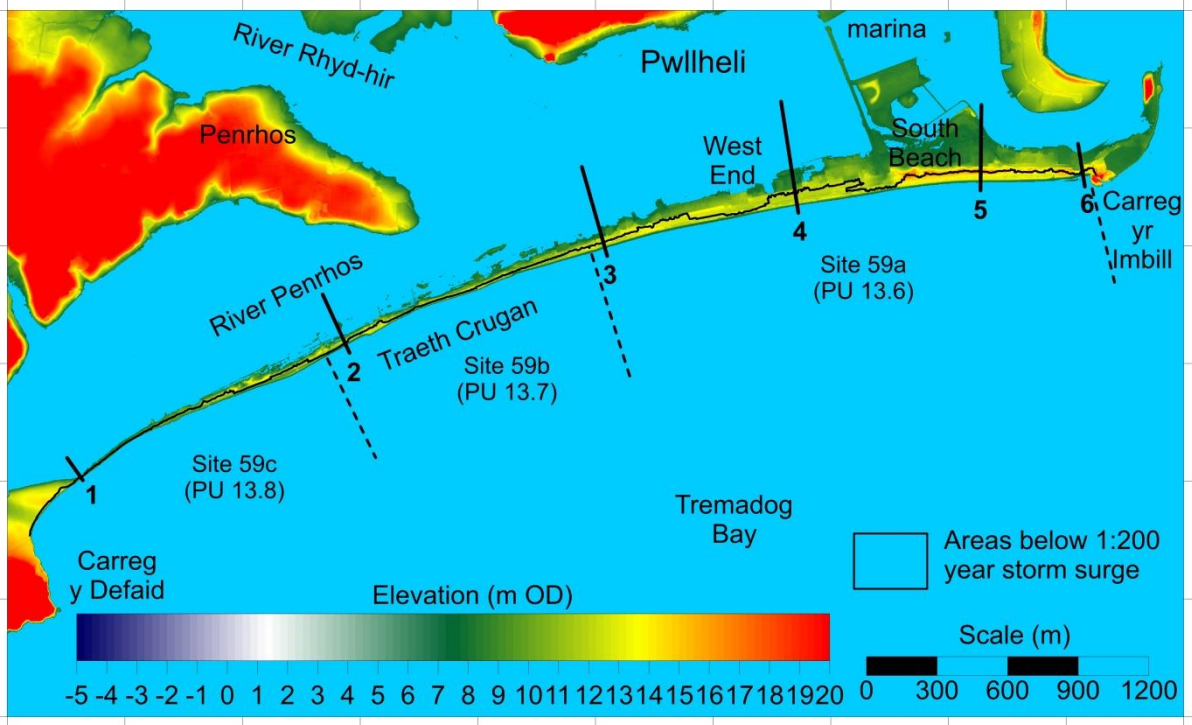
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



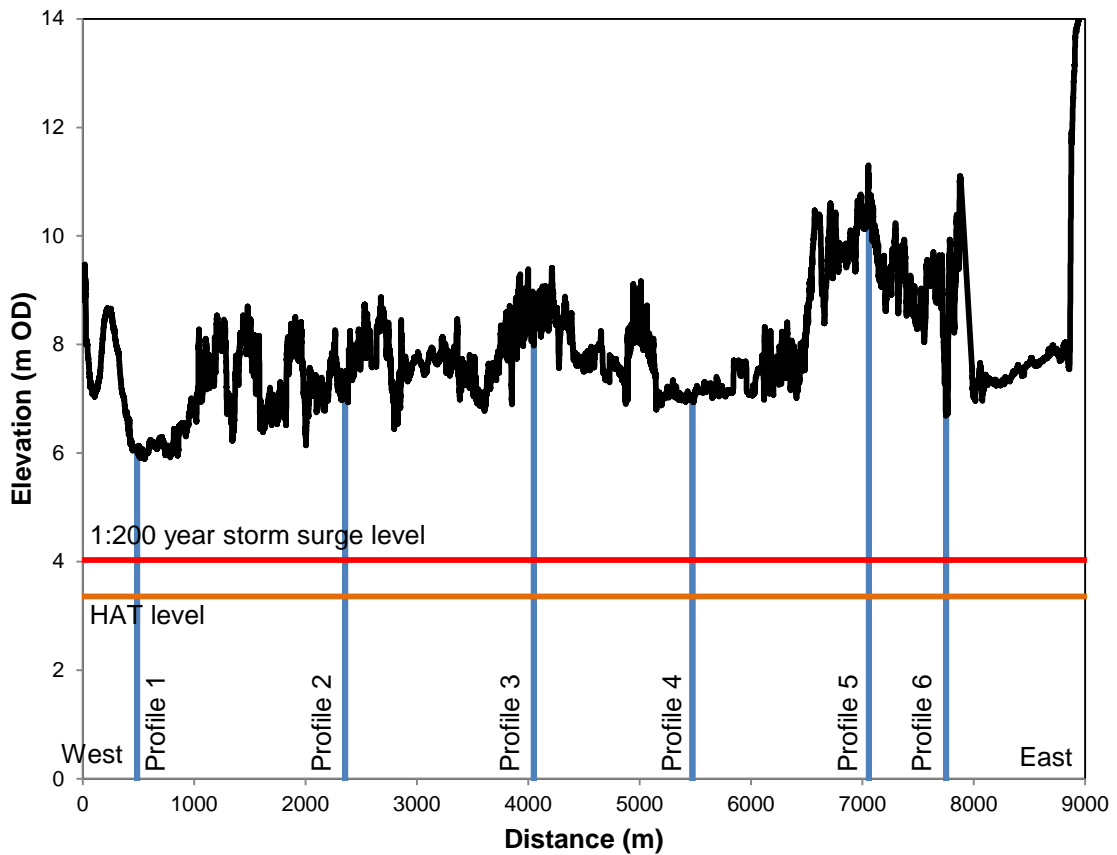
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



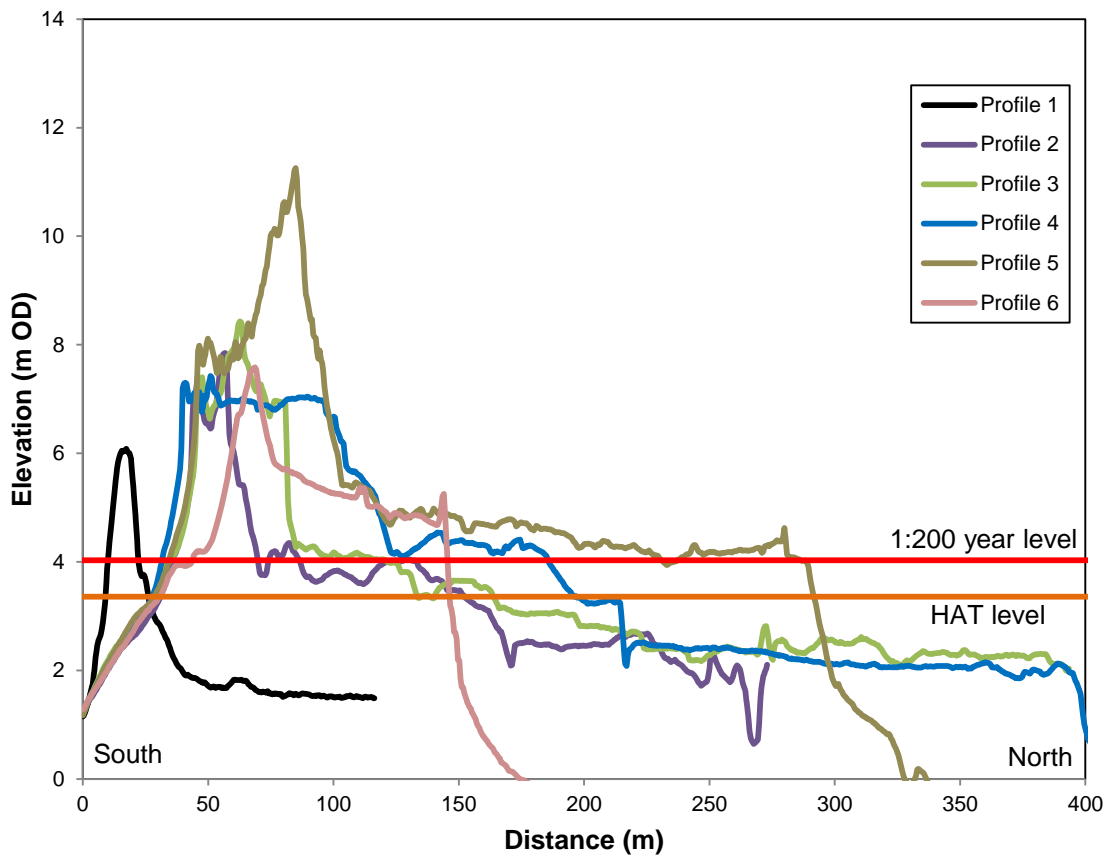
LiDAR digital terrain model, flown 4 February 2015. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 60: The Warren, Abersoch

Site description

Morphological setting	Bay (Tremadoc Bay)
Morphological type	Fringing and climbing
Erosion/progradation status	Stable, locally prograding
Defence structures	None
Hinterland type	Chalet and caravan parks, agricultural
Typical hinterland level	4.0 to 6.0 m OD
Conservation designations	None (adjacent to SAC)
Notable features	Abersoch Holiday Park

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.16 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.97 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	09/01/2013
Principal aspect of dune frontage	south southeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1195 (235929E 326863N)
Distance offshore	4.8 km
Mean wind speed	14.84 knots
Mean wind direction	234.5 ° (SW)
Mean significant wave height (Hs)	0.62 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.25 sec
Mean wave direction	218.4 ° (SW)
Mean wave direction scaled for wave power	210.5 ° (SSW)
Mean annual wave power	13.6 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 8; LD)	236-302 µm (average: 261 µm)
Calcium carbonate content (%) (N= 3)	3.05-3.44% (average: 3.25%)
Silica content (%) (N= 3)	89-90.7% (average: 89.9%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Medium
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Grazing	Minor
Scrub clearance	Minor
Rock armour protection to dune toe	Significant

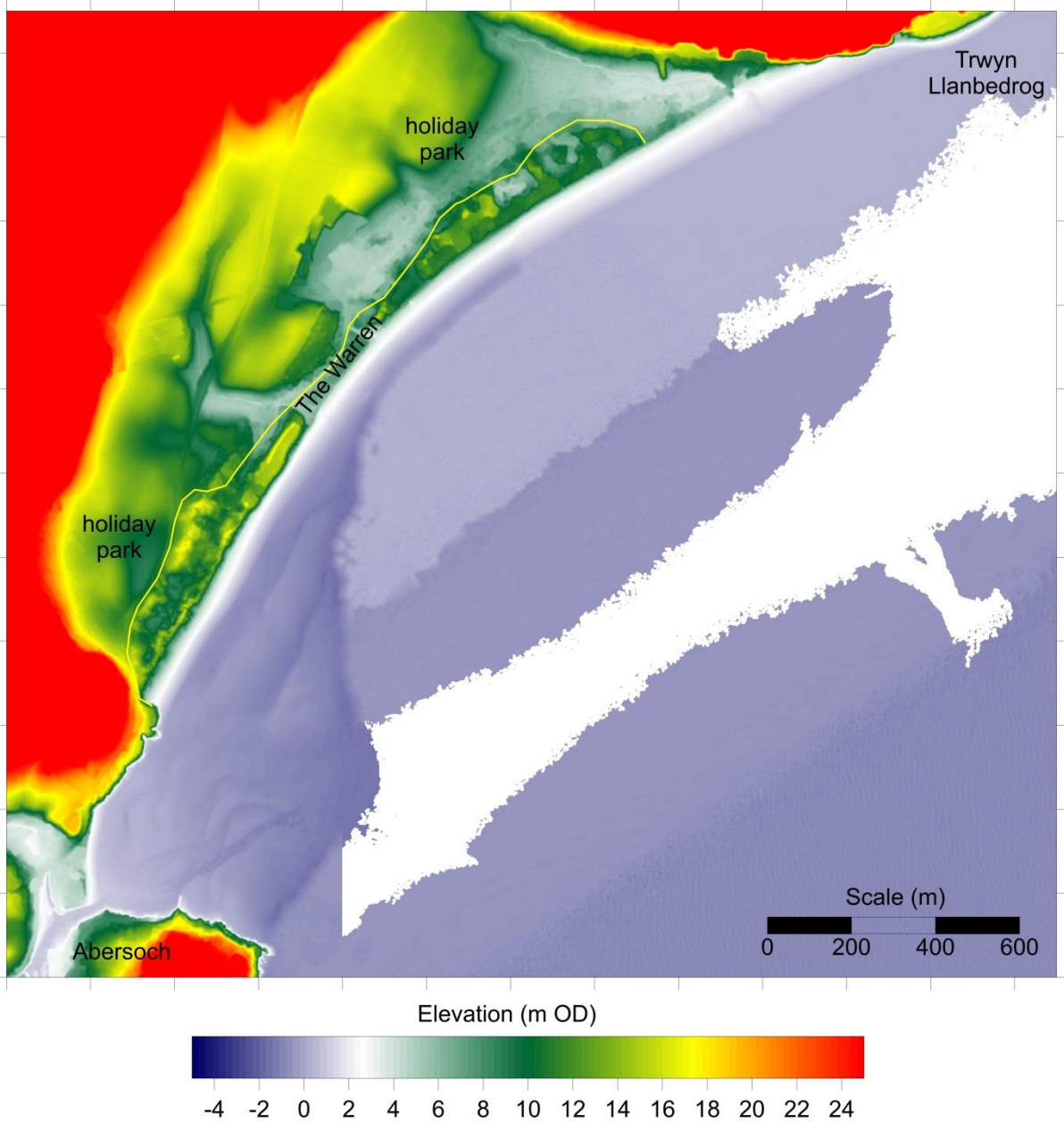
Further information

Gwynedd Council Coast Protection Unit (2003) North Cardigan Shoreline Management Plan (CD Version)

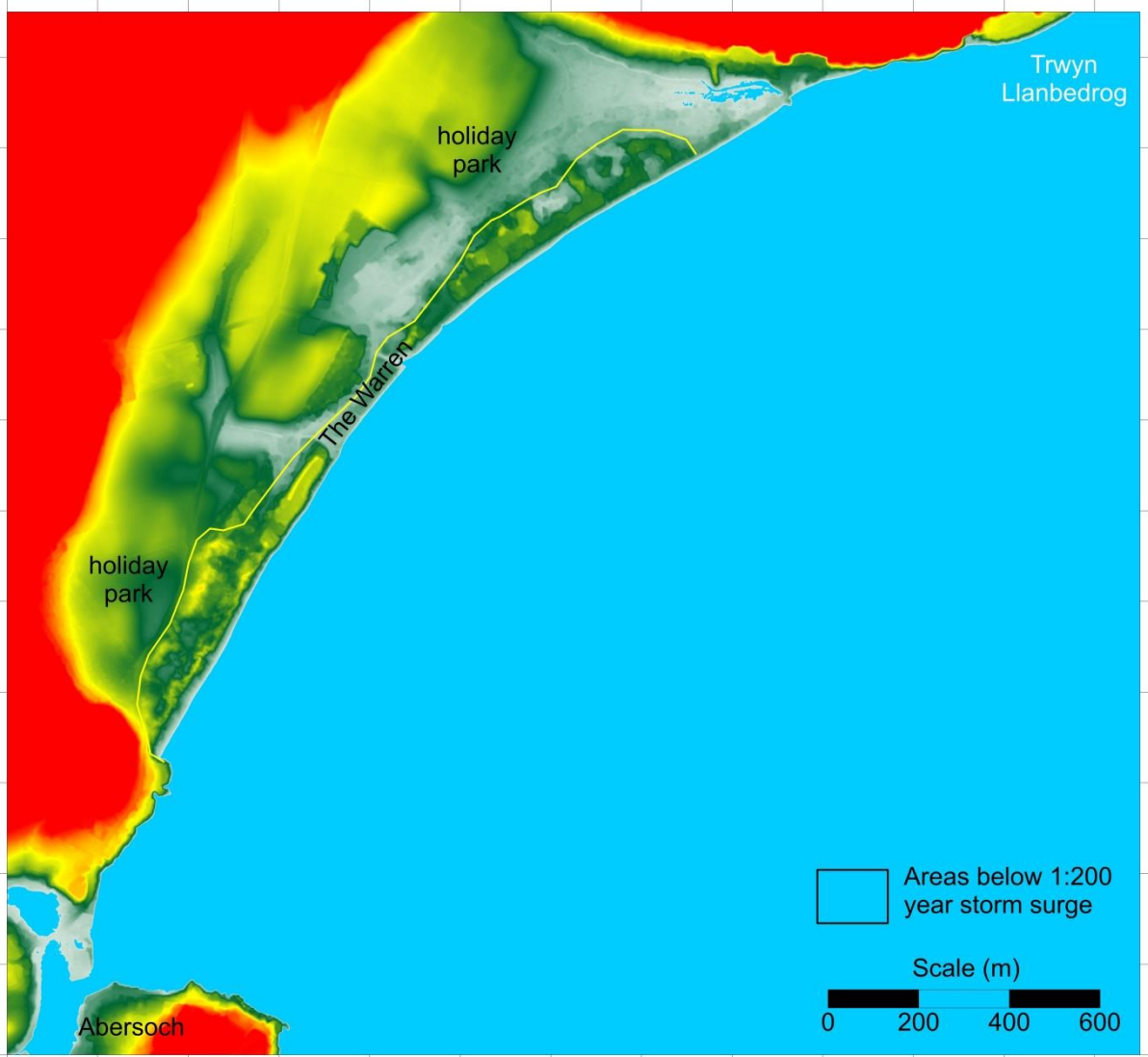
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 61: Morfa Gors, Abersoch

Site description

Morphological setting	Bay (Tremadoc Bay)
Morphological type	Fringing and climbing
Erosion/progradation status	Stable (mostly defended)
Defence structures	Sea wall and groynes in S, two boat ramps
Hinterland type	Golf course, woodland, housing
Typical hinterland level	2.7 to 3.4 m OD
Conservation designations	None (adjacent to SAC)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.16 m OD
1:200 year storm surge level	3.91 ± 0.2 m OD
Maximum crest level	17.27 m OD
Minimum crest level	4.85 m OD
LiDAR survey date	09/01/2013
Principal aspect of dune frontage	southeast to northeast

Dune barrier parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	6.56	Above HAT	47	Above HAT	48
Profile 2	6.36	138	89	177	101
Profile 3	9.75	242	43	367	148
Profile 4	13.84	268	71	706	245
Profile 5	9.46	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 6	15.05	Above HAT	Above 1:200	Above HAT	Above 1:200

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1195 (235929E 326863N)
Distance offshore	4.8 km
Mean wind speed	14.84 knots
Mean wind direction	234.5 ° (SW)
Mean significant wave height (Hs)	0.62 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.25 sec
Mean wave direction	218.4 ° (SW)
Mean wave direction scaled for wave power	210.5 ° (SSW)
Mean annual wave power	13.6 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 6; LD)	240-272 µm (average: 256 µm)
Calcium carbonate content (%) (N= 3)	2.91-5.94% (average: 4.25%)
Silica content (%) (N= 3)	86.8-91.3% (average: 89.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low / Medium
Historical / Archaeological	Low
Overall significance score	9
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Fencing	Significant
Marram planting	Minor
Grazing	Minor
Scrub clearance	Minor
Rock armour protection to dune toe	Significant
Groynes	Significant

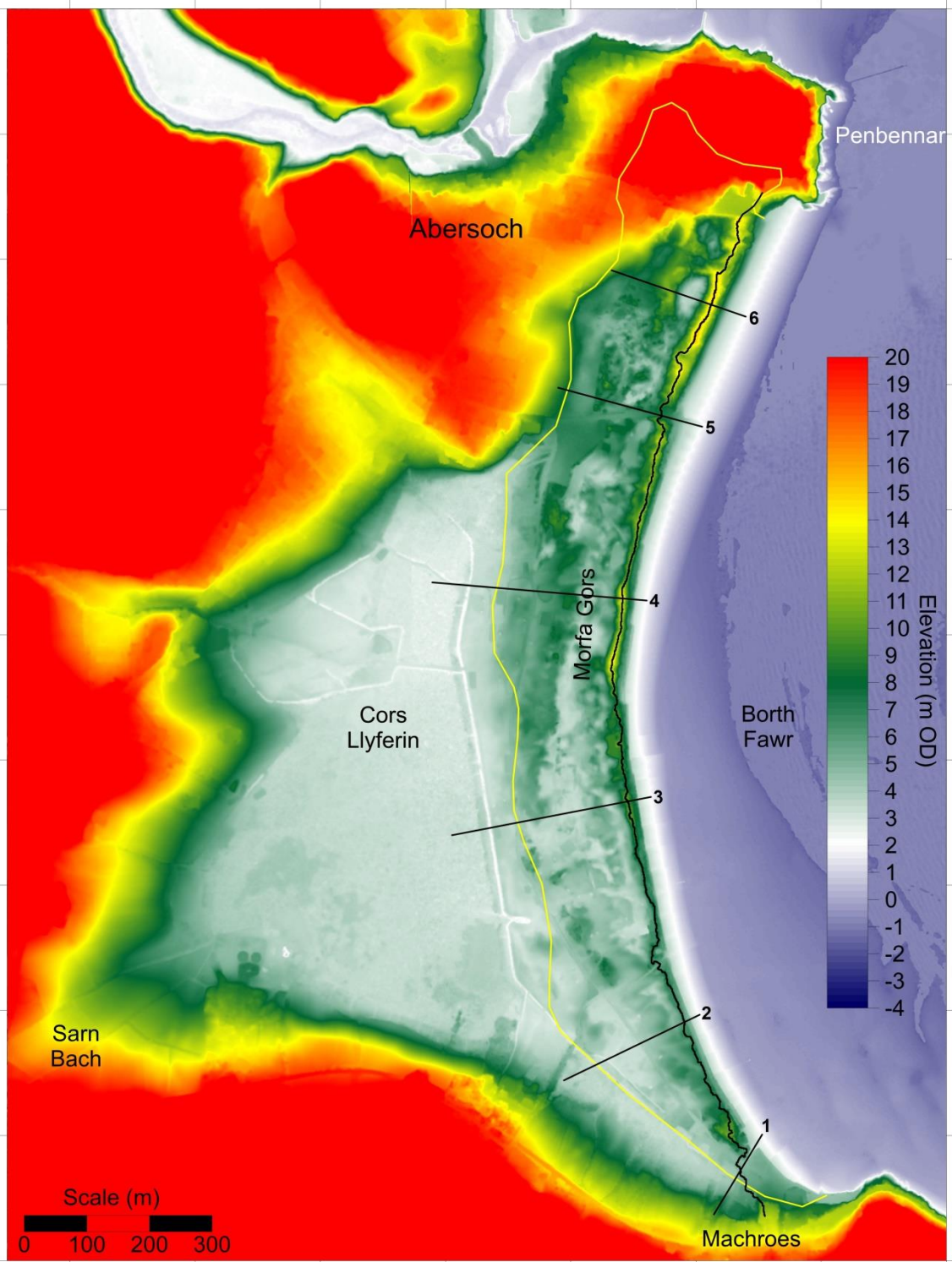
Further information

Gwynedd Council Coast Protection Unit (2003) North Cardigan Shoreline Management Plan (CD Version)

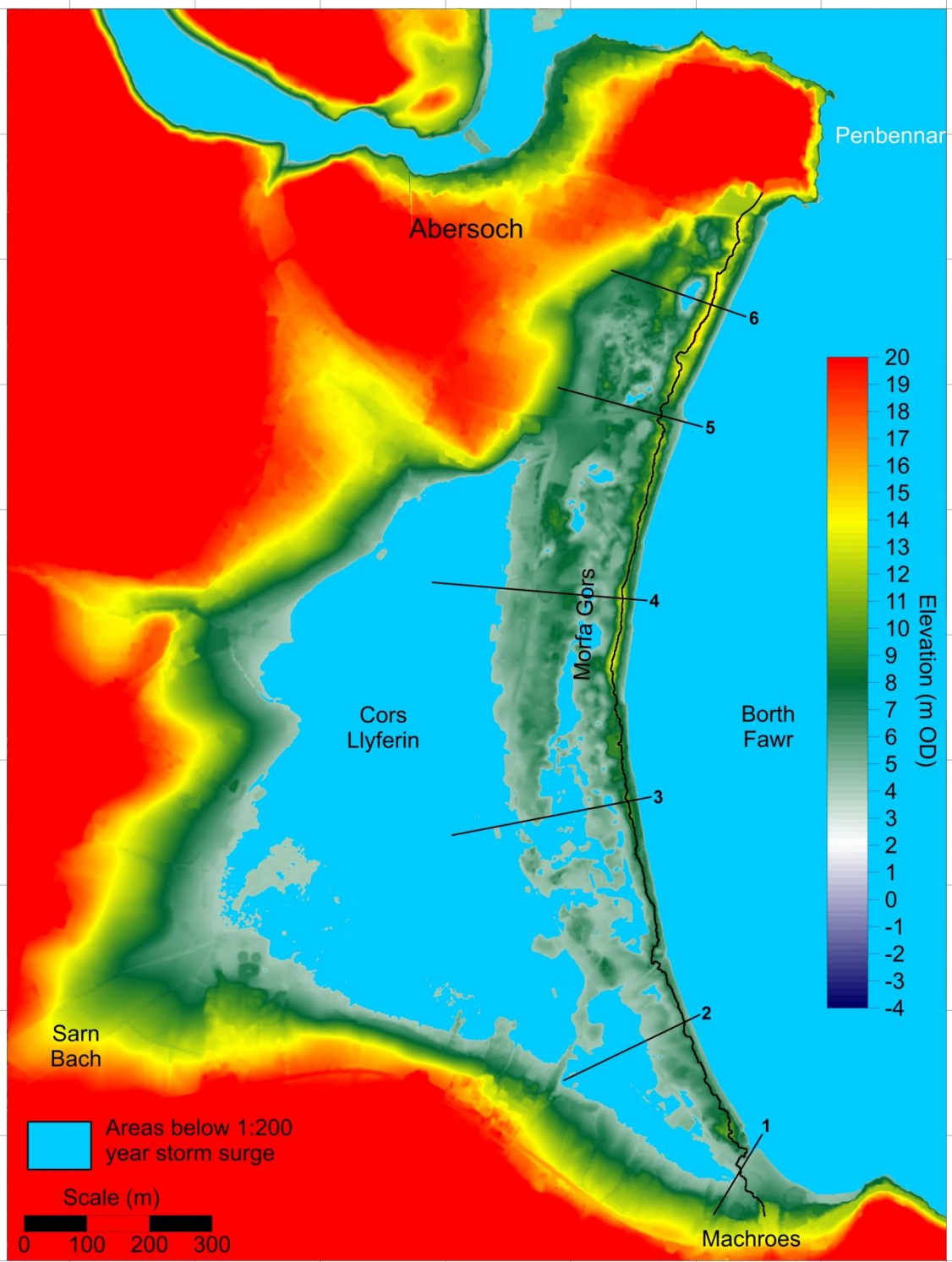
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



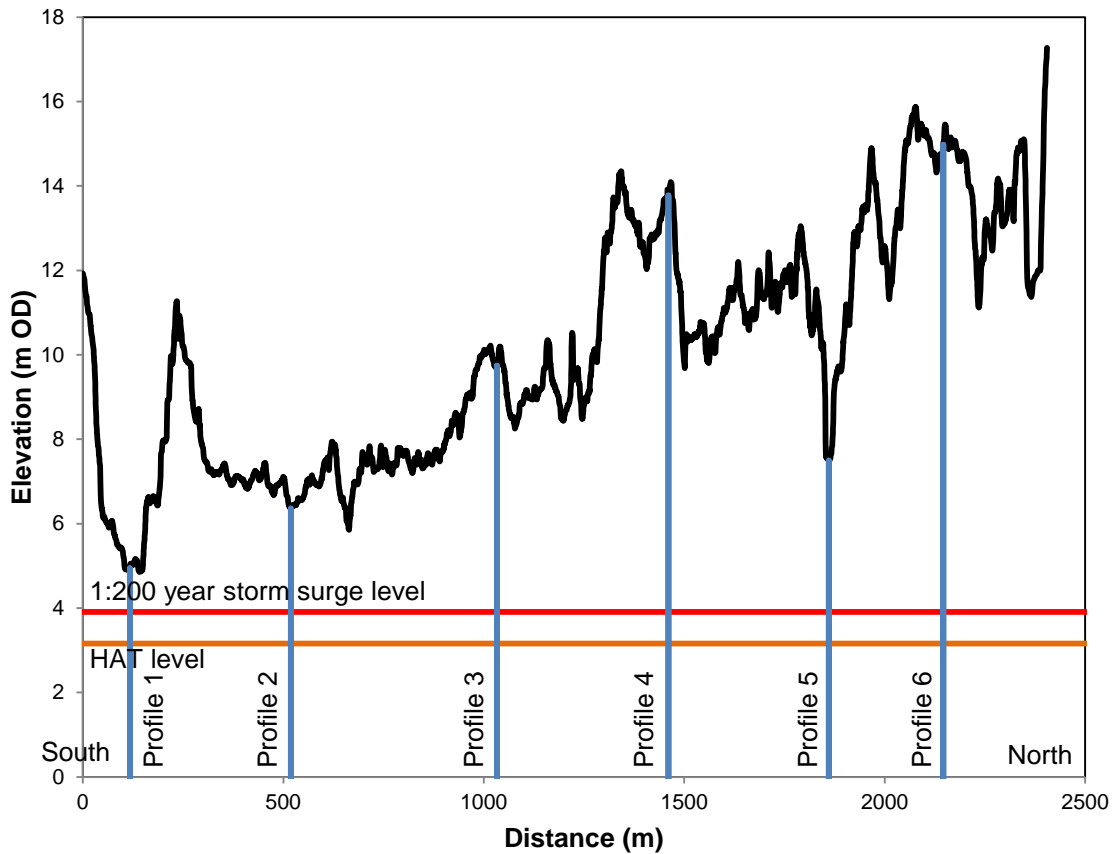
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 geological maps.



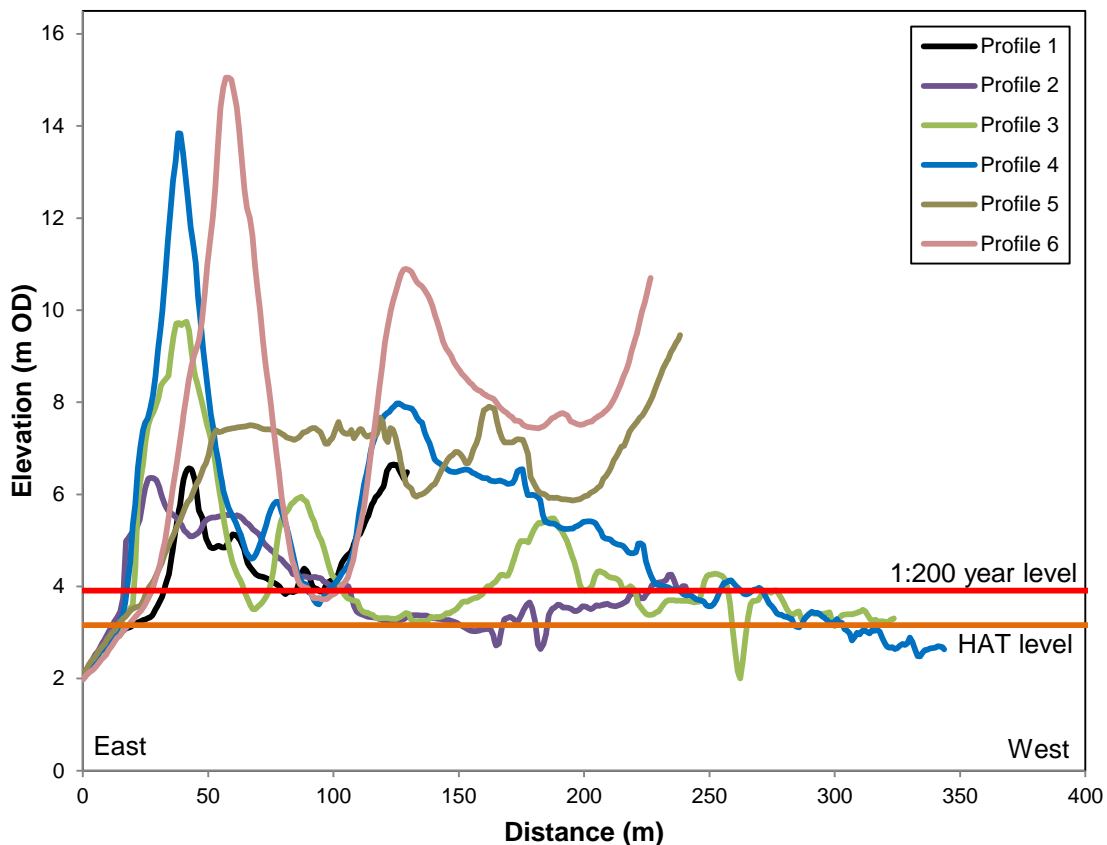
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 62: Tywyn yr Wylfa, Abersoch

Site description

Morphological setting	Bay (Tremadoc Bay)
Morphological type	Cliff-top
Erosion/progradation status	Stable; cut off from active sand source
Defence structures	None
Hinterland type	Agriculture
Typical hinterland level	>50 m OD
Conservation designations	Porth Ceiriad, Porth Neigwl Ac Ynysoedd Sant Tudwal SSSI, SAC, SPA
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.10 m OD
1:200 year storm surge level	3.74 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	09/01/2013
Principal aspect of dune frontage	n/a

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1169 (226911E 318024N)
Distance offshore	5.9 km
Mean wind speed	14.68 knots
Mean wind direction	235.4 ° (SW)
Mean significant wave height (Hs)	1.06 m
Mean zero up-crossing period (Tz)	3.99 sec
Mean peak wave period (Tp)	6.11 sec
Mean wave direction	234.8 ° (SW)
Mean wave direction scaled for wave power	231.3 ° (SW)
Mean annual wave power	47.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

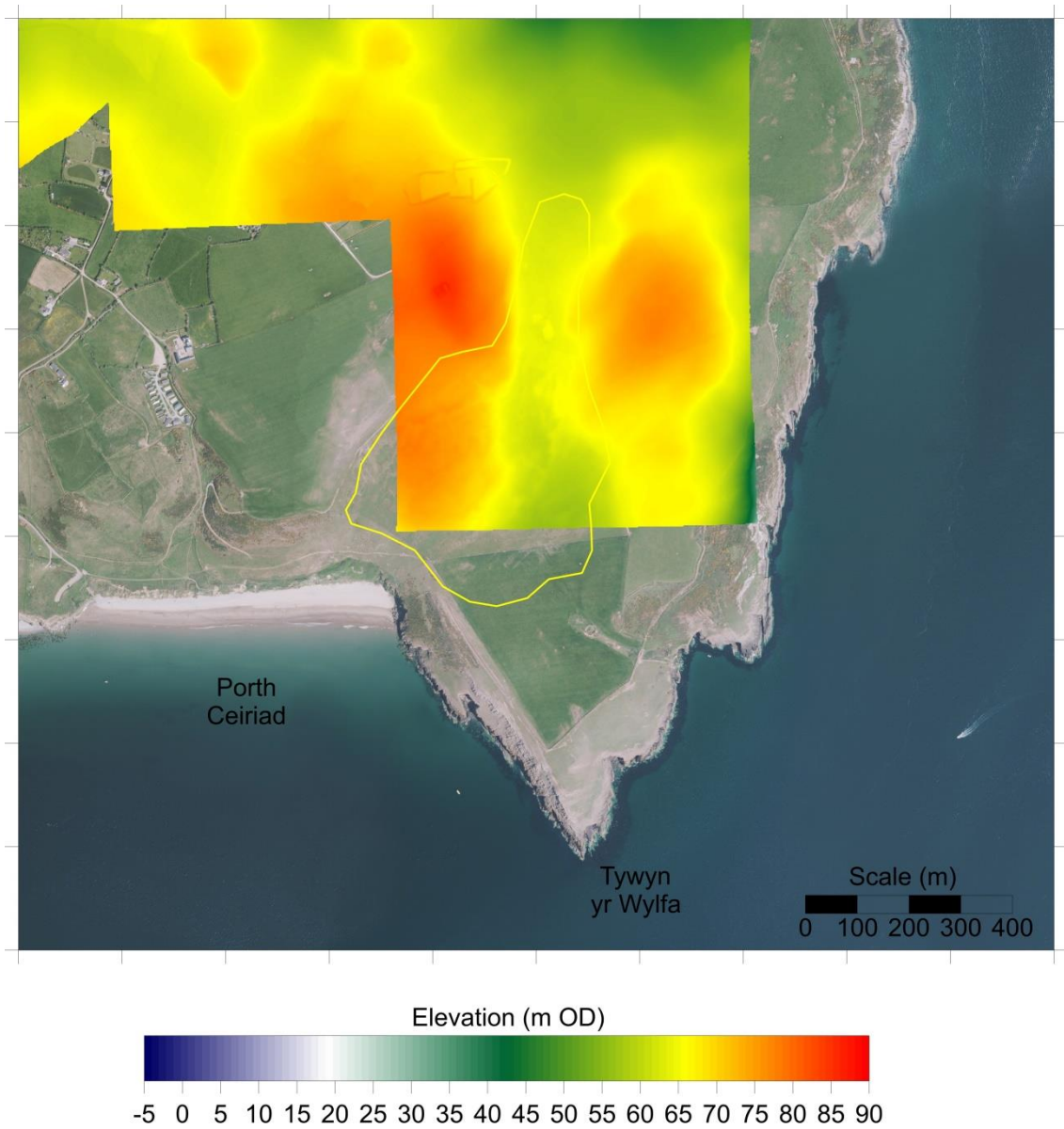
None identified	
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Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1:50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 geological maps.

Site 63: Tai Morfa, Porth Neigwl

Site description

Morphological setting	Bay (Porth Neigwyl)
Morphological type	Fringing, climbing, transgressive valley-blocking, (forming a localised barrier against marine flooding), cliff top-sand sheet at SE end
Erosion/progradation status	Stable and slowly eroding
Defence structures	None
Hinterland type	Agriculture, caravan site, Tai Morfa settlement
Typical hinterland level	2.3 to 6.3 m OD
Conservation designations	Porth Ceiriad, Porth Neigwl Ac Ynysoedd Sant Tudwal SSSI, SAC, SPA
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.00 m OD
1:200 year storm surge level	3.52 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	09/01/2013
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1169 (226911E 318024N)
Distance offshore	5.9 km
Mean wind speed	14.68 knots
Mean wind direction	235.4 ° (SW)
Mean significant wave height (Hs)	1.06 m
Mean zero up-crossing period (Tz)	3.99 sec
Mean peak wave period (Tp)	6.11 sec
Mean wave direction	234.8 ° (SW)
Mean wave direction scaled for wave power	231.3 ° (SW)
Mean annual wave power	47.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 8; LD)	274-420 µm (average: 323 µm)
Calcium carbonate content (%) (N= 3)	0.29-2.21% (average: 1.52%)
Silica content (%) (N= 3)	92.1-93.2% (average: 92.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	10
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

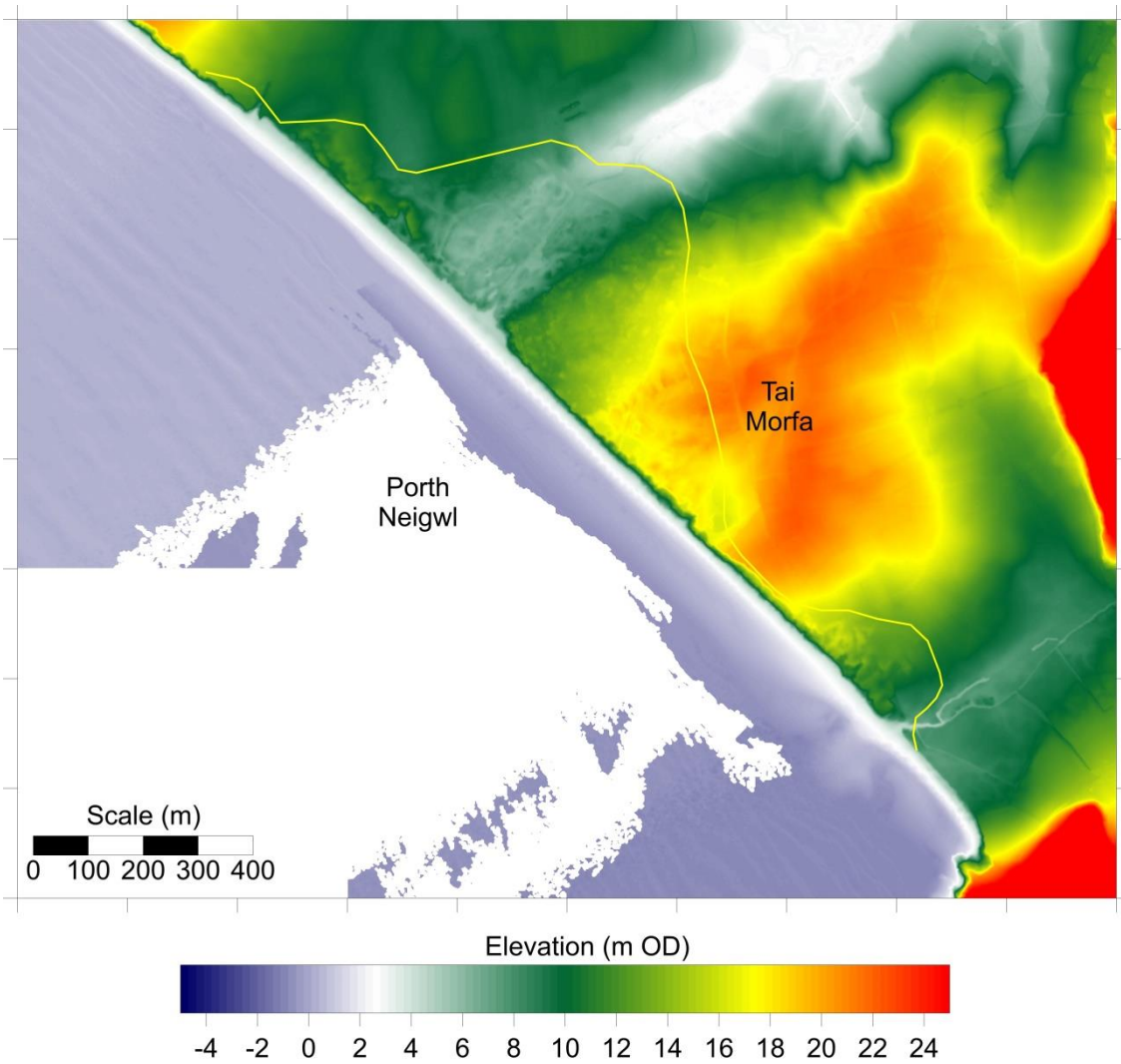
Grazing	Significant
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Further information

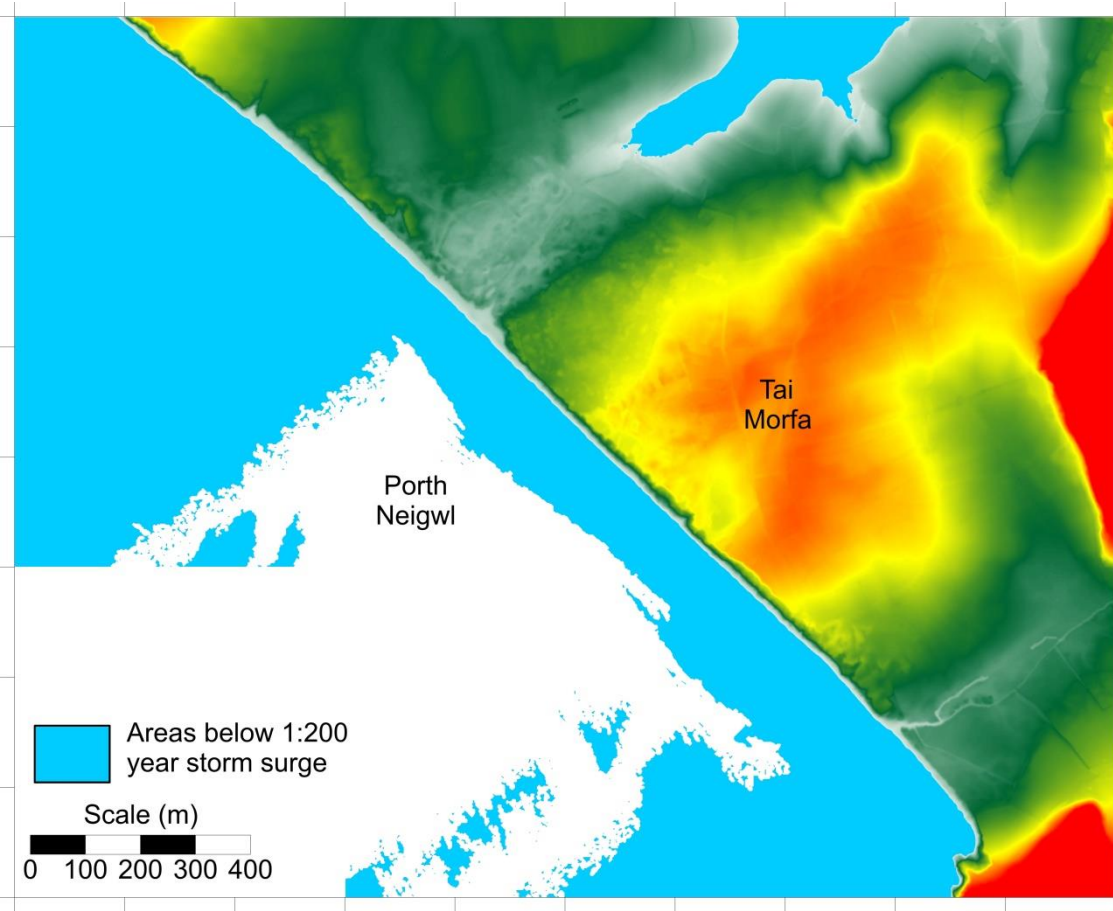
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geologicval maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 64: Morfa Dinlle

Site description

Morphological setting	Bay (Caernarfon Bay); adjoins Menai Strait in the north
Morphological type	Barrier spit with multiple dune ridges developed on shingle ridges; localised blowouts and small parabolic dunes (stabilized); thin, patchy blown sand veneer over shingle in the Dinas Dinlle and Caernarfon Airport areas
Erosion/progradation status	eroding in south, stable in centre, slowly prograding in north
Defence structures	Rock armour protecting Fort Belan at N end; sea wall and rock groynes at Dinas Dinlle
Hinterland type	Reclaimed marsh, shingle ridges, airfield, caravans, intertidal area of Foryd Bay behind
Typical hinterland level	1.5 to 2.5 m OD on marsh 2.6 to 4.2 m OD on Caernarfon Airfield
Conservation designations	Morfa Dinlle SSSI, SAC, SPA
Notable features	Caernarfon Airport; Fort Belan

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.70 m OD
1:200 year storm surge level	3.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	west-southwest to northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1318 (236201E 362472N)
Distance offshore	3.1 km
Mean wind speed	12.64 knots
Mean wind direction	230.1 ° (SW)
Mean significant wave height (Hs)	0.70 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.58 sec
Mean wave direction	247.9 ° (WSW)
Mean wave direction scaled for wave power	245.6 ° (WSW)
Mean annual wave power	18.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 18; LD)	173-311 µm (average: 225 µm)
Calcium carbonate content (%) (N= 5)	2.00-3.00% (average: 2.52%)
Silica content (%) (N= 5)	90.3-92.6% (average: 91.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	Low
Economic / Military	Medium
Historical / Archaeological	Medium
Overall significance score	14.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing	Significant
Scrub clearance	Minor
Rock groynes	Significant
Beach sediment recycling	significant
Rock armour to dune toe	Minor
Management of shingle ridge level	Significant

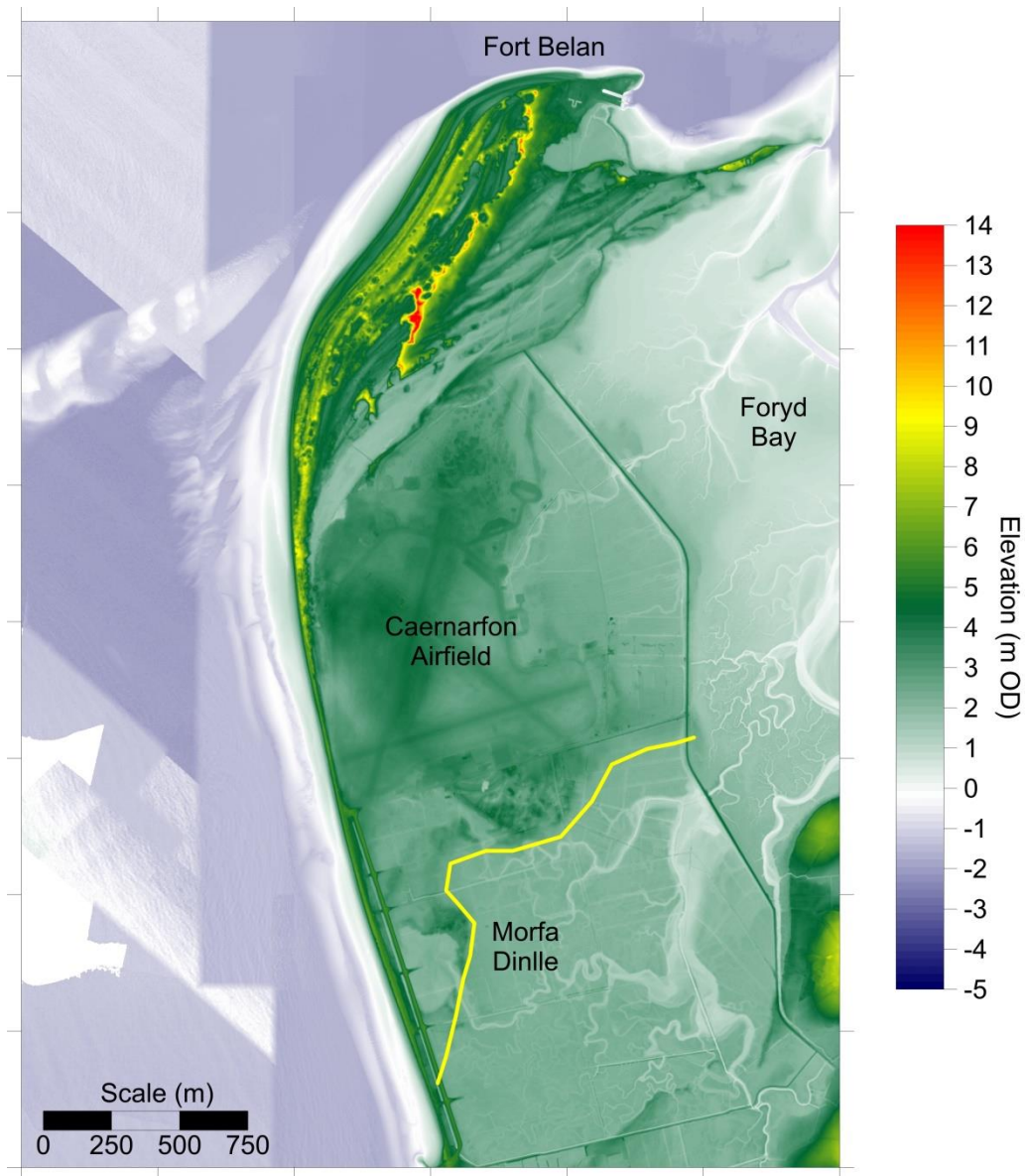
Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

Pye K, Blott SJ. 2011. Dinas Dinlle Options for Beach and Sea Defence Management. Report to the Environment Agency Wales. Report No. EX1252, Kenneth Pye Associates Ltd., Crowthorne.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 65: Newborough

Site description

Morphological setting	Bay and estuarine (Caernarfon Bay, between the Menai Strait in the south and the Maltraeth estuary in the north)
Morphological type	Transgressive on Newborough Warren and behind Traeth Penrhos, climbing on rock ridge behind Llanddwyn Island, barrier spits with foredune ridges at the entrance to the Menai Strait and Maltraeth estuary
Erosion/progradation status	Prograding at the northwestern and southeastern ends, slowing eroding along most of Newborough Warren and southern part of the Newborough Forest frontages
Defence structures	Rock armour reinforcement along parts of Abermenai spit
Hinterland type	Forest, grazing land, arable fields, active tidal flats and saltmarsh within the Maltraeth estuary and Menai Strait
Typical hinterland level	Intertidal behind Abermenai 2.4 to 4.7 m OD on behind Newborough Warren Rising ground behind Newborough Forest Intertidal behind Traeth Penrhos
Conservation designations	Newborough Warren - Ynys Llanddwyn SSSI, SAC, SPA, NNR
Notable features	Newborough Forest, Llanddwyn Island; NRW dune rejuvenation trial areas

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.70 m OD
1:200 year storm surge level	3.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	April 2014 and 04/02/2015
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1318 (236201E 362472N)
Distance offshore	3.1 km
Mean wind speed	12.64 knots
Mean wind direction	230.1 ° (SW)
Mean significant wave height (Hs)	0.70 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.58 sec
Mean wave direction	247.9 ° (WSW)
Mean wave direction scaled for wave power	245.6 ° (WSW)
Mean annual wave power	18.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 58; LD)	175-332 µm (average: 215 µm)
Calcium carbonate content (%) (N= 11)	2.21-5.52% (average: 3.3%)
Silica content (%) (N= 11)	88.1-92.9% (average: 90.3%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Medium
Historical / Archaeological	Medium
Overall significance score	16
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing	Significant
Scrub clearance	Significant
Sand fencing	Significant
Marram planting	Significant
Tree planting	Significant
Turf stripping	Significant
Notches cut in frontal dunes	Significant
Tree felling	Significant
Rock armour to dune toe (Abrmenai)	Significant

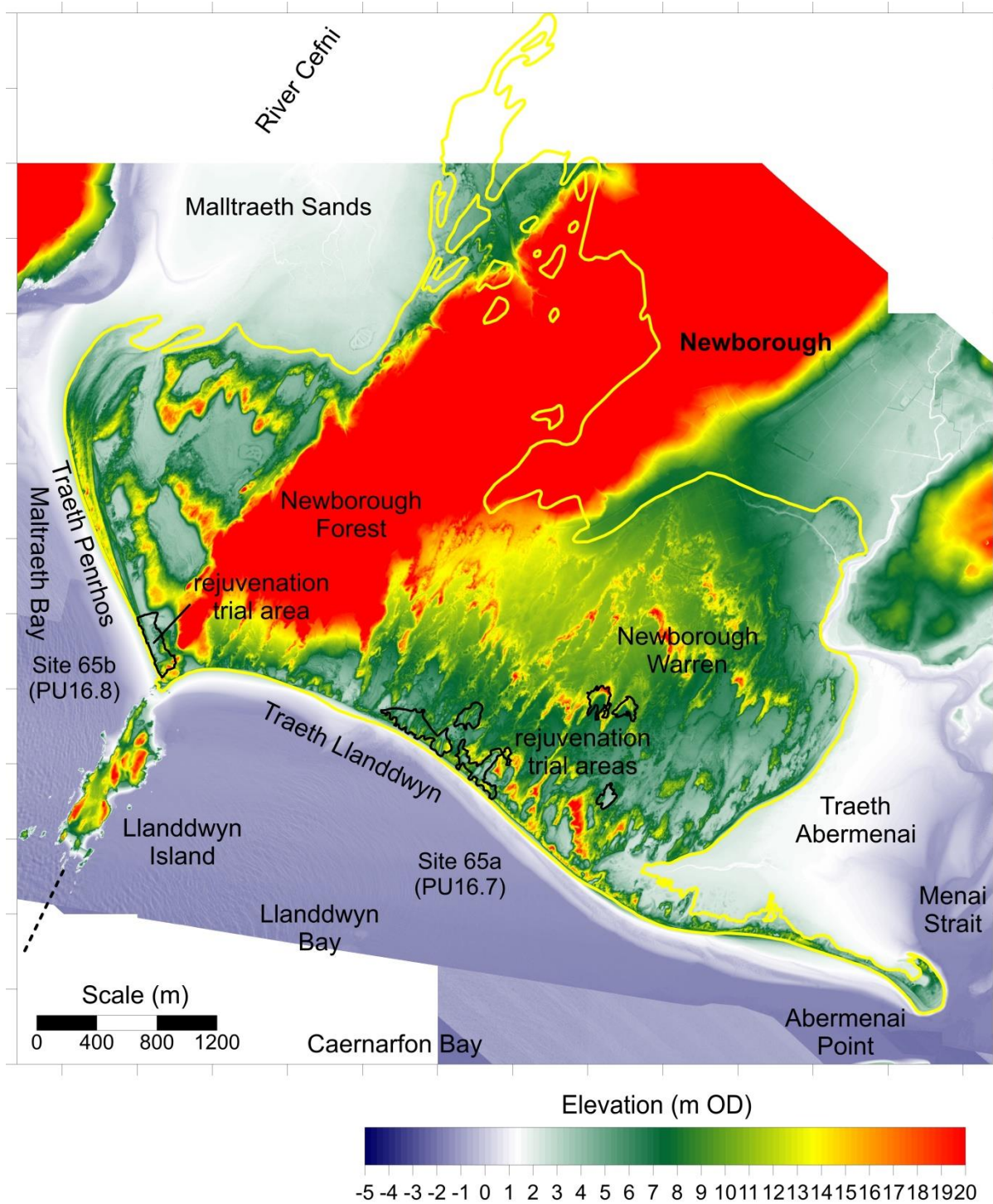
Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

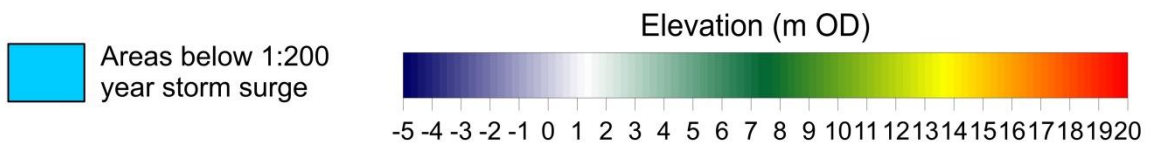
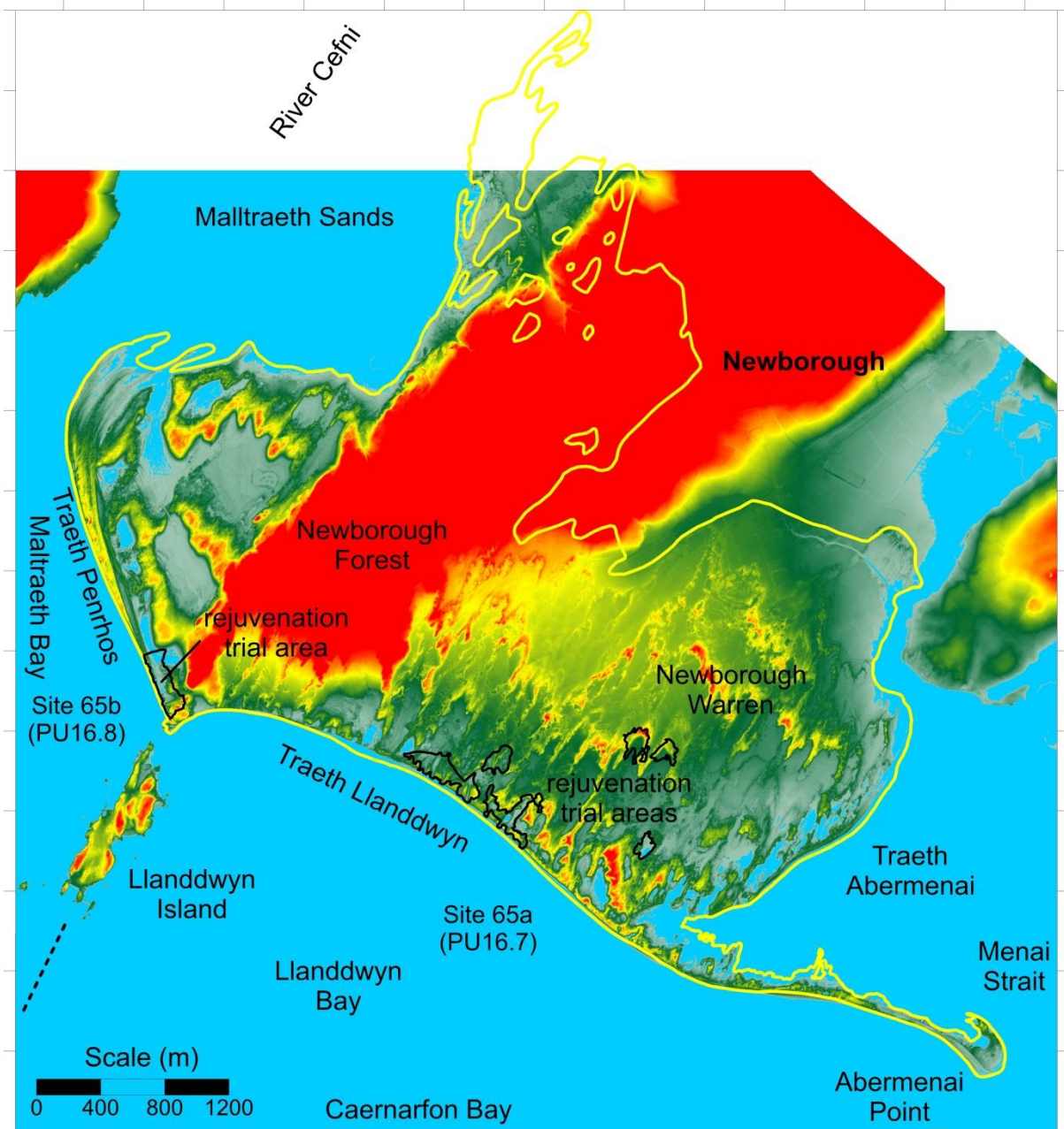
Pye K, Blott SJ. 2012. A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 3 Newborough Warren. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 66: Porth Twyn-mawr and Porth Gro

Site description

Morphological setting	Behind two small bays with pocket beaches (Porth Twyn-mawr and Porth Gro, Anglesey west shore)
Morphological type	Transgressive and climbing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Grazing land, arable fields
Typical hinterland level	Rising ground
Conservation designations	Penrhynoedd Llangadwaladr SSSI
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.75 m OD
1:200 year storm surge level	3.40 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	No LiDAR coverage
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1318 (236201E 362472N)
Distance offshore	3.1 km
Mean wind speed	12.64 knots
Mean wind direction	230.1 ° (SW)
Mean significant wave height (Hs)	0.70 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.58 sec
Mean wave direction	247.9 ° (WSW)
Mean wave direction scaled for wave power	245.6 ° (WSW)
Mean annual wave power	18.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	183-492 µm (average: 402 µm)
Calcium carbonate content (%) (N= 4)	2.00-5.76% (average: 4.02%)
Silica content (%) (N= 4)	74.8-93.9% (average: 87.9%)

Dune site importance and SMP2 Policy

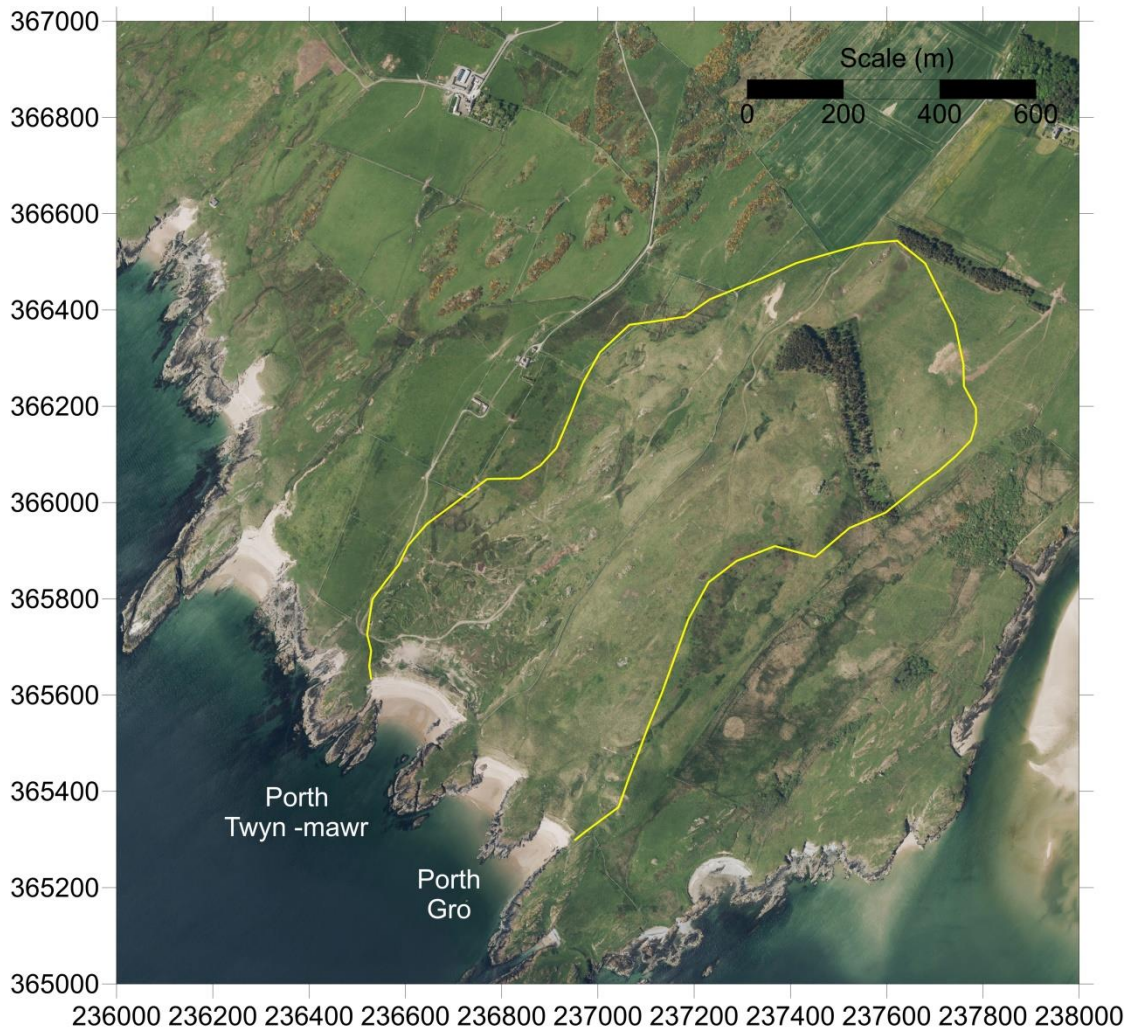
Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing	Significant
Scrub clearance	Minor

Further information

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on aerial photograph interpretation and OS mapping.

Site 67: Tywyn Aberffraw

Site description

Morphological setting	Bay (Aberffraw Bay, Anglesey west shore)
Morphological type	Transgressive, climbing, fringing
Erosion/progradation status	Stable / slowly prograding
Defence structures	None
Hinterland type	Agriculture, lake
Typical hinterland level	2.5 to 3.8 m OD, rising behind
Conservation designations	Tywyn Aberffraw SSSI, SAC
Notable features	Llyn Coron behind; good example of en-echelon compound parabolic dunes

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.80 m OD
1:200 year storm surge level	3.40 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1318 (236201E 362472N)
Distance offshore	3.1 km
Mean wind speed	12.64 knots
Mean wind direction	230.1 ° (SW)
Mean significant wave height (Hs)	0.70 m
Mean zero up-crossing period (Tz)	3.53 sec
Mean peak wave period (Tp)	5.58 sec
Mean wave direction	247.9 ° (WSW)
Mean wave direction scaled for wave power	245.6 ° (WSW)
Mean annual wave power	18.7 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 16; LD)	171-229 µm (average: 191 µm)
Calcium carbonate content (%) (N= 4)	3.32-4.55% (average: 3.73%)
Silica content (%) (N= 4)	89.1-91.6% (average: 90.8%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Very High
Geomorphological Features	Very High
Recreation	Medium
Economic / Military	Low / Medium
Historical / Archaeological	Low / Medium
Overall significance score	14
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing Scrub clearance	Significant Minor
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Further information

Bailey SD, Wintle AG, Duller GAT, Bristow CS. 2001. Sand deposition during the last millennium at Aberffraw, Anglesey, North Wales, as determined by OSL dating of quartz. *Quaternary Science Reviews* 20, 701-704.

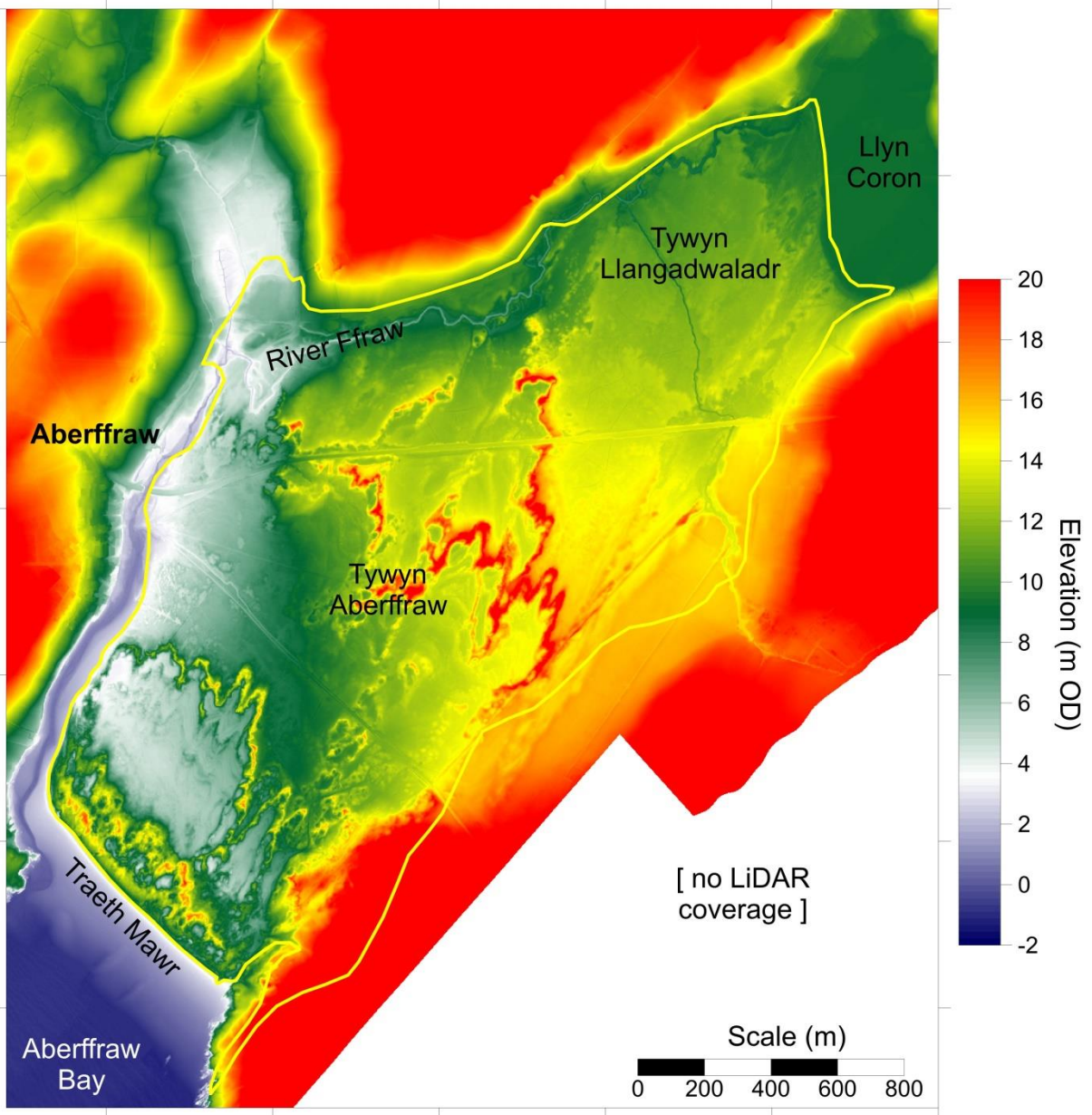
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.

May VJ. 2003. Tywyn Aberffraw, Anglesey (SH 362 685). In May VJ, Hansom JD (eds) *Coastal Geomorphology of Great Britain*. Geological Conservation Review Series No. 28, Joint Nature Conservation Committee, Peterborough, 356-359.

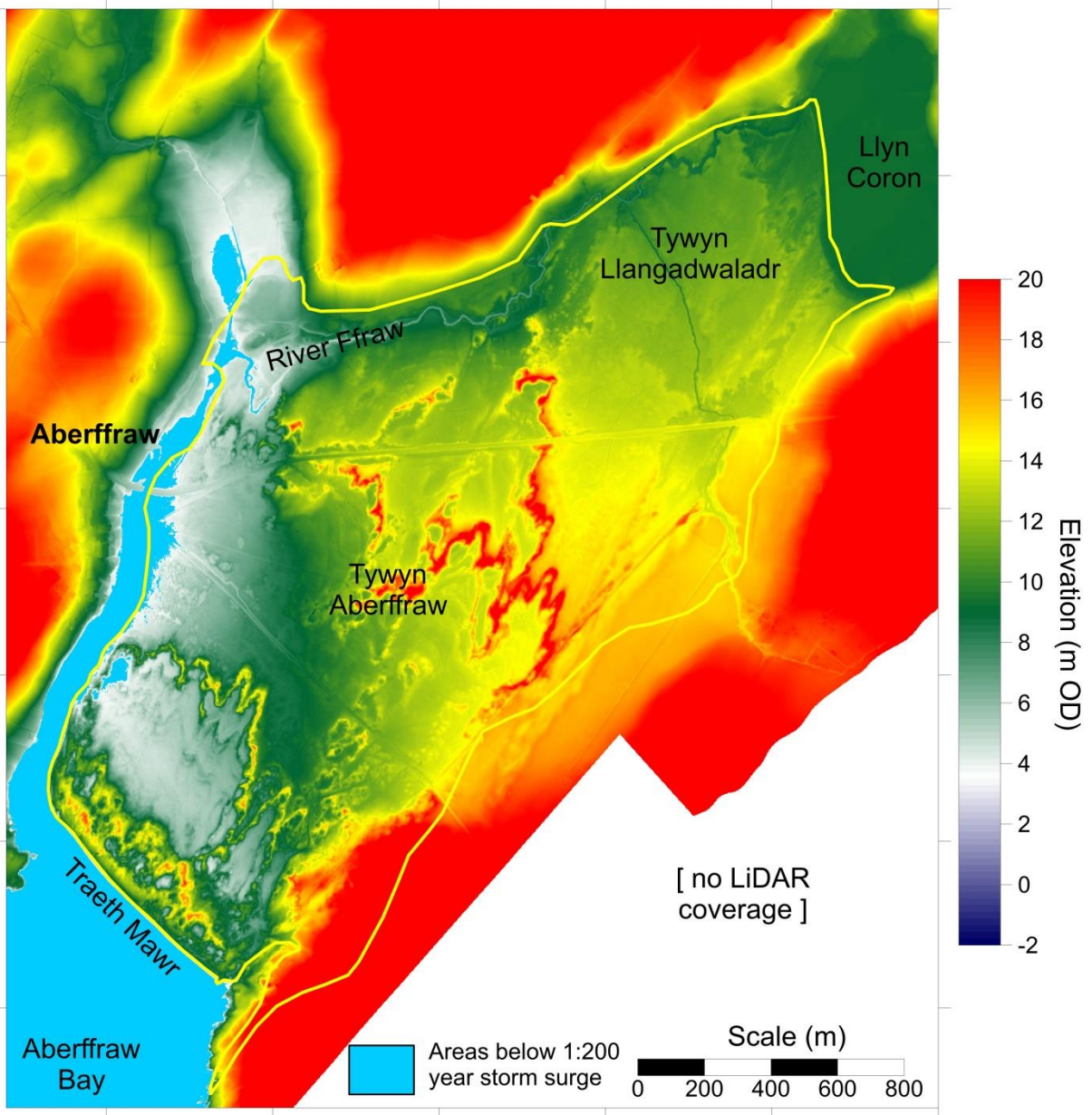
Pye K, Blott SJ. 2012. A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 2 Aberffraw. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 68: Porth Trecastell

Site description

Morphological setting	Shallow bay
Morphological type	Fringing and climbing
Erosion/progradation status	
Defence structures	None
Hinterland type	Car park, agriculture
Typical hinterland level	5.0 to 6.2 m OD on car park and valley behind, then rising ground
Conservation designations	None
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.90 m OD
1:200 year storm surge level	3.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/02/2015
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1356 (227351E 371436N)
Distance offshore	4.7 km
Mean wind speed	13.58 knots
Mean wind direction	230.3 ° (SW)
Mean significant wave height (Hs)	0.91 m
Mean zero up-crossing period (Tz)	3.73 sec
Mean peak wave period (Tp)	5.74 sec
Mean wave direction	236.8 ° (WSW)
Mean wave direction scaled for wave power	232.9 ° (SW)
Mean annual wave power	33.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

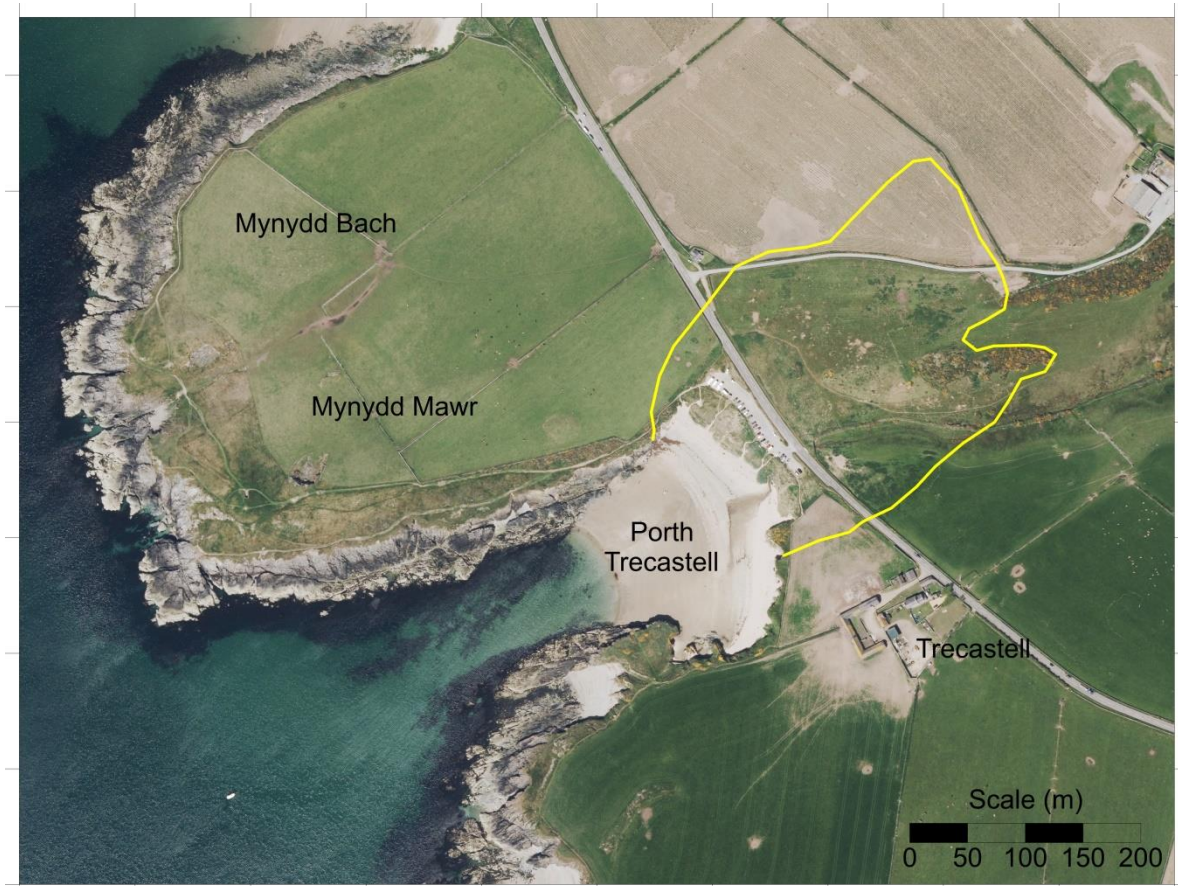
Current and past dune and beach management measures

Grazing	Significant
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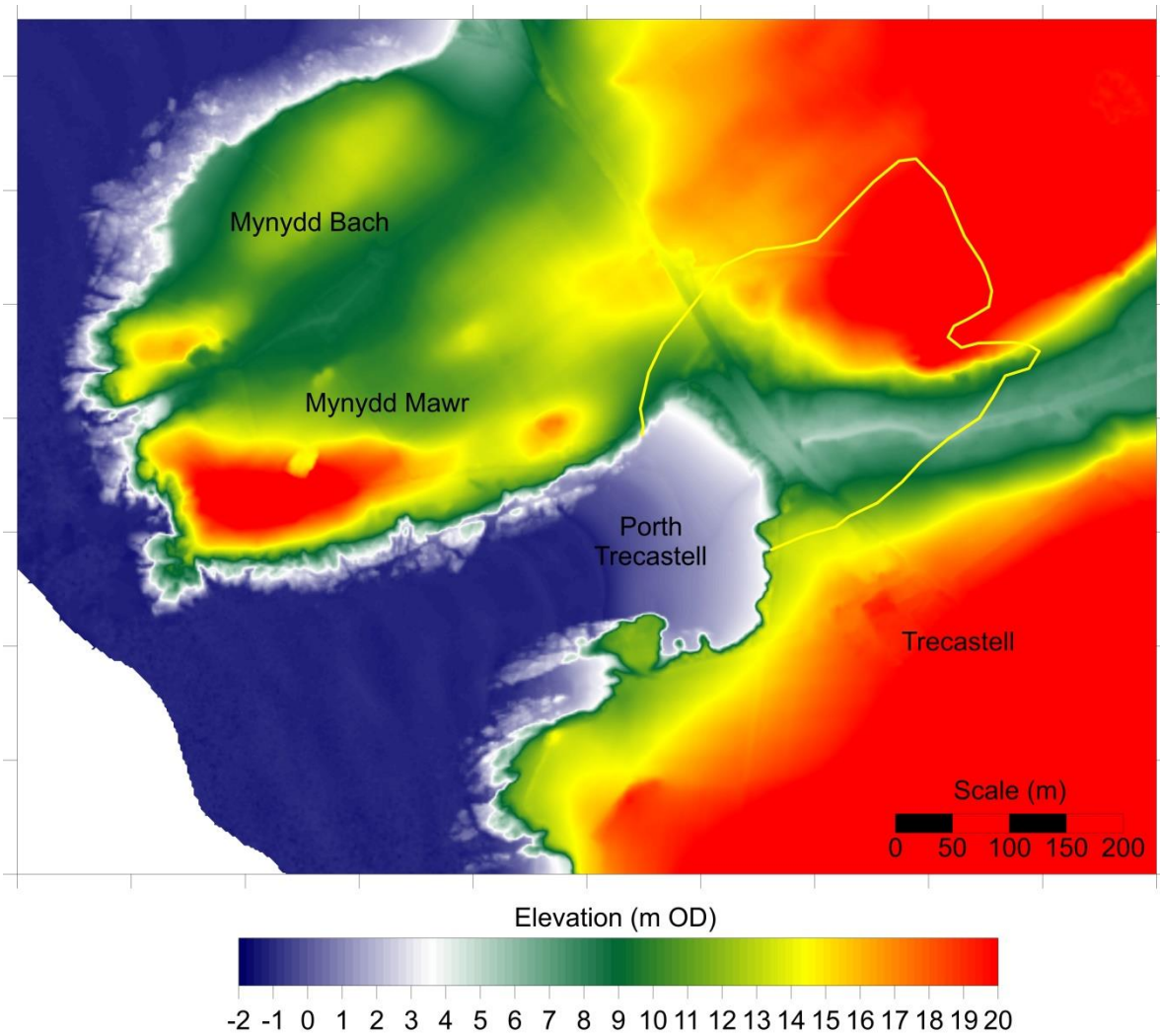
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

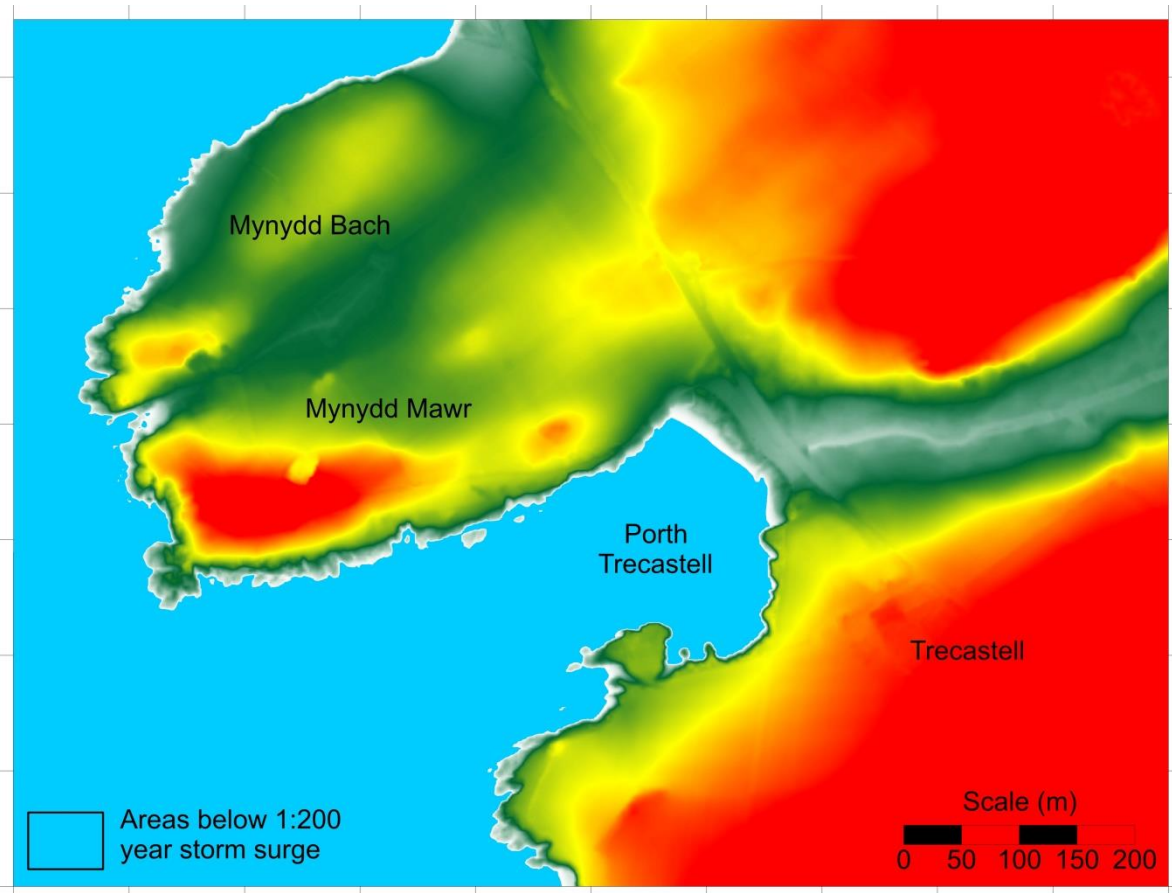
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 69: Tywyn Fferam and Tywyn Llyn

Site description

Morphological setting	Shallow bay
Morphological type	Barrier tombolos
Erosion/progradation status	
Defence structures	None
Hinterland type	Caravans, agriculture, houses, lake
Typical hinterland level	3.0 to 4.0 m OD around Llyn Maelog >7.0 m OD on houses at Craig y Defaid >4.8 m OD on houses at Rhosneigr >5.8 m OD on agricultural land
Conservation designations	Llyn Maelog SSSI (inland only)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.90 m OD
1:200 year storm surge level	3.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1356 (227351E 371436N)
Distance offshore	4.7 km
Mean wind speed	13.58 knots
Mean wind direction	230.3 ° (SW)
Mean significant wave height (Hs)	0.91 m
Mean zero up-crossing period (Tz)	3.73 sec
Mean peak wave period (Tp)	5.74 sec
Mean wave direction	236.8 ° (WSW)
Mean wave direction scaled for wave power	232.9 ° (SW)
Mean annual wave power	33.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 6; LD)	257-583 µm (average: 401 µm)
Calcium carbonate content (%) (N= 3)	2.82-4.78% (average: 3.53%)
Silica content (%) (N= 3)	89-92.7% (average: 90.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing	Significant
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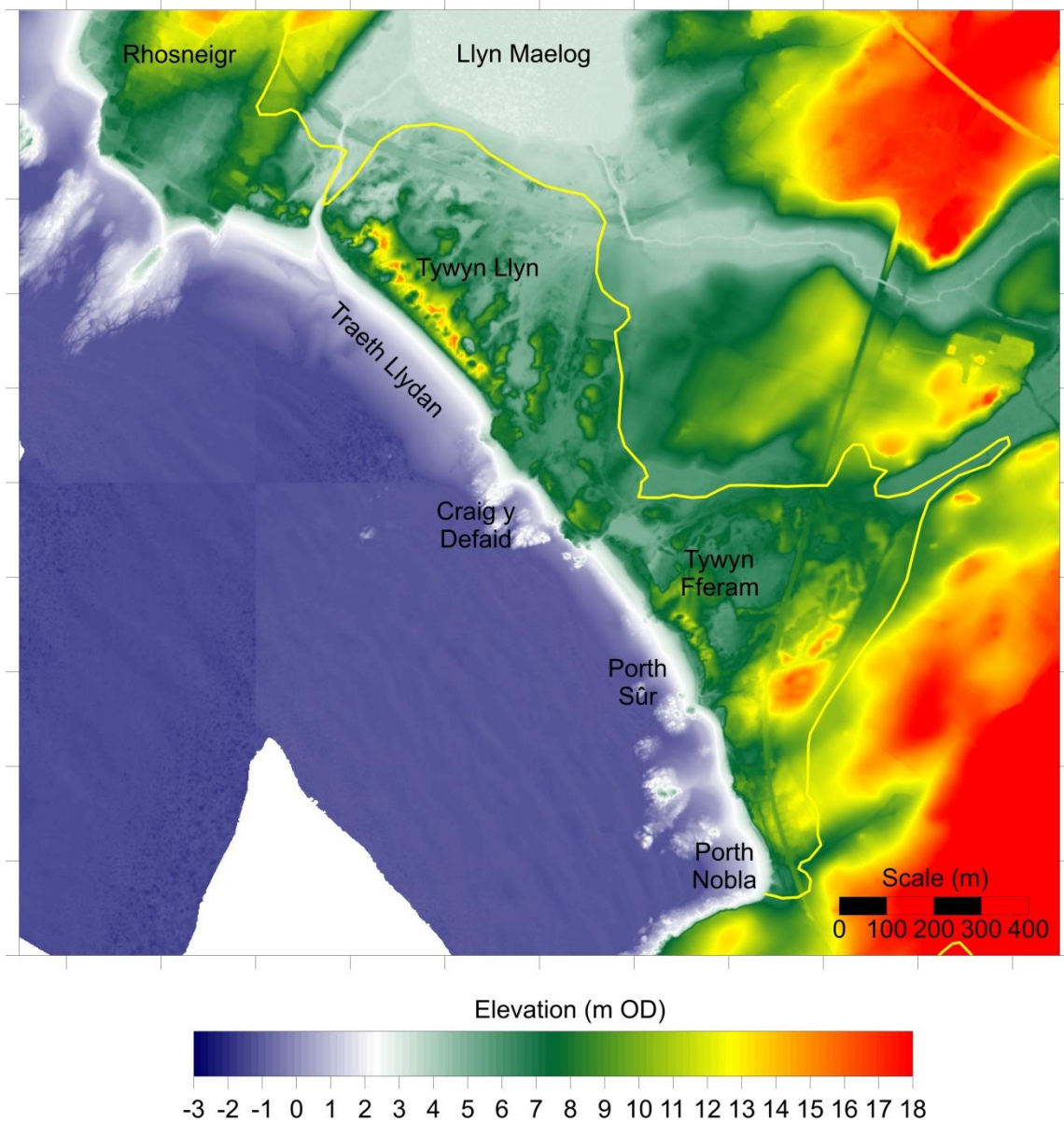
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

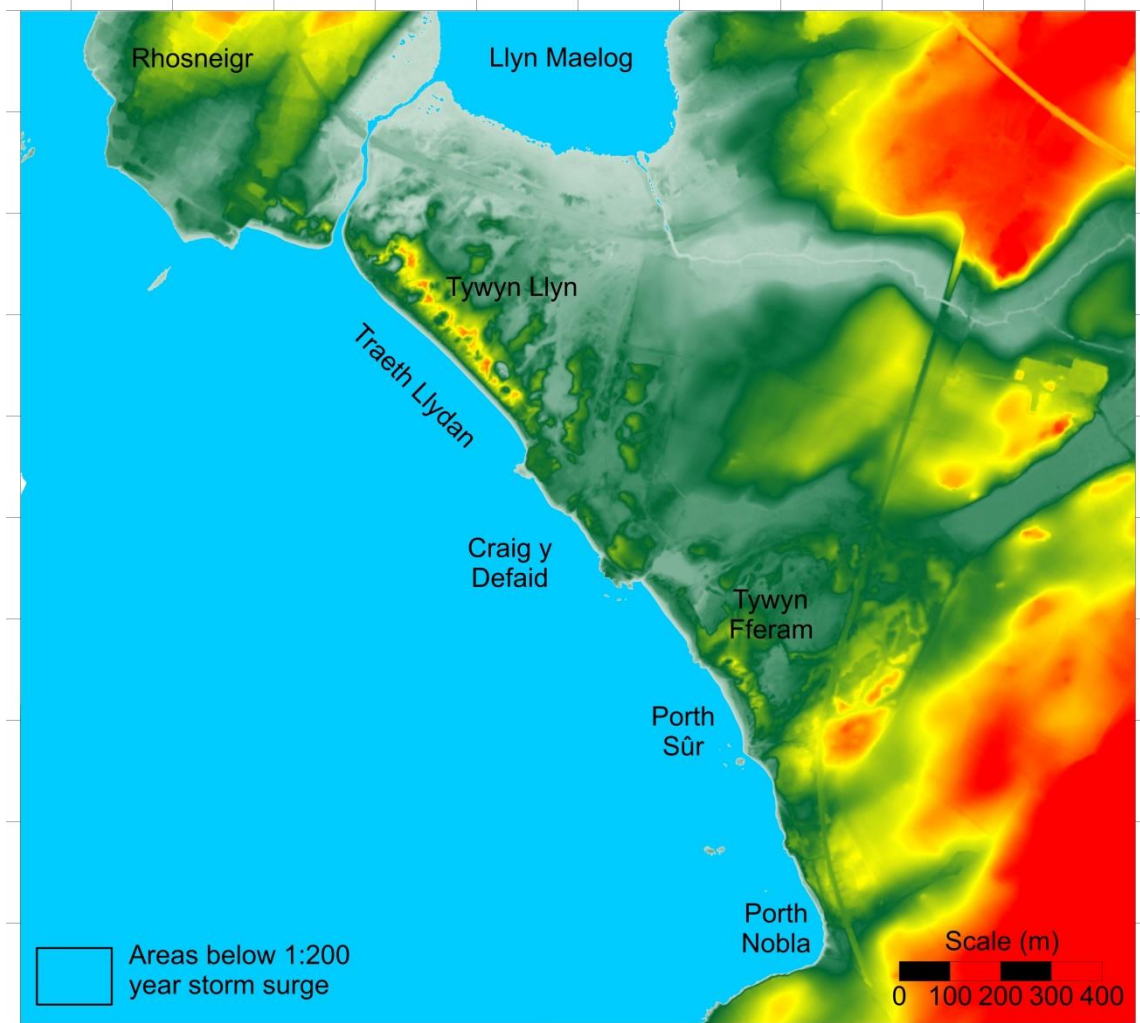
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 70: Tywyn Trewan

Site description

Morphological setting	Bay (Cymyran Bay, Anglesey west shore)
Morphological type	Fringing and climbing, small barrier spits at both ends
Erosion/progradation status	Stable
Defence structures	Sea wall
Hinterland type	Airfield, golf course, grazing land, arable fields, two lakes
Typical hinterland level	3.7 to 11.0 m OD on airfield
Conservation designations	None (adjacent to Ynys Feurig SSSI and Beddmanarch-Cymyran SSSI)
Notable features	Anglesey Airport and RAF Valley

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.95 m OD
1:200 year storm surge level	3.41 ± 0.2 m OD
Maximum crest level	14.92 m OD
Minimum crest level	6.22 m OD
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	southwest

Frontal dune morphology at selected cross-sections

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	11.76	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 2	8.23	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 3	6.92	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 4	11.52	Above HAT	Above 1:200	Above HAT	Above 1:200
Profile 5	11.00	160	95	430	347
Profile 6	14.12	Above HAT	Above 1:200	Above HAT	Above 1:200

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1356 (227351E 371436N)
Distance offshore	4.7 km
Mean wind speed	13.58 knots
Mean wind direction	230.3 ° (SW)
Mean significant wave height (Hs)	0.91 m
Mean zero up-crossing period (Tz)	3.73 sec
Mean peak wave period (Tp)	5.74 sec
Mean wave direction	236.8 ° (WSW)
Mean wave direction scaled for wave power	232.9 ° (SW)
Mean annual wave power	33.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 14; LD)	167-437 µm (average: 254 µm)
Calcium carbonate content (%) (N= 4)	2.46-4.12% (average: 3.48%)
Silica content (%) (N= 4)	88.9-92.2% (average: 90.6%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Low
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	High
Historical / Archaeological	Low
Overall significance score	11.5
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

Grazing	Significant
Concrete / cement dune toe revetment (northern end)	Significant
Internal dune gabions	Minor
Sand fencing	Minor

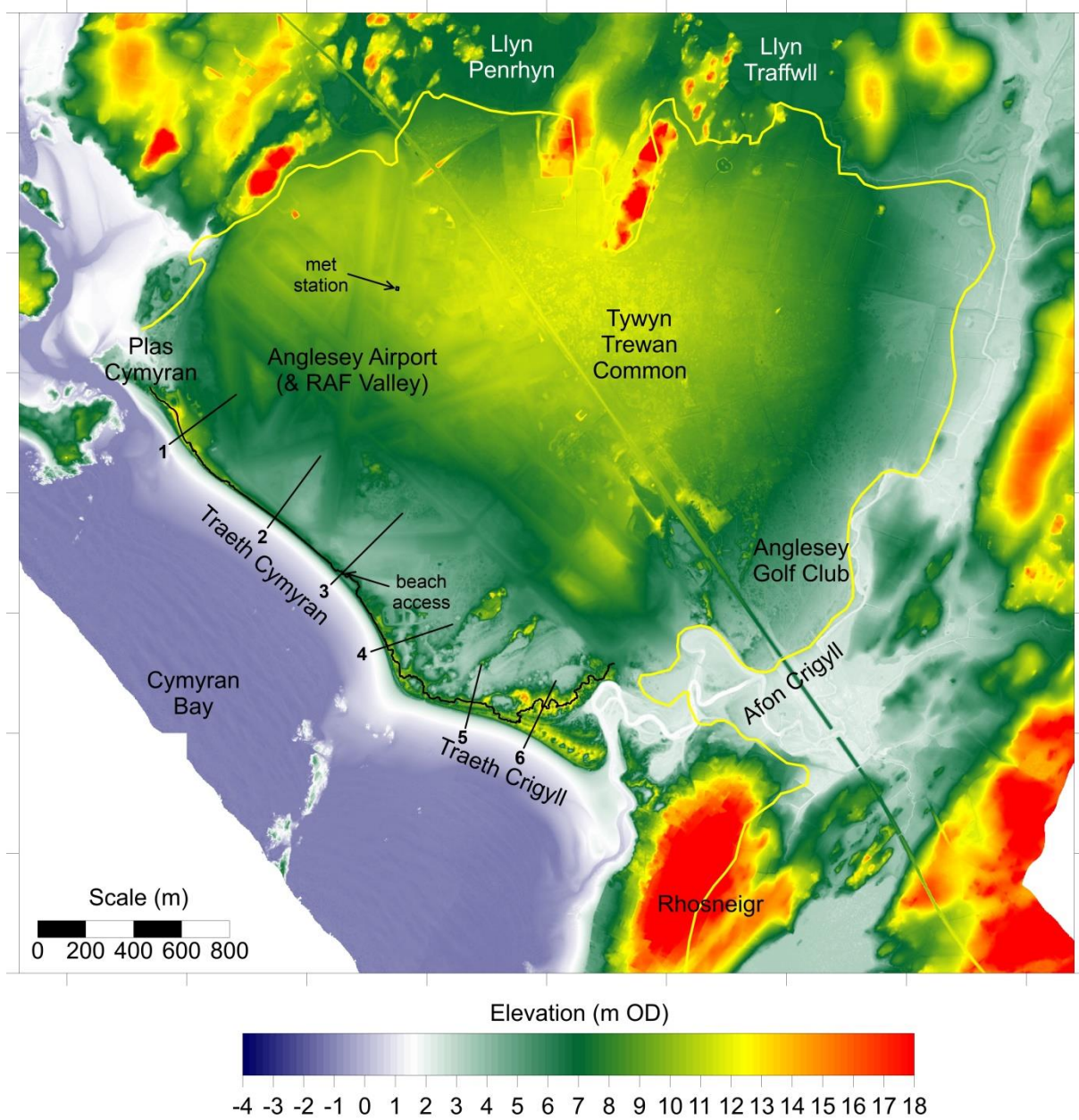
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

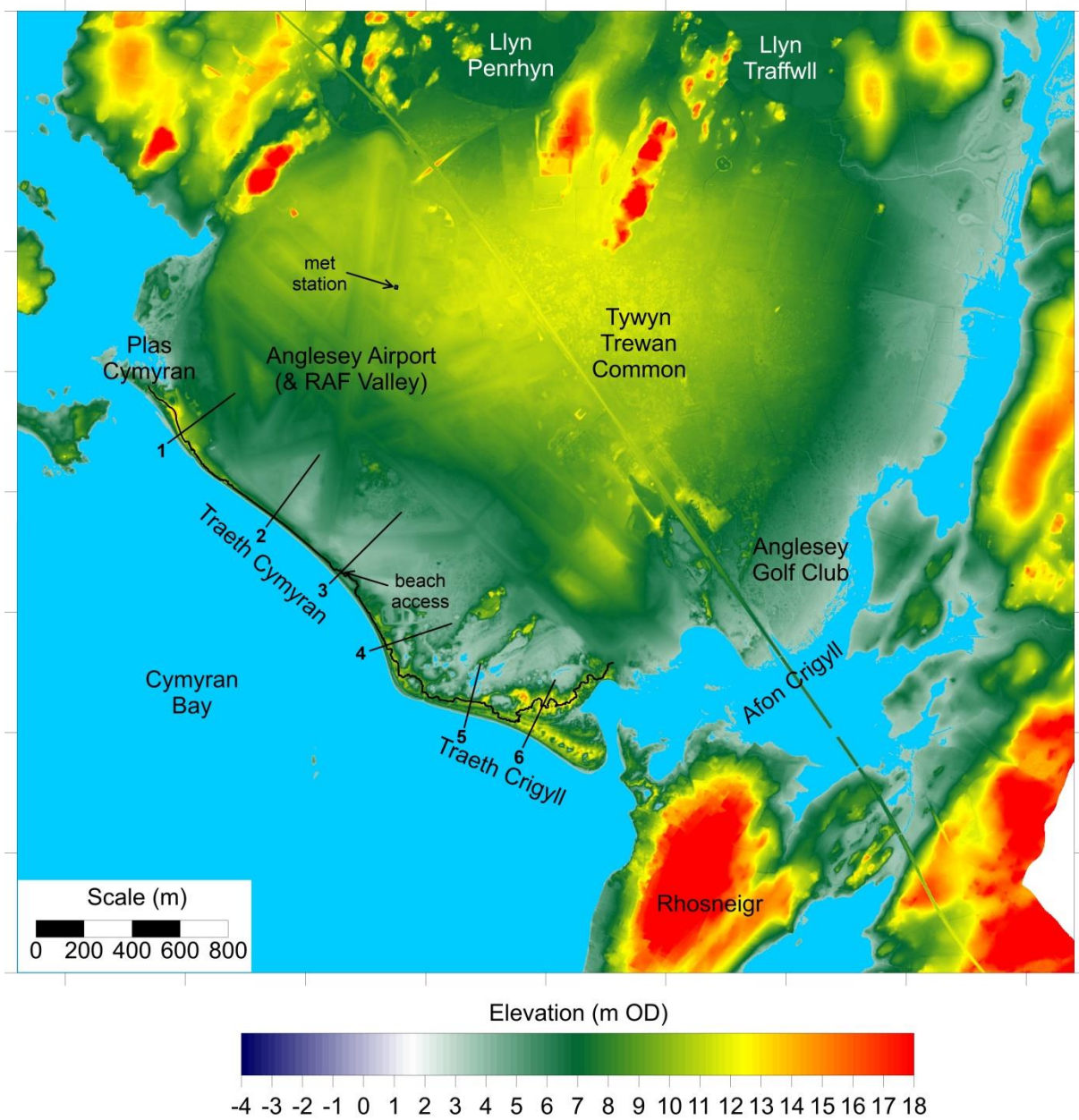
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



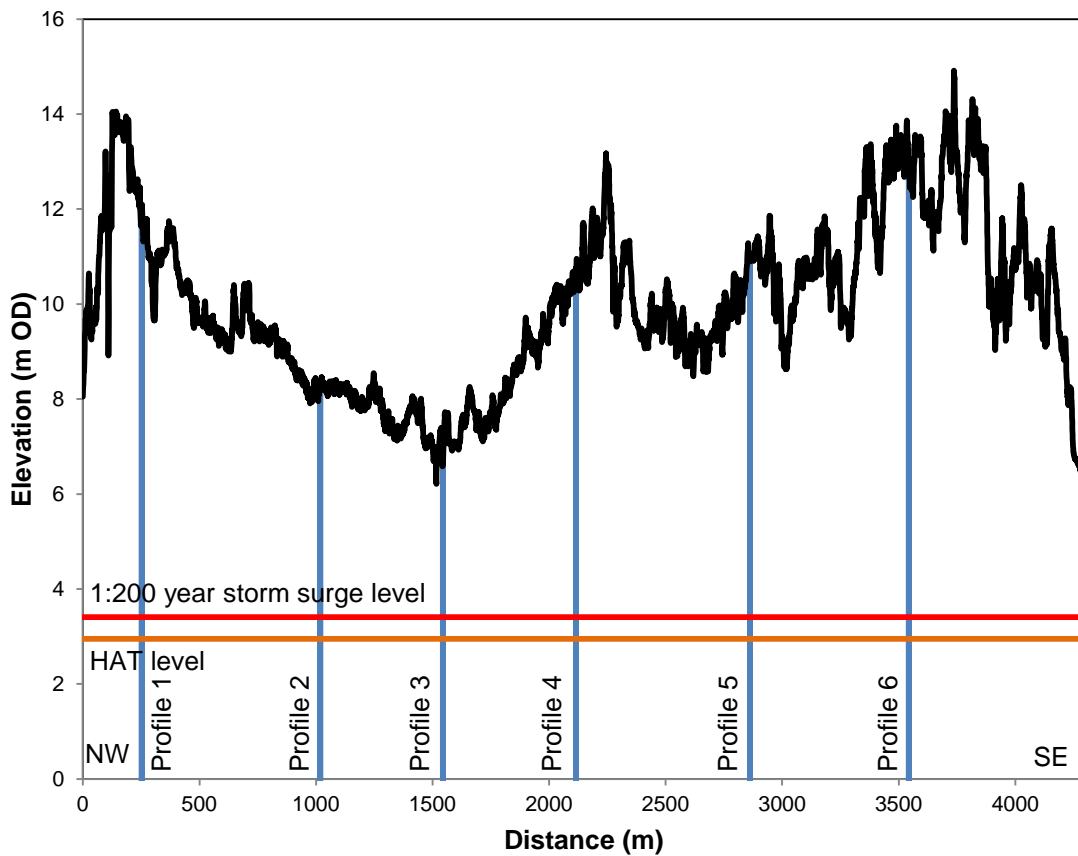
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS geological maps.



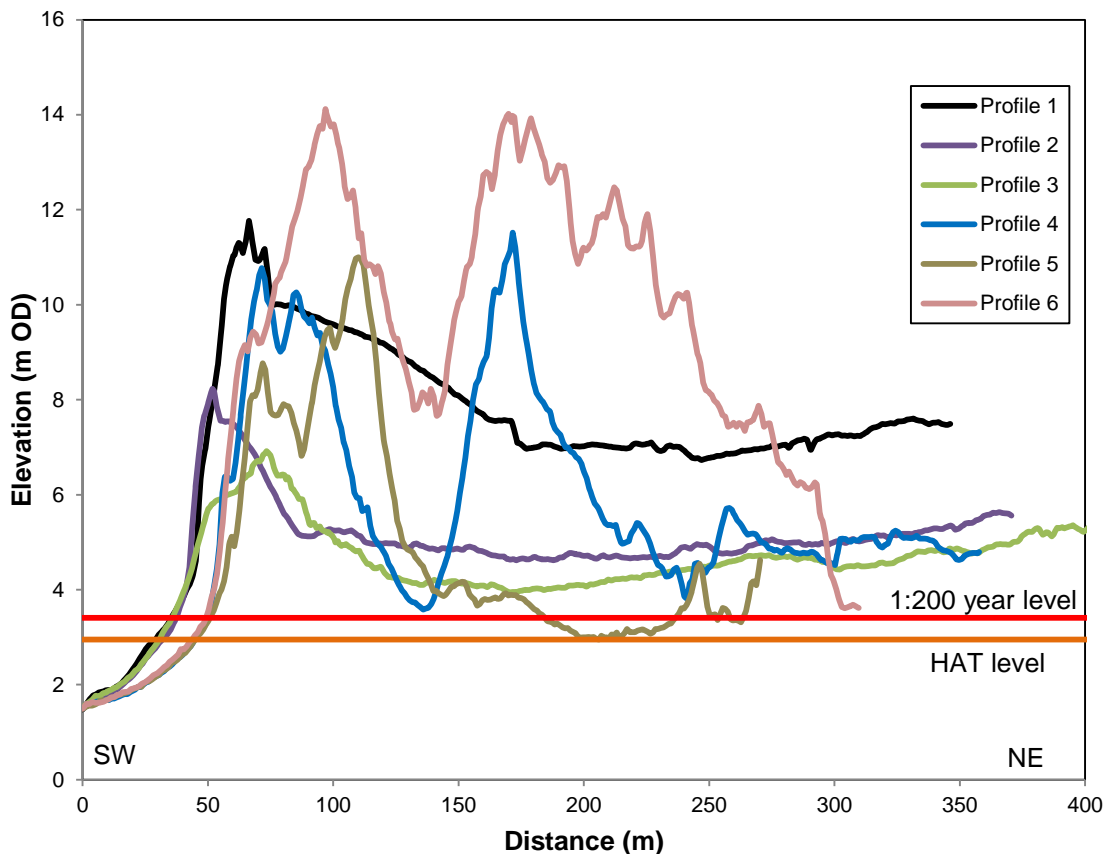
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 71: Tywyn Bryn-y-Bar, Holy Island

Site description

Morphological setting	Bay (Silver Bay), Anglesey west shore
Morphological type	Barrier tombolo
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Forest, camping, agriculture
Typical hinterland level	Rising ground
Conservation designations	None (adjacent to Glannau Rhoscolyn SSSI and SPA)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	2.95 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008 (partial coverage)
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1356 (227351E 371436N)
Distance offshore	4.7 km
Mean wind speed	13.58 knots
Mean wind direction	230.3 ° (SW)
Mean significant wave height (Hs)	0.91 m
Mean zero up-crossing period (Tz)	3.73 sec
Mean peak wave period (Tp)	5.74 sec
Mean wave direction	236.8 ° (WSW)
Mean wave direction scaled for wave power	232.9 ° (SW)
Mean annual wave power	33.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Grazing	Minor
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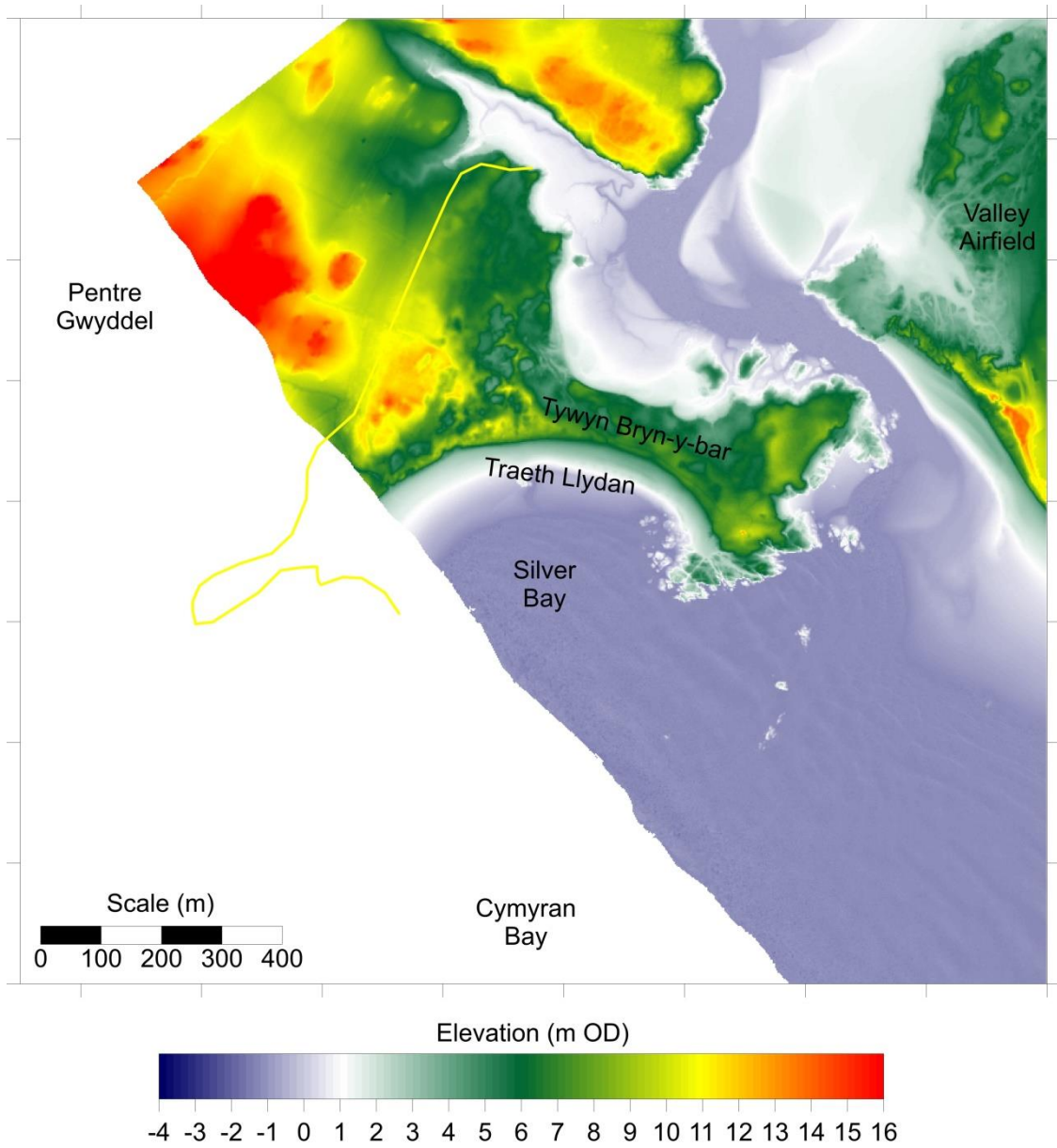
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

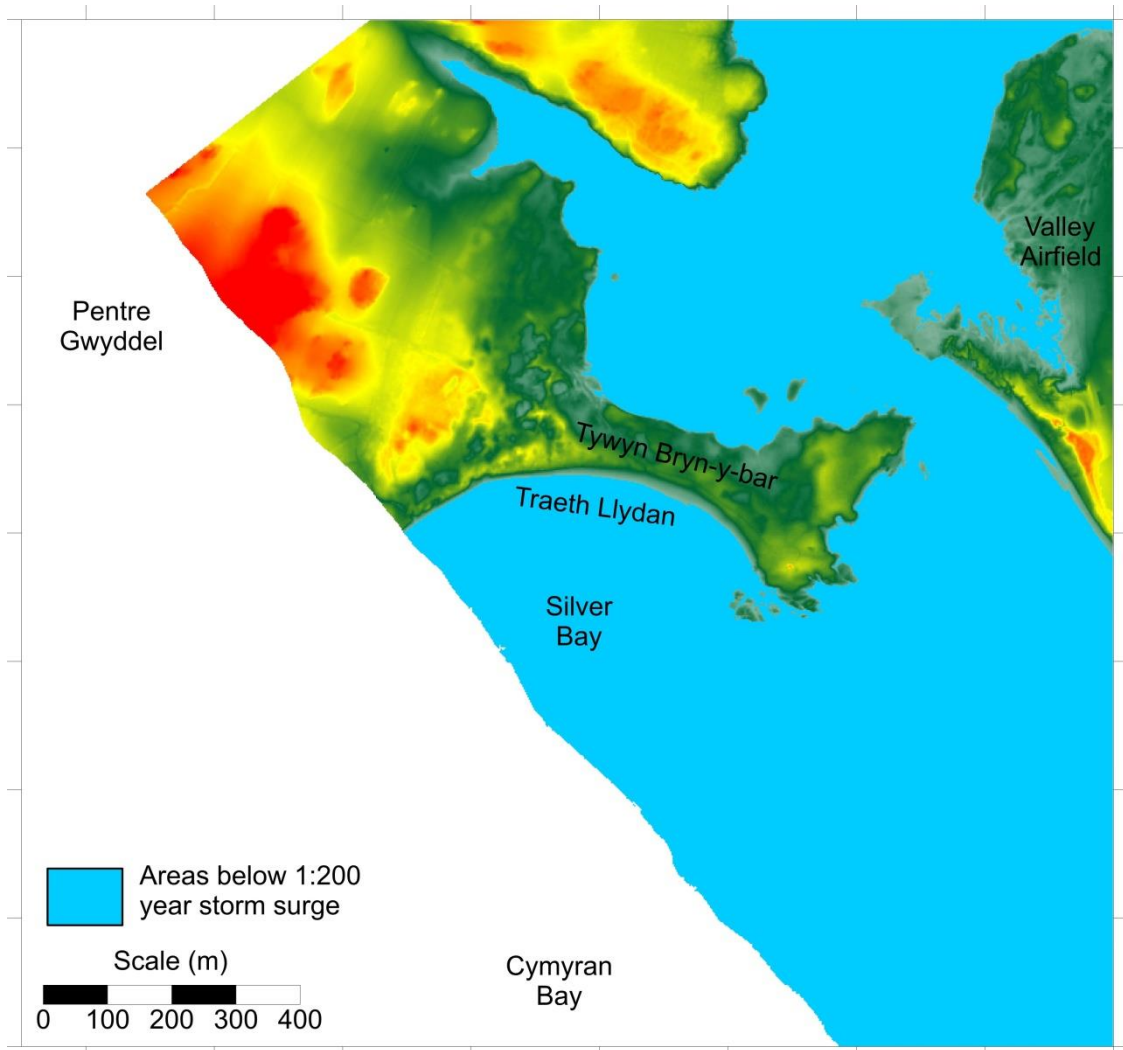
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 72: Trearddur Bay, Holy Island

Site description

Morphological setting	Bay (Trearddur Bay), Anglesey west shore
Morphological type	Fringing
Erosion/progradation status	Stable (protected)
Defence structures	Sea wall
Hinterland type	Car park, houses, scrub land
Typical hinterland level	3.9 to 4.0 m OD on car park 4.2 to 4.3 m OD in housing areas 1.9 to 2.4 m OD on scrub land behind
Conservation designations	None
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.00 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.42 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	04/03/2015
Principal aspect of dune frontage	southwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1356 (227351E 371436N)
Distance offshore	4.7 km
Mean wind speed	13.58 knots
Mean wind direction	230.3 ° (SW)
Mean significant wave height (Hs)	0.91 m
Mean zero up-crossing period (Tz)	3.73 sec
Mean peak wave period (Tp)	5.74 sec
Mean wave direction	236.8 ° (WSW)
Mean wave direction scaled for wave power	232.9 ° (SW)
Mean annual wave power	33.9 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; DS)	265-350 µm (average: 305 µm)
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Current and past dune and beach management measures

Promenade protects seaward side of dunes	Major
Marram planting	Minor

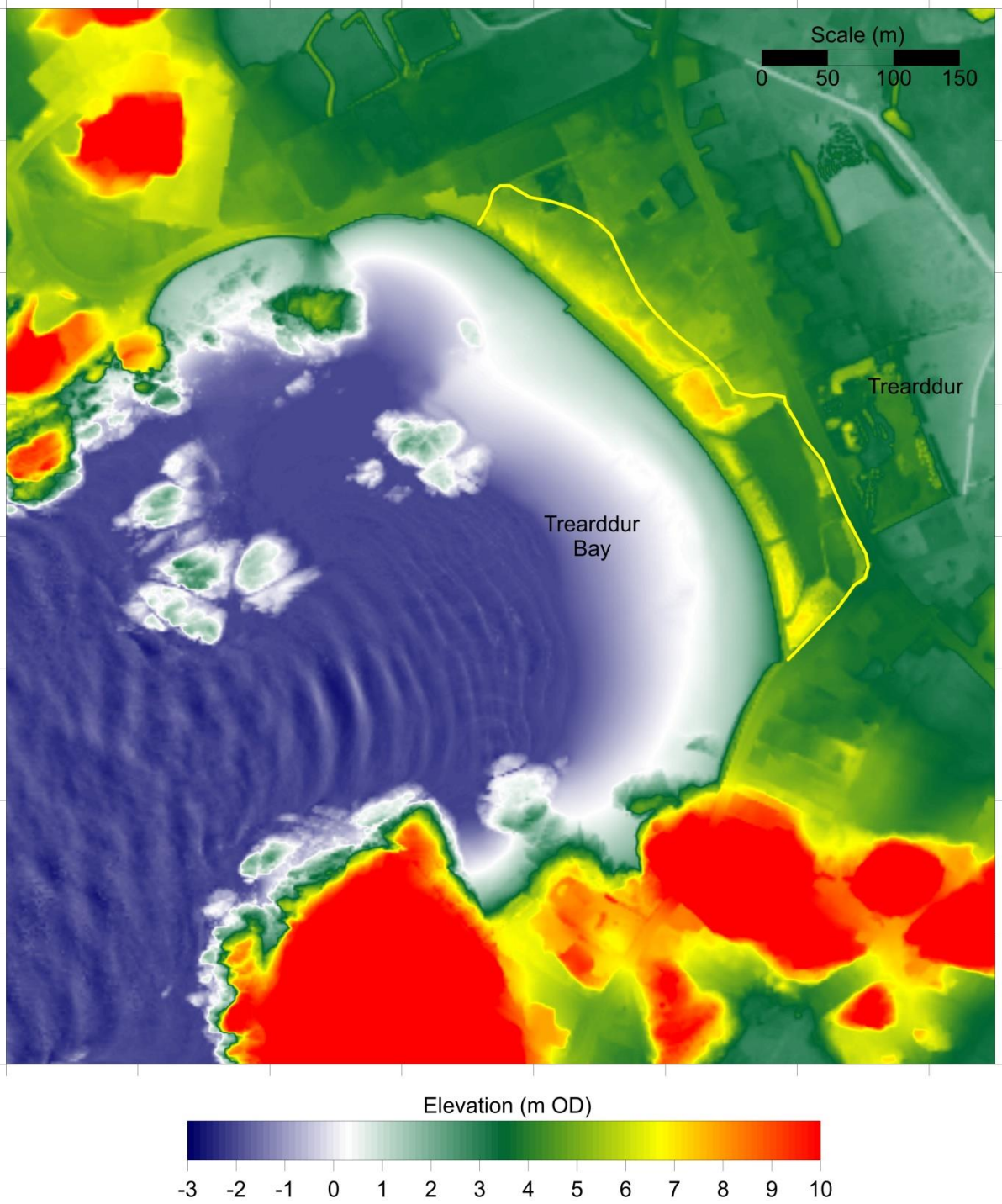
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

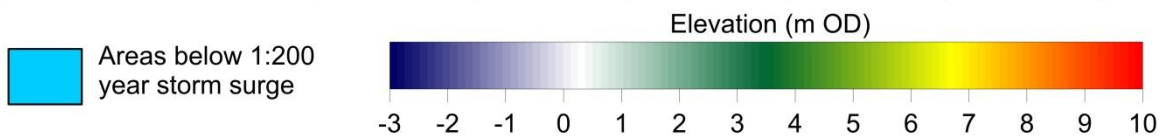
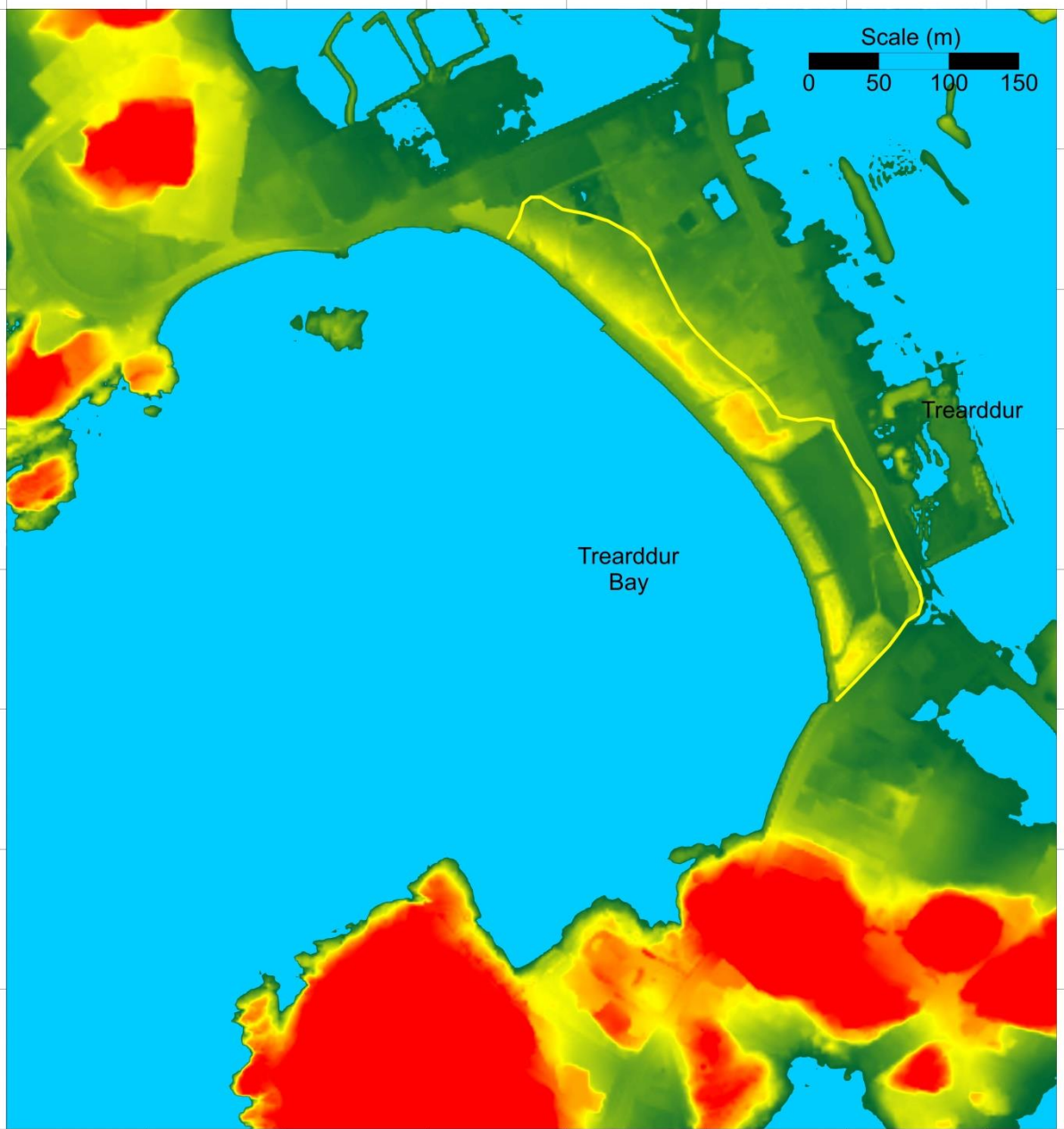
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 73: Traeth Penrhos, Holy Island

Site description

Morphological setting	Bay (behind Traeth Penrhos, east side of Holy Island)
Morphological type	Barrier, fringing
Erosion/progradation status	Stable
Defence structures	Sea wall
Hinterland type	Marsh, coastal road, houses, aluminium works further inland
Typical hinterland level	3.0 to 4.4 m OD on marsh in front of coastal road 2.0 to 2.8 m OD on marsh behind coastal road >4.2 m OD on coastal road
Conservation designations	None
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.25 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.93 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	north

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1424 (227463E 389250N)
Distance offshore	2.4 km
Mean wind speed	14.15 knots
Mean wind direction	230.5 ° (SW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.38 sec
Mean peak wave period (Tp)	5.26 sec
Mean wave direction	271.9 ° (W)
Mean wave direction scaled for wave power	272.1 ° (W)
Mean annual wave power	22.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 1; DS)	202 µm
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

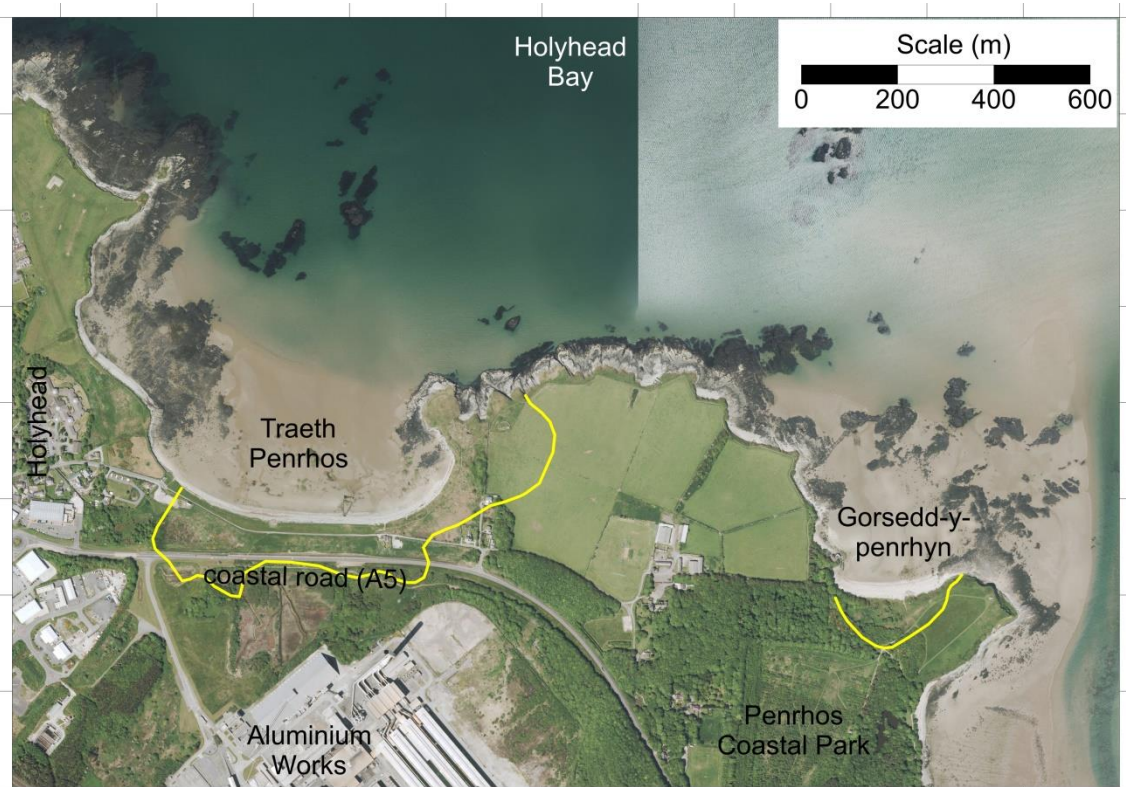
Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

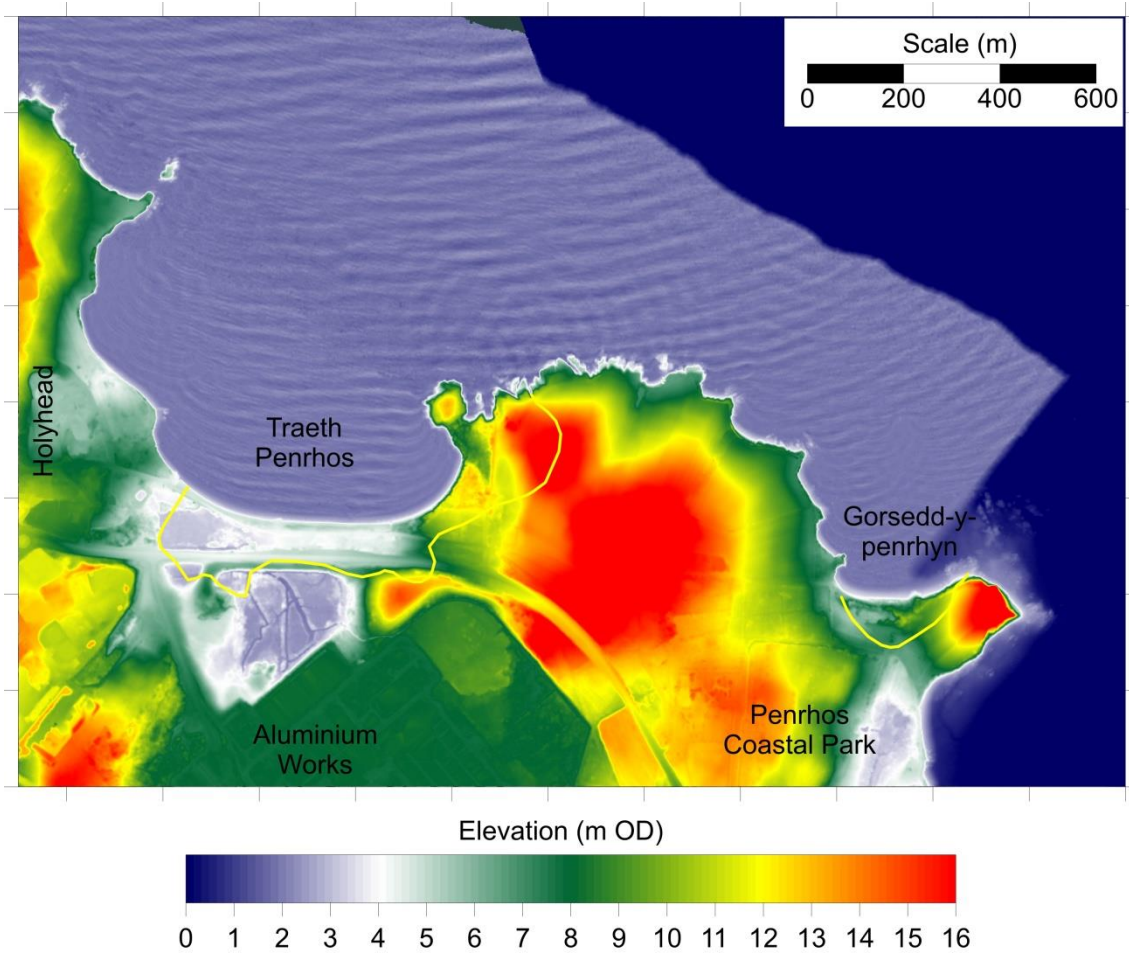
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

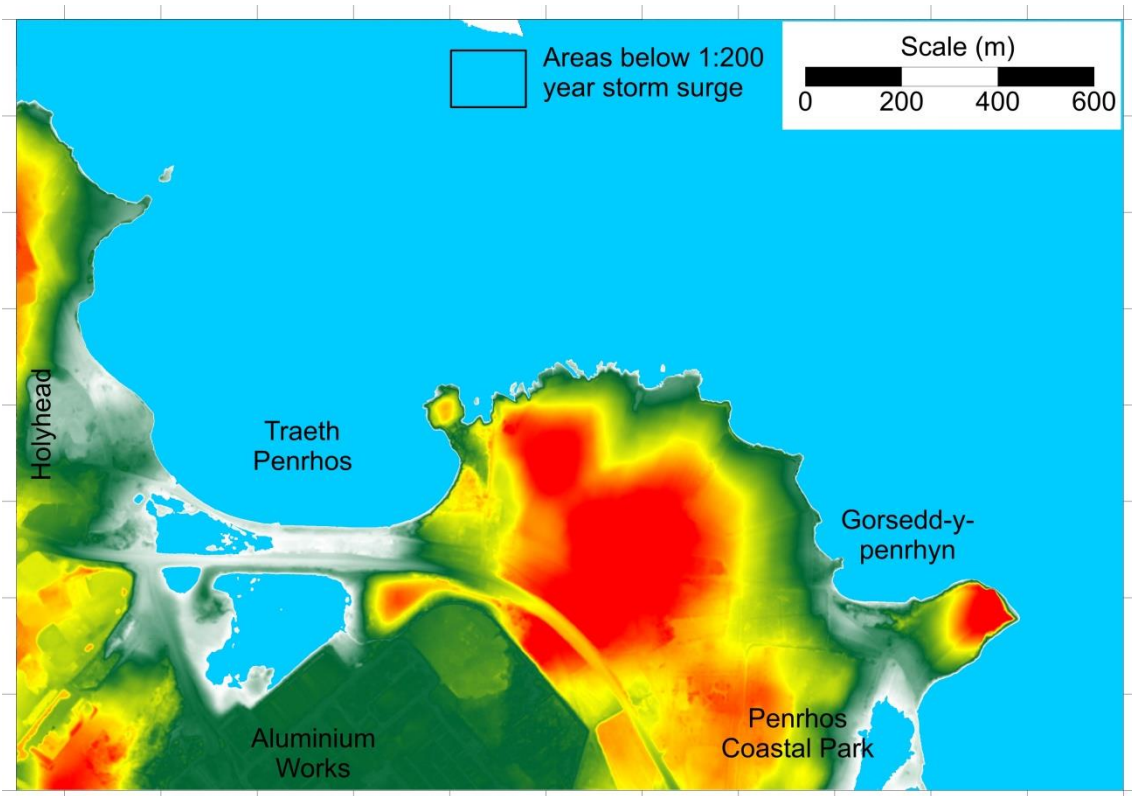
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 74: Gorsedd-y-penrhyn, Holy Island

Site description

Morphological setting	Bay (behind Gorsedd-y-penrhyn, east side of Holy Island)
Morphological type	Fringing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Forest, Country Park
Typical hinterland level	>5.4 m OD on forest
Conservation designations	Beddmanarch-Cymyran SSSI
Notable features	Country Park and viewpoint

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.25 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.93 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	north

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1424 (227463E 389250N)
Distance offshore	2.4 km
Mean wind speed	14.15 knots
Mean wind direction	230.5 ° (SW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.38 sec
Mean peak wave period (Tp)	5.26 sec
Mean wave direction	271.9 ° (W)
Mean wave direction scaled for wave power	272.1 ° (W)
Mean annual wave power	22.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

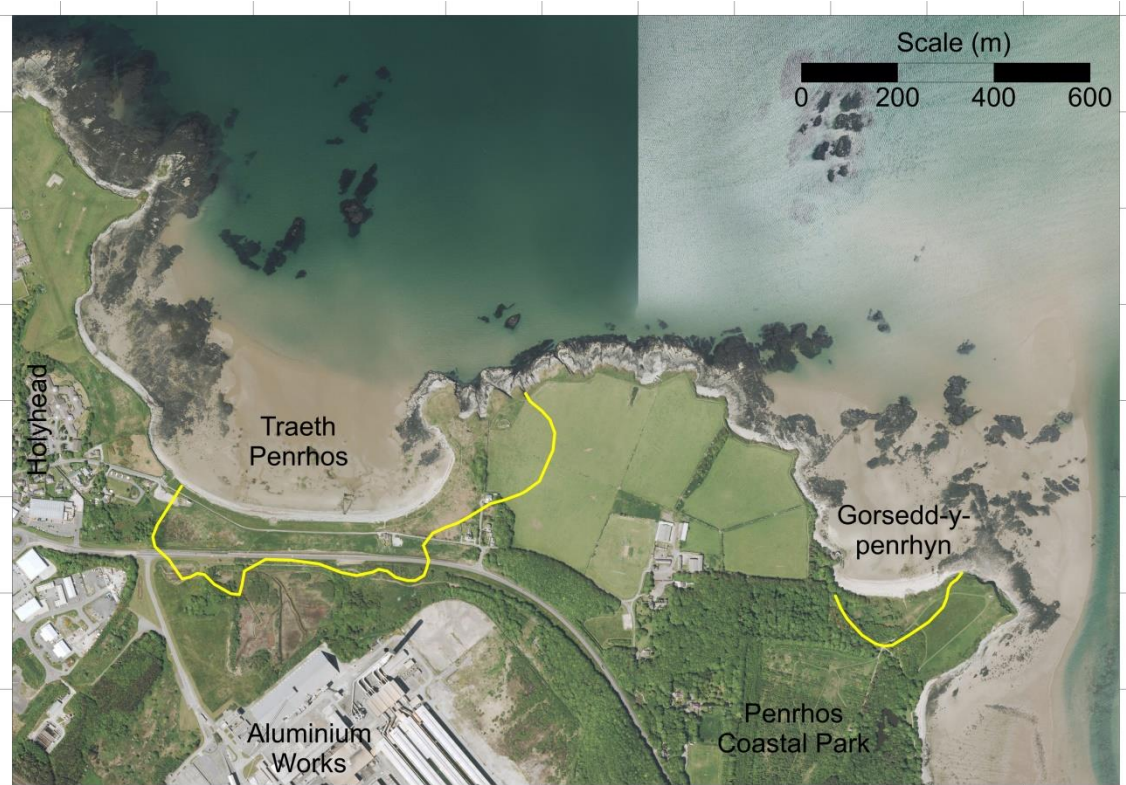
Current and past dune and beach management measures

None identified	
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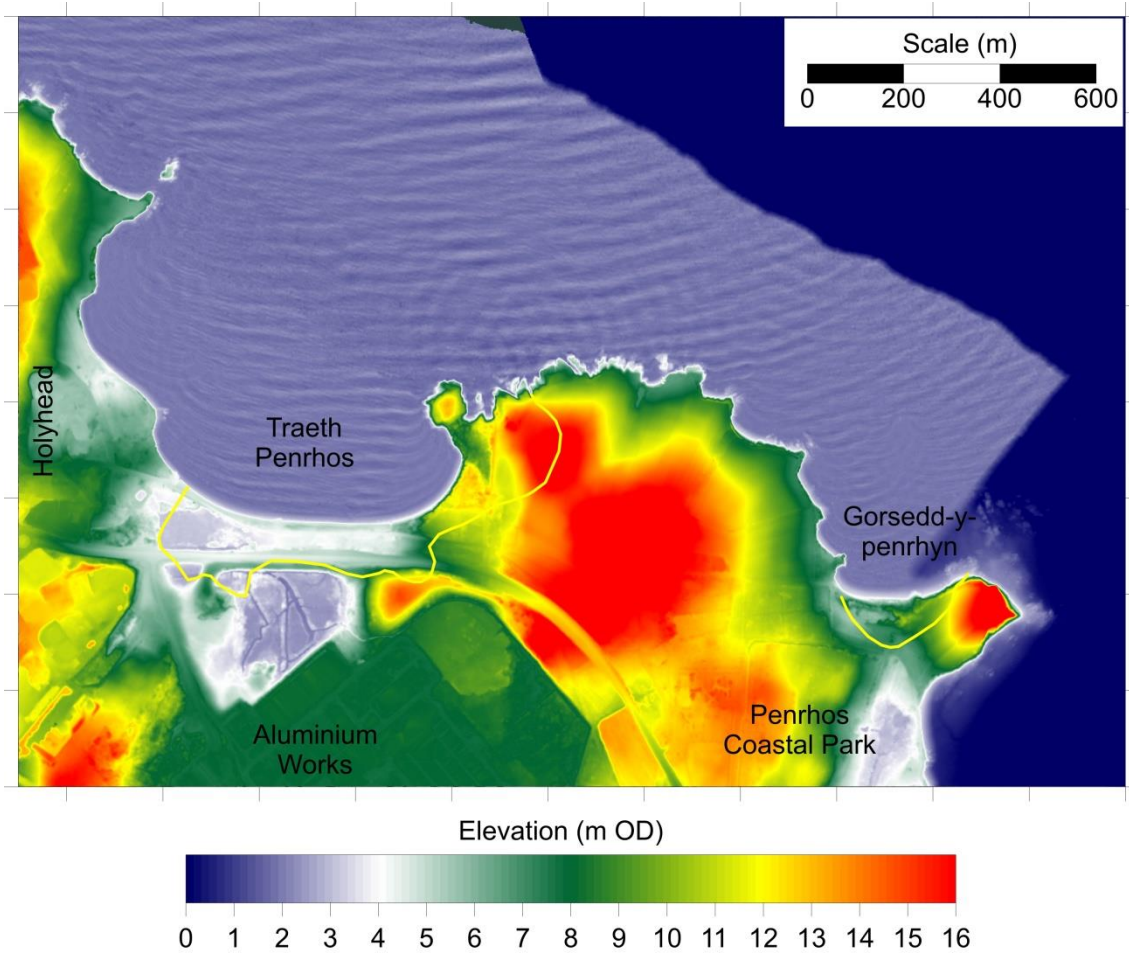
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

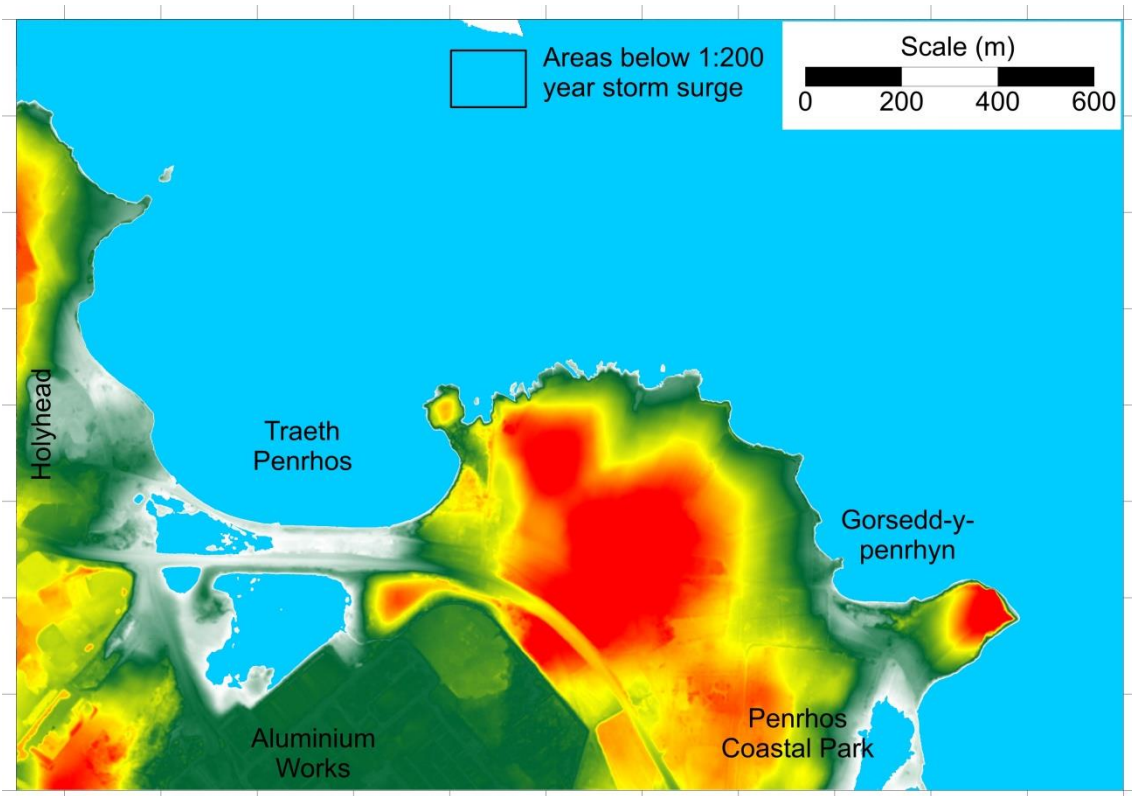
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 75: Tywyn-gwyn

Site description

Morphological setting	Shallow bay and estuary (behind Traeth y Gribin, adjacent to Afon Alaw estuary)
Morphological type	Fringing and barrier
Erosion/progradation status	Stable, but southern tip displays short term erosion and accretion due to river channel movements
Defence structures	None
Hinterland type	Marsh, agriculture
Typical hinterland level	2.0 to 3.0 m OD on marsh
Conservation designations	Beddmanarch-Cymyran SSSI
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.25 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.93 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	West northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1424 (227463E 389250N)
Distance offshore	2.4 km
Mean wind speed	14.15 knots
Mean wind direction	230.5 ° (SW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.38 sec
Mean peak wave period (Tp)	5.26 sec
Mean wave direction	271.9 ° (W)
Mean wave direction scaled for wave power	272.1 ° (W)
Mean annual wave power	22.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	186-378 µm (average: 238 µm)
Calcium carbonate content (%) (N= 4)	0.48-2.02% (average: 1.18%)
Silica content (%) (N= 4)	85-94% (average: 91.3%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Medium
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8.5
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

None identified	
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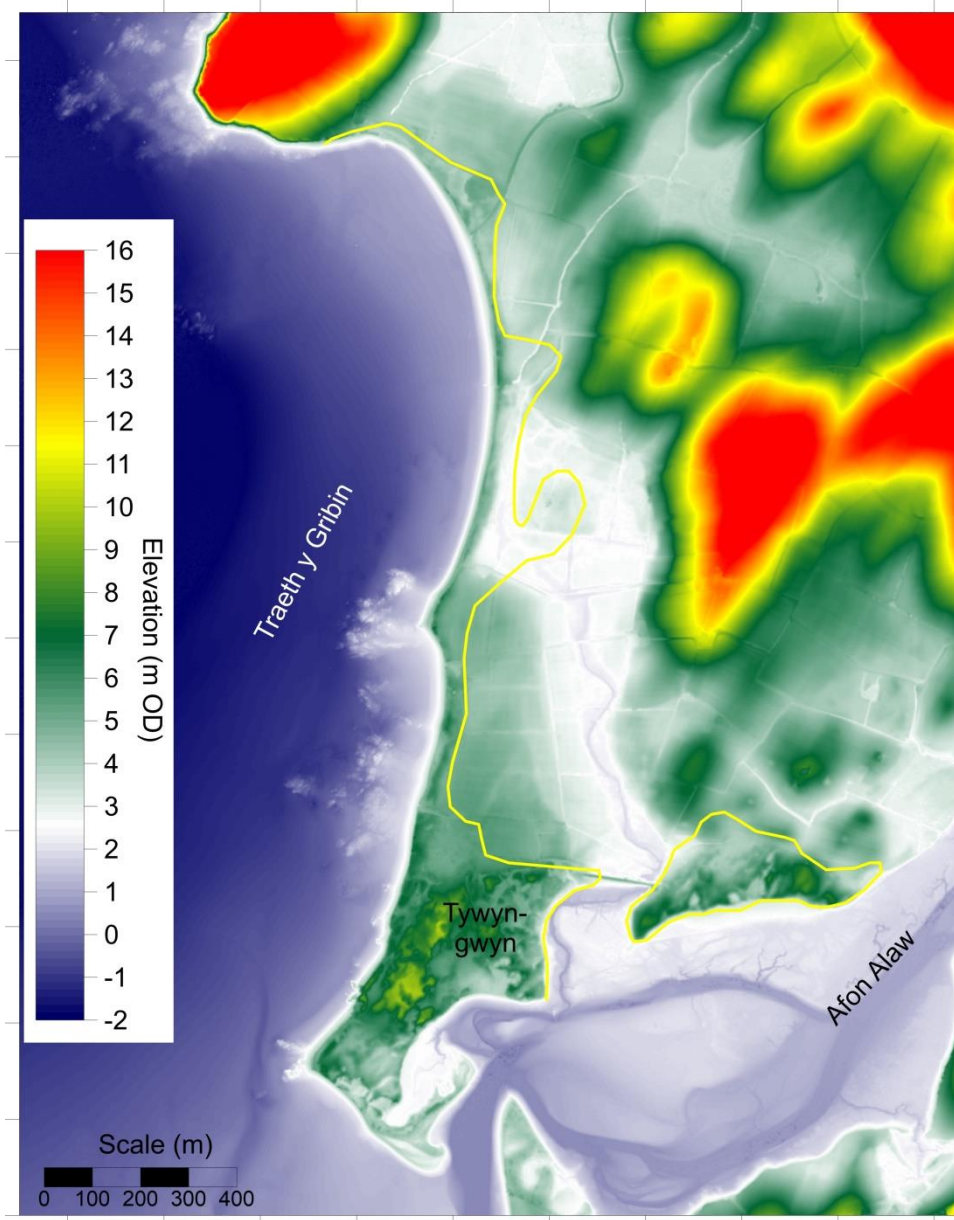
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

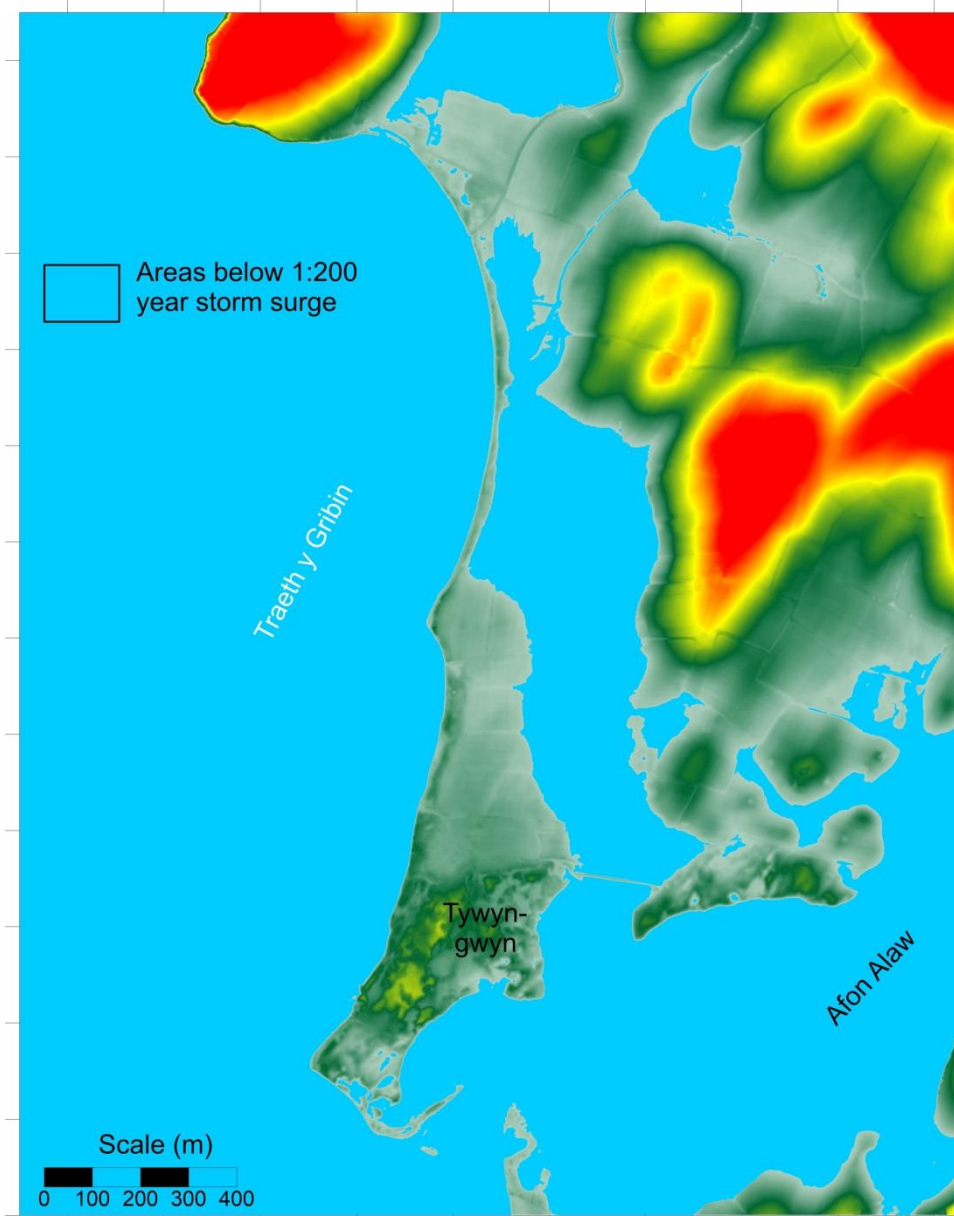
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2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 76: Tywyn-mawr

Site description

Morphological setting	Bay (behin Traeth Tywyn-mawr), Anglesey north shore
Morphological type	Fringing and climbing
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Agriculture, caravans, marsh
Typical hinterland level	2.7 to 4.0 m OD on marsh
Conservation designations	None
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	3.25 m OD
1:200 year storm surge level (McMillan et al., 2011)	3.93 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	27/12/2008
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1424 (227463E 389250N)
Distance offshore	2.4 km
Mean wind speed	14.15 knots
Mean wind direction	230.5 ° (SW)
Mean significant wave height (Hs)	0.79 m
Mean zero up-crossing period (Tz)	3.38 sec
Mean peak wave period (Tp)	5.26 sec
Mean wave direction	271.9 ° (W)
Mean wave direction scaled for wave power	272.1 ° (W)
Mean annual wave power	22.1 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	220-304 µm (average: 248 µm)
Calcium carbonate content (%) (N= 3)	4.84-11.15% (average: 7.67%)
Silica content (%) (N= 3)	82.6-90.4% (average: 87.2%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

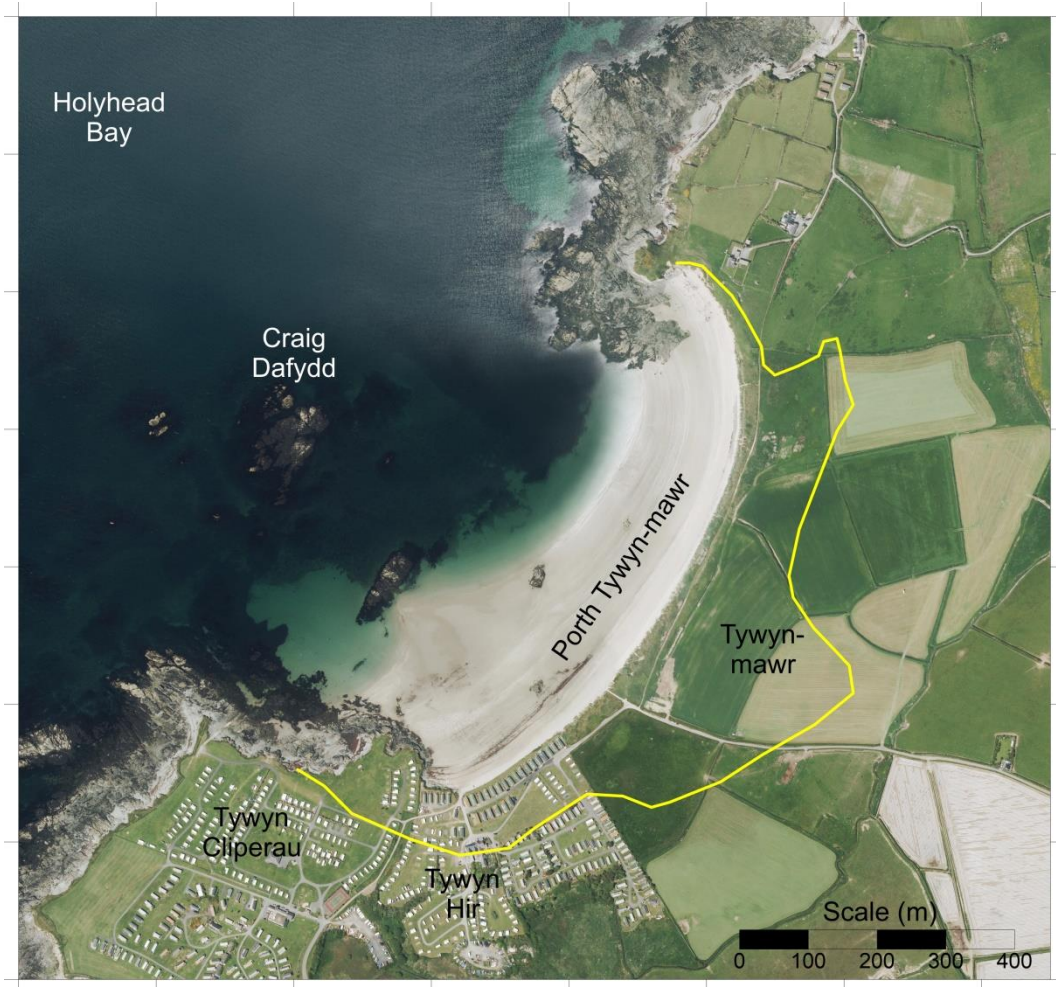
Current and past dune and beach management measures

None identified	
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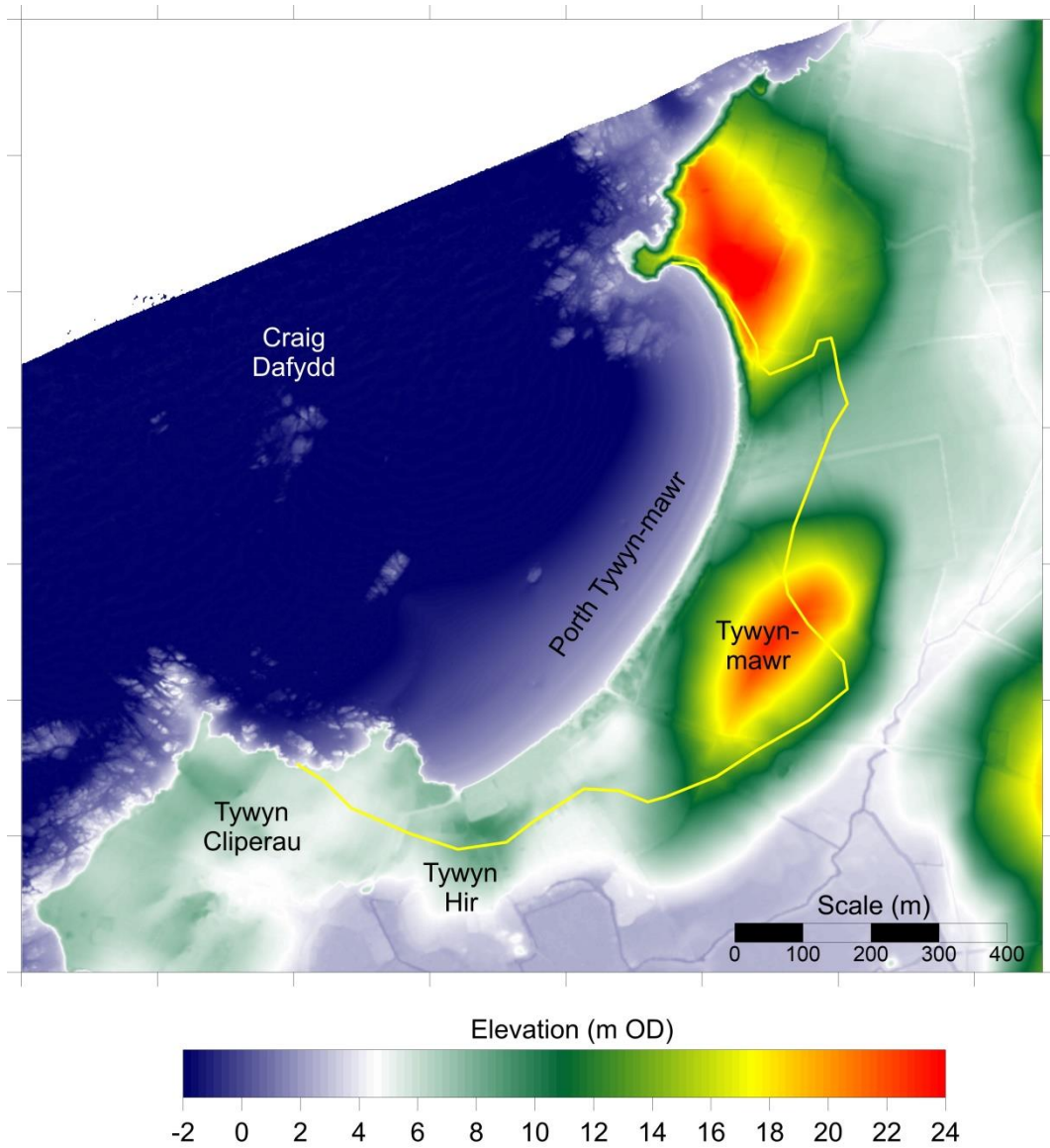
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

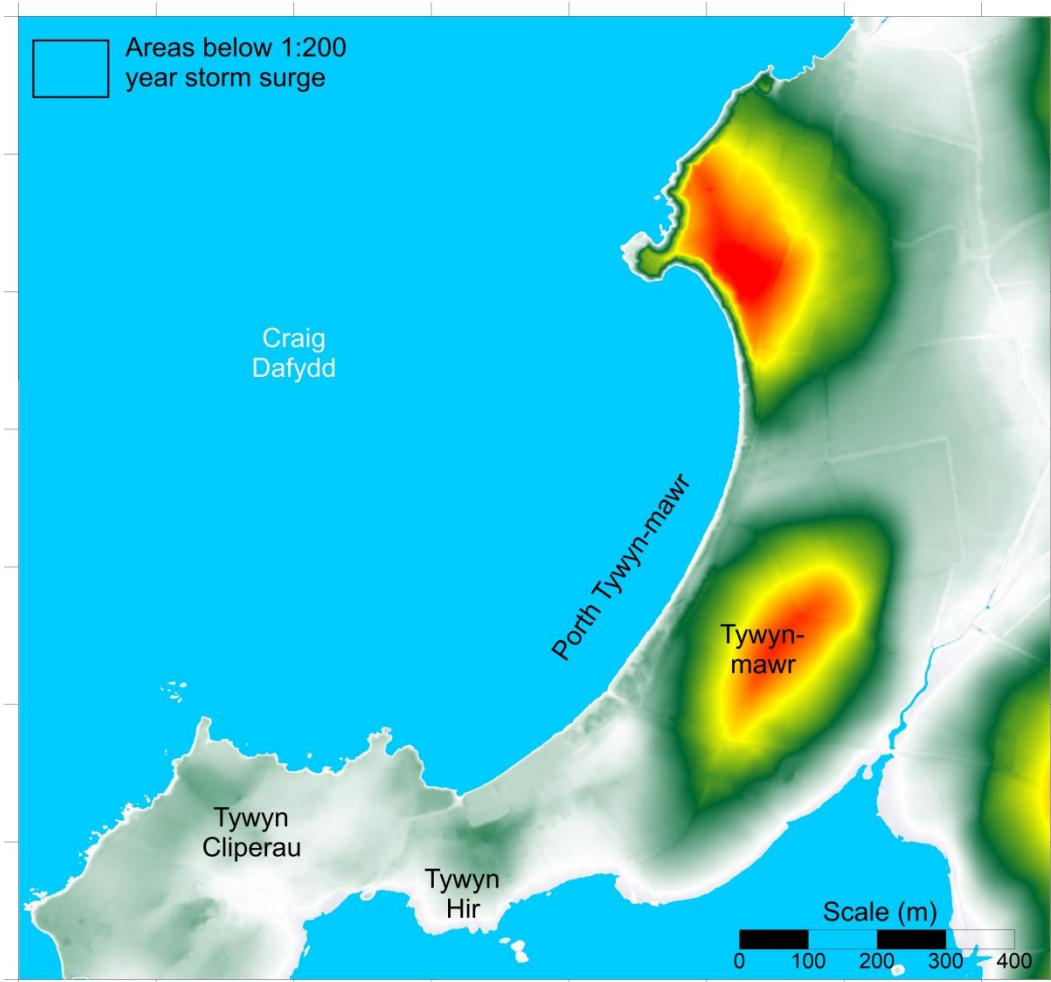
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated level of 1 in 200 year storm surge.

Site 77: Traeth Dulas

Site description

Morphological setting	Bay (Dulas Bay, Anglesey east shore)
Morphological type	Fringing and barrier spit
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Estuary, heath
Typical hinterland level	Intertidal sandflats to front and rear, rising ground to south
Conservation designations	Coed Y Gell and Morfa Dulas SSSI
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.40 m OD
1:200 year storm surge level (McMillan et al., 2011)	4.96 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	31/03/2007 (partial coverage)
Principal aspect of dune frontage	northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1434 (254224E 389054N)
Distance offshore	4.3 km
Mean wind speed	13.29 knots
Mean wind direction	230.0 ° (SW)
Mean significant wave height (Hs)	0.51 m
Mean zero up-crossing period (Tz)	2.66 sec
Mean peak wave period (Tp)	3.55 sec
Mean wave direction	320.7 ° (NW)
Mean wave direction scaled for wave power	339.8 ° (NNW)
Mean annual wave power	8.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 5; LD)	322-616 µm (average: 435 µm)
Calcium carbonate content (%) (N= 3)	1.04-4.62% (average: 3.36%)
Silica content (%) (N= 3)	86-93.4% (average: 88.4%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

None identified	
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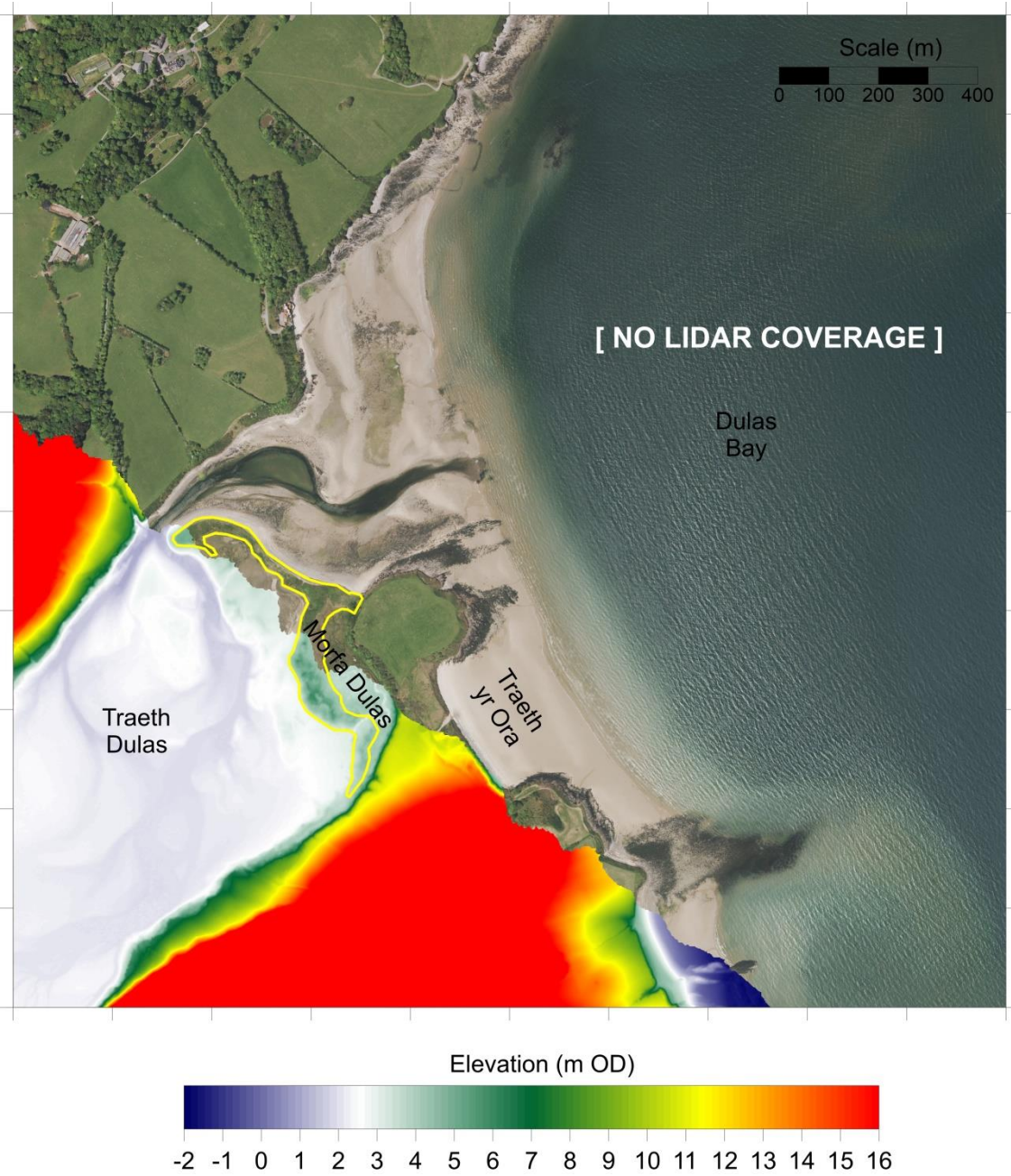
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 78: Traeth Lligwy

Site description

Morphological setting	Bay Lligwy Bay, Anglesey east shore)
Morphological type	Mid-bay barrier, fringing and climbing on margins
Erosion/progradation status	Stable
Defence structures	None
Hinterland type	Marsh (active and reclaimed), tidal flat, grazing land, car park, camping / caravan site
Typical hinterland level	4.2 to 4.6 m OD on marsh, rising ground behind
Conservation designations	Traeth Lligwy SSSI
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.45 m OD
1:200 year storm surge level (McMillan et al., 2011)	4.96 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	31/03/2007
Principal aspect of dune frontage	northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1434 (254224E 389054N)
Distance offshore	4.3 km
Mean wind speed	13.29 knots
Mean wind direction	230.0 ° (SW)
Mean significant wave height (Hs)	0.51 m
Mean zero up-crossing period (Tz)	2.66 sec
Mean peak wave period (Tp)	3.55 sec
Mean wave direction	320.7 ° (NW)
Mean wave direction scaled for wave power	339.8 ° (NNW)
Mean annual wave power	8.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 6; LD)	297-379 µm (average: 323 µm)
Calcium carbonate content (%) (N= 3)	2.12-3.77% (average: 2.82%)
Silica content (%) (N= 3)	91.9-94.9% (average: 93.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	High
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	10
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

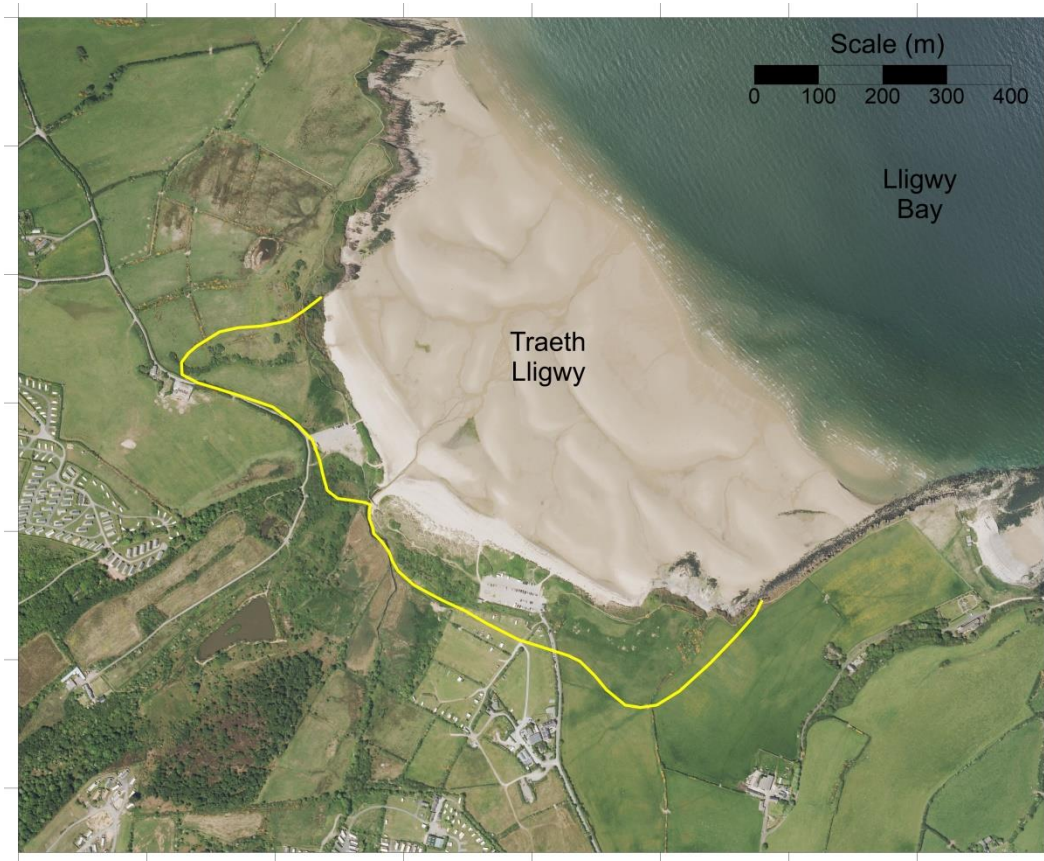
Current and past dune and beach management measures

None identified	
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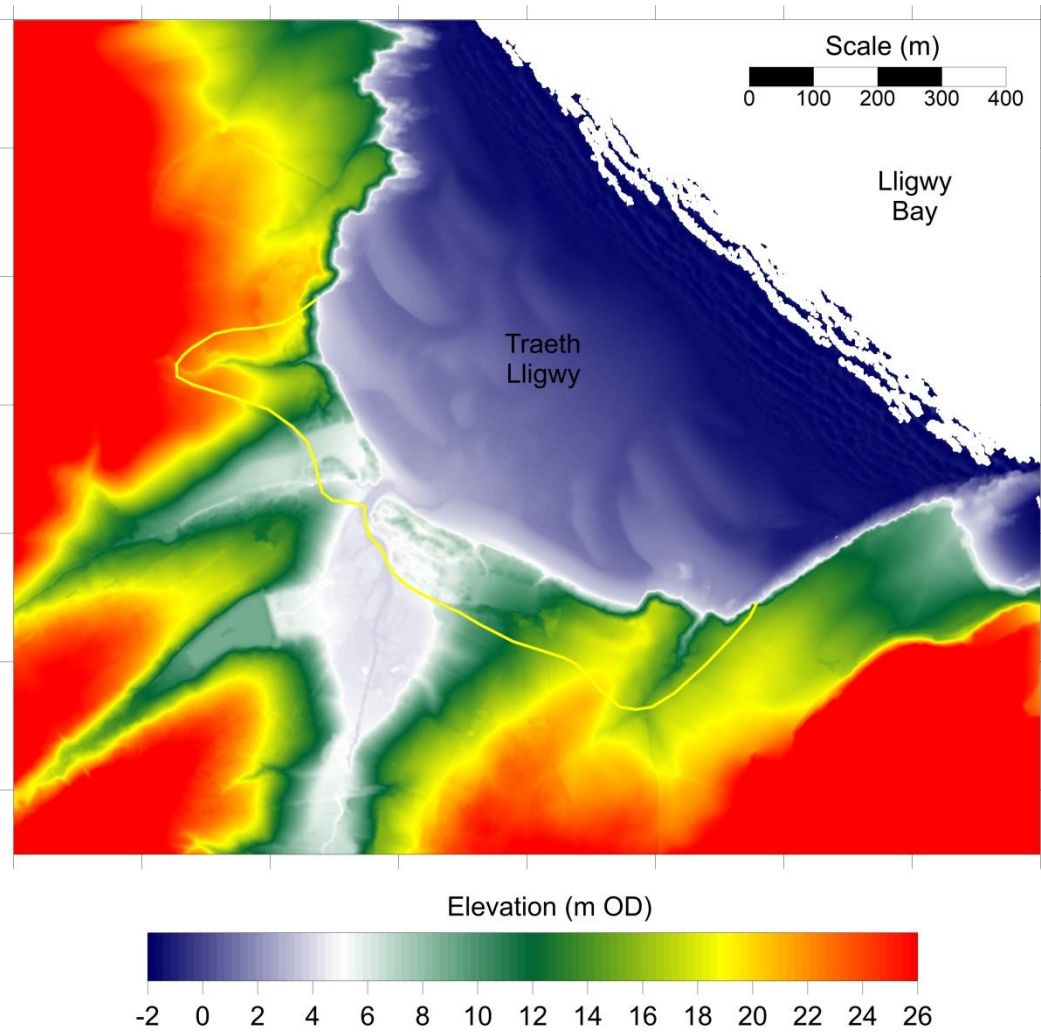
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

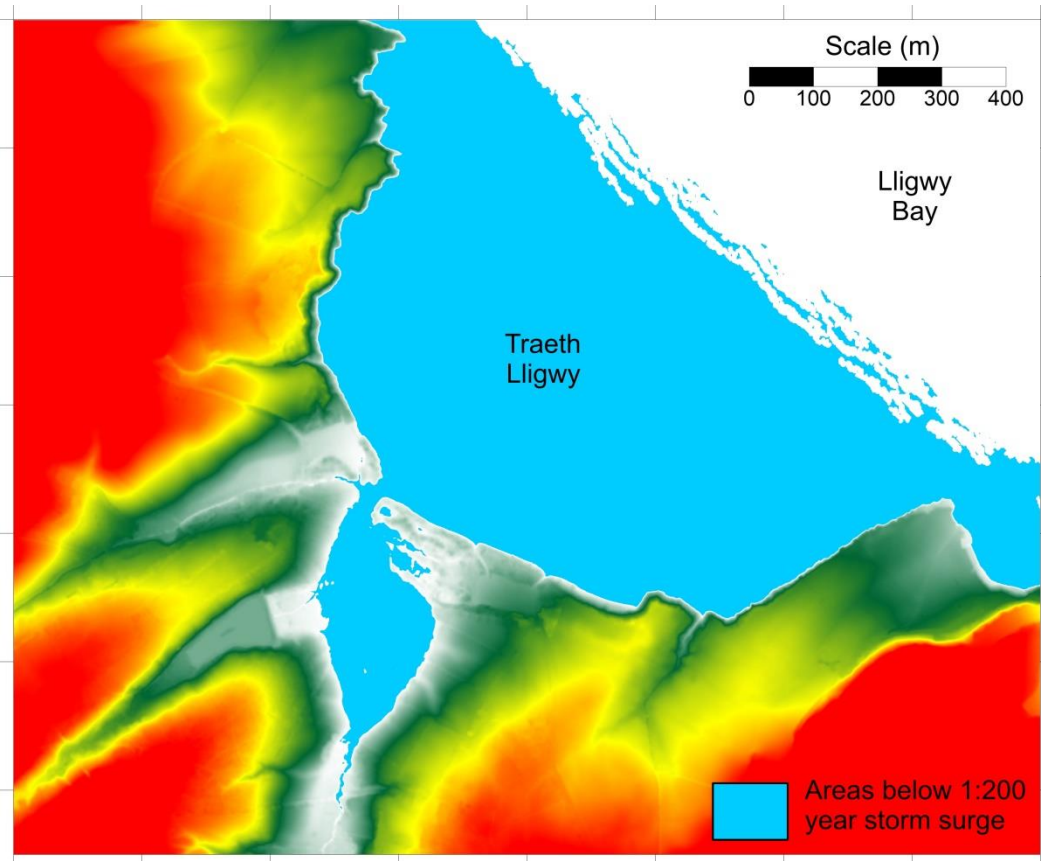
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS mapping.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 79: Benllech Sand

Site description

Morphological setting	Open coast, shallow bay (Anglesey east shore)
Morphological type	Fringing, climbing, cliff top (isolated from modern sand supply)
Erosion/progradation status	Stable
Defence structures	Rock armour, sea wall at extreme W end
Hinterland type	Agriculture, caravans, houses
Typical hinterland level	Rising ground
Conservation designations	None (adjacent to Trwyn Dwlban SSSI)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.50 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.01 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	31/03/2007
Principal aspect of dune frontage	northeast

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1434 (254224E 389054N)
Distance offshore	4.3 km
Mean wind speed	13.29 knots
Mean wind direction	230.0 ° (SW)
Mean significant wave height (Hs)	0.51 m
Mean zero up-crossing period (Tz)	2.66 sec
Mean peak wave period (Tp)	3.55 sec
Mean wave direction	320.7 ° (NW)
Mean wave direction scaled for wave power	339.8 ° (NNW)
Mean annual wave power	8.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	None
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

None identified	
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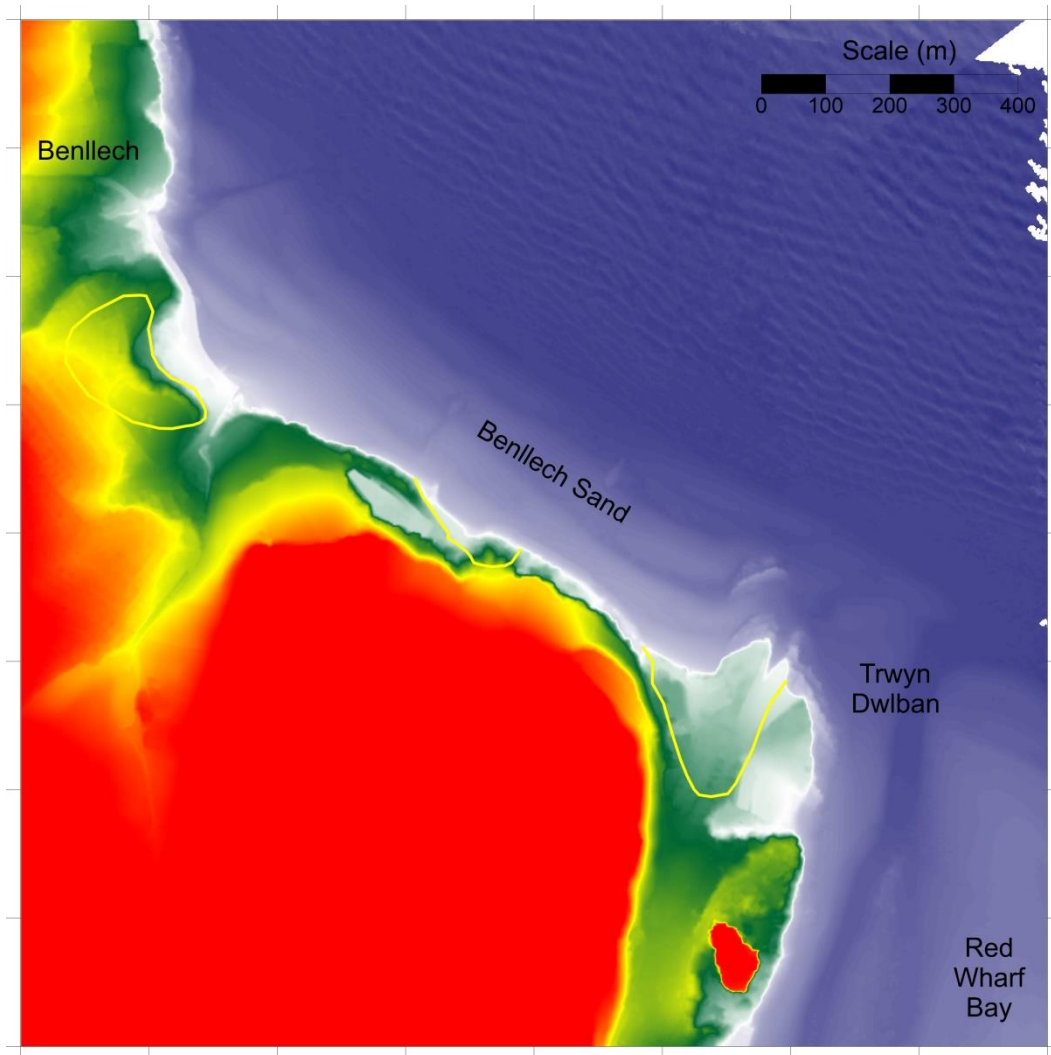
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

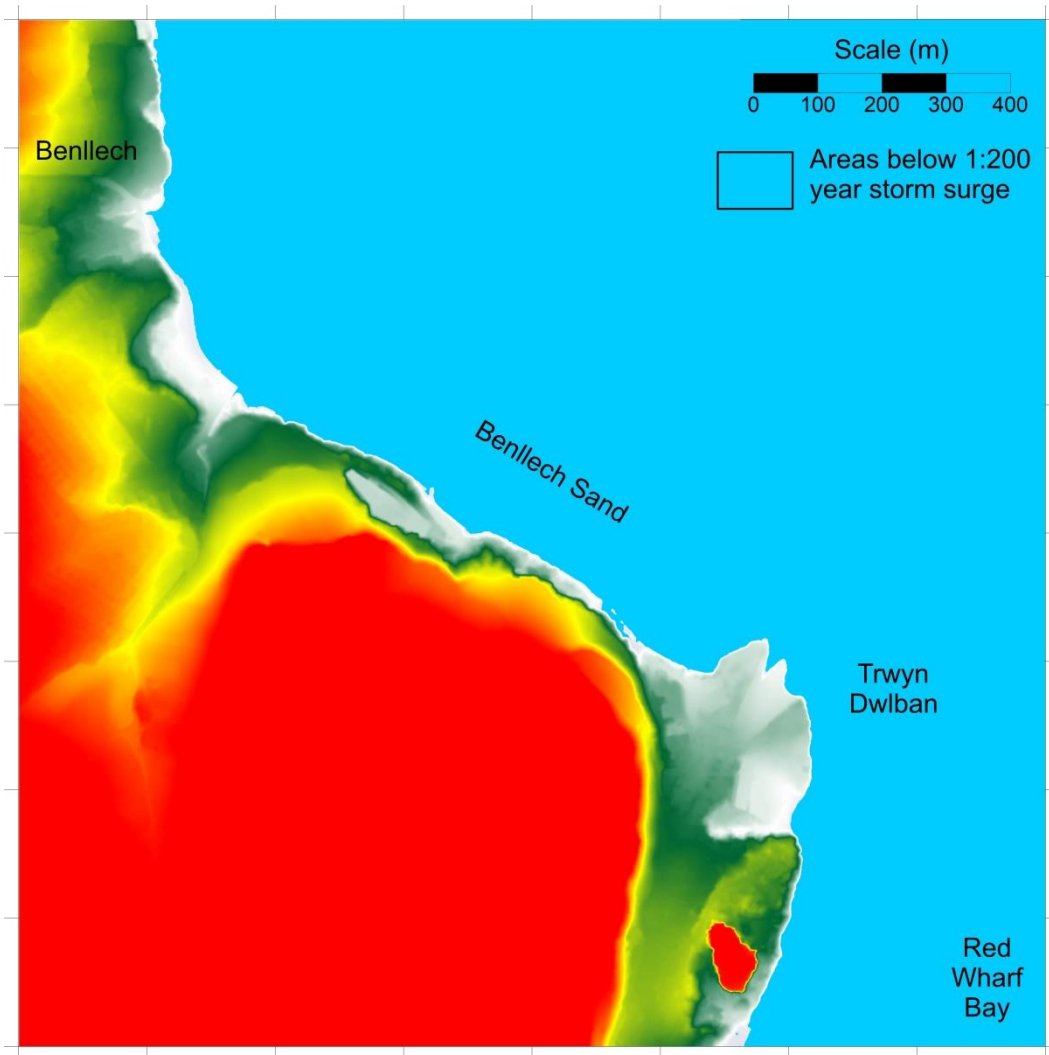
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LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS mapping.



Areas below the estimated 1 in 200 year storm surge level.

Site 80: Red Wharf Bay

Site description

Morphological setting	Bay (Red Wharf Bay, Anglesey East shore)
Morphological type	Fringing, small barrier spit
Erosion/progradation status	stable
Defence structures	Sea wall and rock armour on short sections
Hinterland type	Agriculture, marsh, houses
Typical hinterland level	3.6 m to 6.0 m OD on marsh and agricultural land, rising ground behind
Conservation designations	None (adjacent to SAC and SPA offshore)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.50 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.03 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	31/03/2007
Principal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1434 (254224E 389054N)
Distance offshore	4.3 km
Mean wind speed	13.29 knots
Mean wind direction	230.0 ° (SW)
Mean significant wave height (Hs)	0.51 m
Mean zero up-crossing period (Tz)	2.66 sec
Mean peak wave period (Tp)	3.55 sec
Mean wave direction	320.7 ° (NW)
Mean wave direction scaled for wave power	339.8 ° (NNW)
Mean annual wave power	8.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	194-356 µm (average: 247 µm)
Calcium carbonate content (%) (N= 3)	1.02-1.27% (average: 6.23%)
Silica content (%) (N= 3)	85.6-91.8% (average: 87.7%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7
SMP2 Policy in Epoch 1	NAI
SMP2 Policy in Epoch 2	NAI
SMP2 Policy in Epoch 3	NAI

Current and past dune and beach management measures

None identified	
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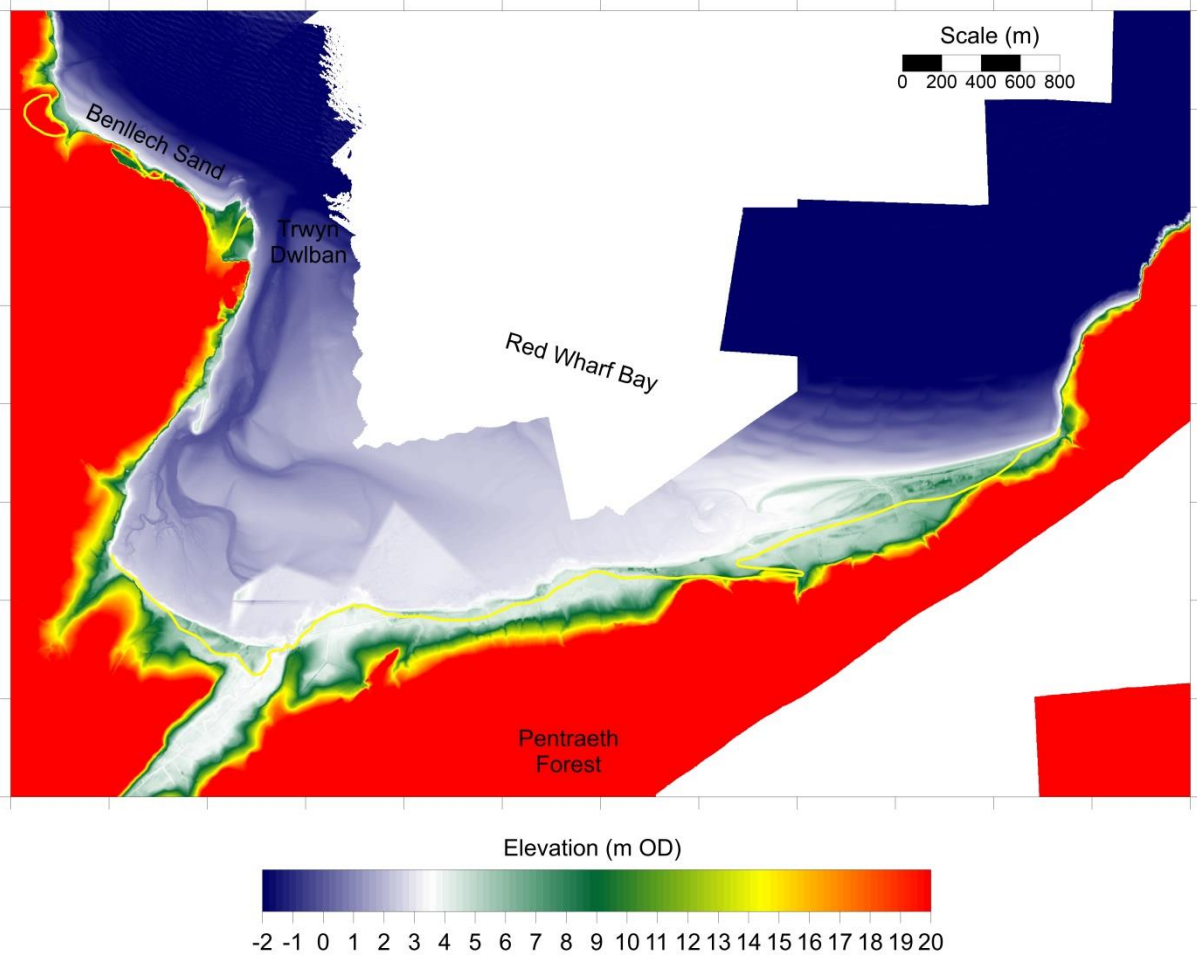
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

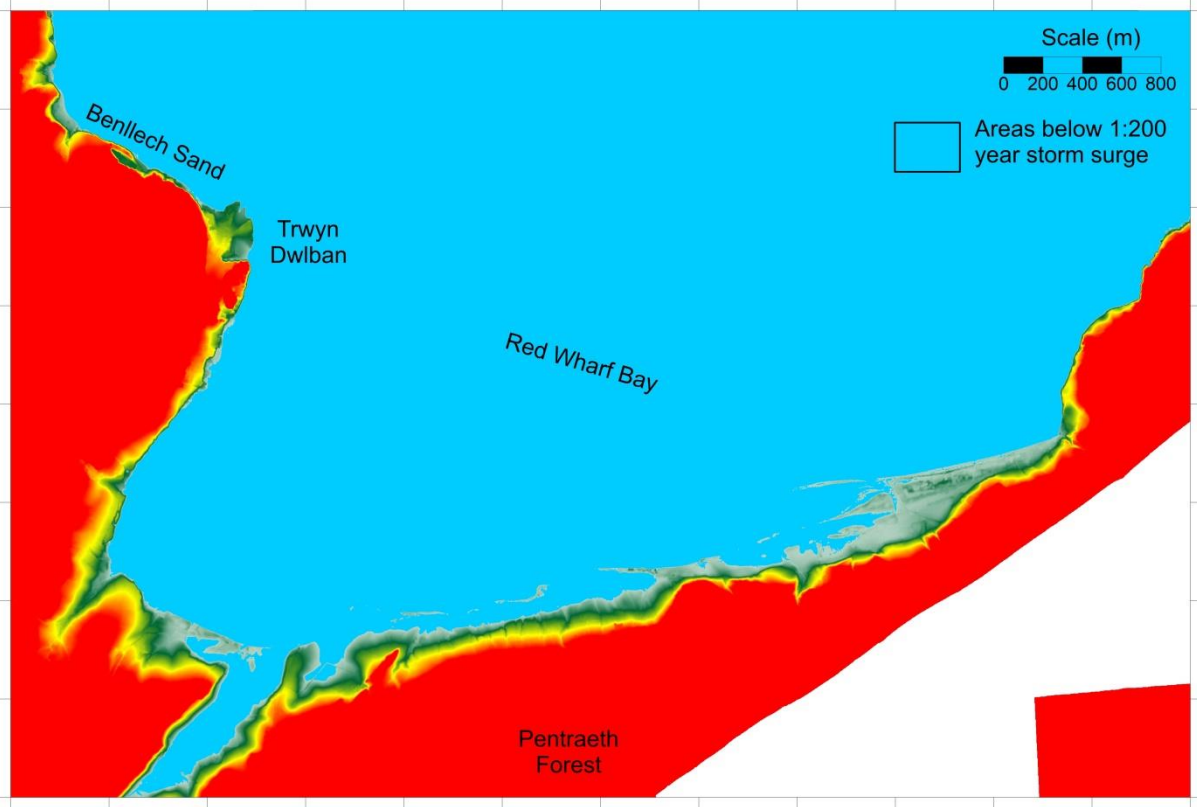
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



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Areas below the estimated 1 in 200 year storm surge level.

Site 81: Conwy Morfa

Site description

Morphological setting	Bay, estuary (Conwy Bay, Conwy estuary)
Morphological type	Ness
Erosion/progradation status	Stable / accreting on SW side, slowly eroding on NW side, stable or slowly accreting on NE / E on side
Defence structures	Groyne and rock armour at E end
Hinterland type	Golf course, caravan parks, marina, major road (A55) leading to Conwy tunnel
Typical hinterland level	3.6 to 6.5 m OD on golf course, road behind descends into Conwy tunnel behind
Conservation designations	None (adjacent to Aber Afon Conwy SSSI)
Notable features	Conwy golf course, former rifle range

Key water level and dune crest level

Highest astronomical tide (HAT) level	4.80 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.30 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	21/03/2015
Pincipal aspect of dune frontage	northwest

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1432 (272059E 388917N)
Distance offshore	5.6 km
Mean wind speed	12.88 knots
Mean wind direction	234.7 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	2.78 sec
Mean peak wave period (Tp)	3.80 sec
Mean wave direction	304.7 ° (NW)
Mean wave direction scaled for wave power	307.7 ° (NW)
Mean annual wave power	13.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 8; LD)	257-296 µm (average: 273 µm)
Calcium carbonate content (%) (N= 3)	1.02-1.27% (average: 1.16%)
Silica content (%) (N= 3)	93.4-96.5% (average: 94.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium
Nature Conservation Designation	Low
Geomorphological Features	Medium
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	9
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Sand fencing	Significant
Dune toe rip rap	Significant
Upper beach wooden revetment	Significant
Ad hoc dumping of demolition debris along dune toe	Significant

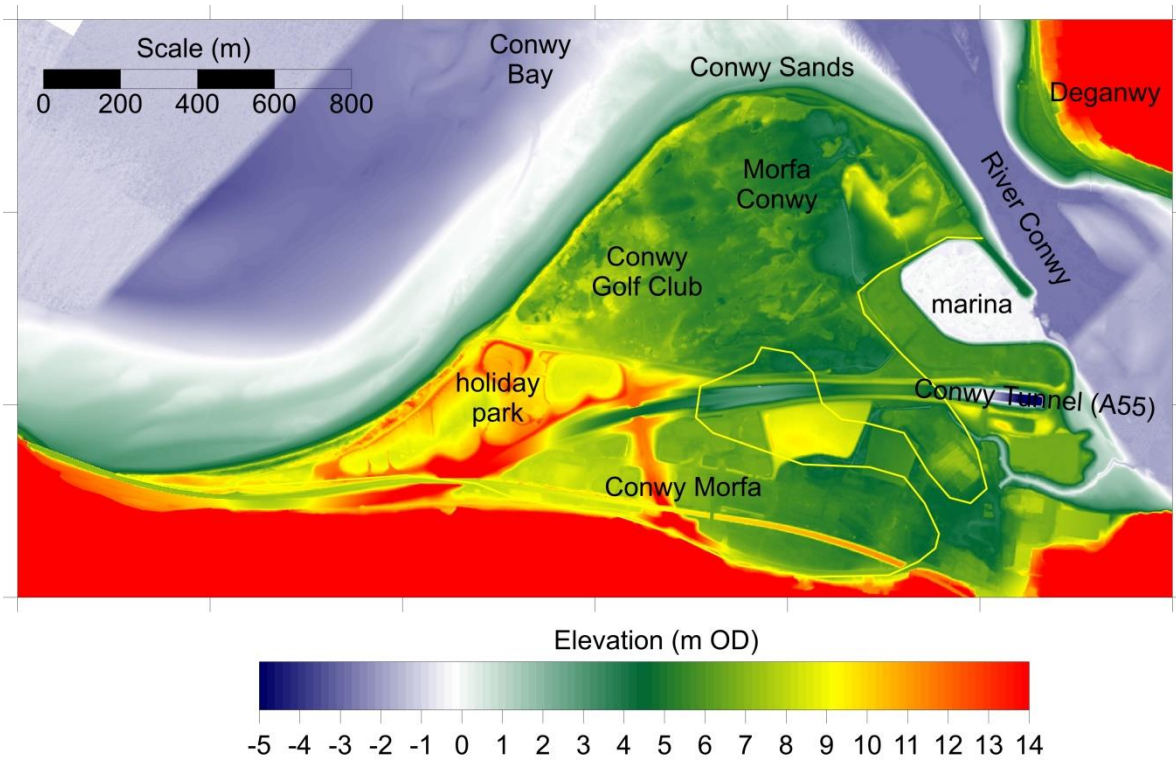
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

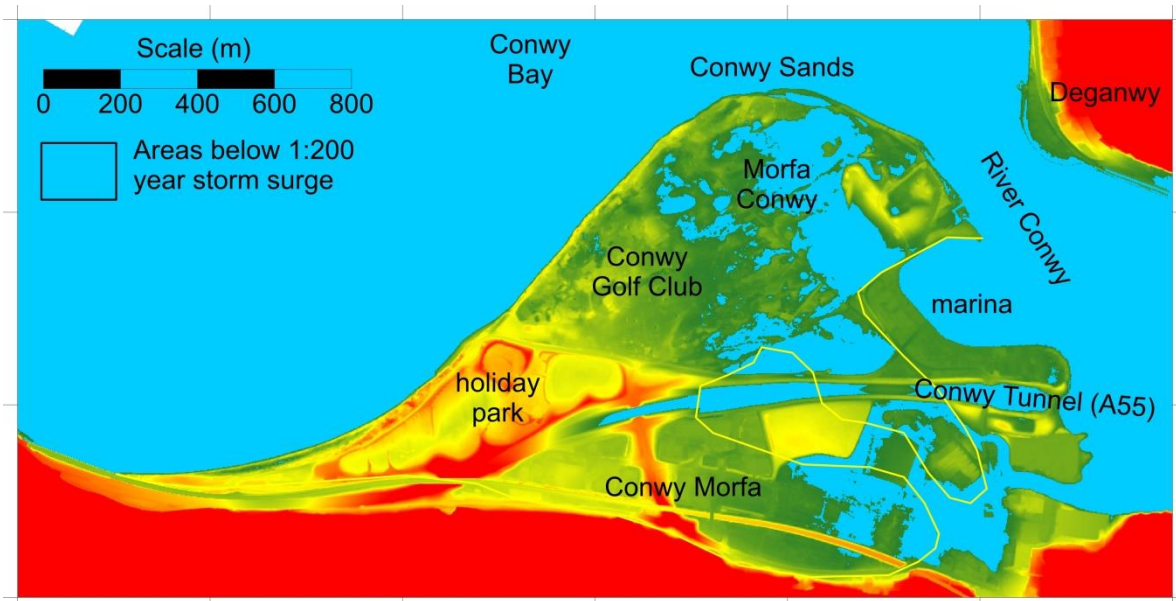
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



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LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 82: Deganwy South

Site description

Morphological setting	Bay, estuary (Conwy Bay, Conway estuary)
Morphological type	Fringing dunes on seaward side of defences
Erosion/progradation status	Stable (protected)
Defence structures	Sea wall
Hinterland type	Houses, railway
Typical hinterland level	5.0 to 5.7 m OD on road and housing areas 5.0 to 7.0 m OD on railway
Conservation designations	Aber Afon Conwy SSSI (adjacent to SAC)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.80 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.30 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	21/03/2015
Principal aspect of dune frontage	west

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1432 (272059E 388917N)
Distance offshore	5.6 km
Mean wind speed	12.88 knots
Mean wind direction	234.7 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	2.78 sec
Mean peak wave period (Tp)	3.80 sec
Mean wave direction	304.7 ° (NW)
Mean wave direction scaled for wave power	307.7 ° (NW)
Mean annual wave power	13.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	6.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Sand fencing	Significant
Dune toe rip rap	Significant

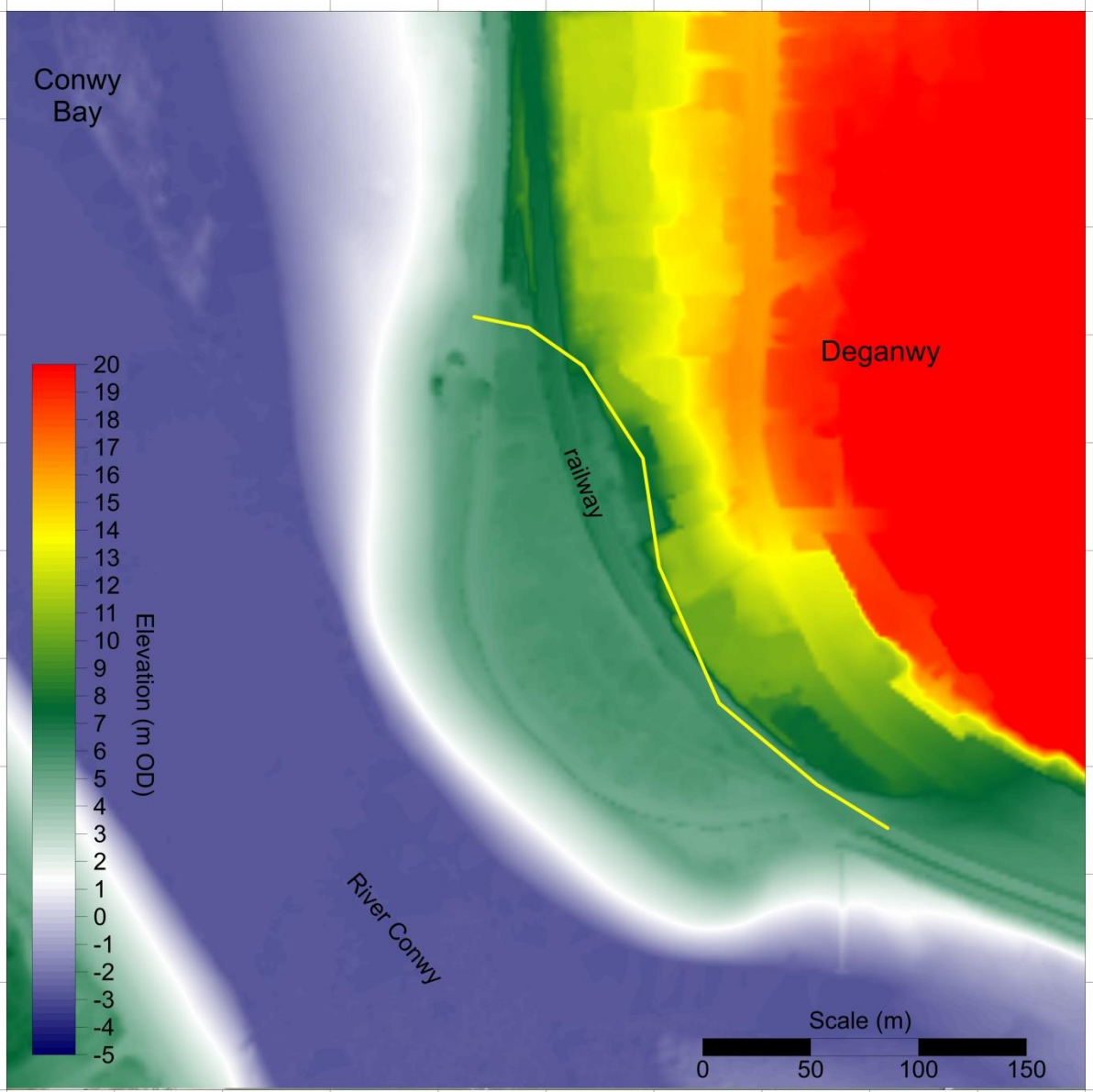
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

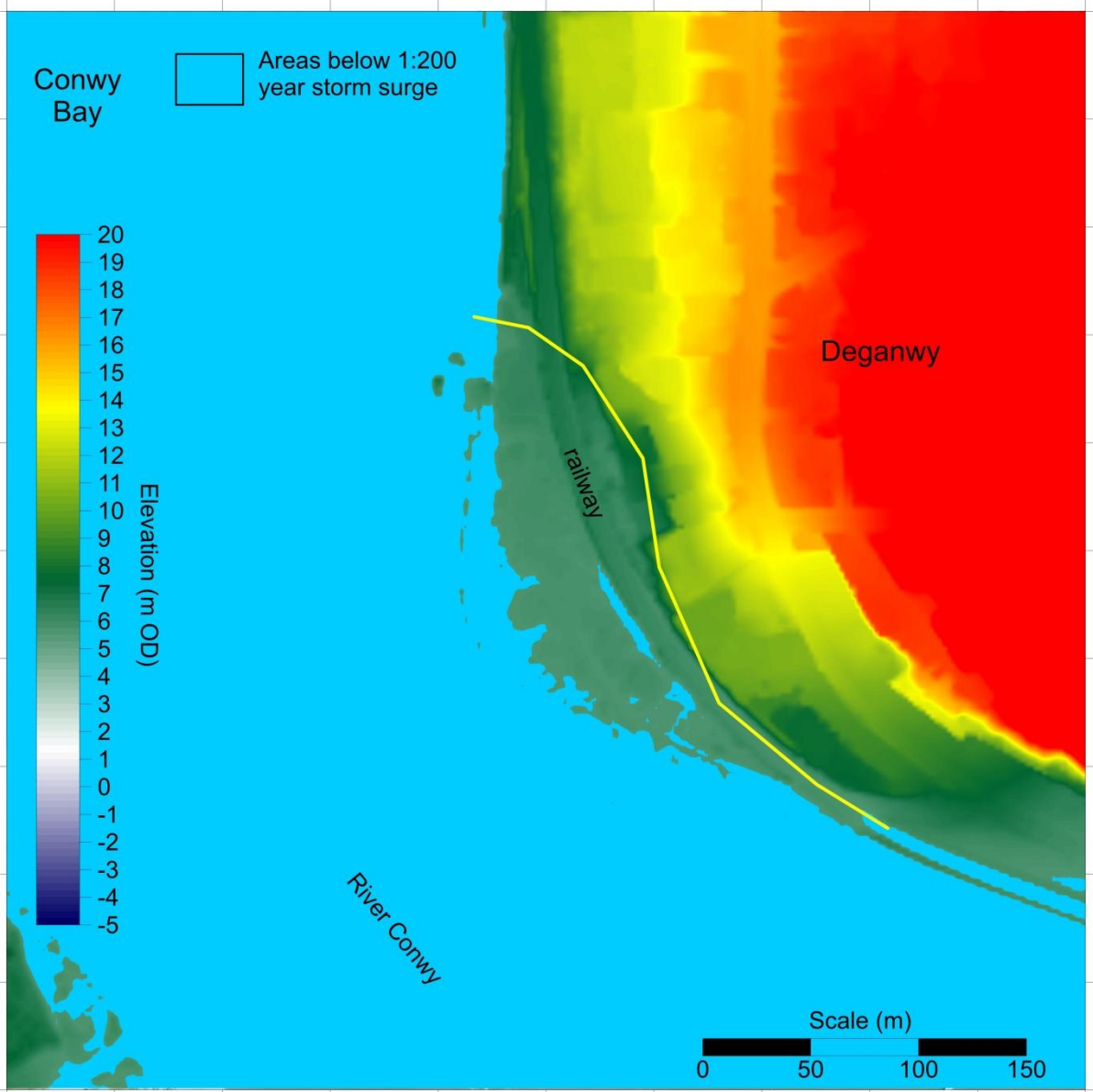
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 83: Deganwy North and Llandudno West Shore

Site description

Morphological setting	Bay, estuary (Conwy Bay, Conway estuary)
Morphological type	Fringing dunes on seaward side of defences; old barrier spit system with recurves at Deganwy north, and climbing dune sat Deganwy south, now behind defences; thin transgressive sand sheets at Llandudno West shore
Erosion/progradation status	Stable, slowly prograding / vertically accreting within some groyne bays)
Defence structures	Sea wall, revetment, fishtail groynes, rock armour
Hinterland type	Golf course, houses, railway
Typical hinterland level	3.9 to 4.8 m OD on golf course 3.2 to 5.3 m OD on housing areas
Conservation designations	None (adjacent to Aber Afon Conwy SSSI)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.80 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.30 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	21/03/2015
Principal aspect of dune frontage	west

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1432 (272059E 388917N)
Distance offshore	5.6 km
Mean wind speed	12.88 knots
Mean wind direction	234.7 ° (SW)
Mean significant wave height (Hs)	0.64 m
Mean zero up-crossing period (Tz)	2.78 sec
Mean peak wave period (Tp)	3.80 sec
Mean wave direction	304.7 ° (NW)
Mean wave direction scaled for wave power	307.7 ° (NW)
Mean annual wave power	13.4 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 9; LD)	225-334 µm (average: 256 µm)
Calcium carbonate content (%) (N= 3)	1.89-4.27% (average: 2.93%)
Silica content (%) (N= 3)	88.4-91.8% (average: 90.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low / Medium
Nature Conservation Designation	Low
Geomorphological Features	Low
Recreation	Medium
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	7.5
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Sand fencing	Significant
Dune toe rip rap	Significant
Fishtail rock groyne	Significant

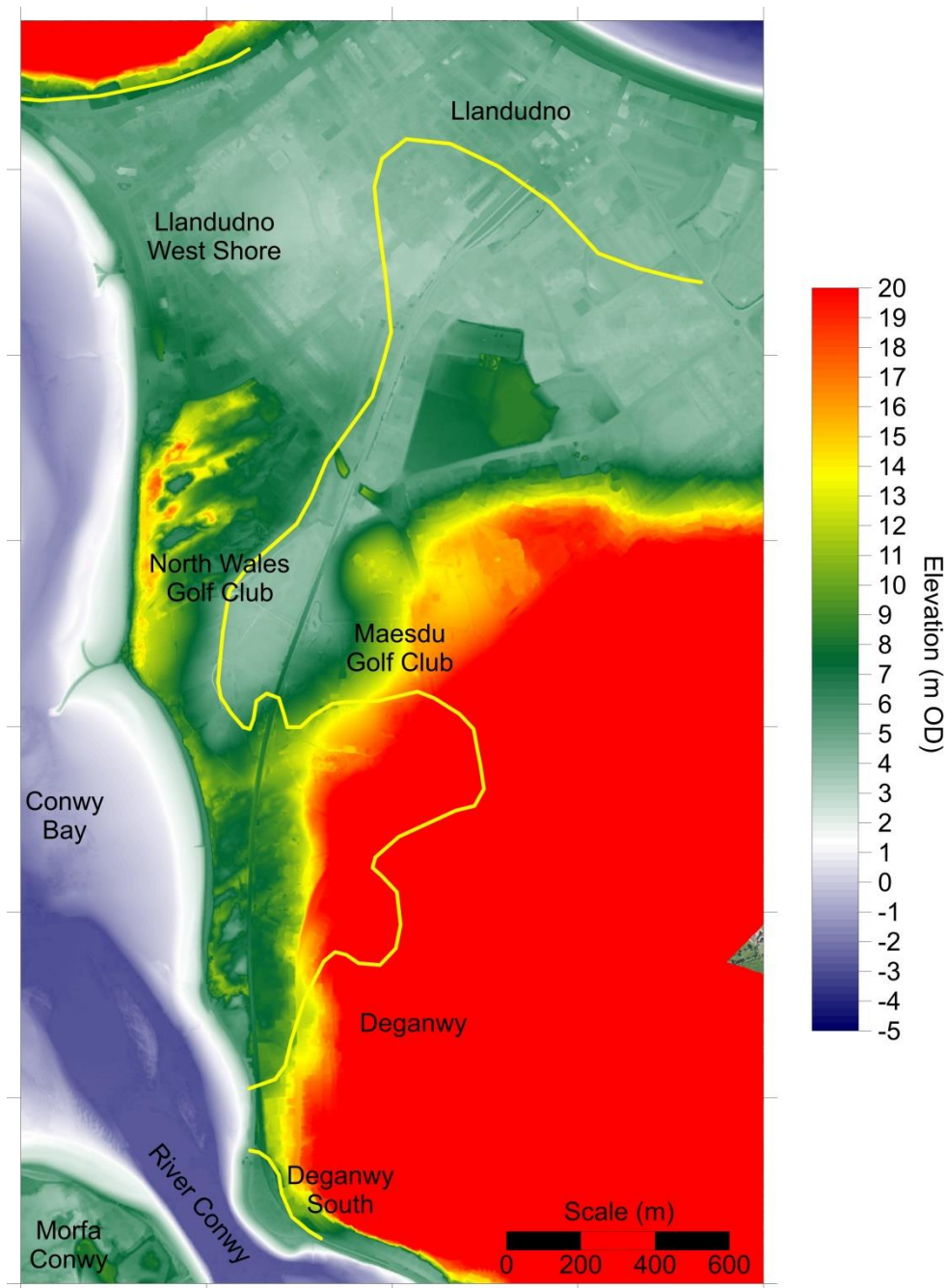
Further information

Conwy County Borough Council (2000) Ynys Enlli to Great Ormes Head Shoreline Management Plan. Conwy Borough Council Coast Protection Department, Conwy.

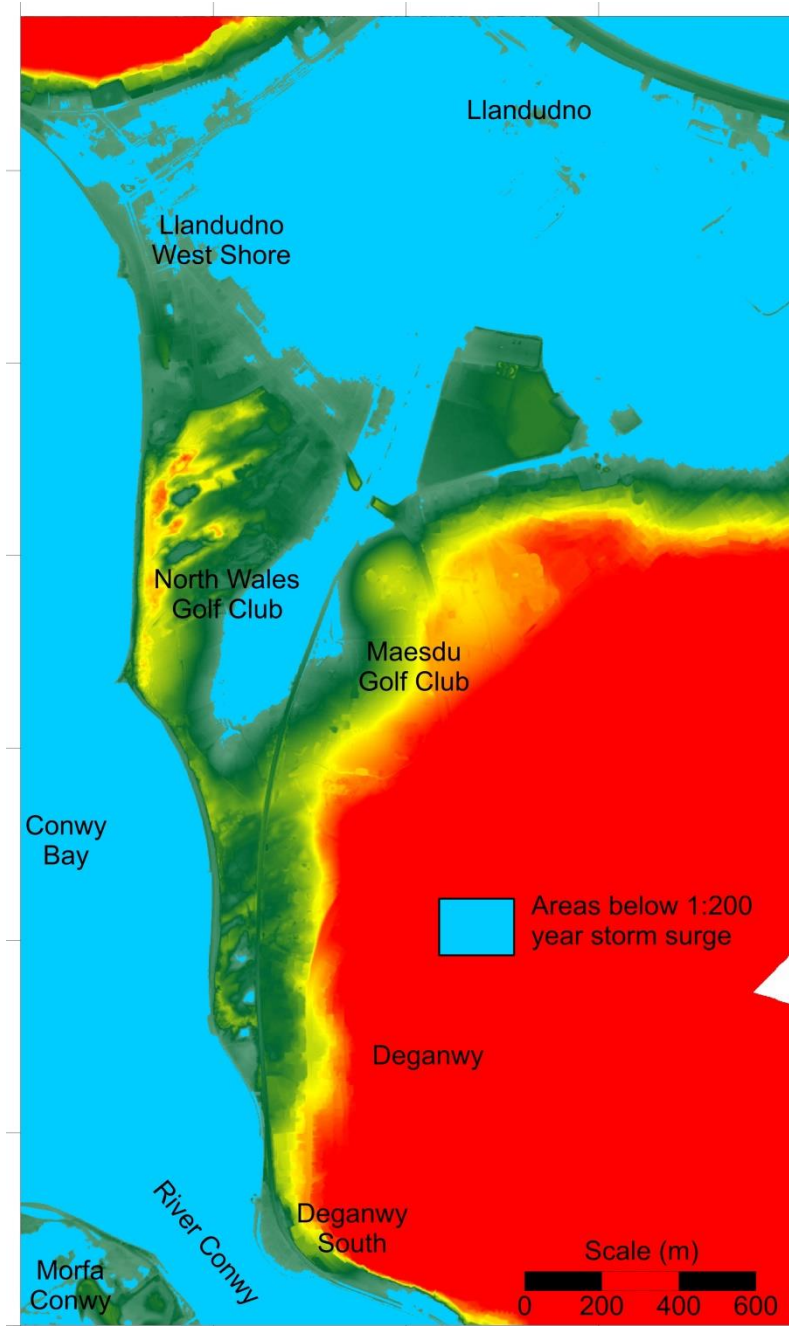
Haskoning (2012) West of Wales Shoreline Management Plan SMP2. Haskoning UK Ltd., Peterborough.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 84: Llandudno East Shore

Site description

Morphological setting	Bay (Llandudno Bay between Great Orme and Little Orme)
Morphological type	Fringing, minor transgressive; dunes now largely levelled for road construction and urban development; small residual dune area on seaward side of road west of Craigside
Erosion/progradation status	Slowly eroding in east, stabilised by defences and largely built-on elsewhere
Defence structures	Sea wall, rock armour
Hinterland type	Housing, agricultural fields
Typical hinterland level	4.2 to 5.6 m OD on housing areas
Conservation designations	Creigiau Rhiwledyn/Little Ormes Head SSSI (adjacent to SAC and SPA)
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.75 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.41 ± 0.2 m OD
Maximum crest level	n/d
Minimum crest level	n/d
LiDAR survey date	21/03/2015
Principal aspect of dune frontage	north

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1431 (281042E 388851N)
Distance offshore	6.2 km
Mean wind speed	13.00 knots
Mean wind direction	237.3 ° (WSW)
Mean significant wave height (Hs)	0.63 m
Mean zero up-crossing period (Tz)	2.78 sec
Mean peak wave period (Tp)	3.78 sec
Mean wave direction	305.7 ° (NW)
Mean wave direction scaled for wave power	307.2 ° (NW)
Mean annual wave power	13.3 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size	No data
Calcium carbonate content (%)	No data
Silica content (%)	No data

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Low
Nature Conservation Designation	High
Geomorphological Features	Low
Recreation	Low
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	8
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

Current and past dune and beach management measures

Dune re-profiling and vegetation	Major
Gravel beach nourishment in front of dunes	Major

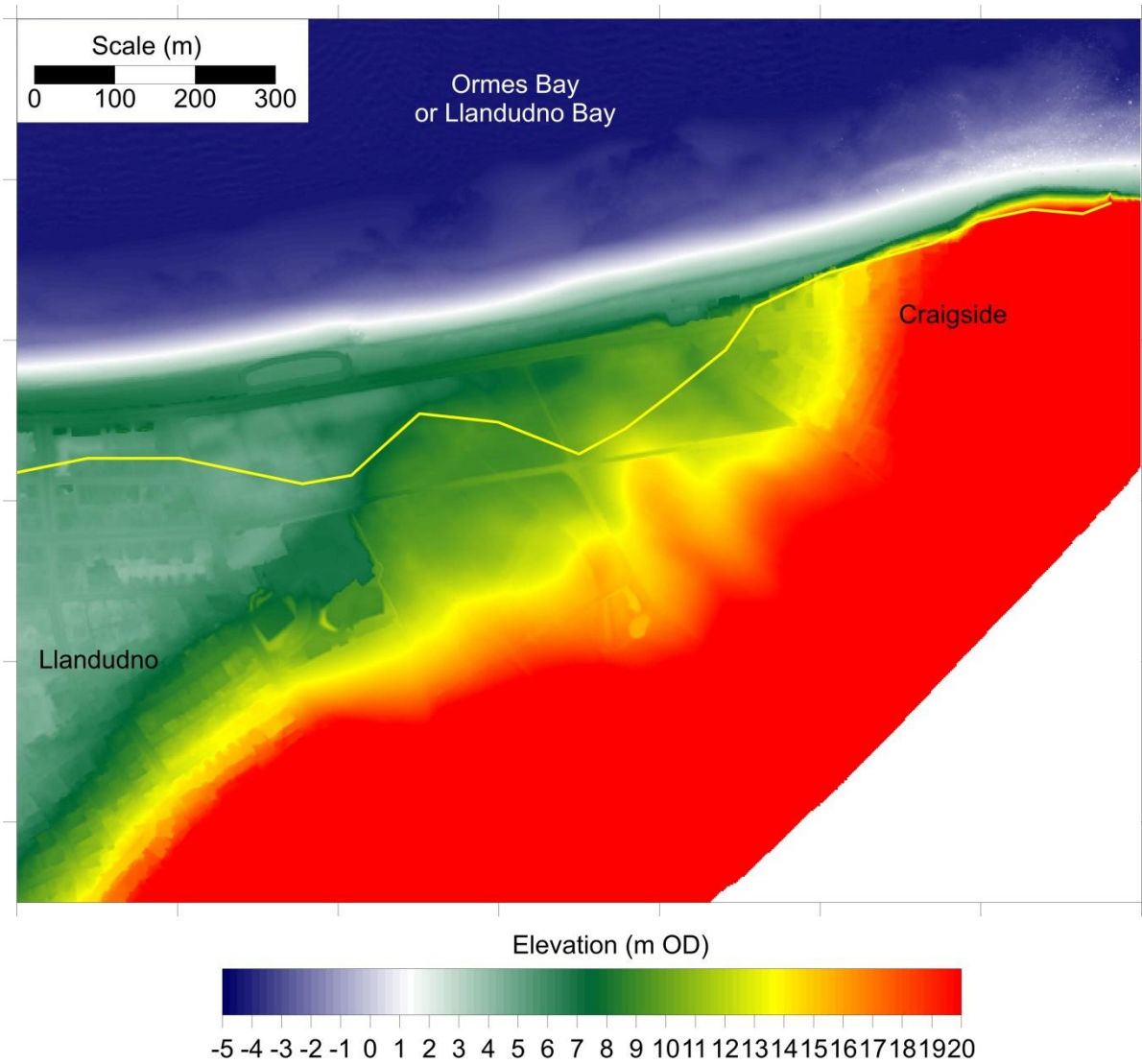
Further information

Halcrow (2011) North West England and North Wales Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

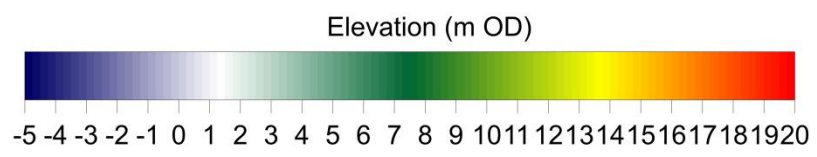
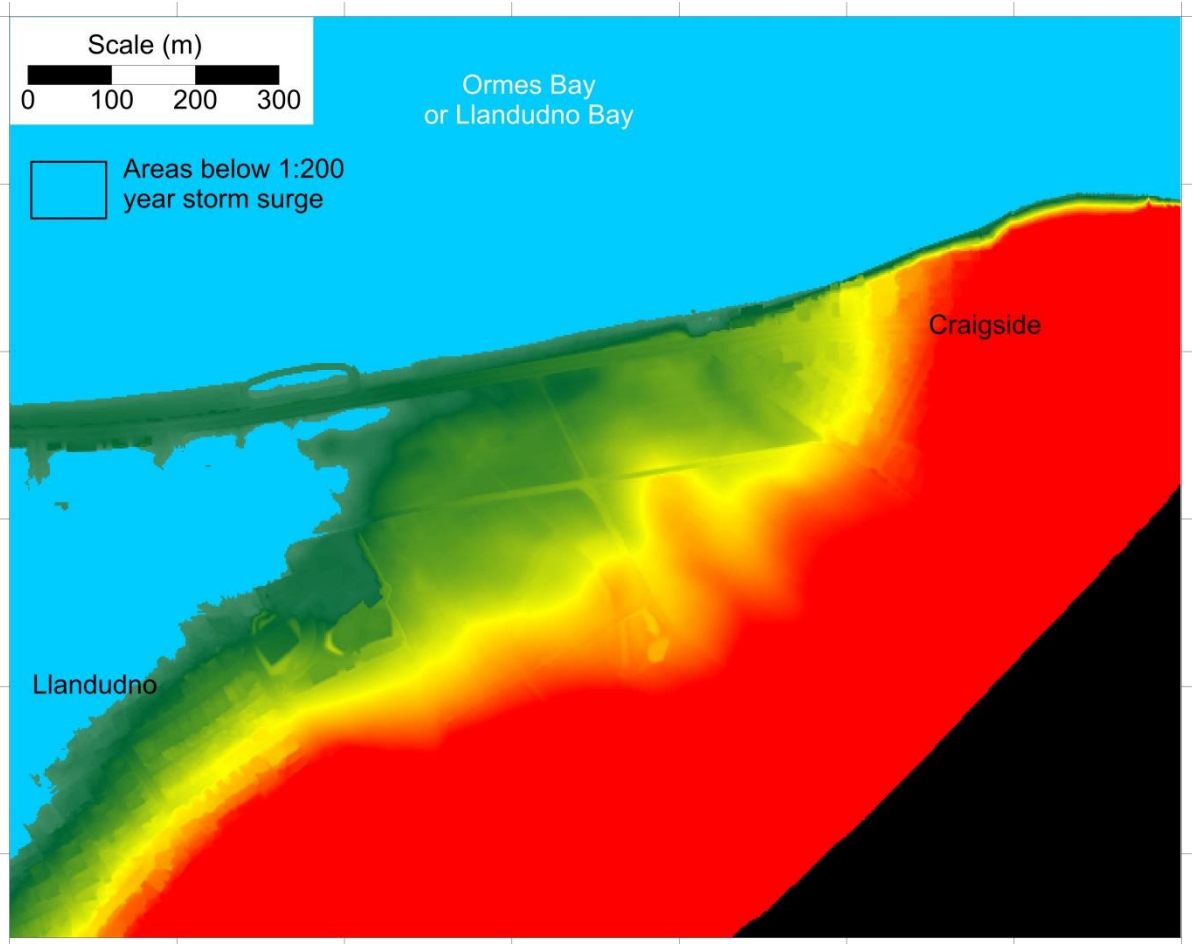
Shoreline Management Partnership (1999) Liverpool Bay Shoreline Management Plan. Sub-Cell 11a Great Ormes Head to Formby Point. Liverpool Bay Coastal Group.



2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



Areas below the estimated 1 in 200 year storm surge level.

Site 85: Kinmel Dunes

Site description

Morphological setting	Bay (Liverpool Bay, SE shore of Irish Sea)
Morphological type	Barrier spit, mostly built on but area of residual dunes at eastern end by entrance to Clwyd estuary
Erosion/progradation status	Defended along most of the frontage, slowly prograding at E end at mouth of Clwyd
Defence structures	Sea wall (parapet top at 6.9 m OD) and promenade along all of the site except for the extreme eastern end
Hinterland type	Housing, car parks, Clwyd estuary
Typical hinterland level	3.5 to 4.5 m OD on car parks and housing areas
Conservation designations	LNR
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	4.90 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.71 ± 0.2 m OD
Maximum crest level	10.54 m OD
Minimum crest level	6.15 m OD
LiDAR survey date	21/03/2015 (50 cm)
Principal aspect of dune frontage	north

Frontal dune morphological parameters at selected cross-sections

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	6.89	111	50	82	15
Profile 2	6.92	61	54	62	18
Profile 3	9.54	97	87	227	152
Profile 4	6.15	54	28	45	6
Profile 5	10.54	220	210	667	498

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1440 (298806E 388728N)
Distance offshore	7.0 km
Mean wind speed	12.76 knots
Mean wind direction	241.0 ° (WSW)
Mean significant wave height (Hs)	0.59 m
Mean zero up-crossing period (Tz)	2.73 sec
Mean peak wave period (Tp)	3.67 sec
Mean wave direction	302.0 ° (WNW)
Mean wave direction scaled for wave power	303.1 ° (WNW)
Mean annual wave power	12.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 10; LD)	279-305 µm (average: 287 µm)
Calcium carbonate content (%) (N= 3)	5.96-7.5% (average: 6.64%)
Silica content (%) (N= 3)	85.4-87.2% (average: 86.5%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	Medium / High
Nature Conservation Designation	Low / Medium
Geomorphological Features	Low
Recreation	High
Economic / Military	Low
Historical / Archaeological	Low
Overall significance score	10
SMP2 Policy in Epoch 1	HTL
SMP2 Policy in Epoch 2	HTL
SMP2 Policy in Epoch 3	HTL

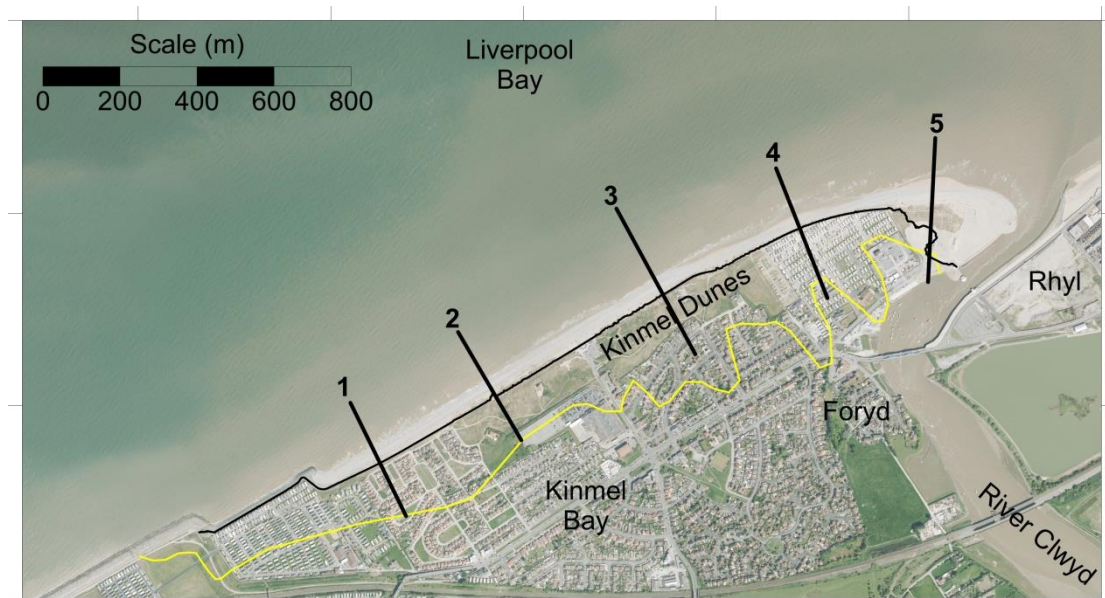
Current and past dune and beach management measures

Dune sediment nourishment (dredging arisings)	Significant
Sand fencing	Significant

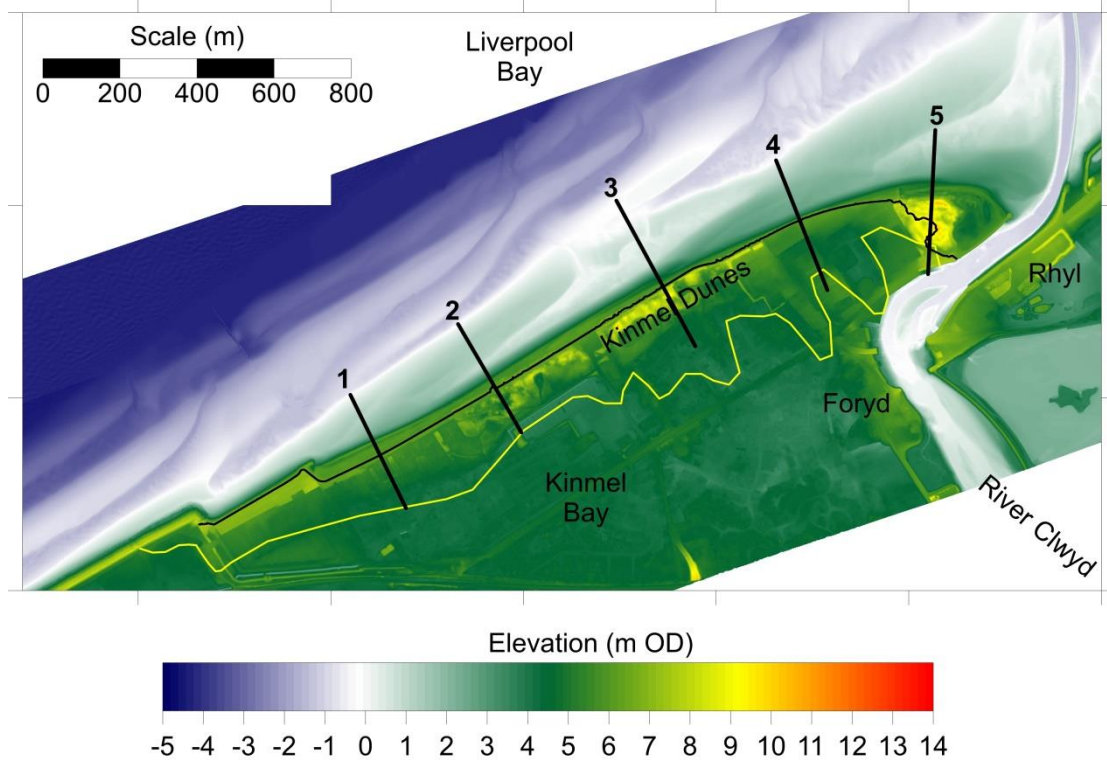
Further information

Halcrow (2011) North West England and North Wales Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

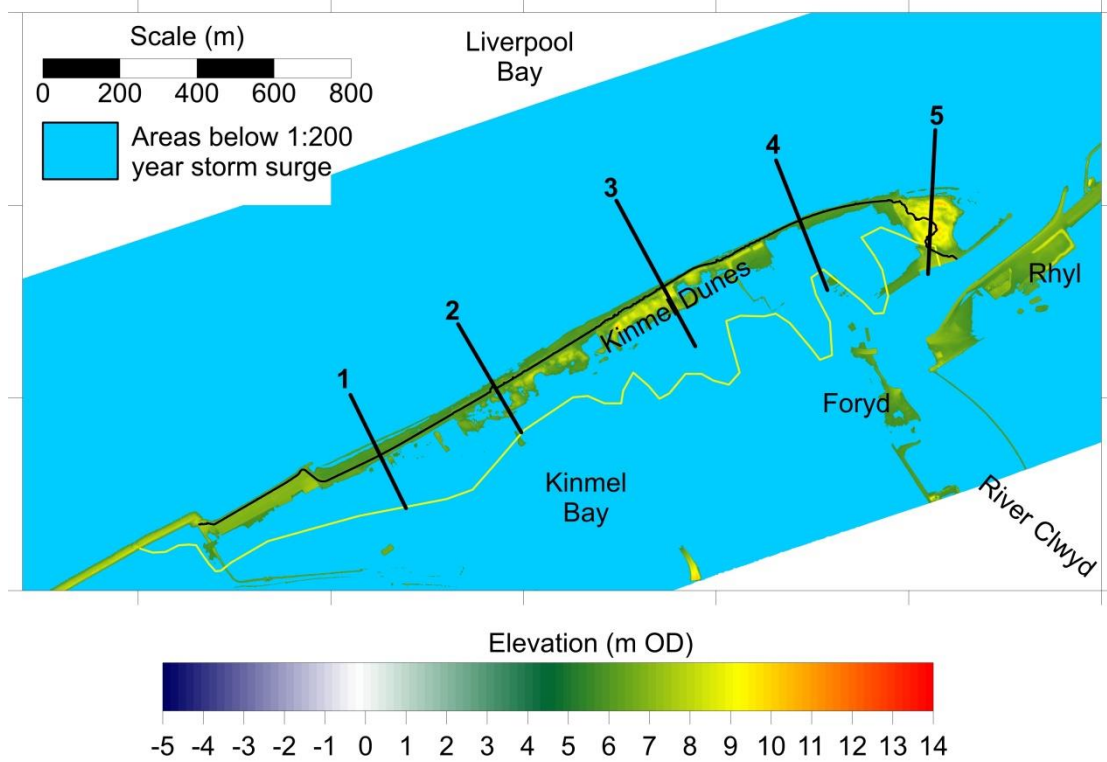
Shoreline Management Partnership (1999) Liverpool Bay Shoreline Management Plan. Sub-Cell 11a Great Ormes Head to Formby Point. Liverpool Bay Coastal Group.



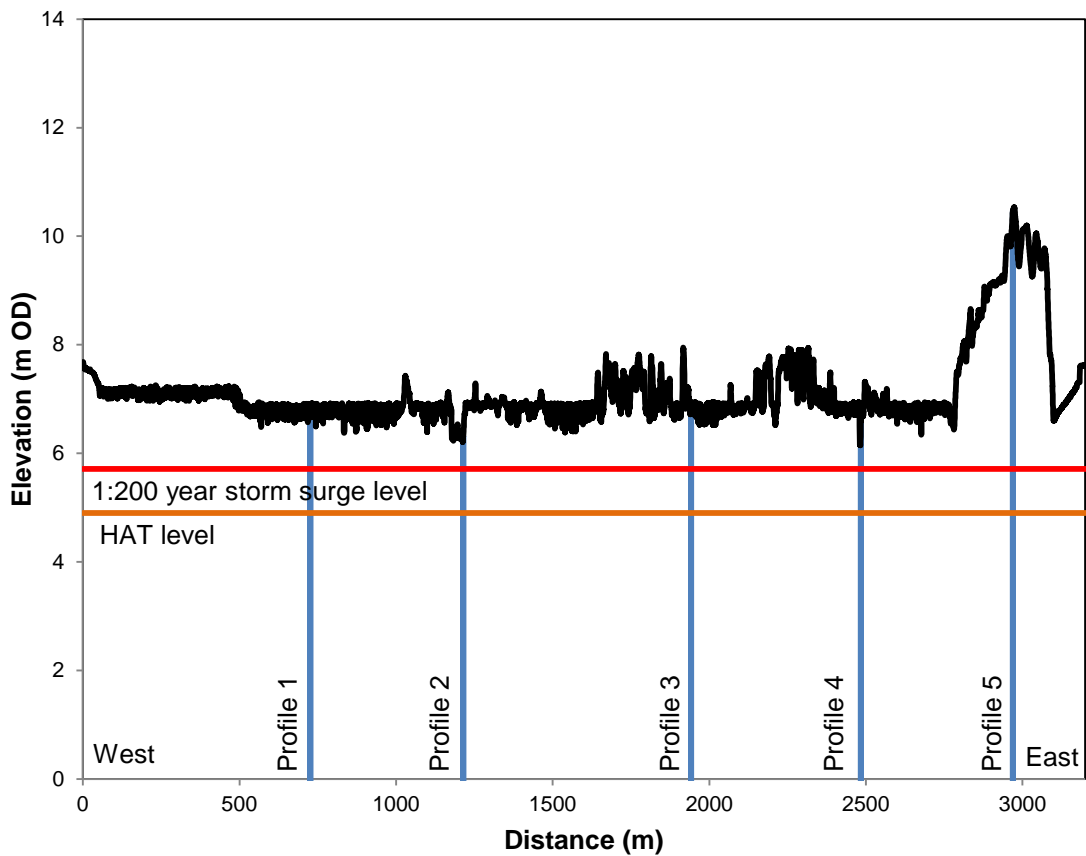
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



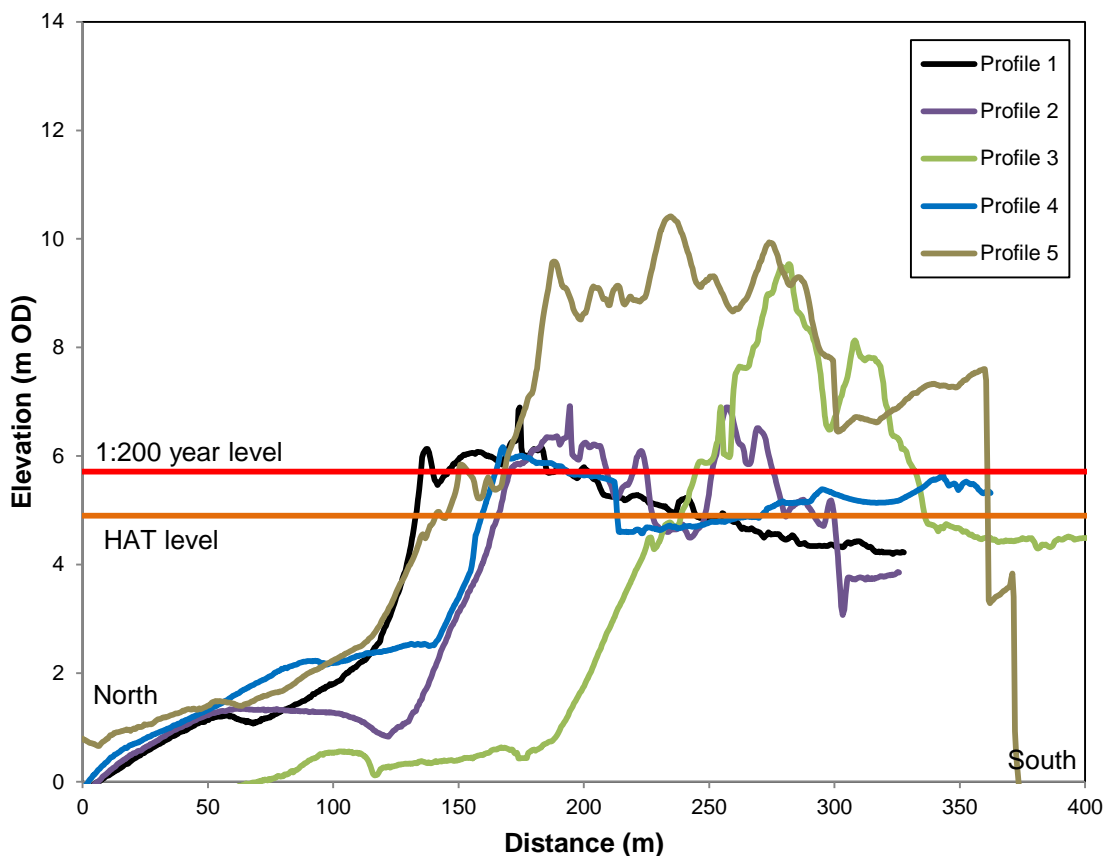
LiDAR digital terrain model, flown 21 March 2015. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 86: Rhyl East and Ffrith Beach

Site description

Morphological setting	Bay (Liverpool Bay, SE shore of Irish Sea)
Morphological type	Barrier (section between Rhyl and Frith Beach now largely eroded)
Erosion/progradation status	Dunes are stable due to presence of defences but frontage suffers from low / falling beach levels in front of sea defences
Defence structures	Sea wall (parapet top at 7.2 m OD) and groynes along the whole site
Hinterland type	Housing, golf course, caravans
Typical hinterland level	3.9 to 5.0 m OD in caravan and housing areas
Conservation designations	None
Notable features	Rhyl and Prestatyn seafronts

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.05 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.80 ± 0.2 m OD
Maximum crest level	13.79 m OD
Minimum crest level	7.2 m OD
LiDAR survey date	21/03/2015 (50 cm)
Principal aspect of dune frontage	north

Frontal dune morphological parameters at selected cross-sections

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	7.20	123	9	43	4
Profile 2	7.21	201	9	69	6
Profile 3	10.09	62	49	161	120
Profile 4	8.58	88	79	181	118
Profile 5	13.44	104	89	283	210
Profile 6	8.41	60	50	100	57

Nearshore wind and wave parameters

CEFAS WaveNet Hindcast Point	1440 (298806E 388728N)
Distance offshore	7.0 km
Mean wind speed	12.76 knots
Mean wind direction	241.0 ° (WSW)
Mean significant wave height (Hs)	0.59 m
Mean zero up-crossing period (Tz)	2.73 sec
Mean peak wave period (Tp)	3.67 sec
Mean wave direction	302.0 ° (WNW)
Mean wave direction scaled for wave power	303.1 ° (WNW)
Mean annual wave power	12.2 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 7; LD)	278-312 µm (average: 291 µm)
Calcium carbonate content (%) (N= 3)	4.14-4.84% (average: 4.5%)
Silica content (%) (N= 3)	87.6-90.5% (average: 89.2%)

Dune site importance and SMP2 Policy

	Site 86a	Site 86b
Flood and Coastal Erosion Risk Management (FCERM)	Medium	High
Nature Conservation Designation	Low	Low
Geomorphological Features	Low	Low
Recreation	High	High
Economic / Military	Medium	Low
Historical / Archaeological	Low	Low
Overall significance score	10	10
SMP2 Policy in Epoch 1	HTL	HTL
SMP2 Policy in Epoch 2	HTL	HTL
SMP2 Policy in Epoch 3	HTL	HTL

Current and past dune and beach management measures

Concrete promenade protects frontal dunes	Significant
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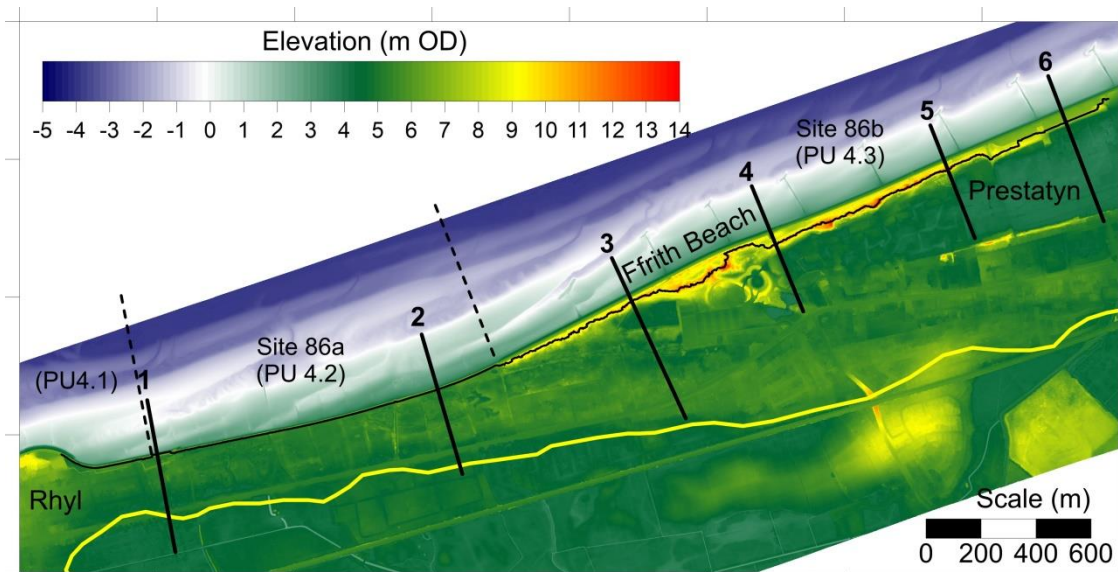
Further information

Halcrow (2011) North West England and North Wales Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

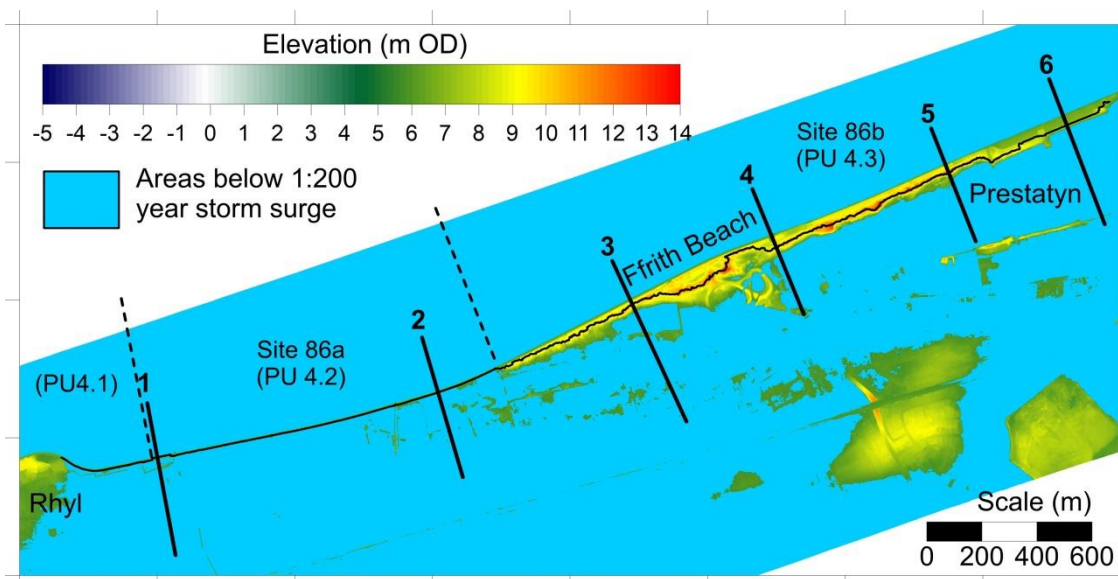
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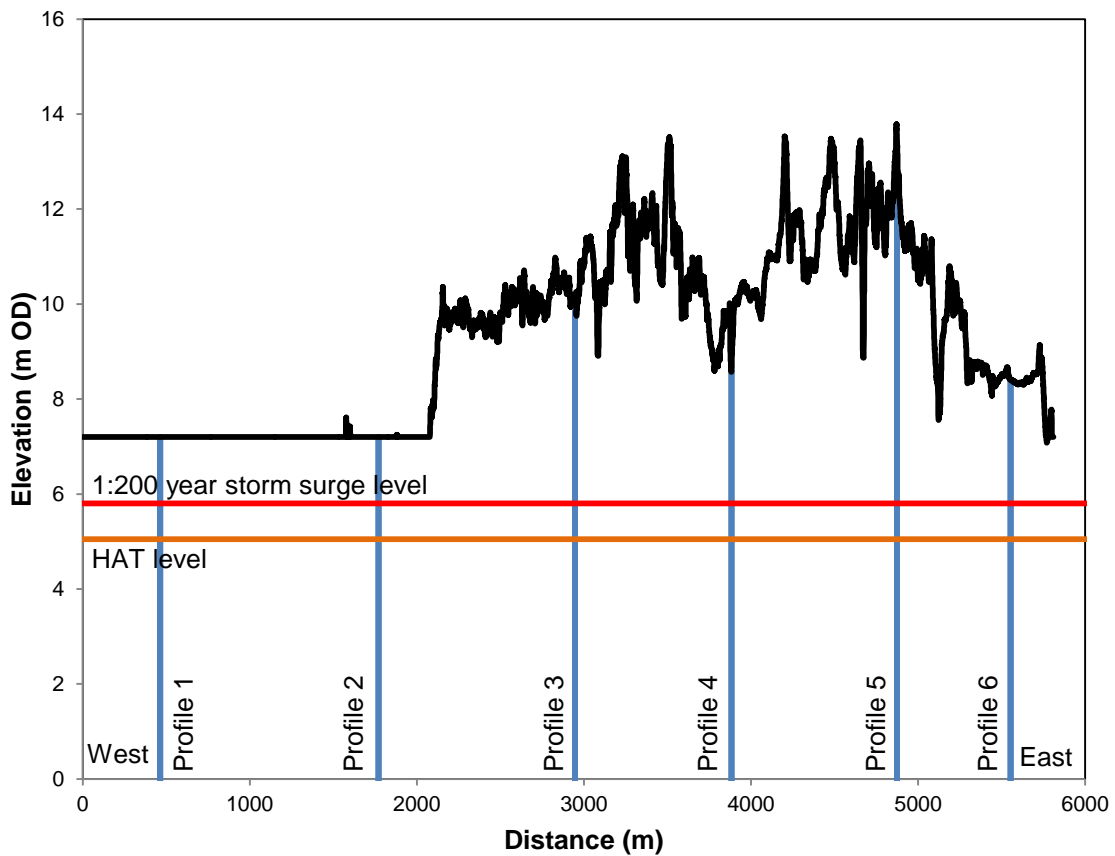
2013 -14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



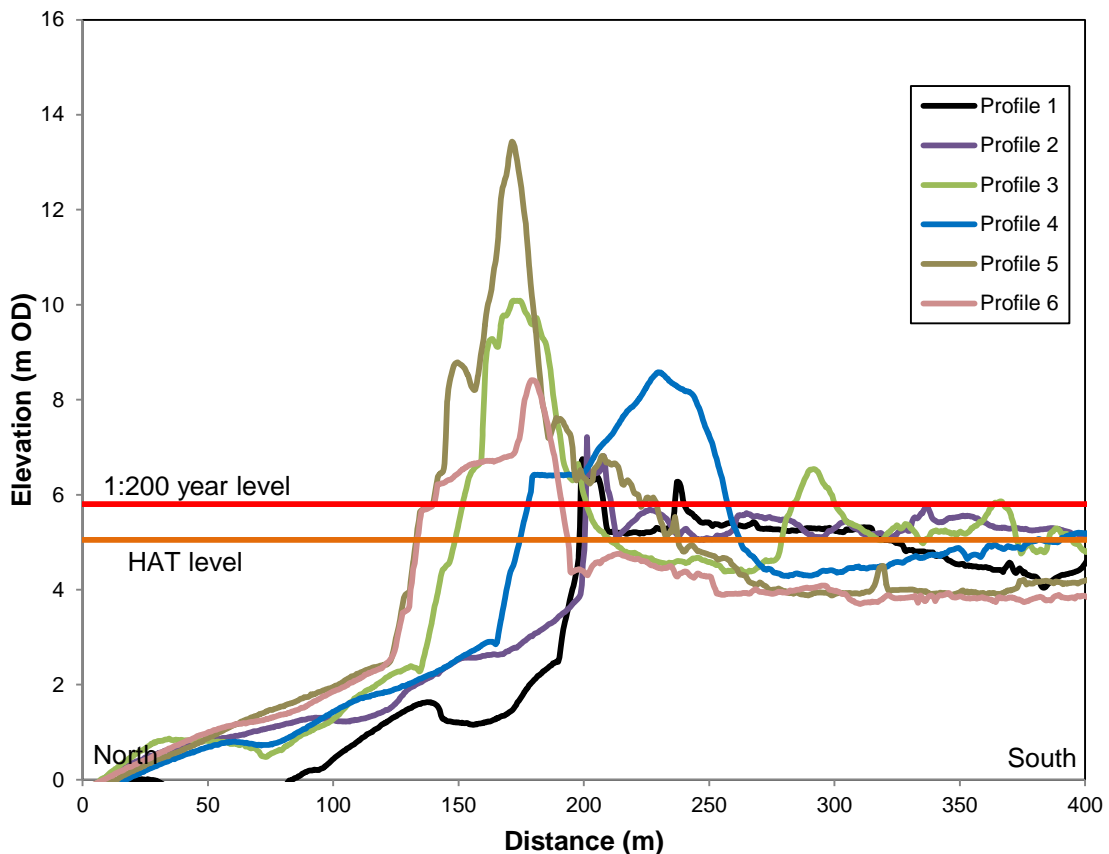
LiDAR digital terrain model. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale maps.



Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles.

Site 87: Barkby Beach, Gronant Dunes and Talacre Warren

Site description

Morphological setting	Bay, estuary (Liverpool Bay, SE shore of Irish Sea, northeastern end adjacent to mouth of the Dee estuary)
Morphological type	Barrier spit; multiple recurves at Gronant and Talacre
Erosion/progradation status	Tendency for erosion at Barkby Beach, progradation at Gronant, erosion along Talacre Warren and progradation and spit extension at Talacre east / Point Ayr
Defence structures	Groynes along western part of Barkby Beach
Hinterland type	Golf course, caravans, agricultural
Typical hinterland level	3.3 to 4.3 m OD in golf course and caravan areas
Conservation designations	Gronant Dunes and Talacre Warren SSSI, Dee Estuary / Aber Afon Dyfrdwy SSSI, SAC, SPA, Ramsar, LNR
Notable features	

Key water level and dune crest level parameters

Highest astronomical tide (HAT) level	5.15 m OD
1:200 year storm surge level (McMillan et al., 2011)	5.91 ± 0.2 m OD
Maximum crest level	25.57 m OD
Minimum crest level	5.28 m OD
LiDAR survey date	21/03/2015 (50 cm)
Principal aspect of dune frontage	north

Dune barrier parameters at selected cross-sectional profiles

	Minimum Crest Level (m OD)	Width at HAT level (m)	Width at 1:200 level (m)	Volume at HAT level (m ³ m ⁻¹)	Volume at 1:200 level (m ³ m ⁻¹)
Profile 1	13.06	48	39	172	139
Profile 2	10.28	223	210	420	275
Profile 3	8.32	376	363	180	89
Profile 4	10.96	121	110	214	154
Profile 5	25.31	417	331	2175	1887
Profile 6	14.45	278	232	582	438
Profile 7	7.99	297	275	126	45
Profile 8	8.77	92	73	111	66

Nearshore wind wave parameters

CEFAS WaveNet Hindcast Point	1439 (307719E 388657N)
Distance offshore	4.1 km
Mean wind speed	12.40 knots
Mean wind direction	241.9 ° (WSW)
Mean significant wave height (Hs)	0.56 m
Mean zero up-crossing period (Tz)	2.70 sec
Mean peak wave period (Tp)	3.61 sec
Mean wave direction	301.6 ° (WNW)
Mean wave direction scaled for wave power	304.1 ° (NW)
Mean annual wave power	11.0 MJm ⁻¹ s ⁻¹ yr ⁻¹

Dune sediment characteristics

Mean particle size (N= 21; LD)	248-357 µm (average: 309 µm)
Calcium carbonate content (%) (N= 5)	4.71-7.03% (average: 5.5%)
Silica content (%) (N= 5)	80.2-88.4% (average: 86.1%)

Dune site importance and SMP2 Policy

Flood and Coastal Erosion Risk Management (FCERM)	High
Nature Conservation Designation	High
Geomorphological Features	High
Recreation	High
Economic / Military	Medium
Historical / Archaeological	Low
Overall significance score	15
SMP2 Policy in Epoch 1	MR
SMP2 Policy in Epoch 2	MR
SMP2 Policy in Epoch 3	MR

Current and past dune and beach management measures

Concrete promenade protects frontal dunes at Barkby	Significant
Rock armour dune toe protection Barkby to Gronant	Major
Sand fencing	Significant
Marram planting	Significant
Beach nourishment (Talacre and Barkby)	Major
Dune nourishment (Talacre)	Significant
Boardwalks (Gronant)	Significant

Further information

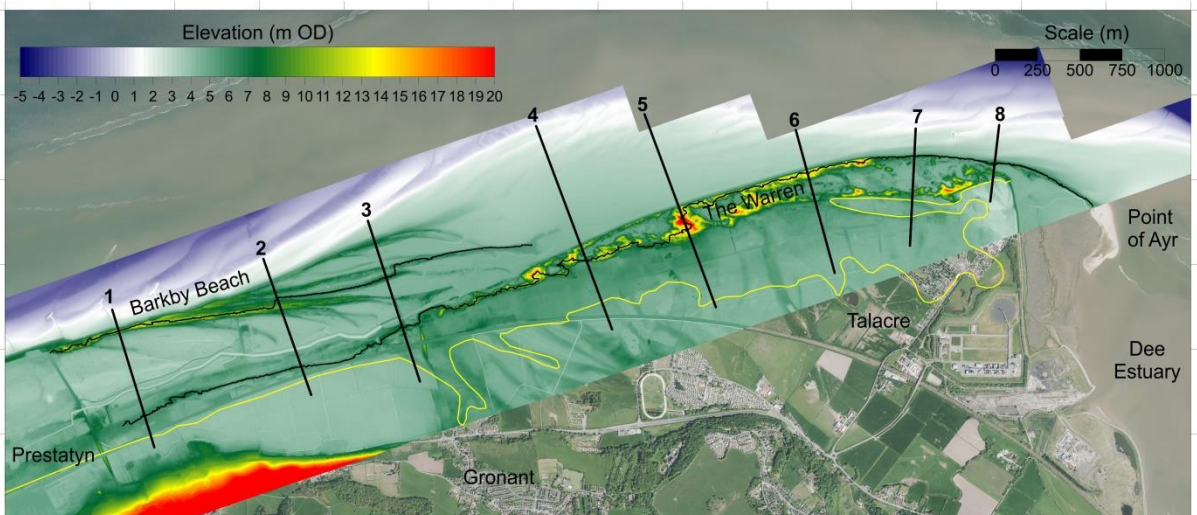
Halcrow (2011) North West England and North Wales Shoreline Management Plan SMP2. Halcrow Group Ltd., Swindon.

Pye K, Blott SJ. 2012. A Geomorphological Survey of Welsh Dune Systems to Determine Best Methods of Dune Rejuvenation – Appendix 1. Gronant Dunes and Talacre Warren. CCW Contract Science Report 1002. Countryside Council for Wales, Bangor.

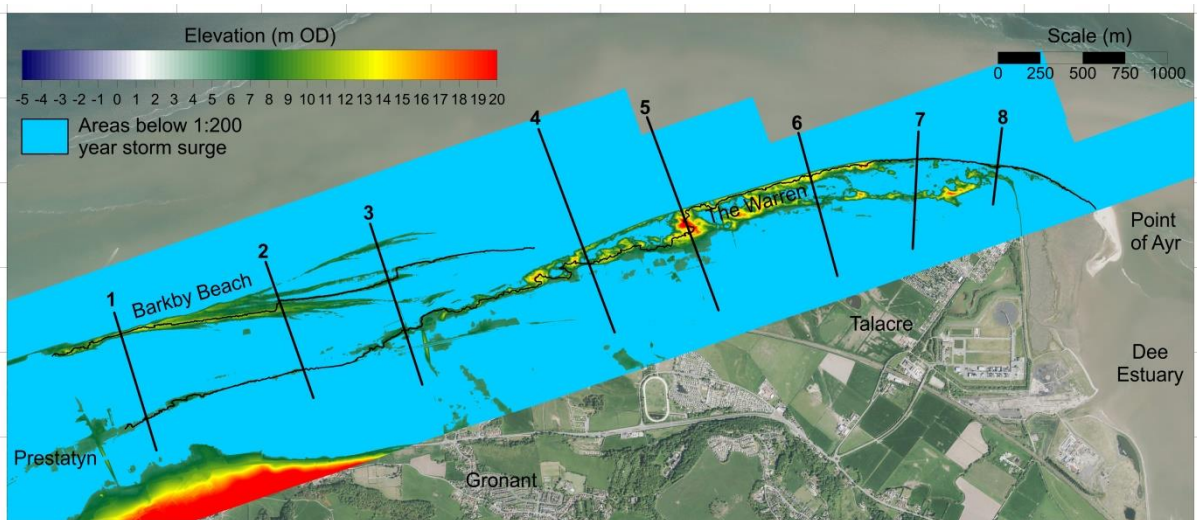
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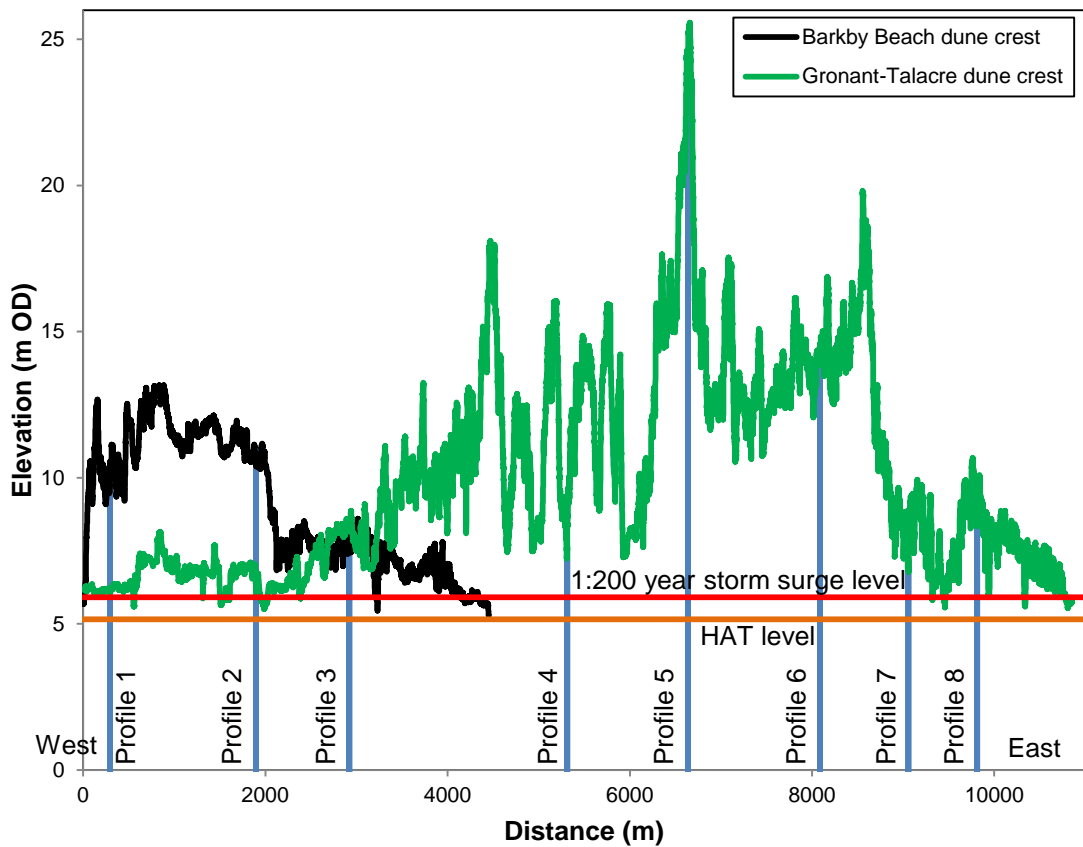
2013-14 aerial photography. The yellow line indicates the limit of blown sand based on BGS 1: 50 000 scale geological maps and KPAL field surveys.



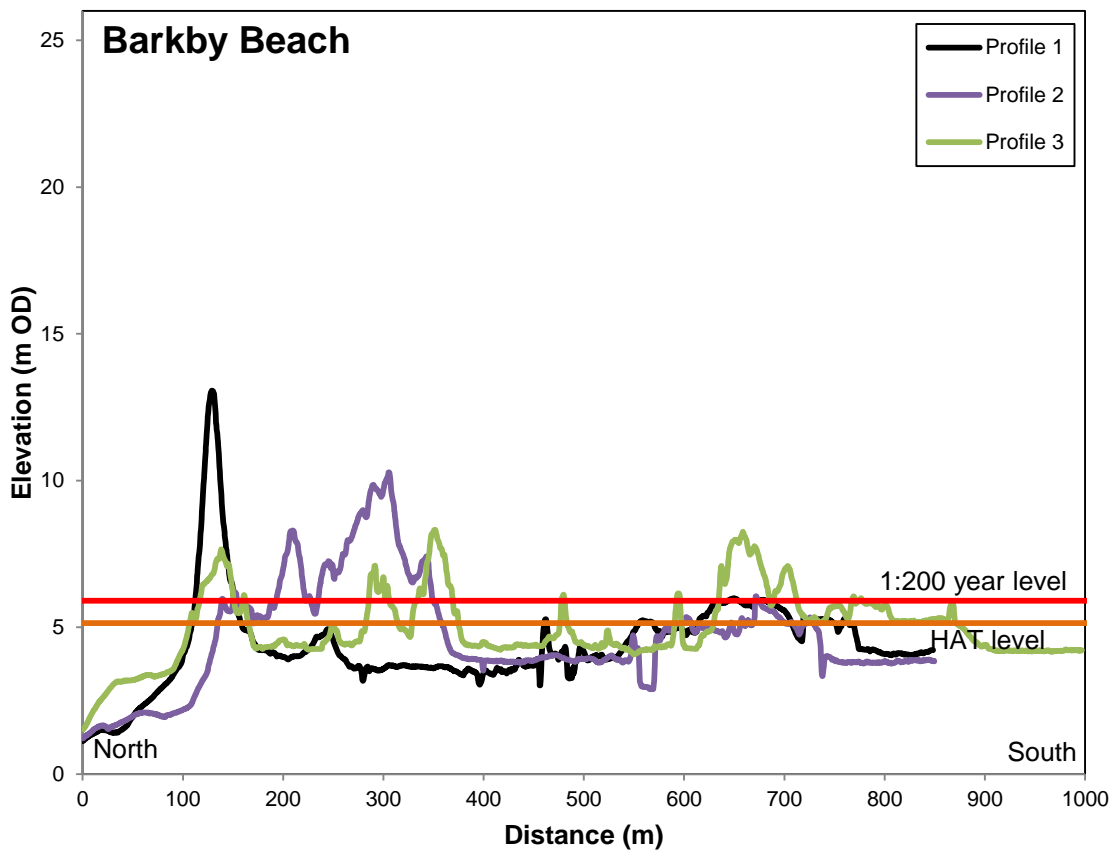
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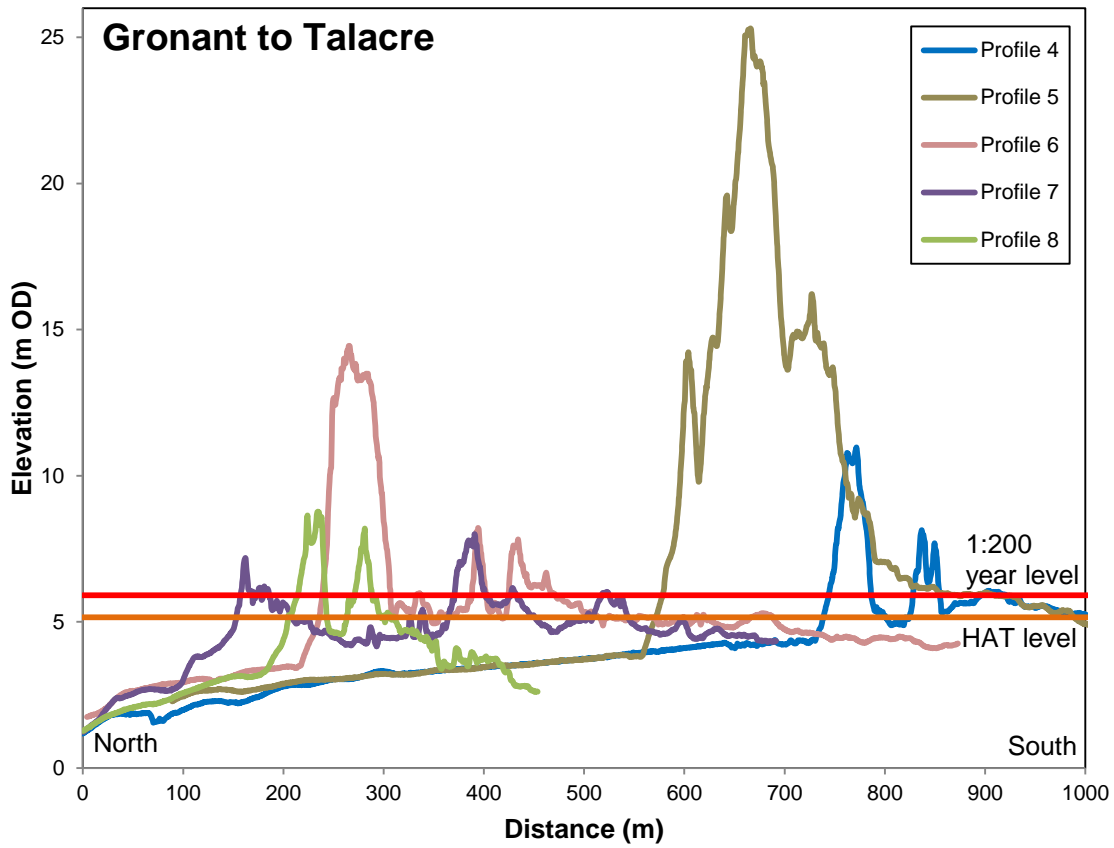
Areas below the estimated 1 in 200 year storm surge level.



Elevations measured along the dune crest.



Elevations measured along shore-normal profiles: Barkby Beach



Elevations measured along shore-normal profiles: Gronant Dunes and Talacre Warren



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