How Will the Sefton Coast change over the next century?
Potential impacts of climate change

Gems in the Dunes On-line Workshop

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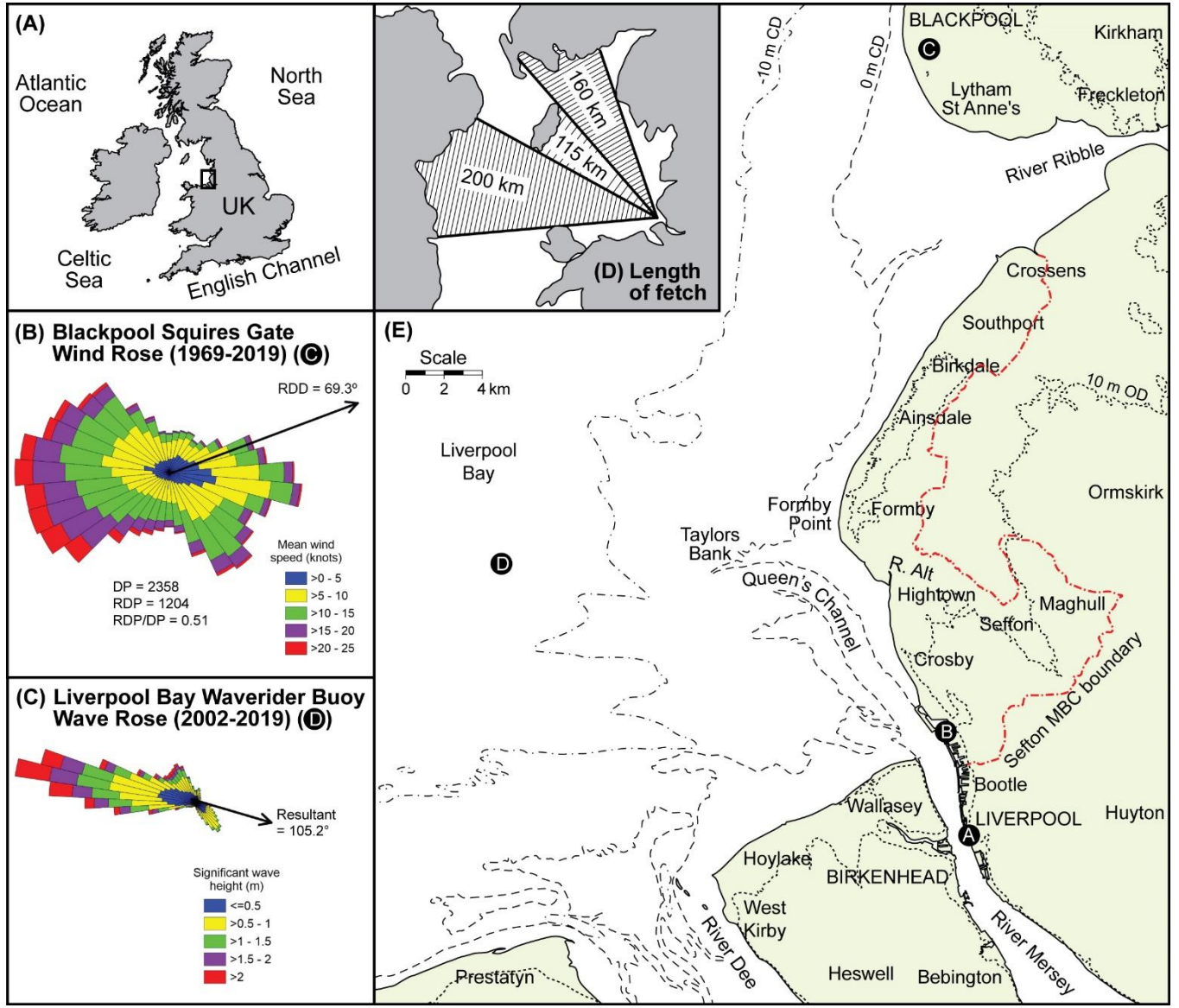
The Sefton Coast

Tide Station:
A: Liverpool

Met Stations:
B: Hall Road, Crosby
C: Squire's Gate Airport

Wave buoy:
D: Liverpool Bay



Influences on Dune Dynamics and Hydrology

A - Dune system morphology and pattern of shoreline change

Reflects:

- Past history of natural aeolian sand accumulation and human modification
- Present rates of sediment supply from offshore and alongshore
- Rate of change of mean sea level
- 'Average' wave climate (energy distribution and direction)
- Frequency and magnitude of storm surges
- Present dune dynamics

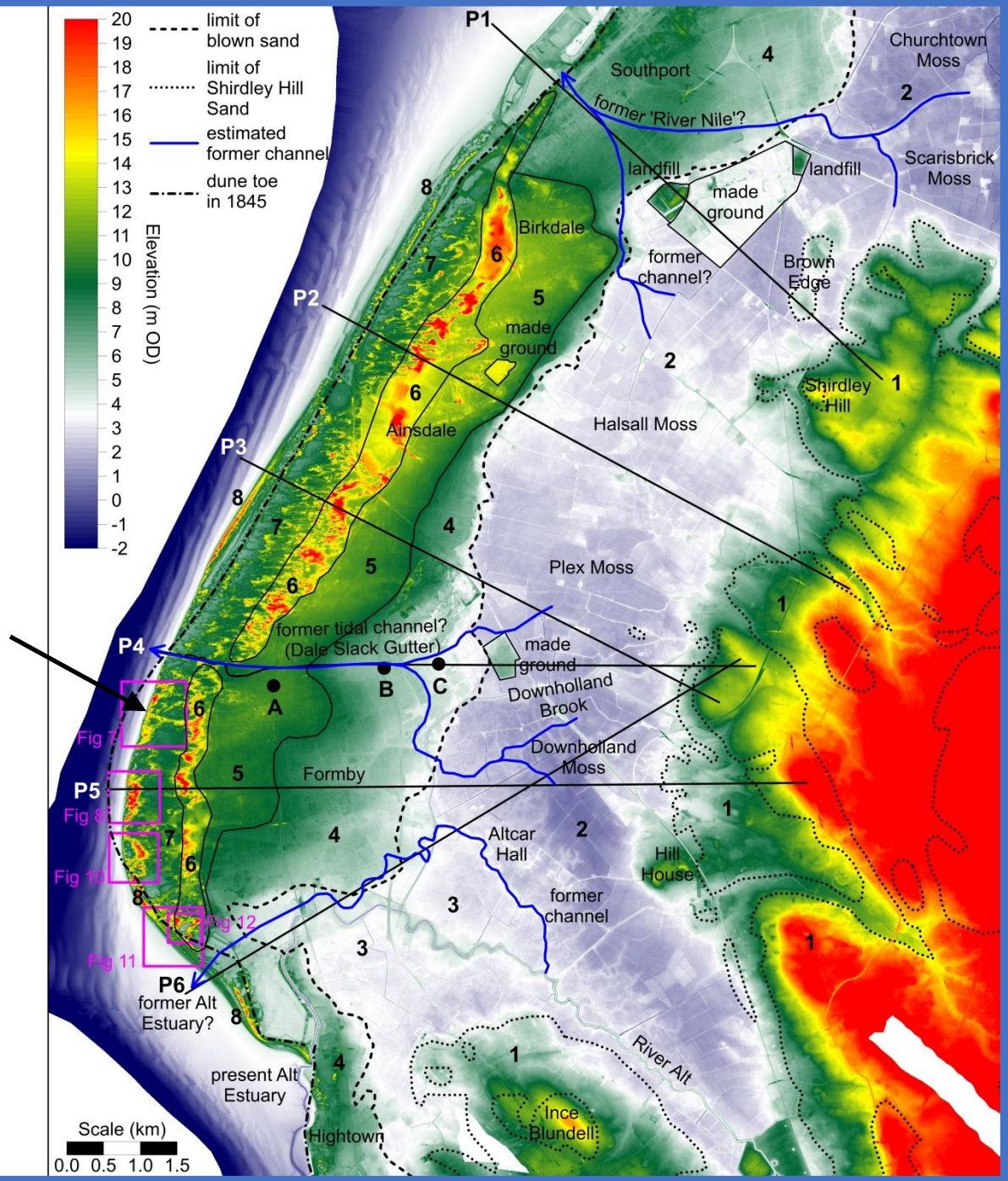
B – Climate

- Temperature
- Precipitation
- Wind speed and direction
- Evaporation

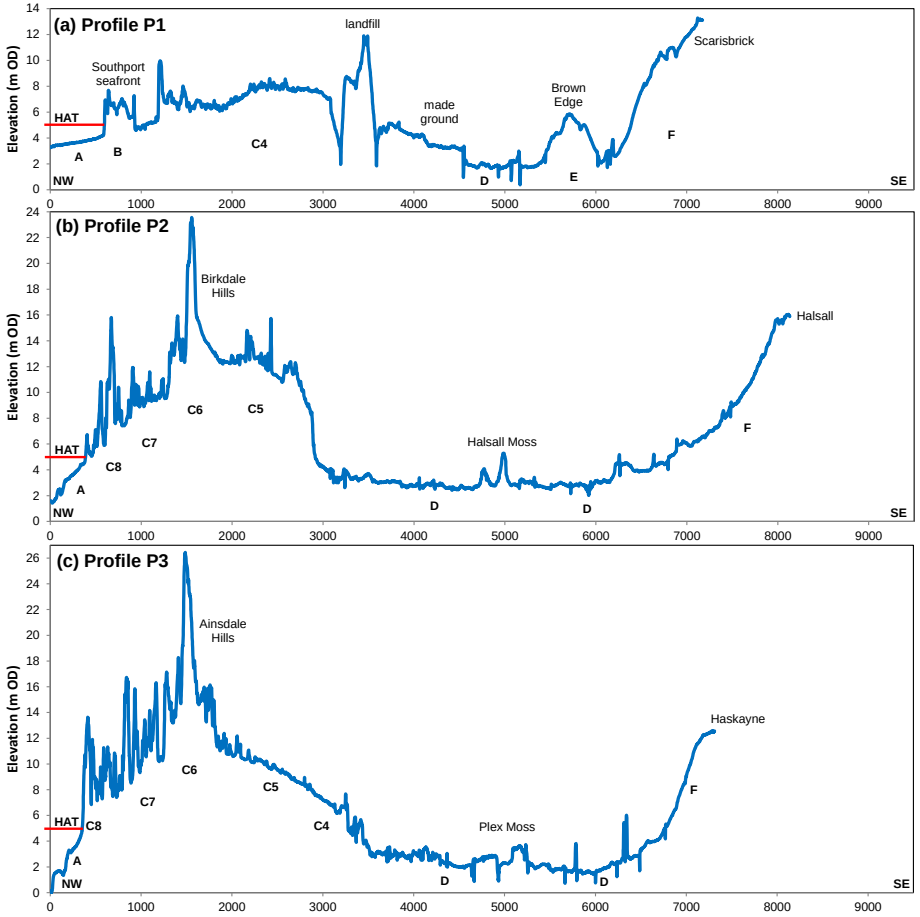
C – Human influences

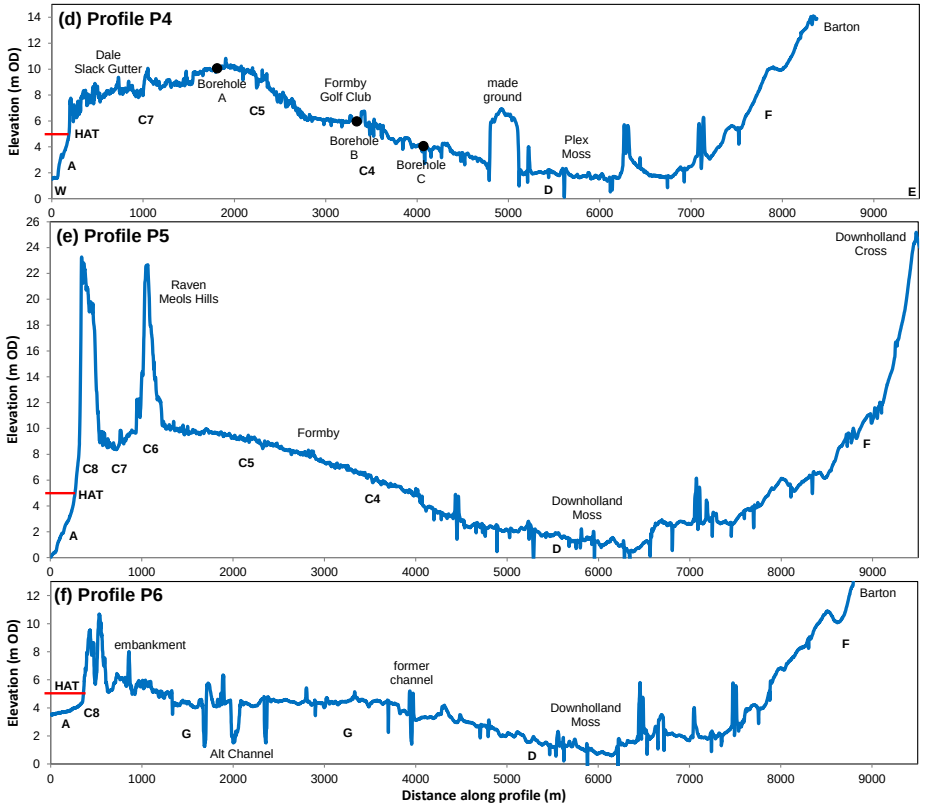
- Vegetation planting / thinning / clearance
- Groundwater abstraction
- Drainage pumping
- Surface excavations
- Recreational pressure

Geomorphological features of the Sefton Coast and West Lancashire Plain



Topographic cross-sections extracted from the LiDAR DTM





KPAL

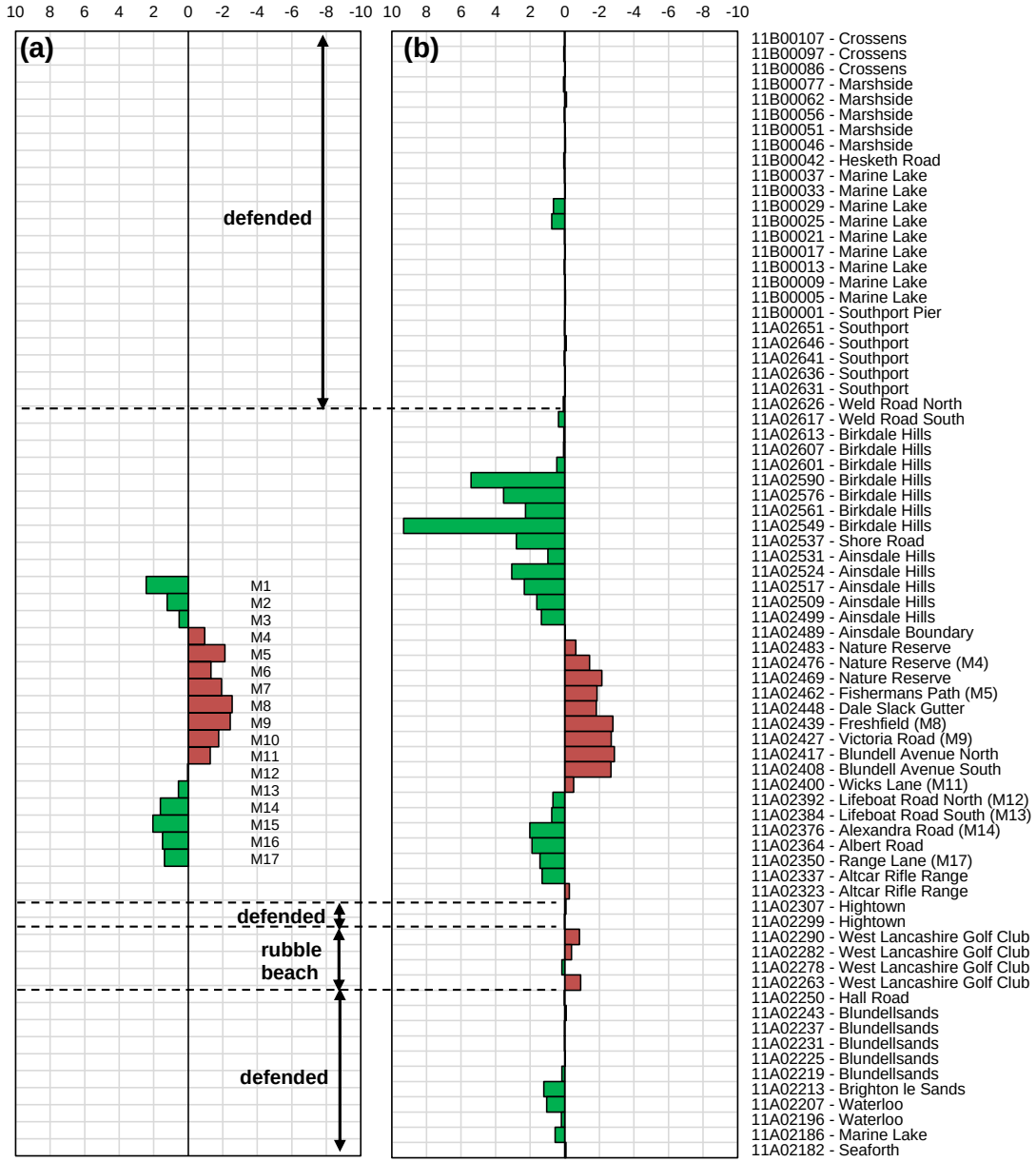

Victoria Road
Formby
Blundell Avenue
Wicks Lane


Birkdale
Royal Birkdale
Golf Club
Weld Road
dunes
Green Beach


Range Lane
Cabin Hill
NNR
Devil's Hole
Ravenmeols
LNR
Albert Road

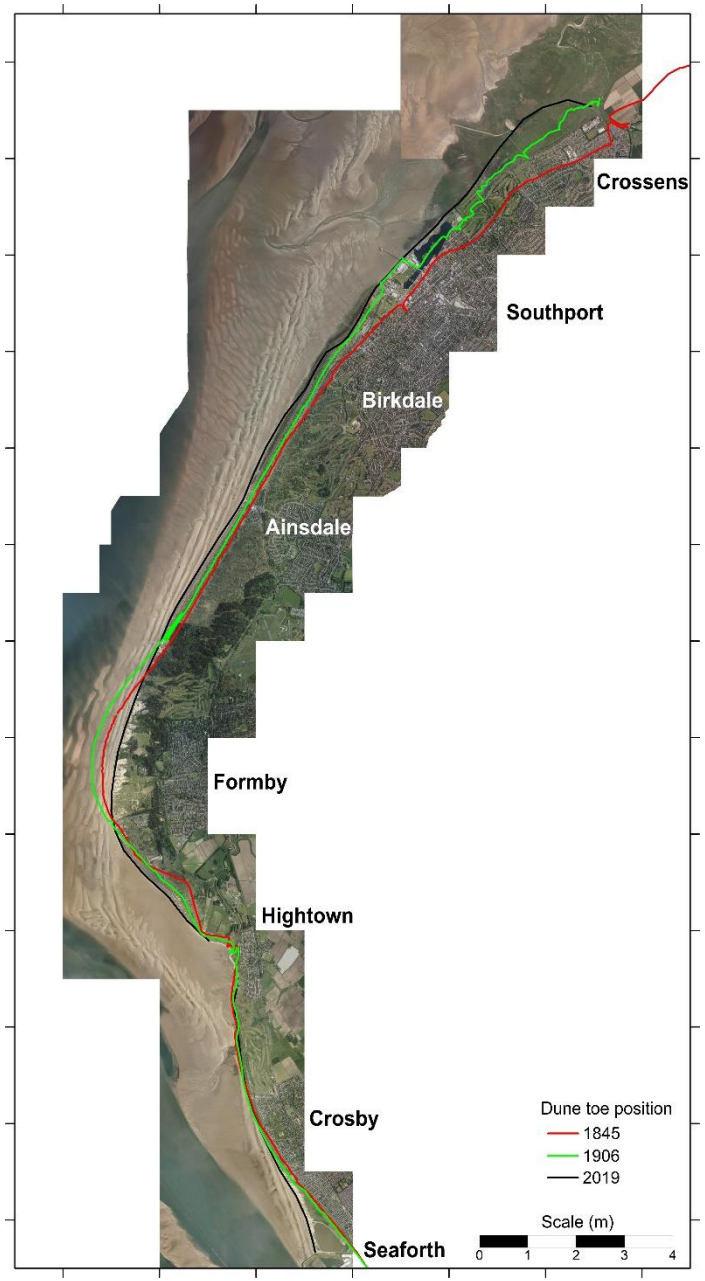
Dune toe trend 1991-2020 (m/yr)

Dune toe trend 2007-2019 (m/yr)

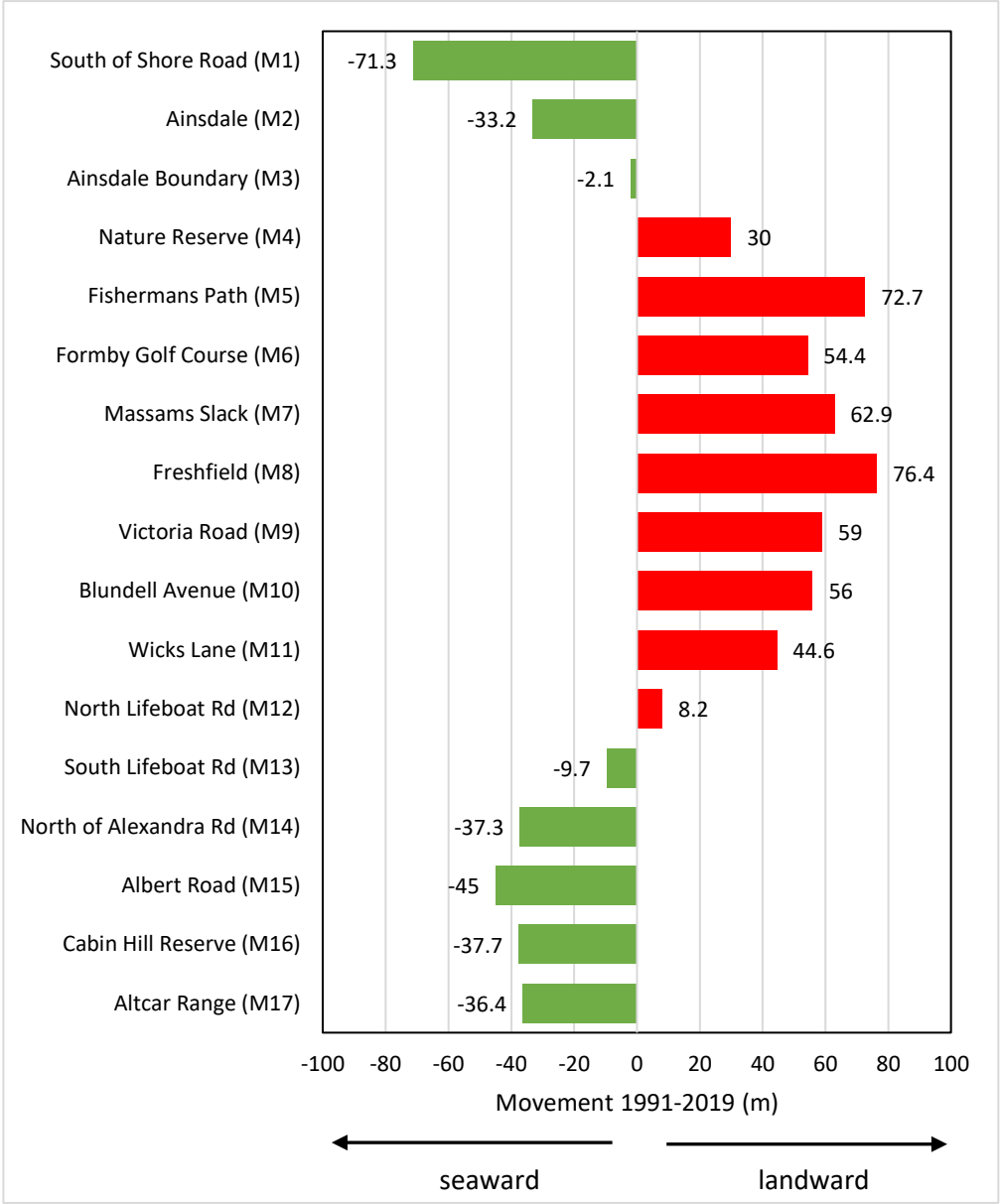


11B00107 - Crossens
11B00097 - Crossens
11B00086 - Crossens
11B00077 - Marshside
11B00062 - Marshside
11B00056 - Marshside
11B00051 - Marshside
11B00046 - Marshside
11B00042 - Hesketh Road
11B00037 - Marine Lake
11B00033 - Marine Lake
11B00029 - Marine Lake
11B00025 - Marine Lake
11B00021 - Marine Lake
11B00017 - Marine Lake
11B00013 - Marine Lake
11B00009 - Marine Lake
11B00005 - Marine Lake
11B00001 - Southport Pier
11A02651 - Southport
11A02646 - Southport
11A02641 - Southport
11A02636 - Southport
11A02631 - Southport
11A02626 - Weld Road North
11A02617 - Weld Road South
11A02613 - Birkdale Hills
11A02607 - Birkdale Hills
11A02601 - Birkdale Hills
11A02590 - Birkdale Hills
11A02576 - Birkdale Hills
11A02561 - Birkdale Hills
11A02549 - Birkdale Hills
11A02537 - Shore Road
11A02531 - Ainsdale Hills
11A02524 - Ainsdale Hills
11A02517 - Ainsdale Hills
11A02509 - Ainsdale Hills
11A02499 - Ainsdale Hills
11A02489 - Ainsdale Boundary
11A02483 - Nature Reserve
11A02476 - Nature Reserve (M4)
11A02469 - Nature Reserve
11A02462 - Fishermans Path (M5)
11A02448 - Dale Slack Gutter
11A02439 - Freshfield (M8)
11A02427 - Victoria Road (M9)
11A02417 - Blundell Avenue North
11A02408 - Blundell Avenue South
11A02400 - Wicks Lane (M11)
11A02392 - Lifeboat Road North (M12)
11A02384 - Lifeboat Road South (M13)
11A02376 - Alexandra Road (M14)
11A02364 - Albert Road
11A02350 - Range Lane (M17)
11A02337 - Altcar Rifle Range
11A02323 - Altcar Rifle Range
11A02307 - Hightown
11A02299 - Hightown
11A02290 - West Lancashire Golf Club
11A02282 - West Lancashire Golf Club
11A02278 - West Lancashire Golf Club
11A02263 - West Lancashire Golf Club
11A02250 - Hall Road
11A02243 - Blundellsands
11A02237 - Blundellsands
11A02231 - Blundellsands
11A02225 - Blundellsands
11A02219 - Blundellsands
11A02213 - Brighton le Sands
11A02207 - Waterloo
11A02196 - Waterloo
11A02186 - Marine Lake
11A02182 - Seaforth

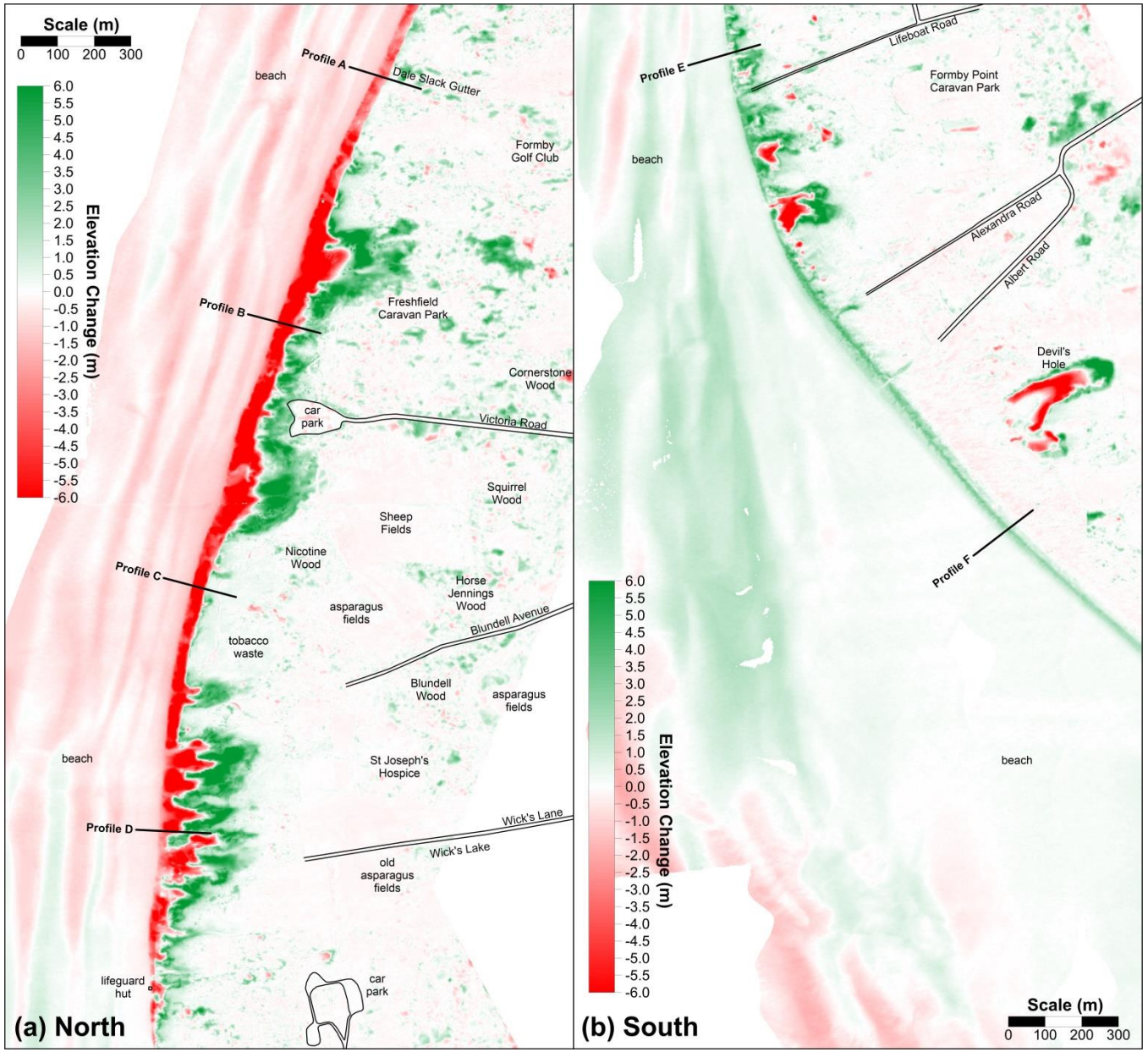
Historical dune toe positions



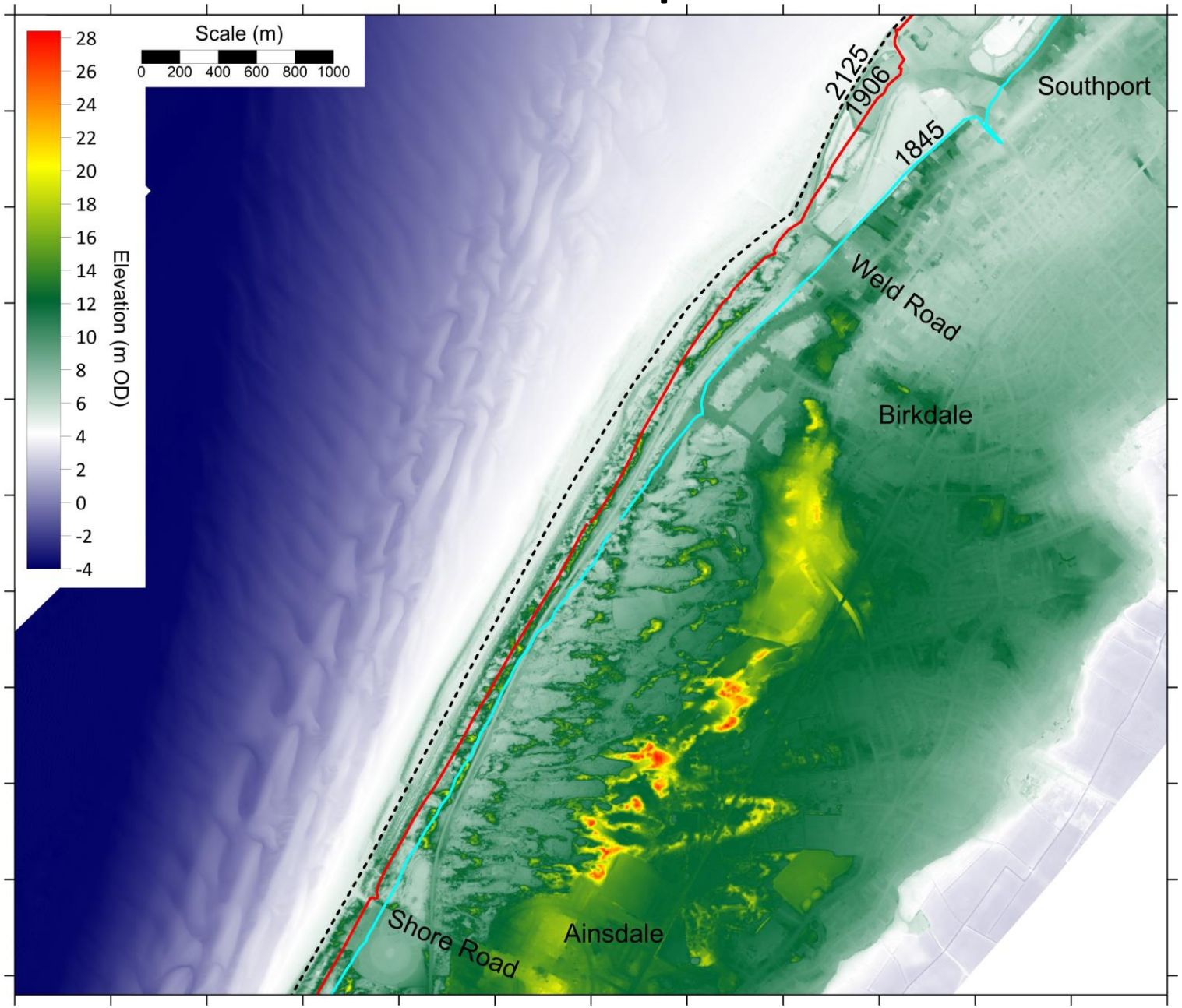
Seaward and landward movement of dune toe, measured at 17 marker post positions between 1991 and 2019



Changes in elevation at Formby Point, 1999-2014

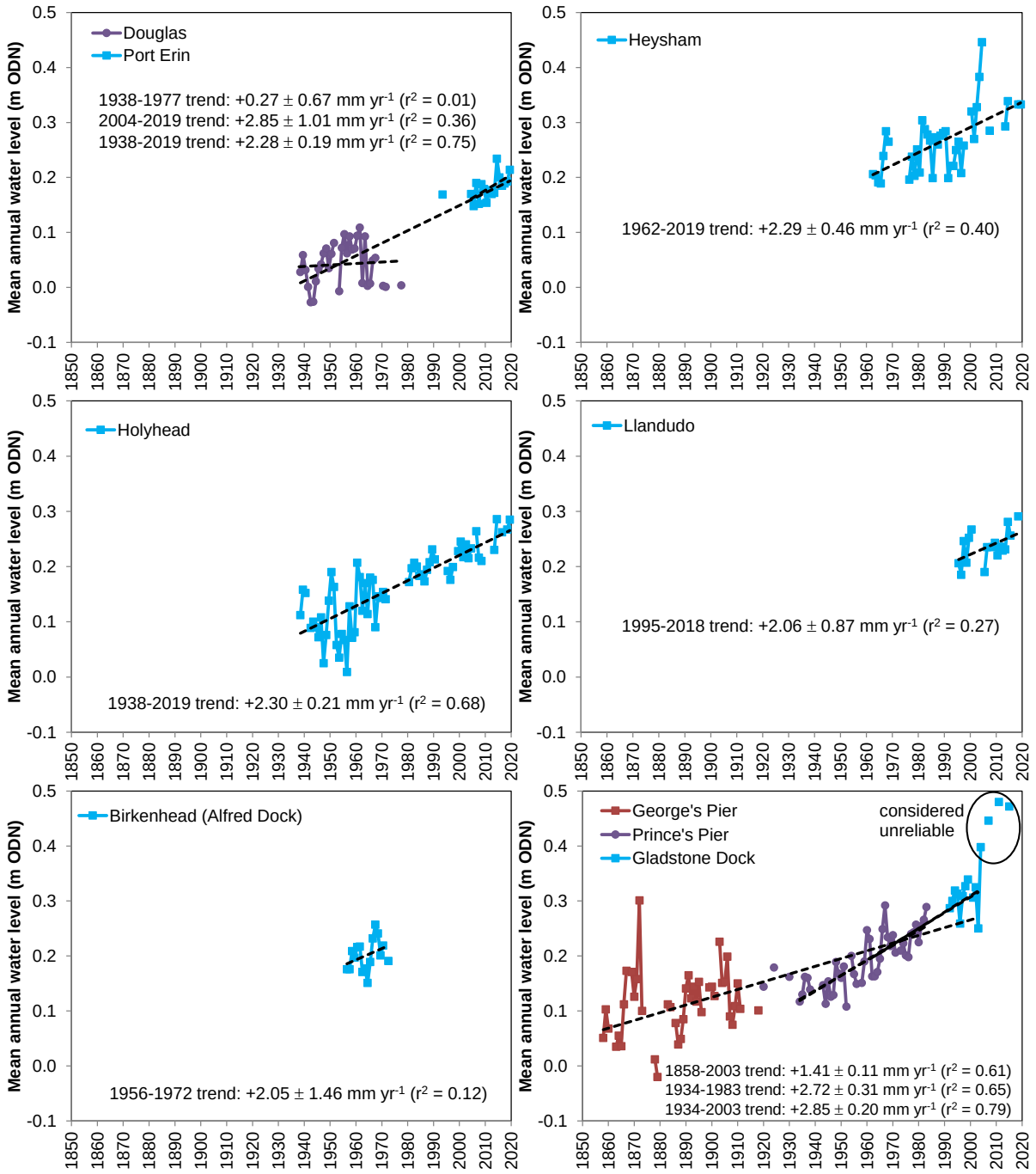


LiDAR DTM flown 28th September 2018



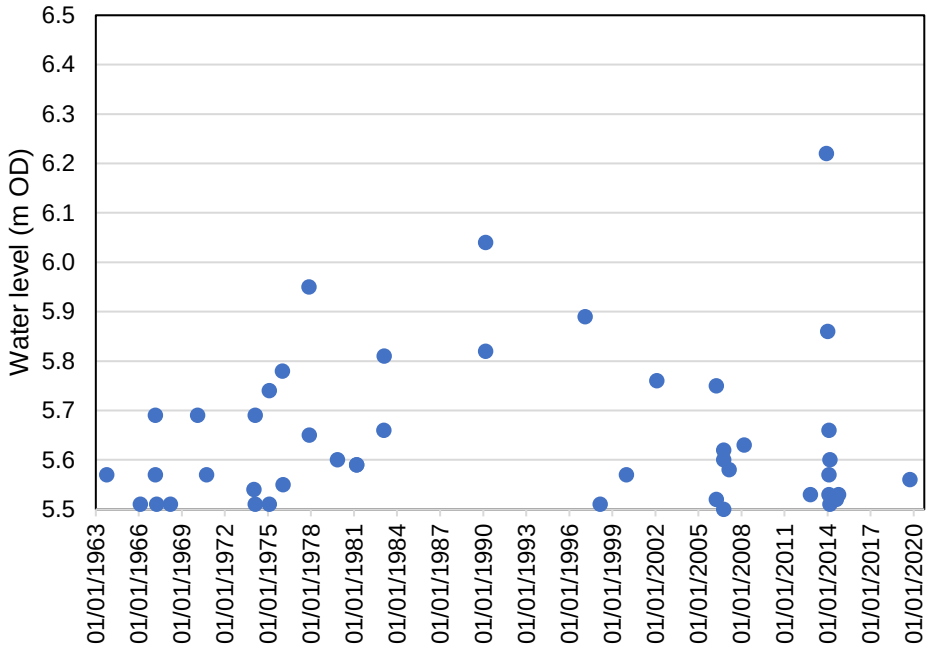
Mean sea level records for the Irish Sea

Primary data source: NTSLF



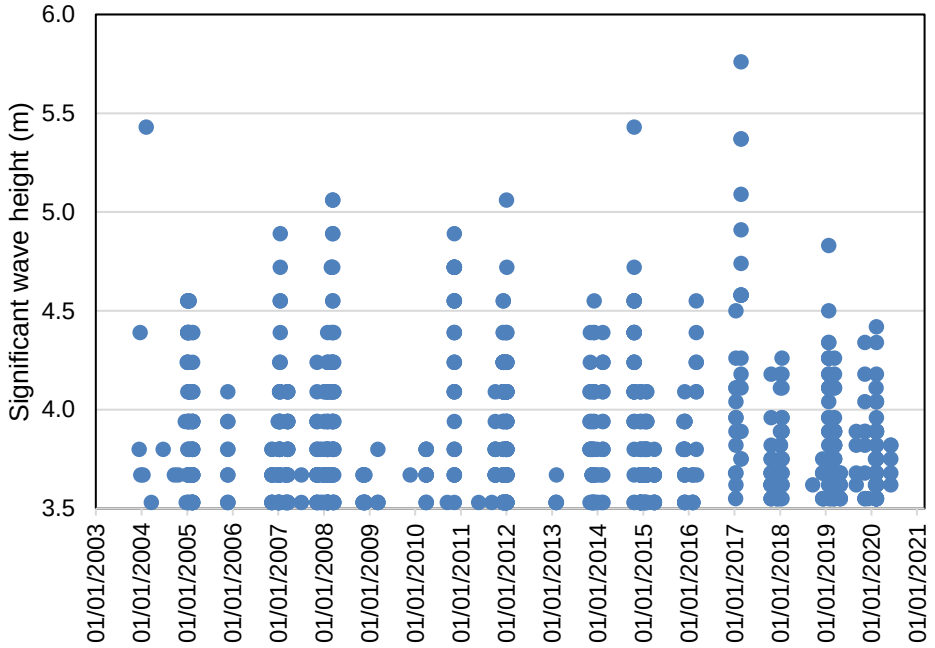
Highest tides recorded at Liverpool 1963-2020

Primary data source: NTSLF



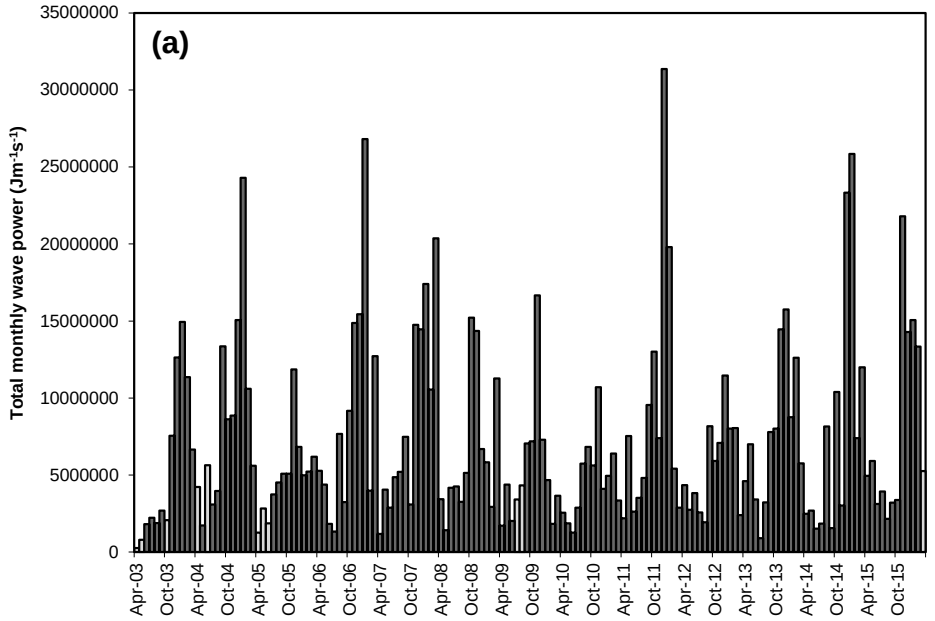
Highest waves recorded in Liverpool Bay 2003-2020

Primary data source: CEFAS Wavenet



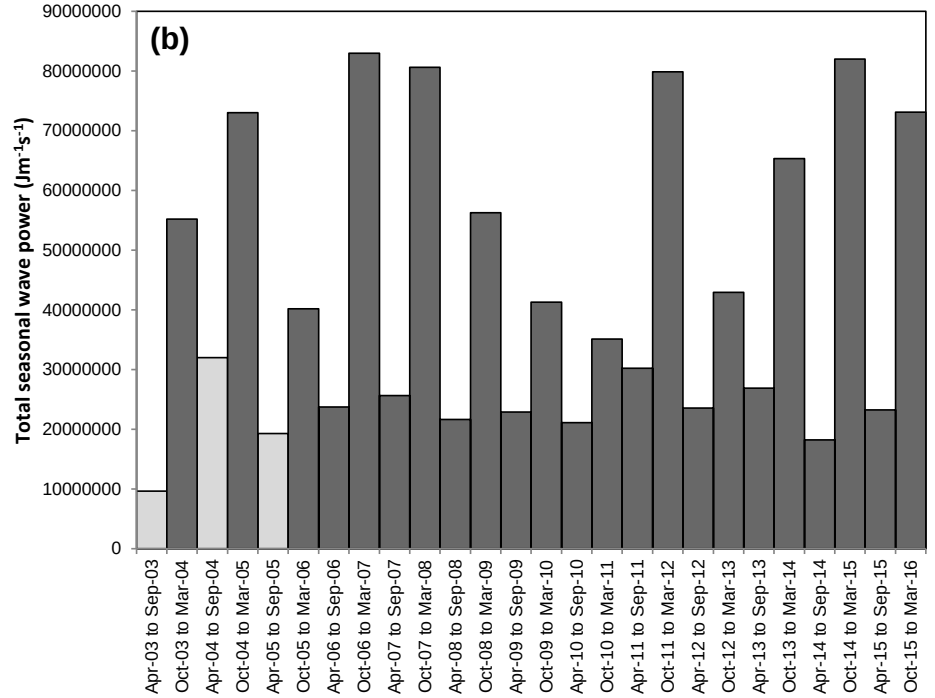
Monthly wave power recorded at the Liverpool Bay wave buoy

Primary data source: CEFAS Wavenet

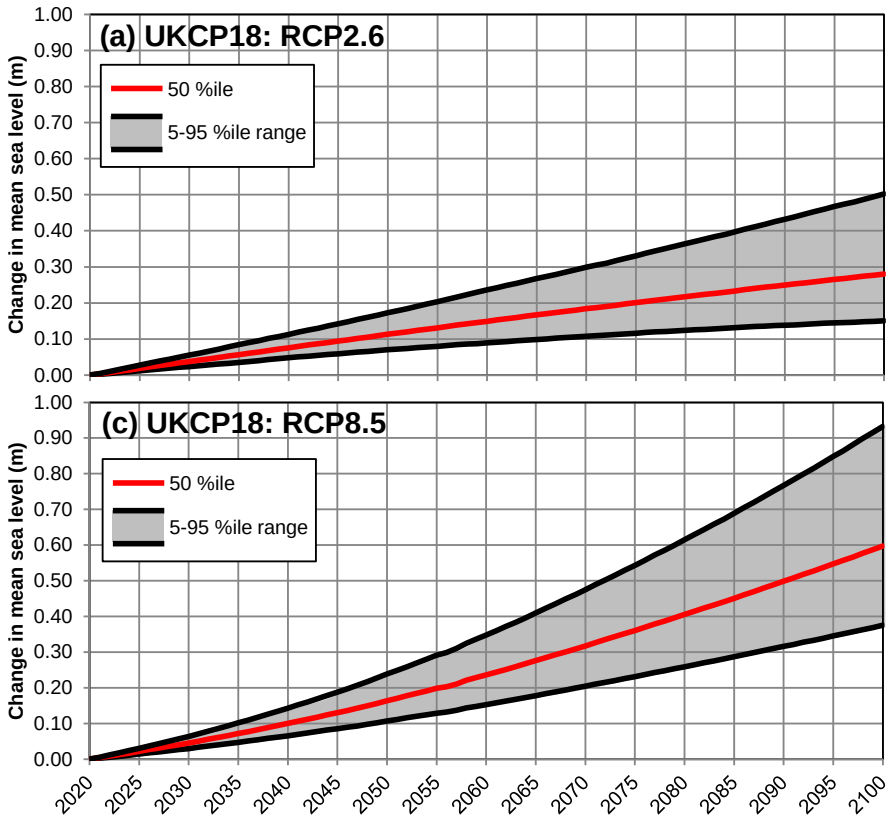


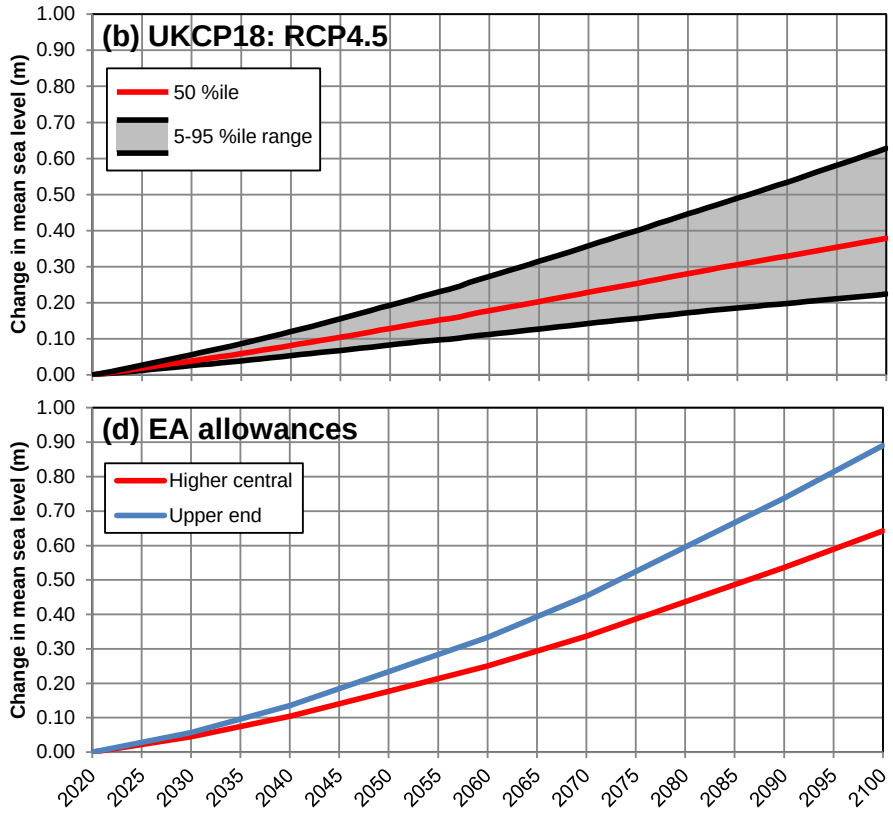
Seasonal wave power recorded at the Liverpool Bay wave buoy

Primary data source: CEFAS Wavenet



Projected increases in mean sea level at Formby according to UKCP18 (3 scenarios) and EA recommended allowances

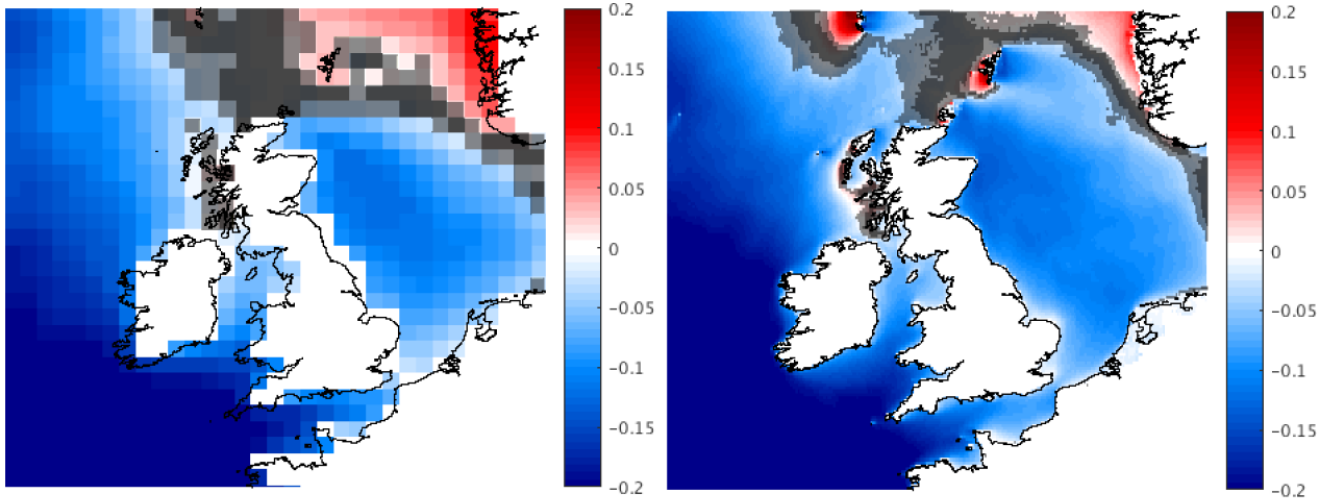




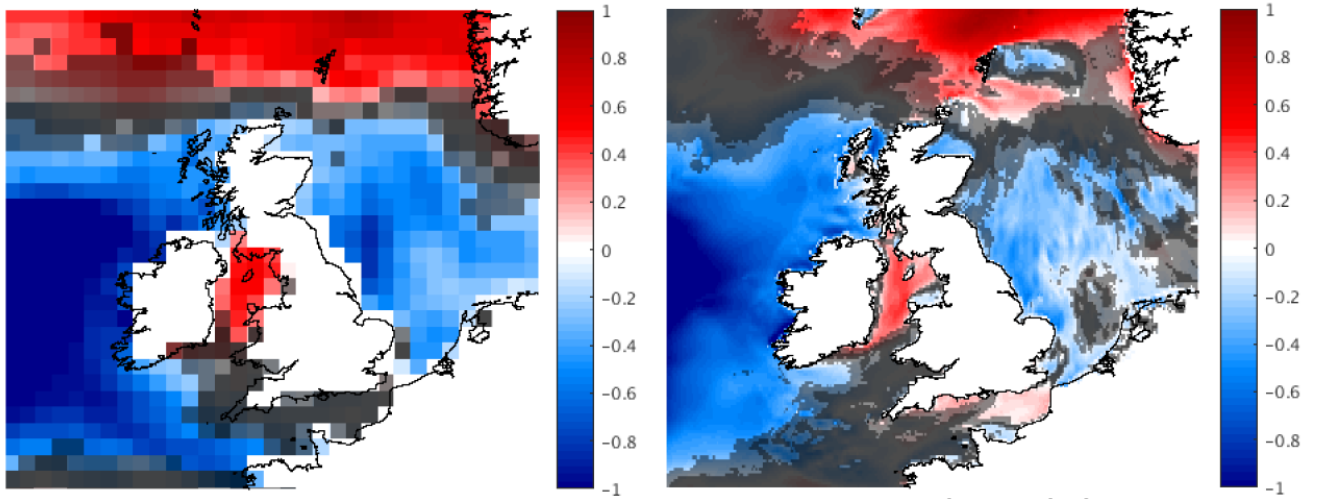
Projected changes in wave climate around the British Isles by 2100 (RCP8.5 scenario)

Data from UKCP18 / Palmer *et al*. (2018)

Mean SWH (m)



Mean Annual Max (m)

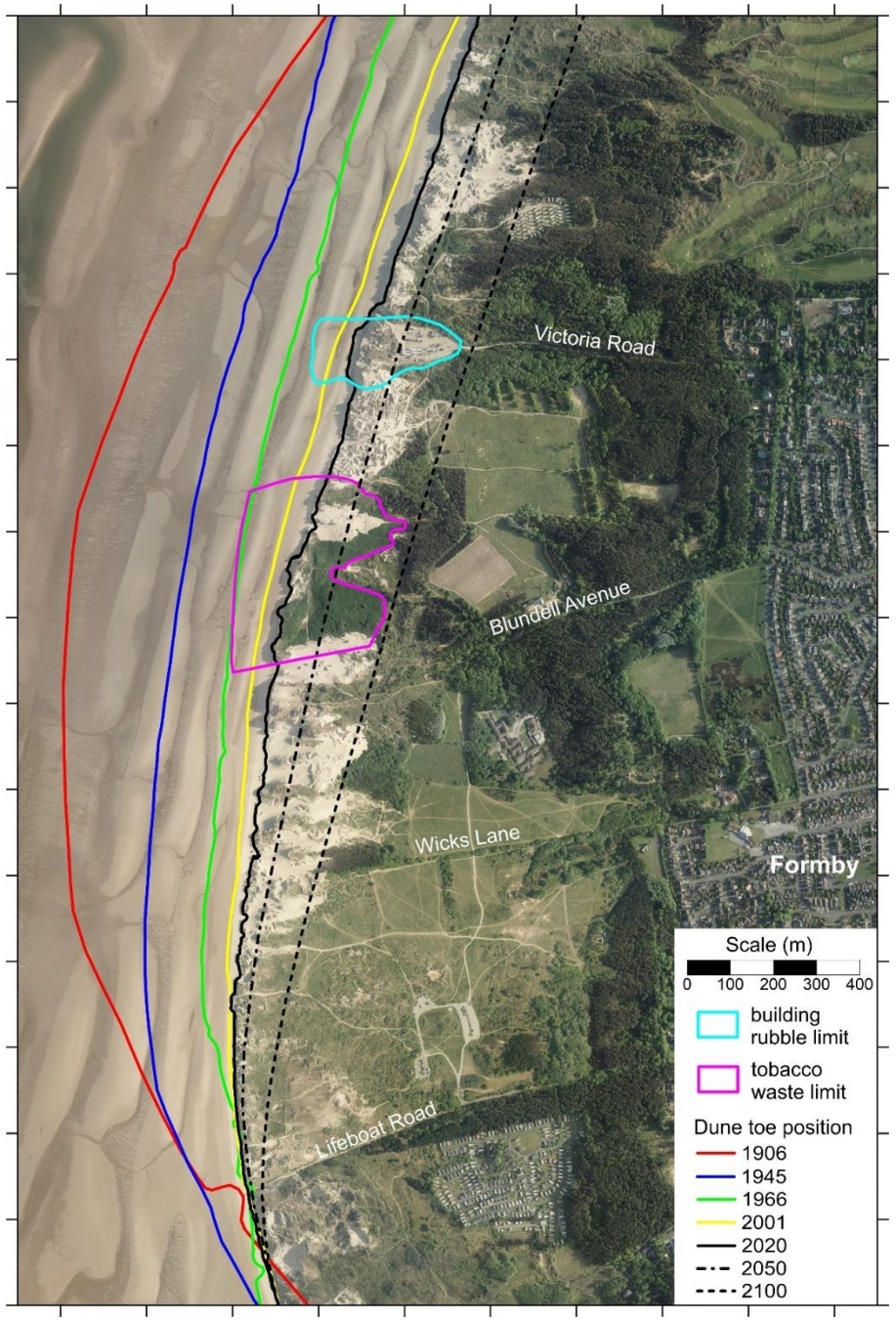


Global model

Regional model

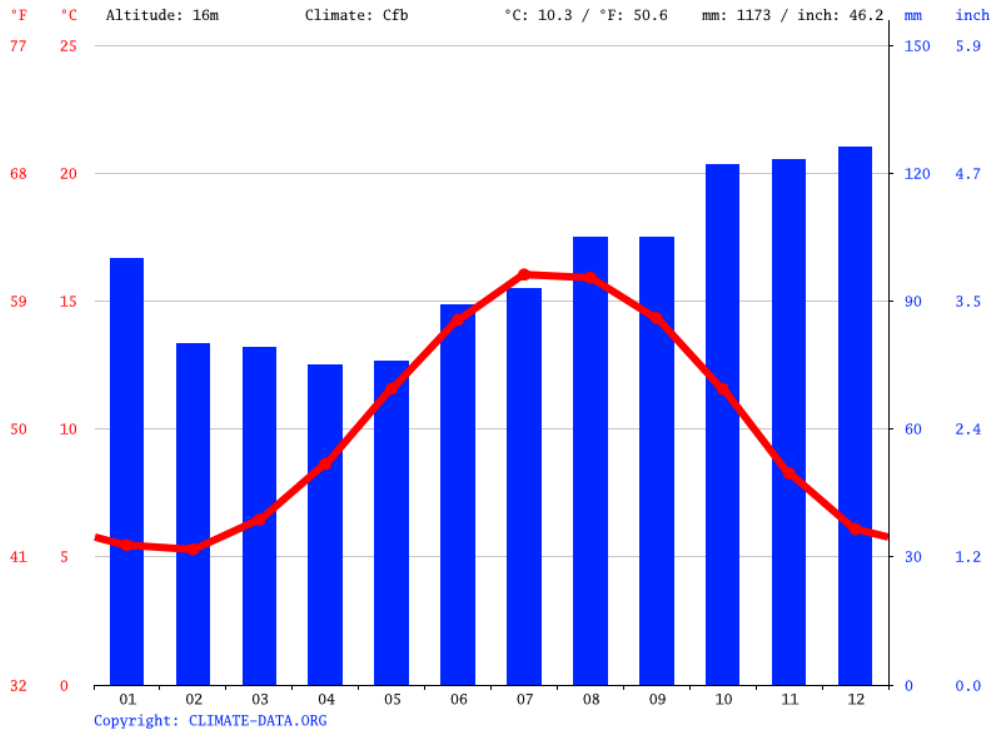
Long-term historical and projected future changes in shoreline position

Data from historical OS maps (1906), aerial photographs (1945 and 1966), dune toe surveys (2001 and 2020), and projections to 2050 and 2100 taking into account SLR



Baseline photograph 2018

Average Climate Data at Ainsdale



	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	5.5 °C	5.3 °C	6.4 °C	8.6 °C	11.6 °C	14.3 °C	16 °C	15.9 °C	14.3 °C	11.6 °C	8.3 °C	6.1 °C
Min. Temperature °C	3.7 °C	3.3 °C	4 °C	5.8 °C	8.8 °C	11.6 °C	13.6 °C	13.7 °C	12.1 °C	9.6 °C	6.5 °C	4.3 °C
Max. Temperature °C	7.1 °C	7.3 °C	8.9 °C	11.3 °C	14.2 °C	16.6 °C	18.3 °C	18 °C	16.5 °C	13.5 °C	9.9 °C	7.7 °C
Precipitation / Rainfall mm	100	80	79	75	76	89	93	105	105	122	123	126
Humidity(%)	83%	81%	79%	77%	76%	77%	77%	79%	79%	81%	83%	83%
Rainy days (d)	12	11	11	10	10	10	13	13	11	12	14	13
Min. Water Temperature °C	6.7	6.3	6	7.6	10	13.3	15.3	16.7	15	12.4	9.7	8
Avg. Water Temperature °C	7.3	6.5	6.8	8.7	11.5	14.3	16.4	17.1	15.9	13.6	11.1	8.8
Max. Water temperature °C	8	6.8	7.5	10	13	15.4	17.2	17.4	16.6	14.8	12.2	9.6

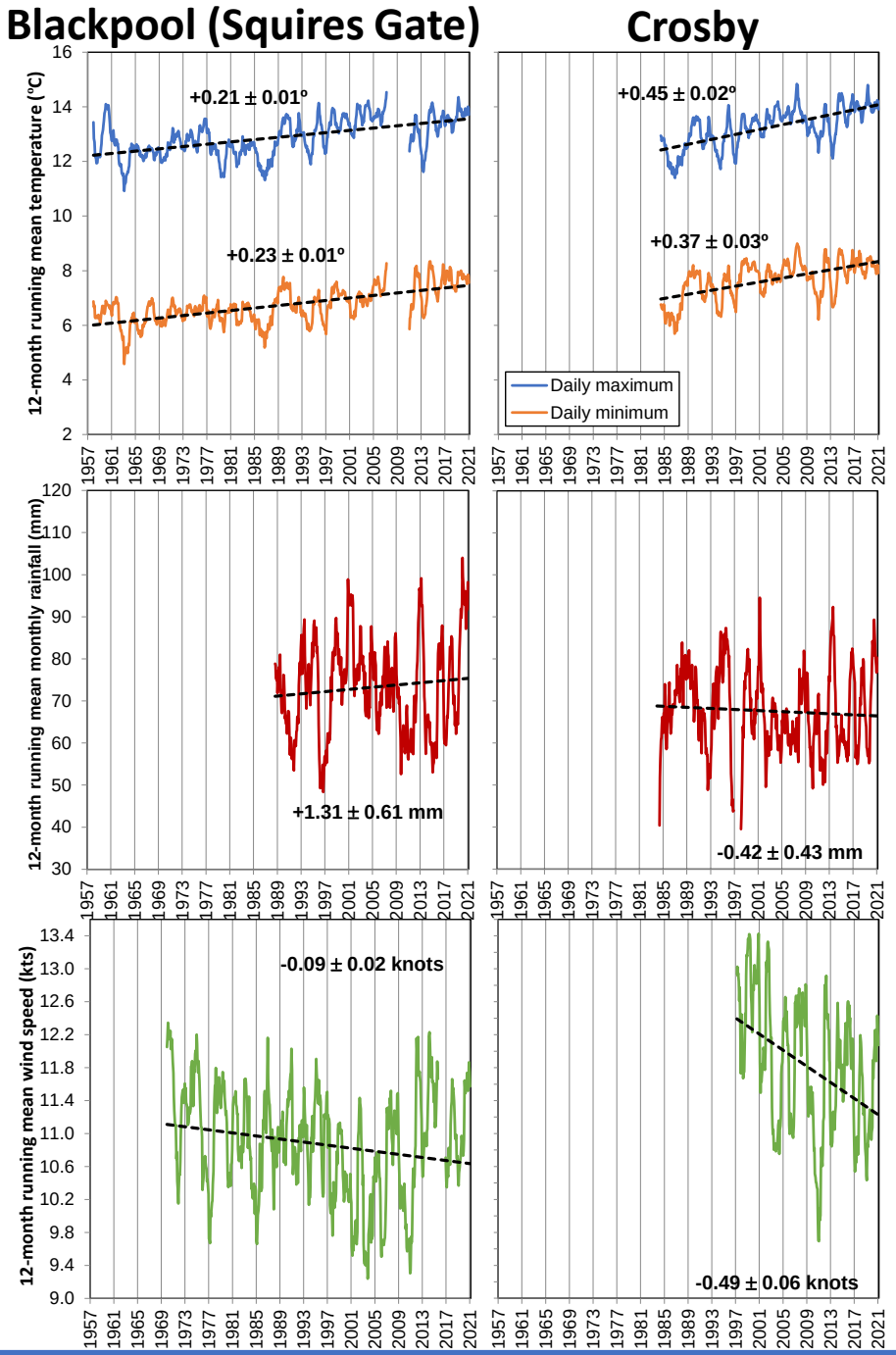
Source: https://en.climate-data.org

Daily maximum and minimum temperature (12-month running mean, 1957-2021)

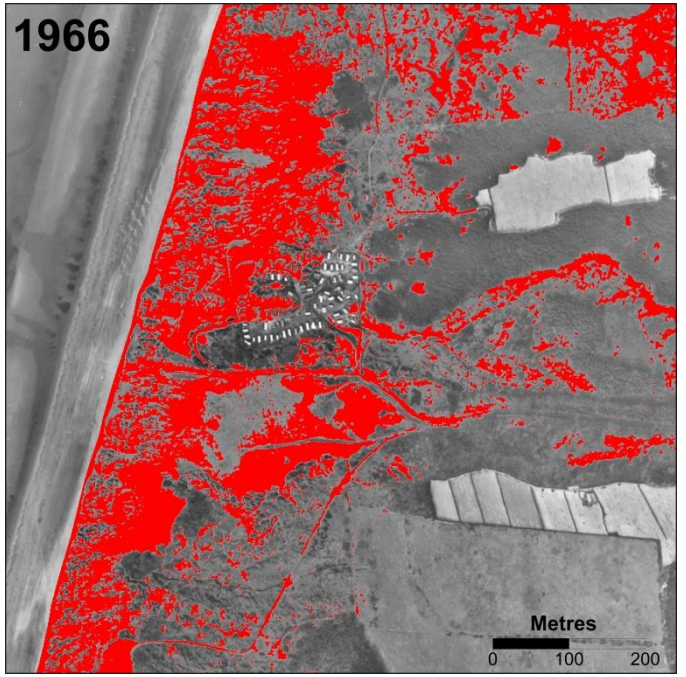
Monthly rainfall total (12-month running mean, 1984-2021)

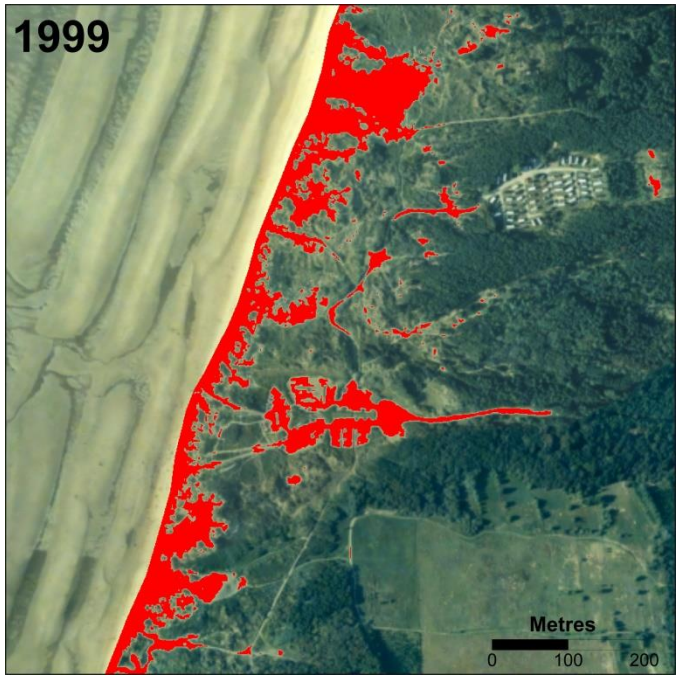
Hourly wind speed (12-month running mean, 1969-2021)

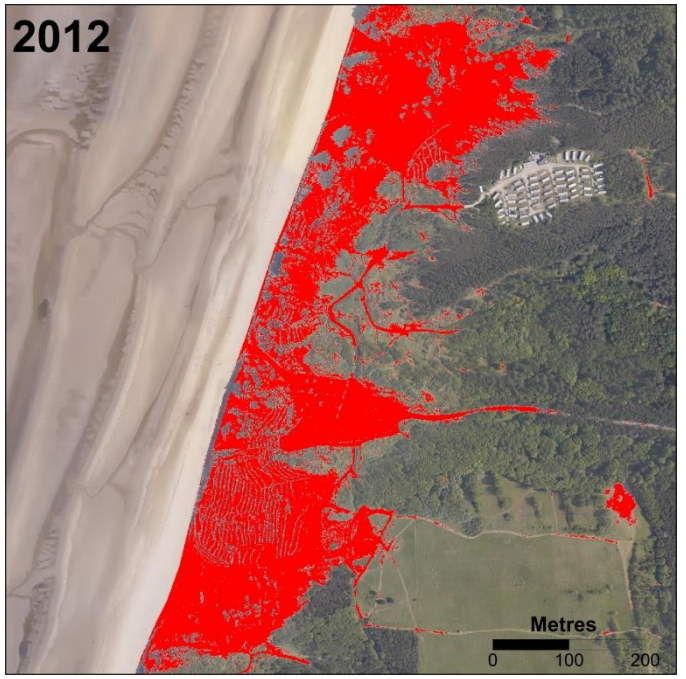
Primary data source: MIDAS



Changes in bare sand area in the Victoria Road area, Formby

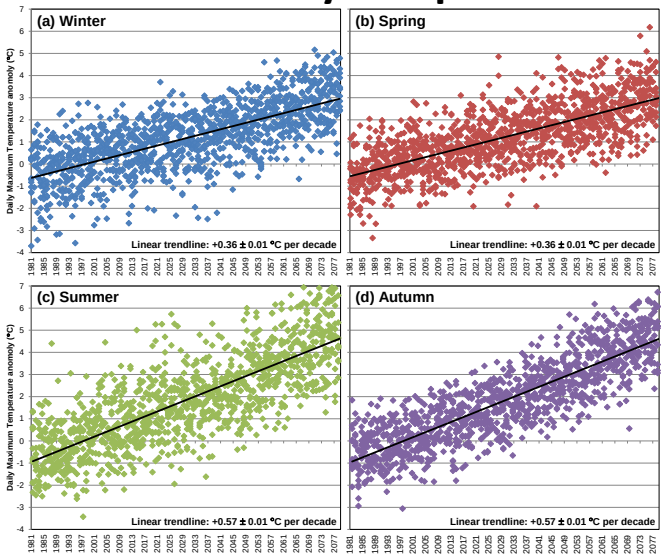




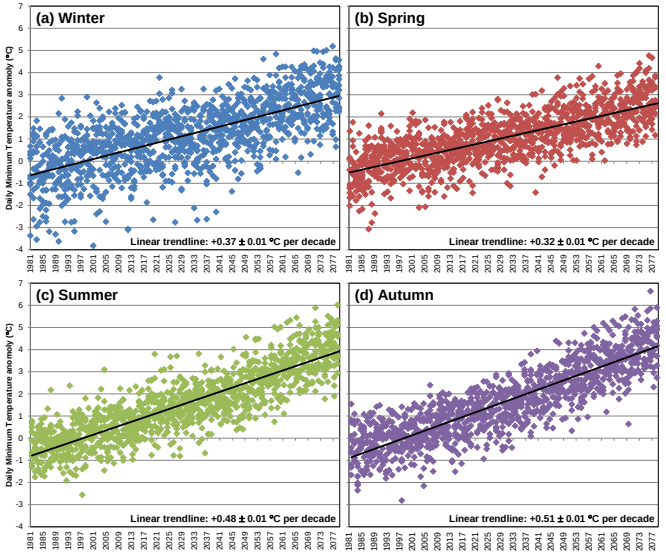


Projected changes in climate parameters at Formby (UKCP18 RCP8.5 scenario, anomalies from 1981)

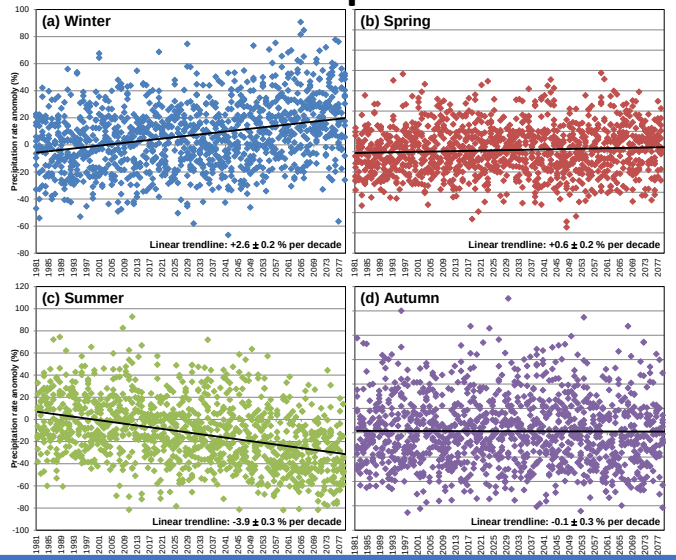
Max Daily Temperature



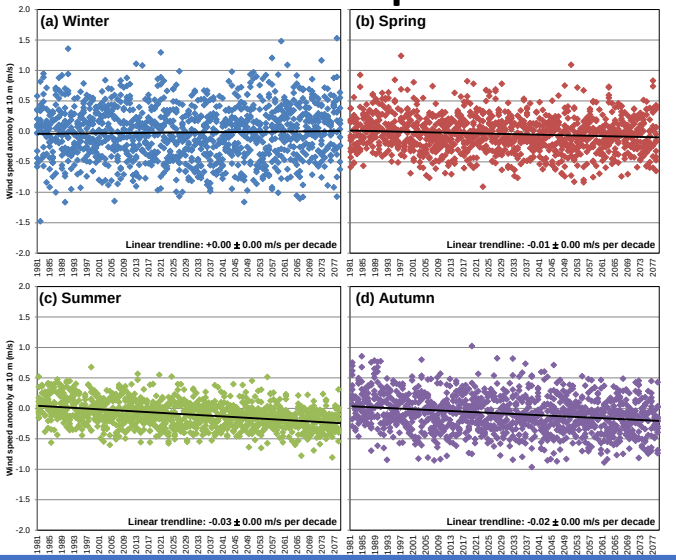
Min Daily Temperature



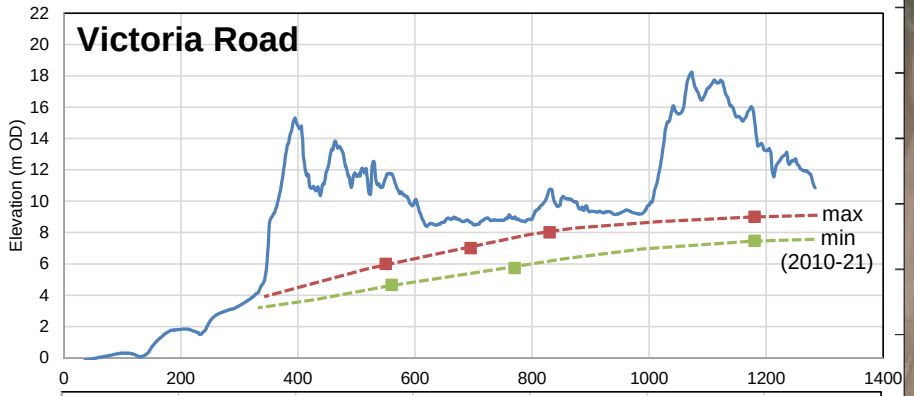
Precipitation

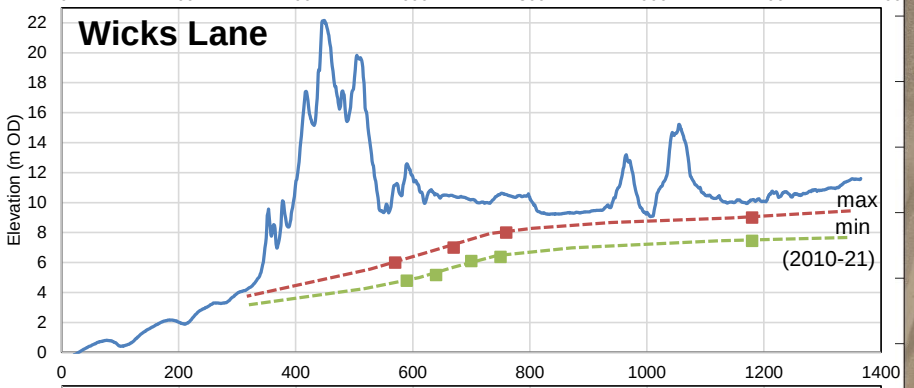


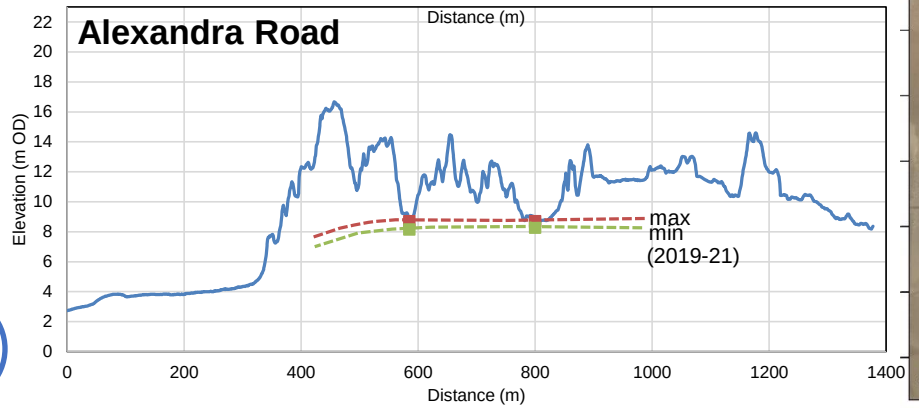
Wind speed



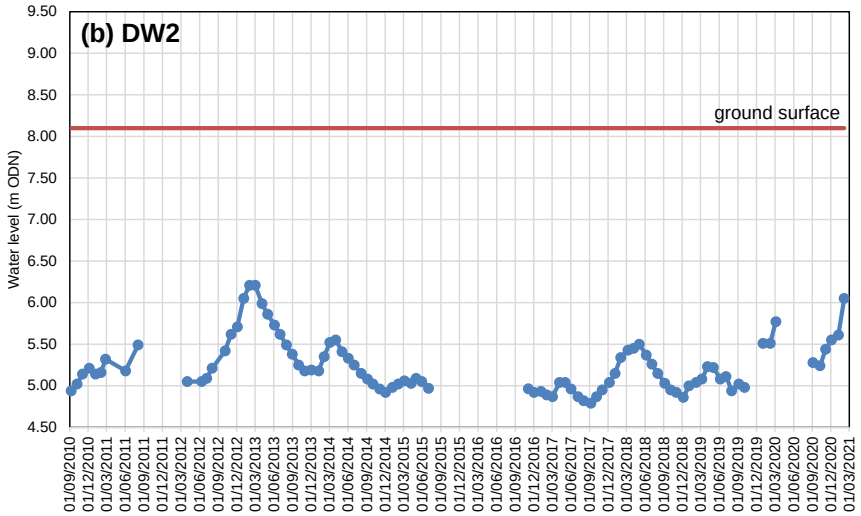
Water table levels from National Trust dipwell data 2010-2021

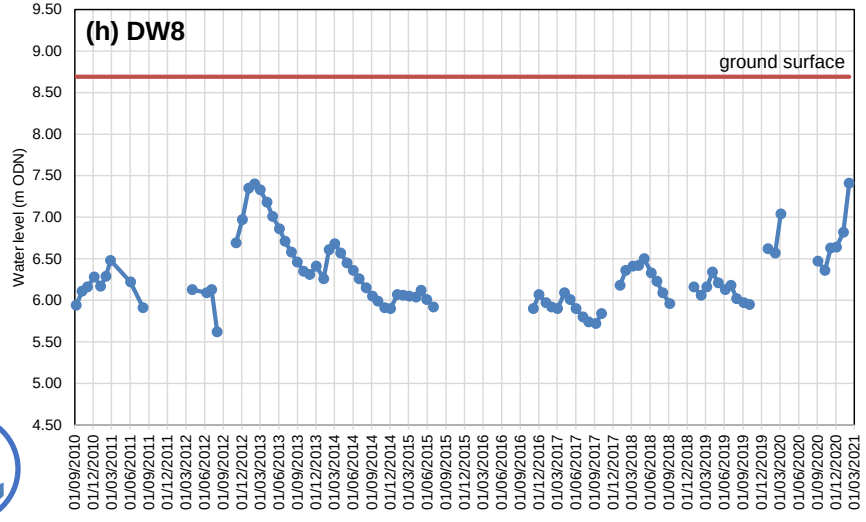






Locations of dipwells locations within the National Trust Formby property (2010-present)





Conclusions

A - Shoreline change

- Continuation of erosion at Formby Point with little change in maximum rates
- Extension of erosion front northwards and to a lesser extent southwards
- Slowing of progradation rates at Ainsdale north, Birkdale and Ravenmeols
- Continued vertical marsh growth between Birkdale and Marshside but erosion of marsh edge
- Reduction in rates of alongshore sediment transport rates as coast ‘flattens’
- Frontal dune erosion between Altcar and Crosby until coastal defences improved
- Erosion will cause lowering of water tables near the shore, progressively extending landwards
- Progradation will favour slight raising of water tables near the shore, creating wetter slacks unless infilled by windblown sand

B - Climate change

- Further slight increase in average temperatures, especially in winter
- Further slight increase in precipitation, especially in winter
- Increased variability with greater frequency of both droughts and flooding due to thunderstorms
- Slight regional reduction in wind speeds associated with general shift to more south-westerly influence, but coastal aspect dependent
- Limited overall change in overall potential evaporation rates
- Limited effect of on average wave climate and storm surge frequency / magnitude

Conclusions

C - Human influences

- Reduction in tree and scrub cover likely in short term if management measures continue (uncertain for medium to longer term)
- Increase in mobile sand and mobile dunes likely in short term due to management interventions (uncertain for medium to longer term)
- Increase in shallow excavations likely in short term (uncertain for medium to longer term)
- Some degree of conflict between creation of artificial pools and enhancement of sand mobility – siting critical; objectives to create self-sustaining slacks within dynamic dunes will require careful design
- Limited increase in groundwater abstraction likely, but greater temporal variability
- Increased surface and groundwater pumping likely for flood risk management purposes, but high degree of temporal and spatial variability