SOUTH WEST COASTAL MONITORING

making space for sand



Making Space for Sand - Pentewan Beach Report

Topographic and LiDAR Data Analysis

SWCM TBR04 18/12/2023

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Document Title	**Making Space for Sand - Pentewan Report**
Reference	**TBR04**
Status	**Final**
Date	**18/12/2023**
Project Name	**Making Space for Sand**
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Cover Photograph: Pentewan Beach, 14 November 2019
Taken by: Joseff Saunders

Summary

This report utilises Light Detection and Ranging (LiDAR), topography and aerial imagery data collected by the South West Coastal Monitoring (SWCM) Programme to analyse beach and dune volume at Pentewan. The aim is to highlight coastal change at Pentewan using SWCM data since 2007, focusing on beach and dune areas categorised into four zones: Beach, Mobile, Fixed, and Developed. Pentewan is a southeast facing sandy beach approximately 800 m wide and 200 m long, backed by a caravan park which sits atop an extant dune system. Topographic data collected bi-annually along fixed cross-shore profile lines are presented to indicate change to the intertidal beach area over time. LiDAR data from each available flight is compared to create difference models of the intertidal area, compare volumetric data over time and to show change in Mean Seal Level (MSL) and dune toe contours over time.

There has been a total of 34 topographic surveys at Pentewan since 2007. Analysis of topographic data suggests the survey unit to have remained stable between 2007 and 2023, with erosion observed in 2016 and 2019, despite this, the beach had recovered by 2023, recording the highest combined profile area during the spring survey.

Volume extracted from 12 LiDAR flights since 2007 have seen the Mobile Zone gradually increase in volume up until 2022, with a loss of material observed in 2014 following the winter storms which primarily affected the upper beach. The Beach Zone has also shown gradual accretion between 2007 and 2022, however has remained stable overall. Accretion was recorded following the 2013/14 storms, similarly to the topographic data, likely because of the sheltered nature of the beach.

Overall Pentewan beach has remained stable since 2007 with relatively small fluctuations in material between surveys.

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1.0 Introduction

The aim of this report is to highlight beach and dune change at Pentewan Beach using data collected as part of the South West Coastal Monitoring (SWCM) Programme since 2007. Four zones have been identified to define the beach/dune area and are defined as:

- **Beach Zone** – The wet beach area has been defined using Mean Low Water Spring (MLWS) and Mean High Water Spring (MHWS) contours extracted from all LiDAR data captured by SWCM. The Beach Zone will therefore encompass the area between the MHWS and MLWS contours, with volumes for this area extracted from each LiDAR surface.
- **Mobile Zone** – This area is defined as the active dune face and embryo dune[1] from MHWS +1 m to the back of the mobile area, often distinguished by vegetation depth or urban development. The Mobile Zone has been defined using aerial imagery from 2007 to 2021 and historic OS maps and has been verified through site visits.
- **Fixed Zone** – This area is defined by permanent dune vegetation that may also include scrub or invasive species, effectively denoting vegetation atop sandy soil.
- **Developed Zone** – This is defined as urban development areas (i.e., car parks, unnatural grassy areas, roads, houses etc.) which have been built atop previously present dune systems.

1.1 Study Site

Pentewan is a southeast facing beach backed by a caravan park and confined by two rocky headlands to the north and south (Fig.1). The sandy beach consists of a low tide terrace with a cross-shore length of 200 m and longshore length of 820 m and mean spring tidal range of 4.5 m. The beach has a predominantly easterly wave climate. Pentewan has very little active dune vegetation present, however the theorised zones are represented in Figure 1.

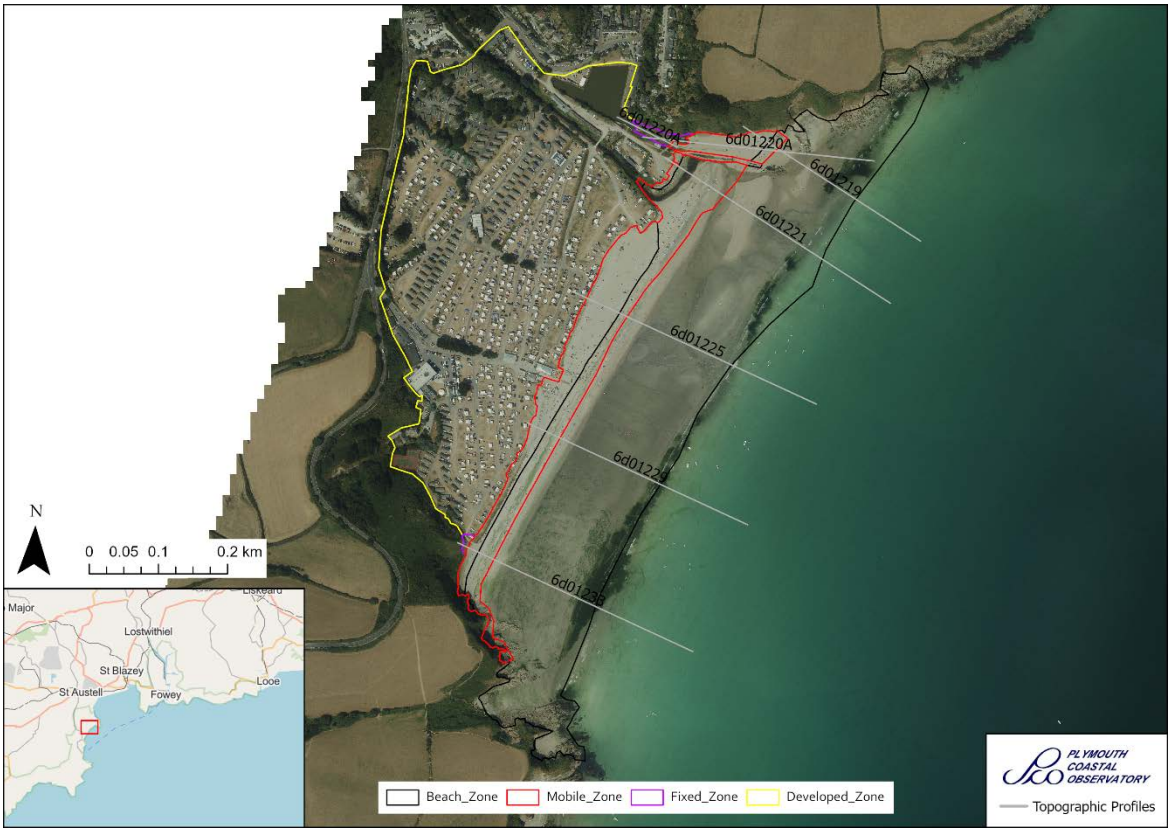


Figure 1 - Location Map of Pentewan Beach and Dune System, indicating the four defined zones outlined in section 1.0. Interim topographic profiles are also overlain to show their location, as detailed in section 2.1

[1] An embryo dune, or yellow dune, is the earliest stage of dune growth, usually found along the seaward extent of a dune system or newly formed dune.

2.0 Methods

Data utilised in this report was collected by SWCM between 2007 and 2024. Information on topographic and LiDAR data collection and specifications can be found on the Website for the National Network of Coastal Monitoring Programmes.

2.1 Topographic Data

SWCM have undertaken routine topographic beach surveys at 34 of the 40 MS4S sites since 2006. All surveys are conducted from the MLWS contour to the backshore. On average, each surveyed beach receives two interim surveys a year and one full coverage survey every 5 years:

- Interim - Conducted twice a year in the spring (conducted between January and April), and autumn (conducted between September and December). An interim survey consists of collecting data points at 5m intervals along pre-defined profiles; these are outlined in Figure 1.
- Full coverage – Conducted once per phase (6 years), or annually at more vulnerable sites (conducted between May and September). Full coverage surveys include a full profile survey at 50 m intervals and continuous spot height data collected across a 5 m grid covering the whole beach.

Analysis of the Cross-Sectional Area (CSA) change is conducted for each individual profile between each separate survey. Changes in CSA are measured relative to the fixed master profile which is defined by a pre-determined stable landward position and the MLWS level in reference to Ordnance Datum.

2.1.1 Topographic Data Analysis

Topographic data is presented as the following, where applicable:

Trend Analysis Plot - The combined profile trend in CSA is presented for each survey unit (example shown in Fig.2). The sum of all interim profile CSA is combined for each survey conducted to date to provide a survey unit with a single 'beach area' value, known hence-forth as the Combined Profile Area (CPA). CPA is compared using linear trend analysis over a temporal scale (Fig.2).

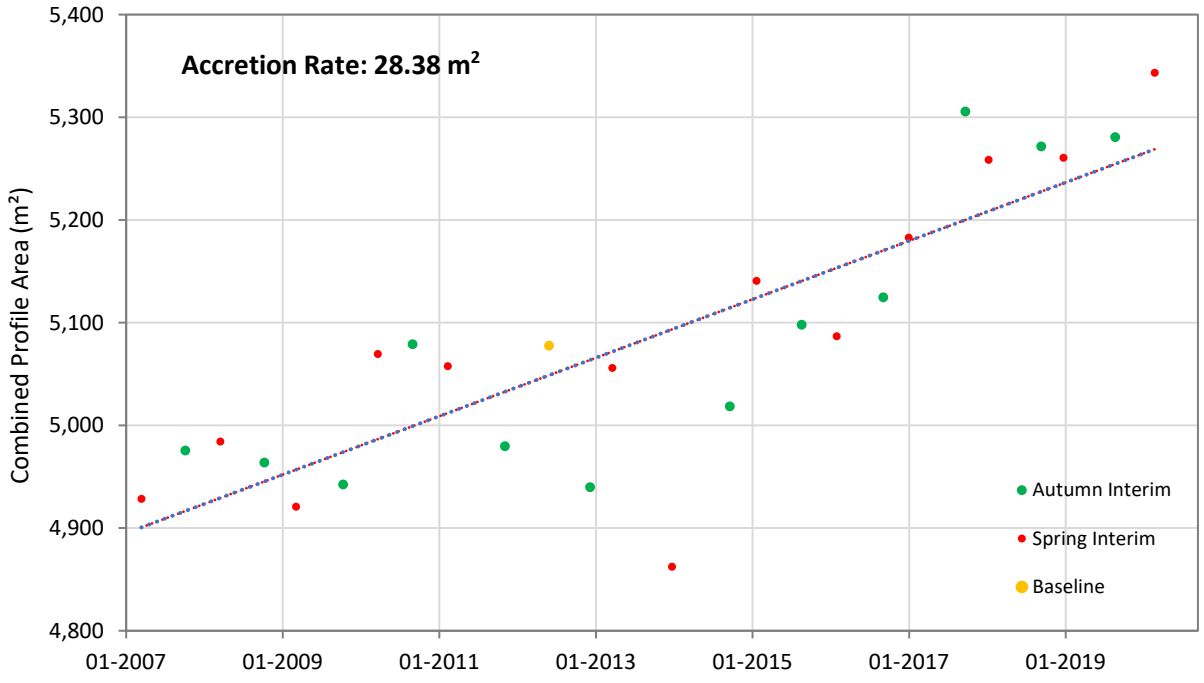


Figure 2 - Example of trend analysis for CPA for each survey with a linear trend rate highlighted at 28.4 m^2 y^{-1} equating to the increase of 0.56% of the average CPA per year.

If a profile has been omitted from a particular survey, for reasons of obstruction or similar, the average CSA of that profile from all available surveys is taken to ensure a consistent 'beach area'; if fewer than 75% of surveys have been conducted for a particular profile, the profile is omitted.

Profile Extremes Analysis - This plot displays the range of CSA values recorded throughout the duration of data collection (2006-2022) for each individual interim profile; the most recent survey is represented as a green dot. An example is given in figure 3. This plot provides the reader with information on how the CSA for each interim profile from the most recent survey corresponds to the entire dataset range.

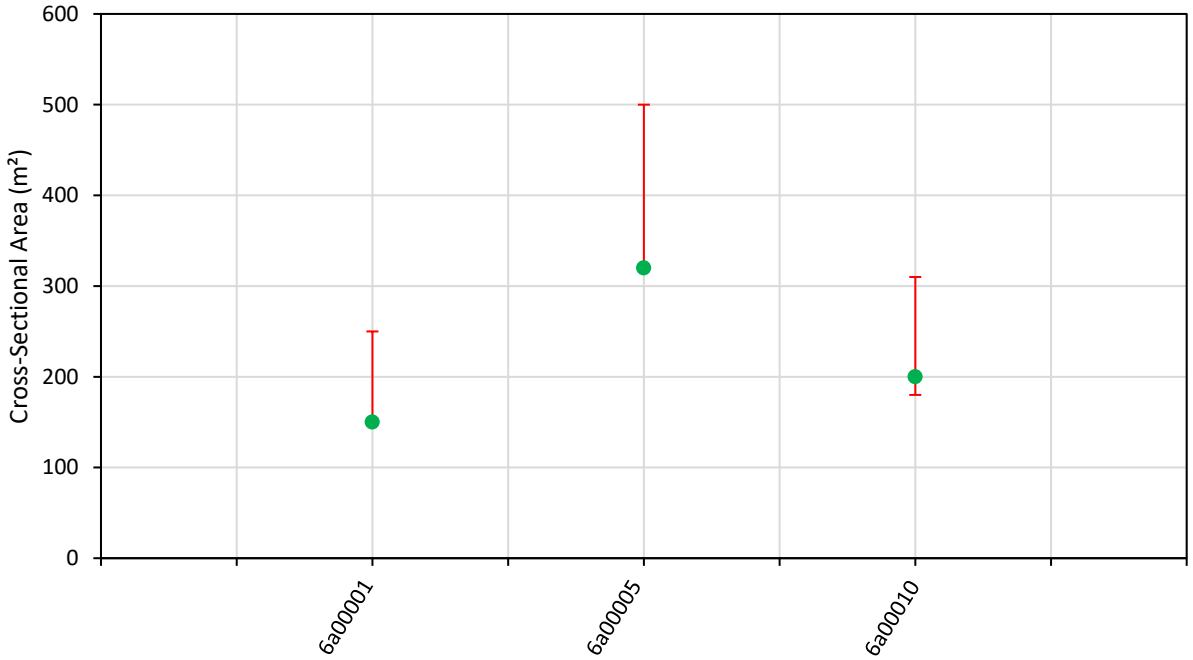


Figure 3 - Example plot showing the most recent CSA value recorded for three separate profile lines (green dots). The error bars represent the range of CSA recorded by each profile throughout the topographic dataset.

CSA Time Series Plot - CSA measurements for each interim profile are displayed on a separate plot representing values from each interim and full coverage survey conducted to date (example shown in Fig.4). This provides the reader with information on each interim profile's CSA evolution through time.

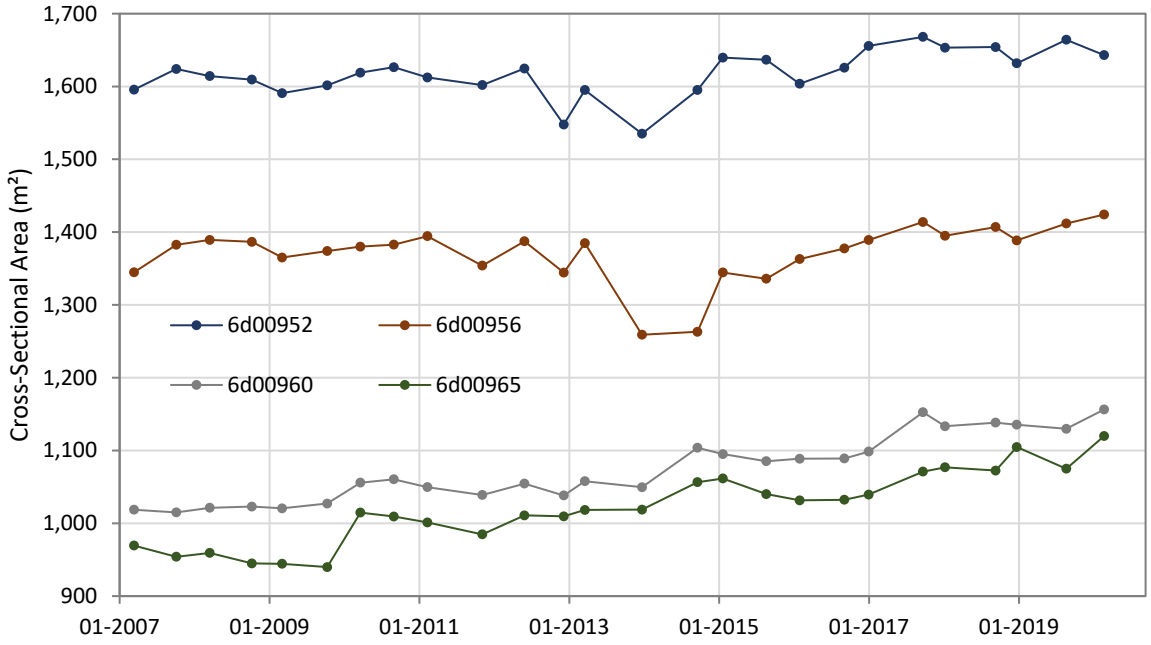


Figure 4 - Example of a cross-sectional area plot showing each of the interim profiles recorded for every survey since the 2007 baseline.

Individual Profile Charts - Each interim profile is portrayed as a cross-sectional profile comparing the most recent spring interim (blue), the previous spring interim (green) and the original full coverage survey (red). Profiles are displayed against the master profile (dotted red line) and are presented in the Appendices.

The 2013/2014 Storms – The winter period between September 2013 and April 2014 was, for many beaches in Cornwall, the most destructive period since SWCM records began in 2007. An abnormal number of significant storms, occurring in quick succession, heavily impacted many beaches, causing the loss of sediment from the intertidal area and dune face. This period is extensively discussed throughout this report and will hereinafter be referred to as the 2013/2014 winter period.

2.2 LiDAR Data

Airborne Light Detection and Ranging (LiDAR) data have been captured as part of the SWCM since 2007. Products include a point clouds, from which filtered and unfiltered 1 m^2 gridded surface models are derived:

- Unfiltered (Digital Elevation Model) representing the earth's surface including natural and artificial features such as trees and buildings.
- Filtered (Digital Terrain Model) representing the bare earth surface, with trees, buildings, cars etc. removed.

LiDAR is captured between September and March to minimise vegetation capture. Data is captured between MLWS and up to approximately 500 m inland. This report utilises "filtered" LiDAR data.

2.2.1 LiDAR Data Analysis

LiDAR data analysis is presented as the following:

Difference Modelling – Separate LiDAR surfaces are compared to produce a difference model of change based on gridded spot height elevations. The raw spot height data is processed into a gridded digital terrain model (DTM) and successive models are subtracted from one another to produce a difference model for the survey unit. Change in elevation is shown for values +/- 0.25 m and is represented by a colour scale bar.

Volume Extraction - Net sediment volume (m^3) is extracted for each LiDAR surface from the Beach Zone above MLWS and Mobile Zone above MHWS for trend comparison over time.

Contour Analysis – Contours are mapped from four LiDAR epochs spanning from 2007 to 2023, representing Mean Sea Level (MSL) and dune toe (calculated using the Stockdon equation by UoP, 2023[2]).

2.3 Accuracy Statement

Topographic Data – All survey points recorded along profiles have a measurement accuracy of +/- 0.03 m RMSE[3] in the horizontal and +/-0.03 m RMSE in the vertical.

LiDAR Data – Each LiDAR point cloud dataset has an average point density of 1.5 points per square metre. The digital terrain surfaces provide a minimum accuracy in elevation data of +/- 0.10 m RMSE with a minimum horizontal standard deviation as < 0.05 m. Please note that while every endeavour has been made to capture LiDAR as far seaward as MLWS, tidal and weather restrictions may in some instances have precluded this and coverage may be slightly reduced.

[2] Please refer to the following for Dune Toe elevation calculation: UoP, 2023. MS4S: Contemporary Dune Evolution and Future Predictions, Report, University of Plymouth, 33 pp.

[3] RMSE – Root-Mean-Square Error

3.0 Results

3.1 Topographic Data Analysis

There has been a total of 34 topographic surveys at Pentewan since 2007; 4 of full coverage surveys and 30 interim surveys. Exact dates of each survey for Pentewan are available to view on our survey record. Analysis of the CPA indicates the survey unit has remained relatively stable between 2007 and 2023, eroding at 1.7 m^2 y^{-1} , equating to 0.04% of the average beach area per year (Fig.5). The lowest recorded combined area was during the 2014 spring interim (3,691 m^2), following the highly energetic winter period, however the beach had recovered by the following year. A similarly low combined profile area was also recorded during the 2019 spring and autumn interim surveys (Fig,5) however the beach has since recovered with the highest recorded combined profile area seen during the latest spring interim in 2023 (3,961 m^2). The beach overall is relatively stable with <1% difference between the highest and lowest recorded combined profile areas.

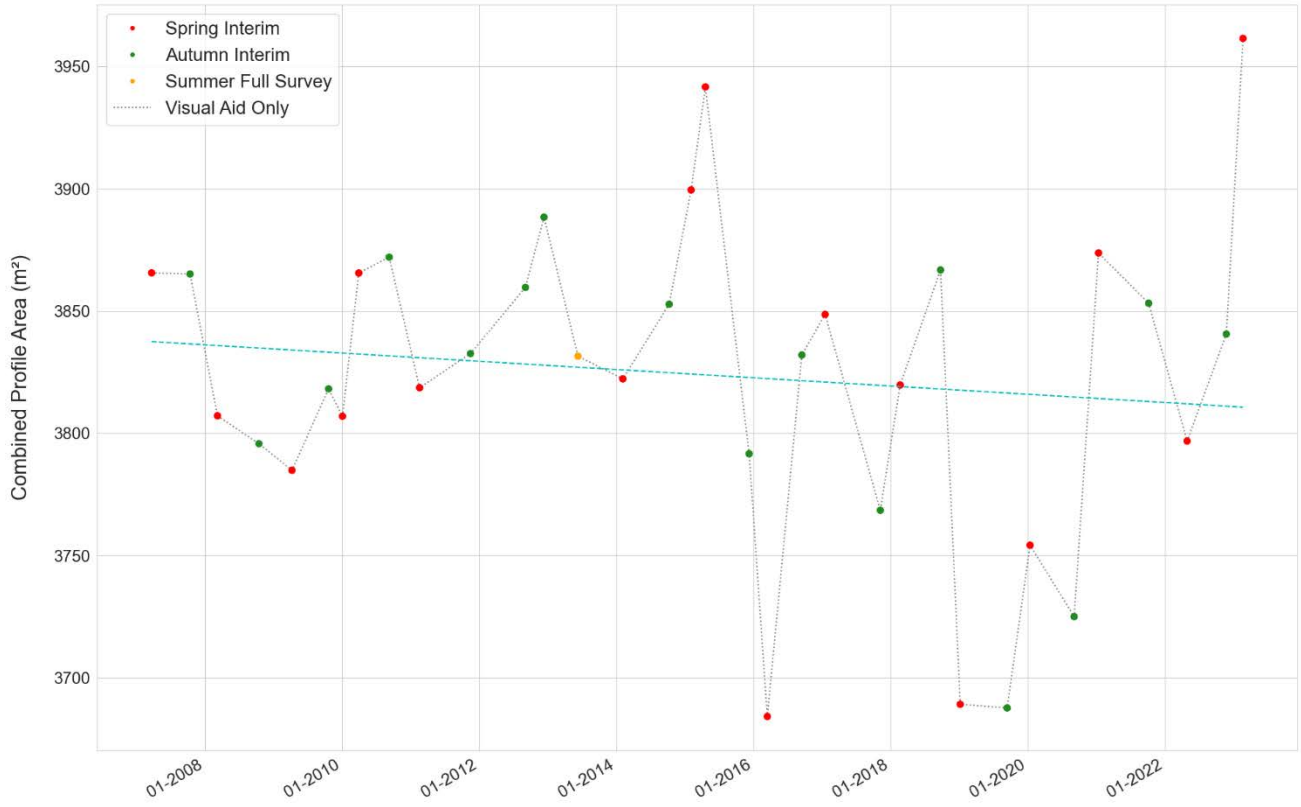


Figure 5 - The Combined Profile Area (CPA) for Pentewan, including every spring (red), summer (yellow) and autumn (green) survey completed between 2007 and 2023.

When comparing to the entire dataset (Fig.6), during the 2023 spring interim, the majority of Pentewan's profiles were relatively healthy with regards to the cross-sectional area with only 6d01221 and 6d01233 showing average levels.

When comparing profile cross-sectional areas to the entire time series (Fig.7), all profiles appear to be relatively stable throughout the time series. Profile 6d01219 and 6d01220A showed the largest range of change in cross-sectional areas however, both have remained stable throughout the monitoring period (Fig.7).

Profile Charts for Pentewan can be found in Appendix 1, these display the cross-sections of each profile for the initial baseline survey conducted in 2007 along with the two most recent interim surveys. All profiles (except for 6d01233) have shown an increase in the upper beach dune since the 2007 survey.

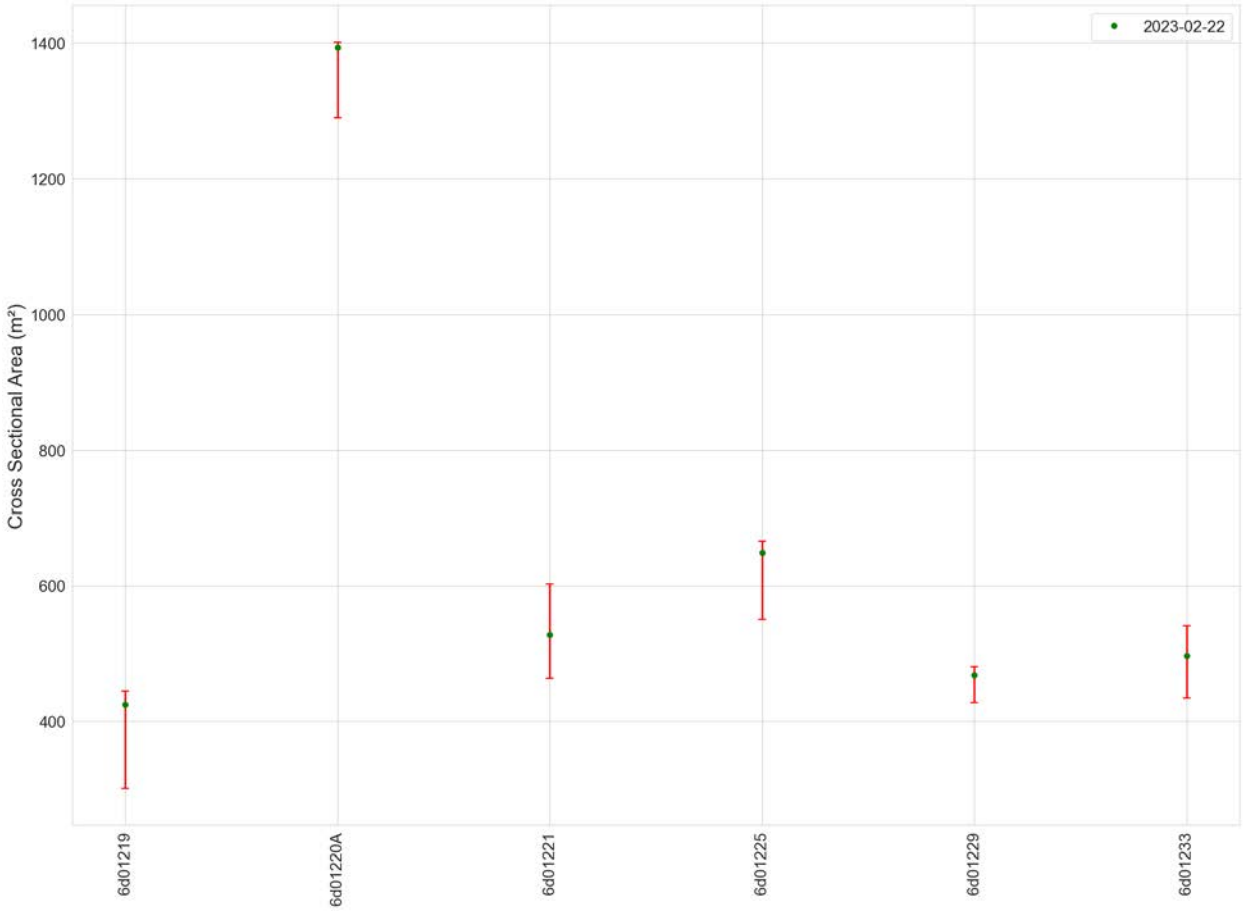


Figure 6 - Cross-sectional area of each interim profile, comparing the current area of the profile (green dot), with the maximum and minimum values (red error bar) recorded between 2007 and 2023.

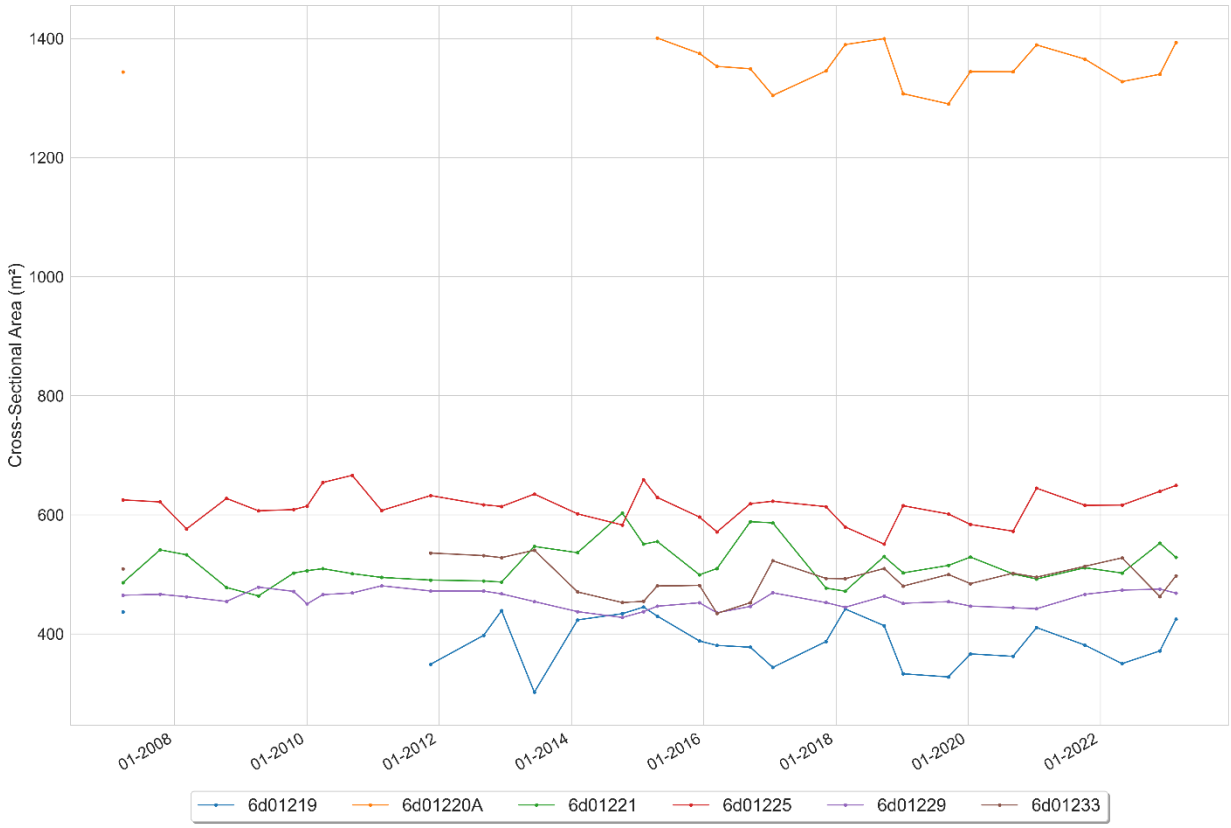


Figure 7 - Cross-sectional area of each interim profile, comparing the values recorded during each interim and baseline survey between 2007 and 2023.

3.2 LiDAR Data Analysis

There has been a total of 12 LiDAR flights captured at Pentewan since 2007.

3.2.1 Difference Models

Difference models between each epoch of LiDAR data are presented here. Accretion and erosion values observed behind the dune system can be attributable to noise in the filtered LiDAR data or man-made changes in elevation and should be dismissed as such.

03/2007 to 03/2022 – Figure 8 shows the difference in elevation between the first filtered LiDAR data from 2007 compared to the most recent, captured in 2022. The plot shows a large band of accretion across the entire upper beach face with the largest increase along the exit of the St Austell River (Fig.8), there are also small areas of erosion to the north along the low tide terrace and in front of the sailing club.

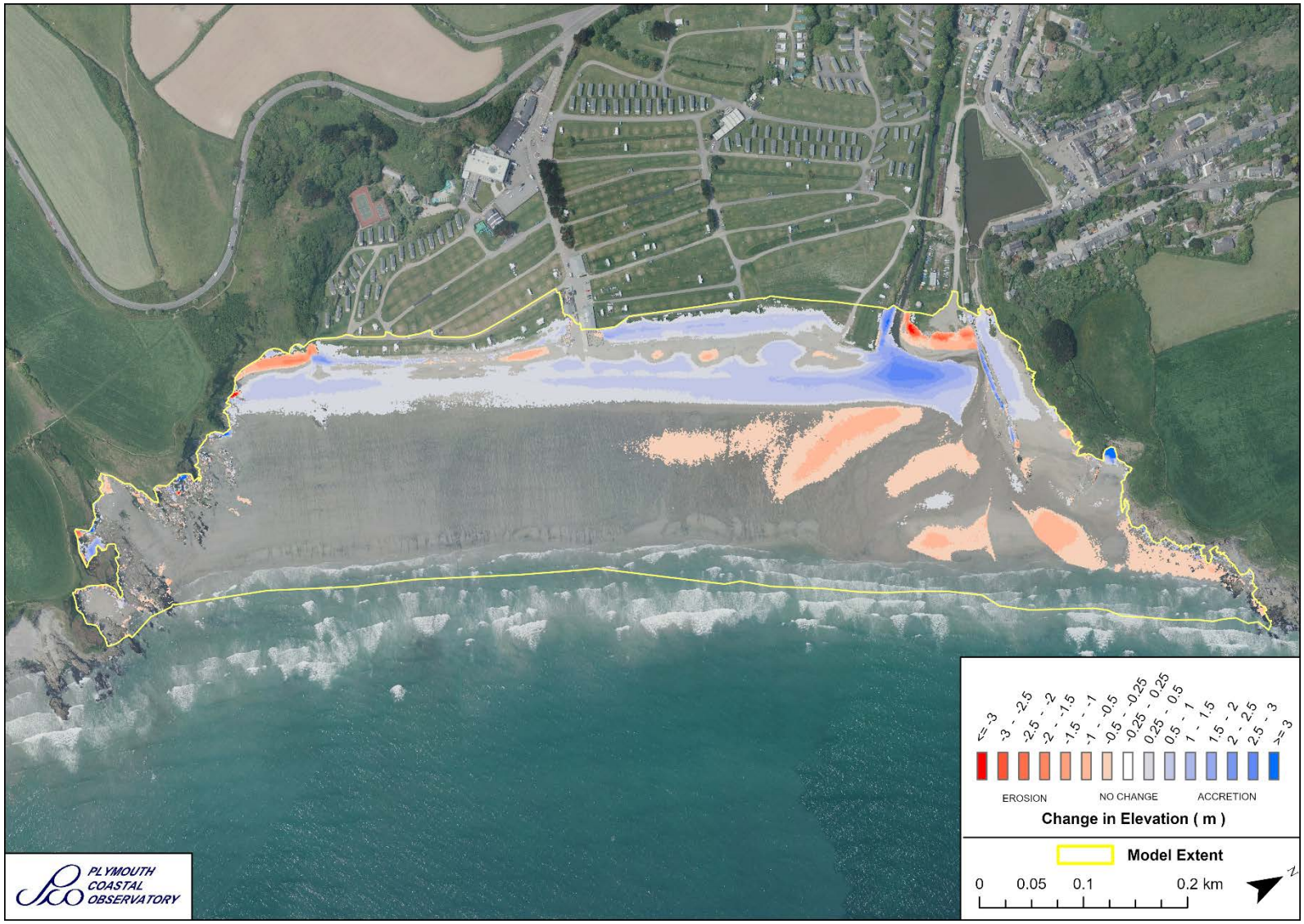


Figure 8 - Difference model indicating the changes in elevation observed between the March 2007 and March 2022 filtered LiDAR datasets within the yellow model extent.

03/2007 to 01/2008 – Figure 9 shows the differences in elevation between filtered LiDAR data from 2008 compared to 2009. There is considerable accretion around the exit of the river supplemented by erosion across the low tide terrace to the north of the beach (Fig.9). There is also a small band of minor accretion across the upper beach face along the majority of the beach frontage.

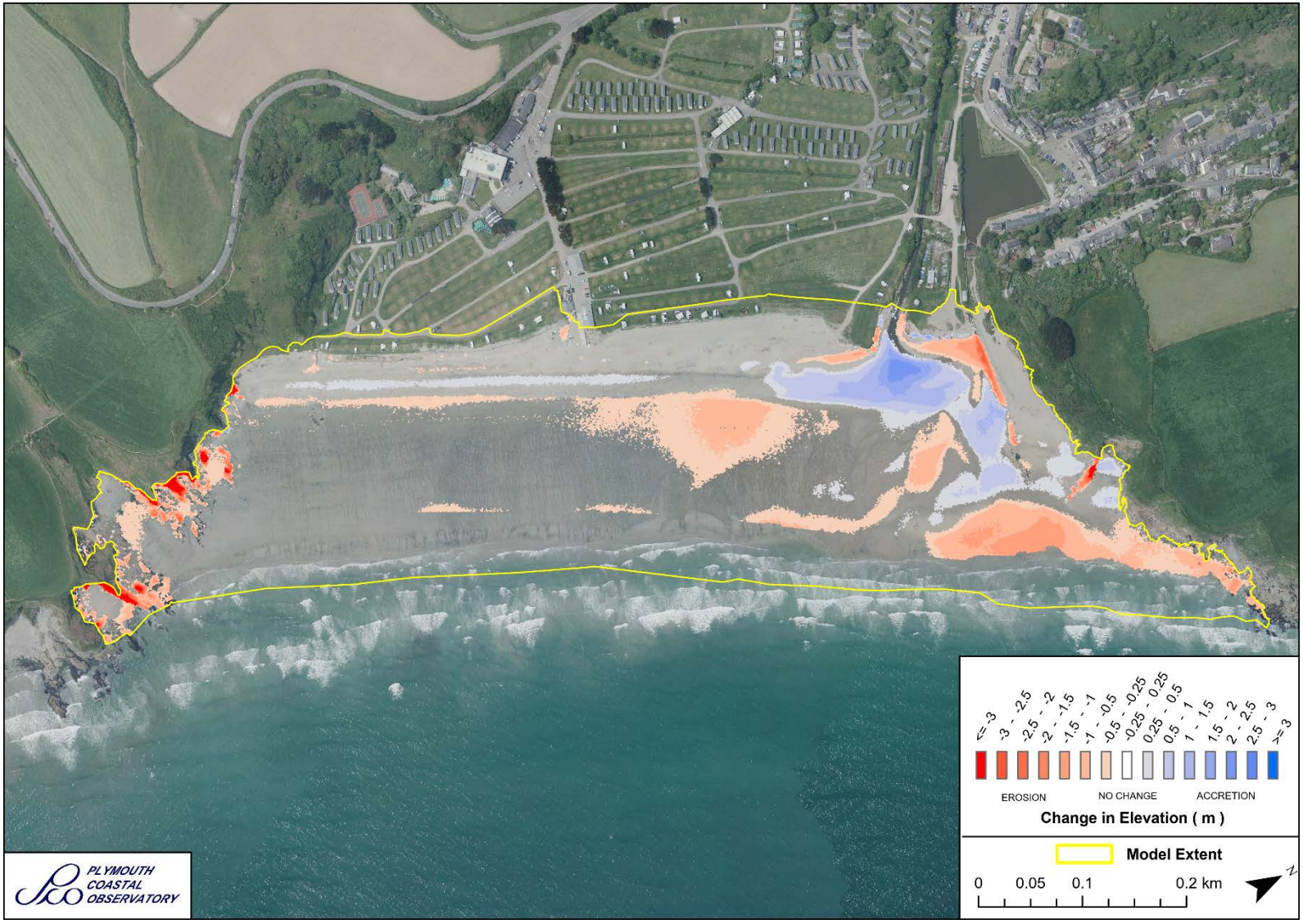


Figure 9 - Difference model indicating the changes in elevation observed between the March 2007 and January 2008 filtered LiDAR datasets within the yellow model extent.

01/2008 to 02/2009 – Figure 10 shows the differences in elevation between filtered LiDAR data from 2008 compared to 2009. There is a mixture of accretion and erosion across the entire beach, with the majority of accretion observed toward the upper beach face and subsequent erosion to the north along the low-tide terrace (Fig.10).

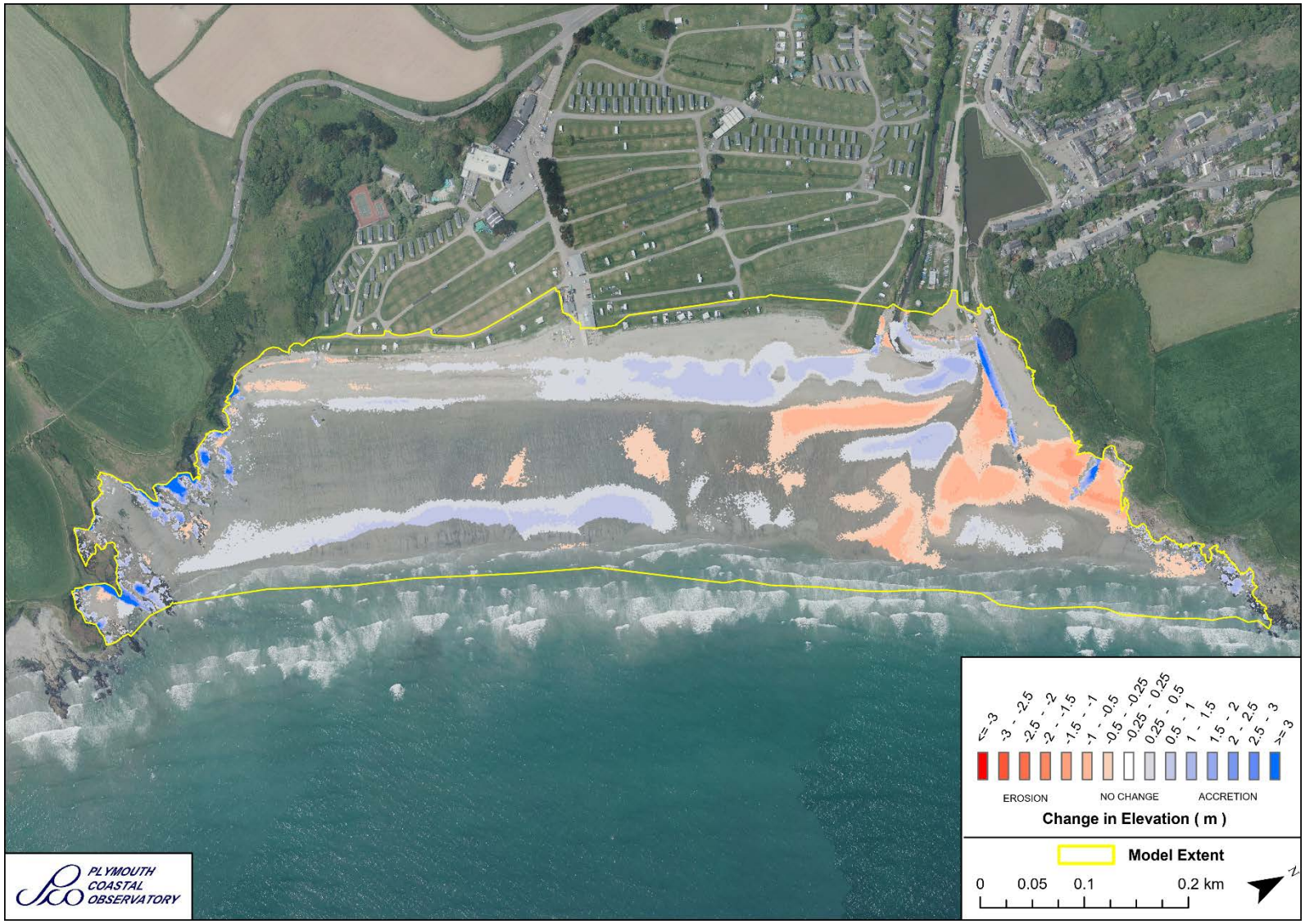


Figure 10 - Difference model indicating the changes in elevation observed between the January 2008 and February 2009 filtered LiDAR datasets within the yellow model extent.

02/2009 to 10/2009 – Figure 11 shows the differences in elevation between filtered LiDAR data from spring 2009 compared to autumn 2009. There is a band of accretion along the upper beach face to the south and also to the north of the beach along the low tide terrace, erosion was observed along the upper beach face to the north of the beach along the exit of the river.

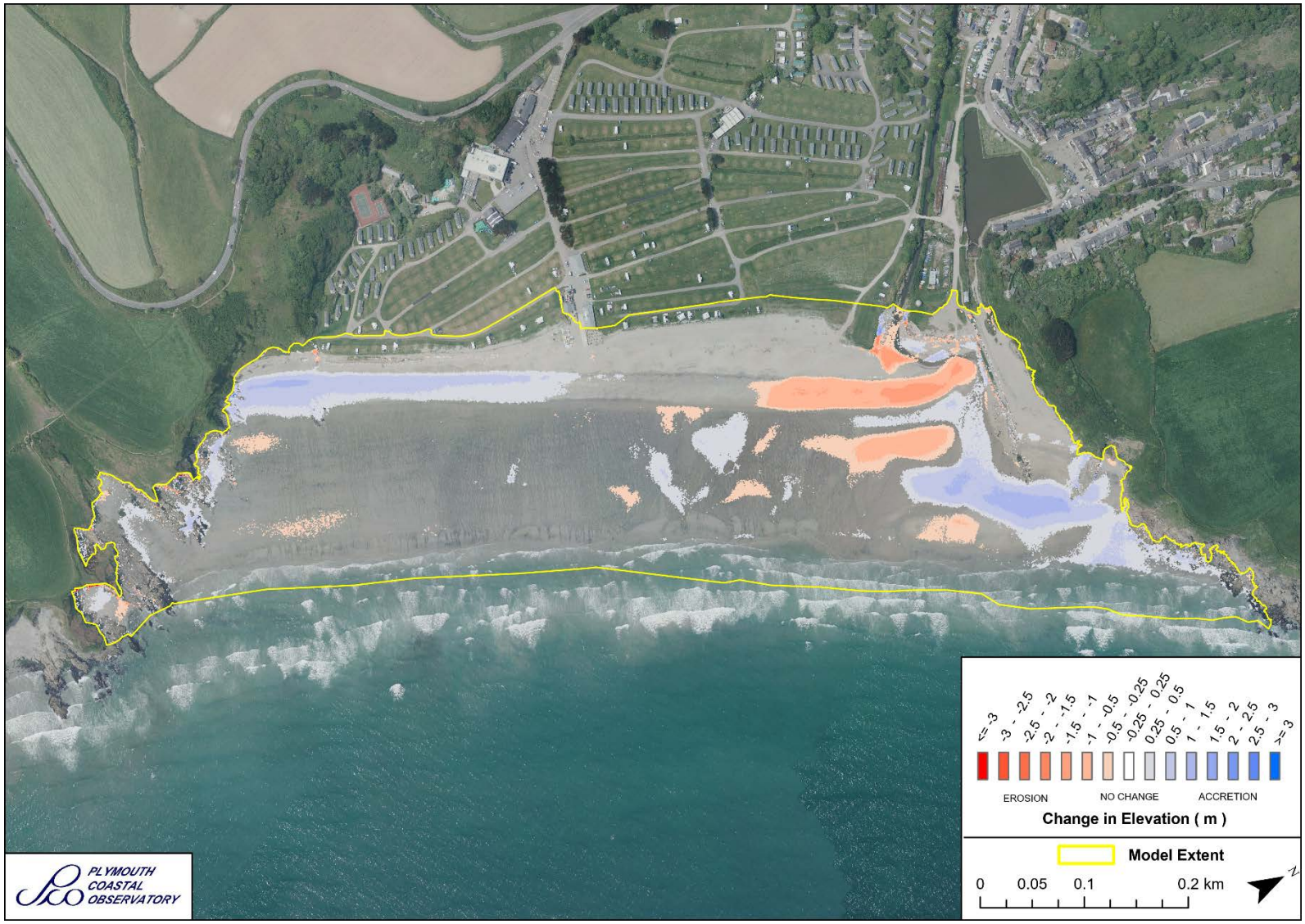


Figure 11 – Difference model indicating the changes in elevation observed between the February 2009 and October 2009 filtered LiDAR datasets within the yellow model extent.

10/2009 to 01/2011 - Figure 12 shows the differences in elevation between filtered LiDAR data from autumn 2009 compared to spring 2011. There had been considerable change in the beach volume, with erosion observed along the majority upper beach face and to the north of the beach along the low tide terrace, with a reduced level of accretion along the low tide terrace (Fig.12).

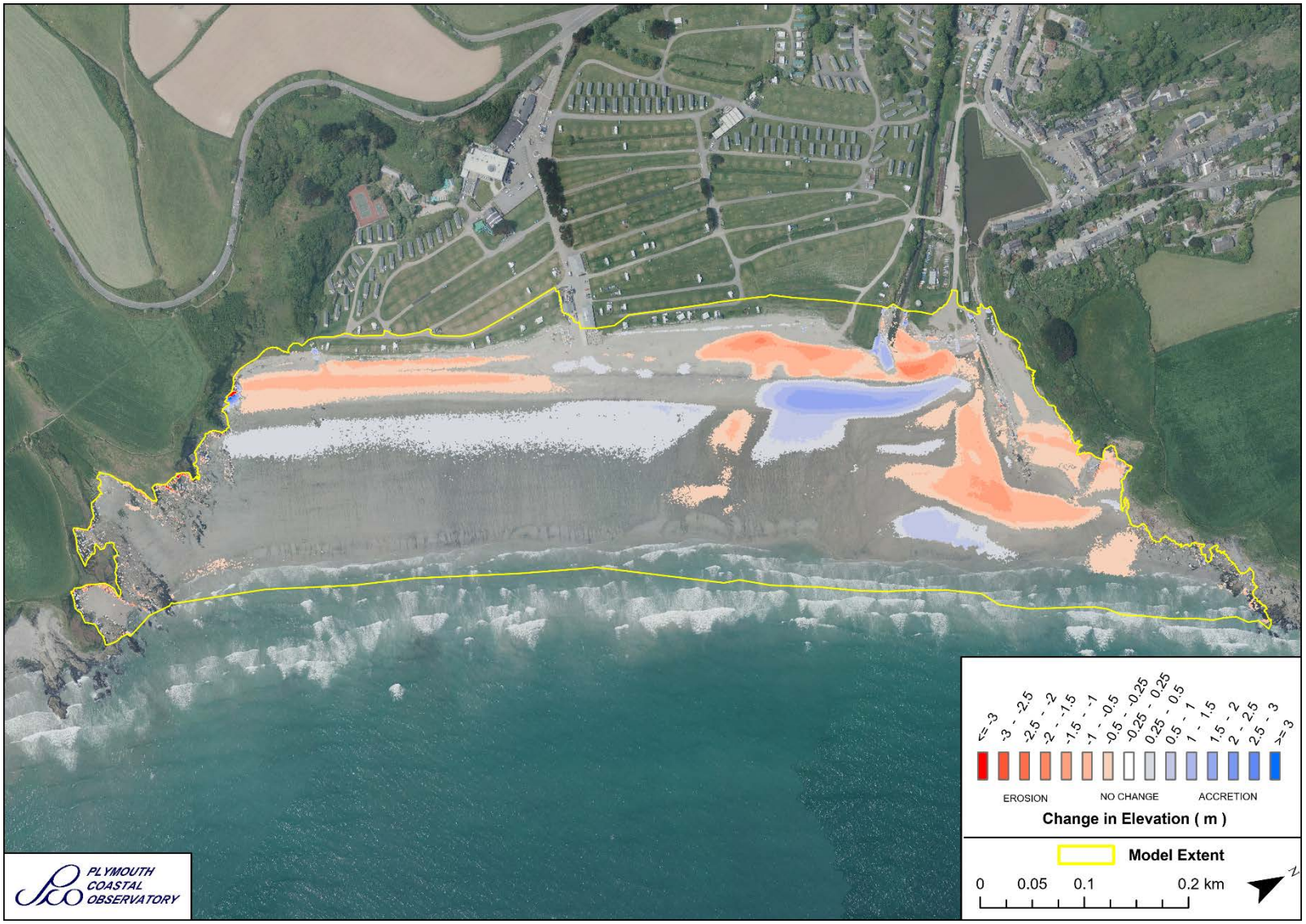


Figure 12 - Difference model indicating the changes in elevation observed between the October 2009 and January 2011 filtered LiDAR datasets within the yellow model extent.

01/2011 to 03/2012 - Figure 13 shows the differences in elevation between filtered LiDAR data from 2011 compared to 2012. There is minimal overall change observed across the majority of the beach, with a mixture of accretion and erosion pockets primarily to the north across the low tide terrace.

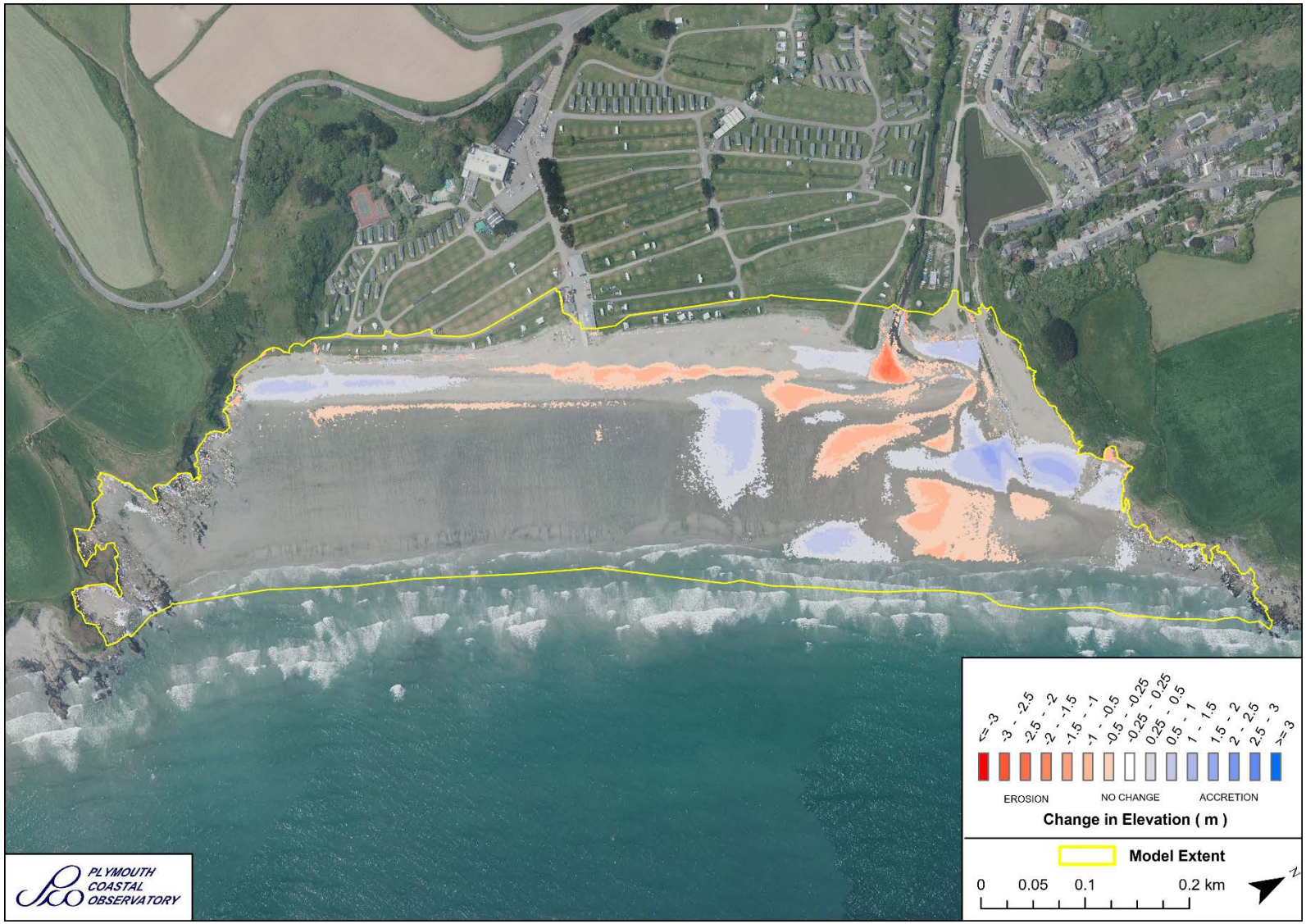


Figure 13 - Difference model indicating the changes in elevation observed between the January 2011 and March 2012 filtered LiDAR datasets within the yellow model extent.

03/2012 to 05/2014 - Figure 14 shows the differences in elevation between filtered LiDAR data from 2012 compared to 2014. There is considerable erosion observed across the entire upper beach face and along the low tide terrace to the south, indicating the impact of the 2013/14 winter storm season (Fig.14). There are some areas to the north of the beach which showed areas of accretion suggesting that there was some longshore transport from south to north along the predominant south-westerly wave direction.

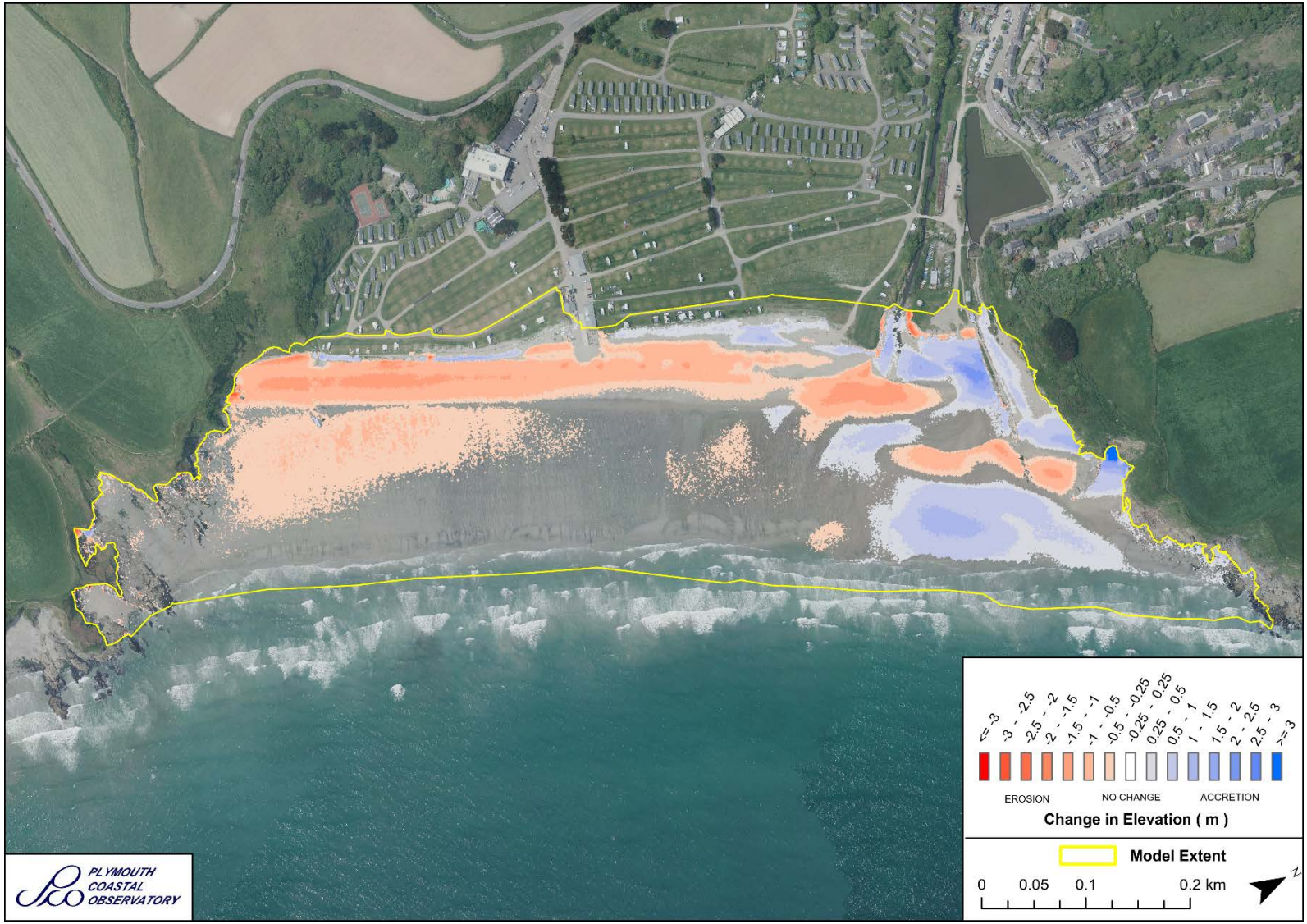


Figure 14 - Difference model indicating the changes in elevation observed between the March 2012 and May 2014 filtered LiDAR datasets within the yellow model extent.

05/2014 to 02/2016 - Figure 15 shows the differences in elevation between filtered LiDAR data from 2014 compared to 2016. There is minimal change observed across the lower beach to the south, with the majority of erosion observed along the exit of the river to the north. There is also a small band of accretion along the upper beach face (Fig.15).

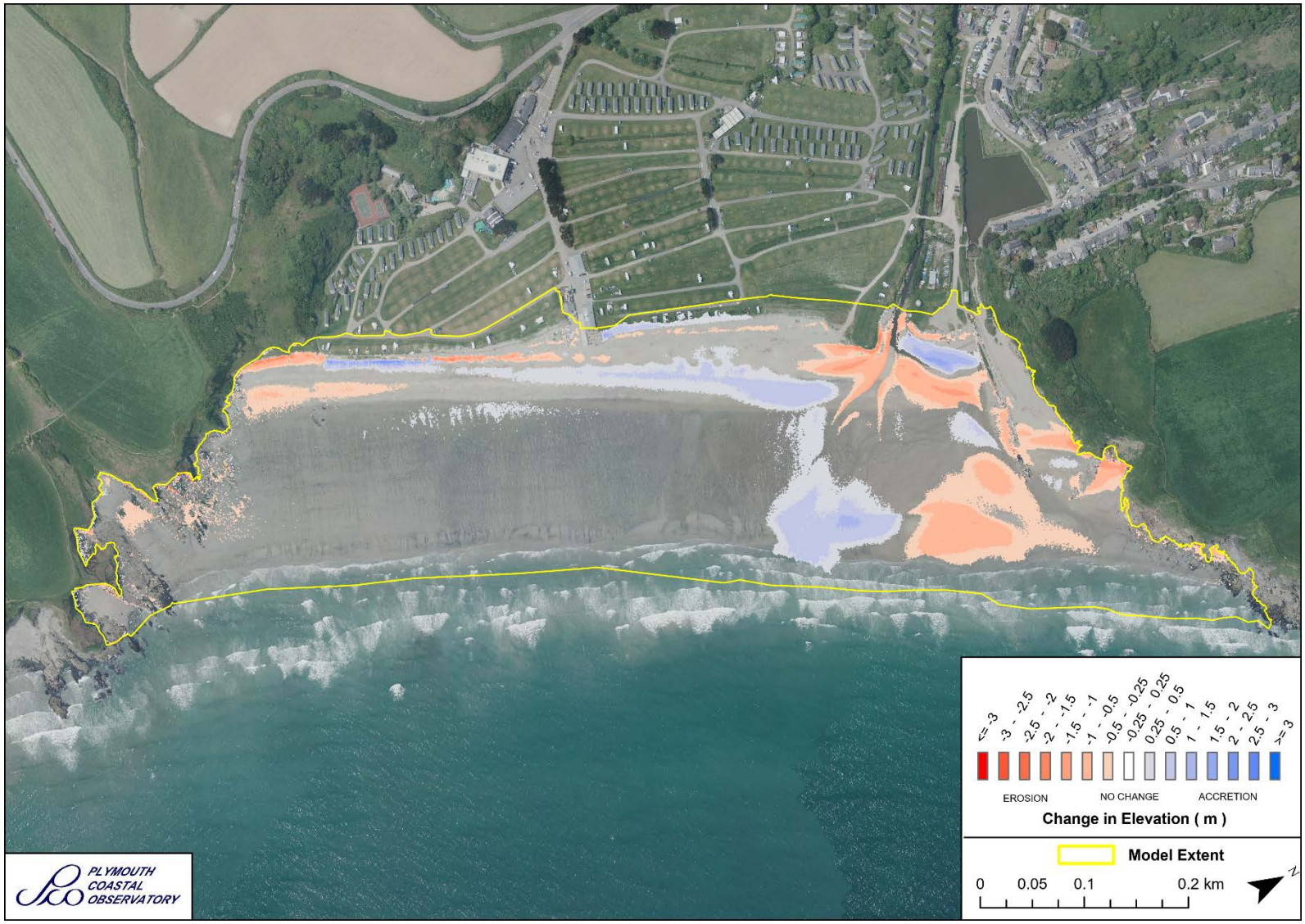


Figure 15 - Difference model indicating the changes in elevation observed between the February 2014 and February 2016 filtered LiDAR datasets within the yellow model extent.

02/2016 to 03/2017 - Figure 16 shows the differences in elevation between filtered LiDAR data from 2016 compared to 2017. There is accretion observed to the south of the beach across the low tide terrace and along the upper beach face, with a very high area of accretion along the exit of the St Austell River (Fig.16). Smaller areas of erosion can be observed primarily to the north of the beach along the low tide terrace.

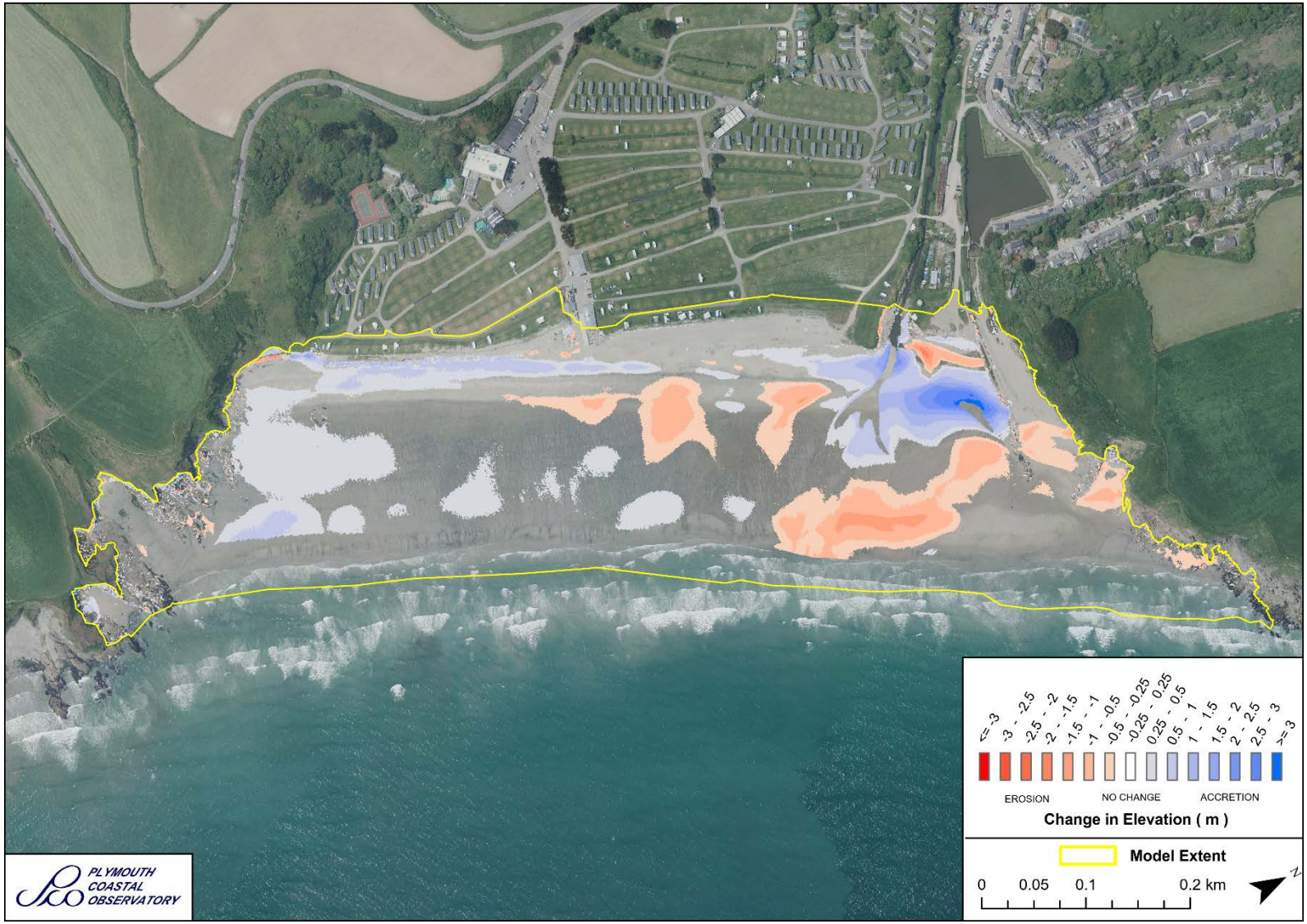


Figure 16 - Difference model indicating the changes in elevation observed between the February 2016 and March 2017 filtered LiDAR datasets within the yellow model extent.

03/2017 to 04/2019 - Figure 17 shows the differences in elevation between filtered LiDAR data from 2017 compared to 2019. There is considerable change observed between the two LiDAR datasets, with accretion primarily occurring along the upper beach face of the entire area compensated by a larger band of erosion along the low tide terrace and particularly along the northern exit of the St Austell River.

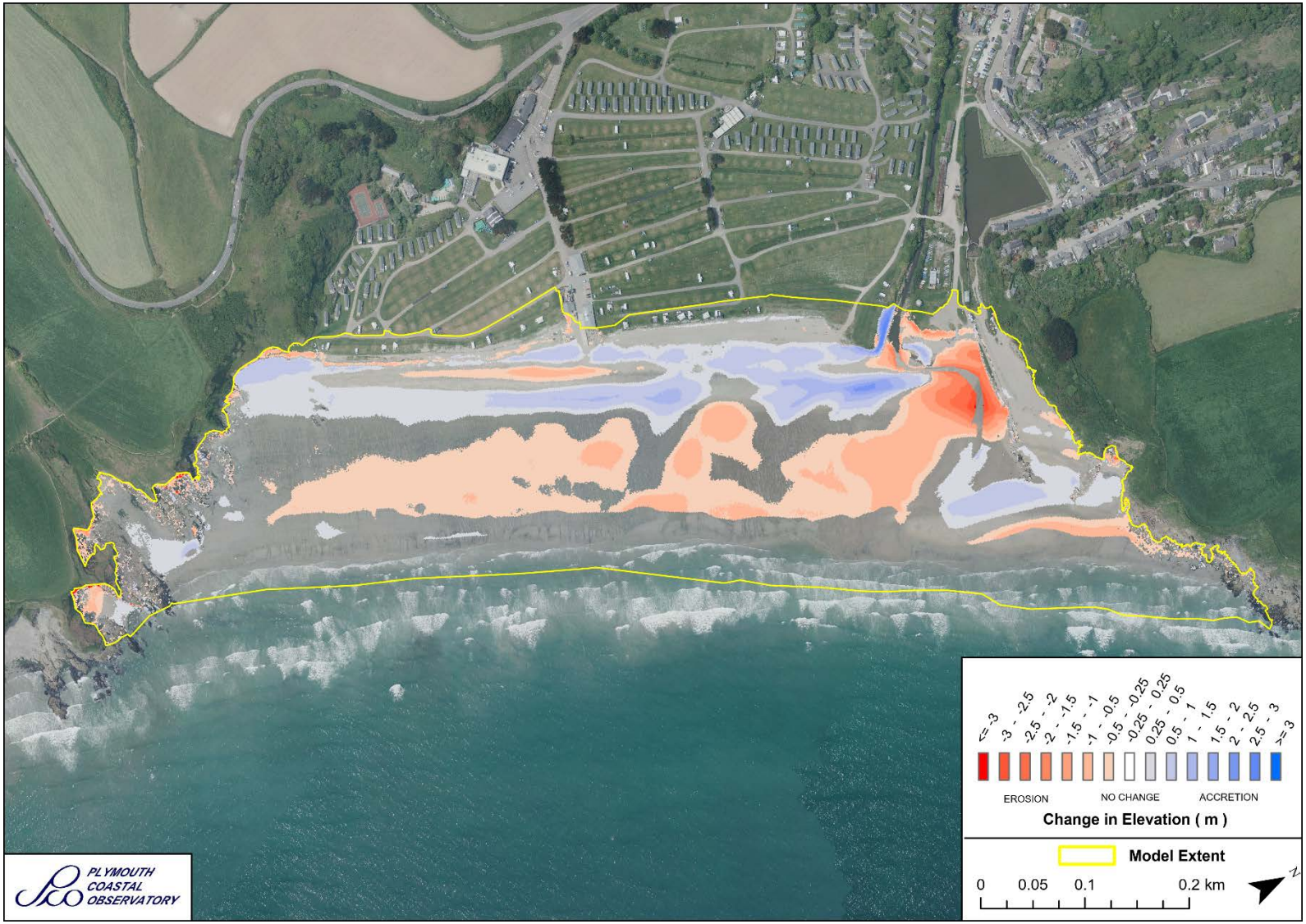


Figure 17 - Difference model indicating the changes in elevation observed between the March 2017 and April 2019 filtered LiDAR datasets within the yellow model extent.

04/2019 to 09/2020 - Figure 18 shows the differences in elevation between filtered LiDAR data from 2019 compared to 2020. A mix of erosion and accretion can be observed across the beach with loss of material observed along the beach foot and a gain in material along the upper beach face to the south and along the river mouth (Fig.18).

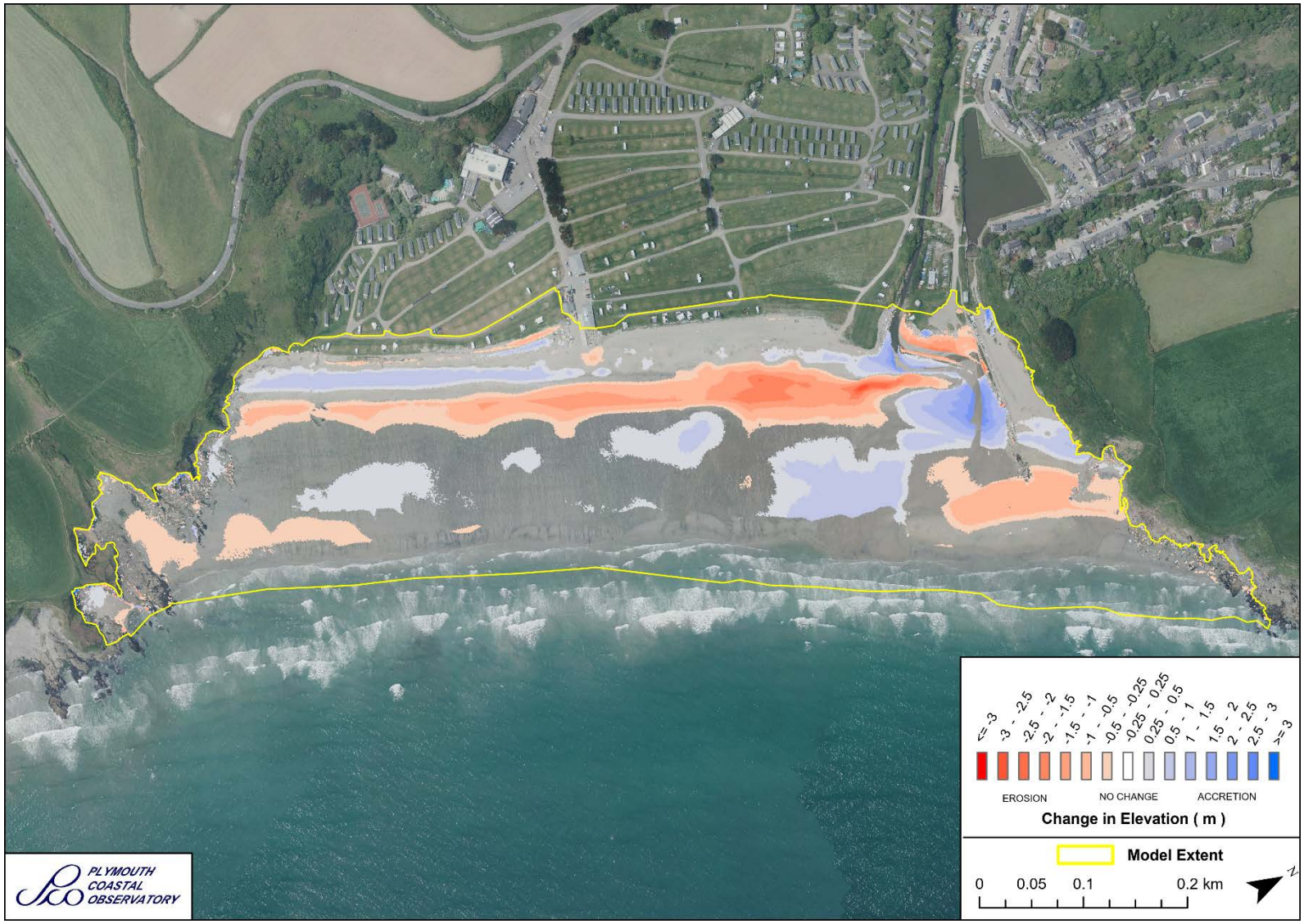


Figure 18 - Difference model indicating the changes in elevation observed between the April 2019 and September 2020 filtered LiDAR datasets within the yellow model extent.

09/2020 to 03/2022 - Figure 19 shows the differences in elevation between filtered LiDAR data from 2020 compared to 2022. The data suggest primarily accretion between the two datasets with a band of material increase along the beach toe with a smaller area of erosion along the mouth of the river (Fig.19).

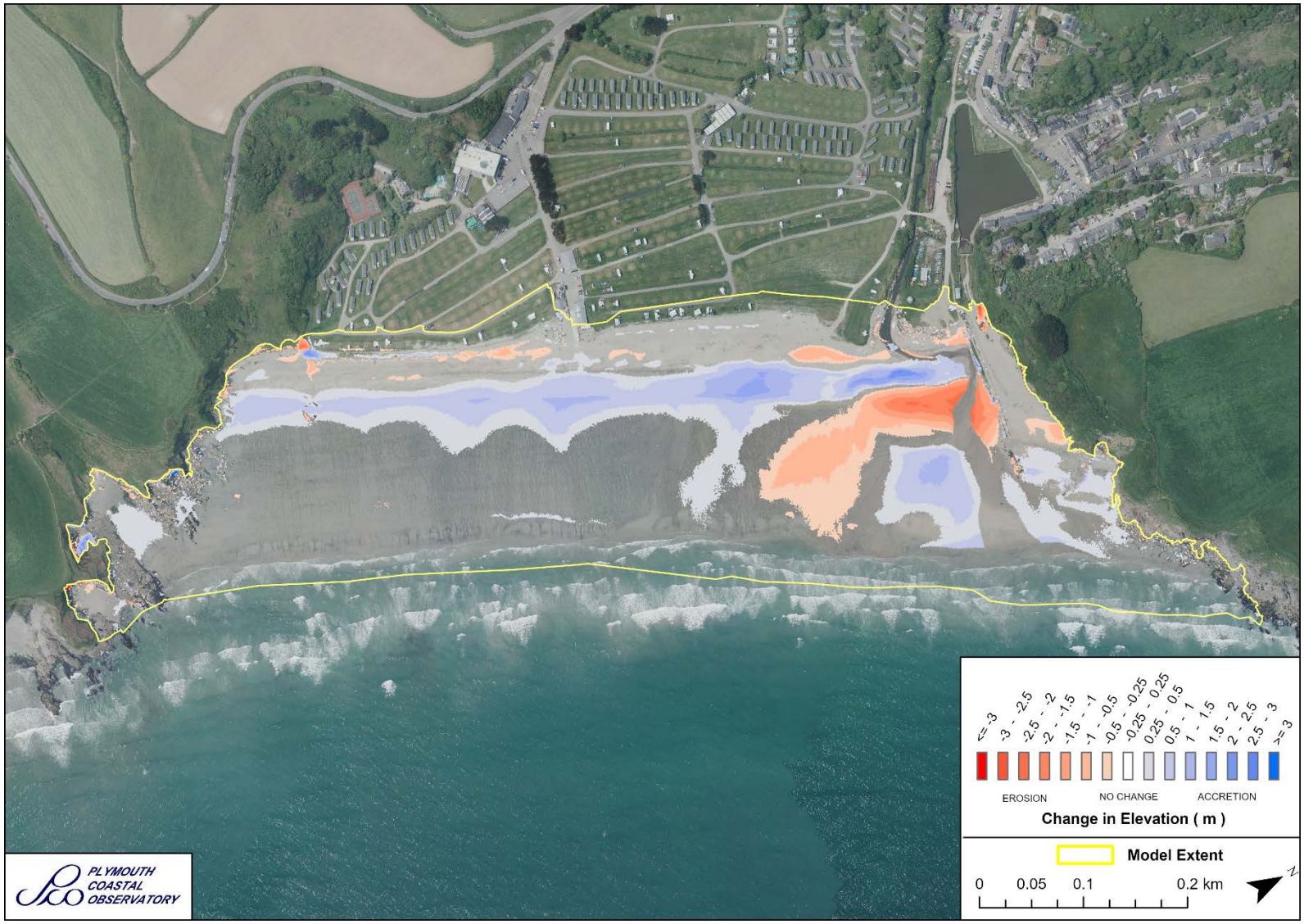


Figure 19 - Difference model indicating the changes in elevation observed between the September 2020 and March 2022 filtered LIDAR datasets within the yellow model extent.

3.2.2 Beach and Dune Volume Extraction

Surface volume extracted from each available LiDAR dataset from the Mobile Zone above the MHWS contour (2.35 m OD) are shown in Table 1. The Mobile Zone volume has shown a gradual accretional trend between 2007 and 2022, with the lowest volume recorded during the May 2014 survey (47,712 m^3) and the highest volume recorded during the October 2009 survey (58,914 m^3) (Fig.20).

Surface volume extracted from each LiDAR dataset from the Beach Zone above the MLWS contour (-2.35 m OD) are also shown in Table 1. Surface volume from the Beach Zone at Pentewan has also shown a gradual accretional trend between 2007 and 2022, however is disconnected to the Mobile Zone (Fig.21). In contrast to the Mobile Zone, the highest surface volume for the Beach Zone was recorded during the 2014 LiDAR survey at 356,385 m^3 (Fig.21), agreeing with the difference model shown in Figure 14. In agreement with the topographic data, the Beach Zone shows minimal change in surface volume between flights, with recorded beach volumes differing by 12% between the lowest value (315,869 m^3 in 2007) and the highest value (356,385 m^3 in 2014).

Table 1 – Surface volume values (m^3) extracted from all available filtered LiDAR datasets for the Mobile Zone above MHWS (2.35 m OD) and for the Beach Zone above MLWS (-2.35).

Date	Mobile Zone Volume (m^3)	Beach Zone Volume (m^3)
03/2007	50,706	315,869
01/2008	49,853	337,829
02/2009	56,998	320,553
10/2009	58,914	343,662
01/2011	52,840	352,216
03/2012	52,632	354,887
05/2014	47,712	356,385
02/2016	48,085	344,950
03/2017	54,518	335,809
04/2019	57,203	355,117
09/2020	58,571	327,827
03/2022	52,364	330,194

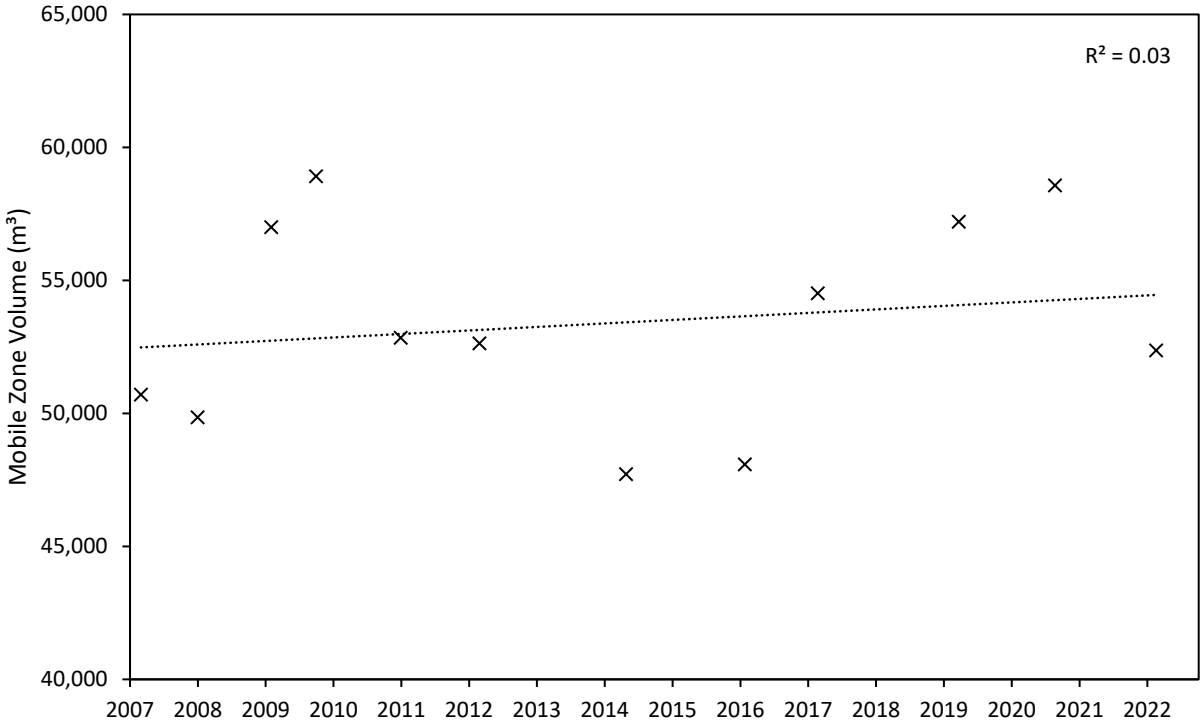


Figure 20 – Plot indicating beach volume (m^3) recorded in the Mobile Zone above MHWS (2.35 m OD) for each filtered LiDAR datasets between 2007 and 2022.

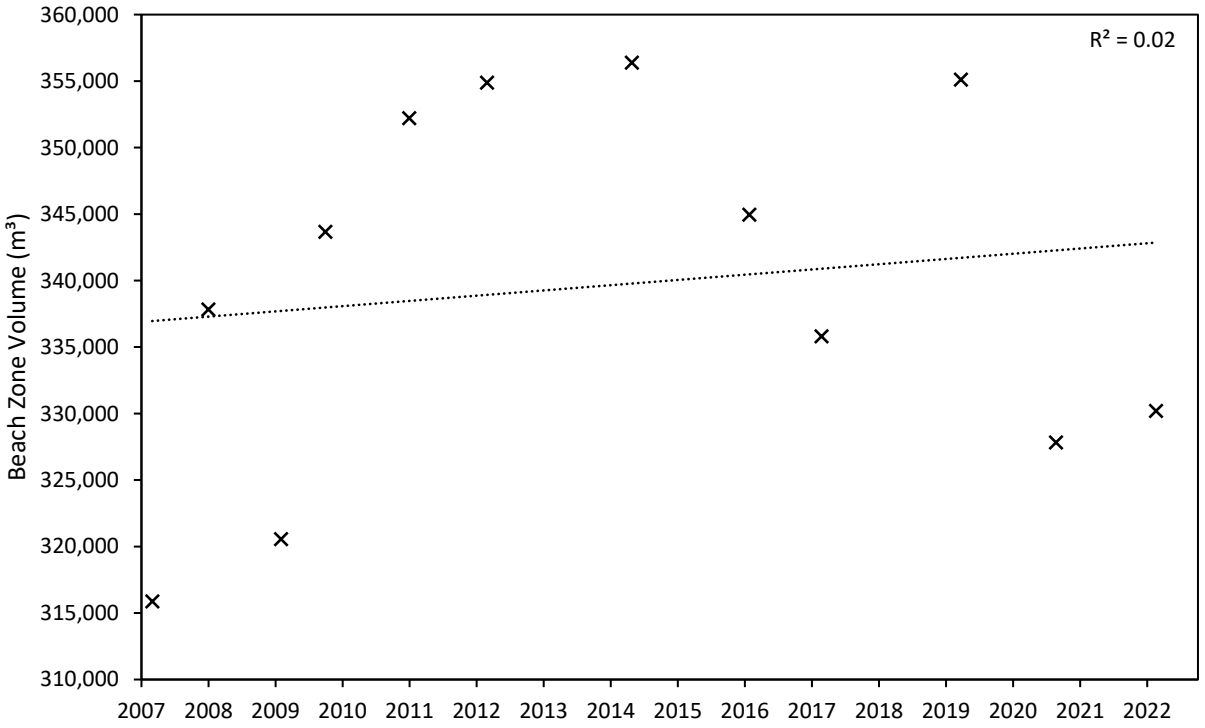


Figure 21 - Plot indicating beach volume (m^3) recorded in the Mobile Zone above MLWS (-2.35 m OD) for each filtered LiDAR datasets between 2007 and 2022.

3.2.3 Contour Comparison

Figure 22 indicates the Mean Sea Level (MSL) and Dune Toe contours from 2007, 2014, 2019 and 2022 LiDAR datasets, projected onto aerial imagery captured in 2022. MSL contours agree with CPA and volumetric data, indicating a general widening of the beach from 2007 to 2022, not counting the implications of the river mouth (Fig.22). The same is true of the dune toe contour (Fig.22), with the 2022 contour showing a widening of the dune compared to the 2007 contour. The 2014 contour shows the narrowest dune toe, agreeing with the mobile zone volume plot (Fig.20).

3.3 Historic Aerial Maps

Historic aerial photography captured in 1947 by the RAF, in 2001 by the Environment Agency and from 2007 onwards by the SWCM are presented here.

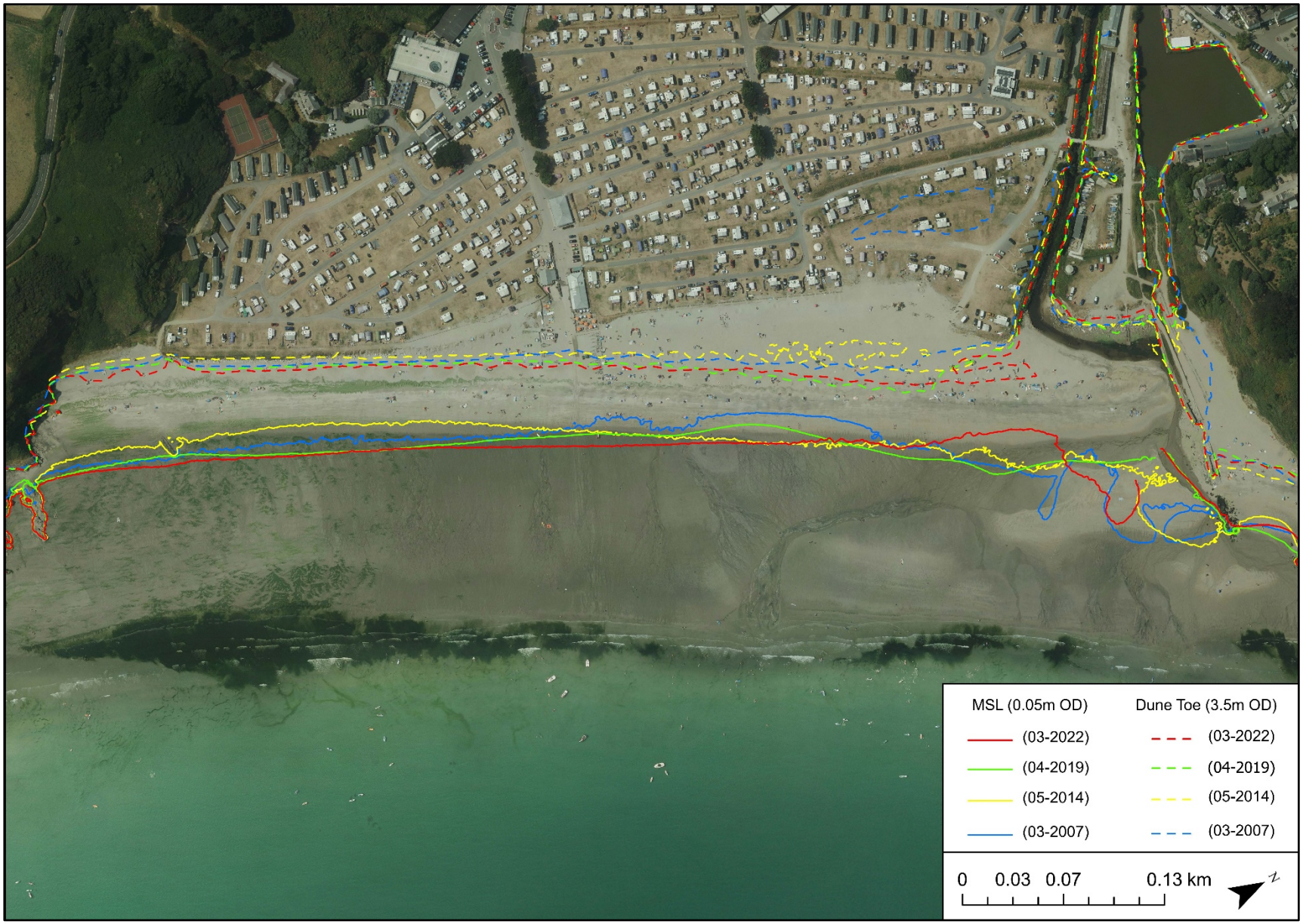


Figure 22 - Contour map indicating Mean Sea level (solid line) and Dune Toe (dashed line) extracted from 2007, 2014, 2019 and 2022 LiDAR datasets.



Figure 23 - Aerial imagery from 2001.



Figure 24 - Aerial imagery from 2007.



Figure 25 - Aerial Imagery from 2009.



Figure 26 - Aerial Imagery from 2014.



Figure 27 - Aerial Imagery from 2018.



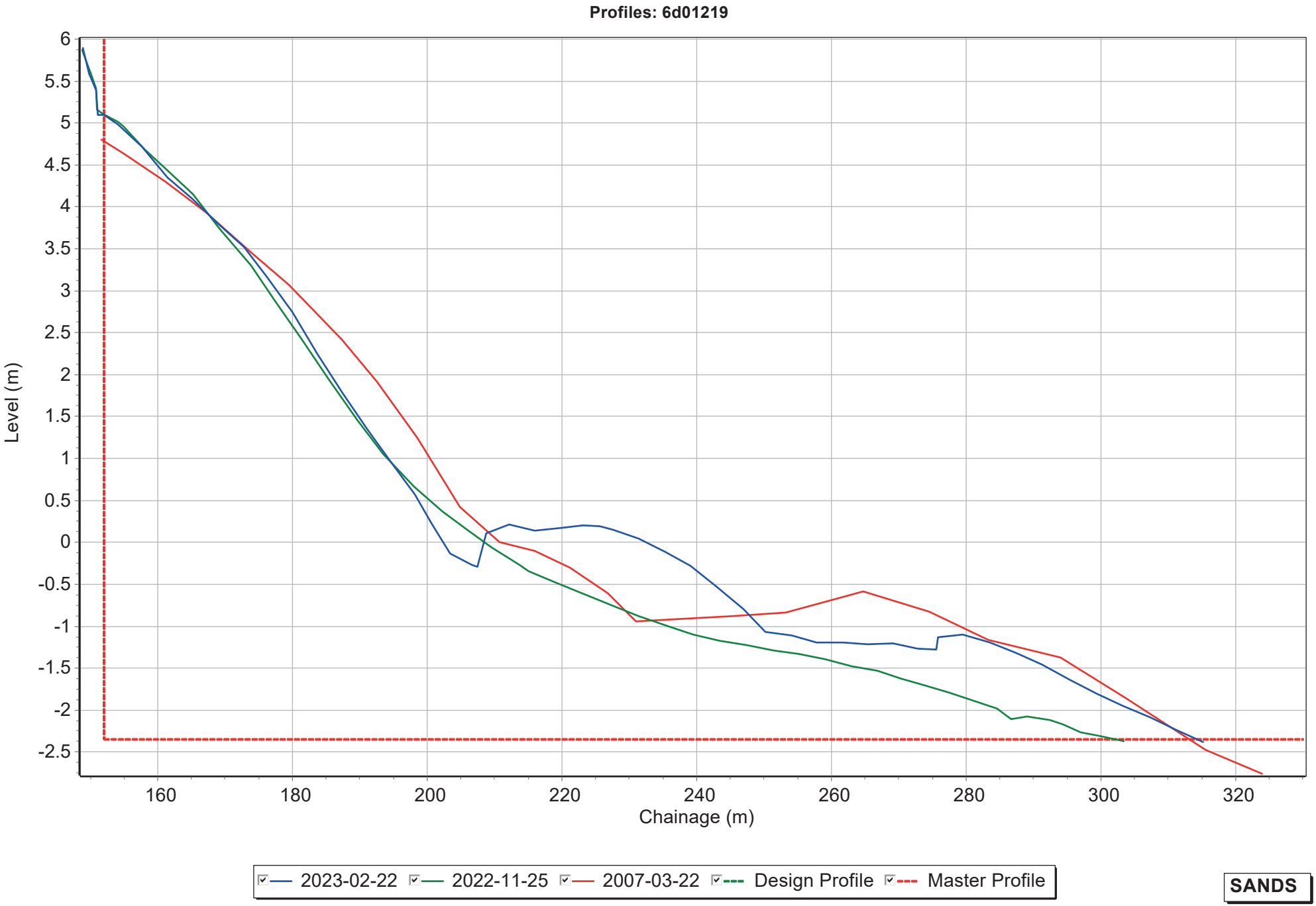
Figure 28 - Aerial Imagery from 2022.

Glossary

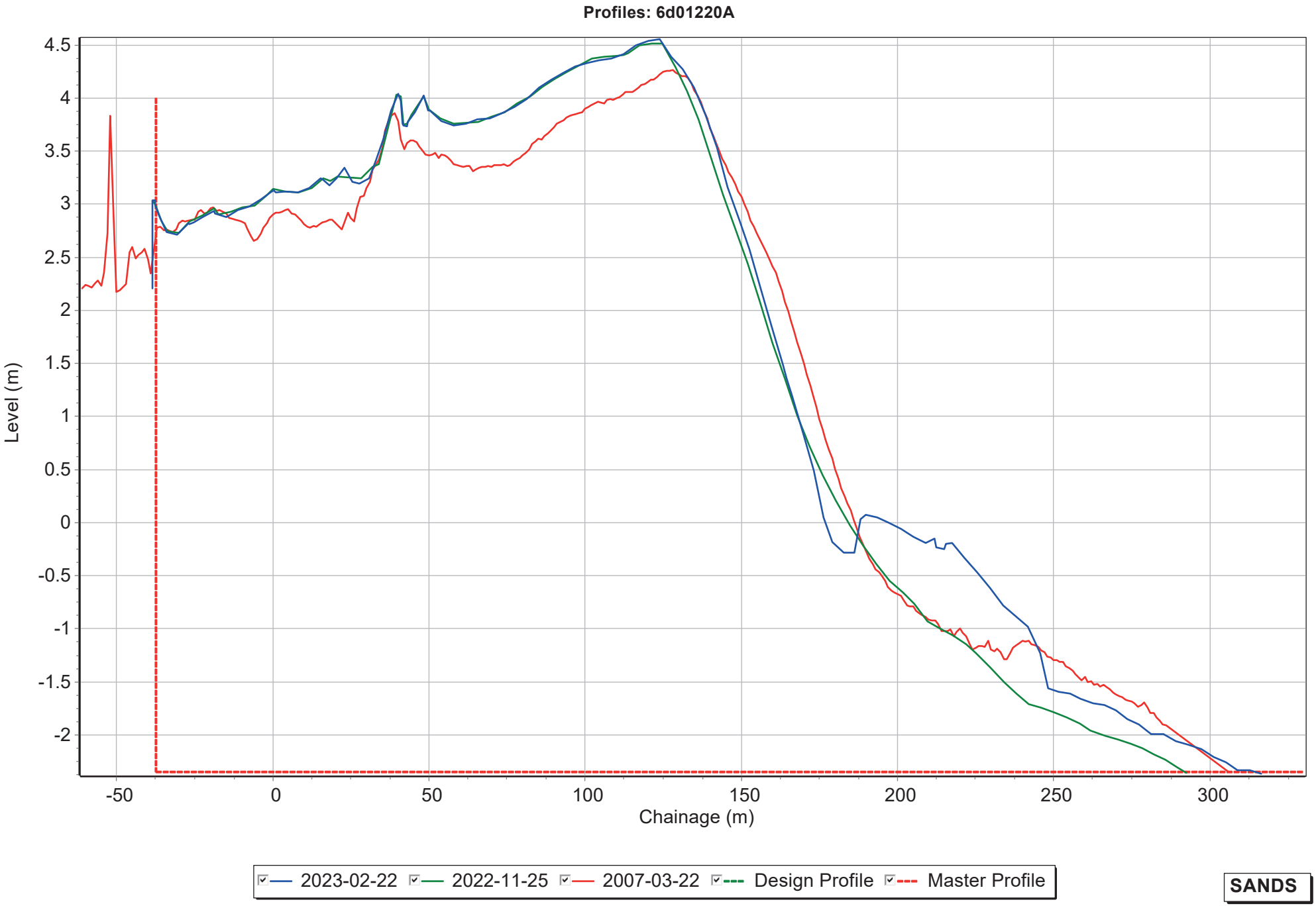
1. Accretion: The net accumulation of deposited sediment, deposited by waves, tides or current.
2. Coastal Morphodynamics: The study of changes in coastal landforms and landscapes over time.
3. Contour Analysis: Mapping of contours from LiDAR datasets to represent Mean Sea Level (MSL) and Dune Toe elevations.
4. Cross-Sectional Area (CSA): The area of a two-dimensional cross-section of a cross-shore beach profile, running between Mean Low Water Spring and the back of the beach.
5. Developed Zone: Areas of urban development built atop previously present dune systems.
6. Difference Modelling: Comparison of separate LiDAR surfaces to produce a difference model of change based on gridded spot height elevations.
7. Digital Elevation Model (DEM) and Digital Terrain Model (DTM): DEM represents the Earth's surface with all features, while DTM represents the bare earth surface, excluding vegetation and structures.
8. Embryo Dune: The earliest stage of dune growth, typically found along the seaward extent of a dune system or newly formed dune.
9. Erosion: The process by which local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and sands along the coast.
10. Fixed Zone: Area defined by permanent dune vegetation, including scrub or invasive species, denoting vegetation atop sandy soil.
11. Intertidal Bar: A ridge or mound of sand, gravel, or other sediment deposited in the intertidal zone along a shoreline.
12. LiDAR: Light Detection and Ranging, a remote sensing method that uses light in the form of a pulsed laser to measure variable distances to the Earth.
13. Mean High Water Spring (MHWS): The height of mean high-water springs is the average throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
14. Mean Low Water Spring (MLWS): The height of the mean low-water springs is the average height obtained by the two successive low waters during the same period.
15. Mobile Zone: The area including the active dune face and embryo dune that is in motion due to wind action or other factors.
16. Root-Mean-Square Error (RMSE): A measure of the differences between values predicted by a model and the observed values.
17. Tidal Range: The vertical difference between high tide and low tide during a tidal cycle.

Appendices

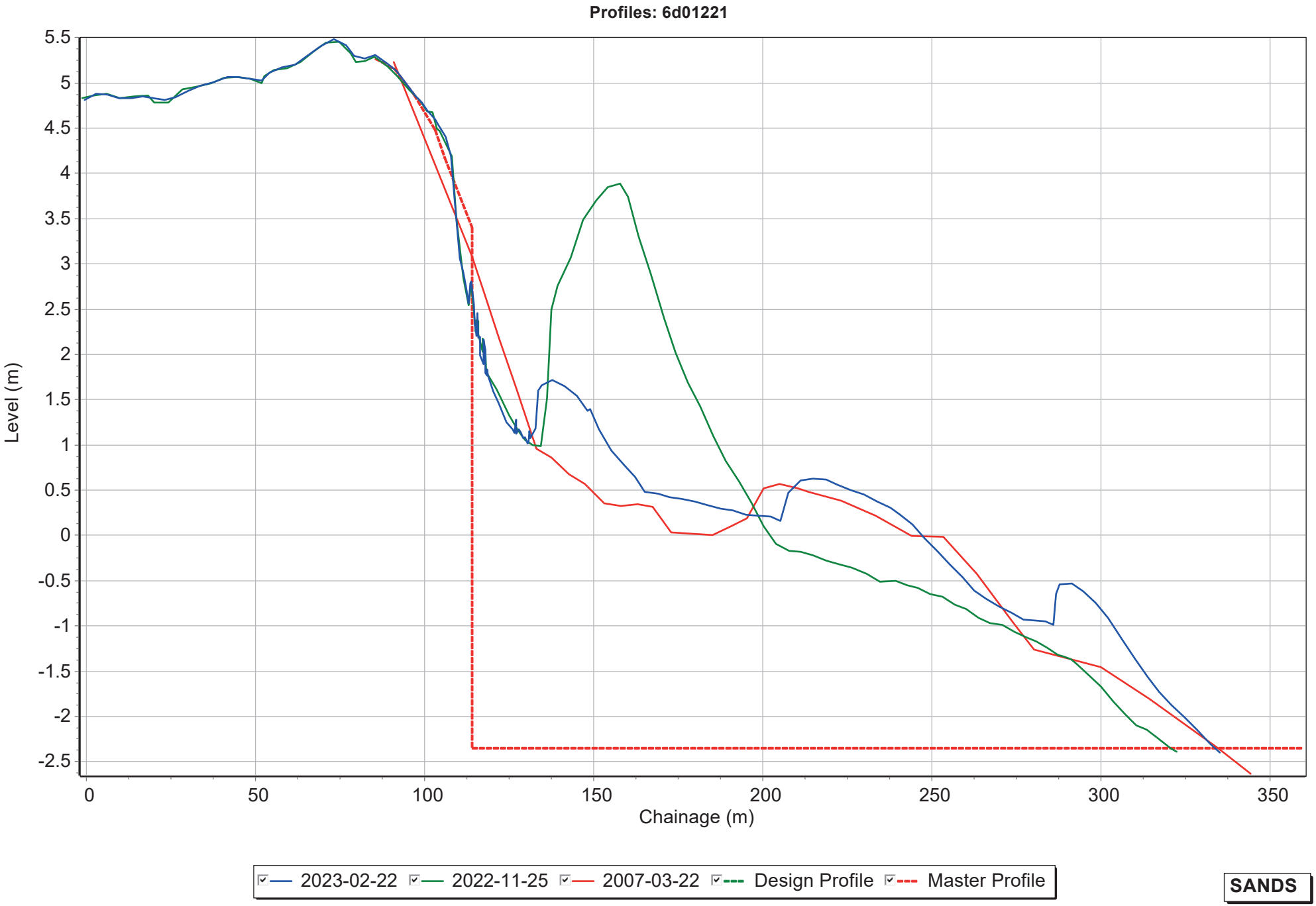
Appendix 1 – Profile charts showing the cross-shore area of each interim profile from the most recent survey (blue), second most recent survey (green) and first survey, also known as the baseline (red) at Pentewan are presented below.


Profiles: 6d01219
Level (m)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
160
180
200
220
240
260
280
300
320
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

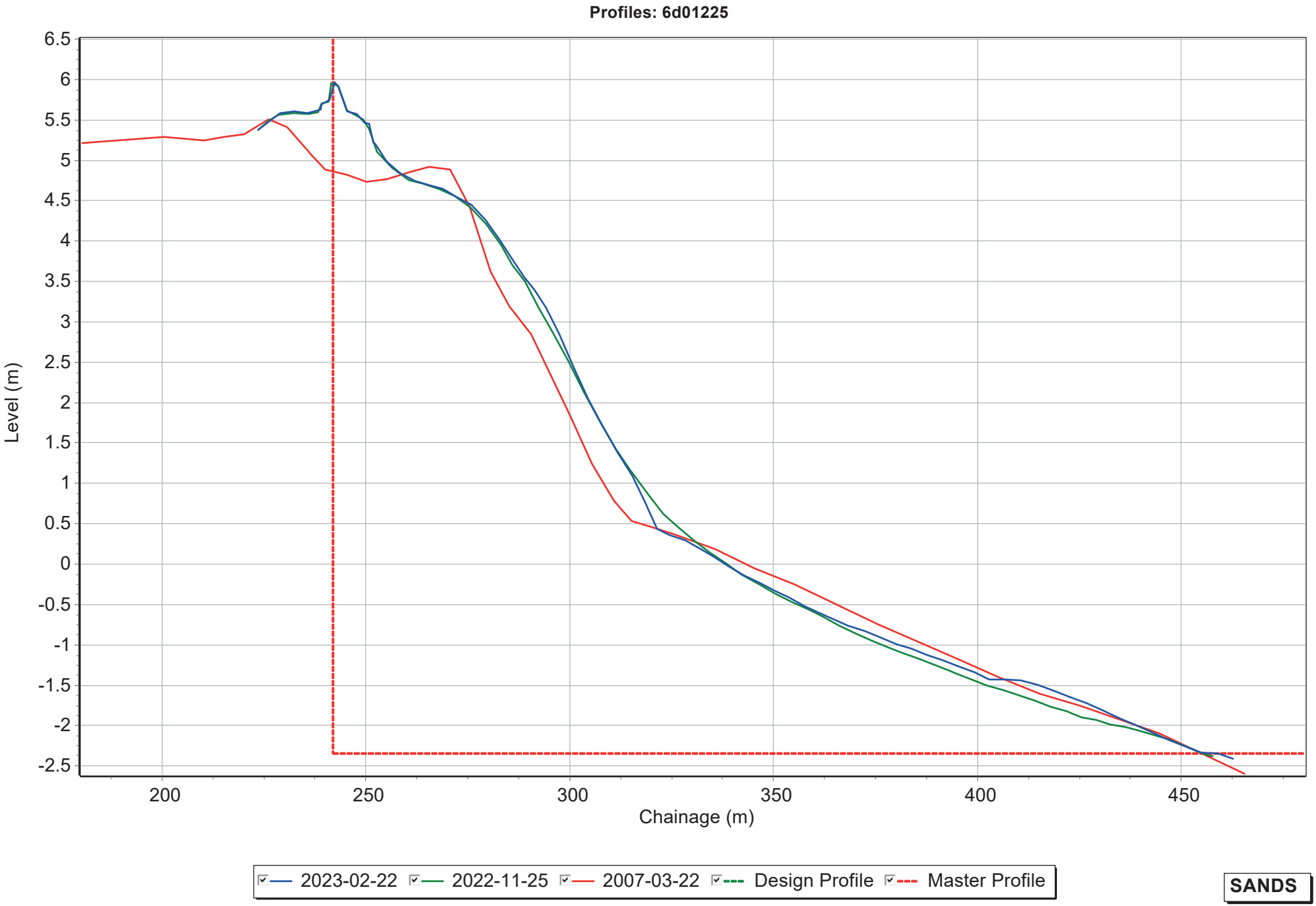
SANDS


Profiles: 6d01220A
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Level (m)
-50
0
50
100
150
200
250
300
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

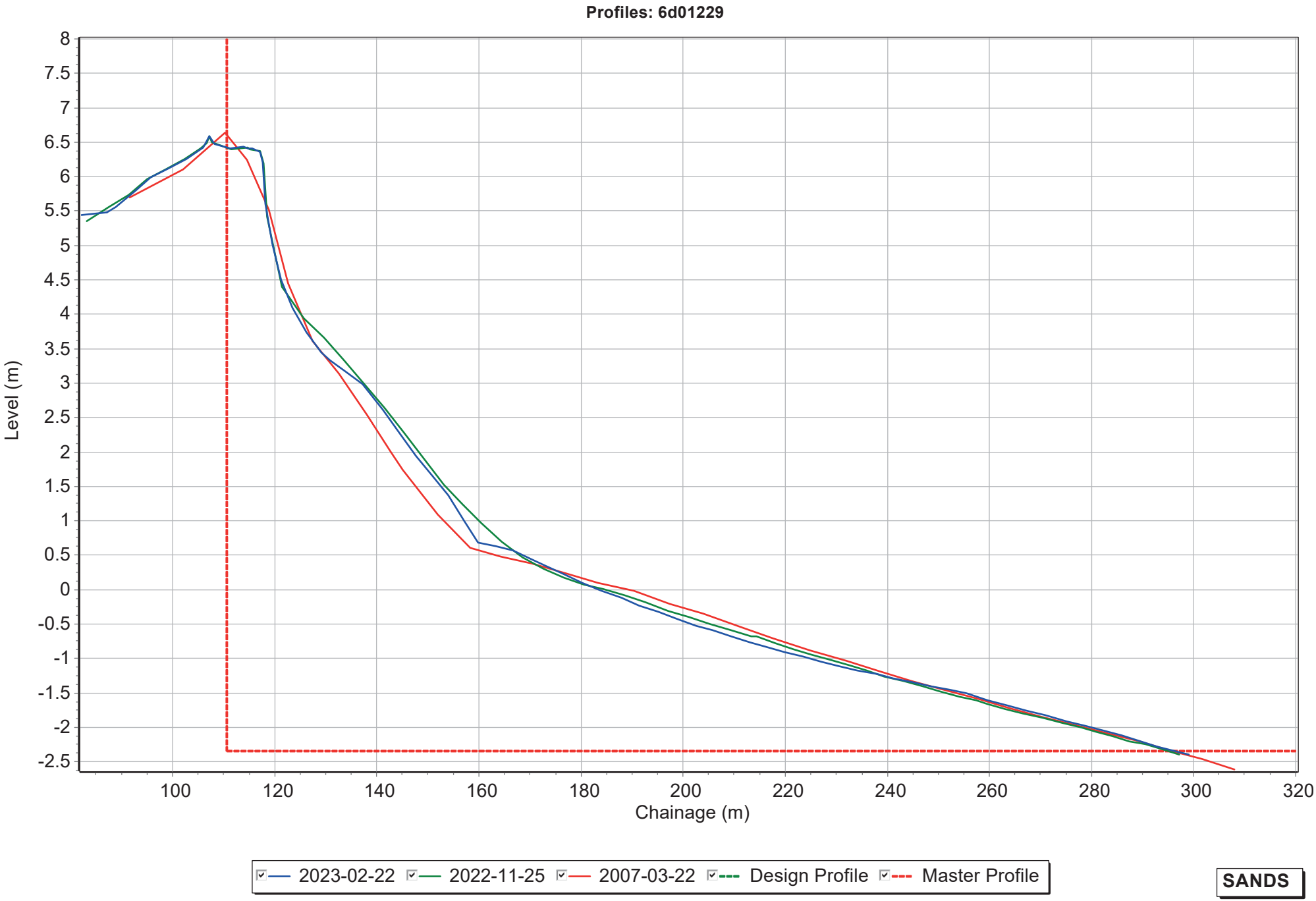
SANDS


Profiles: 6d01221
Level (m)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
50
100
150
200
250
300
350
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

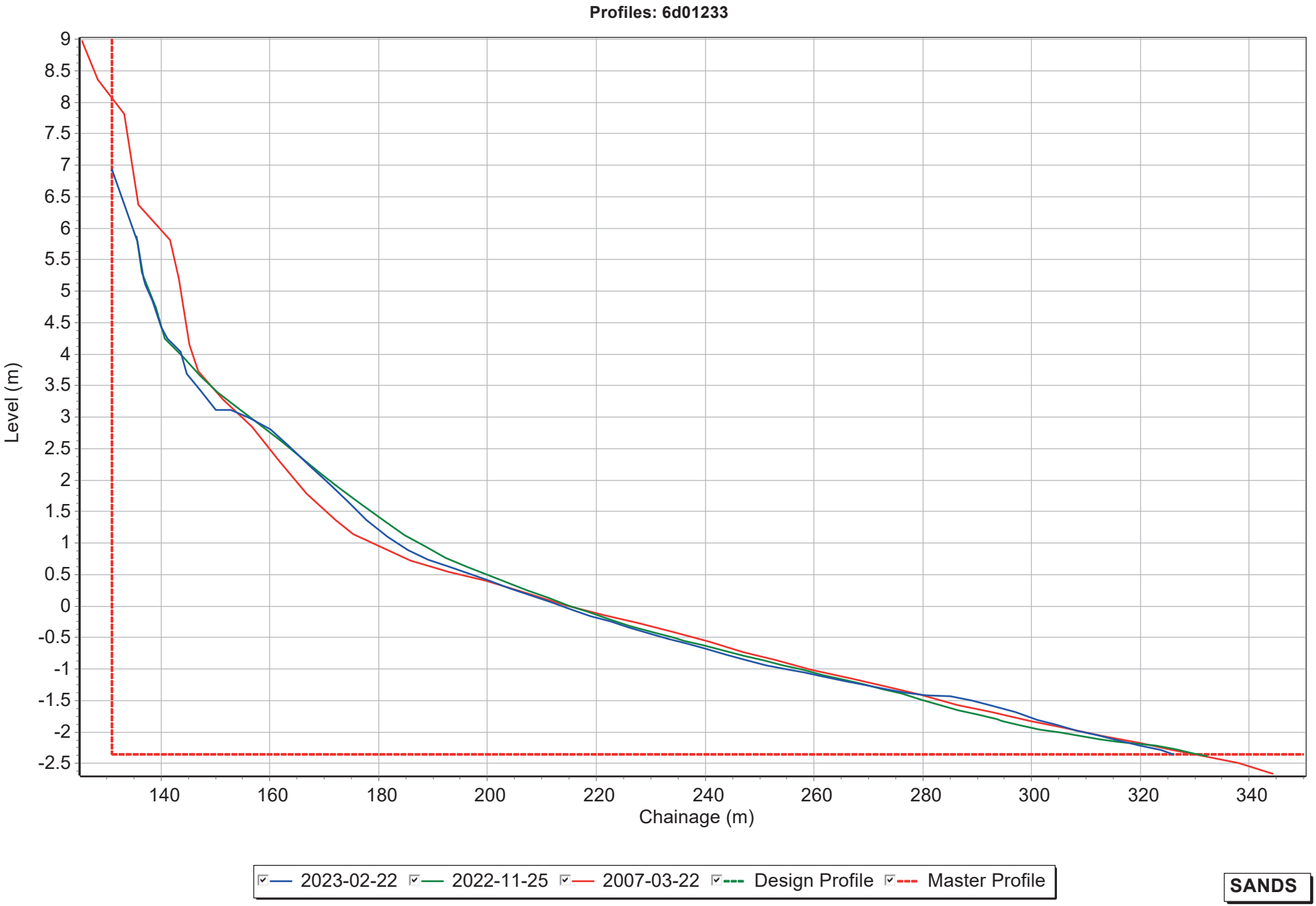
SANDS


Profiles: 6d01225
Level (m)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
200
250
300
350
400
450
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

SANDS


Profiles: 6d01229
Level (m)
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
100
120
140
160
180
200
220
240
260
280
300
320
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

SANDS


Profiles: 6d01233
Level (m)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
140
160
180
200
220
240
260
280
300
320
340
Chainage (m)
2023-02-22
2022-11-25
2007-03-22
Design Profile
Master Profile

SANDS