Ceredigion Beach Profile Monitoring Volume I

2012-2013 Survey

Volume I

Cyngor Sir Ceredigion

October 2013

Report for Council Review

9W1559

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SUMMARY

Cyngor Sir Ceredigion annually undertakes topographic and LiDAR surveys of a number of beaches located along the Ceredigion coastline. This data is used to inform an annual monitoring report which then summarises the changes in beach profile seen over a 12 month period.

This is the eighteenth year that the survey has been undertaken at 15 locations along this coast. For the third consecutive year, LiDAR has been flown along the whole coastline. Biannual monitoring has been continued at two locations at Aberystwyth, as this helps to discern seasonal trends from the overall analysis. Subsequently, there is now a relatively long time period over which data has been collated. This is progressively enabling long term trends to be identified. Within the report, each location is discussed individually with a description of the changes, concerns and what actions might be required.

The 2012/13 report has identified that there are a large number of locations in Ceredigion which are continuing to erode. In summary, the following has been identified at each location:

- Pen Yr Ergyd – The evolution of the spit and the main channel of the estuary is starting to become apparent with the on-going monitoring. Dredging and spit/channel maintenance information should still be collated, to inform this monitoring. The narrowing of the upper beach along the frontage of the spit this year renews the concerns of spit instability and the risk of breach during a major storm.
- Aberporth – The channel at Traeth Dyffryn has widened and deepened this year, renewing the pressures placed on the base of the defences. Due to the healthy beach levels, there are minimal risks of defence undermining this year, but a defence inspection would be beneficial to put monitoring into context. There are no concerns at Traeth Dôlwen, although pressure on the headland frontage between the two bays should be a focus for monitoring.
- Tresaith – No immediate concerns at Tresaith as the accretion across the width of the upper beach this year has led to healthy beach volumes being maintained. The profile envelopes show the beach to have been much lower in previous years.
- Llangrannog – Erosion at the lower and upper beach has resulted in the lowest beach levels recorded during the monitoring period. The increased pressure placed on the toe of the defences is a concern and so defence inspection would be beneficial following this year's retreat.
- New Quay Bay – Despite the long term tendency for lowering within the harbour, particularly in front of the Old Stone Pier, there are no concerns this year. Accretion and beach volume increase has occurred at the lower beach across the bay.
- Llanina – Long term lowering continues at Llanina, however this year's accretion along the length of the beach and at the base of the cliffs have reduced the pressures seen in previous years. This change needs to be treated with caution, as it may just be depicting the annual variability at Llanina. The recommendation for LiDAR collection during winter remains.

- Aberaeron South Beach – There has not been the same level of consistent beach lowering here this year, but monitoring shows that the south is tending to be under more pressure for retreat than the north with the potential for cliff retreat still being present along the south beach. The importance of the Pier in holding the northern section of the beach is evident this year.
- Aberaeron North Beach – Coastal Protection works continue to stabilise beach levels with lower beach accretion reflecting the benefits of the renourishment works. The drift of sediments to the east and the localised erosion to the southwest of the groyne bays continues. The annual flying of LiDAR should continue, as it has proven valuable in identifying long term change across the profile.
- Aberarth – The southern beach continues to lower along the length of the profile. This long term trend is a cause for concern, in relation to the on-going vulnerability of cliff retreat in this area. The erosion seen around the pier this year, where previously there was accretion, needs to be revisited in the 2013-2014 reporting.
- Llansantffraed – Overall lowering across the whole of the beach has been seen in 2012. This continues to be a concern due to the risk of erosion to the vulnerable boulder clay cliffs.
- Llanrhystud – The tendency for material to be lost from the beach is a continuing concern. Although the northern area of the beach has been on a path to recovery since 2007, the upper beach towards the southern area has not recovered from the significant cut back seen in 2010 and the central beach has further retreated this year.
- Tan-y-Bwlch – The crest of the shingle ridge remains relatively stable again this year, but continues to narrow where the river Ystwyth comes closest to the sea. The slow, on-going beach loss here remains a concern, in relation to the vulnerability of the shingle ridge to a breach. The 2013-2014 reporting needs to understand if the landwards movement of the central berms seen this year is a process which is becoming more widespread along the beach.
- South Marine Terrace – The beach continues to slowly lower each summer, and recover with accretion during the winter. This year the southern beach has reverted back to its long term trend of lowering, whilst the northerly profiles have retained their beach volume. As the long term lowering of crest levels are putting the foundations of the defences at increased risk, a coastal defence inspection is still recommended.
- Victoria and Marine Terrace – Beach lowering continues in the north, and this year the losses in the south are of particular concern in relation to the vulnerability of the toe and the defences. The recommendation to link beach monitoring to a coastal defence inspection, remains.
- Borth – This second year of monitoring since the construction of the Coast Protection Scheme (Phase 1) has shown the benefits of the scheme in protecting the shingle ridge in front of the town. Furthermore the works have not had any large net major impact on the adjacent coastline. There is concern about an area of erosion to the north of the scheme which has been evident since 2011. It is recommended that this is considered in examining Phase 2 of the Protection Scheme.

CONTENTS

1 INTRODUCTION

The annual Beach Monitoring Programme undertaken along the Ceredigion coastline by Cyngor Sir Ceredigion is in its eighteenth consecutive year. The monitoring consists of a mixture of topographic profiles and LiDAR survey in 15 locations. Figure 1 shows the geographical spread of the 15 locations along the Ceredigion coastline. As per the previous two years of surveying, LiDAR has been flown along the whole coastline, providing an overall picture of change between these three consecutive years and allowing a medium-term comparison to LiDAR data from the first year of LiDAR survey in 2006.

The objective of this monitoring report is to inform local coastal management practices and decisions. As each year of new data is added to the monitoring programme, long term change and trends are identified with greater clarity. As a result of this data, not only can the decision to intervene be better informed, but the question of how to intervene can also be considered. Subsequent to this annual monitoring, design of the Aberaeron North Beach and Borth Coast Protection Schemes has used the data directly.

The West of Wales Shoreline Management Plan 2 (SMP2) has now been approved. The SMP2 used data from this monitoring programme to inform the likely long term evolution of the Ceredigion coastline. The analysis of historical data within the SMP2, has, likewise, been used in developing this monitoring report, so that an overall picture of beach evolution can be developed.

This report provides a detailed account of the changes observed over the 2012/2013 monitoring period. A summary of the most significant changes is then made from this perspective. Most locations are only surveyed once in the 12 month period, but South Marine Terrace and Victoria and Marine Terrace in Aberystwyth, benefit from biannual monitoring and the analysis of winter profiles (winter 2013) is included in this report.

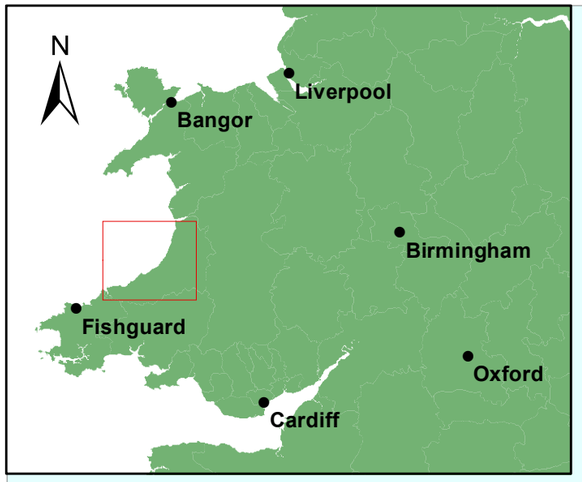
As for previous years, the general issues and specific objectives are stated for each area, to provide context for the monitoring undertaken.

1.1 Report Layout

Section 2 provides the findings of the monitoring, referencing the various data interpretation methods used; these are graphically illustrated in Volume II. This section also includes discussions from 2006 to present, to provide a basis of comparison for the present year.

Section 3 summarises an overview of the behaviour of the coast. This includes a geographic representation of how the beach has changed (positive or negatively) at MSL, for the whole coastline. Section 4 provides a description of the main concerns, and recommendations related to them.

In last year's report, Appendix A contained a disc at the back of the report, which included the discussion of changes from 1995 to 2005, for each survey location. This has not been included this year and reference should be made to the disc previously provided for long term assessments.



Borth
Aberystwyth, Victoria and Marine Terrace
Aberystwyth, South Marine Terrace
Tan-Y-Bwlch
Llanrhystud
Llansantffraed
Aberarth
Aberaeron North Beach
Aberaeron South Beach
Llanina
New Quay
Llangrannog
Tresaith
Pen-Yr-Ergyd
Aberporth
A487(T)
Borth
Aberaeron
New Quay
Lampeter
Cardigan

Title
Beach Monitoring Report Locations

Project
2012/2013 Ceredigion Beach Monitoring Report

Client
Ceredigion County Council

Date	*Scale*
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Figure
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2 DISCUSSION OF CHANGES

The data which informs the monitoring report is from two sources. The first is topographic surveys at set transect locations as defined at the start of each monitoring period per site. Topographic surveys were carried out in August 2012 and February 2013. The second is LIDAR data which is flown in winter months. This was specified due to ambiguities introduced by dense vegetation cover during summer months. LIDAR was introduced to this project in 2006 and has been flown at all locations since 2009. LIDAR data which was collected during the 2012/2013 monitoring period was flown in February 2013.

This section analyses any changes in beach profiles and infers beach trends for each specified location following the 2012 summer and 2013 winter surveys. The results are illustrated using the following methods, in Volume II:

- Topographic Surveys provides 2D beach profiles, which are superimposed upon a profile envelope showing the maxima and minima of all previous years' profiles. The 2011 profile has also been included to provide a short-term comparison to the 2012 profile. The Highest Astronomical Tide (HAT), Mean High Water Spring (MHWS), Mean Sea Level (MSL) and Mean Low Water Spring (MLWS) are also included as guidance for considering the beach response to wave action. All topographic levels are referenced Above Ordnance Datum (AOD).
- Trends for each profile are plotted to show the pattern of erosion and/or accretion over previous years. The graphs plot the distance from the intersection of the beach at various water levels to a datum position, generally defined as the position of the beach in the first year data was taken. The distance of the intersection point from datum is plotted positive to indicate accretion or negative to indicate erosion. A discussion of the resulting trends is included later in this section.
- A 3D representation of beach progression over all years of monitoring years is plotted for each location. They give an additional visual illustration of the beaches over the years and are beneficial to the interpretation and analysis of the trends. It is noted that the lowest levels of the 3D charts can sometimes give a misleading picture as some values are set at zero by default.
- At a number of locations, topographic surveys are not undertaken and only annual LiDAR provides the required data. The 2D profiles are still provided, being extracted through the LiDAR at the following sites:
  - Pen Yr Ergyd
  - New Quay Bay (Llanina)
  - Borth
- Since 2009, LiDAR has been flown along additional sites at Aberaeron and Aberarth. The benefits of this data were significant and subsequently, in 2010, 2011 and 2012, LiDAR was flown for the whole Ceredigion coastline. Subsequently, for each site there is a figure showing the 2011 - 2012/2013 LiDAR survey. Plan comparisons with the first year of LiDAR data (location dependent) are presented to show accretion and erosion patterns.

- At Pen-yr-Ergyd a number of profiles have been extracted from the LiDAR at the spit at the mouth of the Teifi Estuary.
- Since the 2008 report, analysis of indicative beach volumes has been undertaken for all profiles. A maximum elevation boundary is chosen based on the morphology of the backshore, so that only the morphologically dynamic area of the beach is analysed, and any man-made structures are excluded. A minimum elevation, based on the lowest point of the shortest length profile since monitoring at each site began, was taken as the lower boundary. The integration of the graph between these boundaries was then calculated for each year of monitoring. The change in area over time has subsequently been plotted and included in the interpretation of trends. The graphs for indicative beach volume analysis are included in Volume II of the 2012/2013 Report.

2.1 Pen-yr-Ergyd LiDAR

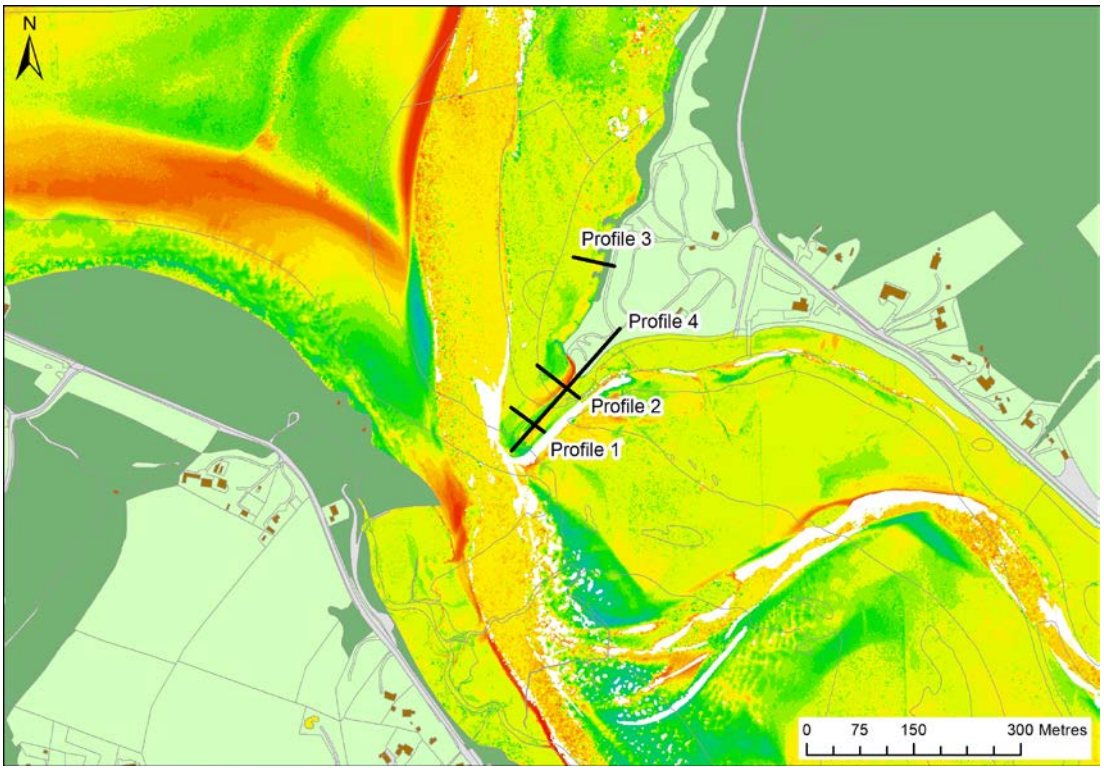


Figure 2.1 – LiDAR image of the Pen-yr-Ergyd spit located in the mouth of the Teifi Estuary. The locations of the 4 profiles taken on the spit have been marked on this figure.

Processes, issues and key features

The Pen-yr-Ergyd spit lies at the mouth of the Teifi Estuary, to the southern end of the Ceredigion shoreline. Like other bays along the Cardigan coastline, the estuary acts as a local sediment cell, with little interaction with other bays along the wider coastline. Generally, there is significant change within the estuary, caused by changes in the estuary dynamics.

Pen-yr-Ergyd shingle spit self-feeds in extending across the mouth of the estuary. A rock revetment and short rock groynes protect the remainder of the spit. However, as the shingle spit extends, its width is likely to reach a critical minima at which a breach will occur under storm conditions. The head of the spit may detach and the new spit head will come under increased pressure to erode. The spit is currently used as an access point to the estuary channel for many boats, and a floating pontoon has been constructed on the landward face. Shingle and rock material has been placed onto the spit to increase the protection it provides. The Poppit Dunes are recognised as an area of potentially significant future erosion.

Objectives of Monitoring for the area

- To provide the Council with a pre-warning of failure of the spit;
- To better understand whether the spit will continue to extend and impose increased pressure on the Poppit Dunes;

- To provide a baseline information for assessing subsequent changes.
- The data is also to be made available to the Teifi Estuary Management Group who are undertaking more detailed examination of local change and management.

Following recommendations made in 2006, this area has been monitored through annual LiDAR survey and profiles are taken through the spit to monitor its geomorphological evolution.

Table 2.1.1 – Dates of the LiDAR collection at Pen-yr-Ergyd

Annual LiDAR Collection	Date of LiDAR flight
2008	2nd and 3rd August 2008
2009	6th, 7th, 9th, and 21st August 2009
2010/2011	22nd January and 4th March 2011
2011/2012	8th February 2012
2013	28th February 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Figure PYE1 indicates that since 2009, the estuary has been accreting in a number of locations. Notably, the crest of the spit and its seaward end appear to have accreted during this time period due to placement of material. There has been a general accretion over much of the Poppit Dune frontage, including the further accretion of the southern and on the western side of the entrance channel.*

In front of the Poppit Dunes there continues to be some erosion of what appears to be an ebb channel from the entrance.

On the east coast alternate areas of accretion and erosion can be seen on the stretch of coastline immediately adjacent to Gwbert. Profile 1 at the southern extent of the spit has been widened over the crest, extending further on its seaward side than in 2009. However, the toe of the profile is little changed and still some 3m set back from its position in 2006. The crest height at this location has not changed significantly since 2006. Profile 2, located on the spit but closer to its root, has also been widened on its seaward face. This widening comes from a berm being created at approximately 50m chainage. The general pattern has been for erosion of the lower front face.

Comparing Profiles 1 and 2, it may be seen that there has been some growth in the width to the back (inner) side of the shingle ridge, compensating for movement back of the front face. This might be considered a classic roll over mechanism. In the case of Profile 2, there is no significant roll over retained on the back face.

On the coast opposite to the spit, there has also been accretion, which follows the line of the main channel here. Accretion can also be seen over a larger area but to a lesser depth towards the Poppit Dunes. On the east coast alternate areas of accretion and erosion can be seen on the stretch of coastline immediately adjacent to Gwbert.

Profile 3, is unchanged from 2009 and is subsequently still largely unaltered from 2006.

Profile 4, located along the length of the crest of the spit has also not changed significantly this year, with the exception of a lengthening back to previous (2006) levels.

The only area which has lowered significantly can be seen at approximately 210m chainage but the 2010 level is still within the profile envelope.

2011 The evolution of the spit continues to be monitored through LiDAR. Comparing 2010 and 2011 data shows the removal of material from the end of the spit at the channel entrance. It is understood that sediment has been recycled from the back of the spit head and placed on the front face.

The continued replenishment of the spit crest is also shown through the maintenance of the crest (Profiles 1 and 2); this remains at an average of around +4.0mODN. However, in particular at Profile 1 there is shown to be increased movement of sediment over the crest. Profile 2 shows the crest is being maintained.

The 2D profiles show the general maintenance of the width and height of the spit at its higher elevations. Therefore, the width at the base of the spit is, however, narrower than in 2006, on Profiles 1-3. Profile 4 shows little change since 2006 and the height and length of the spit has been maintained through re-nourishment operations.

The Poppit Dunes continue to show accretion over the majority of their area, with the exception of a small region of acute lowering at the estuary mouth. This erosion is in line with patterns seen in 2010-2011 monitoring.

2012 LiDAR has been gathered again this year to allow the evolution of the spit at Pen-Yr – Ergyd to be monitored. Comparison between the 2011 and 2012/2013 LiDAR data in Figure PYE1 shows deposition of material on the end of the spit at the channel entrance. This accretion is opposite to the removal of material seen here last year.

On the south side of the channel, behind the spit, there is an area of accretion extending landwards up the channel. Additionally immediately in front of the spit on the eastern shore there has been a concentrated area of deposition on Poppit Sands where previously there was erosion. Moving to the central area of Poppit Sands, erosion dominates the upper beach along the remaining length of the sands. There is widespread accretion at the tip of Poppit Sands, extending out into the channel

Along the northern shore, the upper beach has benefitted from the recharge, thus adding protection to the Caravan Park and the spit. The northern side of the channel flowing around Poppit Sands is dominated by a clear strip of erosion.

The 2D graphs provide valuable information for identifying more in depth patterns of accretion and erosion along the breadth of the spit. The continued replenishment of the spit crest is clear in Profiles 1-3. On all three profiles the recharge crest has been maintained this year. Indeed this redistribution of the recharge material has resulted in the crest height rising above the previous upper profile maximum on all three profiles.

On Profile 2, the recharge material has tended to erode back at the upper beach, resulting in a steep frontage being formed this year. The eroded material has been deposited over the lower toe of the profile, which has allowed the beach level to accrete to the upper profile envelope. However, the general pattern forming at Profile 2 is one of erosion, with the whole profile showing signs of moving back towards the previous minimum.

On Profile 1, the frontage of the spit has continued to benefit from the recharge along its length. This is mainly due to the eroding drift from Profile 2 moving westwards and depositing material along the whole frontage and crest of Profile 1. Profile 3 has also maintained its recharge profile, with material largely being deposited on the crest.

Profile 4 is located lengthways along the centre of the spit. The increase in crest height experienced at other profiles this year is also clearly shown in Profile 4. The re-working and deposition of recharge material on the crest of the spit has resulted in the level of the spit being significantly greater than the previous upper profile maximum.

Beach Behaviour

Figure PYE1, which shows a comparison of LiDAR between 2006 and 2012/2013, indicates that an area of erosion in front of the estuary mouth is observable over this longer timescale. It was identified last year that this appeared to show the evolution of an ebb channel. This year the ebb channel has further strengthened and is more extensive across the mouth of the estuary, pushing more strongly against the Poppit Sands.

It is understood that the strengthening of the ebb channel is closely related to the advancing nature of the spit and its growing influence on the western side of the channel. If the spit, and subsequently the ebb channel continue to move in this direction, it could lead to greater erosional pressure against the Poppit Dune system. This early indication of a change in estuary dynamics should be carefully monitored. The information could be critical to ensuring that potential consequences of this change are fully understood.

Further into the estuary entrance, the general accretion of the estuary banks continues. This is also the case on the front face and to the crest of the spit itself, both of which continue to benefit from re-nourishment operations.

However, the evidence this year of erosion and subsequent steepening along parts of the frontage (Profile 2) of the spit is a cause for concern. This shows that, despite the recharge, the spit is still working its way back to its natural form. At present the spit has a low vulnerability, due to the maintenance of the high crest levels along the length of the spit. However, the evidence of erosion along the central frontage of the spit this year suggests the potential for narrowing of the spit, and ultimately shows that the spit is still considered highly vulnerable to breach in a major storm.

Concerns

When set in the context of long term change, the narrowing of the spit remains a concern. There have been few large storms in recent years that have challenged the stability of the spit, but there remains the risk of this occurring and causing a breach.

The continued maintenance of the crest height and action needs to continue to ensure that its width and height do not reduce to a critical level. Evidence of this narrowing can be seen despite the efforts which have been put into maintaining the crest height and width of the spit.

The strong interrelationship between the extent of the spit and the behaviour of Poppit Sands needs to be carefully monitored to provide early indication of a change in estuary behaviour.

Actions

The long term evolution of the estuary is well documented and the SMP2 provides a good account of geomorphological change. Monitoring will continue to add to this understanding. This will outline where nourishment should be targeted, to maintain the integrity of the spit. The recommendation that options are considered to prevent a breach of the spit, remains. It is also recommended that options are considered for what to do in the event of a breach.

As per the 2009 recommendations, the recording and monitoring of dredging and material recycling activities should be an ongoing process and should ideally be used to inform this annual monitoring study.

2.2 Aberporth

Processes, issues and key features

At Traeth Dôlwen, to the south, works on the coastal slope to prevent further slippage of the clay cliffs have been undertaken in the past. This includes a wave return wall at the toe of the slope. The beach levels are therefore important to the overall bay stability and slipway access. At Traeth Dyffryn the coastal defences, including rock protection and a concrete wave return wall, act to provide toe support to the coastal slope as well as protection from scour by the stream and erosion by wave action. Both sand beaches are an amenity value to the town of Aberporth.

Objectives of monitoring for the area

Both beaches are subject to significant movement of sediment, with periods when beaches are drawn down, exposing rear coastal slopes. This is anticipated to be a generally cyclic process. It is therefore important to monitor beach levels (with Profile 1 at Traeth Dôlwen and Profiles 2 and 3 at Traeth Dyffryn) to ensure that the coastal defences are not in any immediate threat of being undermined, that their amenity value can be sustained and to establish longer term trends. The key objectives are:

- To assess the pressure on the channel at the back of the Traeth Dyffryn and to better understand the degree to which the channel deepens.
- To observe cyclic/trend behaviour.

Table 2.2.1 – Dates of the LiDAR collection at Aberporth

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	20th January 2011
2011/2012	8th February 2012
2013	28 February 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Profile 1 shows variable change along its length. Above HAT, in line with previous trends, the profile has lowered to below the profile envelope. This is also the case below MSL. Conversely, between MHWS and MSL, the beach has increased in level.*

The upper berm of the beach at Profile 2 is flatter this year, compared with 2009. The landward berm is not as high, however it has widened, creating a smoother profile. Significant accretion to above the profile envelope has occurred between MHWS and MSL to cause this smoothing. Profile 3 is similar to Profile 2, with the same pattern of accretion and flattening of the profile between MHWS and MSL, in most places reaching the top of or exceeding the profile envelope. At Profile 2 the channel at the landward extent of the profile has narrowed and deepened.

LiDAR was flown during the winter 2010/2011. This is the second year that LiDAR has been flown at Aberporth, the first time occurring in 2006. Figure ABP1 shows that over this time period, significant accretion can be seen to have occurred in Traeth Dyffryn (Profiles 2 and 3). This accretion has occurred in the centre of the profile, where wave action moves up and down the beach with the tide. Above this on the profile, erosion can be seen.

At Traeth Dôlwen the same pattern can be seen where some accretion of the central part of the beach has occurred, with erosion of the lower beach, extending to in front of the headland between the two bays.

2011

The cyclicity of beach movement is evidenced on Profile 1 at Traeth Dôlwen, with a redistribution of material along the profile. Accretion has occurred at the toe of the wave return wall, whilst beach levels between MHWS and MSL have lowered. Below MSL sediment has accreted, filling in the erosion that occurred there last year. This year, movement remains within the profile envelope overall, but is at the upper limit between chainages 20m and 40m, while lying at the lower limit seaward of this, suggesting a steepening of the beach.

At Profiles 2 and 3, which tend to show significant annual change, Profile 2 shows most fluctuation this year. On both profiles, the main berm of Traeth Dyffryn has accreted, at some locations by approximately 80cm, exceeding the profile envelope. Below MHWS, erosion has occurred; on Profile 2 this has seen a significant lowering of the beach compared to summer 2010, however, on both profiles the beach remains within the profile envelope.

Figure ABP1 shows the comparison between 2010-2011 LiDAR data. The overall pattern of accretion and erosion is mirrored on both beaches and likely reflect the position of the active swash zone.

2012

The cyclical movement of beach material continues at Profile 1. Similar to 2011, there has been further accretion at the upper beach near the wave return wall. The berm in between HAT and MHWS flattens this year, resulting in erosion of the profile to the middle profile envelope. Below MHWS from chainage 40 onwards the beach shows consistent accretion and reaches the upper profile envelope. Around chainage 50 there is a peak in the accretion, suggesting the material from the berm has been redistributed seawards.

Both Profile 2 and 3 display a changeable beach profile with significant fluctuation along the profile lengths. At Profile 2 the large berm between HAT and MHWS has largely been retained, despite erosion on the landward side below MHWS and the seaward side above HAT. This would indicate a slight movement of the river channel away from the defence. On the seaward face, a significant amount of accretion has occurred below MWHS, which has resulted in a new berm being created. Overall, movement remains within the profile envelope, with the profile predominantly positioned in the mid to upper profile envelope. At chainage 150 around the new berm and chainage 200 the profile exceeds the profile envelope.

Profile 3 is similar to Profile 2, with the same pattern of erosion on the landward side of the main Traeth Dyffryn berm and accretion of a new berm above MSL. In this location the erosion on the landward side of the berm shows a deepening of the channel. Similar to profile 2 the seaward face of the profile is in the mid to upper profile envelope with the accretion of the new berm exceeding the upper profile envelope at chainage 150. As noted above at Profile 2 the channel at the landward extent of the profile has widened and in Profile 3 it has deepened.

Comparison between the 2011 and 2012/2013 LiDAR data shows evidence of two clear areas of accretion at Traeth Dyffryn, relating to the two berms displayed along the lengths of Profile 2 and 3. The berms are also intersected by two areas of erosion, which

continues along the eastern edge of the bay where the channel flows at the foot of the cliffs.

This year a significant area of erosion emanates from the headland and extends out to the foreshore of the two bays at Aberporth.

At Traeth Dôlwen, the beach is largely accreting, with only a small area of erosion in the mid to upper beach. The upper beach at the base of the wave return wall is also showing accretion.

Beach Behaviour

The large changes for the trend plots at Traeth Dyffryn continue to show how the berm responds to prevailing wave conditions. This movement is not a cause for concern, it instead provides an understanding of the process of wave dissipation through changes in beach morphology, which in turn provides protection to the backshore. All three profiles are showing a positive trend of MSL above the baseline, suggesting a healthy lower beach with an advancing beach level. Further to this, despite the changeable pattern at Profile 2, all water levels have been above the baseline since 2003 and Profile 3 demonstrates an overall positive trend.

The process of changing beach morphology continues to alter the position and shape of the channel at the back of the beach at Traeth Dyffryn. This year, the channel is wider and deeper than in summer 2011. Where the channel deepens behind Profile 3, it has not yet reached the lowest level recorded. With the beach being very healthy it is not, as yet, an area of concern.

3D graphs show the relative stability of Profile 1, albeit with an annual variation in beach level and the lower beach is currently in an advancing phase. Profiles 2 and 3 at Traeth Dyffryn continue to be more dynamic with regards to the response of the beach berm in the centre of the profile. The formation of the new berm, seawards of the main berm can be clearly seen on Profile 2, but is not yet visible on Profile 3. The 3D graphs show that this new berm is larger than any previous cycles of berm creation at this section of the beach.

In Figure ABP1 the LiDAR between 2006 and 2012/2013 indicates that significant accretion has occurred to the centre of Traeth Dyffryn. Indeed the growth of a second berm and the retention of the initial berm between 2012 and 2013 have greatly contributed to the accretion seen at this area of the beach. An area of erosion, over the 2006-2012/2013 period can be seen above this on the profile.

Interestingly at Traeth Dôlwen, the pattern of erosion at the base of the central headland, which has been evident in the last two years, has not continued this year. Instead an area of accretion has built up across the beach, extending into the nearshore area. This suggests that the pressure of erosion on the headland varies over a longer cycle. In addition, the accretion which occurred at the headland frontage last year has reversed and is now displaying a pattern of erosion. This perhaps suggests an inverse relationship of accretion and erosion exists between Traeth Dôlwen and the headland.

Indicative beach volume analysis indicates that Profile 1 (Traeth Dôlwen) has not changed significantly over the monitoring period. It also appears to behave almost

independently of Traeth Dyffryn. Profiles 2 and 3 continue to clearly show an overall trend of increasing volume over the monitoring period. Based on this analysis, there is little cause for concern at Aberporth, and the beach appears to respond well to prevailing hydrodynamic conditions.

Concerns

The only concern this year is that the upper beach shows no sign of significant recovery over the monitoring period. This, in part, is seen as being due to the build-up of the beach in front, preventing, under the prevailing hydrodynamic conditions this year, sediment from being pushed further inshore. The defences seem to be at minimal risk from undermining. This year the channel to the back of Traeth Dyffryn has deepened in one area and widened behind Profile 3. This renews the concerns for the pressures placed on the base of the defences. However, at this point there is a substantial toe to the defence.

LiDAR indicates that the beach continues to respond well to changes in hydrodynamic conditions, in particular the second area of accretion in the centre of the profile greatly contributing to the overall beach stability. The erosion of the headland frontage between the two bays is considered as part of the general pattern of behaviour of the building beach.

Actions

It is recommended that the benefits of monitoring would be strengthened by a continued defence condition assessment for the area. As in previous years, it is recommended that monitoring focusses on the following key aspects:

- The response of the beach to sea level rise, assessing whether the capacity for the beach to respond to changing hydrodynamic conditions is reduced through longer term increases in water levels;
- The effect of climate change on the stream to the back of Traeth Dyffryn, where increasing flows might be a cause for concern with regards to the stability of the defences.

2.3 Tresaith

Processes, issues and key features

Tresaith is set back from the main cliff line and the beach is subsequently held between two headlands. The beach receives sediment from both directions alongshore. A rock revetment and sea wall are located at the crest of the beach, supporting and protecting the coastal slope from beach draw down. There is gradual erosion and deterioration of the existing defences, with some slope instability issues to the north of the frontage. The sandy beach is an important amenity asset, which should be safeguarded.

Objectives of Monitoring for the area

To monitor beach levels to ensure that the coastal defences are not at risk of being undermined, either immediately or in the longer term and, based on the SMP2 recommendation, to examine opportunities for retreat at the southern end.

Table 2.3.1 – Dates of the LiDAR collection at Tresaith

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	20th January 2011
2011/2012	8th February 2012
2013	28 February 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *On Profile 1 there has been a shift in material again around MHWS to HAT. This has caused the shingle berm which was located here in 2009 to develop into two berms. From MHWS to MSL the beach has accreted to a higher level than 2009, and to above the profile envelope along a 20m length. Conversely, at LW there has been a small amount of erosion.*

Profile 2 shows the same general pattern of erosion and accretion along its length although the berm which was previously located between MHWS and HAT has flattened and is not visible on the profile this year. At approximately 25m chainage, where this berm was located previously, the profile is at its lower limit.

LiDAR has been flown at Tresaith for the second year since 2006. Figure TRS1 shows the comparison between these two years. Significant accretion can be seen in two long profiles along the beach. The first is where wave activity is concentrated in centre of the foreshore. This accretion intensifies towards the southwest of the bay. Located immediately adjacent to the cliffs in this area is the second area of accretion. A small area of beach lowering is visible in the north east of the bay. These patterns of erosion and accretion suggest that the bay has adapted to and is, therefore, quite sensitive to changes in net wave direction.

The change in beach alignment is also consistent with the concept that this is effectively a perched open beach, which has developed where the set back of a softer shoreline has created sufficient width.

2011 Profile 1 exhibits a cyclic movement of material, with opposite areas of accretion and erosion compared with 2010 data. This has resulted in accretion (to above the profile envelope) at MHWS to HAT, shifting the berm landwards. Erosion has occurred below

MHWS. It is possible that the material that was located here has been redistributed between the accretion seen above MHWS and also below MSL.

Profile 2 has generally accreted this year, particularly at the upper beach, which has significantly filled in again between MHWS and HAT. The berm, previously located at ~40m chainage, has redistributed, causing some lowering of beach level in this location, with accretion at and below MSL. This reverses the pattern of material loss seen last year at this location. Overall, the beach lies at its upper profile envelope.

LiDAR data shows that between 2010-2011, beach material has shifted from the east of the bay to the west. This is in line with the prevailing westerly wave direction.

2012

Profile 1 and 2 exhibit very similar patterns of erosion and accretion. Profile 1 has undergone erosion below HAT and MHWS. This erosion has reduced the beach level from the centre profile envelope to the lower profile envelope at chainage 50. At MSL the seawards redistribution of material takes the beach to the upper profile envelope and creates a berm just below MSL. This accretion of the berm has resulted in the profile being significantly higher than the previous upper profile limit.

Profile 2 also exhibits a seawards redistribution of beach material. Erosion takes the beach from the upper profile at HAT to the lower profile at chainage 40. The seawards movement of material has created a berm just above MSL, raising the profile to the upper profile envelope. From chainage 50, the profile remains in the upper profile envelope, moving toward the middle profile envelope at the seawards extent of the profile. This year, the lower beach has fallen below the 2011 profile, signifying foreshore erosion.

LiDAR data shows that between 2011 and 2012/2013 the shifting of beach material from the east to the west of the bay has become more pronounced, with an area of clear accretion to the west of Profile 1.

Beach Behaviour

The continued movement of the berm at Tresaith is picked up through the trend plots. The zig-zag pattern of change indicates the changing position of the point of intersect between the beach and the tidal levels. This year, at both profiles, the berm has migrated seawards and is now positioned around MSL. The beach continues to actively respond to changing hydrodynamic conditions.

The trend plots indicate how the beach responds very similarly on both Profiles 1 and 2. HAT and MHWS show a decrease this year, which is consistent with the erosion at Profile 1 and 2 in this area on the 2D graphs. All water levels at both profiles are above the baseline, indicating healthy beach levels are still being maintained. This does not pick up the apparent east-west ‘shift’ in the beach, seen in the comparison of LiDAR data between 2011 and 2012/2013.

In Figure TRS1 the LiDAR data shows that when comparing 2006 data with 2012/2013 data, Tresaith has accreted across the width of the upper beach. This is the opposite to the previous year (2011) which largely saw lowering across most of the profile. Instead, this pattern of erosion has moved down the profile to the foreshore area, where it extends across the width of the beach. This suggests that this beach is sensitive to net wave direction. Erosion to the base of the cliffs in the south west has been identified by LiDAR again, although this year it is isolated to one area, reducing the pressure on this cliff frontage.

The 3D graphs show the cyclic movement of the berm on both profiles, with the patterns of erosion and accretion being clear at the upper beach (2-4m AOD) and the lower beach (0-1m AOD).

Indicative beach volume analysis shows that overall Tresaith beach is on an upward trend in beach volume. This commenced in around 2007, however this year both profiles display a reduction in beach volume which is associated with the area above MSL. This correlates to the erosion around HAT and MHWS and the seawards movement of material shown in the 2D graphs.

Since 1995, there has been an overall small trend for increasing beach volumes, suggesting that the LiDAR and profile snapshots need to be supplemented with this trend data.

Concerns

There are no immediate concerns at Tresaith this year. Monitoring is providing the confidence in understanding how this beach responds to wave direction, and will continue to build a long term pattern of change. The critical consideration needs to be the effect of climate change on long term beach change.

The location of the profile in relation to the profile envelopes on the 2D graphs indicate that Tresaith has been much lower in previous years and is not a cause for concern this year. The only exception is the area below MHWS which shows a reduction in profile of the central area of the beach, which needs to be monitored.

Actions

None.

2.4 Llangrannog

This frontage is characterised by concrete and masonry walls at the back of the beach. The beach comprises a mixture of shingle and sand. There are significant periods when the beach levels drop, and the car park at the back of the beach is inundated at high spring tides. The flow level of the stream which outflows onto the beach has a large effect on the beach material located immediately adjacent to it.

Processes, issues and key features

The short term SMP2 policy for the Llangrannog Management Unit is Hold the Line in Epoch 1, but highlighting the need for change in the way the frontage is managed in future years. This reflects the important assets established immediately behind the defences. This policy will have no significant impact upon the adjacent coastline but will maintain an important centre for the rural communities of this area.

Objectives for Monitoring of the Area

The frontage has historically undergone significant change, although this has tended to be both erosion and accretion. It is this vulnerability which needs to be examined as well as identifying any longer term trends.

Table 2.4.1 – Dates of the LiDAR collection at Llangrannog

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	20th January 2011
2011/2012	8th February 2012
2013	28 February 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Profile 1 has eroded to below the profile envelope below MHWS. This is accompanied with accretion below MSL, to a level above the profile envelope. Overall, the upper section of the beach has steepened and the lower part has smoothed.*

Profile 2 shows an overall steepening trend, as the profile has eroded below MHWS and accreted above. A similar steepening pattern has occurred on Profile 3, where the majority of the profile has accreted, with the exception of a small part of the beach between approximately 65 and 100m chainage. These two profiles are sensitive to the flows through the culverts below the road from the Nant Haven, as well as wave action.

Profile 4 is located lengthways along the back of the beach. The profile shows that there has been significant change this year, with erosion along its entire length, with the exception of two either ends of the profile, which remain fairly stable. The profile is located below its profile envelope along the majority of its length.

2011 Patterns seen on Profile 1 last year have reversed, and this year the profile has accreted in its upper reaches (above MSL) and has lowered (steepened) below this. The profile is subsequently above the profile envelope above MSL. Profile 2 also exhibits a significant amount of change this year, but is a reversal of Profile 1 whereby material has tended to shift seaward. The profile is subsequently above the previous envelope of change, but at a slightly higher chainage than Profile 1.

Profile 3 is similar that the profile is high within the previous envelope, just above MSL, but there has not been the same significant change from the previous year. This is with

the exception of between 10 and ~38m chainage where the beach has lowered to its lower profile envelope.

Profile 4 has accreted along its length, so that the profile is at its upper limit to around 65m chainage. Seawards of this there is little change from summer 2010.

2012

Profile 1 exhibits a cyclic movement of material. The profile has consistently shown an alternating pattern over the last three years, with cycles of erosion in 2010 and 2012 and accretion in 2011, suggesting large volumes of material are being moved around the beach on an annual basis. Below MHWS towards the seawards extent, the profile is significantly eroded this year, with the profile remaining at or below the lower profile envelope for most of its length. Below the MSL there is an area of accretion, forming a berm between chainage 50 and 60.

Profile 2 shows alternating areas of accretion and erosion along the profile length. Between HAT and MHWS the profile is eroding whilst immediately below MHWS the beach is accreting to the upper profile envelope. This has impacted upon the berms at the upper beach, as although the berm between HAT and MHWS is still present, some seawards movement of material has resulted in another berm developing just below MHWS. Similarly at chainage 60 there is a seawards movement of material resulting in a more pronounced berm at the lower beach accreting above the upper profile limit.

Profile 3 has accreted at the upper beach to above the previous upper profile envelope around HAT and MHWS. At chainage 40, erosion to below the lower profile limit has resulted in beach material moving seawards and significant accretion of the large berm to above the upper profile limit.

Of particular concern at Profiles 1, 2 and 3 is the lower beach which is eroding to or below the lower profile envelope. This trend needs to be considered in future monitoring.

Profile 4 is located lengthways along the back of the beach and so is a toe profile at the base of the defence. This year there is significant lowering in the centre of the beach with material being redistributed largely to the west of the beach, showing growth towards Profiles 3 and to a lesser extent 2. This erosion in the centre is of particular concern as the beach level at the toe of the wall is at its lowest level since monitoring began at Llangrannog.

Beach Behaviour

The trend plots for Profile 1 clearly show the lower beach erosion which has occurred this year and is a continuation of a period of retreat which has been occurring since 2010. Moving north along the beach (Profiles 2 and 3), the lower beach retreat is still evident, but is not quite as widespread as it is in the southern section of the beach. Towards the north the growth of the main berms is clear in the trend plots with Profiles 2 and 3 clearly continuing with their advancing trend at MSL.

2012-2013 LiDAR data shows that there is a clear area of accretion across the beach at Llangrannog (Figure LGN1). This largely relates to the growth of the berm present in Profiles 1-3. There are areas of low beach levels around the upper beach which relates to the erosion seen this year at the toe of the defences. The lower beach retreat identified in the 2D graphs is not visible in the LiDAR, suggesting that this trend would benefit from further years monitoring for a direct comparison.

The 3D graphs continue to show a general retreat of the lower beach from 2009 on Profiles 1, 2 and 3. The upper beach in these three profiles remains fairly consistent.

Indicative beach volume analysis shows that although Profiles 1 and 2 display an overall increasing trend, both profiles have however decreased this year which has largely occurred above MSL. This is consistent with the erosion around the MSL in the 2D graphs. Conversely Profile 3 continues its trend of increasing volume, which has also occurred above MSL. This relates to the growth of the main berm seen in the 2D graphs for Profile 3.

There is a trend for sudden change at this beach, followed by a stabilising period. This trend continues. This year marks significant change along the beach, with erosion occurring along all profiles.

Of considerable concern is the lowering seen in the central area of the upper beach. Profile 4 highlights that material is taken from the centre of the beach with sediments moved towards Profile 3 and to a lesser extent 2. This is further supported by the area of erosion seen at the upper beach in the LiDAR and the build-up of sediments in the north eastern area of the beach.

Concerns

Profile 1, 2 and 3 are eroding below the lower profile limit at the most seawards extent, suggesting lower beach retreat. The trend plots have indicated that this retreat has been occurring since 2009. This behaviour, which has been quite distinct in this year of monitoring, needs to be carefully monitored over the coming year.

The erosion that has occurred in the central area of the upper beach has resulted in beach levels at the toe of the defences being at their lowest level during the monitoring period. This is a considerable area of concern as it is reasonable to assume that there are increased pressures on the defences after this year's retreat.

There is only 6 years' monitoring data at Llangrannog therefore a full picture of the long term change at this beach has not been fully understood. The profile envelope at this location is not established as with other locations. Therefore the fluctuations in beach behaviour will be more pronounced within the profile envelope.

Actions

The assessment of a critical threshold of beach level needs to be undertaken, accompanied with a defence inspection to monitor structural integrity of the defence, in light of the erosion at the defence toe. This threshold should be used as a trigger to action if there is an indication of persistent erosion at the upper beach. This toe depth analysis could be undertaken as part of a wider coastal defence inspection.

2.5 New Quay Bay – New Quay LiDAR

Processes, issues and key features

The main issues at this location are the maintenance of the harbour and recreational beach use. The Old Stone Pier and the Penpolion jetty act as a defence for the harbour, retaining the beach and provide protection to the softer coastal slope and RNLI lifeboat station to the south. Annual dredging of approximately 1500 Tons occurs from within the harbour and is deposited to the north of and adjacent to the Old Stone Pier. Being a crenulated bay, waves are the dominant process by which the bay is shaped.

Aim of Monitoring

To monitor beach retention to ensure no detrimental change to the harbour and recreational use of the beach and to monitor the effectiveness of the Old Stone Pier and Penpolion jetty structures.

Table 2.5.1 – Dates of the LiDAR collection at New Quay

Annual LiDAR Collection	Date of LiDAR flight
2008	2nd and 3rd August 2008
2009	6th, 7th, 9th, and 21st August 2009
2010/2011	20th January 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Material appears to have rolled landwards compared with 2009, to create a new profile maximum around MSL. This has occurred alongside beach lowering below MSL, where, in 2009, significant accretion had previously occurred.*

The inset in Figure NQY1 shows a comparison between 2009 and 2010 LiDAR. The figure shows that New Quay Bay has accreted along its length, with the exception of a small area within the bay. This is the location of annual dredging operations.

A comparison between summer 2010 topographic survey and winter 2011 LiDAR survey is shown in Figure NQY1. Although this is not a direct comparison due to the seasonal difference in surveys, the graph indicates that the two datasets are comparable. It can be seen that during winter months the berm previously located between 20m and 50m chainage has been removed, and a deposition of material is shown at 100m chainage.

2011 Comparison of LiDAR taken in 2010 and 2011 is shown on the inset in Figure NQY1. This year, there has been a tendency towards lowering within the bay, with accretion of the upper beach around the majority of the length of the bay. Profile 1 has been taken through the LiDAR comparison and shows this tendency for lowering around MSL to approximately 60m chainage. The influence of the Old Stone jetty, in terms of preventing waves from entering the harbour, can be seen to reduce at the point where accretion changes to erosion or negligible change, to the south of the bay.

2012 Similar to 2011, only LiDAR has been collected again this year. Comparison of LiDAR taken in 2011 and 2012/2013 indicates that the opposite pattern of beach change has occurred this year with two clear areas of accretion across the bay. There is also a tendency for lowering at the upper beach, showing pressure placed on the base of the cliffs and sea wall around the length of the bay.

Profile 1 has been extracted through the LiDAR comparison and shows erosion at the upper beach has created a new profile minimum around MHWS which is significantly lower than previous. However from chainage 20 to seawards the beach accretes along the length of the profile. Indeed the lower beach significantly advances above the previous upper profile limit.

Beach Behaviour

Trend plots for the 2D profile at New Quay show that MHWS and HAT have tended to remain stable since 2006, consistently being within 4m seawards or landwards of the horizontal baseline. Following the lowering at MSL in 2011, a period of accretion has occurred this year, raising this water level to approximately 4m below the baseline. The large variation at MLWS is assumed to be due to the dredging and, related to this, whether or not a berm is present on the profile. It therefore reflects this management well.

The 3D chart is starting to pick up beach changes over the medium term now. This will continue to develop as annual monitoring builds on the dataset.

The indicative volume graphs show that beach volume has tended to decrease since 2006, although this trend is not particularly strong. A cyclic pattern is already evident over this relatively short timescale, which will be considered in future monitoring. This year there has been an overall increase in beach volume, largely relating to the area below MSL, which is consistent with the accretion on the 2D graphs.

In Figure NQY1, comparison between 2006 and 2012/2013 LiDAR indicates that the two areas of accretion this year have impacted on the general advancing of the beach level across the bay. The area of accretion within the central part of the harbour, seen since 2010, has greatly increased this year, in addition to a new area of accretion at the upper beach in the lee of the Penpolion jetty. Erosion still dominates the northern section of the beach in front of the Old Stone Pier. However not all of the erosion within the bay, shown in the longer term comparison, can be explained by the changes seen in the last year. This suggests that, despite the substantial accretion seen this year, there could be longer term trends of lowering within the harbour.

Concerns

At present the main observed process is that of fluctuation between the lower and mid beach areas. Sediment tends to build as a bar across the lower beach, being moved up the beach in other years. This appears to maintain sediment to the toe of the Old Stone Pier and against the Penpolion.

The back, upper beach has shown some loss but this is not seen as being critical at present.

Actions

None.

2.6 New Quay Bay – Llanina LiDAR

Processes, issues and key features

The coastal slope varies in nature over the frontage. In the lee of the Penpolion jetty is the steep shale cliff under George Street. This section tends to exhibit toppling failure with minor surface failing. Further east the slope is gentler, comprising clays to a significant depth. This section suffers from both surface slips and more deep seated failure. Ground water is a significant factor in this, as is the removal by erosion of the slumped toe material. Towards Llanina the slope tends to be steeper but less prone to deep seated failure. Some work has been undertaken to improve drainage of the coastal slope and some minor toe support has been undertaken locally in places along George Street. No direct coastal defence is in place. The toe of the frontage is subject to erosion resulting in periodic slope failure. Isolated properties above the coastal slope and a caravan park are potentially at threat, and some work to mitigate slippage of an access road has been undertaken.

Aim of Monitoring

To estimate the rate of erosion of the coastal slope and to establish the realistic, as opposed to perceived, threat to the area.

Table 2.6.1 – Dates of the LiDAR collection at Llanina

Annual LiDAR Collection	Date of LiDAR flight
2008	2nd and 3rd August 2008
2009	6th, 7th, 9th, and 21st August 2009
2010/2011	20th January 2011
2011/2012	14th January 2012
2013	13th January 2013

Description of Beach (previous years in Appendix A)

2010 *Land based topographic survey has continued this year. Little change appears to have occurred on Profile 1, in line with 2009 monitoring, although the beach appears to have eroded back into the cliffs. Profile 2 has also eroded at its upper reaches but without an associated cut back into the cliffs. The majority of the rest of the profile appears to remain at a similar level to 2009, but with some beach lowering below MSL, at approximately 20 to 50m chainage. Very little change appears to have occurred on Profile 3, but with a tendency towards beach lowering in the lower reaches of the profile.*

LiDAR was flown during winter months in 2010/2011. A comparison between 2009 (summer) and 2010 (winter) is shown in Figure LLN1. The comparison shows that accretion has occurred along the length of the bay, with the exception of a small area where New Quay residential housing commences, in front of Brongwyn Lane. Significant parts of the bay, notably to the south east, have not changed since 2009.

2011 Only LiDAR data has been collected this year, reflecting the confidence in this method. LiDAR has been flown now since 2006. Comparison between 2010-2011 shows that contrary to last year, erosion predominates along the bay. The area just to the west of the centre of the bay is an erosion hotspot, with more general erosion to the east of the watercourse outfall in the centre of the bay. In the far west, to the Penpolion Jetty, varied

levels of erosion and accretion have occurred, possibly due to tidal eddies created in the lee of the structure.

The 2D profiles clearly show the lowering in the bay. On Profile 1 this is from -40m chainage to 40m chainage, on Profile 2 lowering has happened over a longer length; from the top of the profile and extending to around 10m chainage. Finally, Profile 3 has lowered along its length. On Profiles 1 and 3, this lowering has dropped the profile to below its profile envelope.

2012

Similar to 2011, only LiDAR has been collected again this year. Comparison of LiDAR taken in 2011 and 2012/2013 indicates that there has been a tendency towards accretion along the majority of the length of the beach. Notably the erosion at the base of the cliffs shown last year has largely been replaced by areas of accretion in 2012, although there are small areas of erosion still present in the centre of the beach near Profiles 1 and 2.

Profiles have been extracted through the LiDAR comparison. This year Profile 1 shows little change along the profile length, apart from below MHWS to seawards where the beach has accreted to the upper profile envelope. The toe of the slope shown at the 6m AOD and HAT contour levels has remained quite stable this year, compared to the trend of erosion shown in previous years.

Profile 2 has undergone substantial accretion from the upper beach along to chainage -40, raising the beach to the mid to upper profile envelope. Below MSL there are a few small areas of erosion and accretion, but this is largely insignificant change. The toe of the slope shown at the 6m AOD and HAT contour levels has moved forward slightly, possibly suggesting continued movement in the soft coastal slope. This last occurred in 2008 and was followed by a period of erosion at the toe.

Minimal change has occurred along the length of Profile 3 over this year and the overall profile remains low. There continues to be erosion at the back of the beach causing continued retreat at the base of the cliff. There is however, no major change in the upper slope.

Beach Behaviour

Figure LLN1 provides a comparison between 2006 and 2012/2013 LiDAR. The image shows that there seems to be a more equal balance between areas of accretion and erosion. What appears to have happened is a shift (or anti-clockwise rotation) of the curve of the bay, suggesting possibly some slight change in net wave direction over the period of monitoring. However, such an interpretation needs to be treated with caution as, considering the pattern from the LiDAR plot of last year, much of the accretion at the eastern end of Llanina seems to have occurred over the last year and the longer term shift may just highlight the general variability occurring year on year.

The overall influence of this shift has been accretion towards Llanina since last year with a slight increase in the volume of accretion. The most interesting change is that there is less erosion and more accretion along the base of the cliff, compared to 2011, in the central and eastern areas of the beach. This seems to have slightly reduced the pressure on the lowering trend which had become more exacerbated in recent years.

The long term trend of erosion still predominates in the west towards the Penpolion Jetty. The erosion in the west is not entirely accounted for by what happened during last year, suggesting that this lowering is part of a longer term trend at Llanina.

In terms of the coastal slope, Profile 1 shows a pattern of slow erosion at the toe at an average of about 0.5m to 1m/year over the last 4 years, although taken over the longer period of monitoring this average is 0.25 to 0.5m/year over an 8 year period. This shows that there are periods of faster erosion, followed by periods of stability.

Profile 2 shows more variability, with the toe slumping forward and then being eroded back. This demonstrates, overall, little change in the position of the toe but also highlights a continuing movement of the coastal slope.

Profile 3 shows more persistent average erosion at the toe of around 0.25m/year and this seems to be very closely matched to the lowering of the upper beach level.

These patterns of slope erosion match the nature of the cliffs in each location.

Concerns

The general erosion and slope stability is in line with predictions assessed in the SMP. Maintaining beaches at Llanina is still considered to be important, although at present this requires no specific action. It does highlight the need to continue inspection of defence at Llanina. Options for mitigating the potential failure of the cliffs was identified by High Point Rendell (2007) although it is recognised that protecting the toe of the cliff will only slow the rate of cliff slippage.

Actions

Continue monitoring the cliff slope through LiDAR. As this data accumulates further analysis of slope stability will be undertaken.

2.7 Aberaeron South Beach

Processes, issues and key features

This shingle upper beach and sandy lower beach is controlled by timber groynes and the South Pier at its northern end. Rock protection has been put in place at the bottom of the cliff over the southern section of the beach. Repairs to the groynes using rock were undertaken in 2000. The South pier is presently closed towards its end because of damage, despite rock placement to help stability of the structure and to prevent waves from breaking on the structure. The evolution of the area around Aberaeron is a product of the dominant wave direction and the underlying geology. Generally, however, Aberaeron is exposed to a wide range of wave approach from the southwest and northwest.

Objectives of Monitoring for the area

To monitor shingle bank elevation and beach evolution to assess and identify any risk to properties behind the beach. In this, the long term trend of loss is important but the short term variation in the beach is equally significant, to understand the patterns of change of the beach. Consideration should be given to the effect on the beach of a wide range of potential wave approach directions.

Table 2.7.1 – Dates of the LiDAR collection at Aberaeron South

Annual LiDAR Collection	Date of LiDAR flight
2009	6th, 7th, 9th and 21st August 2009
2010/2011	3rd February 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *The berm at approximately 18m chainage (above HAT) on Profile 1 appears to have moved seawards to between MHWS and HAT. This movement of material down the beach has not flattened the profile because it is accompanied with erosion below MSL. The enlargement shows the berm movement in more detail.*

Profile 2 appears also to indicate a loss of material from below MSL, and above HAT, with accretion and the development of a berm between MHWS and HAT. Consequently, at the location of the berm the profile is located in the middle of its profile envelope. Above this berm, the beach has lowered slightly to below its profile envelope. Below MSL the beach is at its lower profile envelope.

LiDAR has been flown in 2006, 2009 and 2010 at Aberaeron South Beach. Figure ABNS1 shows that over this time, beach change can be seen to be variable from the upper beach seaward, and also variable along its length. However, the comparison plot does show how the beach is more subject to change towards the harbour mouth than it is towards the south. At the harbour mouth, the upper beach appears to have a narrow strip of lowering, with a wider area of accretion seawards of this, possibly indicating the location of the main berm. Erosion predominates again at the lower foreshore.

Towards the southern half of the beach, the upper beach shows patterns of accretion, with a very small level of erosion across the bulk of the beach, down to accretion again at the lower foreshore.

2011 At Profile 1 in the centre of the bay, the beach has cut back significantly around MHWS and HAT, to below the profile envelope in one area. This has seen the removal of the main beach berm, leaving a smoother, concave profile. Material has accreted below MSL where the profile is now at its upper limit.

Profile 2, located closer to the South Pier, has undergone the same loss of main berm but the beach is generally higher within the profile envelope. Material loss from the berm appears to have been deposited further down the profile.

Over the last 12 months, LiDAR (Figure ABNS1) indicates that the southern end of Aberaeron South has eroded, with accretion at the northern end of the beach, towards South Pier. The location of the profiles means that this is not quite picked up in the 2-D graphs. LiDAR also indicates that where a general loss of material occurs, it is usually associated with a build-up of a berm in the centre of the profile.

2012 At profile 1 the beach has been eroding significantly between MHWS and MSL. This has resulted in a smooth, concave profile which is more pronounced than the 2011 eroding profile and a beach level which is now eroding below the profile envelope between chainage 16 and 30. The beach profile towards the top of the beach is similar to the 2011 profile, with the exception of the small berm above HAT which has moved seawards. Below MSL, the beach is accreting and is now above the upper profile envelope. Overall, despite losses over the last three years the volume of the beach has been maintained.

Profile 2 has similarly been eroding substantially between MHWS and MSL, and is below the lower profile envelope in some locations. Above HAT, the beach has been accreting and material loss below HAT seems to have been deposited further up the profile, with the berm moving landwards. At the top of the beach there is a sharp decline and immediate incline in the beach level which is likely attributed to erroneous data due to the uneven surface of the upper shingle beach. Overall, the beach is in the mid to lower profile envelope. However, below MSL, material has accreted substantially and the profile is now above the upper profile limit. As with Profile 1, the overall beach volume is being maintained.

Comparison between the 2011 and 2012/2013 LiDAR data shows that the trends for beach change this year seem to spread across the whole width of the beach. This compares to pockets of change last year that were split between the north and south of the beach. In 2012 there has been a tendency for minor loss of the upper shingle beach, spreading across the area covered by both Profile 1 and 2. This year the accretion is not isolated to the north, instead the lower beach is substantially accreting along its whole length.

Beach Behaviour

The trend plots show that variability on Profile 1 continues. The significant retreat below MHWS, shown on the 2D graphs, is also shown on the trend plot, over the last three years. The gradual accretion of the lower beach is shown on the trend plot by the upward trend in the MSL over the last 4 years.

Trend plots for profile 2 shows less variability but with a better overall pattern with all water levels remaining below the baseline. Similar to Profile 1 the significant retreat below MHWS is shown on the trend plot over the last three years. However the accretion below the MSL and the landwards move of the berm above HAT on the 2D graphs is also shown by the recent advancing trend of the MSL and HAT on the trend plots.

3D graphs show the independent behaviour of the upper and lower parts of the beach on Profile 1, with the lower beach showing signs of advancing. Whereas Profile 2 shows a slightly more uniform pattern of change across the whole beach profile, with the cyclical change occurring at all levels of the beach.

Indicative volume graphs also show the variability of Profile 1, with an overall trend of increasing volume. Profile 2 is less clear cut, showing a less discernible positive trend and, since 2006, a relatively high level of fluctuation (in the upper beach). However the last year of monitoring is showing a stabilisation.

LiDAR comparison between 2006 and 2012/2013 is also shown on Figure ABNS1. This data further strengthens the evidence that to the south the beach is retreating, whilst to the north it is accreting. It is now evident that this is a long term trend of accretion and erosion and reflects the dominant wave direction from the south west. This year however the erosion is not as widespread, a change that is evident in the 2006 and 2012/2013 comparison. This can be identified in the centre of the beach which shows an area of accretion building up along the lower beach, continuing the advancing trend emanating from the pier, westwards.

The general pattern of change highlights the importance of the Pier as the main control feature, holding the northern section of the beach.

Concerns

There is not the same level of consistent beach lowering at Profile 2 as has been seen in previous years of monitoring. The migration of the berm at this profile could be a response to a specific hydrodynamic condition. Nevertheless, the lowering in the south of this beach should be carefully monitored, because of the potential for cliff retreat in this area.

Substantial lowering below MHWS (mid beach) gives a steeper profile suggesting higher wave action at this water level, but the lower beach (below MSL) is continuing to show a trend for accreting. Indeed the widespread accretion across the length of the lower beach this year serves to relieve some pressure from the upper beach.

Using the data collected from this annual monitoring campaign, as well as more historical accounts, the SMP2 highlights that there is a concern, at this early stage, about how Aberaeron South Beach is evolving. As highlighted in the SMP2, the importance of the South Pier is evident from the monitoring.

At present, there is no evidence of overall beach loss and no clear evidence of significant roll back, despite the trend for steepening of the upper section of the beach.

Actions

LiDAR has now been flown annually over Aberaeron since 2009, building a strong dataset for this area. This strengthens our understanding of the behaviour of this beach. However, the recommendation to increase the frequency of the monitoring at Aberaeron remains. As LiDAR is now flown during winter, it is recommended that summer topographic surveying is carried out at Aberaeron again, to fulfil this. Comparing profiles between these two surveys should improve the assessment of seasonal behaviour and the range of change that occurs during the year.

2.8 Aberaeron North Beach

Processes, issues and key features

The defences at Aberaeron North Beach were improved in 2008, using placement of 79,000 tonnes of locally sourced limestone to protect against wave attack, with wave wall heightening and refurbishment. The beach has also been re-profiled and nine new groynes have been constructed, with two rock groynes and a 500m long revetment along the north side of the harbour mouth. A steel sheet pile floodwall has also been built.

Prior to this, coastal defence structures consisted of timber groynes and sea wall. They reached the end of their design life and, coupled with this, lowering beach levels were affecting the stability of coastal structures. This raised the risk of flooding to the town as well as a potential loss of properties.

Objectives of Monitoring for the area

The objective is to monitor long term beach response to coast protection measures and their effectiveness. This should focus on longer term trends. Since the construction of the works in 2008, monitoring also needs to confirm the predicted performance of the defences now in place.

Table 2.8.1 – Dates of the LiDAR collection at Aberaeron North

Annual LiDAR Collection	Date of LiDAR flight
2009	6th, 7th, 9th and 21st August 2009
2010/2011	3rd February 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Reprofiling of the beach has occurred in 2009. On Profile 1 this has created a higher beach, which now sits in the centre of the profile envelope to approximately 40m chainage. There is a berm above HAT, in front of the sea wall. Further down the profile the beach is at its lower profile envelope but is smoother in shape. Profile 2 has a similar pattern to Profile 1 with a berm extending outside the profile envelope at the upper beach. Seawards of approximately 30m chainage the profile lies at its lower limit, sometimes lying below it. On Profile 3 reprofiling has created a more uniform berm with a flatter crest. There is not a large difference in overall level but the beach is flatter due to the increase in level below MHWS.*

LiDAR has been flown at Aberaeron in 2006, 2009 and 2010. The comparisons are shown in Figure ABNN1. Since 2009, large areas of accretion can be seen, where material has been placed at Aberaeron in front of the caravan park and area of low lying land. Further to the southwest, there are three areas where the beach is lower than in 2009, immediately adjacent to the new defences.

2011 This being the second year that surveying has occurred on the re-profiled beach, provides an early indication of the performance of the scheme.

Profile 1 has changed very little compared with 2010. Some material appears to have been transported landwards and above MHWS. This has pushed the profile to the upper

profile envelope, with the exception of a small area at the upper beach. Below MHWS, the beach has lowered, but still lying in the centre of the profile envelope.

Profile 2 has undergone erosion at MSL, to take the profile below the previous profile envelope. Further seawards, the profile remains at the lower profile envelope. At Profile 3 there has been a landward movement of beach material, pushing the profile to the upper profile envelope above MHWS. Below MHWS at 50m chainage, the profile lies on the lower profile envelope.

Comparison between 2010 and 2011 LiDAR data shows evidence that the beach has lowered at the southwest ends of the groyne bays. This northwest movement of sediment is consistent with other locations on this coastline.

2012

All profiles at Aberaeron North show fairly smooth profiles with a small amount of change since 2011. Profile 1 is consistently within the mid to upper profile envelope above MHWS, indicating a landward movement of beach material. Below MHWS at chainage 40 to seawards, the beach remains at a very low level, experiencing erosion around chainage 150.

In Profile 2, chainage 25 marks a transition point, where the beach level steeply changes to be in the upper profile envelope landwards, and within the lower profile envelope seawards. Above MHWS the profile lies at the upper profile envelope and does not alter from the 2011 profile. Below MSL the profile lies on the lower profile envelope, eroding below the previous lower profile envelope at chainage 150.

At Profile 3 below HAT, the beach is consistently on the lower profile envelope, showing minimal change from the 2011 profile, with the exception of a small area of erosion at chainage 80. Above HAT the upper beach is displaying instability. The berm at chainage 30 has flattened and is not visible on the profile for this year. The upper beach then erodes below the previous lower profile envelope and the berm at the upper beach moves steeply landwards.

Comparison between the 2011 and 2012/2013 LiDAR data shows that overall accretion has occurred at the lower beach, along the entire length of the Aberaeron North beach. It is evident that localised erosion does still occur, particularly in the lee of the groynes just to the north of the car park.

Beach Behaviour

The trend plots for North Beach indicate that HAT and MHWS have matching behaviour at these water levels on all three profiles. The HAT and MHWS have been relatively stable since 2008. The beach at water levels on all profiles has remained just below the baseline, with the exception of HAT on Profile 2 which has advanced above the baseline. On Profile 3, the beach profiles remain significantly lower than the 1995 baseline, although the HAT and MHWS have been fairly stable since 2008.

LiDAR comparisons between 2006 and 2012/2013 are shown in Figure ABNN1. The main change seen at Aberaeron North is the gradual accretion at the lower beach, which perhaps reflects the continued benefits of the renourishment works over the frontage. The general movement of sediment to the east remains clear in 2012, confirming the established drift along the frontage. In line with this trend the area to the east has shown signs of long term erosion but, since the works, this has not worsened, suggesting that the scheme may have introduced more sediment, restoring some additional drift along the

shore. Erosion towards the centre of the beach has continued in the last 12 months, this will be examined in more detail if this trend continues.

Overall the scheme is retaining sediment, without significant detriment to the coast to the east.

Concerns

The positive effects of the coastal defence works in 2008 are still evident in the LiDAR this year, indicating that there is stability across the system. However, the localised erosion needs to be monitored, to see if this is a long term change or a short term response to prevailing hydrodynamic conditions.

Actions

The recommendation to fly LiDAR annually remains this year. This has been valuable in identifying overall change across the profile.

2.9 Aberarth

Processes, issues and key features

The frontage displays erosion of the clay cliffs at the back of the shingle beach. Coastal structures include timber groynes and breastwork to the back of the beach, along the village frontage. There is a potential for loss of properties. Sediment for this beach principally comes from the cliffs directly to the south. Sediment is retained here through a mixture of the coastal defences, the slight promontory formed by the cliffs themselves and the higher intertidal platform at the mouth of the Arth.

Objectives of Monitoring for the area

The objective is to monitor the rate of erosion of the cliff and the evolution of the beach, to assess and identify the risk to properties, in view of the SMP2 policy of realignment.

Table 2.9.1 – Dates of the LiDAR collection at Aberarth

Annual LiDAR Collection	Date of LiDAR flight
2009	6th, 7th, 9th and 21st August 2009
2010/2011	3rd February 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Profile 1 continues to show erosional trends this year; there has been lowering along its length, particularly above HAT where significant steepening has occurred. Between HAT and MHWS, however, a small amount of accretion has occurred and the profile subsequently sits at its upper limit.*

More variable patterns of erosion and accretion occur along Profile 2 this year (compared with Profile 1). The upper beach has accreted a small amount, however, below this the beach has cut back, reducing the width of the slight berm which existed at approximately 10m chainage and moving its crest landwards.

From HAT down to approximately 30m chainage the beach has accreted to the top of its profile envelope. Below this, beach lowering has predominated.

LiDAR was flown at Aberarth in 2006, 2009 and 2010. Figure ABA1 shows the comparisons between these years. The figure indicates that compared with 2009, there has been little significant change, but with a tendency for beach lowering further down the profile and accretion at the upper beach. It is important to note that this is a comparison between winter 2009 and summer 2010, which could account for this steepening as the calmer summer period causes sediment to be placed onto the beach. Comparison between 2006 and 2010 indicate that Aberarth has tended to lower at the upper beach, with accretion further seawards.

2011 Profile 1 has undergone a variable amount of erosion and accretion, with erosion around HAT and an apparent distribution of material to around MSL. The erosion at HAT is a continuation from last year and the profile subsequently remains low within the profile envelope at this level, but is relatively high in the profile below MHWS.

Profile 2 has more consistently lowered along its length. A significant amount of material has been eroded from above MHWS, taking the profile from its upper limit to its lower limit, down to MHWS. Below MSL, erosion has occurred, also taking the profile to the lower profile envelope limit. An anomaly can be seen in the data at approximately 90m chainage, and is not considered to reflect actual behaviour.

LiDAR data collected in 2010 and 2011 is compared in Figure ABA1. This shows how, in the south there has been erosion at the upper beach with accretion at the lower part of the profile. Further north, against the rock revetment at the mouth of the Arth, there has been a significant amount of accretion. This pattern of accretion in the north east of the frontage, and erosion to the upper beach along the south west half of the frontage is consistent with trends seen at neighbouring Aberaeron South beach, and is likely to be due to prevailing wave direction.

2012

Profile 1 has undergone erosion around HAT and MHWS. The material from the berm which was previously positioned between HAT and MHWS has been removed, resulting in a flattening of the profile to below the previous lower profile envelope. This erosion seems to be a continuation from the preceding year. Around MSL the beach is within the upper profile envelope, and then remains in the middle profile envelope with limited change in the lower beach.

Profile 2 remains within the middle to upper profile envelope through its length. Around HAT the beach has accreted above the 2011 profile with beach material accreting into three small berms, seawards of the existing berm. Below MHWS the profile erodes in a small area to the lower profile envelope, before accreting substantially at MSL to above the upper profile envelope. This accretion suggests the former berm between MHWS and MSL has moved seawards. Below MSL, the beach remains in the upper profile envelope for the rest of its length.

Comparison between the 2011 and 2012/2013 LiDAR data shows evidence of erosion in the centre of the beach, while accretion along the length of the lower beach has been the dominant coastal process. This year erosion at the base of the clay cliffs is not as intense as last year. Although there is still some localised erosion at the back of the beach, accretion has also occurred here this year. However this year, erosion has occurred around the pier where previously accretion had taken place. This change in material distribution will need to be considered next year to maintain the structural integrity of the pier.

Beach Behaviour

The trend plot for Profile 1 shows a retreat of HAT and MHWS, which is consistent with the erosion and removal of the berm seen around this location in the 2D graph. The MSL remains above the baseline and shows a positive trend. Again, this is consistent with the 2D graph which shows the beach level is maintained in the middle profile envelope. Profile 1 continues to fluctuate the most.

The trend plot for Profile 2 shows an overall positive trend across all water levels. HAT and MHWS continue to have a good relationship and have mirrored each other's change since 2007. The overall advance in beach level matches the accretion shown at HAT and MSL in the 2D graphs.

3D graphs also show the variability of Profile 1 with most of this occurring between 2-6mODN. Profile 2 further shows the lower beach to be advancing. No further changes to note have occurred over the monitoring period.

Indicative beach volume analysis for Profile 1 shows that overall lowering has occurred, which is attributable to lowering of the beach above MSL. This is consistent with the 2D graph which shows the removal of the berm and erosion above MSL. Profile 2 shows a sharp increase in volume this year, which has largely occurred above MSL. Again this is consistent with the beach accretion displayed in the 2D graph.

LiDAR data comparisons between 2006 and 2012/2013 are shown in Figure ABA1. The erosion which has occurred in the centre of the beach and around the pier in 2012 appears to be fairly insignificant in the long term comparison. This figure shows that in fact there is a long term trend for accretion around the pier, the mouth of the Arth and the central stretch of the beach. To the south there is still erosion at the upper beach and base of the cliffs, however this is fairly minimal compared to previous years. This pattern of accretion to the north east of the frontage and erosion to the south west upper beach is consistent with trends seen at neighbouring Aberaeron South beach and is likely to be related to the prevailing wave direction.

Concerns

The higher variability of Profile 1 is to be expected, considering that Profile 2 is largely held by the rock revetment at the mouth of the Arth, and is under a greater level of influence of the timber groynes along the frontage. As the clay cliffs are known to be retreating at Aberarth, the lowering around the mid to upper beach at Profile 1, the drop in beach volume this year, and the persistent erosion at the base of the cliffs displayed on the LiDAR are a cause for concern. The longer term rate of erosion of the cliffs appears to be quite low and continued monitoring is required.

Actions

Annual LiDAR continues to be recommended for Aberarth.

2.10 Llansantffraed

Processes, issues and key features

A very stony foreshore with a significant shingle bank below eroding boulder clay cliffs forms the eroding shoreline in this area. An isolated hotel and properties in Llansantffraed village are potentially at risk. Access to the beach and the coastal footpath are also under threat. The hotel owner has put in place some local coast protection measures.

Objectives of Monitoring in this Area

To monitor the frontage to assess the need for a long term management strategy over this frontage and to assess changes to the area in view of localised coastal protection.

Table 2.10.1 – Dates of the LiDAR collection at Llansantffraed

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	3rd February and 3rd March 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach profiles (previous years in Appendix A)

2010

Very little change has occurred on Profile 1 this year compared with 2009, although there has been a small amount of erosion, particularly at the upper reaches of the beach. The profile is presently lying at the bottom of the profile envelope. Profile 2C has variable change along its length, with lowering above HAT and smaller sections of erosion just above MSL and from approximately 75m chainage to seawards. Profile 2B follows this variable pattern, with some accretion above HAT and some lowering below this, down to approximately 100m chainage. This profile also lies below its profile envelope below MHWS down to MSL. Profile 2A shows a similar pattern, with erosion along its length except for some accretion below MSL. The profile is at the bottom of its profile envelope except for its upper reaches, above HAT.

LiDAR has been flown at Llansantffraed in 2006 and 2010. The comparison between these two years of data is shown in Figure LSF1. It shows that there have been pockets of erosion. Notably this can be seen in a long-profile in the north and also to the south of the river here.

Profiles have been taken through the LiDAR data from 2006 and 2010, at the location of the cliff line. Figure LSF2 shows the location of these profiles. The profiles show that the majority of the frontage has lowered over this time period. Specifically, Profiles 3-8, 10, and 12–19 all show either lowering of the beach directly at the toe of the cliff, or erosion of the cliff face itself.

2011

Profile 1 remains at or below the lower profile envelope along most of its length, with little change this year apart from accretion above HAT. Profile 2C shows similar accretion of the beach above HAT, with a significant cut back of the upper profile, to the lower profile envelope. This could explain where the material for accretion has come

from. Below this there has been little change, and the profile is still located at the lower profile envelope. A small berm has been recorded further down the profile, below MSL.

Profile 2B has accreted at the upper beach around HAT, but this has occurred alongside beach lowering around MHWS to MSL, leaving the beach below the previous profile envelope. Below MSL the profile is marginally higher than in 2010, meaning that the profile is sitting in the centre of the profile envelope.

Profile 2A has eroded above HAT, with a small accretion of material between MHWS and HAT, forming a berm. Below MHWS generally, the profiled has increased in level consistently along its length but the profile remains at the lower limit of the profile envelope. At MSL, a small area of erosion can be seen, taking the profile to below the current profile envelope.

LiDAR has been flown for the second consecutive year, as well as that flown in 2006. Figure LSF1 shows that, around the caravan park to the south, the beach has accreted between the two years. Just north of this, there can be seen a pocket of erosion (between profiles 2B and 2C) while further north again the profile has accreted, in front of the town.

2012

Profile 1 displays a similar profile to 2011, with the profile remaining at the lower profile envelope for most of its length. Above HAT, the berm at the upper beach has moved slightly landwards. Around the MSL there is a small area of accretion, however towards the lower beach the profile drops below the previous limit of the lower profile envelope.

Similarly Profile 2C remains consistently within the lower profile envelope along its length. Above HAT erosion has removed the berm from the upper beach, creating a smoother profile. Around chainage 30 the profile erodes to below the lower profile limit and around chainage 100 a substantial amount of material is lost. The profile remains at the lower profile envelope at the most seawards section of the beach.

At Profile 2B the upper beach has a steep peak of accretion at chainage 15, with beach retreat either side of it. This is possibly explained by the local coastal protection measures at the base on the cliff causing this anomaly. From HAT to below MSL the profile remains at or below the lower profile envelope, similar to the 2011 profile. From chainage 60-125 there is an area of erosion, meaning the profile is marginally lower than in 2011. At chainage 130 accretion causes a steep rise in the beach level to the upper profile limit, which is matched by a steep reduction in beach level from chainage 165 seawards to meet the lower profile limit.

Profile 2A has a large area of retreat at the upper beach, with the berm steepening. The beach level remains at the lower profile envelope below HAT and MHWS. Around MSL there is a small area of minimal accretion, with the profile reaching the upper profile envelope from chainage 70-90. However from chainage 100 seawards the beach is retreating as the profile is at the lower profile envelope.

Comparison between the 2011 and 2012/2013 LiDAR data shows evidence of a minor area of accretion to the south near the caravan park. This accretion, which has occurred in previous years, has spread to the middle area of the beach. Moving north there is limited change across the middle area of the beach. This year erosion of the cliff base has occurred consistently in a narrow section along the length of the beach. This erosion, which is the opposite to the pattern of accretion in the previous year, has two intense areas of lowering, firstly to the north in front of the town and secondly to the south near the mouth of the Afon Cledan.

Beach Behaviour

The trend plots for Profile 1 show all water levels have seen a small advance, with the exception of MSL which is advancing despite seeing dramatic changes over the monitoring period. Overall, the beach has been lowering over the monitoring period, although MSL currently sits above the baseline. Profile 2A shows the same overall pattern of lowering, over a shorter period of time, although this year MSL shows a steep increase from its previously low level. Profile 2C shows an overall lowering trend, with all water levels clustered quite closely, albeit below the baseline. Profile 2B continues to be variable in the short term, with a longer term lowering at HAT, MHWS and MSL.

In the 3D plots the cyclical patterns of erosion and accretion is mostly evident in the lower reaches (-2 to 2mOND). The variable nature of Profile 2B is evident.

Indicative beach volume graphs show that despite the decreasing trend of Profile 1, this year is showing some increase in volume, which has largely occurred above MSL. Profiles 2A and 2C both continue to follow an overall trend of reducing beach volume. At Profile 2B, despite the overall advancing trend, the beach volume is decreasing this year, particularly below the MSL. This is consistent with the position of the profile in the lower profile envelope as seen in the 2D graph.

Figure LSF1 provides a comparison between 2006 and 2012/2013 LiDAR. The image indicates that the frontage is, overall, eroding. The upper beach at the base of the cliffs is also showing a trend for erosion along the length of the beach. In particular, the comparison shows that erosion has intensified towards the north, which may be directly related to the erosion that has occurred at this location this year. Erosion is still dominant to the south of the caravan park at the upper beach and around the shallow bay towards the outfall of the watercourse. There are several pockets of accretion in the centre of the beach which seem to have been maintained since 2006.

Overall, the rate of erosion of the cliffs appears less than the long term trends collated within the SMP. This has to take into consideration that there have not been any major storms over the monitoring period. The cliff line is clearly eroding but the trend plots would suggest that at Profile 1, to the north, this is only at a rate of around 0.1m/ yr. To the south the cliff appears to be retreating at a similar rate despite greater variation at HAT.

Concerns

The beach lowering at Llansantffraed continues to be evident through the monitoring. Beach lowering is a concern due to its potential for increasing wave attack and subsequent erosion of the vulnerable boulder clay cliffs at this location.

Retreat of the lower beach in all profiles is a concern, suggesting this is a consistent pattern seen across the whole beach at Llansantffraed.

Actions

The SMP2 has a preferred approach of managed realignment at Llansantffraed. This is continued from SMP1 for the area. Protection of specific assets, at the local scale, is not seen as interfering with the overall processes at present. No specific action beyond keeping local landowners informed is recommended at present.

2.11 Llanrhystud

Processes, issues and key features

The mouth of the Wyre at Llanrhystud is one of the control points along the coast in this area. While the river appears to have created a slight headland, forming a promontory where material is held in place. Localised erosion occurs along the shingle bank to the north and south of this promontory, and overall, the frontage is quite vulnerable to change. A breach in the shingle bank would cause flooding of the low-lying land behind and to the caravan park. Localised coast protection measures have been put in place by the caravan park owner.

Objectives of Monitoring for the Area

To identify any risk of breach of the shingle bank; to assess the long term evolution of the beach and to determine the need for a long-term strategy for Llanrhystud.

Table 2.11.1 – Dates of the LiDAR collection at Llanrhystud

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	3rd February and 3rd March 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *At Profile 1 there is variable erosion and accretion along the profile length. The upper beach is marked by erosion, with accretion around HAT and MHWS. The beach has cut back just above MSL but material has redistributed, possibly manifesting as accretion below this. Generally, the profile is in the centre of the profile envelope. Profile 2 is also variable along its length. The upper beach has not moved significantly although there has been some lowering to below the profile envelope at just above HAT. Below this, from HAT to below MSL the profile has accreted. Between MSL and MLWS erosion has predominantly occurred.*

LiDAR has been flown at Llanrhystud for the first time since 2006. The comparison between 2006 and 2010 is shown in Figure LRS1. LiDAR covers a much larger area than the topographic survey. To the south of the mouth of the Afon Wyre, where the topographic profiles are taken, there appears to be distinct areas of erosion in the centre of the beach cross section and accretion to the top of the beach. This indicates that the beach may be steepening at this location. Directly at the mouth of the estuary, there has been clear erosion in one section, flowing to the north, with significant deposition elsewhere around it. Moving still further north, an area of significant erosion can be seen, in the lee of where the cliff alters alignment. Erosion can then also be seen along this northern section. The critical area of erosion in this area can be seen as being to the south of the Afon Wyre.

Profiles have been taken through the two years of LiDAR data, to compare the location of the cliff line between 2006 and 2010. Figure LRS2 shows the location of these profiles. Profiles 2, 5, 6 8 and 10 show clearly that there has been erosion at the base of the cliffs along this frontage. Of these, only Profile 10 appears to have resulted in recession of the top of the cliff line.

2011 At Profile 1, the beach continues to be variable in its upper reaches, showing alternate erosion and accretion above MHWS. The profile has not changed significantly between MHWS to around 28m chainage. Below this, material has accreted along a 15m length and eroded below MSL, presumably through a redistribution of material, landwards.

As with previous years, Profile 2 mirrors this variable erosion and accretion, with a higher tendency towards erosion. The berm, which was present around HAT in 2010, has been removed and the profile is subsequently at its lower limit. Below MHWS, the profile has generally lowered, leaving a berm between MHWS and HAT. From MSL to around 100m chainage this lowering has continued, but the profile is at the centre of the profile envelope. Seawards of 100m chainage, some improvement in beach level has occurred, taking the profile to the upper profile limit.

LiDAR has been flown for the second consecutive year. The annual comparison shows clear pockets of erosion at the frontage, notably in the bay to the north of the Wyre outfall, around the point of the outfall itself and further along the profile, in a line that starts at the upper profile in the north but moves seaward as it moves to the south. At the point where the line of erosion moves further down the profile, the upper profile, beneath the cliffs, has accreted.

2012 Overall Profile 1 is similar to the summer 2011 monitoring. Generally the profile is in the upper profile envelope from the upper beach to below MHWS, but around MSL the profile lowers to the centre of the profile envelope. There are a few minimal patterns of accretion and erosion, with some small accretion above HAT and below MHWS, and a small area of erosion above MSL.

Profile 2 shows patterns of more variable erosion and accretion. Up to chainage 35, the profile is in the lower profile envelope. The berm between HAT and MHWS has flattened this year and is not visible on the profile, giving a smoother shape to the profile. This erosion of the berm has taken the profile to below the previous minimum. Below MHWS from chainage 40 onwards the profile in the middle profile envelope, albeit two small areas of erosion and accretion. From chainage 90 seawards, the beach level is advancing and is in the upper profile envelope.

Comparison between the 2011 and 2012/2013 LiDAR data shows that accretion either side of the headland is more extensive this year, with accretion at the base of the headland, spreading seawards. However, clear pockets of erosion are still dominant at the mouth of the Afon Wyre. Erosion has also intensified at the cliff base to the east of the headland. Moving south, accretion is present along the length of the beach, with accretion dominating where previously the beach was eroding. Notably there is a narrow strip of accretion at the cliff base, followed immediately by a narrow area of erosion.

Beach Behaviour

Generally there has been a build-up of Profile 1 since a relatively rapid drop in beach level between 1995 and 1997. This year, MHWS and HAT continue to show a seaward movement trend. There is a lowering at MSL with the lower beach showing fluctuation and a landward movement since 2009, which needs to be monitored. This year the retreat correlates with the loss of the berm at MSL in the 2D graphs. Profile 2 continues to show a decreasing trend across all water levels. The only exception this year is MSL which shows an advancing lower beach. This corresponds to the 2D graphs in which the lower beach is consistently in the mid to upper profile envelope.

The 3D profiles show little variation over the monitoring period, except for a steepening of the beach at Profile 1 between 2005 and 2007. Profile 1 is characterised by cyclical change, although the upper beach appears stable. Profile 2 appears to also be characterised by short term cyclical change as the beach advances and retreats regularly, but there appears to be a tendency towards retreat of the lower reaches (0-2m AOD), in the second half of the overall monitoring period.

Indicative beach volume analysis shows that both profiles continue to follow an overall trend of reducing beach volume. The only exception is this year, which shows that the volume at Profile 1 has slightly increased in 2012.

Figure LLN1 provides a comparison between 2006 and 2012/2013 LiDAR. The image shows that t

Figure LRS1 provides a comparison between 2006 and 2012/2013 LiDAR. The image indicates that the mouth of the Afon Wyre is still dominated by erosion. Offshore from the Wyre outfall accretion is widespread, dispersing from the cliff bases either side of the headland, to around the frontage of the headland. This widespread accretion in the long term comparison can, in part, be related to the change this year of increased accretion around the headland. Immediately south of the headland, the trend for erosion at the cliff base extending along the upper beach continues. The trend for accretion at the cliff base to the far south of the beach is also maintained in this long term comparison.

The LiDAR plots do show the influence of the headland at the Wyre outfall and the pinchpoint created by this headland. Overall the upper beach is only retreating at a rate of around 0.1m/year. This does vary year on year with erosion occurring during the late 1990's.

Concerns

The tendency for material to be lost from the beach at Llanrhystud is a continuing concern. The upper beach at Profile 1 has recovered from the significant cut back seen two years ago, and the beach is now positioned in the upper profile envelope. However Profile 2 remains at a low level at the upper beach and a further cut back has occurred in the central beach this year with the loss of the berm. The trend for decreasing beach volume also occurs at both profiles. Profile 1 has been on a path to recovery since 2007, a trend which can be clearly seen in the trend plots this year. In addition, both profiles are advancing along the lower beach.

Actions

LiDAR is recommended to be flown every year. The 2D profiles are also providing a good measure of the short term changes in beach morphology. The recovery seen on Profile 1 over the last 5 years needs to be seen in the context of potentially longer-term cyclical change.

2.12 Aberystwyth – Tan-y-Bwlch

Processes, issues and key features

This frontage consists of a sandy lower beach backed by a steep high shingle to grit upper beach. There is a slow erosional trend at the crest of the southern beach that is likely to continue. The river Ystwyth flows to the back of the shingle bank of Tan y Bwlch. The timber groynes here are constructed to prevent a breach in the bank. However, there is a strong possibility of a breach, resulting in the diversion of the river Ystwyth and regular inundation of the low-lying valley behind. The Stone Pier holds the beach at its northern end while also forming the southern entrance to the harbour.

Objectives of Monitoring for the area

The frontage needs to be monitored annually so that an assessment of the long term evolution can be developed, to inform a long term strategy for the area.

Table 2.12.1 – Dates of the LiDAR collection at Tan-y-Bwlch

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	3rd March 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 *Profile 1 shows little change from 2009, but with some accretion above HAT and between MHWS and MSL, and erosion at MSL. Conversely, Profile 2 has eroded above HAT, forming a visible berm between HAT and MHWS. Below this, there has been little change. This profile lies at the lower part of its profile envelope.*

Profile 2 has generally eroded at the upper beach and accreted between HAT and MHWS to form a small berm. The profile lies at its lower profile envelope.

Profiles 3 to 5 show a variable pattern of erosion and accretion along their lengths, becoming more undulating this year. This change has resulted in two berms developing on all three profiles; one above HAT and another around MHWS, with little change elsewhere. All three profiles are also generally lying at their lower limit from MHWS to seawards. The upper beach at Profiles 4 and 5 is generally lying in the centre of the profile envelope.

Profile 6 shows little significant change from 2009, but lies at the bottom of its profile envelope with the exception of a small berm at MHWS.

Profile 7 has also accreted at MHWS to form a small berm, however erosion has occurred along the majority of the remaining profile length. Similarly, erosion has occurred along the whole length of Profile 8 except for a small area of accretion at the very upper beach and past approximately 50m chainage to seawards.

2011 Profile 1 in the north shows that the upper beach has lowered slightly, making a more pronounced berm at around 5.5mODN. From here down to just below MHWS little change has occurred, but with consistent lowering between MHWS and MSL. Between HAT to 20m chainage, the profile is at the lower profile envelope. Profile 2, conversely, has undergone overall accretion, taking it to the centre of the profile envelope. Two large

berms have developed here, one between MHWS and HAT and another one much further up the profile, at around 30m chainage, steepening the beach.

The upper part of Profile 3 has lowered, from 15m chainage down to HAT. Overall, the profile now sits at, or below the lower profile envelope. Consistent with this, Profiles 4 and 5 are also lowered along their length, and subsequently also sit at or below the lower profile envelope. Overall, these two profiles are also smoother, with one berm located between HAT and MHWS (as opposed to two, last year). The upper beach on Profile 4, above HAT, is steepened due to this lowering along the profile.

Moving south, Profiles 6 and 7 have accreted above HAT but lowered below this (accretion on Profile 6 is to a higher extent than Profile 7). Below MHWS the profile is below the original envelope and lies around the lower limit along the rest of the length.

Unlike the other profiles at Tan-y-Bwlch, Profile 8 shows little change in general, and the profile continues to remain at the lower profile envelope. The profile continues to be concave in shape.

LiDAR comparison data is presented in Figure TYB1. The comparison between 2010-2011 shows the pockets of erosion located along the beach. They are still indicating that the majority of lowering has occurred towards the north, next to the Stone Pier, with generalised lowering along the rest of the beach. In the centre of the bay, an area of accretion can be seen, but it is assumed that this is a snapshot that shows the impact of prevailing wave conditions at the time.

2012

Profile 1 to the north shows little change at the upper beach and mirrors the profile of 2011. The toe of the profile has accreted this year, however the lower beach has eroded below the lower profile limit. Similarly Profile 2 has little change at the upper beach, however the beach has significantly eroded along the majority of its profile. This has resulted in the removal of the two berms from 2011, thus creating a much smoother profile than what existed in previous years. The lower beach has consistently eroded to below the previous limit.

Profiles 3, 4 and to a lesser extent 5, all exhibit a landwards movement of material, causing the berm from 2011 to migrate above HAT. The volume of material moved varies between profiles with the large berm at Profiles 3 and 4 accreting to at or above the upper profile envelope, whereas only a small berm exists in the centre of the envelop at Profile 5.

At Profile 3 the lower beach has eroded to below its previous limit. Conversely, Profiles 4 and 5 have accreted along the lower beaches.

To the south, Profile 6 and 7 exhibit minimal change since 2011. Profile 6 has a general trend of lowering along the profile length, with the toe of the slope showing erosion this year. Profile 7 also undergoes erosion at the profile toe, however below MHWS, accretion raises the beach to the centre of the profile.

At the most southerly point, Profile 8 has accreted in the centre of the beach, resulting in a steep berm forming across the frontage this year. The rest of the profile shows little change since 2011 and the profile remains in the lower profile envelope.

The comparison between 2011 and 2012/2013 LiDAR data shows that the northern frontage of the beach is eroding. To the south there appears to be greater accretion.

This is consistent with last year's trend which showed the majority of lowering occurred towards the north. However, the erosion near the Stone Pier does appear to have rebuilt.

Beach Behaviour

The fact that some profiles show significant up and down change in volume supports the hypothesis that this beach is sensitive to wave direction and tends to move back and forth according to the prevalent hydrodynamic processes. Waves approach this coastline from a broad spectrum from the southwest through to the north (there is a degree of shelter from the northerly swell provided by the adjacent coastline). Despite this sloshing of material, net drift at Tan-Y-Bwlch is in a northerly direction.

In line with this, the comparison between LiDAR data from 2006 and 2012/2013, shown in Figure TYB1, shows that erosion is still the dominant coastal process at the southern beach, with an overall the trend for more accretion to the north. However, again highlighting the variability, this last year, this trend tended to be reversed.

Even taking into account the longer term movement to the north, the trend plots continue to indicate an overall pattern of lower beach levels at most profiles along the length of Tan-Y-Bwlch, compared to the 1995 baseline. This trend is most significant towards the northern end of the beach this year, with the horizontal erosion shown in the trend plots resulting in a steepening of the beach. Further highlighting the variability, the trend plot for the southern beach (Profile 8) continues to show a very different pattern compared to the rest of the beach, with accretion of the beach occurring at all water levels, and in some cases, rising above the 1995 levels this year.

Overall the 3D plots show a gradual retreat since 1995, interlinked with a cyclical pattern of beach material at Tan-Y-Bwlch. The northern beach displays a large variation below 3mODN, on a cyclic basis. Towards the centre of the beach, where the coastline is oriented on a north-south axis, the tendency is for material to move around the whole length of the profile. This is highlighted by the landward movement of the berms in the centre of the beach, which is documented in the 3D plots. It is clear that the berms have reduced in volume since 2004. This central section of the beach will be susceptible to changing wave directions. Further south, where the coastline curves and is oriented on a southwest-north-east axis, there is less change again.

In line with the variability in beach behaviour, the indicative beach volume analysis shows that change occurs to different degrees alongshore at Tan-Y-Bwlch. Despite erosion being the dominant coastal process, the majority of the beach (Profiles 2-8) shows a long term trend of increasing in beach volume. Exclusively, the most northern section of the beach (Profile 1) has a long term trend of decreasing in beach volume. However, across the whole beach there are short term changes of increasing and decreasing volume, supporting the theory that the variability in beach behaviour at Tan-y-Bwlch is due to sensitivity to wave direction.

Concerns

Erosion continues this year at Tan-y-Bwlch. Critically, erosion continues where the shingle ridge is narrowest, where the river turns to flow parallel with the beach. The risk of breach remains and beach width is critical for mitigating this risk. Beach lowering and movement landwards are critical elements that need to be monitored. A breach would cause increased overtopping and inundation of adjacent low lying land.

Similar to the previous two years, the crest of the shingle ridge has not lowered this year, however the width at the upper beach is tending to narrow. The return to a general pattern of beach lowering this year gives rise to a continued cause for concern. This year's monitoring has documented the landward movement of the berms in the centre of the beach, which renew concerns for beach retreat and narrowing. Next year's monitoring needs to understand if the landwards movement of material is becoming widespread along the beach. A critical threshold of crest narrowing needs to be established in relation to risk of breach.

The SMP2 has highlighted a policy of managed realignment along this section of the coast. As part of the SMP2 Action Plan there is the aim to engage landowners in developing this policy.

Actions

The assessment of a critical threshold of beach level needs to be undertaken, in association with a defence inspection to monitor the effectiveness of the current structures in holding the crest protection. The threshold should be used to trigger action, in line with the recommendations contained within the Aberystwyth Coastal Defence Strategy, and the SMP2 Action Plan.

2.13 Aberystwyth – South Marine Terrace

Processes, issues and key features

The frontage of Aberystwyth town consists of a relatively sandy gritty beach down to low water, backed by continuous masonry or concrete wall. The beach is fixed to the south by the harbour defences. In the north, is the Castle Rock outcrop and groyne. The Castle Hill headland is home to the remains of the Aberystwyth Castle. Loss of beach material would result in undermining of the coastal defences structures protecting the town.

Objectives of Monitoring for the area

To identify the evolution of the beach, as well as any risk of loss of beach material. Long term trends are therefore important for assessing the potential threat to the coastal defences, but understanding the short term variations will help in the analysis of critical beach levels.

Table 2.13.1 – Dates of the LiDAR collection at South Marine Terrace

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	3rd March 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 (summer) & 2011 (winter)

The beach at Profile 0 has steepened, with accretion at MHWS, and erosion around MSL. The profile lies at its lower profile envelope. Profile 1 is also at its lower profile envelope, with a small redistribution of material between MHWS to HAT.

Profiles 2 and 3 have flattened, with a cut back at the upper beach and the formation of a berm between MHWS and HAT. The beach is also higher than last year at profile 2, all the way along the profile.

Profile 4 is similar to Profiles 1 and 3, although no erosion has occurred above HAT. A berm has developed between MHWS and HAT, with accretion below this.

Profile 5 shows more widespread accretion, with a large berm above HAT, to the top of the profile envelope. A redistribution of material at the upper beach has formed a smoother profile. There is also development of a smaller berm between HAT and MHWS.

The large berm previously located above HAT on Profile 6 has redistributed this year and two berms are visible to what would be either side of it. Overall, this profile has accreted and is central within its profile envelope.

On Profile 7 a berm has formed between HAT and MHWS but the beach has cut back above this. There has been little change along the rest of the profile

At Profile 0 the beach is lying above both 2009 winter and 2010 summer levels, along most of its length. This has placed it within the upper middle part of its profile envelope.

Profile 1 shows a very different pattern, with significant erosion from MHWS down to the end of the profile, leaving the beach beneath the profile envelope. Prior to this, there was little difference in beach level between the winter 2009 and summer 2010 profiles.

Profile 2 has smoothed compared to the summer 2010 profile. Erosion has occurred to leave the profile beneath the profile envelope in a number of places, particularly, between MHWS and MSL. A similar pattern can be seen on Profiles 3, 4, 5, 6 and 7 whereby the summer berm between MHWS and MSL has been removed, smoothing the profile. These profiles, however, are within their profile envelopes and, with the exception of the berm removal, are not significantly changed from the summer beach level. They are tending to be lower than their winter 2009 levels.

Profile 8 has lowered along much of the profile length compared with both summer 2010 and winter 2009 levels, particularly above HAT level.

Profile 9 is anomalous in that it has increased in level above HAT to sit in the upper part of the profile envelope.

2011 (summer) & 2012 (winter)

There has been a reversal when comparing summer profiles on Profile 0, from steepening during 2010 to a flattening in 2011, with accretion from below MHWS to lower down the profile. Over the winter this profile has tended to rebuild and 2011 and 2012 data are comparable, with the profile lying in the centre of the envelope. Profile 1 also shows the same pattern of accretion from MHWS seawards in summer 2011, although has lowered along its length during the winter, with a significant cut back around HAT. Despite this, the profile remains around the centre of the profile envelope, with the exception of around the HAT level.

Conversely, Profiles 2, 3 and 4, to the north, lowered along their length taking them to the lower limit of the profile envelope during summer months. The summer has tended towards a smoother profile too. This summer lowering is a reversal of the pattern seen in 2009-2010 data. During winter, however, consistent with Profiles 0 and 1, the beach has actually built back up consistently along its length.

During summer 2011 Profile 5 has also lowered but here, a small berm had developed between MHWS and HAT. Over winter 2012, however, this profile has undergone a significant build-up of sediment along its length but particularly in the re-formation of a berm above HAT, raising the beach back to the higher 2010 summer levels.

Profile 6 has a similar pattern of lower levels during summer 2011, and with a recovery along the length in winter 2012 except here, the berm was not removed during the summer months. During winter, this berm has rolled landwards. There has also been a slight draw-down of some material as would be expected during this period. Above HAT this profile lies towards the top of the profile envelope. Profile 7 exhibits similar behaviour, with winter 2011 representing a low point in the general beach level over the past two years. The largest difference between Profiles 6 and 7 is that at Profile 7, the beach has steepened during winter 2012, with some lowering below MHWS. This profile sits in the centre of the profile envelope above this lowering.

Profiles 8 and 9 do not follow this pattern of change and instead, winter 2012 represents some of the lowest levels in the last two years. This is in contrast to summer 2011, where the profile accreted in the centre of the profile to some of the highest levels. Profile 8 has steepened significantly this winter. Profile 9, conversely has lowered along its whole length.

Comparison between 2010 and 2011 (winter) LiDAR data indicates that there has been beach lowering to the north, down to where the bay curves to a southwest-northeast orientation.

2012 (summer) & 2013 (winter)

There has been a similar pattern of behaviour between summer and winter at Profile 0 over the last year and the previous year. The summer profile is eroded back to the lower part of the profile, with the winter profile accreting.

On Profile 1 the erosion, seen at the top of the beach between summer 2011 and winter 2012, has been made good with an initial smoothing out of the profile over summer 2012 and further growth over the whole profile in the winter 2013. This has not fully made up the loss from winter 2012 but has restored the profile to the middle of the envelope.

The loss at the upper beach on Profile 2, against the wall, that occurred in the summer of 2011 was been made good over the winter of 2012 and this has been maintained through to the winter of 2013. Over the central part of the profile the beach remains relatively low and the berm which developed during the winter of 2012 has been redistributed more evenly over the profile.

Overall, Profiles 3 and 4 show the beach to be higher against the wall, indicating the greater width of beach and a better ability to adapt without severe drawdown. The upper beach, however, is still at the lower end of the envelope. Around HAT there had been development of a berm in the winter of 2012 and this was maintained in summer 2012, raising the profile to the middle, and in the case of Profile 4, upper profile envelope. This berm has been eroded by the winter of 2013, with sediment generally moved down the profile with quite significant accretion towards low water.

Typically from the trend plots, it can be seen that over Profiles 0, 1 and 2 the whole profile tends to act in unison, building over the whole profile or eroding over the whole profile. Interestingly also, in the case of Profiles 0 and 2, tending to build over the winter and erode over the summer.

In the case of profiles 3 and 4, the trend plots show a more chaotic pattern.

With all these profiles there continues to be a slow overall loss of volumes.

Following lowering along the majority of the beach in summer 2011, Profiles 5 and 6 remained low over the upper beach during the winter of 2012, but rebuilding around the 4m to 5m OD level. There was little change to this during the summer of 2012 but by the winter of 2013 sediment had been pushed further up the profile as well as being drawn down the beach. In places, therefore, during the winter both profiles have exceeded the upper envelop against the wall and just above MSL. Neither profile shows a typical summer accretion / winter erosion pattern. Both profiles have maintained their overall volume.

The main movement over Profiles 7 and 8 has been above MHWS. At Profile 7, the beach has rebuilt back up to the upper envelope at around 7m OD, following the erosion in summer 2011. In neither case, however, has the profile filled back to the upper envelope against the wall. This erosion at the back of the wall is shown on the LiDAR Plot over this section of the frontage. Both profiles maintain their overall volume.

Profile 9 tends to show a different pattern to other profiles in that there was a build-up of the upper beach in summer 2011, which then eroded and has remained relatively low

from the winter of 2012 through to the summer of 2012. By the winter profile of 2013, the upper beach has eroded back to the lower profile. Even so, overall, the beach has maintained its volume.

Figure SMT1 shows a comparison between 2011 and 2012/2013 LiDAR data and highlights the specific change discussed above. There has been a large area of accretion in the centre of the bay, over the lower part of the profile. This has increased in volume compared to last year's accretion. This overall trend of accretion is matched by a zone of erosion around MHWS and slight accretion of the upper beach. Erosion tends to dominate the lower beach over the northern part of the frontage with some accretion of the upper beach.

Beach Behaviour

Overall, the relatively large variation at different water levels shown in the trend plots (for summer only) continues to show the successive build-up and erosion cycles of the beach, and the presence or absence of the berm within the profile.

Overall, over the southern profiles there is a loss of volume, increasing towards the south; Profiles 0 and 1 have lost on average some 15m^3 to 20m^3, Profiles 2, 3, and 4 have tended to lose some 5m^3 to 10m^3. While there has been a minor trend of loss on Profile 5 and 8, generally the more northerly profiles have retained there volume.

As noted previously, overlaying the profiles indicates that the profiles show a similar pattern of peaks and troughs, at similar timescales. Where these troughs and peaks align this suggests a cross-shore movement of material. Conversely, if the profiles are shifted in opposition it would indicate a long shore movement of material. If this is carried out using the area plots it can be seen that in any year, there is some local indication of movement from one profile to the next but that in other years the trend is for overall loss and gain. The loss of volume to the south would suggest that there is a potential trend of drift to the north. However, any such trend is quite small.

While all profiles do show significant variation and over several profiles quite rapid drawn down at the wall, it is at Profile 4 through to 8 where this historically has caused problems. In each of these profiles the crest beach level has remained low for some time.

Concerns

This year the southern beach has reverted back to the long term trend of beach lowering. This suggests that the reversal of the lowering seen last year was just a short term reversal. Beach lowering was particularly prevalent during the summer months, however the 2D profiles show that the beach significantly built itself back up during the winter. This might suggest an annual cyclical pattern of summer lowering and winter recovery but it is accepted that this is not a clear trend.

Of particular concern are the long term low levels of the beach, commonly seen at the crest of the beach. While this persists there is a risk to the foundations of the wall.

Actions

The monitoring highlights the variation in beach behaviour at the toe of the defence. It would be sensible to examine threshold levels of the defences so that these two aspects can be related.

2.14 Aberystwyth – Victoria and Marine Terrace

Processes, issues and key features

The frontage of Aberystwyth town consists of a relatively sandy gritty beach down to low water backed by continuous masonry or concrete wall. The defences to this bay are out of alignment with the natural curve of the bay and Victoria and Marine Terrace continues to be sensitive to changes in wave direction. Although the beach is held by rocky headlands to the north and south, there is a slow loss of material. Significant loss of beach material would result in undermining of the coast defences structures protecting the town.

Objectives of Monitoring for the area

The objective is to identify evolution of the beach and to assess whether the slow loss of beach material is threatening to significantly undermine the coastal defences. Vulnerability in terms of variation is important and identifying any longer term trends.

Table 2.14.1 – Dates of the LiDAR collection at Victoria and Marine Terrace

Annual LiDAR Collection	Date of LiDAR flight
2010/2011	3rd March 2011
2011/2012	14th January 2012
2013	13th January 2013

Descriptions of Beach Profiles (previous years in Appendix A)

2010 (summer) and 2011 (winter)

Profiles 1-4 have undergone accretion to above 2009 levels. This accretion has mostly been between MHWS and MSL. On these profiles there can also be seen the same pattern of beach lowering just above MLWS. The only area where erosion has occurred is on Profile 1, where there has been some cut-back of the beach above MHWS.

Profile 5, located at the southern end of Victoria and Marine Terrace, is the only one which does not follow the same pattern of erosion and accretion. Here, there has been some accretion around MHWS and at MLWS, with erosion between MSL and MLWS, to the lower profile envelope.

Over winter 2011 the beach has lowered over all profiles, reversing the accretion which had occurred over the summer months. On Profiles 1, 2 and some of Profile 5, this has resulted in the profile being located at, or below the lower profile envelope along much of its length.

Whilst Profiles 3 and 4 have lowered to below summer 2010 levels, they have not lowered below winter 2009 levels.

2011 (summer) and 2012 (winter)

Profile 1 has undergone little change above MSL when comparing summer profiles, but below this the profile has eroded. Furthermore, during winter 2012, the profile has lowered even further, to below the profile envelope along the majority of its length. This is converse to the pattern seen on SMT, to the immediate south of the frontage.

Profile 2 has lowered to around 30m chainage, with minimal change further along the profile, during summer months. As for Profile 1, winter 2012 has seen further lowering

down to MSL, with accretion (compared to the summer profile) beyond this. This draw down of material is expected over the winter months. The profile remains at the lower profile envelope along its length. During summer, Profiles 3, 4 and 5 have all consistently lowered along their length, leaving both at their lower profile envelopes with the exception of the area around MHWS on Profile 4, which lies at the centre of the profile envelope. Winter has not seen a significant level of change on Profile 3, apart from a slight draw down of material to further seawards on the profile. On Profile 4, conversely, the beach has tended to steepen over the winter this year, with a redistribution of material landwards on the profile. Profile 5 remains stable and does not tend towards large variations in beach level, tending to be sheltered to an extent by The Weg.

Figure VTA1, showing comparison of LiDAR data collected in 2010 and 2011 shows that the northern part of the beach, north of The Weg rock outcrop in the centre, has largely undergone an increase in level. This is in contrast to the south (Profiles 3-5) where consistent lowering has occurred.

2012 (summer) 2013 (winter)

Profile 1 continued to undergo erosion below MWHS and MSL during summer 2012 with the profile significantly lowering to below the previous lower limit. The profile from summer 2011 covered all but the uppermost rocks at the toe of the wall. The full extent of the rock profile was exposed by the erosion in the winter of 2012. Over the winter of 2013 the profile has accreted around MSL compared to the previous winter. This has also reversed the erosion that occurred during the summer months, although the beach still remains in the lower profile envelope. Overall there continues to be loss of volume.

Profile 2 displays similar patterns of change to Profile 1, with a small area of summer erosion around MSL and a recovery during the 2013 winter months.

In summer 2012, Profile 3 undergoes minimal erosion above HAT to below the lower profile limit and minor accretion along the central area of the beach compared to the previous summer. Interestingly the winter profile shows that the same areas have contrasting patterns of accretion and erosion, suggesting movement up and down the beach. The profile remains in the lower profile envelope. Despite this, overall, the general longer term trend is for the beach to maintain its volume.

During summer 2012 Profile 4 remains in the centre of the profile with minimal change since summer 2011. The high level of the summer 2011 contrasts sharply with the erosion of Profiles 1 and 2 to the north. By the winter 2013 the profile lost sediment quite uniformly. There is slight alternating pattern of change at Profile4, with accretion above HAT and below MSL and erosion in between MHWS and MSL. Overall the profile shows a slight change in volume.

Profile 5 underwent accretion along the majority of its length during summer 2012, raising the beach to the centre of the profile, with the exception of erosion below MLWS to the lower profile envelope. However, this profile over the winter of 2013, reached the lowest level across nearly all the beach. In particular the beach level against the wall is excessively low.

Figure VTA1 provides a comparison between 2006 and 2012/2013 LiDAR. The image indicates that the opposite pattern of beach change has occurred this year, compared with the trend exhibited in 2011. The LiDAR data for this year shows that the southerly beach (Profiles 4-5) near the pier has eroded, where previously accretion has occurred.

The central area of the beach (Profile 3), either side of The Weg has undergone extensive accretion this year, spreading from the upper beach, seawards to the lower beach. Last year lowering was widespread at this central location. The northerly beach has had a slight reduction in accretion this year, although pockets of accretion and erosion are still spread across this section of the beach.

Beach behaviour

The trend plots for summer profiles indicate that the northern profiles (1 and 2) continue to show stronger trends for erosion. The profiles in the south continue to show the highest variability. There has been a general advance across most levels on Profile 3. The lowering of the lower beach on Profiles 1 and 2 is evident on the 3D graphs. The more consistent variability of the southern profiles is also evident, where cyclic beach building and draw down can be seen.

Indicative volume analysis shows that on all profiles, there has been a tendency towards a reduction in beach volume, with greater losses in the north than the south. It was highlighted last year that there is an interrelationship between Profiles 1 and 2, in which their volumes displayed an inverse variation over the monitoring period. This year Profile 1 retreats sharply, whereas Profile 2 shows a more gradual decreasing trend. This supports the evidence of an inverse relationship between the northern profiles.

In the south, Profiles 3 and 4 show limited discernible trend and remain similar in the timing of their response to wave direction. Profile 5, to the far south, has a significantly greater movement of beach material, although this appears to have a cyclical trend, which is sometimes linked to the trends of the northern profiles. This variation can be attributed to the more northerly orientation of Profile 5 and therefore the exposure to a different incoming wave direction on occasion.

There does not appear to be much relationship between Profiles 1 and 2, and Profiles 4 and 5, with interaction limited by the presence of The Weg.

This all highlights the influence of The Weg, dominating processes over the wider width of the bay. This does vary with specific wave and probably water level conditions. The erosion seen at the middle of the beach, might suggest that the main storms with higher wave action have occurred on a relatively low water level. This possibly has meant that The Weg has been more influential in drawing sediment into its lee. Potentially, over previous years with higher water levels, this influence is less and sediment has been spread more evenly over the frontage.

Comparing LiDAR data collected in 2006 and 2012/2013, which comprises of snapshots of these two years, the beach appears to show a general pattern of accretion in the north and erosion in the south. The erosion to the south is more widespread towards the pier, which can be accounted for by the concentrated erosion seen in the last 12 months in this location. This year the northerly section of Victoria and Marine Terrace is continuing to show the long term trend of accretion, further north than Profile 1. The comparison of LiDAR reflects the cyclic nature of the beaches in this area of Aberystwyth whereby the beach tends to undergo periods of erosion and accretion.

Concerns

Beach lowering over the summer months is a cause for concern. Although losses are small, and some recovery of levels does tend to occur cyclically, the cumulative loss of sediment from the beach will inevitably have an impact on the integrity of defences in

the area. Profiles 1 and 2 appear still adequately protected despite the loss of the beach, which has been on-going since 2010.

There is an indication of long term loss of sediment and this needs to be anticipated in the medium to long term.

The main concern is with respect to loses at Profile 5 and the vulnerability of the toe of the wall in this area. This should be inspected prior to the winter.

Actions

The recommendation that analysis of the depth of the toe of the defences is undertaken is continued this year. While monitoring alone provides a relative picture of change, to have a threshold identified will allow action to be taken in advance of the beach reaching a critical level. This toe depth analysis could be undertaken as part of a wider coastal defence inspection.

Specifically there is an action to review the condition of the toe and the defence around Profile 5.

2.15 Borth LiDAR

Processes, issues and key features

The Borth frontage lies in the centre of Cardigan Bay and extends over some 4.2km, from the cliffs at South Borth to the Dyfi Estuary in the northern part of Ceredigion. Borth is exposed to a predominant wave direction of southwest to west, but southern parts are also exposed to waves from more northerly directions. Borth can be characterised as an open barrier beach, held in place by harder geology headlands to the north and south.

Continued lowering of the village frontage consisting of a shingle and cobble ridge with sandy beach, has been a cause for concern. Without mitigation, there was the potential for a breach of the ridge with the deterioration of the groynes and timber breastwork, resulting in flooding to the village of Borth. Subsequently, a Coast Protection Scheme has been designed for the frontage and Phase 1 construction is now complete. This scheme involved the placement of 110,000m^3 shingle, construction of two rock breakwaters and two rock groynes, and an offshore rock reef. The offshore rock reef, as well as being a coastal defence structure, is also intended to improve the surf conditions in the area. Design of Phase 2 of the scheme is currently underway and plans have been submitted for both Planning Permission and Marine Licence Consent. Construction of the scheme should commence before the end of 2013 with a duration of approximately six months.

Objectives of Monitoring for the area

A full LiDAR survey of the area is undertaken annually, from the beach under the cliffs south of Borth to the northern-most groyne at Ynyslas. This has previously identified that there has been deterioration and loss of material of the shingle frontage. Specifically, erosion at the southern end of the frontage is accompanied with accretion over the northern end of the village and by Ynyslas, with gradual erosion of the shingle bank along most of the rest of the frontage. Continued monitoring of flood and coastal erosion risk to the village will allow increased understanding of how the new coastal protection scheme has performed. The monitoring should continue to assist the long term strategy for this area.

Table 2.15.1 – Dates of the LiDAR collection at Borth

Annual LiDAR Collection	Date of LiDAR flight
2008	2nd and 3rd August 2008
2009	6th, 7th, 9th, and 21st August 2009
2010/2011	19th January 2011
2011/2012	8th February 2012
2013	25th February 2013

Description of Surveys (previous years in Appendix A)

2006 *As previously mentioned the cross-sectional profiles are computed with the help of an interpolation process that can influence the results and therefore the analysis of the behavioural beach patterns in Borth.*

Most of the beach profiles generally appear to be steepening, which coincides with last year's behaviour.

The topographic survey in Figure 2.11a to Figure 2.14d confirms the relatively stable sandy beach and the continued pressure on the shingle/ cobble ridge, when compared to previous years.

2007 *The interpolation process used to analyse beach profile differences at Borth for previous monitoring reports has been replaced by analysis using annual LiDAR survey. This is the second year in which LiDAR has been flown.*

Figure 2.15a shows the 2007 LiDAR survey of the frontage at Borth. This figure shows a narrow section of dunes just to the north of the town of Borth, at the site of the golf course. Continued erosion of the frontage could result in a breach through the dune system.

Figures 2.15b shows a comparison between the 2006 and 2007 LiDAR surveys at Borth. The figure shows higher amounts of erosion along the Borth frontage compared to accretion. The largest differences between 2006 and 2007 are to be found to the south of the frontage with erosion of the beach in front of the village of Borth. Towards the north there are local areas of erosion but relatively small changes between the two annual datasets.

2008 *Figure 2.15b shows the differences between the 2007 and 2008 LiDAR. Generally there are larger areas of accretion compared with erosion. An area which needs to be considered in future monitoring is at 260700, 290250 which shows an area of erosion extending across two groyne bays. To the north of the town of Borth, at the narrow section of sand dunes needs to be continually monitored to assess the threat of a breach, however the differences between 2007 and 2008 present no immediate concern.*

2009 *Figure 2.15b shows the LiDAR comparison between 2008-2009. The figure shows that the area has been marked by accretion this year, with a subsequent formation of a series of northwest-southeast oriented ridges, located slightly offshore. This ridge formation is in-line with observations from previous years, except that in the past, larger areas of erosion were also present adjacent to those troughs.*

Pockets of erosion, also shown in Figure 2.15b are mainly located towards the northern end of the village and where the row of houses seaward of the road, ends. This erosion has predominantly been located on the upper beach. The removal of the shingle ridge at this location is a catalyst for the implementation of the Borth Coastal Protection Scheme and should continue to be monitored.

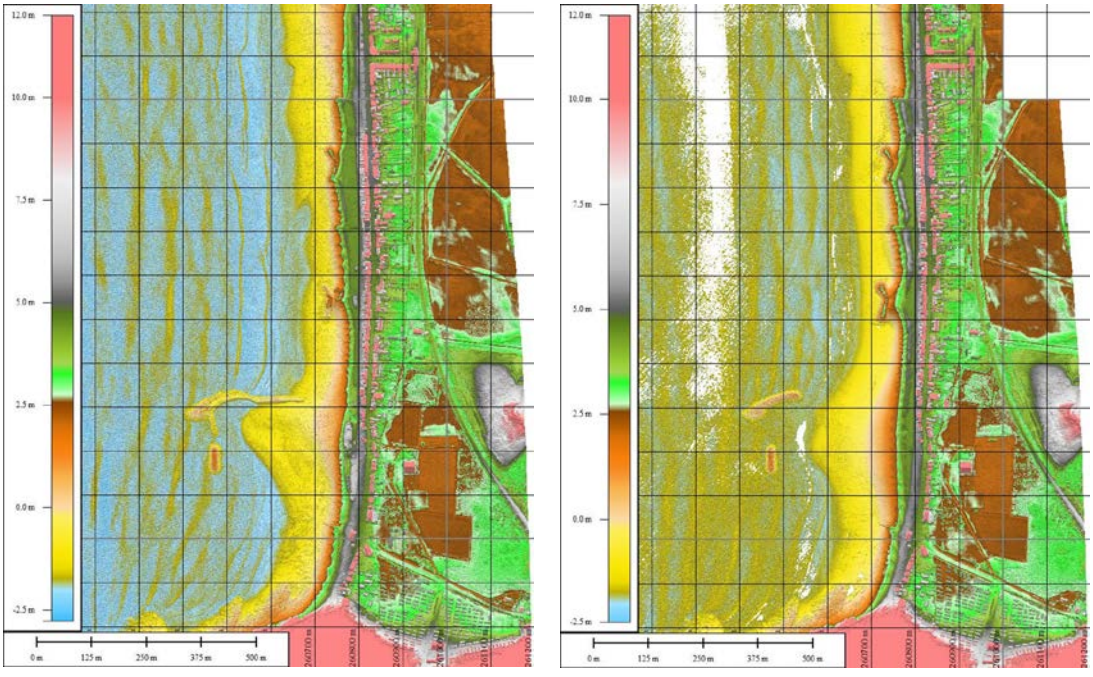
2010 *A comparison of LiDAR data from 2009 to 2010 can be seen in Figure BOR1. Over this time period, there has again been the characteristic pattern of alternate erosion and accretion along the frontage. Erosion is most prominent in a line fronting the main town, where the properties encroach seawards of the main road through Borth. This is the location of the present coastal protection scheme. Other areas of erosion include offshore of, and parallel to, this backshore erosion, in a line extending from the cliffs in the south to the outskirts of the town in the north. Towards Ynys-las erosion can be seen at a similar location on the profile. Elsewhere on the figure, accretion can be seen. Immediately adjacent to the cliffs in the south there are two areas of accretion. Another,*

relatively pronounced, area of accretion can be seen immediately to the north of where properties set back to the landwards side of the road, directly adjacent to the defences. From here on northwards, this accretion at the toe of the defences continues all the way to Ynys-las. Further offshore, accretion dominates along the whole coastline.

2011 *The comparison between 2010 and 2011 LiDAR data clearly shows the positive effect of the beach renourishment that has been undertaken, as well as picking up the construction of offshore breakwaters and rock groynes. Immediately outside the area of nourishment, however, erosion predominates. Specifically, this erosion has occurred both seaward and to the north of the works. Further north again, an area of accretion can then be seen to the northern part of the town, in region of the upper profile, to around 40m north of the Borth and Ynyslas Golf Club. High tides and winds during the month of October (2011) have provided a good test to the success of the scheme. The high water levels and storm waves were not able to penetrate the back line of defence.*

2012 Comparison between the 2011 and 2012/2013 LiDAR data shows that the effects of the beach renourishment scheme continue to be realised, with this area continuing to undergo accretion over the last 12 months. It should be noted that the scheme was still under construction in 2011 during the LiDAR survey of 2001. The main area of accretion (nourishment) has slightly increased and spread further seawards during 2012. However the LiDAR has identified pockets of erosion around the offshore breakwaters, which may still be down to construction works. Similar to last year, erosion dominates the upper beach in the area immediately north of the coastal protection scheme. Along the remaining beach length, erosion dominates the upper beach and accretion is in the form of bars across the frontage. At the most northerly section, near Ynyslas Golf Club, a strip of accretion remains at the upper beach, amidst the areas of erosion.

During construction, due to the temporary access to the breakwater there was significant accretion immediately behind the reef. A comparison of during construction (left) and post construction (right) is shown below.



It may be seen that the accumulation of sediment behind the reef has dispersed over the last year. Furthermore it can be seen that the recharge material along the village frontage is being reworked forming shallow bays between structures and developing protective ridges.

Beach Behaviour

Figure BTH1 also shows a comparison of 2006 and 2012/2013 LiDAR data. A comparison between this figure, and the equivalent figure in the 2011-2012 report (comparing 2006 and 2011/2012 data) shows that the scheme has not had any significant wider impacts and that the coastline to the north is behaving as it was prior to its construction. This is possibly with the exception of the small area of erosion immediately north of the scheme which was evident in 2011 and still remains this year; in the 2010-2011 report this was marked by accretion.

The eroding beach immediately outside the area of nourishment should be monitored to ensure that the beach does not reach a critical width for protection, prior to the construction of Phase 2 of the Borth Coastal Protection Scheme.

Concerns

The long term comparison of LiDAR shows that the coast protection scheme has provided vital protection to the vulnerable shingle ridge on which the village sits. Furthermore, the works have not had any large net major impact on the adjacent coastline. There is continuing concern with respect to the defence provided by the beach to the length north of the current scheme. This is being considered in examining Phase 2 of the Protection Scheme.

Actions

None.

3 OVERVIEW

LiDAR has been flown over the whole coastline, for a third consecutive year. Following a recommendation made in 2010, this is also the third year that LiDAR has been flown during winter months, to reduce the potential impact of vegetation on the terrain data. As the LiDAR dataset continues to build, the aim is to develop additional methods of interrogating the data. Critically, the interpretation of trends of change, rather than the 'snap-shots' currently used, will be hugely beneficial to understanding long term patterns.

Monitoring has continued to allow identification of areas that are slowly losing sediment. These are discussed in more detail below. Without this data, the high variability of the beaches, as they naturally respond to changing hydrodynamic conditions, would mean that these longer term trends would not necessarily be visible.

Building on the 2011-2012 report, the SMP2 has consolidated the interpretations of long term change and is used in this report. The management intent contained within the SMP2 also puts the changes seen through monitoring into context, highlighting where beach lowering needs to be addressed (or at least raising awareness that action might be needed in the near future). In turn, the on-going monitoring has also been used within the SMP2, to inform the development of management intent.

The intention in 2010-2011 was to use LiDAR collected during the winter in the 2011-2012 report, to assess cliff changes at Llanina. However due to the short timescale of monitoring, the LiDAR was inconclusive. In this third year, the LiDAR data has shown a reversal in the widespread lowering and is instead showing accretion along the length of the beach. This needs to be treated with caution as the LiDAR could be just depicting the annual variability at Llanina. Therefore collection of LiDAR data in the winter from Llanina should continue, to enable the long term analysis of slope stability.

4 CONCERNS AND RECOMMENDATIONS

Long term beach lowering continues in most locations this year. This section highlights specific recommendations for the 2012-2013 report, as well summarising the key areas of concern, highlighted through monitoring this year:

- In general, there is benefit in undertaking a condition assessment and toe depth analysis of the defences along the coastline, and combining this with monitoring data to ensure that areas where action is needed are made a priority. The following specific locations will significantly benefit from this information:
    - Aberporth, Traeth Dyffryn – this year the channel at the back of the bay is wider and deeper, renewing the pressures placed on the base of the defences. However due to the healthy beach levels, there are minimal risks of defence undermining this year.
    - Aberaeron South Beach – the long term lowering seen in the south of the beach where there is potential for cliff retreat. However the widespread lower beach accretion this year has relieved some pressures from the upper beach.

- Aberystwyth – Tan-y-Bwlch, South Marine Terrace and Victoria and Marine Terrace all show signs of beach lowering and maintenance of the integrity of these defences is essential for protecting this important town.

- Llangrannog – increased pressures on the defences following this year's upper beach retreat. Considerable erosion has occurred at the toe of the defences, presenting risks of undermining.

- To provide a quantitative assessment of the width of the Pen-yr-Ergyd spit, both at the crest and at its base. The narrowing of the upper beach along the frontage of the spit this year renews the concerns of spit instability and the risk of breach during a major storm.

- Acquire and collate any dredging and nourishment works data, for the relevant locations. This is required to inform the annual monitoring report.

The specific areas of concern include:

- Llangrannog – the trend for lower beach erosion has strengthened this year with levels at their lowest since monitoring began. The loss of material from the upper beach this year is a further concern, placing pressure on the defences, especially at the toe, where erosion this year has increased the risk of undermining.
- Aberarth –The southern beach (Profile 1) continues to lower at the upper to mid beach, to erode at the cliff base and to decrease in beach volume. This long term trend is a cause for concern, in relation to the on-going vulnerability of cliff retreat in this area. In addition, this year has seen erosion around the pier, where previously there was accretion. This has not affected the long term pattern of accretion in this area shown by the LiDAR, but it should be considered in the 2013-2014 reporting.
- Llansantffraed – beach lowering continues to be a concern due to the risk of erosion to the vulnerable boulder clay cliffs. The retreat of the lower beach across all profiles this year is suggestive of whole beach roll back. The SMP2 approach of managed realignment needs to ensure that local landowners are kept informed about options for local protection of assets.
- Llanrhystud – The tendency for material to be lost from the beach is a continuing concern. Although Profile 1 has been on a path to recovery since 2007, the upper beach at Profile 2 has not recovered from the significant cut back seen in 2010 and the central beach has further retreated this year. Overall, the tendency for the Llanrhystud to reduce in beach volume continues.
- Tan-y-Bwlch – The crest of the shingle ridge remains relatively stable again this year, but continues to narrow where the river Ystwyth comes closest to the sea. The slow, on-going beach loss here remains a concern. This year has seen the landward movement of the berms in the centre of the beach, which renews the concerns of retreat. The 2013-2014 reporting needs to understand if this beach roll back is becoming more widespread along the beach.
- South Marine Terrace - The beach continues its cycle of lowering each summer, and building itself back up during the winter months. This year the

southern beach has reverted back to its long term trend of lowering, whilst the northerly profiles have retained their beach volume. The long term lowering of crest levels are putting the foundations of the defences at increased risk.

- Victoria and Marine Terrace – Beach lowering over the summer months continues, creating concern for the impact of this on the long term integrity of the defences. Profiles 1 and 2 appear still adequately protected despite the continued erosion since 2010. This year, the losses at Profile 5 are of particular concern in respect to the vulnerability of the toe and defences.
- Borth – This second year of monitoring since the construction of the Coast Protection Scheme (Phase 1) has shown the benefits of the scheme in protecting the shingle ridge in front of the town. Furthermore the works have not had any large net major impact on the adjacent coastline. There is concern about an area of erosion to the north of the scheme which has been evident since 2011. It is recommended that this is considered in examining Phase 2 of the Protection Scheme.

It is further recommended that:

- The monitoring information and extracts from this report are provided to the Teifi Estuary Management Group.
- A synopsis of information provided in his report (and subsequent reports on monitoring) is provided to local communities to further entrench their understanding of change and to facilitate their involvement in management decisions.