CH2MHILL

Cell 1 Regional Coastal Monitoring Annual General Meeting, York

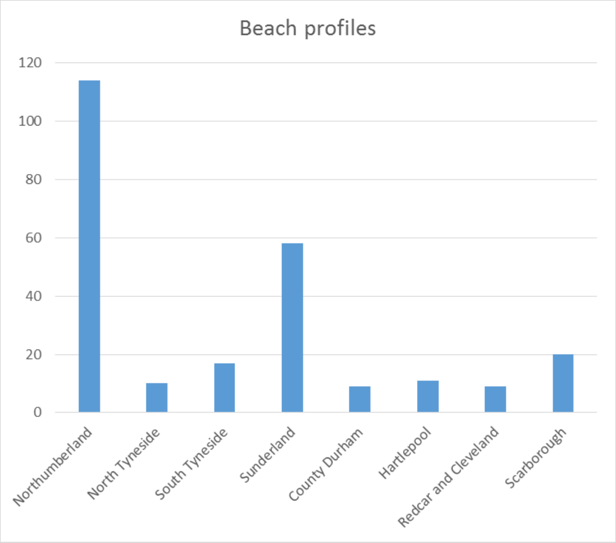
Beach and Cliff Monitoring Analysis

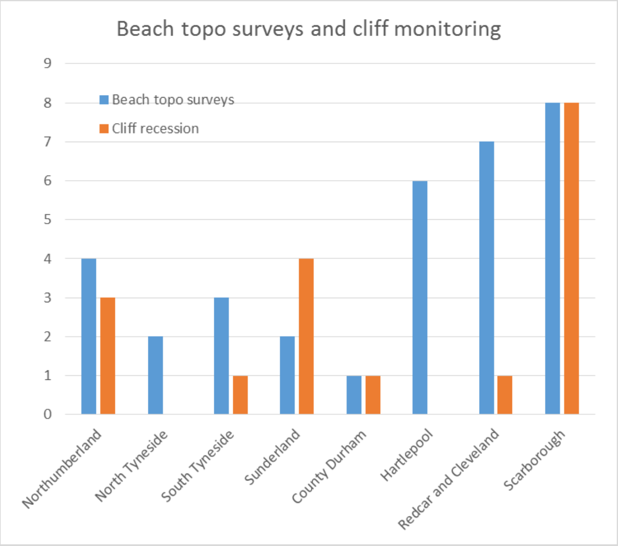
Paul Fish

Data collection

- 248 profiles recorded
  - 149 of which are surveyed 6-monthly
  - 99 surveyed annually
- 31 beach topographic surveys
  - 11 6-monthly
  - 18 annually
  - 2 every 5 years
- Cliff top monitoring at 14 locations
  - All surveyed every 6 months
- Aerial surveys undertaken in 2010 and 2012/13
  - Historical data from 2003 and 2008 (not whole coastline)
  - Calculation of cliff top and cliff toe recession rates
  - Assessment of change in dunes

Location and nature of monitoring





Benefits and problems encountered

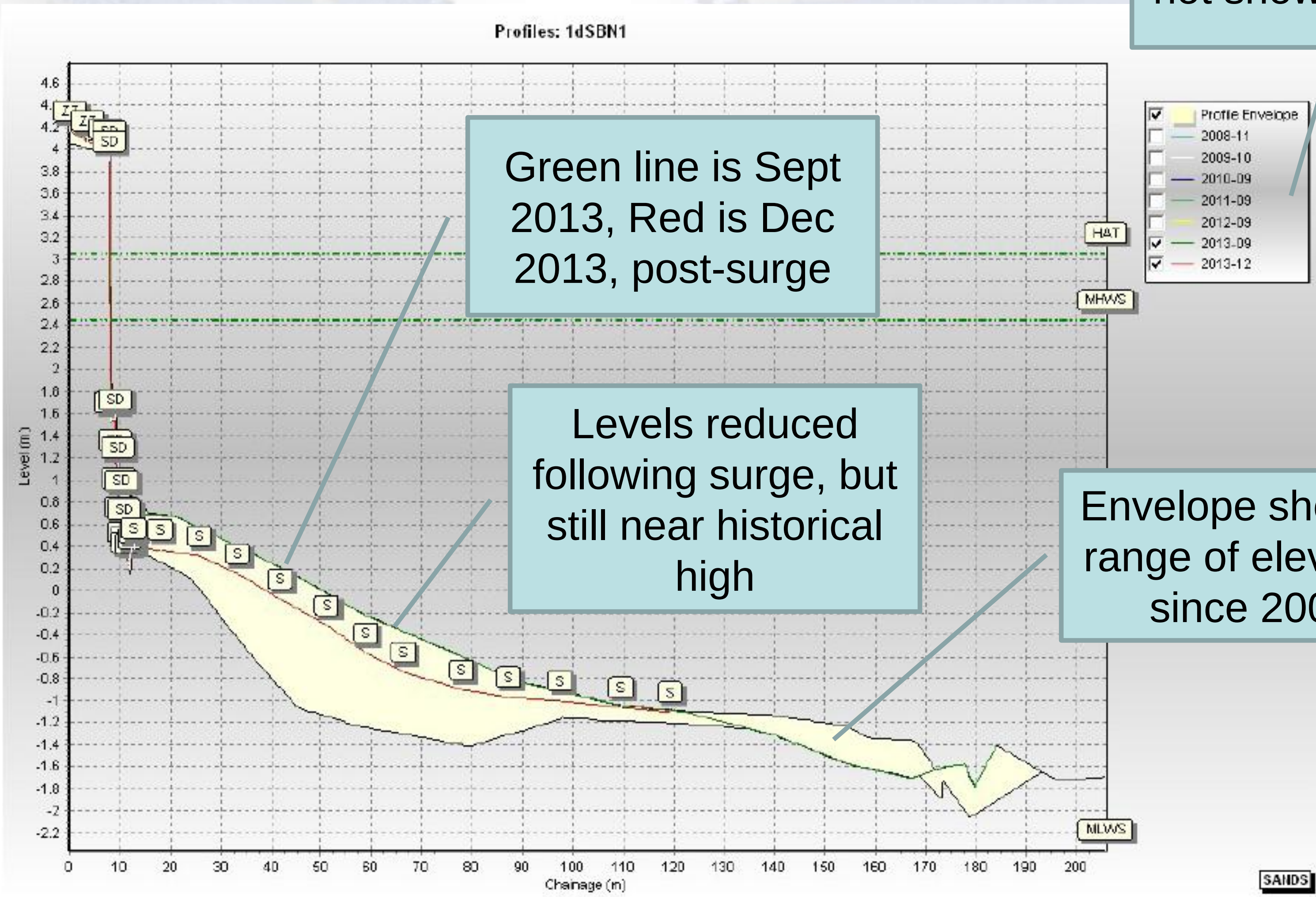
Data	Benefits	Problems encountered
Beach profiles	• Consistent time-series data for easy assessment of long-term trends	• No information on sediment movement direction unless combined with topographic survey
Beach topographic surveys	• Highlights spatial pattern of change over a range of timescales	• Underlying trends unclear short-term data that are dominated with seasonal effects and sandbar migration • Long-term comparisons increasingly useful
Cliff monitoring pegs	• Provides precise data on cliff position at discrete locations • Easily understood and valuable long-term data	• Method can give low accuracy data over the short term as ‘cliff top’ cannot easily be identified.
Aerial surveys for cliff assessment	• Gives precise and accurate information on position of cliff top and toe • Numerous other applications	• Data acquisition can be challenging – tides, weather and GPS satellites all have to OK • Shadow/vegetation can make precise identification of features difficult

Beach profiles: results from autumn 2012 to autumn 2013

- Northumberland: beaches within past range. Few beaches eroding
- North Tyneside: beaches within past range. Much subtle change, local variability with steepening, accretion and erosion observed.
- South Tyneside: beaches within past range. Accretion of dunes where stabilisation measures in place
- Sunderland: most beaches within past range. Localised steeping
- Durham: most beaches within past range. Localised lowering
- Hartlepool: widespread beach steeping or erosion
- Redcar & Cleveland: widespread steepening and lowering
- Scarborough: localised steepening and lowering (including December surge)

Typical data – Scarborough North Bay

Other years' data not show for clarity



Green line is Sept 2013, Red is Dec 2013, post-surge

Levels reduced following surge, but still near historical high

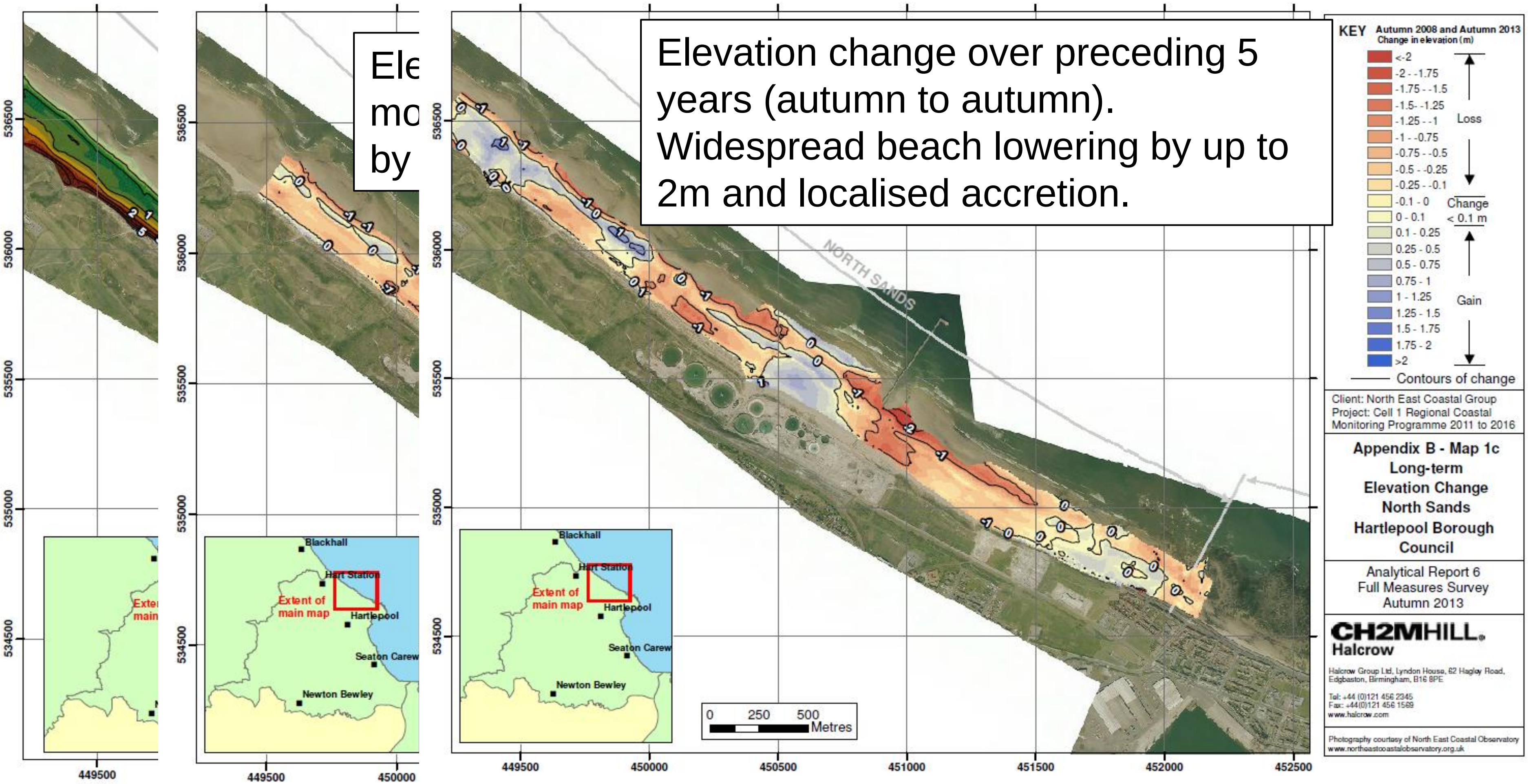
Envelope showing range of elevation since 2008

Beach topographic surveys

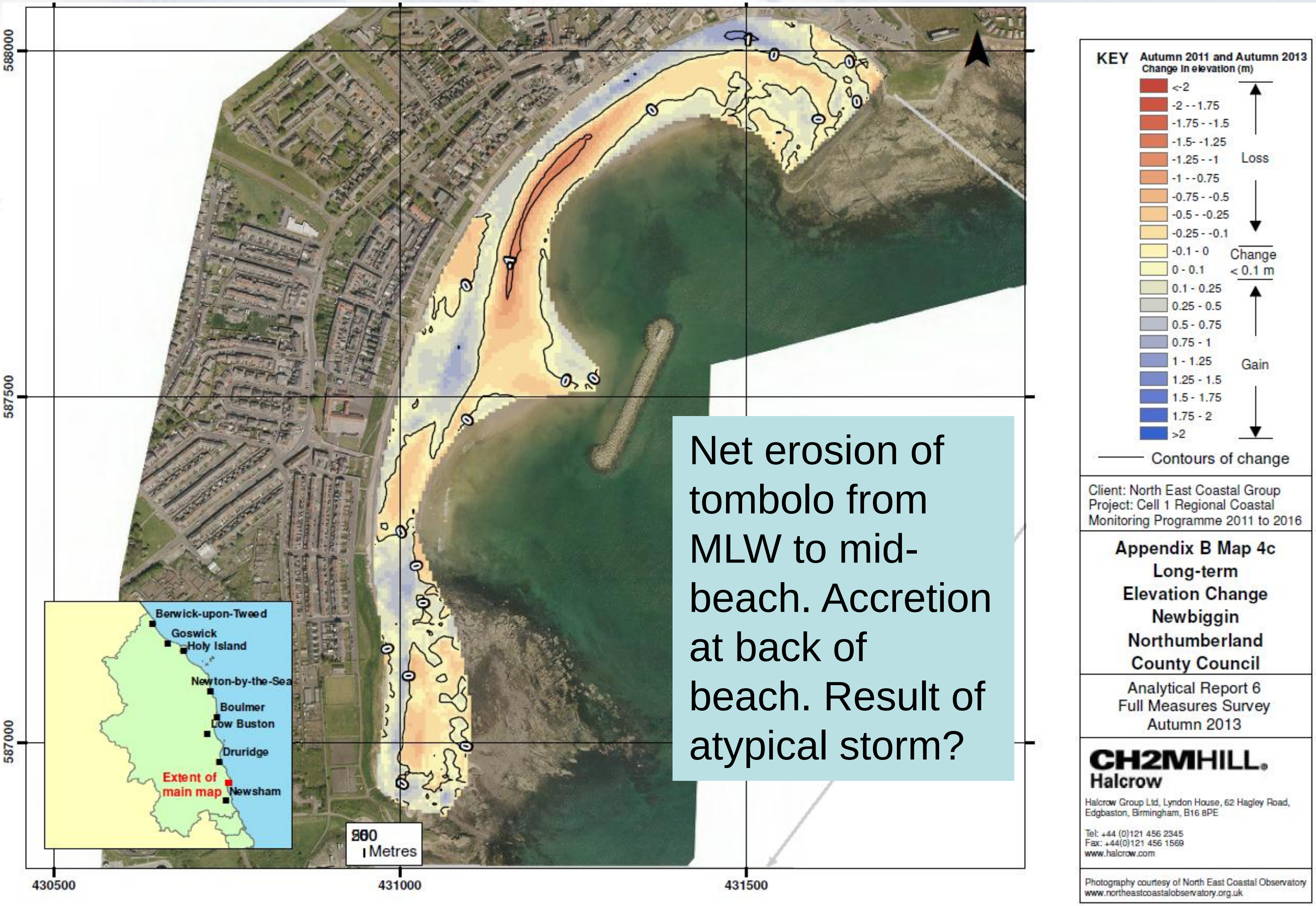
- Current beach elevation plot
  - Shows pattern of beach morphology, highlighting sand bars etc
- Calculation of change since ***last*** survey (6 or 12 months)
  - Shows pattern of short-term change, generally highlighting magnitude and pattern of seasonal events.
  - Highlight migration of sand bars, cliff recession, accretion at the back of beach
- Calculation of change since ***baseline*** survey (c. 5 years)
  - Shows pattern of long-term change. Over time underlying trends will emerge.
  - Data on beach face generally still dominated by migrating bars.
  - Suggests net long-term change in beaches is too small to yet be quantified. Pattern is masked by seasonal ‘noise’

Beach topographic surveys showing beach lowering, North Sands Hartlepool

Elevation change over preceding 5 years (autumn to autumn). Widespread beach lowering by up to 2m and localised accretion.



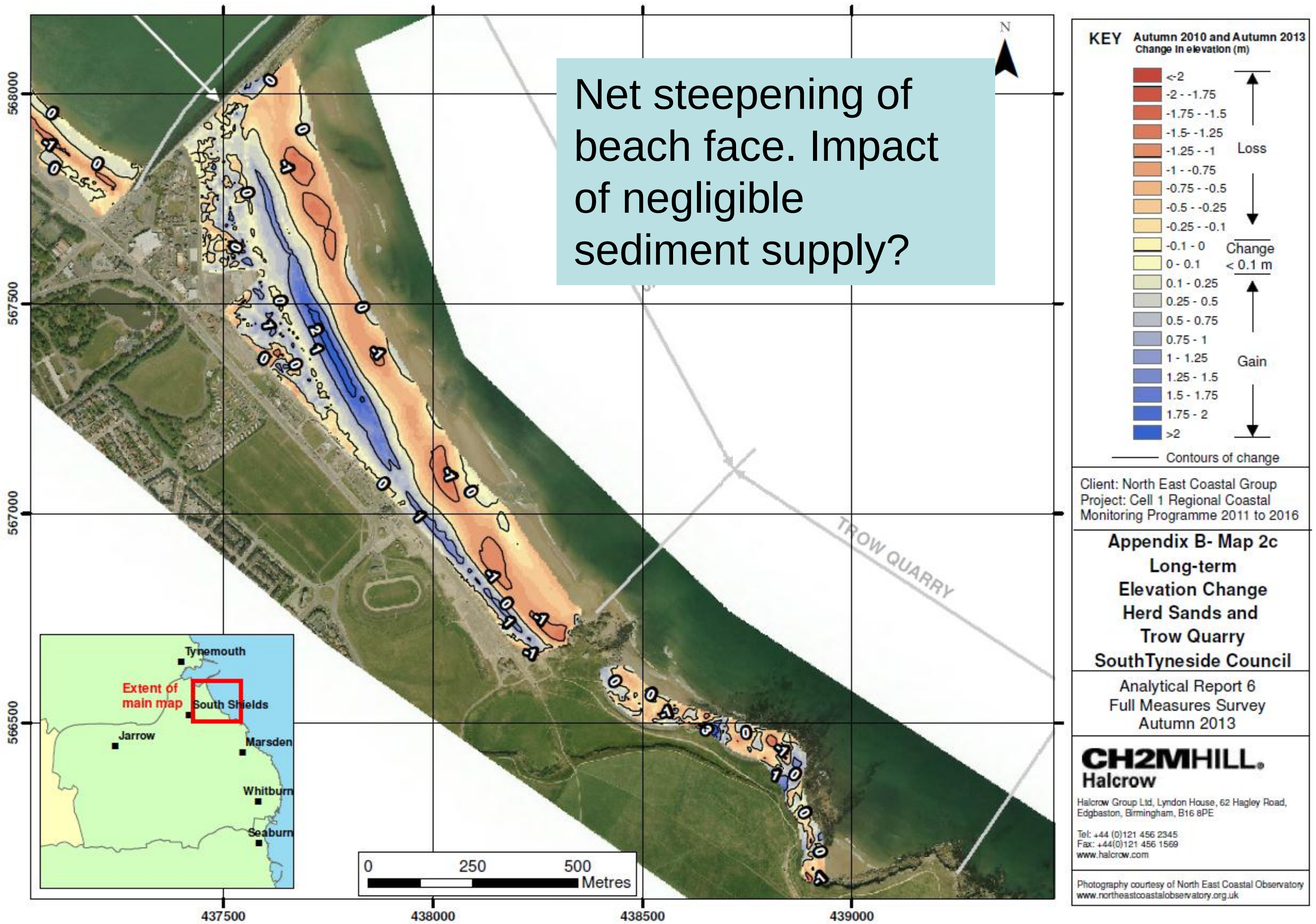
Long-term beach topographic change - Newbiggin



Net erosion of tombolo from MLW to mid-beach. Accretion at back of beach. Result of atypical storm?

CH2MHILL.

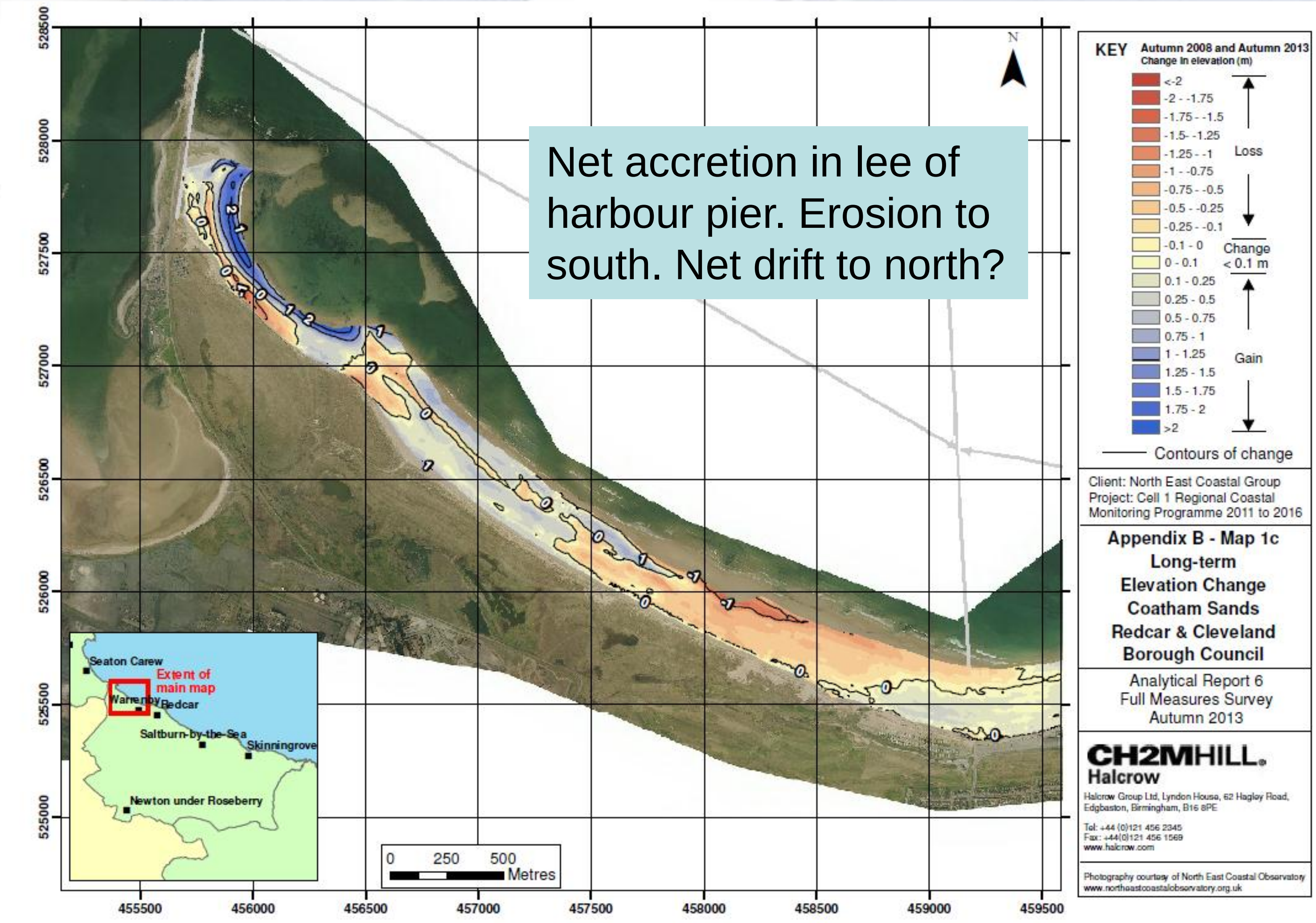
Long-term beach topographic change – Herd Sands, Tyneside



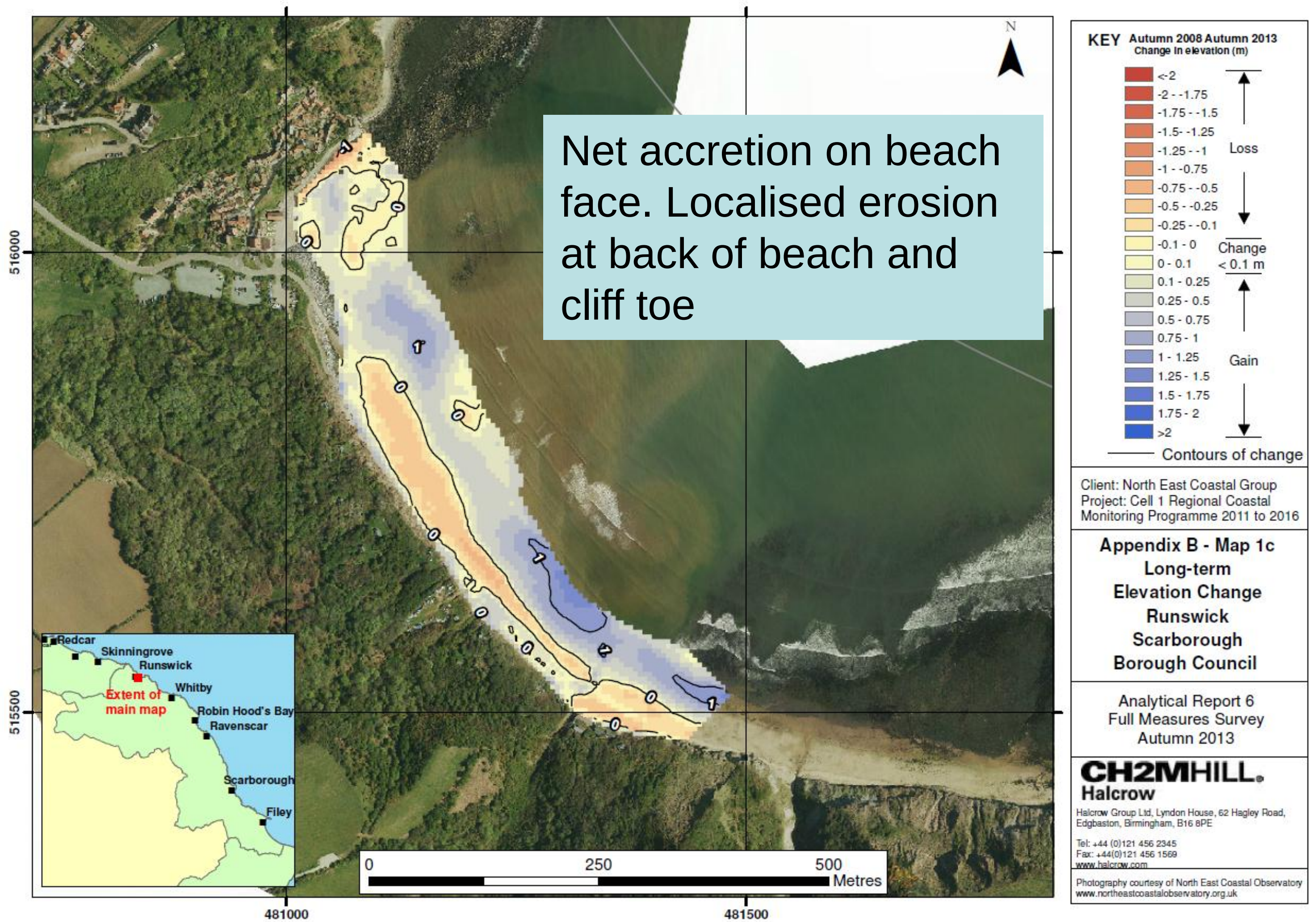
Net steepening of beach face. Impact of negligible sediment supply?

Long-term beach topographic change – Coatham Sands, Redcar

Net accretion in lee of harbour pier. Erosion to south. Net drift to north?

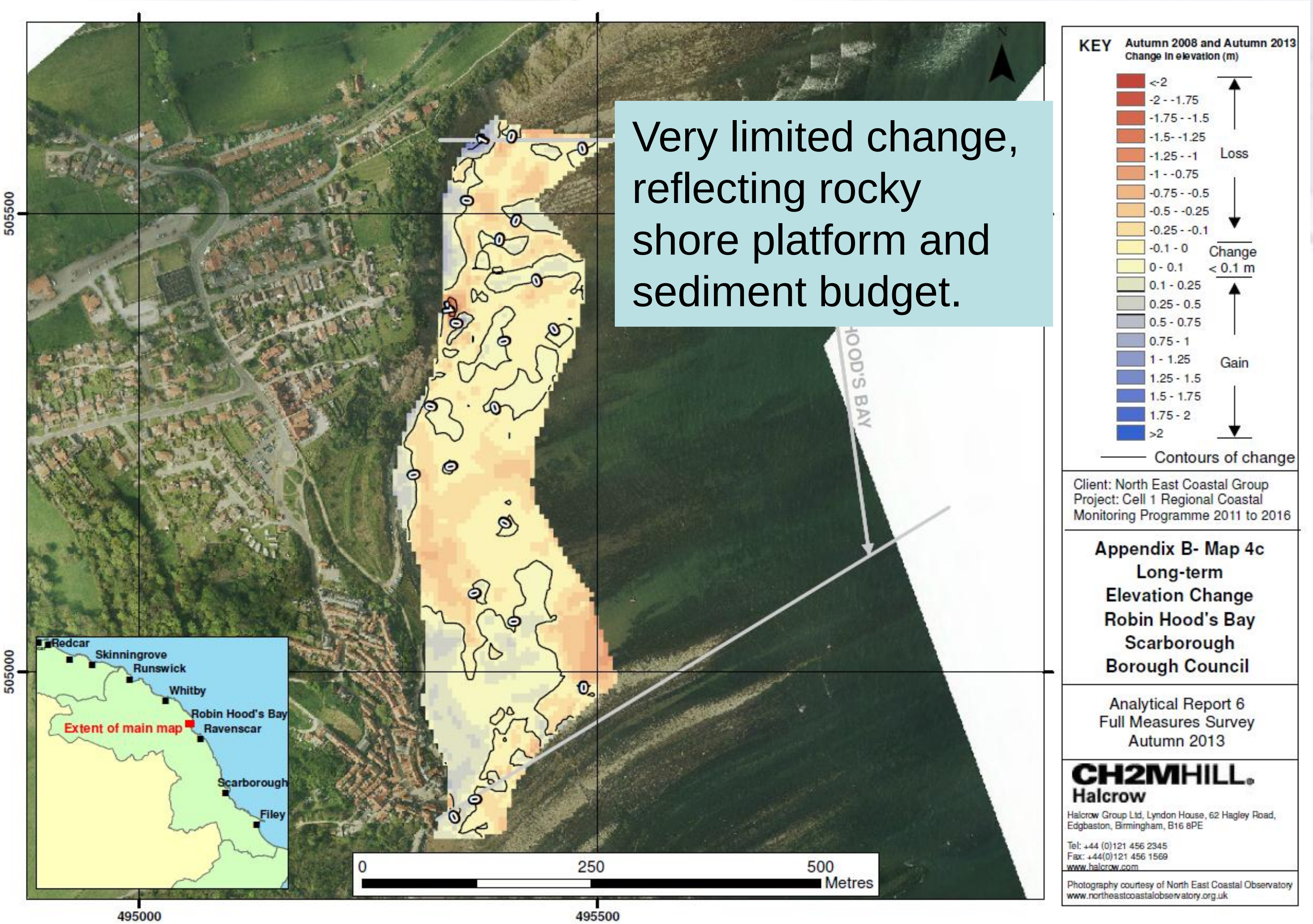


Long-term beach topographic change – Runswick Bay



Net accretion on beach face. Localised erosion at back of beach and cliff toe

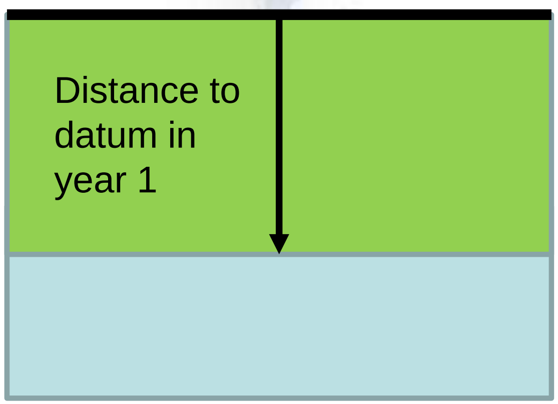
Long-term beach topographic change – Robin Hood’s Bay

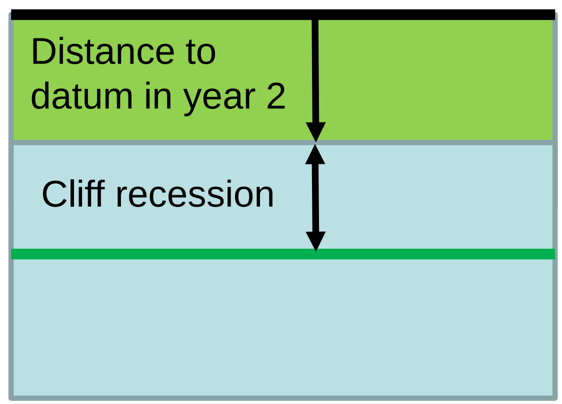


Very limited change, reflecting rocky shore platform and sediment budget.

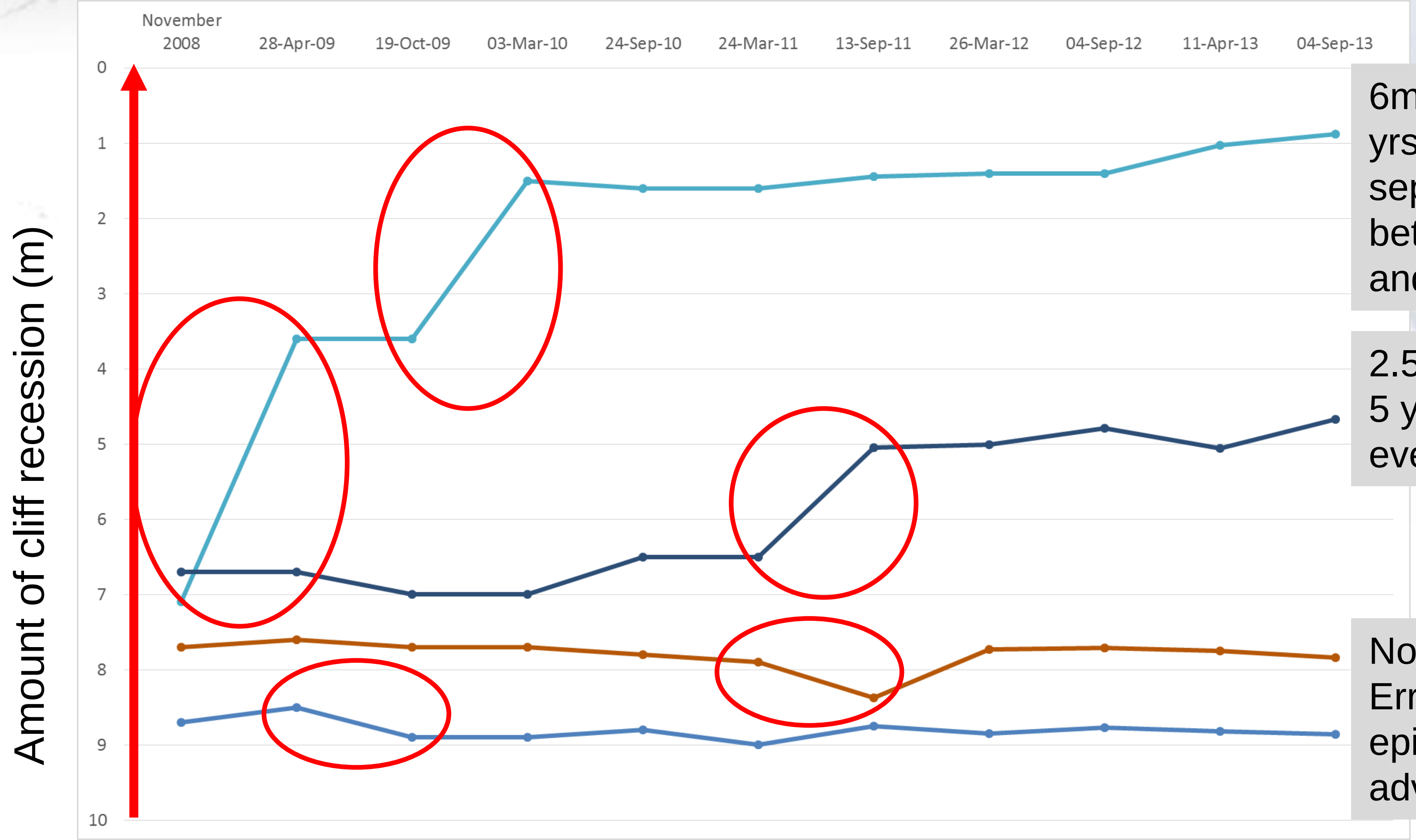
Cliff top surveys

- Method measures distance from inland datum cliff edge every 6 to 12 months
- Allows short- and long-term change to be recorded and rates of change to be calculated
- Short-term data prone to measurement error - cliff edge not clearly identifiable, obscured by vegetation, difficult to access. Error often > change
- Independent checks available from analysis of aerial photography





Cliff recession monitoring data – Soft cliffs at Filey



6m recession in 5 yrs – 1.2m/yr (2 separate events between 2008 and 2010

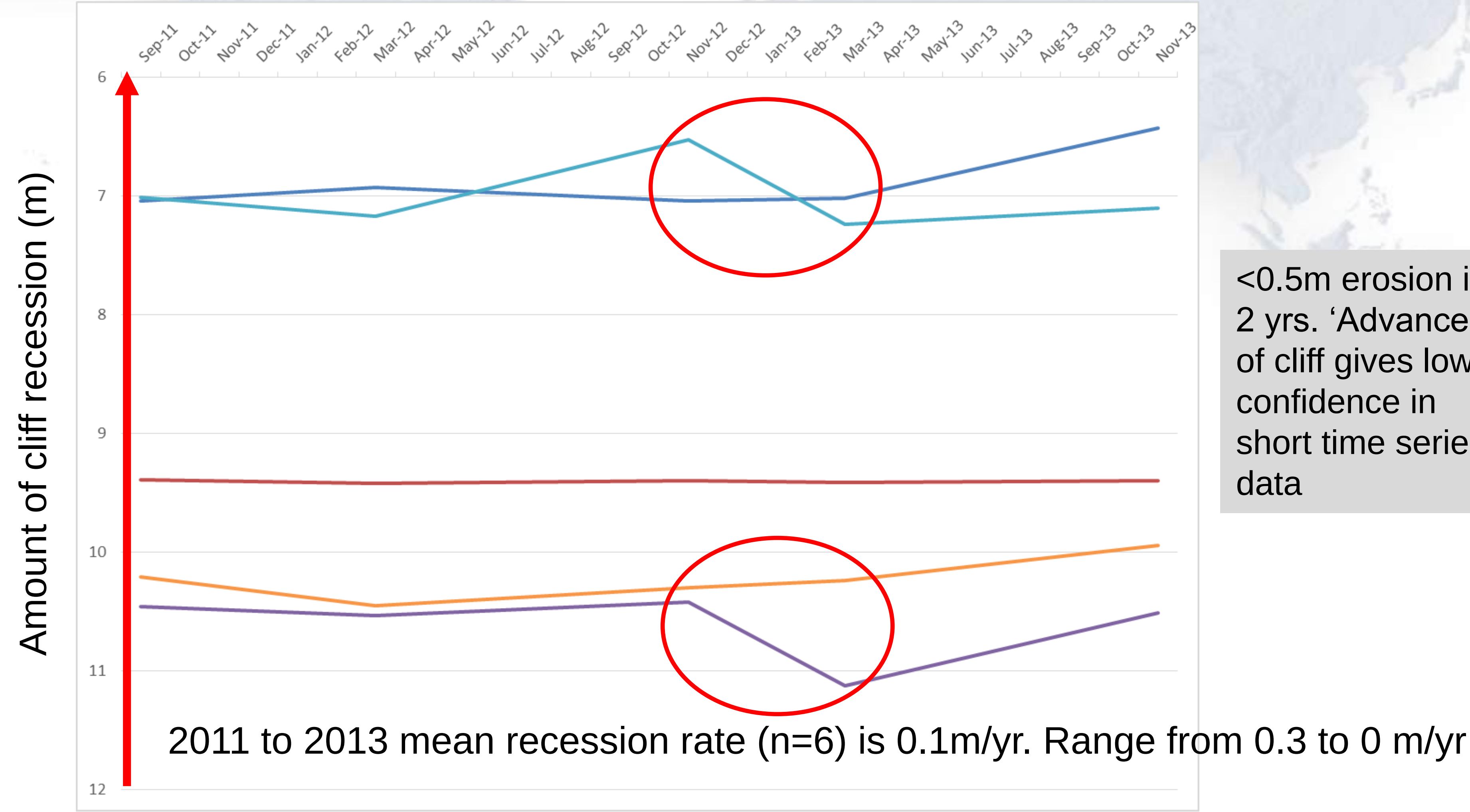
2.5m recession in 5 yrs – 0.5m/yr (1 event in 2011)

No net change. Error indicates episodic cliff advance of 0.5m

Survey: 2008 to 2013 mean recession rate (n=27) 0.1m/yr. Range from 1.3 to 0 m/yr

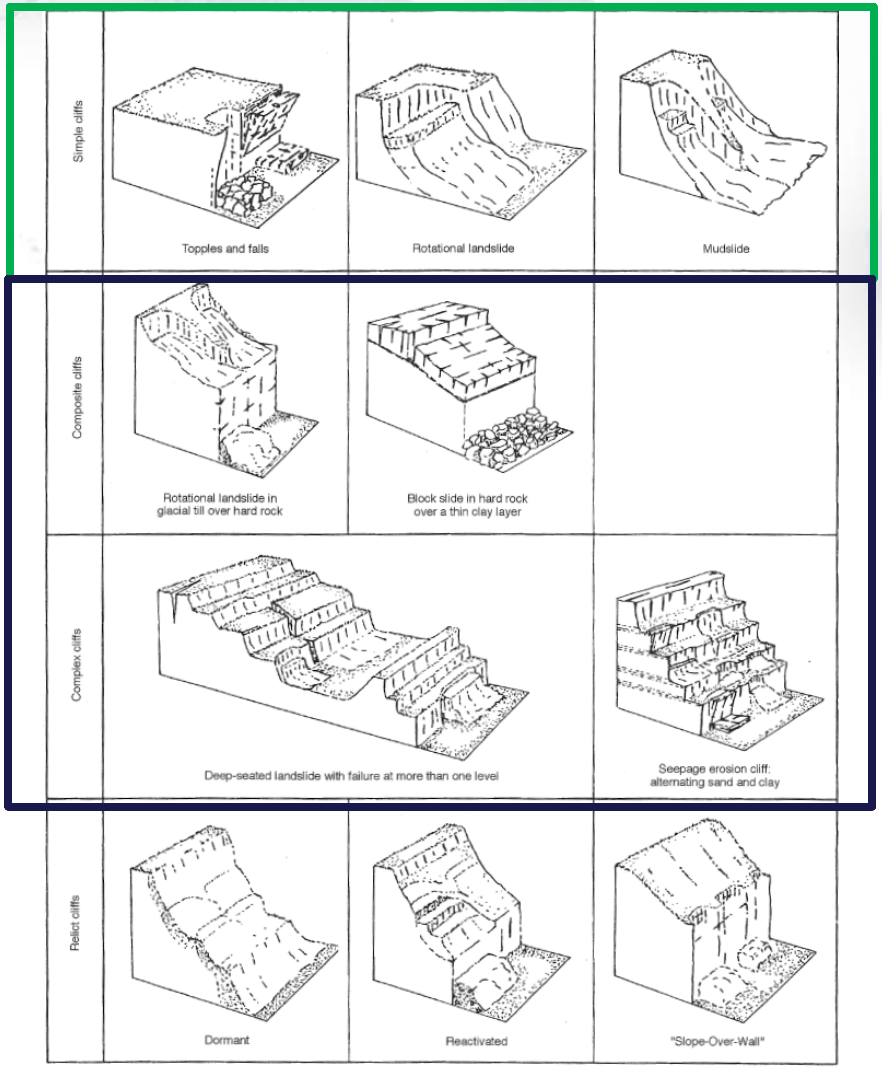
CH2MHILL.

Cliff recession monitoring data – hard rock cliffs at Trow Quarry, South Tyneside



<0.5m erosion in 2 yrs. 'Advance' of cliff gives low confidence in short time series data

Cliff behaviour units – data from aerial photo analysis



- **Simple Cliffs** and **Simple Landslides**: simple relationship between toe erosion and cliff top retreat. Cause and effect in a day (single storm) to a year.
- **Composite** and **Complex Cliffs**: complex relationship between toe erosion and ground water in landslide sub-systems. Cause and effect separated by many years - 10 to 100 years
- Aerial photo assessment is underpinned by recognition of cliff behaviour units

Cliff Recession - comparison of ground survey and aerial photography analysis at Filey Bay

- Survey data: 2008 to 2013 mean recession rate (n=27) for all CBU types = 0.1m/yr. Range from 1.3 to 0 m/yr
- Aerial survey (2003 to 2013):

Location	Cliff Type	Cliff Top	Cliff Toe	Profiles
Filey Bay South	Composite Cliff	No data	0.45	2
Hunmanby Gap to Speeton	Simple Landslide	1.36	0.40	8
Flat Cliffs	Complex Cliffs	No data	0.00	3
Flat Cliffs to Filey	Simple landslide	0.15	0.65	6
Filey to the Brigg	Simple landslide	0.00	0.32 *adv.*	4

- Variation in rate by CBU: simple landslides most dynamic
- Average and range of data from both methods comparable

The future

- Partial measures report spring 2014 – assess impact of the storm surge on the coastline
- Walkover inspection of the whole coast – focus on residual impacts of the surge
- Future full measures report – determine longer-term patterns of beach evolution
- Integrate finings of Sediment Transport Study with ongoing monitoring results
- Repeat bathymetry survey – determine changes below MLW and establish improved baselines
- Repeat aerial survey – determine short term change in cliffs; consider use of LiDAR for beach volume changes