

Coastal Cliff Instability Workshop 2014

Introduction to workshop and cliff instability – Andy Bradbury, Southern Coastal Group Chair, NFDC

There is a good representation of delegates from a variety of backgrounds at the workshop today. Apologies that due to recent storm surge events, some of the engineers are otherwise busy with flood related problems, including Neil Watson from the Environment Agency who was going to present on FDGiA funding.

- There are a variety of sites covered in this workshop demonstrating site specific requirements for landslide incident management. When do you react to ground movement and related safety requirements?
- Along the south coast there are a variety of coastal landforms, dominated by soft rock cliffs that are episodically eroding/landsliding. There is also an abundance of progressively eroding soft rock cliffs and some hard rock cliffs. There are properties at risk of erosion and flooding in the next 100 years. Futurecoast defines different coastal landforms (simple cliff face/simple landslide/complex landslide/relict systems).
- Cliff behaviour and morphology depends on many factors and therefore can't be treated exactly the same, and may behave differently temporally and spatially within the same location, e.g. Barton Cliffs.
- Through monitoring of cliff sites, information on their behaviour and causes can be found. Monitoring techniques are useful in linking rainfall events to mass movement (e.g. Barton) and remote sensing can be used to show spatial change (digital terrain models from lidar and laser scanning at Totland).

Dorset Coastal Rockfalls and Landslides Protocol- Richard Edmonds, Earth Science Manager, Dorset County Council

- Protocols were developed in response to the extreme weather of 2012-13 in partnership with Jurassic Coast Dorset and East Devon World heritage site and Dorset County Council.
- Multiple land sliding and rock fall events occurred in the Dorset area, some repetitive and other one-off events. These included:
 - Charmouth (July 2012) occurred on a popular beach.
 - Black Ven landslide blocked beach access.
 - Monmouth Landslide, now popular as visitors climb over rock fall.
 - Eype landslide blocked the beach at West Bay.
 - Axmouth landslide caused harbour beach access to become blocked.
- A variety of issues arise following a landslide – assessment of the hazard, decisions on action, communication of the issue to many organisations and public, and media interest.
 - The 2012 rock fall at Burton Freshwater was a fatal event which resulted in coast path closure.
 - Monmouth beach huts destroyed by a 2012 event and the road closed.
 - Portland West Weares landslide and failure of the scree slope resulting in toppling of cliffs resulted in a closure of the top coast path.
 - Swanage (December 2012 onwards) saw landslides which involved 160 different landowners and was a complex event.
 - St Oswald's Bay (April 2013) was a massive rock fall/landslide event which led to the relocation of the coastal path.
- Despite warnings people are still attracted to landslide sites. How do you manage this interest? Temporary signs are erected by coastguard teams to avoid repeat rescues from the mud at Charmouth. A variety of warning signs are used in different locations, however how do we decide what is best? Should there be a consistent protocol on signage and where they are located? Whose responsibility are they, and is it the public's responsibility to take care of their own safety, know the risks and use common sense?
- A protocol has been constructed to try and help with the issues raised by landslides "Dorset Coastal Cliff Fall and Landslide Protocol" Sept 2013 V5. This covers how to assess an event type and understand behaviour. Difference between quickly occurring rock falls and slow/episodic landslides. There are hazards to look for-overhangs/cracks/jointing/towers/loose rocks/roll-out hazard and over steepened cliffs. Rock falls and landslides are a generic and constant risk, as we don't know when they will occur.

- Protocol gives 3 tier response to events, and a response kit has been prepared to help after a landslide event allowing something to be done quickly and consistently, often by anyone and include signs and instructions.

Q - People are ignoring the signs what else can we do?

A - There is a general consensus that personal responsibility is required to an extent.

Q - Can't we stabilise the cliffs first?

A - No, costly, and sometimes causes further problems

Q - When do we reopen a beach after an event?

A - When it is deemed safe, usually the local authority decide after it has been handed over by the Police (the only people who can close a beach).

Q - What rights does the landowner get?

A - The land owner is often the last to decide what is happening and is left behind without advice.

Barton-on-Sea Instability – Peter Ferguson, Engineer, NFDC

- Introduction to location and geological setting of Barton cliffs. Previously a shallow sea, influenced by river systems, with Pleistocene fluvial systems dominating the upper layers and Eocene Strata forming different beds in the lower cliff. An unconformity exists between the two layers of permeable and impermeable rock, with instability in the lower layers.
- Scientific interest to maintain the site as an exposure site, due to the presence of fossils in the sediment. Erosion and translational landsliding have occurred historically, with a complex management history from the 1930s including slope regradation, sheet pile barriers, drainage, rock armour and rock groynes. Steel sheet piling was installed to act as flow directors to funnel water through the landslide.
- Complex system of different events and locations of movement. Through consistent monitoring of the area using laser scanner and lidar, this movement can be monitored. Frequent site visits are also undertaken. Rainfall data and groundwater measurements are also collected, in addition to marker stones in a shear surface/active area to monitor rates of movement at Marine Drive. The marker stones all moved at the same steady rate and angle through the landslide. Monitoring has linked antecedent rainfall with large movement events.
- While Barton is categorised as a Managed Realignment site in the SMP, Geotechnical Engineering was tasked with providing more information about the landslide complex. The works were extensive and the public were kept fully informed. Throughout the works there were no negative comments received from the local community. The data provided helped inform future management of the site. Funding is required for future management.

Q - The rock revetment is being pushed out into the sea, is it still protecting the cliff base?

A - Yes effectively, the unit is still intact and performs as specified, just in a different location. Designed to be flexible, a small tear occurred but this did not impact the bulk, it is just steeper and has translated towards the sea.

Q - Who owns the land?

A - NFDC and a couple of private landowners, therefore funding is easier to acquire. If we make improvements to our monitoring now, then in the future less funding will be needed.

Q - It is good to highlight that an effort was made to inform public of risks and intentions during monitoring and works phases, and this was really successful, no negative comments received which is rare. Public engagement works. Media communication is vital to ensure the correct information is conveyed.

Coastal Cliff Instability Problems on the Isle of Wight- Peter Marsden Principal Engineer, IOW Council

- Introduction to the geology of the Isle of Wight – this varies spatially across the Island, and most geology is relatively recent ~125m/y.
- Variety of different landslide/rock fall events:
 - Landsliding at Wootton

- Rock fall on relatively stable chalk cliffs at Bembridge
- 3 of 4 access points to Sandown Bay in front of cliffs blocked by landsliding. These occurred on sites where the cliff top had been previously stabilised. Beach huts below the cliff top failures were moved to more stable locations. Such failures can however provide sediment to beaches, which is particularly needed where there is an amenity beach.
- Cliff talus failure occurred at Shanklin, where saturated ground moved sediment across a car park to the back of a hotel.
- Remedial measures have been undertaken including cliff top trimming and battering, rock bolts, shuttering and netting. Rock Catch fencing has also been installed along frontages. Improved drainage has also been a priority, especially at the top of cliffs where concrete kerbs have been added to channel rainwater away from cliff tops.
- The use of warning signs to alert public to the risks of cliff falls have also been used.
- There is a history of landslide and ground movement at Bonchurch, where usually the rock catch fencing at the cliff base stops it from blocking access, and beach sized material is placed onto the beach to renourish it.
- The IOW Undercliff has a complex history of landsliding. A technical report was produced in 1991 which identified Ventnor as the largest urban development in an area of active landsliding, and reviewed the existing database on landsliding. It aimed to undertake field investigations and develop a landsliding model. Monitoring of the landslide complex has gathered data including groundwater and rainfall levels. A geomorphological map of the area was also produced, alongside an improved cross-sectional model of the site.
- Nearly 200 pieces of equipment are used to monitor ground movement on the IOW including inclinometers, tiltmeters, extensometers, crackmeters, piezometers, standpipes, weather stations and a GPS point network. These monitoring systems help to show a direct relationship between antecedent rainfall and landslide events.
- Defra funded a scheme to create a rock revetment with slope stabilisation at Wheelers Bay, Ventnor (2000, £1.5m), and rock revetment and slope stabilisation/concrete shear drains were also installed at Castle Cove Ventnor 1994 (£2.6m). At Castlehaven 2003, 650m rock revetment was installed with 170 siphon wells located in the slope (£6.5m).

Landsliding also occurs at Niton, Chale, Brook, Compton and Afton Down. There is a proposed plan to stabilise the main road at Afton down as this is at the top of steep Chalk cliffs (~70m) and the pressure from its use by vehicles is causing tension cracks in the verge on the cliffs.

Totland landslide also commenced in 2012 and pushed the seawall out up to 20m in places and is still active. Monitoring by Channel Coastal Observatory has helped gauge the behaviour and rate of landslide movement. Laser scanning and an in-depth study by a contractor has also provided useful information.

Q - Are coastal planners and engineers working together?

A - Not enough, but things have improved, and there is more control over building standards and appropriate development on and near landslides. Risk planning services are being reduced.

Living with Ground Instability - Robin McInnes Coastal and Geotechnical Services working with CH2MHill

- Ground instability is a significant global risk particularly when the impacts of climate change and population growth are taken into account. Internationally there has been a substantial increase in published literature on landsliding over the last 20 years; despite this loss of life related to landslides has also increased.
- Within the UK, Futurecoast (Defra 2002) suggests that there >3,300km of cliffs in England and Wales, >80% formed in 'soft rock', >32% affected by active erosion or landslip, >50% sensitive to climate change, but <6 have coastal protection or cliff stabilisation measures in place. There has been a legacy of development in the coastal zones over the last 150 years, often in unsuitable locations. Since 1980s with the formation of SCOPAC and the development of coastal cells and SMPs planning on the coast has improved in the UK and in Europe.
- The West Dorset coast at Lyme Regis is similar in geomorphology to the Ventnor Undercliff, which is the largest urban landslide complex in north-western Europe. In response to the need for improved understanding of landslide risk and mitigation measures there was an exchange in information between the Isle of Wight and other councils on approaches to management and monitoring of landslides. Holbeck Hall landslide,

Scarborough in 1993 further highlighted the importance of monitoring, as well as the understanding the legalities and responsibilities of cliff ownership.

- Publications have been produced to provide advice to homeowners in areas affected by landslides, and to advise on the human and economic consequences, and this now forms a key component of coastal risk management and planning (McInnes and Moore, 2013 and 2011).
- There is a UN framework – The International Strategy for Disaster Reduction (ISDR), which coordinates disaster management globally. The United States Geological Survey (USGS) and the Hong Kong Geotechnical Office also provide excellent advice for those living in areas that are prone to landsliding.
- In Hong Kong, 500 people have been killed in landslide related incidents in the last 50 years. There is dense development and population and this is moving into unstable areas. There was a promotion of best practice in building planning and management of slope systems to the public to reduce risk and allow public to understand hazards.
- The Publication on ‘Living with Ground instability’ (McInnes & Moore) in 2014 will provide international advice for communities on living with ground instability.

Q - Should we be proactive or reactive when it comes to landslides?

A - Depends on site, some landslides are too quick to prepare for. It is expensive to protect the entire coastline just in case.

Q - Surely people understand the risks - why do they buy property in risky areas?

A - Hopefully they undertake a structural survey, however it costs more to get wider/in depth searches. Property is often cheaper in areas more at risk.

Q - Do utilities know about the risks of development discharging waste water near to/on landslide complexes?

A – Yes, new developments usually have meetings with contractors and local authorities and should know the risk.

Laser Scanning Coastal Cliffs and Landslides – Stuart McVey, Senior surveyor, NFDC & CCO

- CCO have invested in a Leica Scanstation C10 for scanning as part of their monitoring programme. The equipment is easy to transport and has a long range scanning field. It integrates well with RTK surveying equipment and can give 6mm accuracy. Each scan is relatively quick and it has a field of view that enables good coverage of horizontal and vertical surfaces.
- The scanner was used to collect 3D surface data at Monmouth ledges, Lyme Regis; where the camera option was also used to create a 3D colour image from the pointcloud data. A high definition survey enabled fine detail analysis, with features such as stress cracks, fractures and fossils to be recorded.
- The scanner was also used to survey the St Oswald’s Bay cliff fall (April 2013). The cliffs were scanned as part of the SCOPAC monitoring programme as routine practice in January 2013. This provided a 3D model of the cliffs before the rockfall event. After the event, the beach was scanned again to include the mass that had fallen, although some of the beach material had been eroded at the base by June 2013.
- Profiles of the cliff face prior to the event pick out a clear notch at the base of the cliff which has been measured as almost 5m horizontal and 3m vertical, spanning 18m along the cliff base. The beach level adjacent to the cliff fall has also risen 1m. A 3D animation can also be made from the data.

Q- You have identified a notch at the base of the cliff- have you found any more?

A - No we aren’t specifically looking for them but can notify those responsible if we find them in the future.

Q- What about UAV/drone aeroplanes for remote scanning?

A - They are not suitable for scanning vertical surfaces and would require ground controls to be installed. They do provide good coverage and would be useful if ground controls were easier to install.

Q- This is a good example of secondary findings and uses of our data. The rockfall was effectively captured although this was not planned. More reason to use the scanner and survey regularly, and change can be quantified with repeat surveys.

Questions at the End

Gordon Wilkinson, Eastleigh: Is ground water movement a major factor in cliff stability, particularly between differing strata at Netley? The top layer of cliff is sand, underlain by a layer of gravel. There is already a toe protection in place. Yes it is, especially permeable sandy layers such as in the image of Netley. It is a site specific issue, so if you are worried then investigate further. If there is an impermeable barrier in the cliff you will get horizontal flow, leading to instability. In some cases it is primarily weathering from rainfall, such as Poole.

David Lowsley, Chichester: Is it an issue of gradual erosion by weathering rather than the more dramatic losses through wave action? The site under consideration is at Selsey, which is affected by rainfall and sea-spray as well as wave action. Is weathering a major issue? Use rain gauges and more met stations along the coast. Look at antecedent rainfall and associated events after. It is a management issue, so rainwater runoff must be managed away from cliff faces.

Uwe Dornbusch, Environment Agency: Cliff Instability can provide a benefit to the sediment budget in the form of coastal sediment. When considering a sediment budget containing cliffs, the input from cliffs was a large unknown. The beach grade sediment from cliffs is generally quite low, and therefore the input to the system depends on the geology of the cliffs. Some of the rubble can be used on beaches if it is the right grading. Landslides can offer protection to the base of cliffs, e.g. Barton.

Andrew Colenutt, New Forest: Bathymetric and topographic data stitched together can be useful to create a seamless map of the coast. It is useful, and BGS are interested in this aspect. Lidar does not pick up overhangs on cliffs, however mobile scanner systems on boats at high tide can pick up high resolution cliff face data. This method has been carried out in the South Downs, where steep cliffs have some overhanging sections. Bathymetry can also pick up relict offshore landslide deposits.

Jon Evans, CCO: With SLR and storm intensity predicted to rise- will infrastructure damage increase? How can we protect such vulnerable land? There is limited money available to protect land. People should know the risks when they purchase the property near rapidly eroding cliffs. This should be made extremely clear even if house is 100m from present cliff line. Erosion is a natural process, and extreme defence projects are very costly. The SCAPE model is available and has been tested on the Norfolk coastline. This uses the current cliff line position and applies sea level rise in order to predict the rate of erosion in the future. It does not, however, take in to account any ground water influences. Wave activity may often be a secondary influence to rainwater, although this has been left out.

Nathan Edwards, Shepway: If the SMP classifies a frontage as No Active Intervention, what are the most cost effective cliff stabilisation methods that could be funded by Local Authorities to help reduce erosion? If the SMP states no active intervention then that is the case, and no money is available even if your predictions of erosion rates are greater than the current predictions. There are no cheap methods, and even vegetation growth only stabilises the top layer of sediment, although this may protect against weathering. If the land owner previously had defences then they can replace them like for like, or maintain them however they can't improve their own defences.

Lauren Siggers, CCO: After the recent storm surges, and last year's rainy season, is there an increased likelihood of landslides on the south coast for 2014? Yes. It seems that there is a cyclic pattern for extreme weather events/landslides of 10-15 years. Currently we are in an active phase since April 2012. The impact of the recent weather on cliffs is still ongoing. The effect of wave impact on the cliffs will probably have ended, however rainfall takes ~2months to pass through a cliff system, therefore more events can be expected. At Barton, e.g., the rainfall levels over the past few months have been: 150mm in October, 100mm in November, 200mm in December, and ~100mm so far for January. BGS are involved with identifying relict landslides and comparing with active landslides to present a trend for future.

Clare Wilkinson, CCO: What is the best way to keep the public informed about cliff instability? Do signs work better with pictures, or with more information on them? No one will take inappropriate signs down, and often put new signs in front of old ones. It needs to be controlled and more effective. Maybe using online updates and GIS to inform the

public? Who is responsible? This needs consistency otherwise people won't take notice. In the urban environment there are signs everywhere - should it be the same at coast?

Sally Hawkins, CCO: Where does the responsibility lie when members of the public ignore warning signs? We don't want to over-scare the public with warnings. There is a disproportionate amount of media interest in landslides and rock falls. However signs are becoming part of the furniture around landslide events. Perhaps a variation in the signage would make people take more notice? Signs should be used however as you can't ever count the amount of lives saved, only the amount lost.

Linda Jewell, Fareham: How certain are we that we can predict the future rate of erosion on cliffs at Solent Breezes? The site has a No Active Intervention policy in the current SMP, however the holiday park is a permanent residence for some people. It is protected by gabion baskets, however these have slipped in the recent storms. Needs monitoring to identify a trend/rate/linearity, and to monitor cliff top retreat. At this site historical information can be applied if the rates of retreat are relatively constant, and extrapolated in to the future.

Travis Mason, CCO: We have 4/5 rain gauges at met stations at the CCO. Are rain gauges worth the effort, and over what spacing? Yes, modern rain gauge systems work. At Bournemouth there are 4 rain gauges which download data automatically every day. Each covers a radius of ~2km, with a 0.2mm tipping bucket gauge in each. It is definitely worth the effort in order to observe the relationship between rainfall and cliff failure. This can be seen in Lyme Regis, Barton and Scarborough. They should be used where a landslide risk is known. At Bournemouth, a large variation in the rain gauges can be seen even over a 2km difference, especially during summer thunderstorm events.