

**Reflections on the December Tidal Surge and How This Relates to Adapting to
Environmental Change in the Broads**
Report by Head of Strategy and Projects

Summary: This paper seeks to give an overview of the tidal surge on 5/6 December 2013 and the impacts it had on the Broads and adjoining coast. Evaluation of the event continues but preliminary suggestions are that the impacts were as broadly predicted and the defences coped well. There has been damage and repairs will follow. It is difficult to relate this directly to a changing climate but the event will no doubt help stimulate people's thinking on the options to build resilience and adaptation to get the best for the Broads from environmental change. The current approach that the Broads Authority leads on is summarised.

Recommendation: That the Authority

- (i) notes that the Broads Flood Alleviation Project's approach has coped well with a testing event (although differing winds might have made things more of a challenge). With the Flood Alleviation Project now over half way through, determining the follow-on approach after 2021 becomes a higher priority and the importance of the joint work on climate change adaptation in influencing the outcome is recognised;
- (ii) reinforces its belief that a strategic priority is to work alongside the key agencies and engage with the public to help those resident in and visiting the Broads to contribute to the debate about future water management options so that wide support can evolve for positive action to get the best for the Broads in the face of environmental change;
- (iii) welcomes the opportunity to understand more fully the challenges of flood management as influenced by climate change through a Member's workshop on the subject later in 2014.

1 Background

- 1.1 Flood protection in the lower river system in the Broads is managed through a unique public private partnership called the Broads Flood Alleviation Project. The £140million project was awarded in 2001 to Broadland Environmental Services Limited – a joint venture company created between Halcrow and BAM Nutall who work in partnership with the Environment Agency.
- 1.2 The main aim of the project is to strengthen existing flood defences and restore them to the 1995 level of protection making some additional allowance

for sea level rise and future settlement of the flood-banks. Around 240km of flood-banks protect approximately 21,300ha containing more than 1700 properties of which more than 1000 are residential, and over 7000ha designated as SSSIs and with a European nature designation.

- 1.3 The main capital work is being undertaken in the first 12/13 years of the project and BESL are about to move into the maintenance phase through to 2021 and then must leave a residual life of at least 7 years. The work involves strengthening existing flood-banks in situ, setting back or rolling back banks to make space for water and undertaken erosion protection works. Over 110km of existing banks have been strengthened and over 40km of new embankments created bringing protection to 14 previously undefended communities.
- 1.4 The Broads Authority is a consultee on any proposals and as the relevant Planning Authority ultimately gives permission for the work to go ahead.
- 1.5 The policy for management of the coastline is determined through the Shoreline Management Plan (SMP). This is broken down into sections around the UK coast with the Broads aspect falling within the cell from Kelling to Lowestoft. Simply put, the District Council take the lead where there is a cliff and the Environment Agency where there is low-lying land prone to inundation although the intention is for all bodies to work closely and take a holistic and collective approach. The Broads Authority is involved as a minor player on the SMP management group and would be involved as Planning Authority if any construction work was proposed.
- 1.6 In 2009 the Broads Authority formed a Climate Change Adaptation Panel bringing together high level representatives of the key agencies to coordinate a joint approach to forward planning. Under the chairmanship of Professor Kerry Turner from UEA the Panel is led by the Broads Authority with the support of the Environment Agency, Natural England, National Farmers Union, and Norfolk County Council (linking to other local authorities).

2 The tidal surge and storm

- 2.1 On the evening of 5/6th December the North Sea was subject to a tidal surge. This is when a low pressure system over the sea causes a bulge in water levels and raises the sea level higher than expected. As this was predicted to coincide with stormy weather, early warning was given about potentially dangerous conditions for coastal areas. (Impacts of the low pressure were in fact felt across many parts of the UK with flooding and damage to places like North Wales, Scotland, Yorkshire and Lincolnshire).
- 2.2 Data is still being collected about the magnitude of the situation but there is general acceptance that sea levels rose higher than they had since the bad flooding around North Sea coasts in 1953. A figure of levels 2.97m higher than predicted have been given for Lowestoft. (It may also be of interest that West Flanders province in Belgium were giving warnings of a 6.1m storm surge – again the highest for 60 years / the Eastern Scheldt storm barrier

closed for the first time in 6 years/ that the Elbe River Harbour was under more than 6m of water – the second highest level since records began in 1825. The Thames Barrier was closed during the early hours of the 6th for the first time since late-December 2012. In all there have been 121 closures since the barrier was first opened in 1982, 77 of them to counter storm surges and 44 to deal with river flooding heading downstream. There were no closures at all in 2011 for the first time since 1997).

- 2.3 Eventually the wind didn't swing round as far as feared and so the impacts in East Anglia were less than they could have been if the wind had been behind the tide. Also, the Broads system was at a relatively low level with a low tide and limited rain recently enabling much of the surge to be accommodated without over-topping. This is why more over-topping occurred with the later tides as the system had 'filled'.
- 2.4 The Environment Agency and other agencies attempted to evacuate 18,000 people at risk across the country, with 9000 homes in Norfolk contacted. A total figure for properties finally affected in East Anglia is still being collated but it is suggested that "several hundred properties" have been affected. Impacts include 7 cliff top properties in Hemsby collapsing into the sea; flooding in Lowestoft closing the two main bridges in the town for a time; the A143 closed at Haddiscoe until the morning of the 9th; the Harbour Inn at Southwold was flooded for the 9th time since November. Impacts in Norfolk seem to have been greater in West and North Norfolk (with significant flooding in Boston, Lincolnshire) with flooding at Wells, Blakeney, Salthouse and Cley though no loss of life or significant injuries. Parts of the coastal footpath remain closed at present.

3 Overview of the Broads Authority's Activities Related to the Event

- 3.1 Operationally, for 4 days from Thursday to Sunday - the rangers were solely focused on site checks in vulnerable/ flood hit areas and small repair works to moorings, etc. There were also a number of trees down on sites particularly in the northern Broads due to the winds on Thursday which the team cleared. The more significant impacts were:
- Burgh Castle Moorings (TG 47295 03794). Area of flood defence breached by the first flood surge Thursday night. Removed 25 large pieces of planks/wood from mooring and safety ladders cleaned
 - Reedham Quay (TG 41983 01710). It is believed the water did not overtop the defences (came close) rather the water got behind the defences another way. The Friday tide (around 12pm) was higher at this location than the Thursday night tide due to the build-up of water in the Yare
 - Thorpe Dockyard: Again, high water on Friday (around 2pm) was higher than Thursday night. On Friday night the fire service had to evacuate properties on this stretch including Bungalow Lane which is the next road along – evacuations were going on around 4-5pm on the Friday. We had to close the office as the access road which dips under the railway line became impassable

- A call into Broads Control spoke of an Otter Den floating near the Wherry Pub at Oulton Broad. Otters were still going in and out of the Den. It was in old Pegasus Boatyard but had come free in high tides. It had broken up by the next day with no signs of activity when checked
- Great Yarmouth Yacht Station - Overtopped moorings. Tide mark 1.5 feet up brickwork on Yacht Station wall
- Somerleyton - Overtopped moorings. Footpath muddy. Signs and safety equipment displaced
- St Olaves - Bridge Stores overtopped. Footpath to BA Moorings muddy and fence down. St Olaves Moorings - overtopped. Charging point waterlogged and not working. On 7 Road between St Olaves Bridge and Haddiscoe Bridge flooded but passable. Haddiscoe marshes flooded
- Loddon - EA in attendance on the 7 opening the Mill race to let in more fresh water for the fish congregating there
- A number of electric charging points were reported as not working and needing to be checked

3.2 As well as the operational response on the ground the Deputy Head Ranger was involved at Gold and Silver Control for planning for the floods which took up about two days as well as several phone calls as part of standby to the coastguard and fire service – just giving local information to them.

4 Overview from the Environment Agency on Their Operational Aspects

4.1 Eccles to Winterton Sea Defences

4.1.1 The Agency feel this was certainly the nearest to a design storm event they had experienced on this frontage since they embarked upon the current beach management approach almost 20 years ago. The initial assessment indicates that the defences stood up well to this severe test and generally performed in line with predictions.

4.1.2 The most visible impact is the removal of large quantities of sand from the top of the beach and the resultant exposure of lengths of seawall previously buried under sand. However the Agency felt the upper beach did its job in absorbing much of the wave energy during the peak of the storm. Although severe, this event was fairly short-lived, and a storm of longer duration with the residual elements of the surge affecting successive tides would pose a greater threat to the integrity of the defences and risk of flooding in the Broads.

4.1.3 Following the storm, there have been encouraging signs of beach levels starting to recover. The Agency comment that it is noticeable how the new rock groynes in the Horsey/Somerton Holmes area are very effective in encouraging sand build-up compared to the sections where there are ageing steel and timber groynes. They hope to be replacing more of these groynes with new rock structures during 2014.

4.1.4 In contrast to other places around the Norfolk and Suffolk coast there has been little need for post-surge emergency works between Eccles and

Winterton. These have been limited to repairing damaged access structures and other public safety works.

4.2 Fisheries

- 4.2.1 The Agency report that there have been four episodes this winter where salt water concentrations at Acle Bridge have reached 30,000 microsiemens per cm (equates to over 50% sea water concentration) when the Environment Agency deployed the barrier at Herbert Woods boatyard.
- **On 9 October 13** – approx 2000 fish died in the River Thurne at Potter Heigham. EA received 10 calls. Fish rescue saved around 300 bream which were transferred inside the boatyard.
 - **Late October 13** – Barrier was raised for 24 hours, but no saline threat. No increased salinity registered at Potter Heigham.
 - **30 November 13** - Over 1000 dead fish in the lower reaches, Acle and Upton Dykes. No reports of fish deaths further up. Received 6 calls.
 - **5/6 December 13** – Barrier was raised for 5 days. Salinity reached 40,000µs at Potter Heigham, however there were no reports of dead or distressed fish. Fisheries team moved a small number of fish over the barrier from the River Thurne in to the boatyard. On the Chet the sluice at the mill was opened to allow more freshwater through for the fish congregating there. The Agency did extensive monitoring and fisheries teams were out on 6 and 7 Dec, checking areas where fish congregate.
- 4.2.2 Each season is different in terms of the number of events, and the use of the barrier. The Agency feel this has been quite a busy year with two known fish kills as a result of saline incursion. The December event followed from earlier events and as a result it is quite likely that most of the fish were already further up the system following the salt events.

4.3 Broads Flood Alleviation Project

- 4.3.1 The initial assessment is that the defences behaved as expected. The initial high tide pushed water into the system which had been experiencing a lower than typical low tide. This tended to mean the upstream flooding didn't happen until the following two high tides when over-topping occurred in the places designed to deal with such major events. These areas have been chosen to alleviate risk to people, property and areas of high biodiversity value.
- 4.3.2 The flooding in the Haddiscoe area broadly followed the predicted design scenario where around 30 to 60% of the area is expected to flood if there is a surge event or high levels of rainfall come into the system. Coordination with the Drainage Boards will manage the evacuation of this water back into the river system.
- 4.3.3 There was a minor breach of the bank at Burgh Castle and some areas of damage to banks elsewhere but relatively small amounts. For example a rough assumption was that of the 18km+ banking around Haddiscoe island the damage was limited to a length of 50 or so metres.

- 4.3.4 Repairs will be undertaken when conditions are suitable and full monitoring data as it is collated will be related back to the modelling to see if improvements need to be made.
- 4.3.5 The flooding in the river system does need to be related back to the coastal management and current Shoreline Management Plan. Significant events are occurring at a frequency initially thought to be typical of the later epoch from 2025 and so learning from the event will be used to help look at overall policy. The Environment Agency continues its collation of data about the event to assist with the review.

5 Overview from Other Coastal Interests – NNDC, WDC/SCDC

- 5.1 The North Norfolk coast generally held up well with some damage and flooding but no major losses. Repairs will start to the damage caused which will eat into reserves and money that could have gone into the coming year's improvements (for example the estimate for the cost of replacing lost and damaged hand-rails around their coast is £250k). The District Council will be exploring if there can be any help from the Government. The Council will also be carrying on with their community level consultations to gain the reaction from local people that may be starting to recognise new approaches may be needed in places to safeguard locations where protection is vital for life and most properties.
- 5.2 The view on the Suffolk coast is that the protection generally worked although it was very lucky the wind did not move round and create higher energy waves. Again money that might have supported new work will be diverted into repairs. The Suffolk approach is already putting greater emphasis on locally derived funding contributions to new defences and this will no doubt help focus the debate on what is realistically possible.
- 5.3 The detail of how and why Lowestoft flooded will be investigated and this may suggest it is vital to look holistically about coastal and riverine approaches here as is being done elsewhere on the Suffolk coast where impacts were worse and could have been far worse (e.g Blyth estuary). Each flooding event is different and the complexities of estuarine situations mean understanding the associated land management practices is important. Waveney DC will be interested to also learn of the assessment at Great Yarmouth where significant flooding did not occur as perhaps it might.

6 Conclusion

- 6.1 In conclusion the view is that the flood defence improvements since the 1950s had been able to cope with the situation although different wind conditions may have altered that. The model predictions proved to be pretty accurate and although there are repairs to be made the basic designs worked. There are concerns about beach removal in places which heightens the need to consider how sustainable the chosen options will be if such storms become more frequent and sea levels continue to rise.

7 Relating the event to climate change

7.1 Current work

- 7.1.1 At this stage it is very hard to be sure how much this event was a manifestation of a changing climate. It was within previous recorded variations and could be the result of a number of differing influences. We have now had two years of particularly unusual weather patterns and it certainly helps illustrate the need to explore how we can become more resilient to differing weather conditions and strengthens the argument for planning ahead to enable the Broads to be adaptable.
- 7.1.2 The preliminary work on a Climate Adaptation Plan for the Broads identified that the management of water is likely to be central to choices that need to be considered. The likelihood of more extreme weather events (frequency and duration), changing rainfall patterns and a rising sea level are all factors that can cause flooding stress. (Though at the same time it is important to also remember the need to consider water resources and water quality to lessen other stresses on the environment.)
- 7.1.3 The Climate Change Adaptation Panel, made up of the key agencies with an interest in adaptation for the Broads, promotes the idea of using three simple options around flood management to help people relate to the choices that are likely to become increasingly important over the coming couple of decades. (See Appendix 1). The Panel's view, supported by the Broads Authority, was to begin a process of engagement from late summer with a wider range of interests to raise awareness of the need to further the investigation of, and planning for, coping with predicted environmental change.
- 7.1.4 This approach was chosen to enable differing interests and perspectives to contribute to the debate. With so many competing demands on the special qualities of the Broads, it is vital to ensure many views are collated so that as we move to planning change the solutions (or choices) give the greatest public benefit(s). The Project is concentrating on parish councils, farmers, businesses (especially those related to tourism) and young people aged 16 to 26.
- 7.1.5 Environmental matters are of course complex and many factors will need further study and consideration. The current flood policy is strongly driven by the need to meet environmental designation requirements with comparatively few properties and human life risks factors to accommodate (as opposed to a place like the Netherlands where over 50% of the area is already below sea level and that area is highly significant in terms of population and GDP). The predominately freshwater system is already highly dynamic with the 'natural' connections to the sea already being a significant factor in the system's operation (e.g. the importance of the brackish nature of Breydon Water for wildlife).
- 7.1.6 The current emphasis is therefore to raise the level of awareness of predicated change and how this might relate to the lives of those resident and

visiting the Broads as well as the environmental setting. By sharing clear information without undue judgements involved, the Project seeks to generate a quality debate that can hopefully enable choices to be made that provide options and benefits and retain the special qualities of the Broads.

- 7.1.7 To foster this approach the view from the Panel has been to remain relatively neutral on the judgements related to the future of the Broads (apart from the belief that the Broads will remain an important environmental and recreation asset that will retain national recognition) until a wider collation of attitudes about choices is known. This will then provide a depth of opinion on the direction of travel and strengthen the case for appropriate resources to be released to support the collective (and ideally close to consensus) view about the future for the Broads.

7.2 The Next Steps

- 7.2.1 The preliminary events discussing the possible details of how climate change and sea level rise will affect the Broads have not proved popular. This is likely to be due to a collection of factors including the effectiveness of promotion, the fact the topic has dropped right down the national political agenda, the uncertainties involved not seen as so important with other worries to the fore and the need to still evolve the communication processes – for example using the right language to encourage involvement. However the project continues with new approaches planned for later in 2014. Plans are well advanced for a two-day young person's event at How Hill (March 1 and 2) and investigations about a larger public event in April either at the Forum in Norwich or Great Yarmouth are being made. The intention is still to draw in wider viewpoints and help the refinement of the adaptation plan that is now likely to be submitted to Defra towards the end of 2014 in keeping with their timetable for the next iteration of the national adaptation plan. The adaptation plan will seek to identify the next steps in terms of research, policy development and outlining positive steps that can be taken to improve resilience and build in adaptive assessment.
- 7.2.2 The Panel has raised the idea of exploring whether a different, more holistic approach will be needed to make best use of limited public funding and to retain the wide range of ecosystem services the Broads provides for society. Taking a combined approach to inland and coastal flooding policy will be vital.
- 7.2.3 As part of the planned events programme there will be a specific event for Members on climate change and flood management in the coming months.

Background papers: None

Author: Simon Hooton
Date of report: 3 January 2014

Broads Plan Objectives: CC2, CC3, CC4

Appendices: APPENDIX 1 – 3 simple future flood management scenarios

Appendix 1 3 simple future flood management scenarios

A significant issue for the Broads is flooding and flood management. The Broads⁰ Community have created three simple scenarios summarising possible approaches to future flood management.

(a) Carrying on as normal...

Responding in a way similar to now, looking at slowly improving flood defences when they become priority needs and resources can be made available. Responses would be a similar mix of approaches - raising and strengthening defences in some places and realigning in others, promoting the need for personal action alongside public action; planning ahead with relatively short term documents; and trying to meet as wide a range of other objectives as possible at the same time. This is a cautious and prioritised approach.

However, the predicted environmental changes suggest that this approach would become unsustainable. The flood banks cannot go high enough within the current footprints and would need to get much wider as well as higher. This would create broader and more noticeable soke dykes behind the walls. Realignments on the line of the river would become more noticeable – bigger areas holding more water (reeds at lower water levels) where scouring occurred on ‘sharp corners’.

The frequency of over-topping, or the power of the water causing more breaches, would start to threaten individual holdings, and a clamour would grow about an unfair change of policy by ‘insufficient action’. The frequency of serious events would increase, putting pressure on infrastructure and emergency planning. More unpredictable results would occur.

(b) Seeking to control and restrain the water...

This scenario means looking primarily at hard engineering solutions, such as:

- building barriers to hold back the sea
- raising river defences through hard engineering with steel, wood and concrete
- seeking to move water away through pumping
- more stringent control brought in about what individuals would need to do to their own locations to retain continuity of defence
-

This would see many more large and strong defences. A barrier across one or more rivers would become almost certain. To make the barriers cost effective, they would be likely to incorporate energy harvesting (such as tidal sluices, wind turbines, or solar panels) or crossing points, making them more obvious in the Broads’ landscape.

The natural edges to rivers would decline and views from boats would lessen. More minor water control structures would be found on ditch and stream connections, with tidal flaps or manually elevated gates to hold back water. There would be a tendency to ‘restore things’ as soon as possible – so more water pumps and drainage channels.

Protection away from the water’s edge may increase with walls and barriers in car parks and open spaces beside rivers. Water controlled within these boundaries would

be much higher, potentially requiring more sophisticated mooring and management of boats (such as gates into marinas, and higher mooring poles present all the time). This is likely to give a greater feeling of security, and reduce the likelihood of loss of life and lessen damage to property. It would also create a clearer policy for those wishing to invest in new development. Looking further forward, there might be considerable technical challenges in building robust defences on insubstantial foundations, and so costs could rise rapidly.

(c) Allowing water to find spaces and dissipate...

Excess water would be allowed to remain in places before naturally dissipating. Choices would be made about where flood water could be allowed to go - possibly in the lower reaches, with washland areas normally managed perhaps by grazing but with an acceptance that they would get flooded relatively frequently and the water may stay there for weeks or even months (like the Wash levels do now).

In the upper reaches there may be areas identified for flood waters by not building up high defences and accepting they would flood occasionally. New buildings would require places set aside to deal with flooding (such as public open spaces designed to hold excess water when conditions dictate). There would be controls to ensure more effort was made to allow excessive rain to drain into the ground and remain there, reducing the occurrence of flash flooding. Green spaces would be retained with hollows to hold water and perhaps 'woody debris' in place to create simple dams and flood areas during extreme events.

Drainage areas would be divided into smaller units with allocated water holding areas that would not be rapidly pumped drier. Land management practices are likely to become more restricted at times of flood (for example, less chance to get on and manage certain compartments of fen or grazing marsh).

Extreme events may create significant standing water with damage to boundary banks. It would be less likely that such breaches would be repaired, perhaps creating new seasonal open water bodies. There would be strong encouragement for individuals to take personal action to protect their property and land through banks around their house or door flood barriers.