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## Environment Agency

# Coastal Habitats 2100: The East Coast Response to Tidal Surges

Project Report



May 2014

AMEC Environment & Infrastructure UK Limited

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The aerial photograph is from 6<sup>th</sup> December 2013 East Coast surge, showing damage at Hemsby (North Norfolk Coast). The aerial photograph is copyright © Environment Agency's Geomatics Team

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**Environment Agency****Coastal Habitats 2100:  
The East Coast  
Response to Tidal  
Surges****Project Report**

May 2014

AMEC Environment & Infrastructure  
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## Executive Summary

On 5<sup>th</sup> and 6<sup>th</sup> December 2013 the largest storm surge in 60 years hit the East Coast of England, causing extensive damage to property and habitats. The Intergovernmental Panel on Climate Change predicts with confidence that in the 21<sup>st</sup> Century sea levels will rise, the rate at which sea levels continue to rise year on year will increase, and that storm events will become more frequent. Climate change driven sea-level rise means that the likelihood of events such as that which occurred in December 2013 is increasing.

Therefore, a workshop was held on Thursday 6<sup>th</sup> March 2014 with approximately 20 delegates, representing a wide range of East Coast conservation managers, regulators, policy makers and stakeholders from a range of organisations. The overall aim of the study was to bring together these East Coast stakeholders to share their experiences of the December tidal surge, to hear what actions have been undertaken to facilitate recovery from the surge and to consider how habitat management on the East Coast can be adapted for on-going climate change.

Based upon the workshop feedback and in the context of the latest climate change predictions, a number of recommendations are made for the East Coast response to tidal surges; these predominantly centre around updating current guidance, undertaking further research, and facilitating more collaborative working and information sharing across all levels (see box below).

### Key Recommendations for the East Coast Response to Tidal Surges

- **Regular partnership meetings:** The East Coast Tidal Surge workshop delegates and Steering Group meet periodically (e.g. twice a year) to discuss progress and actions.
- **Revised guidance:** Guidance on coastal adaptation options and flooding response is updated on the basis that events will be sudden and extreme and happen now not in the future. The documents need to be revised promptly;
- **Re-run modelling:** The Defra CR0422 project is re-run using IPCC AR5 climate change projections of sea level rise so that the extent of habitat predicted to be lost is based upon the most up to date climate change predictions;
- **Affected sites desk study:** A further desk study is undertaken to establish which sites have rebounded well and why and those that haven't, to inform further decision making;
- **Further coastal research:** Further research is needed to understand the location/ extent and amount of sediment / substrate material being eroded, transported and deposited during storm surges to better understand coastal dynamics in surge scenarios;
- **Data capture:** Following each surge event, the extent of flooding is mapped using aerial photography or ground-level survey by a cross-partnership group, and the mapping is digitised to build up a historical archive of flood events for future decision making;
- **Community engagement:** Ongoing proactive engagement and communication with local community groups and politicians regarding the climate change message to change perspectives and make the case for coastal habitat adaptation / 'make space for water'. Ensure the climate change messages to the public, landowners and local community groups is consistent and clear;
- **Create new coastal adaptation and surge response website:** With the loss of the Environment Agency's Climate Ready website, a national interactive website should be created and maintained which would contain succinct, practical, and accessible documents for a varied audience of professionals with different technical/policy backgrounds. Website to also contain sub-domains by regional geographical areas. The sub-domains would enable practitioners, site managers, decision makers, local community groups and landowners to collaborate together. The emphasis should be on more formally involving local community groups and local landowners in the decision making process to assist LLFAs meet their statutory duty.
- **Use of NELMS:** Greater emphasis is placed on working with local landowners to realise opportunities within the New Environmental Land Management Scheme (NELMS).



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# 1. Introduction

## 1.1 Recent Tidal Surge

On 5<sup>th</sup> and 6<sup>th</sup> December 2013 the largest storm surge in 60 years hit the East Coast of England, causing extensive damage to property and habitats. The Intergovernmental Panel on Climate Change (IPCC) predicts with confidence that in the 21<sup>st</sup> Century sea levels will rise, the rate at which sea levels continue to rise year on year will increase, and that storm events will become more frequent (IPCC, 2013). Climate change driven sea-level rise means that the likelihood of events such as that which occurred in December 2013 is increasing.

## 1.2 Climate Change and Coastal Adaptation

Amongst the latest IPCC reports are two (IPCC, 2014a and b), which focus on climate change adaptation and provides principles for successful adaptation (Box 1.1). In particular IPCC (2014a and b) state there is high confidence that adaptation can prevent most of the projected damage caused by rising sea levels. However the current and near-term risk from rising sea levels with current levels of adaption is deemed to be medium increasing to high by 2080 unless significant adaption is implemented (IPCC, 2014a and b).

The EU Adaptation Strategy was adopted in 2013. It provides for a coherent approach and improved coordination to enhance the preparedness and capacity across all governance levels to respond to the impacts of climate change<sup>1</sup>. The *Climate Change Act 2008* is the statutory instrument for climate change mitigation and adaption in the UK. The UK Climate Change Risk Assessment (CCRA) (HM Government, 2012), and the National Adaptation Programme (NAP) (HM Government, 2013) implement the requirements of the Act.

### Box 1.1 Key Messages/Principles for Effective Adaptation (adapted from IPCC, 2014)<sup>2</sup>

- Adaptation is place and context specific
- Adaptation planning/ implementation can be enhanced by collaborative working
- Adaptation planning/ implementation depends upon recognising diverse social-cultural contexts, values, and risk perception
- Poor planning, overemphasizing short-term outcomes, or failing to anticipate consequences can result in maladaptation
- Gaps exist between adaptation needs and the funds available for adaptation
- Significant co-benefits, synergies, and trade-offs can be realised across initiatives and across regions
- Transformations in economic, social, technological, and political decisions and actions can enable resilient adaptation

**“Adaptation:** *The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.*

**Incremental adaptation:** *Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.*

**Transformational adaptation:** *Adaptation that changes the fundamental attributes of a system in response to climate and its effects”*

<sup>1</sup> [http://ec.europa.eu/clima/policies/adaptation/what/index\\_en.htm](http://ec.europa.eu/clima/policies/adaptation/what/index_en.htm)

<sup>2</sup> Principally taken from Chapter C1 ‘Principles for Effective Adaptation’

The *Flood Risk Regulations 2009* and the *Flood and Water Management Act 2010* places a statutory duty on the Environment Agency and Lead Local Flood Authorities (unitary authorities or county councils) to prepare Flood Risk Management Plans (FRMPs) at the River Basin District and local level respectively. These include flooding from the sea. FRMPs highlight the hazards and risks of flooding and set out how Risk Management Authorities (RMAs)<sup>3</sup> work together with communities to manage flood risk. Through this legislation and the National Flood and Coastal Erosion Risk Management Strategy for England (Environment Agency, 2011), the emphasis is on collaborative working and information sharing between RMAs. Additionally, other national guidance advocates a managed adaptive approach and coastal realignment as options to those authorities with a flood and coastal erosion risk management role (Environment Agency, c.2009; Defra, 2009).

Defra's consultation paper 'Adapting to Coastal Change: Developing a Policy Framework' (Defra, 2010) advocated the creation of a new Coastal Change Pathfinder programme to explore new and innovative approaches to supporting local authorities and their communities to plan for and adapt to coastal change. The Coastal Change Pathfinder Programme ran between 2009 and 2011, whereby fifteen local authorities in England received nearly £11million for coastal adaptation. The adaptation predominantly took the form of 'rollback' projects<sup>4</sup>. North Norfolk Coast District Council was one of the five largest Pathfinder projects, receiving £3 million. A recent review of the programme concluded that overall, the Pathfinder programme has shown that communities can be encouraged to adapt to coastal change (Defra, 2012). The main barriers to adaptation identified, that are relevant to other future coastal adaptation projects, are given in Box 1.2 (Defra, 2012).

Recent additional impetus for the coastal adaptation message has been added by National Trust's 'Living With Change – Our Shifting Shores' policy<sup>5</sup>.

**Box 1.2 Main Barriers to Successful Adaptation Projects (adapted from Defra, 2012)<sup>6</sup>**

- public understanding and awareness;
- funding for delivering adaptation, and lack of ring-fencing of funding;
- planning policy – which can also be an enabler;
- resourcing capacity within local authorities and other partners and the priority given to coastal change adaptation;
- difficulties in identifying suitable sites for adaptation;
- lack of a rigorous monitoring and evaluation framework, lack of clarity over aims and objectives.

<sup>3</sup> In England this comprises the Environment Agency, Lead Local Flood Authorities, District Councils for areas for which there are no unitary authorities, Internal Drainage Boards, water companies, and highway authorities

<sup>4</sup> Whereby properties/businesses are relocated away from the coast

<sup>5</sup> See:

[http://www.nationaltrust.org.uk/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobheadername2=MDT-Type&blobheadername3=Content-Type&blobheadervalue1=inline%3B+filename%3D348%252F288%252F2014\\_ShiftingShoresreport.pdf&blobheadervalue2=abinary%3B+charset%3DUTF-8&blobheadervalue3=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1349120436333&ssbinary=true/](http://www.nationaltrust.org.uk/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobheadername2=MDT-Type&blobheadername3=Content-Type&blobheadervalue1=inline%3B+filename%3D348%252F288%252F2014_ShiftingShoresreport.pdf&blobheadervalue2=abinary%3B+charset%3DUTF-8&blobheadervalue3=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1349120436333&ssbinary=true/)

<sup>6</sup> Principally taken from Chapter C1 'Principles for Effective Adaptation'

## 1.3 About This Study

### 1.3.1 Need and Aim

Following the tidal surge of 5<sup>th</sup> and 6<sup>th</sup> December 2013, the steering group decided to bring together East Coast stakeholders to share their experiences of the tidal surge, to hear what actions have been undertaken to facilitate recovery from the surge and to consider how habitat management on the East Coast can be adapted for on-going climate change.

Therefore, a workshop was held on Thursday 6<sup>th</sup> March 2014 with approximately 20 delegates, representing a wide range of East Coast conservation managers, regulators, policy makers and stakeholders from a range of organisations (see Appendix A).

The study was funded by the Environment Agency Climate Ready Support Service and headed by a Steering Group which comprised representatives from The Environment Agency, Defra, Natural England; and RSPB.

### 1.3.2 Workshop

Presentations were given at the workshop by AMEC E&I UK Ltd and the University of London and University of Cambridge and break out groups discussed a series of questions (Appendix B). Delegates were also encouraged to complete questionnaires individually and pass these to the workshop facilitators.

The workshop was facilitated by AMEC E&I UK Ltd and the Environment Agency.

### 1.3.3 Report

This study report provides the headline information and themes presented and discussed at the workshop and the key feedback points provided by the delegates in Sections 2, 3 and 4, although it has been updated to take into account post-workshop comments from the Steering Group and relevant developments in climate change research and policy that have subsequently been identified.

Recommendations arising from the study are given in Section 5.

The report has been written for an informed readership of practitioners and therefore does not include a detailed policy and legislative appraisal.

## 2. The 2013 East Coast Storm Surge Experience

The tidal surge along the East Coast of England occurred on 5<sup>th</sup> and 6<sup>th</sup> December 2013 and caused extensive flooding, damage to property and infrastructure and disruption. The magnitude of the surge tide was the largest such event in 60 years; the last such event on this scale was in 1953.

The recent East Coast floods highlighted the vulnerability of England's coastal habitats to storm surge and rising sea levels. The east of England holds a large number of nationally and internationally designated nature sites of nature conservation interest, is low-lying and is extremely vulnerable to sea level rise (SLR) driven by climate change and isostatic rebound, as indicated by the results of Defra project CR0422 on Consequences for Biodiversity of Options for Coastal Zone Adaptation to Climate Change (Entec, 2010).

Examples of specific immediate effects on coastal wildlife sites in the East of England include<sup>7</sup>:

- Emergency closure of the Norfolk Coast Path National Trail.
- Total inundation with seawater of Blakeney Freshes with seawater (c. 157 ha, to a depth of 2m).
- At Blakeney Point, the buildings, including the Lifeboat House were damaged, and the boardwalk was either moved or damaged.
- At Cley Marshes site two major breaches in the shingle bank occurred, at Salthouse and Pope's Marsh and there was extensive wash-back of shingle, up to 100m, onto the marshes.
- At Holkham, the sea wall was breached at Deepdale and over topped in a number of places resulting in Norton Marsh being flooded. Many dead birds and other wildlife were noted along the tide line.

Further summary details of the tidal surge are given below:

- The storm surge increased in intensity as it travelled south along the east coast from Wick in Scotland down to London. Actual water levels were notably higher than predicted water levels, with distance southwards from the north-east of England.
- At Lowestoft, the 'surge residual peak' (the level above what was expected) was more than 2m higher than predicted levels; at Blakeney Overfalls the actual peak wave height was around 3.75m (UK National Tide Gauge Network; CEFAS wavenet<sup>8</sup>).
- Along the East Anglian coast wave heights were generally higher on the Norfolk Coast (up to 0.8m higher) than in the 1953 flood; e.g. at Burnham Overy Staithe and Stiffkey, but were lower than the 1953 flood on the Suffolk Coast.
- The wave energy (power) along the Norfolk Coast eastwards was not as powerful as in 1953 but the surge (wave height) was generally higher.

<sup>7</sup> Anecdotal information obtained from the Environment Agency

<sup>8</sup> <http://www.ntsif.org/data/uk-network-real-time>  
<http://www.cefas.defra.gov.uk/our-science/observing-and-modelling/monitoring-programmes/wavenet.aspx>

- The local coastal setting/landscape was an important determinant of wave height.
- Along the East Anglia coast, the surge caused cliff and dune retreats (e.g. cliffs at Covehithe; at Holkham the dunes were sliced and retreated up to 13m), and barrier breaches (e.g. Benacre).

A summary of feedback on the recent experience, provided by the workshop delegates, is presented by general theme in Table 2.1.

**Table 2.1 Delegates Feedback by Main Theme: The East Coast Surge Experience**

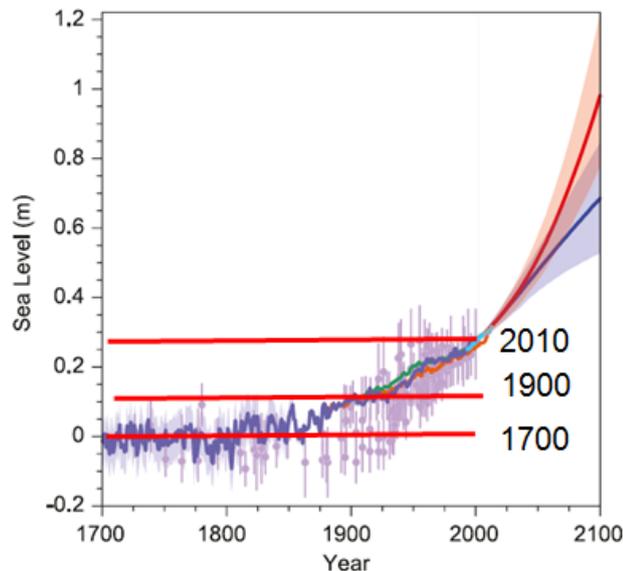
Feedback Themes	Feedback/comments
Summary of the event and the overall effect	<p>There was not just one surge event, but several events over the winter.</p> <p>The overall tone regarding the effects of the recent surge should not be one of region-wide catastrophe and devastation. Most coastal sites appear to be reasonably resilient. In Suffolk there are plenty of adaptive measures already in place where flooding is a relatively regular occurrence. However, a number of local authority and coastal defences were affected which could prompt a re-think on managing the whole coast.</p> <p>It is clear that the consequences of the event range from slight to major. Between Norfolk and Suffolk there are only approximately four locations/sites where 'game changing' detrimental effects occurred, and in broad terms, Norfolk was more affected than Suffolk; the remainder of the coastline seems to have 'repaired' itself within a timescale of weeks (e.g. substrate material has 're-appeared' or floodwater has retreated and the habitats appear to be largely unaffected).</p> <p>That said, concern was expressed it may be too early to assess the true effect on wildlife this year, and if affected areas do not recover soon then another event could be catastrophic.</p>
Planning for Such Events	<p>A certain amount of planning had been undertaken and implemented at sites known to be at greatest risk, for example managed re-alignment at Titchwell, uprating sluices at Cley Marshes, and also creation of wetlands inland through the EARHCP programme.</p> <p>However, at sites generally considered to be at less risk, less planning had taken place and hence effects were consequently more significant.</p> <p>In general it was felt that it was known that such an event could take place and that a strategic plan was in place. Although there was also concern that some legal and policy interpretations were incomplete in advance of the event and that some sites lacked management plans and emergency measures.</p>
Biggest Issues	<p>A range of site issues relate to the damage caused to habitats, species, and infrastructure such as paths, hides, buildings etc.</p> <p>However, it was also observed that there was inadequate forward planning and appropriate response to aid mitigation and recovery immediately after the event. More planning is required in respect of developing a plan to deal with climate change and how this will be delivered.</p> <p>Resources were stretched as there was also inland flooding coincident with the coastal surge.</p> <p>Lack of funding to deliver actions going forward.</p>

<p>Proactive community engagement</p>	<p>Outreaching and networking with local community groups well in advance of the surge event ensured that the local community groups were prepared, able to distribute information quickly on affected areas, and able to mobilise into action in response to the surge. Community action was more effective than external agency action.</p> <p>Regular communication from statutory and non-statutory authorities to local landowners and local community groups in the days leading up to the flooding ensured that loss of stock was limited.</p> <p>However, there were still issues, for Natural England for example, in providing consistent advice both internally and externally.</p>
<p>Various non-ecological / socio-economic issues occurred during the flood event</p>	<p>Issues included flood tourism (people travelling to, or just watching the floods) which could have led to further emergencies, mobile communication, sandbag collection/use.</p>
<p>Communication of the climate change message</p>	<p>The opportunity was lost to get the scientific facts and media messaging correct during and immediately after the floods.</p> <p>Despite the obvious damage caused by the surge event, it did demonstrate the benefits of coastal adaptation to some local communities living near certain sites; in particular, the use of more extensive intertidal areas to soak up flooding, instead of hard defences. Delegates expressed that such experiences were beginning to change people's mindsets and perceptions to a more positive view of climate change adaptation.</p>

### 3. Climate Change Observations, Predictions and Threats

#### 3.1.1 Sea level rise observations and predictions

- There are numerous factors affecting relative sea levels and sea level rise at any given time and location (vertical land movements/isostatic rebound, sedimentation, atmospheric pressure, winds, ocean currents, density of sea water), but only two main causes of absolute sea level rise at the global scale; namely thermal expansion of sea water and melting land ice.
- Global sea level has risen by 19cm (0.19m) between 1901 and 2010 (IPCC, 2013) (see Figure 3.1 below).



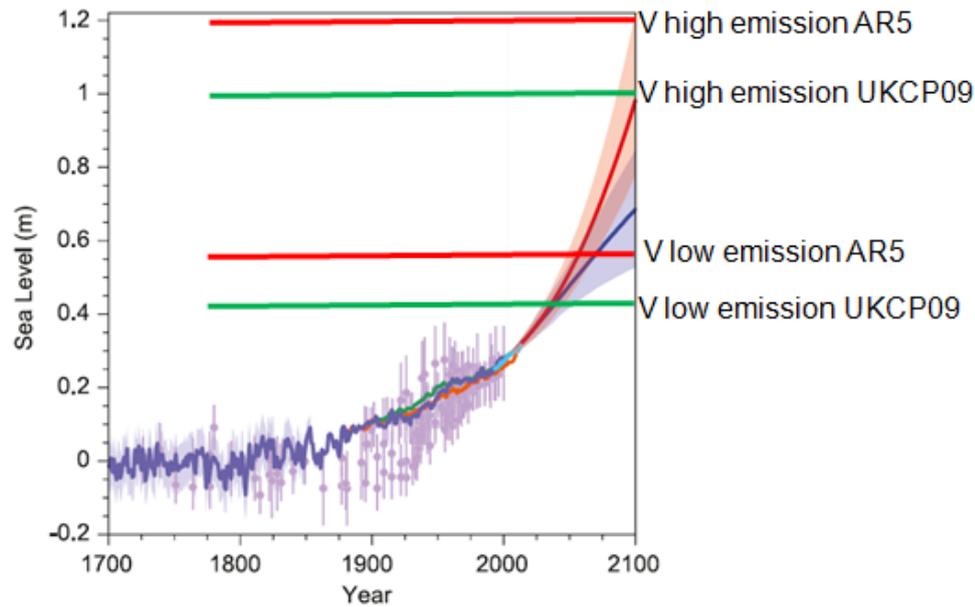
**Figure 3.1 Observed Sea Level Rise Between 1900 and 2010 (IPCC, 2013).**

**Graph Notes:** The graph shows observed trends up to and including 2010. Beyond 2010 the graph shows predicted sea level rise under different scenarios.

- Mean UK sea level has risen 15cm (0.15m) since 1916 (UK National Tide Gauge Network).
- A UK sea level increase of 12 – 76 cm (0.12 to 0.76m) by 2090 - 2099 was predicted in 2009 (UKCP09<sup>9</sup>). However, global mean sea level rise is now expected to be greater than that predicted in 2009; an increase of 28–98cm (0.28 to 0.98m) by 2081-2100 is expected<sup>10</sup> (IPCC, 2013) (see Figure 3.2). This is because the AR5 predictions used improved modelling of land-ice contribution since previous modelling (AR4).

<sup>9</sup> <http://ukclimateprojections.metoffice.gov.uk/21678>

<sup>10</sup> This prediction was published in Working Group I's contribution ('the physical science basis of climate change') to The Fifth Assessment Report (AR5); see chapter 3 'Observations: Ocean' and chapter 13 'Sea Level Change' (IPCC, 2013).



**Figure 3.2 Predicted Sea Level Rise (IPCC, 2013).**

**Graph Notes:** The graph shows observed trends up to and including 2010. Beyond 2010 the graph shows predicted sea level rise under different scenarios.

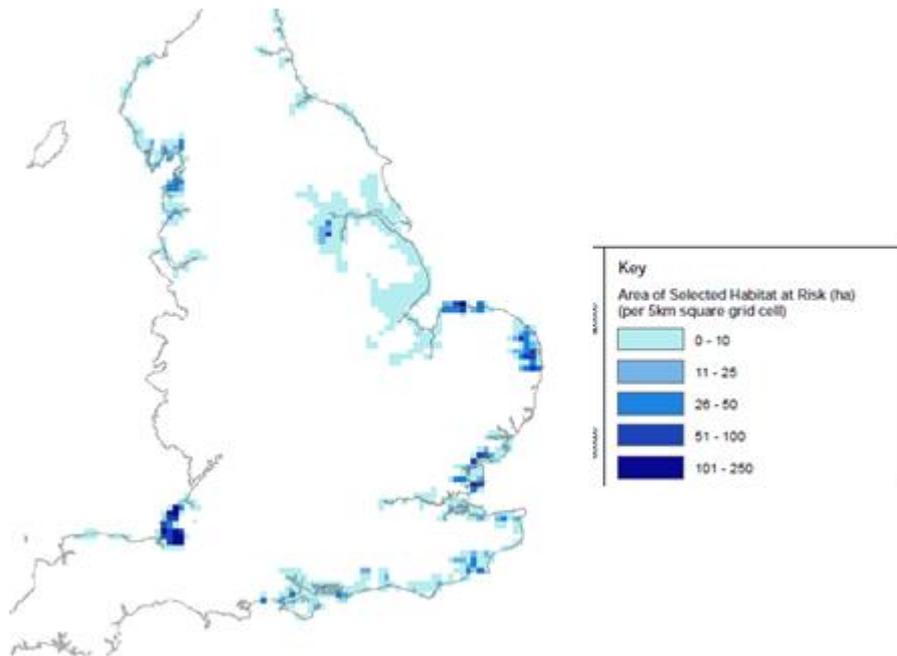
- The rate of global mean sea level rise in the last twenty years is nearly twice as fast as the rate in the last 100 years; the rate of global mean sea level rise between 1993 and 2010 was 3.2mm per year, which is nearly twice that of the period between 1901 and 2010, which was 1.7 mm per year (IPCC, 2013)<sup>3</sup>.
- It is virtually certain that sea levels will continue to rise into the 21<sup>st</sup> Century (IPCC, 2013)<sup>11</sup>;
- The average rate at which sea levels rise year on year is very likely to increase (i.e. it will be greater in the 21<sup>st</sup> Century than in the 20<sup>th</sup> century) (IPCC, 2013)<sup>3</sup>;
- The significant increase in the return frequency of sea level extremes is very likely to continue (i.e. storm events will happen more regularly) (IPCC, 2013)<sup>3</sup>.

### 3.1.2 Threats to coastal habitats and their tolerances to sea level rise

- Defra project CR0422 on the Consequences for Biodiversity of Options for Coastal Zone Adaptation to Climate Change modelled the risk of loss of lowland open-water and wetland priority BAP habitats in the coastal floodplain, as a result of flooding from the sea, under a range of UKCP09 sea-level rise scenarios.
- Loss of coastal UKBAP habitat due to sea level rise, based upon UKCP09 projections for 2100, are projected to be focussed along the eastern coast of England, around the Thames estuary and south-east coast and on the southern side of the Severn estuary (Defra CR0422, Entec, 2010) (see Figure 3.3).
- As stated previously, sea level rise projections have increased since this work was completed (see section above comparing UKCP 2009 with IPCC 2013). Unfortunately in this

<sup>11</sup> This prediction was published in Working Group I's contribution ('the physical science basis of climate change') to The Fifth Assessment Report (AR5); see chapter 3 'Observations: Ocean' and chapter 13 'Sea Level Change' (IPCC, 2013). The AR5 predictions used improved modelling of land-ice contribution since previous modelling (AR4).

project we have not had capacity to re-run modelling to include the higher figures for sea-level rise. We can expect, however, in broad terms that similar areas of coastal habitat will be at risk, but that the timescale for this happening has been brought forward.



**Figure 3.3 Example Predicted UKBAP Coastal Habitat Loss Due to Flooding (Entec, 2010).** **Notes:** This maps shows areas where losses of UKBAP habitat in the coastal floodplain is predicted under UKCP09 scenarios; the darker the blue, the greater the loss of habitat per 5km grid square

- Up to 20% of all the selected UKBAP habitats are projected to be at risk of loss although there are localised areas where average projected losses could be higher, notably on the north Norfolk coast, Essex and on the south coast (Defra CR0422, Entec, 2010).
- With respect to average areas at risk of loss, South-West and Anglian region are almost identical under current climate conditions (1,635 ha for South-West and 1,634 ha for Anglian) (Defra CR0422, Entec, 2010).
- Under future climate change conditions (UKCP09, 2100 medium emission with degraded defences scenario), more habitat is indicated to be at risk of loss in Anglian region compared to the South-West (2073 ha at risk in Anglian under the 2100 medium with degraded defences scenario compared to 2,013 ha in the South-West. See Entec, 2010 for further results.
- The Defra CR0422 (Entec, 2010) study provides a 'sensitivity matrix' for selected coastal UKBAP habitats (see Figure 3.4). Where inundation events exceed the frequency and duration indicated in the matrix, then the existing habitats will be damaged or lost.

BAP Habitat Sensitivity Matrix: Coastal Floodplain Grazing Marsh (GRASS)

		Flood Frequency										
		Events Per Year						Years between Events				
		365	52	26	12	4	2	1	10	100	1000	
Flood Duration	hours	1	1.0	1.0	1.0	1.0	0.9	0.6	0.2	0.0	0.0	0.0
		12	1.0	1.0	1.0	1.0	1.0	0.7	0.4	0.0	0.0	0.0
	days	1		1.0	1.0	1.0	1.0	0.8	0.5	0.0	0.0	0.0
		2		1.0	1.0	1.0	1.0	0.9	0.5	0.0	0.0	0.0
		7			1.0	1.0	1.0	1.0	0.7	0.1	0.0	0.0
		14				1.0	1.0	1.0	0.9	0.1	0.0	0.0
	months	1					1.0	1.0	1.0	0.2	0.0	0.0
		6							1.0	0.6	0.0	0.0
		12								0.9	0.0	0.0

Figure 3.4 Example Habitat Tolerance ('Sensitivity') Matrices for UKBAP Habitats (Entec, 2010).

**Notes:** A series of matrices were developed for different habitats. Each matrix shows 'tipping points' of habitats change for selected UK BAP habitats occurring at/near the coast, in terms of flood frequency (x axis) and flood duration (y axis). Red colour indicates that under a given flood duration and flood frequency (return period), the habitat is irreplaceably changed; yellow/orange indicates when the habitat would change but could recover; green indicates when a flood event is unlikely to cause any change.

- Higher expected rates of sea level rise are now projected, and associated increases in storm surge (IPCC 2013), compared to UKCP09, will increase the rate of habitat loss as a result of likely increased frequency of saline flooding, increased duration of flooding, possible changes to seasonality of inundation events.

## 4. Future Approaches and Decision Points

A summary of approaches currently used to address the effects of sea level rise and potential habitat losses at the coast is provided below.

- The UK Government policy, delivered by the Environment Agency with assistance from Natural England to meet obligations under the Habitats and Bird Directive, is that Natura 2000 (and Ramsar) sites behind seawalls should be protected *in situ* where it is sustainable to do. Where there are SSSIs behind seawalls that are no longer sustainable Natural England will offer advice to secure the best possible nature conservation outcome.
- Environment Agency Shoreline Management Plans (SMPs) are developed by Coastal Groups comprising representatives from local councils and the Environment Agency. SMPs identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline and focus on 'No Active Intervention' (NAI), 'Hold The Line' (HTL) or 'Managed Realignment' (MR).
- Future approaches are a balance of many factors including cost, sustainability, the legal requirements pertaining to designated sites and flood control, but maintaining the status quo is probably not an option even in the shorter term. Adaptation would therefore seem to offer a way forward. A summary of coastal habitat adaptation options and examples is provided in Table 4.1.
- Examples of coastal habitat adaptation are Beach Realignment or Bank Realignment. Beach Realignment involves deliberately breaching sections of existing seawalls or embankments in order to allow the waters of adjacent coasts or estuaries to inundate the land behind through a defined gap (the 'breach'). Bank Realignment involves the deliberate removal of existing seawalls or embankments in order to allow the waters of adjacent coasts or estuaries to inundate the land behind.
- Managed Realignments have been undertaken at RSPB's Wallasea Island in Essex and Titchwell Marsh on the North Norfolk Coast. The Titchwell Marsh project (protecting internationally important wetlands, people and property) is known to have withstood the December surge. See Figure 4.1. Recently uprated sluices on Norfolk Wildlife Trust's Cley Nature Reserve, facilitating rapid removal of saline flood waters, is also understood to have coped well after the December surge to transport flood water quickly from the site.

Table 4.1 Coastal Habitat Adaptation Options

Climate Impact on Habitats	Habitat Adaptation Response	Legislative & Policy Driver/Option	Examples
Loss of intertidal habitat through coastal squeeze	Re-create intertidal habitats to compensate for losses	Managed Re-alignment (MR) via Bank Realignment or Breach Realignment Environment Agency Shoreline Management Plan and Water Framework Directive	Wallasea Island (Essex) Titchwell (North Norfolk Coast SSSI)
Increased saline inundation and eventual loss of coastal freshwater wetlands	Re-create freshwater wetlands away from vulnerable coastal areas	Various: e.g. Environment Agency Regional Habitat Creation Programme (EARHCP)	Methwold EARHCP site (Norfolk) Hilgay EARHCP site (Norfolk)
	Accept over-washing and flooding will occur and provide (additional) drainage/ sluices to drain seawater off the wetland site	Flood Risk Management ( <i>Flood and Water Management Act 2010</i> and <i>Flood Risk Regulations 2009</i> ) Reduced/No Intervention'	Cley-Salthouse (North Norfolk Coast SSSI)  Pakefield to Easton Bavents SSSI (Suffolk)

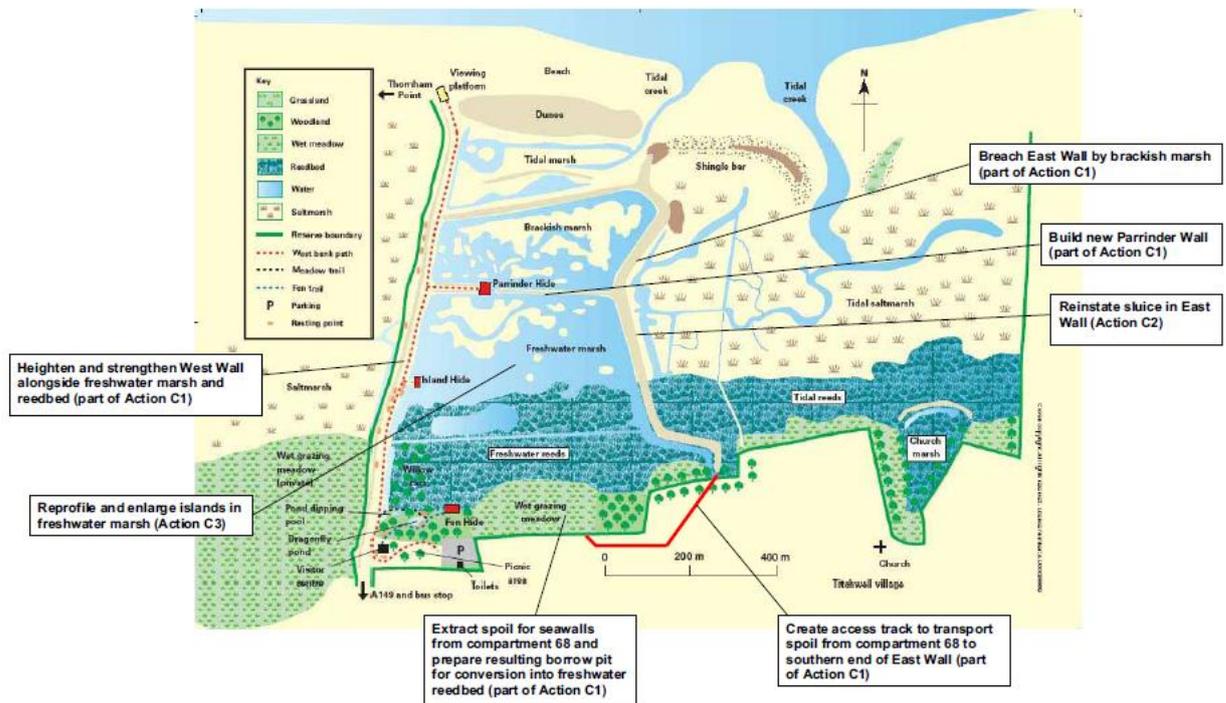


Figure 4.1 Example of Successful Coastal Habitat Adaptation (Titchwell, North Norfolk Coast).

**Notes:** Commenced in 2008 under LIFE funding. See: <http://www.rspb.org.uk/ourwork/projects/details.aspx?id=262957>

A summary of the feedback on future approaches and decision points which was given at the study workshop by various delegates is presented by general theme in Table 4.2.

**Table 4.2 Delegates Feedback by Main Theme: Future Decision Points**

Feedback Themes	Feedback/comments
Thinking Ahead – what will your site look like	<p>A number of site specific points were made in response to this question, although a few recurring themes comprise:</p> <ul style="list-style-type: none"> <li>• More saline inundation.</li> <li>• More saltmarsh, much less freshwater habitat (this will need to be created inland);</li> <li>• Sites likely to change ecologically and geomorphologically;</li> <li>• Needing to set back walls to reduce/prevent fragmentation/deterioration in quality of saltmarsh.</li> </ul> <p>From a policy perspective it was observed that there is a need to define what is wanted in terms of future biodiversity and landscape and plan how to deliver it.</p> <p>Overall there was a general consensus that the coast would look very different in 50-60 years compared to now. Change will have to be accepted in the face of climate change.</p>
What are the critical decisions and when do you need to tackle them	<p>A number of different points of view on this question including:</p> <ul style="list-style-type: none"> <li>• Difficult to tell at what point decisions need to be made, may be sooner rather than later depending on the occurrence of events.</li> <li>• Difficult to change without a strong driver;</li> <li>• When it become too expensive to maintain the site as currently;</li> <li>• Depends on government decisions – more certainty with government allows more flexibility for the site manager;</li> <li>• Legal requirements will be key, as will continued/discontinued agricultural subsidy;</li> <li>• Better contingency planning is required for such extreme events;</li> <li>• Use conservation objectives effectively to indicate when and how changes might occur;</li> <li>• Need to have policy and mechanisms in place to manage change rather than be managed by it. Need to consider ecological impact (losses, replacement of habitat, legal drivers etc).</li> </ul> <p>It was suggested that there was a need for a national public debate regarding priorities for the future.</p>
Are these decisions close to being made	<p>At a site level there is on-going thinking in respect of decisions that need to be made but some are closer than others to being made.</p> <p>More importantly however, there seems to be a policy lag. Decisions need to be taken about priorities for the future and this could take some time and this then needs to be implemented.</p> <p>One key issue appears to be that EU legislation, which covers the majority of coastal sites, is not designed to facilitate change – indeed it drives maintenance of the status quo in respect of habitat features and species. The driver to do something on these sites is whether deterioration or adverse effect has occurred. Where it has not then nothing has to be done. This needs to change. Need EU acceptance of change for these sites.</p>

<p>Understand natural coastal dynamics/terminology</p>	<p>The coast is a naturally dynamic system and therefore it is not appropriate to discuss 'loss' of substrate material (cliff/sand dunes) in terms of 'damage', however obviously coastal surges can damage infrastructure such as property which counts as loss. The terminology used needs to be right. Indeed, examples were given in the workshop where substrate (gravel and sand dune) material lost during the surge re-appeared several weeks later. The coast needs 'space to move' but is constrained by coastal development (infrastructure and land use), i.e. the natural processes and functioning of the coastal system (e.g. substrate deposition and accumulation and water movement) are compromised by coastal development. The coast 'will attempt to do what it wants'.</p> <p>The location/extent and amount of sediment / substrate material being eroded, transported and deposited during storm surges is unknown but is fundamental to the understanding of coastal processes. Archival and decadal data/photos of coastal changes are needed to place current and future storm surge events in context. In the immediate aftermath of the surge event, local photographer and light aircraft pilot Mike Page took very useful photos of the flooding.</p>
<p>Availability of funding and options for projects and financial incentives for landowners</p>	<p>Concern raised over missed opportunities within agri-environment schemes to adapt (change) land uses. Are there opportunities within the forthcoming NELMS?</p> <p>Statutory and non-statutory authorities do not have the funding available to purchase all of the land that may be needed for coastal habitat adaptation. Therefore the level of funding and timescales (20 years) available for farmers is vital for getting landowners on board.</p> <p>Funding to undertake the initial feasibility studies / options appraisal studies is what is stifling coastal habitat adaptation at some sites (e.g. Minsmere)</p>
<p>Update national coastal adaptation and flooding response guidance based upon the latest science</p>	<p>National guidance and planning policy for the predicted change is there but is too 'linear' was on the basis of climate change effects being felt on a transitional/gradual basis; it did not allow people to prepare for extreme and sudden events like the December 2013 surge or for the timeline for the effects to be brought forward. Guidance needs updating.</p> <p>For some key sites that were significantly affected, the response/management can't be business as usual</p> <p>The climate change science and associated technical documents are 'impenetrable' (difficult to easily interpret)</p>

<p>Influence and change perspectives and mindsets through clear and effective and persistent communication</p>	<p>A cultural change from a 'preservationist' view to an 'accommodating change' view needs to occur in the public mind, in politician's minds and within statutory and non-statutory organisations.</p> <p>Concern raised over the slow pace/lack of progress in the last few years to make the necessary policy, on-the-ground changes and mindset changes to adapt to and mitigate climate change, despite various studies being undertaken.</p> <p>Concern raised that climate change and flooding became/is still a background issue with the change in Government and with other socio-economic priorities. Concern raised over lack of political will and lack of climate change officers within organisations.</p> <p>Although Making Space for Water as a concept has been around since at least 2004, it is a relatively new concept for most people. The mindset of landowners is not going to change <i>en masse</i> but it will begin with a few individuals leading the way. Influencing the public mindset and landowner's mindsets and involving the public and landowners is vital but is really difficult.</p> <p>Concern that the issue of coastal flooding and climate change will soon be lost in the media and in the public mind; responsibility from practitioners to keep the message alive in the public mind, in politician's minds and between statutory and non-statutory organisations.</p> <p>The correct and effective framing of climate change adaptation arguments to secure funding and apply political pressure is vital. Suggestion of encouraging members of NGOs to apply political pressure.</p> <p>The requirement for sustainable coastal adaptation needs to be translated into or aligned with Government socio-economic drivers to secure more political will and more funding.</p>
<p>Acceptance that the risk is currently here and is predicted to worsen so action is need now</p>	<p>Although inevitably there is some uncertainty over climate change and sea level rise projections going forward (albeit isostatic rebound is certain), our latest understanding is that in fact the timescales for sea level rise appear to be coming forward; there is a big risk already even without future predictions. Emphasising the importance of acting now.</p> <p>The risk of sea level rise cannot be eliminated but can be reduced via sustainable adaptation.</p>
<p>There are successful case studies to use as examples</p>	<p>Titchwell and Cley are two sites on the North Norfolk Coast that have re-bounded well after the December 2013 storm surge; they are 'success stories' as a result of taking pro-active adaptation. They have been designed to ensure the floodwater drained off quickly and indeed it did, thereby reducing the residency time of saline water on-site.</p> <p>Inland retreating (coastal habitat adaptation) is a detailed, stepped approach where potentially suitable sites for the work are considered in detail.</p>
<p>Other</p>	<p>Inland retreating (coastal habitat adaptation) is a detailed, stepped approach where potentially suitable sites for the work are considered in detail</p> <p>Action needs to focus at a landscape/catchment scale not just a site by site scale.</p> <p>The future resilience of the public rights of way infrastructure is a big issue for some sites that needs addressing in addition to ecological requirements</p>

## 5. Recommendations

Based upon the workshop feedback and in the context of the latest climate change predictions, it is recommended that:

- The workshop delegates and Steering Group meet periodically (e.g. twice a year) to discuss progress and actions.
- Guidance on coastal adaptation options and flooding response is updated on the basis that events will be sudden and extreme and happen now not in the future – for example impacts were not in line with SMPs. The documents need to be revised promptly;
- The Defra CR0422 project is re-run using IPCC AR5 climate change projections of sea level rise so that the extent of habitat predicted to be lost is based upon the most up to date climate change predictions;
- A further desk study is undertaken to establish which sites have rebounded well and why and those that haven't, to inform further decision making;
- Undertake a co-ordinated, collaborative approach for identifying and prioritising sites for adaptation in the region and the funding sources that could contribute to that adaptation;
- Further research is needed to understand the location/ extent and amount of sediment / substrate material being eroded, transported and deposited during storm surges to better understand coastal dynamics in surge scenarios;
- Following each surge event, the extent of flooding is mapped using aerial photography or ground-level survey by a cross-partnership group, and the mapping is digitised to build up a historical archive of flood events for future decision making;
- Ongoing proactive engagement and communication with the public, local community groups and politicians regarding the climate change message to change perspectives and make the case for coastal habitat adaptation / 'make space for water';
- Ensure climate change messages to the public, landowners and local community groups is consistent and clear;
- With the loss of the Environment Agency's Climate Ready website, a national interactive website should be created and maintained which would contain:
  - A sub-domain of national information for practitioners, site managers and decision makers to access and use including:
    - a summary of key scientific facts of sea level rise and climate change,
    - the available policy options,
    - sources of funding and further advice and information, and

- successful model case studies.

The emphasis would be on succinct, practical, and accessible documents for a varied audience of professionals with different technical/policy backgrounds.

- Sub-domains by regional geographical areas. The sub-domains (e.g. entitled 'Community: Norfolk') would enable practitioners, site managers, decision makers, local community groups and landowners to:
  - Co-ordinate (non-emergency) local flood response;
  - Disseminate key information for local landowners and local community groups, encouraging networking;
  - Encourage shared responsibility and foster collaborative community working;
  - Collate and archive local aerial photography and mapping of local surge events.

This could build upon or compliment the Climate Local website<sup>12</sup>; however the key difference is that the emphasis should be on more formally involving local community groups and local landowners in the decision making process to assist LLFAs meet their statutory duty (Section 1). This is consistent with the requirement for information sharing and collaborative working as advocated by statutory legislation and national policy guidance (see Section 1).

- Greater emphasis is placed on working with local landowners to realise opportunities within the New Environmental Land Management Scheme (NELMS). The authors understand that the list of coastal options that are currently proposed within NELMS match those in the former Higher Level Stewardship (HLS) scheme to a large extent, but with some mergers where possible<sup>13</sup>. The two options proposed for inter-tidal habitat creation ('managed realignment'), are:
  - C4: Creation of inter-tidal and saline habitat on arable land and intensive grassland (i.e. combining HP7&8 in HLS)
  - C5: Creation of inter-tidal and saline habitat by non-intervention (= HP9 in HLS)

Although payment rates and length of agreements are yet to be confirmed, it is hoped that the good financial and term lengths (20 year agreements) of the HLS options HP7/8 will continue in NELMS, though former take up of these options has been limited historically. The importance of NELMS options for coastal habitat adaptation is recognised by statutory authorities and working partners and this message has been relayed to Defra<sup>9</sup>.

<sup>12</sup> [http://www.local.gov.uk/the-lga-and-climate-change/-/journal\\_content/56/10180/3574359/ARTICLE](http://www.local.gov.uk/the-lga-and-climate-change/-/journal_content/56/10180/3574359/ARTICLE)

<sup>13</sup> Personal communication with Biodiversity Delivery Team of Natural England, 11<sup>th</sup> April 2014.

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## Appendix A

### Organisations Present at, and Format of, Workshop

#### Box A.1 Organisations Present at the Workshop

The Broads Authority  
 Centre for Environment, Fisheries and Aquaculture Science (CEFAS)  
 Defra  
 Environment Agency  
 Lincolnshire Wildlife Trust  
 Natural England  
 Norfolk Coast Partnership  
 Norfolk Wildlife Trust  
 Norfolk County Council  
 RSPB  
 Suffolk County Council  
 University of East Anglia  
 (MoD and National Trust were invited but were unable to attend)

#### Box A.2. Workshop Format

- **1) Introduction by Environment Agency**
- **2a) Presentation by GEDS<sup>1</sup>, Birkbeck, University of London; and Cambridge Coastal Research Unit, University of Cambridge** – nature and impacts of the recent storm surge event
- **2b) Breakout Group Discussion** – delegates experiences of the storm surge
- **3) Presentation by AMEC** – threats to coastal habitats from sea level rise
- **4) Plenary session by all delegates** – delegates experiences of the storm surge
- **5) Presentation by AMEC** – habitat tolerance to sea level rise and management approaches
- **6) Breakout Group Discussion** – approaches and decision points
- **7) Plenary session by all delegates** – approaches and decision points
- **8) Summing up discussion**

Notes: <sup>1</sup> : Department of Geography, Environment and Development Studies

## Appendix B

### Workshop Discussion Points

#### Box B.1 Discussion Points for First Breakout Session

##### ***Recent Storm Surge Events: What Was Your Experience?***

What happened?

Had you planned for such events/this event?

Did your planning pay off?

Did you feel fortunate or unfortunate?

What was your biggest issue?

#### Box B.2 Discussion Points for Second Breakout Session

##### ***Recent Storm Surge Events: What Are Your Future Approaches and Decision Points?***

Thinking ahead – what will your site look like in 50-60 years?

How does it differ from today?

What has been lost or gained?

What are the critical decisions and when do you need to take them?

At what point do you stop trying to manage a habitat as one thing, when it is turning into something else?

What kind of decisions are involved?

What other factors should be considered and how?

Are you close to making decisions on this?

Are there policy/legal/other barriers?

What additional work/resources would be help you make decisions?