

THE CHANGING COAST

Report of a conference organised by the Norfolk Coast Project at Gresham's School, Holt on 25th October 1999

The conference was organised by the Norfolk Coast Project to promote increased awareness, knowledge and understanding of the processes and issues involved in coastal change and management, and to encourage communication and dialogue between the organisations involved in coastal planning and management and local people. In these respects, it is hoped that it will contribute to the future review of Shoreline Management Plans for the area.

Although the Norfolk Coast Project has no direct or statutory role in shoreline management, the conference is part of the Project's ongoing work to promote partnership in sustainable management of the Norfolk Coast Area of Outstanding Natural Beauty.

Speakers and subjects were chosen to give a picture of the mechanisms, theories and issues involved in shoreline management in the area. The views expressed are not necessarily consistent with each other and are not necessarily the views of the Norfolk Coast Project. The aim was to enable access to information and theories as a basis for participation in the development of shoreline management in future. Their presentations have been transcribed more or less as they were delivered to be more readable and more easily understood as we have been unable to include copies of diagrams and photographs. Questions were submitted by the audience, collated and presented to the panel of speakers for the question and answer session. Again, answers have been transcribed in full to aid readability and understanding.

About 180 people attended the conference, including individuals and representatives from a wide range of organisations. A copy of the report was sent to all attendees whose contact details were held.

Items and speakers

- 1 **Local community involvement in shoreline management**
Jim Long, N.E. Parishes Representative for the Norfolk Coast Project
- 2 **Managing a changing coastline: Shoreline Management Planning**
Peter Frew, Engineering Manager, North Norfolk District Council
Clive Flanders, Principal Engineer, Environment Agency Eastern Region
- 3 **Coastal change in Norfolk: a wider perspective and future trends**
John Pethick, Professor of Coastal Science, University of Newcastle
- 4 **Sustainability and sea-level rise: the case for a natural, evolving coast**
Keith Clayton, Emeritus Professor, School of Environmental Sciences, University of East Anglia
- 5 **Wildlife and coastal change**
Peter Lambley, Conservation Officer, English Nature

FORUM

Response from the panel of speakers to issues and questions raised by the audience

1 Local Community Involvement in Shoreline Management

Jim Long, North Eastern Parishes Representative for the Norfolk Coast Project Partnership

Good afternoon ladies and gentlemen. I may not be here long if I challenge some of the comments made in the introduction, but I feel in some way I will be doing that.

I welcome the opportunity to speak on the subject of the changing north Norfolk coast. As far as I am concerned there are two aspects of these changes, the first being the natural changes of which I am sure we will learn more as the conference progresses, the second being the changes brought about by the actions of man. Clearly there is an interaction between these two and both will have a considerable impact upon the people that live here. My particular concern is that where there are choices to be made about managing the coastline that affect the lives of the people that live here they are fully consulted and made part of the decision making process. I do believe that the consultative process has improved in recent years - Quiet Lanes is one example - but there are also some very bad examples and I believe that one bad one destroys the trust built up by many good previous efforts.

Regardless of what has happened in the past or improvements that have been made, at a recent consultative meeting a local representative commented to me 'It's us and them and they won't take any notice of us'. Quite an indictment! I have therefore taken that comment as a theme for this talk as clearly there is still considerable mistrust of the consultative process and this needs to be addressed.

"Us and them" - you may ask who are "us" and who "them". I have asked local opinion to try and ascertain who are "us" and "them", and a general consensus would suggest that "them" are them that organise meetings (so probably we are all part of "them"), them that sit in the front at meetings, them from the council, them from the environment, them from the trust, them from nature, them bird people, them that take timber from the beach, them that aren't from round here, them that talk a lot, them that don't listen to what we say and them that want to change everything. That seems to be what people think "them" are, if you'll excuse the grammar.

What about "us", the locals of Norfolk? I have re-christened us Homo Sapiens Norficus - a different species from the rest, having at least double the amount of salt in their blood as a normal Homo Sapiens. Us have lived in Norfolk for many generations, us have an automatic distrust for outsiders, us don't say a lot but we think a lot, us know more that they think we do, us don't like change, us aren't all mad about birds, us feel ownership of our coast, us don't like being told what to do, us likes to decide what happens around here, and finally, the most commonly made point, us live here, which seems to conclude that "us" own the coast. It would appear on the face of it there still is a great divide between "us" and "them".

What do they know? What do who know? Us and them of course. "Them" come to the coast with years of study and learning behind them, they have scientific tools and instruments to measure erosion, they have experience on what happens on similar coastlines in other parts of the world, and a fount of knowledge to draw upon.

"Us" have generations of handed down local knowledge - an old fisherman has spent his childhood, his working life and many years in retirement watching the sea, seeing what the years have done to his beach and the coastline. He must know what is going on. Do them and us talk? No, neither values the other unfortunately.

Digressing slightly, I have an interest in a segregated launch site for boats in this area and very recently a councillor came to me and said "We have the answer!". I said "Brilliant - what is this answer?" He said "We will put a concrete slipway across the beach at Weybourne." I said "What a brilliant idea, there must have been 10 put there in the last 5 years. Why on earth don't you ask somebody who has some experience round here?" So why don't them and us ask each other? This must be a win-win situation that we all hope for.

Communication and consultation. At the conceptual stage of any action or project that is in any way likely to change anything on this coastline an audit to ascertain local opinion should be carried out. Circulating a draft action plan for comment is not the answer. By that time those formulating the plan have formed their own opinions and clearly will defend it. We therefore need detailed communication at the outset of any plan and hopefully this will lead to joint ownership between "us" and "them".

My final point - the ultimate decision. If in fact any decision to which local opinion does not subscribe is reached it is desperately important that the reasons and the necessity for such a decision are made crystal

clear. Should this not be the case there will always be an “us” and “them” as clearly we come back to the original comment - “they don’t listen to us”. In fact, probably without fully realising it, “us” and “them” have many things in common. We all want the north Norfolk coast to remain the wonderful place it is. We all want the wild open landscape and all that is in it to remain unsoiled and unspoilt. It may seem glib but let us hope that we can focus on these common aspirations and increasingly “us” and “them” can become “we”.

2 Managing a Changing Coastline: Shoreline Management Planning

Presentation 1: Peter Frew, Engineering Manager, North Norfolk District Council

My talk will include a history of flood and coast defence, coastal sub-cell boundaries and Shoreline Management Plans (SMPs) and how they link together, how we prepared the first generation SMP, how we manage the consultation process and how we use the SMP in the community at present.

Coast protection and flood defence are two separate but inextricably linked subjects. Coast protection is defined by the 1949 Coast Protection Act as the prevention of encroachment or erosion by the sea and it is this act which empowers the District Councils to carry out coast protection works. Flood defence on the other hand is the prevention of flooding by the sea and is carried out by the Environment Agency in the main, although there are some powers available to Local Authorities and Internal Drainage Boards under the Water Resources Act and the Land Drainage Act. This is not something arbitrarily decided here in Norfolk - it is a statutory split and at the present we don't have any choice in that matter. But between us we have put together the Shoreline Management Plans that cover North Norfolk.

What is a Shoreline Management Plan? The Ministry of Agriculture, Fisheries and Food (MAFF) guidance notes for the preparation of a SMP describe it as 'a document that sets out the strategy for the coastal defence for a specific length of coast, taking account of natural coastal processes and other environmental influences and needs'. That is a contrast with the way we used to do it. Prior to the introduction of SMPs what used to happen was that each authority and the Environment Agency as well would do what it thought best on its frontage, without reference to what was being done on either side.

In 1991, before the advent of SMPs, North Norfolk District Council (NNDC) decided it needed a strategy for shoreline management. This was developed rather along the lines of a SMP but only looking at its length of coast, from Kelling Hard in the west to Happisburgh Cart Gap in the south-east. The Ministry felt that it was necessary to go wider than district council boundaries, which we fully agreed with, and SMPs are now based on coastal sediment sub-cells.

My definition of a sediment cell is a length of coast in which the sediment is generally unaffected by sediment in any neighbouring cell. You'll all be aware that sediment moves around the British coast in a pattern which is not linked in any way to administrative boundaries. A pity - it would be so much easier if it did! There are about nine sediment cells around the British coast but these are divided into sediment sub-cells in which the sediment generally displays uniform characteristics, and it is these lengths of coast that have been chosen for the SMP boundaries. The Norfolk Coast is mainly divided into two sub cells, that is 3a from Snettisham in the Wash to Sheringham, and 3b from Sheringham all the way round to Lowestoft. Because sub-cells ignore administrative boundaries, in order to prepare the plan we needed to bring together the people who operate on those frontages and we developed a partnership of operators. In the case of sub-cell 3a we brought on board English Nature because of their involvement in management of that part of the coast.

I suppose that the biggest single element of the production of the SMP was the consultation process. There were three consultation periods within the 3b plan. This was slightly different for 3a, reflecting the consultants undertaking it, the nature of the coast and type of response we were getting. (Overhead - 3 stage consultation)

The consultation process formed a very important and time-consuming part of plan development. It started before we actually started undertaking the plan when letters were sent to some 60 different organisations, parish councils and the like. We told people we were going to be developing the plan and asked what they thought we should be looking at (phase one). From that response and data collection we put together a draft plan and then said this is what we have got, do you agree with it? - a second consultation with all the major operators and the people who have an interest in the coast and its management (phase two). Finally, before the plan was adopted, we consulted again with all those same bodies involved in phase two. The SMPs were adopted by the District Councils & Environment Agency as their policy documents for the coast, and we are now in phase 3 - the implementation of those plans and policies.

The consultation process for both SMPs included over 60 consultees including national and regional government like MAFF, the Ministry of Defence, the Department of the Environment and the counties, and for the Norfolk Coast all the environmental players like English Nature, the National Trust, Norfolk Wildlife Trust, RSPB and a host of others. Fisheries, the Association of British Ports, British geological Society, British Gas, and importantly Town and Parish Councils were also included. This involved not only letters, but also meetings where we could listen to what was being said and build the comments into the

management plan - if you look at both plans for this coast those comments are in there, in some cases verbatim.

What could we do to improve on what we did? Consultation is a time consuming process. If we widened the consultation could we or should we afford it? We have to bear in mind that this is not a statutory process - this is not like the development of a Local or Structure Plan. When we developed the SMPs we started with a project team that was made up from the operators on flood and coast defence. We did include English Nature on the plan for the north coast but should we have gone wider than that? These are questions we shall have to look at when we come to the development of the next generation of SMPs which Clive will be talking about.

Finally, as an example of how we are using the SMPs in the community at present, they were used in North Norfolk's case to develop the Local Plan which makes reference to the SMP and vice versa. It is used a lot in development control - the SMP and Local Plan work together in that respect to ensure that there is not inappropriate development in terms of location on the coastline. It is used a lot for local searches for house purchase and I get quite a lot of queries from people asking what the policy is for a piece of coastline. Possibly the biggest single use we have, certainly in terms of work it generates, is school and student studies - no disrespect to those sitting here who are from schools! It is an important usage of SMPs and I hope has proved of use to them.

Managing a Changing Coastline: Shoreline Management Planning

Presentation 2: Clive Flanders, Principal Engineer (Planning & Strategy) Environment Agency, Eastern Region

There are basically four themes to my presentation. The first is previous and present monitoring, which had started before the present shoreline management plans (SMPs) and has continued. The second is the analysis of that data. The third is the lead into the next generation of SMPs and the fourth is the continuing importance of community involvement.

Overhead 1 shows the north Norfolk boundaries for SMPs. It mainly shows sub-cell 3a area (Snettisham to Sheringham). North Norfolk District Council (NNDC) are the lead authority for sub-cell 3b and the Environment Agency for 3a.

Present monitoring:- Coastal monitoring and the whole lead in to coastal management planning in the Anglian region had its origin in the formation of the Anglian Coastal Authorities Group (ACAG) from 1987 onwards. This partnership grew with aims to ensure all subsequent coastal defence policies were sustainable in a region-wide perspective. Following the work undertaken by Sir William Halcrow & Partners to establish the shoreline management system, region-wide strategic data capture commenced in 1991. We are currently in the second five year period of data capture and hope to obtain Ministry of Agriculture, Fisheries and Food (MAFF) approval for a third five year period in the near future.

Going on to look at monitoring in a little more detail, the next overhead shows the coast normal lines where we take beach profiles or cross sections twice a year in August/September and again in January/February. These beach profiles are taken along the entire Anglian coastal frontage and this is purely a small section of that. These are taken at 1 kilometre centres by Surveying Contractors after competitive tendering. Also, on a 5 year rolling programme, these profiles are actually extended from the low water mark out to a depth of 10 metres, giving us more in-depth information about bathymetric profiles, which are more useful for analytical purposes. The data is checked by the Surveying Contractors themselves and is returned to the Agency who do a second quality assurance check and then download the data to their Geographic Information System (GIS) or more recently on to the Beach Visualisation Software (BVS) system.

The next overhead shows a screen shot of the beach profile at Holme showing dune recession from 1992-1998, from the BVS. The system is able to depict all sorts of changes along the coastline. It can show erosion and accretion trends as one section is overlaid on the other, it shows movement of the high water mark, and volumetric changes can be calculated from that. That is one aspect of monitoring.

We also obtain aerial photographs of the whole Region's coastline once a year, typically in August/September when weather conditions are good for flying, when it is not too cloudy and not too hot (avoiding heat shimmers). Black and white stereoscopic images at a resolution of 1:5000 are collected. This example shows the Firs at Holme, with the line of sacrificial brushwood faggoting installed via the Environment Agency's revenue programme by the operational team from Norwich. The faggoting entraps windblown sand and helps to maintain the toe of the dunes against erosion.

The next overhead gives an outline of the coastal monitoring undertaken from the Humber to the Thames in terms of quantity since 1991 when we effectively started it.

Biannual beach profile surveys - 420 strategic profiles, with 6000 sections recorded

Bathymetric surveys - 5 year rolling programme, 700 sections recorded

Annual aerial photographs - 10,000 photographs available

Water level data - 5 POL Class A Gauges, 17 Agency telemetred sites

Wind/wave data - 6 meteorological offices, offshore modelled sites

Any scheme-specific or estuary monitoring is in addition to the statistics shown.

The information is building into a very useful data set which the Ministry will possibly see as a discrete project but which really is only a snapshot in time in comparison to the historic evolution of the coast. The Environment Agency and its coastal partners are therefore very keen to ensure that the robust monitoring campaign is continued in the foreseeable future.

The next overhead briefly outlines our coastal partners' involvement who collectively form the Anglian Coastal Authorities Group. It outlines the partners' financial contribution arrangements. It reinforces the need for reliable and accurate data, which is notably the beach profile information, and outlines the core data available to them.

The second part of my talk deals with what we are doing with the data collected. Data collection feeds into data analysis. Remote sensing such as LIDAR and CASI - types of airborne remote sensing together with satellite imagery - has been used for land use monitoring and also other display aspects. This can enhance the ongoing data collection in a specialised manner. This then feeds down onto the data analysis and we have recently commissioned a North Norfolk data analysis project. During all stages, local knowledge and input is always useful so that we actually know what is happening on the ground and to keep track of local awareness. Specialist input comes from teams such as John Pethick's and is always necessary to give us the wider perspective to this monitoring. This helps to ensure, hopefully, that the sustainable management of the coast is our ultimate aim and objective.

As I previously confirmed, North Norfolk has been the subject of recent data analysis. This has assessed how the slope of the beach (its profile) has changed, identified trends and considered beach volumetric changes. As an example of how we have used the data collected and the sort of analysis that can be done, I would like to outline some examples of coastal change along the North Norfolk Coast which illustrate the varied nature of this area.

It also serves to show the relevance of monitoring in all types of area, be it cliffs, dunes or whatever. The analysis when completed looks at the rate of change experienced over the last 10 years. This is the sort of timescale that most of us can reasonably identify with, although obviously people in the audience have recollections which go back much further.

The following four examples illustrate the sort of change you can only quantify through continuous monitoring.

(Overhead showing Hunstanton cliffs). These chalk cliffs experience wave attack, undercutting and toppling large sections of the cliff which can fall in one event. The casual visitor to the area may think it is a large problem with massive losses to the shoreline overnight and indeed the cliff has undergone significant erosion since 1991. However, as the cliff is getting steeper material is being contributed to the beach and is keeping the beach healthy with regard to coastal processes. The beach is not "losing" a predominant amount of that sediment - it is remaining there and reinforcing the toe of the beach. So, to maintain a balance the cliffs do need to retreat slowly. The beach volume changes for this section of coast show an alternating trend. Having reduced in the first few years of monitoring they are now increasing and more years monitoring will help to give a better overall picture of this trend.

(Overhead showing Holkham). Here there are gravel mounds and sand dunes fronted by saltmarsh and a very wide beach with many sand bars, in places the beach is over 1 kilometre wide at low tide. From analysis we know that sand bars can move at a very fast rate across the beach - up to 80 metres a year - and can be flattened, steepened, narrowed or totally eliminated between 6 month measurement periods. The sand they contain is pulsed up the beach in a rhythmic way so the profiles here can change quite a lot in a single year. Volume analysis shows that while it is a very volatile beach, as regards overall movement it is stable and if anything has been increasing in volume.

(Overhead showing Stiffkey Marshes). Sandbars also migrate landwards at Stiffkey, an area of impressive saltmarshes that are important features for flood defence as they reduce wave energy run up and take the more severe impact away from the sand dunes. Here monitoring illustrates the dynamic nature of creek networks: major creeks that cross the profile line have moved location by 100-170 metres over the last 8 years. The saltmarsh and dune profiles have remained stable illustrating that it is not only when shorelines retreat that we can see big changes in their morphology. Sandbars being driven onshore show up in the volume changes as sudden increases in volume followed by slight decreases, but the overall trend here again is for accretion.

(Overhead showing Weybourne cliffs) The cliff-top at Weybourne didn't move over the measurement period i.e. since 1991, but the toe of the cliff did erode by up to 3 metres by a process of undercutting. This tells us about the processes acting here, the narrower beach and deeper water inshore unfortunately mean that bigger waves can reach it. Looking at whole area volumes, we detect that there is no major change over the 8 year period but there is lots of variability over the years.

I have illustrated here some of the types of things we have seen at some sample locations, but how can these types of analysis help us with the management of the coast? Things we are looking at are what are acceptable rates of change, what is normal variation, when should we in fact be worried and what are the best indicators to use when we are assessing these rates of change. This involves not just the retreat of the cliff or lowering of the dune but the change in actual volume of material there. Analysis gives us a better

understanding of how the whole system works so that we can manage it better. That is looking at pure processes in small timescales and we know this is not the whole picture. John Pethick and Keith Clayton will possibly talk about the longer term picture and the wider perspective, hopefully in the context of sea-level rise. Allowing natural processes to act is not always appropriate, hence we use techniques such as beach renourishment. This form of management can be improved and optimised by understanding the natural processes so these analytical tools are used when we need to protect the built and natural environment. This sort of analysis and understanding feeds into the SMP and also into the formation of plans to protect natural assets, such as Coastal Habitat Management Plans for internationally designated sites.

The third part of my talk focuses on where we go from here in producing second generation SMPs. SMPs should be reviewed after five years, but what other initiatives need to be in place to potentially support this review?

(Overhead). Second generation SMPs will inevitably need to have a far greater regard to the environmental interests - flora, fauna, habitat, species - their statutory protection and means to integrate their future protection into SMPs.

(Overhead) Coastal Habitat Management Plans (CHaMPs) fulfil the UK government's obligations under the European Union Habitats and Birds Directives to avoid damage or deterioration to "Natura 2000" sites and also recognise obligations under the Ramsar convention. The primary objective is to act as a profit and loss accounting system for habitats and species, often referred to as "landbanking", and to give advice on habitat conservation measures to address net loss, either adjacent to or distant from the original sites. There has been a successful European funding bid to compile Coastal Habitats Management Plans for six very diverse and challenging locations - one of those being north Norfolk. From those six CHaMPs, robust guidelines will be produced for assembling CHaMPs at other locations. There is in fact a draft CHaMP in existence for North Norfolk and this will need to be updated prior to reviewing the SMP to operate as an interactive plan with the SMP.

(Overhead). A further potential prerequisite is in the form of inter-regional studies, notably the Southern North Sea Sediment Transport Study, to improve our understanding of sediment transport systems and their impact on the coastline. The limits of the study area would be from Flamborough Head down to the Thames, out to an area to be designated offshore. Offshore area sediment sources, transport pathways, volumes of sediment transport and areas of deposition for a wide range of sediment sizes and timescales would be established. The characteristics of offshore reefs and onshore - offshore wave and current dynamics would also be examined. The benefits for SMPs would in part be an independent review of the validity of the sub-cell boundaries, and there should also be increased confidence regarding the sustainability of the Management Unit policy recommendations within SMPs. If the study goes ahead, the only drawback is in deciding its timing in relation to revisiting the SMP. The potential study period may be August 2000 to February 2002.

Also, we are still awaiting the MAFF guidance on second generation SMPs. There was a "blue book" official guidance note on the first generation and we have learnt a lot from that. There is going to be 2nd generation SMP guidance, which is likely to be out in draft form in April 2000 with the official guidance possibly available in October 2000. In the meantime the Ministry has indicated that it would not be appropriate to consider reviews prior to the release of this guidance.

Finally, how can local community involvement assist in supporting SMPs and sustaining the management of the north Norfolk Coast?. As for the first generation SMPs, consultation will be extensively undertaken in both stages 1 and 2 during the reviews for the second generation SMPs. This I see as a basic minimum input and the guidelines might take that consultation even further, which I think they should. However I don't think we should wait for this official guidance - information from the general public would be gratefully received at any time. This can be recorded by the Sub Cell Group and acted upon at the appropriate time so I believe there is a need for liaison all the time. In addition conferences such as this are mutually beneficial in maintaining the vital links between those with a direct coastal management responsibility and the general public who live adjacent to, and have a strong interest in, the evolving coastline.

3 Coastal Change in Norfolk: the Wider Perspective & future trends

Professor John Pethick, Newcastle University

Let me start by referring to Jim's talk. I feel it is a shame we start off with 'them and us' as along the Norfolk coast more than anywhere else there has always been a great deal of rapport between the "experts" and the local people. For example I was brought up by Bobby Chesney on Scolt and Teddy Eels at Blakeney who taught me everything I know, and indeed many people in the audience will know me. The Norfolk people have taught me an enormous amount about the Norfolk Coast. In fact the local people are more aware of the science of their coast, and I hope the scientists are more aware of the local people, here more than anywhere. People like Tim O'Riordan have put enormous effort into liaising and although it is not perfect it is better than anywhere else in the world.

However, it is not good enough to merely have a local view and I think we need to look at the old adage '*what knows he of Norfolk that only Norfolk knows?*'. We ought to look further afield, which is why I am showing this aerial photograph of the Bramaputra delta to reflect on a wider perspective. We need to understand elsewhere to understand Norfolk, and to apply that knowledge to the sort of information the Environment Agency collects. It is no good just sitting looking at beach profiles of Norfolk and expecting the truth to hit you between the eyes. You need bigger models and bigger ideas than that, and you get those from looking at other systems and using information from other workers around the world.

I have been working in India for many years and this delta is on the border between India and Bangladesh. Why this delta? I believe that north Norfolk is a series of deltas. Deltas characterise a lot of our coast around the world including Norfolk. We seem to have forgotten about them and nobody is doing any work on them at the moment, but I think it is the way in which we can explain some of the features we see in Norfolk.

An aerial photograph of a delta in Africa shows the same type of features as Scolt and other places on the Norfolk coast in appearance, if not in scale. Compare this with Scolt and Blakeney, their sandbars with marshes behind, the waves breaking in front showing the true extent of the tidal delta, protecting the entrance, the marshes and the islands. A diagram from a textbook in the 60s shows these features, with a barrier islands. In Norfolk barrier islands are not generally well developed, apart from Scolt. Stiffkey Meals are not good at all in terms of barrier islands but nevertheless the coast has barrier island-type features. The area between where the tide goes in and out forces the sediment to move seawards for an ebb tide delta and landwards for a flood tide delta. An aerial photograph of Gun Hill shows the same sorts of things.

There is a parallel between text books of the 60s and examples from around the world. What can it tell us? One thing is that we have got the whole sediment movement along this coast wrong. The generally accepted opinion is that sediment is eroded from the Weybourne area, is moved along towards Blakeney Point and drips off the end to form the little recurves, and then floats along over the Stiffkey Meals and eventually into the Wash. What we learn from looking at other systems around the world tells us that this is wrong and in fact the sediment movement is in the opposite direction.

Examples from the Mississippi delta and the Frisian Islands in the Netherlands show barrier islands and the delta with the gap between the islands where the tide goes in and out. This work showed the sediment transport across the delta working in a similar way to cars on a roundabout, in a very complex way. The sediment moves in a series of waves to building up sand bars. Every six months or so, or perhaps during a storm, sediment will pulse forward with some moving across through the system and some shorewards to hang on to the barrier island, building a new ridge on the leading edge and causing what are called "drumstick islands". This means the sediment is moving in one direction and the island growing in the other. This is accepted for most barrier islands in the world but not in Norfolk.

Another example occurs in the Exe estuary in Devon, called the Monster Bank by local fishermen. This has gradually approaching the shore and indeed hit the shore last year. By looking at old maps it is apparent this has been occurring regularly over the last thousand years. What appears to be happening is that as the ebb tide delta gets bigger a wave of sand is carved off, which then moves in towards Dawlish Warren until it hits and "shore welds", then bleeds around to the flood tide delta which gets bigger and bigger until this becomes unstable and spews off down the estuary and back into the ebb tide delta. Meanwhile, the longshore drift moves through the system separately in a clockwise manner and on up the English Channel.

I think the sort of same thing is happening in Norfolk. Looking at a rather old aerial photograph of Blakeney, I am particularly interested in the recurves that form because they grow so quickly - almost overnight. I think that the sand actually comes from a westerly direction - as a series of waves powered by storms. The wave 'jumps' across the channel and then moves in and 'shore-welds' on to form a new far point. If this is so it

has big implications for the work which Peter and Clive have been talking about as it would mean that the sediment is moving not from Weybourne westwards but from the Wash out along the rest of the Norfolk coast down towards Happisburgh, in which case we have got it all wrong.

What should we be doing? For a start not believing what I am saying here! These are ideas and I'm just throwing them up in order for other people to come in and do the hard graft to either knock them down or accept them. There does appear to be enough evidence for somebody to do some detailed work to see if this is right, and you can see how important it is that we understand where the sediment comes from. It might also explain the shape of the Norfolk coast - it might explain the drumstick-like features which appear in places like Scolt, which is not the classic longshore drift idea. Other similar examples can be seen at Wells, Lodge Marsh, Blakeney, and maybe even Burnham Overy channel, although this different because it's probably quite new and not yet well-developed. If we use examples from around the world and relate them to Norfolk we could expect the processes to be the same and we would need to change our ideas.

Where does the sediment come from? Are we doing enough to preserve sediment sources? Are we mismanaging the Norfolk coast? One idea is that it comes from Holderness which is the biggest single input into the North Sea with about 3 million cubic metres a year being eroded from the coast and seabed nearby. Most of it is mud with say about a quarter of a million cubic metres of sand which may come south, nourishing the Lincolnshire coast on its way, and then maybe somehow crossing over the Wash and into the Docking shoal, where it's stored. It may then bleed off down into Norfolk. Some may bleed into the Wash but most moves along the coast eastwards. Assuming the basic geometry of the Docking shoal to be between 2 and 3 metres deep then there is about two thousand million cubic metres of sand stored there with Holderness supplying about a quarter of a million cubic metres a year. This means that it would have taken about 8,000 years to form, which would be about right as glaciation meant that the sea was starting to move into this area about 8 thousand years ago. Hopefully the sediment study the Agency are to do will help to firm up these ideas or totally reject them.

Some of the sediment would bleed off from the shoal towards north Norfolk and Keith Clayton's work some years ago showed between 100,000 to 200,000 cubic metres of sand moving along the coast, and that, together with the output to the Wash, means the total output from Holderness is moving into the Docking shoal and then out again into north Norfolk and the Wash. We shouldn't play around with this as the equation seems quite fine - input = output - so people in Norfolk ought to be worried when the East Riding Council say let us stop erosion in Holderness because that would mean more erosion in Norfolk. These things are large scale. Even if we are 100 kilometres away it still matters and sub-cells are not enough - we need to look on much bigger scales.

I am very worried about my sediment transport pathways - they are completely theoretical and I freely admit I don't know how it works. Does sediment cross over the Wash channel? If so, how? - it must build up an enormous amount of sediment to leap across the deep-water channel. Or does it move down the Lincolnshire coast, building up big sandbars and then down into the Wash and back out again as a series of sandbars up into the Docking shoal, and then bleeds down into the Wash and north Norfolk? How amazing we don't know after all this work that has been put in. We really don't have any idea about this most important factor - where does the sediment come from and how does it move around the coast? A satellite photograph shows these big sand waves and you can try and work out from these the way in which the sediment might be moving, but we need something more than that. We see the same sand waves on old charts, back in 1700.

If this is correct, is it right that we should take sand from the Docking shoal and push it into the Lincolnshire beach nourishment scheme which would be short circuiting the system? Have we looked at the large scale implications of this scheme? I leave this as a question as I don't know the answer but there again does anybody else?

Where is the north Norfolk coast? North Norfolk really consists of two coasts - the "hard" coast inshore with settlements on its edge and the meads further out - a line which includes Scolt Head and Blakeney Point. Between the two is the saltmarsh. Consider a textbook example of a 'bar-built' estuary in Texas. Water comes down a river into the sea, the tidal range is small, the water comes straight into sea without the sea moving appreciably into the estuary. Enormous amounts of sediment move along the shore and the river would be blocked were it not for a large tidal lagoon behind. Enormous amounts of water go in and out of the bar each tide, keeping the entrance open as the river itself would not be able to on its own. This volume of tidal water forms what is called a bar-built estuary and the Texas coast has numerous examples, each only a metre or so deep. By producing these off-shore islands a large enough amount of water is kept behind to keep the mouth open, and the river can discharge into the sea despite longshore drift. Some of these ideas were used by early engineers in this country who had tidal flushing ponds in order to keep sluices open on

the east coast. This type of effect also occurs on the Frisian islands. Therefore on the Norfolk coast the same must be true. For example, the Overy channel, as the river itself would not be able to break through the mouth but for the tidal pond which means that the longshore sediment movement is deflected northwards and causes the delta to form.

Supposing then that we were to restore Holkham marshes to saltmarsh - what would happen? We would have much more water going through the Overy channel and the sediment transport pathway would be pushed further offshore, which would mean that Scolt island would leap northwards and increase even further the amount of water stored behind. But because of more wave action the further offshore it goes, the more sand is pushed back and a new balance is formed between tidal and wave forces.

Restoring marshes would mean that 'managed retreat' on the Norfolk coast could actually produce 'managed advance'. On the other hand, it could be that all the reclamation on the Norfolk coast has made the coast move landwards and caused the erosion we see today. Maybe we have shot ourselves in the foot and erosion on the Norfolk coast is not due to sea-level rise and acts of nature but due to the acts of our forefathers three hundred years ago when taking in our saltmarshes. Perhaps because it was such a big scale idea people have misunderstood it and thought it was a natural phenomenon, and that we must throw groynes and all that sort of thing at it instead of saying let us put right what we did in the first place. Perhaps we should think of restoration rather than retreat. You can see examples of this all the way along the coast - for example at Wells, going along to Stiffkey, the big discharge of fresh and salt water causes an almost right angle bend in the coast.

One exception to this is the Blakeney estuary, where instead of the coast collapsing landward when saltmarshes were enclosed, something different has happened. Old maps show that in the sixteenth century the far point of the shingle spit was about level with the Watchhouse. It was a relatively small spit, but the estuary used to go back much further, so there was a large tidal discharge which was able to keep the mouth of the delta open. When the Cley-Salthouse marshes were reclaimed, the tidal discharge was greatly reduced, so the delta started to collapse and move inland. But as it did this, the estuary actually lengthened parallel to the coast, and so gradually increased the tidal discharge again until now it is so far out to sea that wave pressure is stopping the far point from growing any further and the system is in equilibrium again. So we have to be a bit careful. Brian Funnel's group showed that the reason for the different behaviour of the Blakeney estuary is because underneath Blakeney point is a ridge, a glacial moraine, which is deflecting the Blakeney estuary along the coast instead of at right angles to it. Orford Ness is another example where reclamation has had the same effect.

Looking at a graph for a number of estuaries, there is a clear relationship between the size of the channel and the size of the tidal discharge, and the Blakeney channel fits beautifully on that line - it fits the general pattern of estuaries. In the case of Blakeney Point, it appears that instead of saltmarsh reclamation destroying the equilibrium, it has actually reformed itself in a new equilibrium, so we play around with the Salthouse-Cley marshes at our peril by interfering with this equilibrium. In the case of other channels on the coast, I think we could restore saltmarshes with impunity.

At Brancaster, the Environment Agency feel they can't maintain the sea wall any longer, the area around the golf club house is eroding, and we have a problem. Both the area behind the sea wall and the area in front are designated under the European Habitats Directive. Whatever we do, we interfere with one or other of these areas. Speaking as a jobbing scientist, I think that since the coast is being maintained seaward by a series of deltas, if we introduced another one at Brancaster we would push the coast a bit further offshore here, with protective sand in front of the club house. The freshwater marsh at Brancaster is the only bit of this section of coast which hasn't been restored to saltmarsh - why not restore this last bit?

To sum up, I think that the north Norfolk coast is a balance between tidal and wave forces which I think we haven't quite understood. The true line of the coast is this line of balance between waves on one side and tide on the other. If we change the tidal forces by saltmarsh reclamation we will obviously change the location of the coastline. Reclamation may result in the shore moving landwards and restoration may result in it moving back seawards. Although the idea of trials on coasts where people live are not thought to be acceptable nowadays, we need them to find out if theories are correct - otherwise we are limited to computer models, the last refuge of ignoble minds!

Lastly, have we got the sediment supply wrong? Are we doing the wrong thing on the Norfolk Coast? If we are, are we causing trouble for ourselves along the eastern coast of Norfolk, from Weybourne down to Great Yarmouth? The things I've been talking about today suggest that we might, but I need help to show this.

4 Sustainability and sea-level rise: the case for a natural, evolving coast

Keith Clayton, Emeritus Professor, University of East Anglia

Basically, my message is that the more we leave the coast alone and the braver we are about it, the happier we shall be and the longer everything will last.

In the last decade or so the Ministry of Agriculture, Fisheries and Food (MAFF) has introduced two important ideas which are potentially of great significance although nothing much has come of them yet. The first is that when assessing costs and benefits of schemes, which is the basis on which it is decided if taxpayers who don't live in Norfolk should be paying to look after bits of the coast where you live, the assessment should look not only at rival schemes but also at the possibility of doing nothing. This was initially received in shock and horror but coastal engineers have learnt to massage the figures to show that to do nothing is never the cheapest option. The second idea was that schemes should be sustainable. A simple statement - I gather the MAFF definition is that they should last for 50 years. I may not last for 50 years but I know lots who will and I don't regard 50 years as any approach towards true sustainability. Indeed if they don't produce a manual on what sustainability is in the context of the coast pretty soon, I will try and do it for them. I think what I am going to say today will outline the inevitable conclusions of any approach that goes beyond being sustainable for half the life of most healthy people.

You will also have heard of 'managed retreat', not a term that the Ministry uses although a Secretary of State was brave enough to use it once at a local authority conference in Great Yarmouth. You will know of it in the context of West Brancaster marsh where there is a proposal for a tidal delta near the Golf clubhouse to give them a little bit of protection. Managed retreat is an evolutionary development from doing nothing and from being sustainable. If you literally do nothing and just leave nature to destroy what man has created in the past and then put something that is natural and better back in its place you may go through some pretty painful stages in between. To try to manage that retreat, that process of change towards a more natural coast, is something which is well worth doing and would normally be the right way of going about 'doing nothing'.

There is a myth that were it not for the engineer England possibly, and much of Norfolk certainly, would have disappeared by now. That myth ignores two facts. The first is that when we didn't have any coastal engineers back in the 19th century, or they only worked on ports and limited seaside towns, when there weren't groynes and sea walls all over the place, Britain actually grew in area every year. There was a Royal Commission on coastal erosion, the only one we have ever had, in 1905. It looked at Ordnance Survey maps from the first 6 inch maps through to the current ones of 1905 to see how much Britain had changed. The figure produced was that in 35 years Britain had lost 5,500 acres i.e. 160 acres a year, but the gain was nearly 7 times that at over 40,000 acres. So Britain was getting larger, some through reclamation of salt marshes, some by natural accretion. Basically sediment was being moved from high cliffs and spread out over low mudflats and salt marsh, where it goes a long way. Norfolk was then losing 15 acres a year but the figure since 1905 is just over 400 acres at about 5.5 acres a year. The reduction from 15 to 5.5 acres a year has been at a cost of hundreds of millions of pounds to taxpayers, most of whom don't live in Norfolk.

A second point is that interference with natural processes can only stabilise one part of the coast at the expense of another. Basically, the engineers stabilise short sections of coast by trying to keep the sediment there rather than letting it go anywhere else, so by engineering processes of the coast you are generally able to stabilise short sections at the cost of sections further down, and also for only a short period of time. After work, you need to repair the scheme every 10 years and rebuild every 25 years. In so far as groynes maintain sand they do so at the expense of other areas of the coast.

(Slide of) the eastern-most groyne at Cromer. The success of that groyne, which is readily apparent, is matched by the lack of success elsewhere, so that beyond Cromer the cliffs erode, for example at Cromer golf course.

Looking at the reefs at Sea Palling, sand is accumulating behind them but it doesn't then move down the coast, so that recently the Environment Agency has advertised that it needs to feed the beach at Waxham because the beach here hasn't got enough sand to stop the sea wall being undermined. You win one, but lose another. It's also important to recall that the cost-benefit case for building the reefs at Sea Palling was largely the value of the sea wall built after 1953.

Groynes and reefs do not create new sand. Sea walls, by reflecting waves, can actually lower the beach in front - this slide of the sea wall at Walcott after a storm shows the scour hole at the foot of the wall. Sea walls never get knocked over by the sea onto the land - they always fall into the sea by being undermined at the base, hence the need for a good beach.

Future sea-level rise is assured, for it will result from past, recorded warming as well as our forecasts of future global warming. The contributions to sea-level rise from Greenland and Antarctica on current timescales are small and cancelled out. Half the rise comes from the expansion of the ocean as it warms through, the other half from the melting of mountain glaciers in such places as the Alps, Andes and Himalayas. The huge volume of the ocean means that the global warming since the industrial revolution has still to affect its greatest depths, so expansion will persist.

The North Sea has been rising at 2 millimetres a year for most of the time since the earliest tide gauges were installed and the estimates of future rates of rise vary from 2 to 6 millimetres a year, which will give us a sea level of approximately a foot higher halfway through the next century. This is not a lot, and can be readily accommodated in two ways, unsustainably by building sea walls and sea banks higher, or by feeding large quantities of sand and shingle onto beaches at our coastal resorts. For example Cromer desperately needs sand fed to its beach, not only to rescue its tourist trade, but to protect the sea wall that has been on the same alignment since 1845.

Raising walls and banks also removes the natural beach. Many people enjoy sitting on beaches and as the climate gets warmer we shall enjoy it more. Beaches are good for coastal defence. Everywhere the engineer has not been busy you have good beaches, elsewhere you often have poor beaches, but they are the natural buffer between the sea and the land. Feeding sand onto the beach has been done in Norfolk, on a large scale behind and beyond the reefs and in the Wash, where it was very successful in my view, and on a smaller scale at Great Yarmouth in the seventies, where there were concerns that Gorleston beach was disappearing. They put three months supply of sand down, which lasted three months, and they have not done it again! But basically, feeding sand onto beaches is not an irrational thing to do. The Dutch do it on a huge scale and as a result they pay £1 or £2 a cubic metre for their beach feeds. The Environment Agency can't get anything like that rate and consequently we waste a lot of money on beach feeding because we don't do anywhere near enough to get a good price.

Most of Norfolk's coast is well able to look after itself if we are prepared to let two things happen. Firstly, to allow the slow erosion of cliffs which feed most of our beaches in south east Norfolk. Sand from these cliffs flows down the east coast past Sea Palling and Eccles, past Winterton to at least Great Yarmouth. It used to go as far as Lowestoft! Evidence can be seen at the North Denes where they built a prom in the 1930s and the sea has been going away at 6 metres a year ever since. Rest assured, the reefs at Sea Palling should stop that!

The second and greater challenge for those in this room is to allow the marvellous barrier island coast of north Norfolk to evolve naturally by returning the former salt marshes to tidal influence. I was fascinated and convinced by John Pethick's case for this. This coast has been stabilising for most of its history. The salt marshes have been increasing in area, barriers or tidal deltas have built outwards and we can retain it sustainably. It will survive sea-level rise if the sea can get at it. The point about salt marshes is that they are at high tide level. If they are not at high tide level the tide will come over them more often, mud will be deposited and they soon creep back up towards high tide level. Salt marshes are a superb protection against waves. They are always at high tide level and even in a surge it is hard for large waves to get across salt marshes as they will break on the outer edge. Salt marshes do not stop coastal flooding but they do stop waves damaging property on their landward side. The Environment Agency are well aware of the value of 'saltings' in front of sea banks - if they didn't have them in the Wash the problem of defending The Fens would be far greater. The longer we delay in returning former salt marshes to their natural state the lower they will be relative to the new higher sea level. The lower they are the harder it will be to build them up by natural processes. If they are too low they will turn into mudflats rather than salt marsh and may be eroded by the current and even deepened. Once the salt marsh vegetation is established you are in business. You can of course 'warp' them up - that is to say allow the tide to flood them on spring tides and build up the level with mud. In the past, you would have reclaimed them again when they were high enough. In the future, we could return them to a natural salt marsh state.

The ideas of letting cliffs erode and salt marsh flood are difficult to face but the alternative is a coast such as we find at Jaywick (slide). It's hard to spoil Jaywick - don't be too worried about the Scandinavian boulders, which are sitting on London Clay and who wants to see that! Don't be too impressed by the sand, either. £1 million worth of sand was put between the two fish-tail groynes which makes it look as though they've done a lot of good.

(Blakeney high tide slide) The downside of this flood is the water over the street, but the upside is the marshes out to the point covered, with sediment being deposited. Researchers have measured accretion on salt marshes in Norfolk of up to 10 millimetres a year, so they are quite capable of keeping pace with future sea-level rise as long as they can be flooded.

If I turn to the cliffs, we have so far lost a house every five to eight years since I have lived in Norfolk. If we let the cliffs continue to erode, we shall perhaps lose 30 to 40 in the next hundred years, all with ample warning and I would hope compensated by a more enlightened Treasury than at present. If we don't build defences we have the money available to compensate for flooding or for those who lose their homes.

Understanding the hazards of living on the coast is much more widespread today than it was before 1953. As an example, an Overstrand bungalow owner interviewed in the Eastern Daily Press in 1973, when asked 'Don't you feel nervous about living on the top of the cliff with the waves banging away at the bottom' replied 'Oh no, these falls are nothing to do with the sea, you can tell that because they are all at the top of the cliff.!'!

The knowledge that cliffs actually do erode and houses that are at low level do flood occasionally is now much more widespread, and I was certainly encouraged to hear in a recent Anglia TV programme that people living in such places along the Norfolk coast said 'Yes, we know we are living in a hazardous place, we know we will get flooded occasionally but the salt marsh or birds make it all worthwhile; or the sea views if you live on the cliff'. That improved knowledge is good but it doesn't mean that the next surge will pass off without deaths. We have a warning system for these events which is brilliantly designed in the sense that the scientific information is good, but not in the case of notices which say things like if you hear the siren sound 30 seconds on, fifteen seconds off repeated five times please advise others and take 'immediate protective action'. I suppose what you might do is stand on the table, which would be a disaster because by the time the water was up to your neck you wouldn't feel like getting off. We have far too many people living in bungalows without loft ladders or in caravans over winter, often without the police knowing about them, and I am fairly pessimistic about the chances of the next surge passing off without a number of deaths. I'm reminded of the last surge at Wells, when the Eastern Daily Press questioned police as to why no sirens had been used and were told 'We didn't want to alarm anybody.!'!

I believe that reverting to a more natural coast will be easier in future because more people appreciate that the coast is a hazardous place and that if you choose to live there, that is part of the package along with the advantages. Nonetheless, we do need to predict future change much better. John Pethick's point about where does the sediment come from, how does it move, what happens if we change tidal prisms by allowing reclaimed areas to go back to salt marsh are fundamental questions that need to be answered. One of our difficulties has been that coastal engineers will always say that if they don't build a scheme the cliffs will erode faster or the flood will get higher than is really the case, because that's how they get the funding. As a result, we are fed alarmist stories about rates of change when really, natural change is relatively slow. For example, the cliffs at Happisburgh, where revetments were taken out and cliff erosion of 5-8 metres has been taking place. Very dramatic, but what's happening here is the denial of change while the revetment was there and the beach eroded because the cliff couldn't go back. Take out the revetment, you have a low beach, and the cliffs erode back until you have a high beach in a new natural position. Now that new beach is established, you have a wide sandy bay south of Happisburgh - admirable for the holiday-maker, and with the cliffs behind protected by the beach and no longer eroding quickly. The rate of erosion of the cliffs at Happisburgh has been under half a metre a year for the last hundred years. There's no reason to suppose it's going to be much more in the next hundred. My view is that we should be able to learn to live with coastal changes of that magnitude.

My message is simple. There are four elements which are common around here which adjust naturally to sea-level rise and which provide a natural coast which is a joy to behold. They are beaches, shingle ridges (and my view is that the Environment Agency, formerly the National Rivers Authority, should replace the shingle at Salthouse which it has caused to be lost by its bulldozing), sand dunes (a greatly underestimated resource, which the Dutch manage as a sea defence in front of clay banks by beach replenishment in front of them) and salt marsh (provided it is allowed to behave as natural salt marsh which is reached by the tide). Is there anywhere more precious than Scolt Head Island at any time of year, or Blakeney Point in the winter - or do you prefer Sea Palling and Beach Road, Hemsby?

5 Wildlife and Coastal Change

Peter Lambley, Conservation Officer, English Nature Eastern Team

There are around eight different conservation designations on the north Norfolk coast, including the potential World Heritage Site - no wonder it's been sinking as sea-level rises!

There are many species that are perfectly happy with the changing coast, but there is also a group of species for which the situation is rather different.

Change is nothing new to the wildlife of the north Norfolk coast. The coast has been retreating in places - examples are Brancaster, where we see the remains of a forest of bronze age or earlier, and Holme timber circle. Habitats and species have had to adapt to change for a very long time.

(Blakeney Point slide)- There aren't many sites in Britain where the vegetation, and the fauna associated with it, is adapting to changing geomorphology - to the changing dunes, saltmarsh and so on. As the land develops, so does the vegetation. This is seen very well at both Blakeney and Scolt, with dunes colonised by marram grass and saltmarshes in between. Sand flats on their own are not without interest, with wading birds and seals - these animals actually need change. One of the recognised features of the new European Union designated marine SAC (Special Area of Conservation), which is in development, is glassworts colonising sandflats. Mudflats are not just important for plant life but also for little molluscs, such as hydrobia, which waders such as knot feed on. Another European feature is Atlantic salt meadows, which we know as the meadows covered in sea lavender - the middle saltmarsh, as they used to be called. Again, all these need a changing coast.

Many plant species such as prickly saltwort and sea holly are adapted to conditions where sand builds up in low dunes. We normally think of terns as requiring protection, but Little Terns like open, mobile beach conditions with little marram. After a breach in the 1970s, marram was planted on Scolt because the old Nature Conservancy Council believed this was the right thing to do. Nowadays we recognise that Scolt is essentially best left to develop in its own way. Natterjack toads also need unstable, changing situations because they compete with common toads which don't do very well in such situations.

Coastal cliffs may be where many of our native weed species originated and are very important for many beetles and other species. Eroding cliffs with seepages and so on are very important for wildlife. The recently discovered barbastelle bats in north Norfolk seem to spend much of their time hunting along these cliffs, so even animals not normally associated with coastal change may use these habitats. The vegetated cliffs of the Norfolk coast, covered with kidney vetch and so on, are one of our largest areas of grassland in the county.

Those are some of the plants and animals that need change, but this aerial photo of the RSPB reserve at Titchwell reminds us of the importance of the freshwater element on the coast, principally for birds. The area was flooded in 1949 when sea defences failed and reverted to saltmarsh, but Titchwell was restored to freshwater marsh in 1973. The area to the west, also flooded in 1949, remains as saltmarsh.

An aerial photograph of Holme shows another reserve important for many species, including the grazing marshes at the back for species such as Brent geese. The reserve is perceived to be threatened by erosion of the area in the middle, where the Norfolk Wildlife Trust's building is. Again, coastal change implications here are not so simple.

At Brancaster (aerial photo), we have a marine SAC on the seaward side and a freshwater marsh which is important for birds on the landward side. We have a conflict in the European Habitats Directive.

There are also other features like this half-moon lagoon at Cley. Lagoons are priority habitats which don't look much and have only a few species such as the starlet sea anemone but in European terms they are very important. What do you do, as most of these sit behind some form of defence?

Freshwater reed beds are extremely important for a few species. Bitterns seem to have a very good lobby, even attracting Ministers. Bitterns used to be a species very much of the Fens as well, but we have to accept there are now very few freshwater sites left for bittern in Britain and most are on the coast. These are now nationally rare and important species and we have to do something to try to protect them.

Vast flocks of wintering wildfowl such as Brent geese and widgeon come down to grazing marshes. Blakeney Freshes, shown in this slide, are reasonably well protected at the moment but John Pethick is quite concerned about this area in the medium term, or perhaps even the short term.

The lapwing is an example of a species in decline in Britain. Grazing marshes, particularly where water levels have been raised, are an important habitat for trying to restore population levels. This also applies to other species such as pintail and teal.

We have a situation at Cley with a shingle bank- a European feature - with lagoons behind it and freshwater marsh behind these. What do you do in such a situation? There has been a lot of debate, and the general consensus of the conservation bodies is that the only option in the short to medium term to protect the overall interest of the area is to allow the shingle bank to be much more natural - completely natural if that was possible, but there may have to be an element of maintenance. We see the need in the medium term to protect the freshwater interest. In the longer term there may be the possibility of creating freshwater sites in other areas such as the Fens, but that won't happen in the immediate future. This is why we've come to the view that a new seabank at this site is the best solution which would also benefit residents, although this is not the main priority of English Nature. This scheme hopefully will protect the freshwater interest but allow the coastal processes to operate, at least in the medium term. The shingle bank will retreat at about a metre a year as it has done for centuries, the lagoons will be there for quite a long time and we will still have the bittern. The shingle bank should be maintained in a natural way.

At Brancaster, the situation is one where the existing line of defence is not sustainable and there is agreement on the need to realign the sea wall. This has implications for the European Habitats Directive which we have to take seriously. The changes would be a net loss of the bird interest, with enhancement of marine interest but at the expense of the freshwater interest. Long discussions between MAFF, the Environment Agency, English Nature and others have come up with CHaMPs (Coastal Habitat Management Plans) which are an attempt to produce an inventory of features, a list of conservation objectives, a statement of shoreline evolution with regard to coastal processes and changes to coastal defence options. We have to understand the coastal processes, draw these into the debate and try to identify the features which can and cannot be protected in situ.

One of the things we want to try to do is look at replacement habitat in the long term. The sort of criteria we need to look at in relation to replacement habitat are that ideally it should be as close as possible to the area where it will be lost, and preferably at least within the north Norfolk coast. CHaMPs will have to be part of any SMP. We've produced a draft CHaMP for the north Norfolk coast and English Nature and the Environment Agency have got money from Europe for a 'LIFE' Project to look at how we manage nature conservation on coasts that are changing, like the north Norfolk coast. In the meantime we have to accept that there are going to be problems at places like Cley, Salthouse and Brancaster where we are going to be looking at solutions for the short to medium term. Habitat creation work with Lord Buxton at Stiffkey has shown that freshwater habitats can be created elsewhere. It is going to be a long process but I think this is the way forward in managing freshwater interest on the coast.

Finally, anybody involved with nature conservation along the coast has to understand that there are people on that coast as well, and in any discussions and development of policy which take place you have to bring the local people in. I think a conference like this and the Norfolk Coast Project itself can play an important role in this process.

Question and answer session:

Q How can we improve the flow of information between the people living on the coast and the organisations responsible for coastal planning and management? What could be done in general to improve the consultation process for shoreline management plans?

Clive Flanders - It is certainly a two way process and we should not wait until the formal review of SMPs is underway. Certainly the sub-cell groups would be grateful for any advice and updates rather than wait for the full SMP to come out. On a reciprocal basis we could also think about how to disseminate information about implementation work which is going on in the sub cells, to keep the people living on the coast updated. I think this is an area in which we are slightly deficient at the moment and which we could give some thought to.

Peter Frew - This is an area we have been involved in to some extent in the past and perhaps it could be developed. All the way round the coast there are parish councils, although I have only been to speak to one or two of them. Certainly, if a Parish within the North Norfolk District Council area wishes to have someone along to talk to them about coastal issues and coastal management either myself or one of my colleagues would be more than happy to come and talk, and also to listen. As Clive said, it is a two way process. We had tremendous problems when we were in the first generation of SMPs in actually getting people to respond. It seems strange that we have a very fundamental plan that has been put forward and yet we have to chase and chase to get the responses back from organisations. Without that response we can't really put together the plan and make it representative of everybody on the coast.

Jim Long - I think that is an excellent idea. I am sure that parish councils would like people to talk to them but I think each parish council is too small. I think something rather like the Quiet Lanes (pilot initiative) where they had a venue and people came to that venue to listen to what was going on would be better. I would welcome something like that in the north Norfolk area, as other representatives in other similar areas probably would. If someone were to come along and say what was happening, I think it would be much easier than to get back from the people their opinions on a one to one basis. I think it is unfortunate that in Norfolk the people are fairly reticent and unless you get them in fairly small groups you don't get much feedback.

Q Is it possible, when the draft plans are produced, to produce them in a form that is more understandable? They are very technical documents - could they be made more accessible and understandable to non specialists or is that going to be impossible because the subject is too technical?

Peter Frew - They are certainly very complicated documents. The ones I have been involved with have run to several hundred pages. Summary documents have been produced for the final versions of some but in that respect it may well be that it is appropriate we produce summary documents at intermediate stages as we go through the phases of the review. Those may well be more understandable and of greater help in the consultation process.

Q There is an idea of including compensation in cost benefit analysis for shoreline management and there was also a question about whether MAFF was the right government department to decide this. Is there a prospect of a change of policies and a change in the way shoreline management planning is done from the present system to enable it to be more responsive and incorporate local views and priorities more effectively?

Clive Flanders - Compensation is certainly an area where the Environment Agency is not very happy about the government stance. Last year the government, in its response to the Agricultural Select Committee reinforced its view that there should be no change in policy on compensation. This gives us a great deal of problems in actually implementing schemes, not only on the coast but even more so potentially in estuary situations where you can have something like 20 or 30 Brancaster scenarios, so it is a big problem. At the moment we are looking at the issue of compensation measures in terms of potential overall costs of implementing managed realignment policies, through the Association of Coastal Authorities Group, in order to bring to the Minister's attention whether we are looking at say £50m nation-wide or £500m. The Environment Agency has also been talking to some MPs who share this desire to establish what we are talking about in financial terms, so that we can take this back through the Ministry of Agriculture, Fisheries and Food (MAFF) to see if we can move forward on this issue. Things won't happen overnight so in the meantime it would be naive to think we can move towards another funding scenario. It is quite firmly established that our grants are currently awarded by MAFF and obviously the Environment Agency or its coastal partners can't ignore that fact, but nevertheless we aren't happy with the compensation situation. We are doing what we can to see if we can make inroads into this complex situation.

Keith Clayton - It used to be the Department of the Environment which looked after the high coast - which the local authorities look after now - and MAFF looked after the low coast. That was a bit of a nonsense in some ways and got upset by the situation at Whitstable where the sea wall was both protecting the coast and stopping flooding. By a sleight of hand which I don't think was debated in Parliament or approved by anybody I know about, MAFF suddenly acquired the whole lot, in 1985 I think. I don't see why another bit of sleight of hand shouldn't get it back to the Department of the Environment, where it would be much more appropriately placed, because most of the coast we are talking about is not agricultural at all. In any case, the agricultural equation is nonsense. Look at the erosion of Norfolk cliffs - for £500 worth of agricultural land you can get £50,000 of beach feed material, so the more erosion the better.

John Pethick - I was an adviser to that select committee last year and we put forward the proposal that MAFF should give up the coastal portfolio and hand over to DETR. It was argued very closely, with both DETR and MAFF feeling there were reasons for and against. It was almost there but in the end the idea was rejected. MAFF have a vested interest in looking after agricultural land on the coast and DETR in my view would be much better. The point is we were almost there and we should keep pushing on this. The second point is that this business of compensation seems to be altogether too short term - we ought to be thinking very long term about the coast. Again in the select committee we were suggesting that instead of scales of 5 and 10 years, the timescales of practical politics, we ought to be thinking about the next 500 years or at least the next 200 years. We ought to be thinking not so much about compensation but about breaking the chain of ownership on the coast. When people are living in houses (on the coast), when one is sold some other poor soul continues this chain of ownership in inappropriate locations and we do have these inappropriate developments. Take Skegness, with thousands of old people's bungalows all below high tide line. How do we get rid of that? Well, you wait for people to die and try and get the phasing out over long time periods rather than compensating and moving people out. Phased retreat over centuries is the answer. We need to grasp that nettle now but I fear that what will happen is that we will go right up to the wire and then there will be a catastrophe.

Keith Clayton - I did mention my worry about the warning scheme, which is very weak at the delivery point and in terms of education of people. You talked about bungalows at Skegness - East Lindsey District Council actually sent a leaflet round 500 bungalows on an estate saying if you live in a bungalow, get in touch with your nearest neighbour with a two storey house to go there when there's a flood, which is not rational advice at all. I seriously believe that at least 3000 people will drown in the next repeat of 1953. The reason is that at places like Mablethorpe summer bungalows which were not occupied in winter in 1953 now have central heating because they got compensation from the Lord Mayor's Fund and are now occupied all year by old age pensioners like me who can't climb onto the roof.

Q There still seems to be some confusion over the roles of the Environment Agency and local authorities and the difference between erosion control and flooding control, and also whether Anglian Water has a part to play in this. Obviously there are lots of organisations involved and it is not always clear what they all do. Could Peter and or Clive clarify what the Environment Agency and District Council actually do?

Clive Flanders - In broad terms, the Environment Agency has responsibility and powers for flood defence in low lying areas whereas District Councils generally have the responsibility for coastal erosion i.e. the cliff type scenarios. It's not quite as simple as that because in the case of the traditional seaside resorts the District Council has the responsibility of looking after the promenades and sea walls there. Anglian Water are a private company and possibly confusion has arisen due to their input around the Wash where they are probably predominantly interested in water quality issues.

Q But even though the Environment Agency and District Councils have different responsibilities, those are still combined effectively within shoreline management plans?

Clive Flanders - Yes, they are now. As Peter Frew said earlier, we used to "do our own thing" and the National Rivers Authority, as it was then, was only interested/responsible to a certain point along the coast and then it was "over to the District Council". Now we work in conjunction with District Councils and hopefully arrive at policies which are far more sustainable.

John Pethick - It appears to me that the shoreline management plans suffer from one big problem which is that they have the responsibility for the shore without the responsibility for the coastal management beyond the shore. They can't do anything about inappropriate development and therefore all they can do is say we will have to defend whatever is there. As soon as you defend, you encourage more people to build in those areas despite government guidance. Councils simply cannot withstand the pressure, so we get more and more inappropriate development and more and more risk. Look at Canvey Island - 86 people killed in 1953 would seem to be a message to move everybody out but since 1953 there has been £40 billion of investment in Canvey and all below the high tide line. SMPs cannot do anything about that and are totally ineffectual.

Peter Frew - I largely agree in that respect - they do look at that very narrow strip of shoreline. When North Norfolk District Council was looking at the coastal management strategy we looked at how far inland we should go. A colleague was on the panel which put together the MAFF guidance and at one stage they were going to go about 1 kilometre inland but they thought it might cost too much so eventually just advised everybody to look at the shoreline. Most people recognise that is inadequate and we need to look more deeply into the problems than that. Certainly the Local Government Association has recognised that with its coastal issues Special Interest Group and North Norfolk District Council is looking at how to mirror that in its own district. That doesn't solve the general problem because unless the guidance is changed when it comes out, hopefully in 6-9 months, we will again be looking at the single issue of the shoreline and how it is defended. It's to be hoped that MAFF might look a bit deeper than that.

Peter Lambley - It might be that the wildlife has set a precedent over this with CHaMPs (coastal habitat management plans). These are essentially coastal zone management for a very specific interest and may be used as examples for more general coastal zone management.

John Pethick - If they had statutory power, yes, but they don't have that power. All this is just guidance. Councils can't resist the bottom-up pressure which is coming for development in these places.

Q Peter Frew mentioned the integration of Shoreline Management Plans and the Local Plans in his talk so what we are talking about is an integration of various different plans and strategies, certainly between the Shoreline Management Plan and the Local Plan if you are talking about development control. Maybe there are other operations as well that need to be integrated and perhaps I could throw in dredging at this point.

John Pethick - I was very worried about what Keith was saying about beach nourishment being a good thing, if not quite a panacea for all ills. But where does the material come from? If we start dredging the offshore banks then we let waves come through and we get more coastal erosion. Where are the sediment sources? Keith talked about the Dutch model, but they dredge from immediately offshore, deposit it on the shore, get more erosion, the sand moves back, they dredge it out again and so on. They are actually causing more problems than they solve with their beach nourishment schemes. That was what I was hinting at with the Lincolnshire shore schemes. There are big problems about dredging as a source of sediment for beach nourishment. With navigation dredging we have another tin of worms that I won't open up at the moment. Where does our sand come from? Well, the only places are close to shore at the moment and that causes problems.

Keith Clayton - If we could get it from further off shore, we should and you exaggerate the Dutch issue. When they wanted to build Europort they came and dredged the gravel from just off Great Yarmouth!

Clive Flanders - Hopefully the North Sea Sediment Transport Study will start to address these questions. This is one example of a region-wide initiative whereby we will be looking at offshore sediment sources so that dredging licence applications can be looked at in a much wider perspective. How successful we'll be I don't know but the problem is recognised and we are working towards solving that one.

Q John Pethick's presentation sparked several points and questions. One is about sediment transport - whether the North Sea Sediment Study would be enough to find out about sediment transport and what other means might be used. Is radioactive labelling a possibility, or the idea of overlaying sediment transport maps with tidal stream maps to find out more? Are other techniques possible?

John Pethick - We would love to use radioactive particle tracing but we're not allowed to, even though it is safe and we can use half-lives of only a few days. We have been trying to develop other forms of tracing but we have a big problem in that we're talking of maybe a 500 year pathway between say Lincolnshire and Norfolk. The other way is volumetrically and we need a lot more seabed surveys to be done for this. We can't do this with aerial photography or LIDAR as we are talking about fairly deep down, as much as 10 metres. We need very expensive, regular seabed surveys to see the sand wave movements and trace them volumetrically so we can follow the pattern.

Q Does sediment transport at Blakeney work in opposite directions depending on the coarseness of the sediment i.e. does the shingle still move east to west while the sand goes the other way? And do you need sand accretion from the west before the shingle moves towards the west?

John Pethick - Yes to the first point. I'm not sure I understood the second part. In the Blakeney area, I think sand does move from west to east. The shingle does move from east to west but it is not coming from anywhere or going anywhere - it just tends to shuffle around generally. There is no source of shingle - the shingle on Blakeney is fossil, dumped there in the early glacial period - there is none or very, very little shingle coming in. But if you were to dump a large lump of shingle at Weybourne it probably would move westwards.

Keith Clayton - Yes, I agree, the shingle ridge was pushed forward by the waves as the North Sea rose after the last ice age. During the last ice age only 15-18,000 years ago the sea level was around 120 to 140 metres lower than now and the present North Sea was land. As it filled up and the waves moved forward, you had a coast of shingle which has moved, becoming the present coast. There is a small contribution from the cliffs but it doesn't account for the volume of the shingle bank.

Q Does Professor Pethick believe that the proposed managed retreat at Cley and Salthouse may cause the coastline to advance, as this scheme is an experiment?

John Pethick - No, I was careful to say that the Blakeney-Cley-Salthouse problem was quite distinct from the rest of the coast because here we have an estuary that is lying parallel to the coast and at the moment it is in equilibrium. We have the right amount of tidal discharge for the entrance area of the Blakeney estuary and this has grown up because of man's influence. Because of the reclamation in the 17th century, the estuary was deprived of half of its tidal discharge and so it grew an extension, and that is what we see today. One possibility would be that if you restored the Salthouse-Cley saltmarshes, the far point of Blakeney might actually erode back again, because you would get a much bigger tidal discharge coming out and would need a much wider entrance area, causing far point to erode away. Consequently we have advised the Environment Agency that the Salthouse-Cley marshes should not be restored. I am not a passionate believer in going back to the halcyon days of medieval times when there weren't many people around and the coast was doing its own thing. We should listen to what people want and try to redesign the coast for our own good. Even if it is not natural, as it was in the beginning, we can manage the coast to make it work for our particular needs. In this case I think we ought to look after the Salthouse-Cley marshes in order to preserve the bits of Blakeney we like, rather than restore it and lose those bits. In other cases it will be different.

The reason I am worried about Blakeney Freshes is that the Glaven wants to go straight out through the Blakeney ridge into the sea but it is diverted. It goes along behind the ridge in front of Blakeney Eye along the Blakeney Channel. The Blakeney ridge is moving back into that channel and the Environment Agency dredge it out. If we carry on dredging out the channel but allow the rest of the ridge to roll back it is going to break its back, which will allow the Glaven to go straight out to the sea. This could have the effect of Blakeney Point becoming an island. We could however divert the Glaven through the Blakeney Freshes where it used to run. You would lose some of the freshes, but that would be a long term sustainable solution. At the moment, I understand that the plan is to carry on dredging the Glaven channel for the foreseeable future, which I regard as unsustainable.

Keith Clayton - The foreseeable future in that case is no more than about ten years. All you're doing is putting off for ten years a decision you ought to take now.

Q Historical evidence suggests that Blakeney Point was growing and the channel moving westward in the 16th century and the marshes at Salthouse were not reclaimed until the mid 17th Century so there was already evidence of westerly growth before reclamation of the marshes.

John Pethick - The studies we have done show that the growth of Blakeney Point post-dates the reclamation of the marshes so I would be keen to see any evidence you have to the contrary.

Keith Clayton - There is a further complication anyway, because we are talking about a tidal prism (the amount of water moving in and out on the tide) which is dependent on saltmarsh height, and they are much higher now than 200 years ago. Areas which were being flooded to some depth 200 years ago and adding to the volume of that flow are now flooded less deeply so there is less flow. John at one point referred to a self-sustaining system, with the ebb tide delta building out, producing a bigger tidal prism, so producing a bigger ebb tide delta, which will carry on forever. But it won't go out forever, because the saltmarshes will accrete and reduce the tidal prism in that way. It will self-stabilise in the end.

Q Does conservation take precedence over people in other European countries as it seems to on the north Norfolk coast?

Peter Lambley - I have only limited experience of the low countries and I don't have the details. What is clear, though is that if you look at the saltmarshes of the north Norfolk coast, in most instances they are far better and more extensive than those on comparable coasts. Other than the Frisian Islands, the Dutch and German coast has been heavily modified - essentially they have lost the upper saltmarsh in most instances and in fact there are massive concrete walls there. The thing about the North Norfolk coast, allowing for the fact of influence by man over the last 400 years, is that it is essentially a much more natural coast than those others until you get round to the Danish coast. I think that Britain takes European legislation more seriously than some countries. The LIFE project will be sharing experiences with the Dutch, German and hopefully the Danish to try and get a better understanding of how wildlife can be accommodated in these dynamic situations. You can't work in conservation without considering the human factor. Brancaster is a good

example, where the agencies and local people have got together. We're not there yet but I think we've got something we can all live with and in a sense we're working towards a designer coast that John Pethick talks off. Blakeney probably has further to go but the Agency did make a big effort to get public participation in those discussions and the conservationists were just one of a number of people involved.

Q Coming back to a more general issue of coastal management, if we do look towards restoring the coast to a more natural state, and we do it by a sort of medium term protection for wildlife habitats in some cases, is that going to produce long term results we don't want? Also, what sort of timescales are involved? We have heard that some of these features have been developing for hundreds of years. Are we going to have to wait for hundreds of years to see the results of schemes we undertake now?

Keith Clayton - If we are talking of the likes of saltmarsh then the National Trust undertook an experiment a few years ago on an island in the Blackwater estuary and had saltmarsh plants growing within a couple of years, and it is now a perfectly good saltmarsh.

Q Is that enough to tell us what will happen to the overall shape of the coast?

Keith Clayton - No, you will never meet an academic who doesn't ask for more money for research and it depends on how certain of the facts people want to be. In principle this coast has looked after itself for 5,900 years and it is only in the last 100 years that we have started playing about with it so it probably won't take it very long to get back to the point where it will look after itself for the next 5,900 years, until the next glaciation takes place and the sea level falls.

Q But some of the enclosures of marshes took place several hundred years ago. Is the coast not still reacting to those changes in some cases?

Keith Clayton - I would argue that there are present day instabilities that you can trace back to some of those changes. Overy Sailing Club gets very upset because its sailing water gets more and more shallow - what is happening is that a flood tide delta is developing because you have not got enough water going in and out to clean it out, because there is too much of the marsh enclosed. Am I right John?

John Pethick - Yes, I think so, and as an example of the way in which the coast might respond quickly, the Titchwell breach of 1949 now has a nice big delta in front of it and the saltmarshes restored. Everything was going very nicely until the RSPB came along with their lagoons and reclaimed it again - and now they wonder why the coast is eroding there. It is because they made those lagoons - they are a modern form of reclamation, and we have to be very careful about this form of conservation which produces these physical constraints upon the coast.

Q In the Salthouse situation, if the new clay bank is built and the shingle bank is left to reprofile itself naturally, how long will it take it to roll forward to the new clay bank?

Keith Clayton - In some ways I'd be pleased if it was going to be left alone, but it's going to be messed about with in an attempt to keep it going with too little shingle, and this is the problem with that scheme. If you don't put that shingle bank right it will eventually move landwards faster because there is less shingle in it than the rest of the bank, so not only will you have a bump where the Glaven channel is being dredged out, you will also have a deeper bay at Salthouse itself and this means that shingle will move into that bay from the Blakeney and Weybourne ends, so those beaches will be dragged down and will start joining the general deteriorating condition of the bank. This will speed up the Glaven breach as well as cliff erosion and beach loss at Weybourne. If you don't do something about putting back the shingle which has been lost since 1953 when bulldozing of the bank started, you have an inherently unstable and therefore unsustainable situation, and one which MAFF should not fund.

Peter Frew - Using a scheme which was referred to earlier as an example, at Happisburgh cliffs we had defences constructed in about 1959 which were taken out in about 1992 on safety grounds, and since then we have seen some very rapid erosion and have lost some more defences since. To answer the original question about effects and timescales, I think what you see is a number of effects - you see a very short term catching up process, but there has to be continuing monitoring because beyond that I'm sure there will be longer term effects, which you may not be aware of straight away.

Keith Clayton - Yes, even the fact that you may do nothing or undertake managed retreat doesn't mean that you stop monitoring. We must know what's happening. Until recently we didn't know what was happening - nobody ever measured the profile down a beach until about 25 years ago, they just used maps.

Q This is really a plea from people who don't live on the north Norfolk coast - the strip between Holme and Weybourne - which seems to get an awful lot of attention. Are there implications for wildlife on the rest of the coast and if so what are they?

Peter Lambley - Sidestrand and Trimingham cliffs are very underrated. Large stretches, pretty much from Weybourne round to Happisburgh, are notified as Sites of Special Scientific Interest (SSSI) for their geological interest. This interest is best served by allowing them to erode naturally, in fact some of those areas are specifically notified for mass movement, although I appreciate this is no comfort to those with a bungalow on top. Also, there is a considerable area of grassland on those cliffs, and I don't underestimate their importance, but in the present climate of relatively little money going to coastal cliff defences it is not so much of a wildlife issue as the north Norfolk coast is. Winterton, however, does worry me a lot. I've recently taken over responsibility for this whole stretch of coast. The Winterton area is to be included in a CHaMP (coastal habitat management plan) as part of the Life project and I think there is still a lot of debating to be done about the whole issue of the Happisburgh reefs and the long term future of Happisburgh. It is not just about protecting Winterton for the wildlife but also has huge implications for the coastal community down there. I am very nervous about that whole scheme in the long term.

Keith Clayton - Just to add that a special feature of Winterton is that they are non-calcareous dunes, which are not common, and the feeds that have been put on the coast from offshore, which are necessary because the sand is being retained behind the reefs, are calcareous so the dunes at Winterton will not be nourished in an appropriate way. Winterton Ness is a mobile feature - nesses on the east Anglian coast migrate up and down the coast according to the amount of littoral drift north and south of them. If you interfere, they start moving and English Nature doesn't like migrating reserves!

APPENDIX 1 - CONFERENCE QUESTIONS AND COMMENTS

WILDLIFE AND COASTAL CHANGE

Snettisham Beach resident

Peter Lambley seemed to take it that wildlife interests would prevail. He mentioned that there were also people to be considered. At Hunstanton - Snettisham MAFF seem to have decided people are not valuable enough when holiday making.

Holme resident

How much conservation goes on in other EC countries as to habitats. When the part of the Norfolk coast being only a minute percentage of the EC coastline. Do the conservation bodies use the EC to bulldoze their way over local people?

How long will it take for plants to colonise the new Cley/Salthouse bank once it is built?

High Kelling Parish Councillor

What damage could be done in the long term by the medium term protection of freshwater sites

District Councillor

Do we have any wildlife from Cromer to Eccles - it appears not.

District Councillor

Is there any wildlife east of Cromer?

COASTAL CHANGE IN NORFOLK

Blakeney Parish Councillor

What are the long term effects of the proposed shingle bank from Cley to Weybourne?

Salthouse resident

Does Professor Pethick believe that the proposed managed retreat at Cley/Salthouse may cause the coastline to advance and will this scheme be an experiment.

Jonathan Hooton

Sediment transport in the Blakeney area. Does it work in opposite ways depending on the coarseness of the sediment - i.e. does the shingle still move E - W whilst the sand goes the other way? Do you need a sand accretion from the west before shingle will move towards the west?

Richard Searle, West Norfolk Tourism Forum

Has the reduction in the water flows from the Great Ouse had the effect of allowing the Wash estuary to silt up.

Cley resident

Holkham beach appears to be becoming silted up. Why?

Weybourne resident

What can we restore to allow Weybourne beach to grow? Have the new defences at Weybourne been designed and if so are they on view?

Where does Weybourne's shingle come from?

Have you a website? - (no not yet, but intending to set one up shortly)

Godfrey Sayers, Norfolk Coast Project Central Parishes Representative

John Pethick: Have you overlaid your sediments maps with a tidal stream atlas and if so what light did it shed on sediment movement?

Does Professor Pethick consider that the present monitoring is sufficient?

Is radioactive labelling of sand technically feasible and is it acceptable? (asked by 3 people)

Cley resident

Don't studies of currents and sea velocities give a clue to which of the Blakeney, Scolt Head development theories is most plausible

Wells Harbour Master

Proof of the effect of dredging on our coast is the loss of 1m of sand on Wells shores over the last 5 years

An innocent Question: If the Danes were able to get deeply inland to ravage Norfolk, doesn't this suggest that estuaries were longer, wider and deeper. i.e. there was more water between the coast and Norwich?

East Runton resident

The enclosed marshes from Burnham Deepdale/Norton along to Weybourne should all be reopened to the sea. Then all marsh levels allowed to readjust. The scouring flood can then be somewhat absorbed with less fury further round and down to south.

Salthouse resident

There is already a sediment transport study report published.

SUSTAINABILITY AND SEA LEVEL RISE

Should the RSPB at Titchwell let the sea take over their reserve, instead of building sea walls?

SHORELINE MANAGEMENT PLANNING

Michael Tucker, Snettisham Beach

How does management of the Wash relate to ACAG and the equivalent Humber area coastal body? It didn't seem to figure in Clive Flander's tabulations

District Councillor

2000 people preferred Sea Palling beach over one weekend. For them the beach is extensive and safe for children and is now a major tourism feature.

Is anyone looking at a cost benefit analysis of adequate compensation compared with savings arising from not building defences?

When will Environment Agency be able to give NNDC information showing flood risk areas which can be used to update the local plan.

Lessingham Parish Councillor

Is it possible to balance the needs of the coast and land beyond Cart Gap, Happisburgh with that to the west? Without defences here the Broads will be eventually threatened.

What steps are necessary for the Environment Agency to undertake the research that will convince them or otherwise of the need to adopt some of the policies we have heard about today. Spend some of the money spent on reefs on research.

What is the difference between flooding and encroachment and, assuming that the preventative measures for each are very similar, do we not have the classic buck passing formula here?

Sedgeford resident

Where does the Anglian Water come in as not mentioned, but seem to do a lot of work round here?

Richard Searle, West Norfolk Tourism Forum

Is it right that MAFF should have such power over funding decisions? Surely with the demise of agriculture to the economy of Norfolk, a new agency is needed to make a more modern approach to the subject?

Defences, like the sand dunes at Holme, should be protected from trampling by people.

LOCAL COMMUNITY INVOLVEMENT

How can a public consultation model be developed to ensure that all bodies connect with local communities?

If 'Us' doesn't say much how can 'Them' be expected to respond to verbal consultation - by sign language?!

APPENDIX II - COMMUNICATIONS RELATING TO THE CONFERENCE

(Summary of Email from West Runton resident)

It was not stated what model of sediment movement was used by the Environment Agency and North Norfolk District Council (NNDC) in producing the Shoreline Management Plans (SMPs). It would be useful to include this in the conference report, in order to compare it with what the academics think.

The speakers were not specifically asked to cover this. However, the understanding of coastal processes on which the SMP for sub-cell 3a (Sheringham to Snettisham Scalp) is set out in a report by Jeremy Lowe of the Institute of Estuarine and Coastal Studies in section 3 (pages 3/1 to 3/10) and associated diagrams of the Shoreline Management Plan for this sub-cell. Section 3.2 (transport paths and sediment budgets) is most

relevant in this respect. The SMP is available for inspection at District / Borough Council offices in Cromer and King's Lynn.

Briefly summarised, the report appears to recognise the current uncertainties regarding sediment transport pathways and presents a variety of evidence and views without coming to a clear conclusion.

It appears to agree in general that a consideration of wave energy and direction, and consideration of sand grain size, suggests an overall westwards drift of sand along the north Norfolk coast, at least close inshore. However, it also recognises that a case has been argued for supply of material from the north and west. It appears to support the view that only a relatively small amount of material moves westwards from Cromer and that most of the supply of mud to the sub-cell comes from the Holderness cliffs. The large deposits of sediment covering the floor of the adjacent North Sea are seen as being easily able to account for the immediate source of any sand supplied to the north Norfolk coast.

The report suggests that the pre-ice age form of the coast has been important in determining the present day form, and that glacial till deposited during the last ice age is important in the sediment budget, and in forming features such as Blakeney Point and bars which affect the refraction of wave energy on the shore.

The sub-cell is seen as being particularly sensitive to changes in sea level, since this is considered likely to alter the pattern of wave refraction by sand bars along the coast. This would result in currently sheltered areas becoming exposed to higher energy waves and vice versa, so altering the form of the coastline.