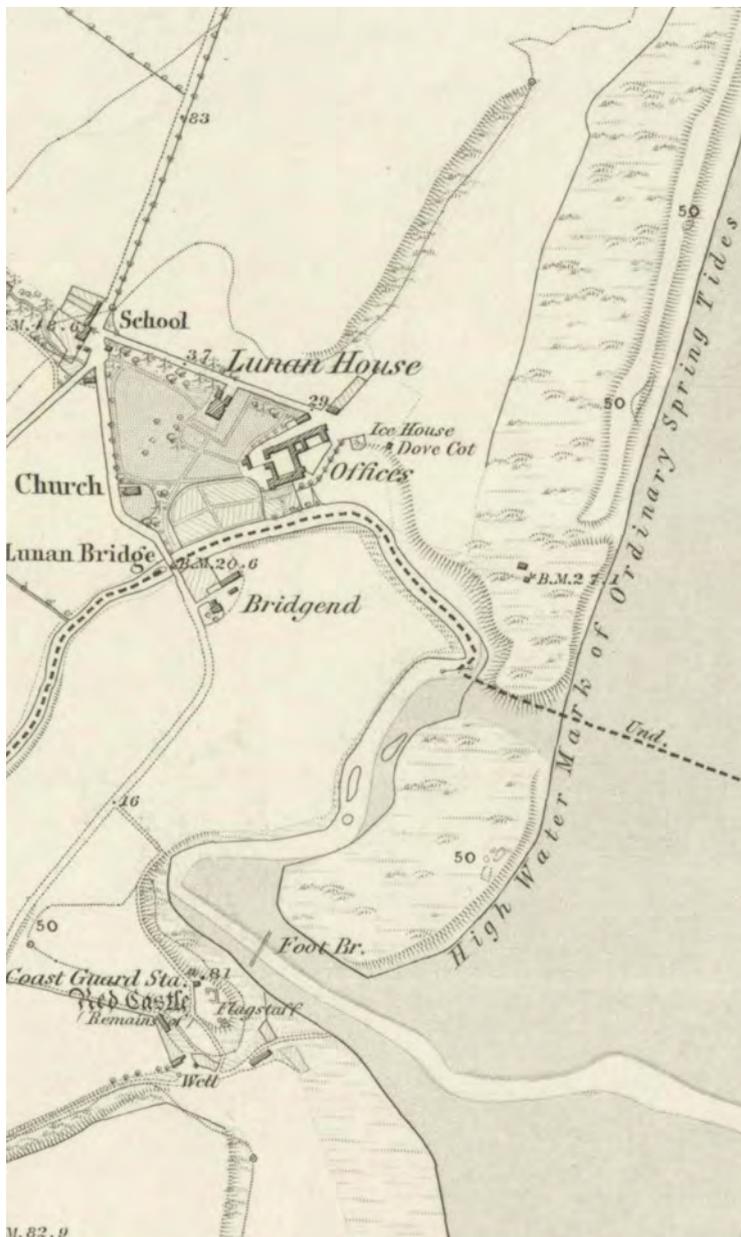


Coastal Zone Assessment Survey

Part 1: Desk-Based Assessment



The Angus
coast from
Monifieth to
Milton Ness



Coastal Zone Assessment Survey

Desk-Based Assessment

The Angus coast from Monifieth to Milton Ness

March 2009

By
Tom Dawson
Stephanie Garling
Joanna Hambly

Commissioned by Historic Scotland



Scottish Coastal Archaeology and the Problem of Erosion

Summary

This report presents the results of the desk-based assessment element of a coastal zone assessment survey of part of the south eastern Scottish coastline, from Monifieth on the Firth of Tay, to Milton Ness north of St Cyrus. The work was carried out by The SCAPE Trust in February 2009 with funding from Historic Scotland. The main aims of the work were to collate and review all known available information regarding the physical nature and historic environment of a 1km strip of the coastal zone; and to integrate and assess this information to inform the vulnerability of the coastal zone and its physical heritage to present and future coastal change.

Examination of Historic Environment Records, aerial photographs, historic maps and published sources revealed extensive evidence of human activity along the coast from the Neolithic to the present. Of particular note are: 1st millennium BC to 1st millennium AD evidence of settlement, agriculture and ceremony in the rich low lying coastal hinterlands; Iron Age promontory forts between Arbroath and Lunan Bay, historic built heritage relating to fishing; and historic ports and 20th century built heritage relating to the two World Wars. The most important source of record on the Historic Environment Record is identification of sites through the examination of aerial photographs, which accounts for 28% of all records in the coastal zone.

The coast edge varies between hard rock cliff and sandy bays and has been extensively modified by glacial processes during the Quaternary period. Except for the dramatic cliff between Arbroath and Lunan Bay, the majority of the coast edge is low lying. A wide rock platform fringes the majority of the study area. A suite of raised beaches are a feature of the coast and evidence of a relative falling sea level trend from the Late Glacial period to the present day. Geological, geomorphological and coastal process information indicates that historically, much of the coast is relatively stable with localised areas of erosion and accretion. A review of the latest information on climate and sea level trends indicates that the most likely future scenario for the Angus coast is that the rate and scale of coastal change will increase in line with observed and modelled changes in sea level and climate, and this will have an impact on all physical coastal heritage.

The project has resulted in the creation of an evidence-based, transferable GIS resource of both the physical and historic character of the survey area. It is this GIS which should be seen as the principle tool for heritage management. This report provides the accompanying context and background as well as a cartographic presentation of some elements of the GIS.

Contents

Summary

1. Introduction	
1.1 Background	1
1.2 Survey area	1
2. Aims and objectives	1
3. Methodology	
3.1 Archaeology and built heritage	2
3.2 Geology and geomorphology	2
4. Report format	
4.1 Map presentation	3
4.2 Built heritage and archaeology maps and gazetteers	3
4.3 Hinterland geology and coastal geomorphology maps and gazetteers	4
4.4 Evolutionary trends maps and gazetteers	4
5. Archaeological context and overview	
5.1 Previous archaeological work	5
5.2 Settlement and agriculture	5
5.3 Defence	5
5.4 20 th century military activity	6
5.5 Built heritage of the coast	6
5.6 Shipwrecks	6
6. Physical context and background	
6.1 Geological context	7
6.2 Quaternary	7
6.3 Post-glacial morphological development	7
6.4 Current evolutionary trends	8
6.5 The present and possible future morphogenetic environment	8
7. Maps and gazetteers	11
Built heritage and archaeology	13
Hinterland geology and geomorphology	215
Evolutionary trend	247
8. Analysis of method of originally locating sites	269
9. Assessment of present and future vulnerability to coastal change	270
10. Sources consulted	271
11. References	274

1. Introduction

1.1 Background

The impact of coastal erosion on Scotland's archaeological and built heritage has long been recognised and Historic Scotland has taken a strategic lead in commissioning a programme of research to assess the scale of the problem in order to inform management and investment priorities. Much of this research has been, carried out through a national programme of Coastal Zone Assessment Surveys (CZAS), guidelines for which are set out in Historic Scotland's Archaeological Procedure Paper 4 (HSAPP4) (1996). Detailed CZAS have now been completed for approximately 30% of the Scottish coastline. In the light of the availability of this substantial dataset along with advances in computer-based technologies, particularly GIS applications, a review of the results and methodologies of CZAS thus far has recently been completed by The SCAPE Trust (Dawson, forthcoming), the outcomes of which are informing a revision of Procedure Paper 4, currently in preparation by The SCAPE Trust. As well as fulfilling the objectives of a CZAS, part of the purpose of the Angus CZAS is to contribute to the process of the revision of HSAPP4 by testing the new procedures.

1.2 Survey area

The assessment area extends from Monifieth, on the Firth of Tay in the south to the Milton Ness headland just north of St. Cyrus. This incorporates the entire length of the Angus coastline and approximately 3 km of the southern Aberdeenshire coast. The shoreline of the Montrose Basin was included in the survey.

The desk-based survey assessed the landscape and historic environment evidence within a 1km strip from the coast edge and within the intertidal zone.

2. Aims and objectives

The aim of the desk based assessment was to collate all known information regarding the physical nature and historic environment of the coast edge; to assess the relative vulnerability of areas to current and future coastal change and to present this information in preparation for the field survey element of the project.

The objectives of the desk-based assessment were:

- to describe the geology, geomorphology and physical evolution of the coast edge and immediate hinterland;
- to collate and review all known heritage sites and finds recorded on the National Monument of Scotland (NMRS) and local Historic Environment Records (HER) and results of any relevant research within the survey area;
- to examine relevant aerial photographs and historic maps in order to identify potential new sites within the survey area;
- to assess the potential vulnerability of the Angus coast to change by reviewing available evidence of current and future coastal processes and current and future climate driven coastal change;
- to present the information as a series of maps and accompanying gazetteers for use in the field.

3. Methodology

3.1 *Archaeology and built heritage*

i Historic Environment Records (HER):

Two separate databases of HER information were supplied in digital format by the National Monuments Record of Scotland (NMRS) and Aberdeenshire County Council. All records relevant to the project were selected by defining the 1km wide search area in ArcGIS. The NMRS and Angus HER's were checked, cross-referenced and integrated into a single database by assigning each site or find, whether recorded on both or only one of the HER's, a unique number. Where sites and finds were recorded on both the NMRS and Aberdeenshire HER's, the most detailed record was selected for incorporation into the project database. The project database formed the basis of all archaeology and built heritage maps and gazetteers.

ii. Historic cartographic sources:

The Ordnance Survey First edition of 1865 and First revision of 1904 were closely scrutinised for buildings and sites within the area of the walk over survey along a 100m wide strip from the coast edge, and the intertidal zone, to identify any potential new sites not yet added to the National or local Historic Environment Record. A geo-referenced digital copy of relevant tiles from the First edition Ordnance Survey map was supplied by the National Library of Scotland.

All relevant pre-Ordnance Survey relevant maps, marine and admiralty charts at the National Library of Scotland were examined.

iii Aerial photographs:

Relevant RAF vertical stereoscopic series from the 1940's and early 1950's at 1:10,000 scale were viewed at RCAHMS in Edinburgh and at Aberdeenshire County Council. The 100m strip along the coast edge, to be walked in the field survey phase of the project was closely examined to capture any potential unrecorded historic features.

In addition, relevant photographs from the 1960's, 1:7,500 Ordnance Survey vertical coverage, the 1973, 1:10,000 coastal survey and the 1988 1:24,000 All Scotland Survey were scanned for any additional information.

3.2 *Geology and geomorphology*

Cartographic, documentary and available GIS datasets were reviewed to compile information to describe the coastal geology, geomorphology, evolution and current and future climate driven morphogenetic environment of the coastal zone. A notable limitation was the lack of any detailed solid and drift geology or soil maps for the Montrose area (Sheet 57), so a range of other, largely secondary, sources were used to describe the geology and geomorphology. The Evolutionary Trend maps describe the erosional status of the coast edge and are based on the EuroSION project GIS dataset (Lenôtre & Thierry, 2002), with further information drawn mainly from Barne *et al.* (1997) and Ramsay and Brampton (2000).

4. Report format

4.1 Map presentation

All maps were generated using Geographic Information System (GIS) technology and specifically the software Esri ArcMap 9.2. Geology, geomorphology and evolutionary trend maps are displayed at a scale of 1:25,000. Built heritage and archaeology maps are displayed at a scale of 1:10,000.

Information on hinterland geology, coastal geomorphology and erosion class (evolutionary trend) are displayed on three separate maps. This is because they were generated using GIS methodology by assigning values representing the different physical characteristics of the coastal zone directly to the mean high water spring line. The result is the creation of a GIS resource comprising a series of polylines that contain information about each physical characteristic (geology, coastal geomorphology coast edge modification, erosion class), which can be directly integrated with other GIS datasets in other projects.

4.2 Built heritage and archaeology maps and gazetteers

The categories used in the gazetteer entries are as follows:

ID: A unique identifying reference number assigned to each site relevant to this project. This number appears on the accompanying built heritage and archaeology map.

Site Name: The name of the site as given in the information sources.

SMR No: If different from the NMRS. The identifying number used by the Angus HER.

NMRS No: The identifier used by the NMRS HER. This includes is generated from the OS map number, site number and sub number.

Eastings:

Northings: The national grid reference as recorded in the HER's. Many sites on the HER have poor provenances and are only accurate to 4 figures, even though the grid reference given will be eight figures, made up with zeros. Isolated finds, wrecks and older records of sites or finds with no physical expression in the landscape are the main site types that are affected by poor provenance. Discrepancies were also found between locations recorded in the Aberdeenshire and National Monuments Record HER's. In these cases, the polygon data from the Angus HER, where available was used.

Original method of discovery:

This describes how the site was originally identified. Categories used in the gazetteers are as follows:

AP *Aerial photograph.*

EV *Archaeological event, such as survey, excavation, watching brief etc.*

FS *findspot.*

HS *historic source, e.g. an historic document Does not include historic Ordnance Survey maps.*

Mon/SB	<i>Monument or standing building. Includes extant and easily visible remains such as a church, toll booth or promontory fort.</i>
OS	<i>Ordnance Survey map</i>

Site Type: A brief description of the nature and broad category of the site.

Description: A summary descriptive text about the site. The text has been compiled by integrating descriptions found on the NMRS and Aberdeenshire County Council (Angus) HER's.

4.3 *Hinterland geology and coastal geomorphology maps and gazetteers*

The geological and geomorphological information presented here is the result of a desk-based assessment and has not been verified in the field. It is, therefore, necessarily general and it is expected that minor variations will be noted in the fieldwork phase of the study.

The gazetteer entries accompanying the coastal geomorphology and hinterland geology maps are set out as follows:

Foreshore: the broad sediment category and geomorphology of the foreshore. This information is drawn from the Euroasion classification of sediment and geomorphology of the foreshore.

Coast Edge: the expected altitude and general aspect of the coast edge.

Hinterland: the expected general geology, geomorphology and landforms of the immediate hinterland to the coast edge.

The classification of the foreshore and hinterland geology and geomorphology on the maps in this desk based assessment diverges very slightly from the categories set out in Historic Scotland's Archaeological Procedure Paper 4 in order to better capture information from the sources consulted.

4.4 *Evolutionary trend maps and gazetteer*

The expected erosional status of the coast is taken from the Euroasion data set and further details drawn mainly from Ramsay and Brampton, (2000) and Barne *et al.*, (1997). The purpose of including an expected erosional status map is to be able to compare the desk-based information with observations of current actual state of the coast edge in the field.

5. Archaeological context and overview

5.1 *Previous archaeological work*

The origin of the majority of recorded heritage within the survey area comprise: historical records of archaeological sites; monuments and finds; the result of developer-led archaeological intervention and a small number of archaeological research projects on individual sites and landscapes. Both the national and local Historic Environment Record (HER) has been considerably developed as a result of national and regional HER enhancement projects, e.g. to identify archaeological sites and landscapes through examination of aerial photographs; the recording of historic features and structures as depicted on the First edition Ordnance Survey map; and the Defence of Britain Survey. This has been of particular benefit in the recording of cropmark evidence for former settlement and agriculture, and built heritage including military remains. Recent systematic archaeological research has been carried out by the Angus and South Aberdeenshire Field School, a collaborative project run by the Centre for Field Archaeology between 1996 and 2000, funded by Edinburgh University and Historic Scotland. The broad aim of the work was to assess the lowland cropmark evidence of a range of sites in the valleys of the Lunan Water and North and South Esk rivers (Dunwell and Ralston, 2008).

5.2 *Settlement and agriculture*

Extensive cropmark complexes revealed through aerial photography provide evidence of intensive and multi-period occupation of the fertile and well-drained raised beach deposits that form the hinterland between Carnoustie and Arbroath, Lunan Bay and Montrose. The evidence comprises the remains of settlement, agriculture and ceremonial activity and includes numerous examples of enclosures, linear boundaries, ring ditches, pits, souterrains, barrows and pit alignments. Medieval and post-medieval rig and furrow, generally showing as cropmarks or soil marks, is widespread and often overlies earlier settlement and cultivation evidence. A small number of largely developer-led excavations have investigated the cropmark evidence and provide more detailed contextual and dating information. A cist burial associated with Bronze Age pottery and flint knives was excavated near Craigmill Burn just east of Carnoustie; two excavations near Elliot to the west of Arbroath recovered evidence of Iron Age settlement, a possible fort and long cist burials; and an excavation at Corbie Knowe at the southern end of Lunan Bay recorded early medieval settlement sealed beneath a layer of blown sand. Angus Field School research excavations at Redcastle, Ironhill East and Newbarns have recovered multi-period activity dating from the late Neolithic to the medieval period (Dunwell and Ralston, 2008). The evidence includes; the remains of Iron Age timber roundhouses; a timber-lined souterrain at Redcastle; a rare medieval (8th – 11th century) timber hall and associated pits at Newbarns; and a Pictish (4th – 8th century AD) square and round barrow cemetery at Redcastle. Isolated finds recorded throughout the survey area are rarely well-provenanced, but are usually located in the hinterland cropmark zones. These range from: Neolithic stone axes; prehistoric worked stone tools; late Neolithic, Bronze Age, Iron Age, Roman and later pottery; and metal finds and coins mainly from the Roman period onwards. Recorded cropmarks extend to the coast edge in the vicinity of East Haven, Elliot, Lunan Bay and the northern edge of the Montrose Basin.

5.3 *Defence*

Seven forts, six of them promontory forts, are located on the rugged cliff edge between Arbroath and Lunan Bay with a single fort overlooking the northern end of Lunan Bay. The promontory forts are very small, commonly with three sides edged by the vertical drop of the cliff and the narrow landward end defended by a single or

multiple rampart and ditches. The remains are generally characterised by earthworks of defensive ditches and other structures, and an occasional report of associated midden material. Two have been subject to modern archaeological excavation, West Mains of Ethie (Wilson, 1980) and Castle Rock, Auchmithie (Ralston, 1986). Associated finds generally indicate Iron Age domestic activity, with Roman artefacts indicating occupation continuing through the Roman period, and some contact with the Roman world. A Roman temporary camp at Gilrivie near Dun on the northern edge of the Montrose Basin was identified through aerial photography in the 1970's. Associated finds indicate a 1st century AD date. Of the areas medieval castles, two are located on the coast edge: Black Jack's Castle on the headland north of Lunan Bay; and a defended tower house at Kaim Mathers on the headland north of the Sands of St. Cyrus; while Red Castle stands on a promontory just behind the coast edge. Evidence of occupation at Black Jack extends into the 18th century. No trace now remains of an 18th century fort at Scurdie Ness recorded as earthworks on the First Edition Ordnance Survey of 1865.

5.4 20th century military activity

Historic military structures and features relating to the defence of Britain in the 20th century are a feature of the survey area. Tank blocks, pill boxes, batteries and gun emplacements, overwhelmingly of World War II date, defend the main settlements and ports, military establishments and potential landing beaches. The majority of these defences were constructed at the coast edge and many have already been impacted by coastal erosion or inundation. Military built heritage such as stores, hangars, rifle ranges, look out and signal towers are very common recorded sites at Barry Buddon, the former World War II military airfield at East Haven and the World War I and II military airfield of Montrose.

5.5 Built heritage of the coast

Other, largely 19th century remains of built heritage specific to the coast edge relate to maritime, fishing and industrial activity. At Buddon Ness are the remains of two lighthouses, an icehouse and a boathouse, and there are fishing stations and salt works at Arbroath and the Fishtown of Usan. Ruinous lime kilns are located on the cliff edge at Boddin Point, and the remains of a chemical and bitumen works is eroding out of the dunes a kilometre southwest of Elliot.

5.6 Shipwrecks

The most numerous maritime records are those of wrecked and grounded, mainly 19th century, vessels. These are generally poorly provenanced and so are often arbitrarily located within a map grid square, however, they potentially comprise significant heritage of the intertidal zone.

6. Physical context and background

6.1 Geological context

The Angus coastline lies within the Midland Valley of Scotland and the underlying geology is composed mainly of rocks of the Lower Devonian age. The principle formation is Old Red Sandstone, which consists of grey, brownish-grey and red sandstones, shales, flagstones and conglomerates originating in a non-marine sedimentary environment from coarse detritus eroded from mountains further to the north. The sedimentary rocks are interbedded with Devonian andesitic and basaltic lavas (summarised from Doody and Sawyer in Barne *et al.*, 1997). The lavas are most evident along the coastline between the southern end of Lunan Bay to Red Head, the

mid section of Lunan Bay to Scurdie Ness and at Milton Ness. These rocks are relatively resistant to erosion and form headlands at Red Head and Scurdie Ness. Small areas of Upper Old Red Sandstone, comprising soft conglomeritic and cross-bedded red mudstones and sandstones, represent the limited evidence for Upper Devonian sedimentation. Exposures of Upper Old Red Sandstone occur at Whiting Ness, north of Arbroath and at Milton Ness north of St Cyrus.

The general structure of the sedimentary rocks of the region incline gently to the southeast, but secondary faulting and deformation in rocks of Lower Devonian age are the result of a period of intensive tectonic activity during the Middle Devonian period. The influence of faulting and jointing on marine erosion is displayed in the Old Red Sandstone cliffs from Arbroath to Red Head in a range of dramatic erosional landforms including stacks, geos, gullies and caves.

The wide sandy expanses of Lunan Bay and St Cyrus have been created by the breaching of weaknesses in the hard rock cliff line by Lunan Water and the North Esk River.

6.2 Quaternary

Landforms and superficial deposits relevant to the Angus coast are mainly attributable to the last glacial cycle that affected the region during the Devensian period. The maximum extent of ice cover occurred between c. 22 and 19,000 years BP when ice flowing eastwards from the Grampian Highlands extended far beyond the Angus coast. The ice sheet scoured the land surface, eroding and transporting vast quantities of terrestrial material deposited as till. The reddish brown, sandy stoney clay till is the most widely distributed quaternary deposit in the region and caps the cliffs along the coast between Arbroath and Lunan Bay, and Lunan Bay and Montrose. The melting of the ice sheet, culminating c. 13,000 years BP, resulted in vast quantities of water released from the down wasting ice of the Highlands which also flowed eastwards. Sediment transported by the glacial meltwaters came to rest at or on stagnant coastal ice and resulted in the deposition of outwash sands and gravels, notably at Monifieth, the hinterland of Broughty Ferry and Barry Buddon, Arbroath, Lunan Bay and Montrose. These glacial outwash gravels have been reworked in the post glacial period and in the Holocene by waves and tides to form the raised beach formations that are a feature of the Angus coastline.

6.3 Post glacial morphological development

The oldest Quaternary landform along the Angus coastline is probably the extensive intertidal rock platform that fringes the coast north of Carnoustie, in front of the cliffs between Arbroath and Lunan Bay and between Lunan Bay and Montrose. A comprehensive understanding of its chronology and development is still uncertain, but it is highly likely that periglacial processes during the Devensian glaciation, and marine erosion in the immediate post glacial period were critical to its formation. The rock platform is the earliest of the assemblage of raised shorelines and associated features of a generally emerging coastline that provide evidence of Quaternary sea level changes in eastern Scotland. Along the Angus coast at least four former shorelines can be identified at approximately 30m, 21m, 15m and 8m. The highest three shorelines are late/post glacial features, the lowest and most continuous 8m raised beach is a Holocene landscape feature formed c. 9,000 – 7,000 years BP during a post-glacial marine transgression when relative sea level was higher than today. It is particularly evident between Dundee and Arbroath, and from Lunan Bay to Montrose. The triangular raised beach foreland of Buddon Ness is also a product of

the Holocene marine transgression when glacially deposited sands were transported onshore, to be then reworked by wind to form the foreland essentially as it is today. All along the coast, as sea levels fell, large areas of intertidal glacially transported sediments were exposed and blown inland to form the extensive links of Barry Buddon, Lunan Bay and St Cyrus and Kinnebar and the fringe of stabilised sand dunes between Carnoustie and Arbroath.

6.4 *Current evolutionary trends*

Ongoing erosion and deposition from wind, wave, tidal and longshore drift processes continue to modify Buddon Ness and the Angus coastline. The Angus coastline is designated as sub-cells 2a and 2b in the coastal cell scheme of Ramsay and Brampton (2000). Coastal cells define lengths of coastline within which sediment exchange may occur, but over whose boundaries sediment exchange does not occur. Sub cell 2a incorporates the southern half of the Angus coast up to the Deil's Head at Arbroath with sub-cell 2b extending to Milton Ness. The principle erosional/depositional trend of sub-cell 2a is of net erosion along the Monifieth and Carnoustie frontage, with episodic storm induced erosion north of Carnoustie. Within sub-cell 2b, the most significant erosion is occurring at Montrose due to transport of material northward where it accretes at St. Cyrus. Lunan Bay appears to be in a state of dynamic equilibrium with little net longshore transport, but high numbers of visitors to the dunes at Lunan Bay has caused recent destabilisation of the dunes and exposure to wind erosion.

6.5 *The present and possible future morphogenetic environment*

The Angus coastline lies within a zone of traditional relative sea level fall due to the rate of isostatic uplift exceeding mean sea level rise. Recent work measuring crustal movement with highly accurate instrumentation (Bingley *et al.*, 2007; Smith *et al.*, 2006) has shown that the current rate of uplift in this zone is less than has been previously estimated. Recent work measuring historical sea level change using detailed instrumental records also indicates a notable late 20th century increase in the rate of sea level rise around Scotland. The closest measurement stations to Angus are at Leith and Aberdeen. These show an increase in the rate of sea level rise from 1991 by 4mm/yr and 2.5mm/yr respectively (Rennie, A., *pers. comm.*). Thus, in the context of current and future relative sea level trends, the Angus coast may already have shifted to one of relative sea level rise rather than the previous trend of relative sea level fall. Modelled best estimates of relative sea level rise scenarios by 2050 for the Angus coast range from <14.5cm south of Montrose and >17.5 north of Montrose to Aberdeen and from <29cm in the south to >34cm in the north by 2100 (Dawson, 2001), although these estimates do not take the most recent trends of isostatic readjustment and sea level rise into account. As most impact to the coast edge occurs during storm surges when water levels are elevated far above the predicted tide, Dawson (2001, 2003) has integrated projections of sea level rise with modelled storm surge elevation values in order to produce best estimates of the frequency and scale of future surges by 2050. These models predict surge values of between 3.48m to 3.75m above mean tide level at a frequency of at least once or more than once every 50 years. More recently, Ball *et al.* (2008) used a Geographic Information System application to model trends in future coastal flood risk as part of a study into coastal flooding commissioned by the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER). Although acknowledging that off-shore wave heights have increased and that storminess could increase around Scotland's coast by the 2080's in conjunction with more frequent and higher positive North Atlantic Oscillation (NAO) indices, they conclude that this data is not yet robust enough to be

used with confidence to model future scenarios, and so confine the variable parameter to sea level change in their models of coastal flood risk hazard in the 2080's, with wave height and storminess data assumed not to have changed from present values. Under this scenario the risk to the Angus coast is generally low to medium with an isolated area of medium risk at Monifieth.