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**Supporting ICZM Delivery in Wales:
Enhancing the Evidence Base for Coastal
Decision Making**

McCue, J; Cousins N; Gubbay, S;

CCW Policy Research Report No. 08/10

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EXECUTIVE SUMMARY

Atkins Limited (Atkins) were commissioned by the Countryside Council for Wales (CCW) to review existing information in relation to current and future potential impacts of climate change at the coast in Wales, analysing the information needed to respond to and advise on climate change and sea level rise in coastal management decisions.

Data and information management is defined as a key pressure “theme” in Making the Most of Wales’ Coast, the ICZM Strategy for Wales. The aim of the study is to help CCW review what information currently exists, where data is stored, and whether it is helpful in improving the understanding of issues such as habitat replacement, natural evolution of landforms and the economic implications of natural shoreline change over time. It does not seek to replicate recent reports that refer to climate change or ICZM in the UK or Wales, nor to provide an in-depth analysis of all reports, data or information relating to climate change impacts on the Welsh coastal zone. It seeks instead to identify the benefits of appropriate new work for both delivering CCW’s remit and the delivery of ICZM in Wales.

The report reviews and evaluates data in relation to three themes that reflect CCW’s core values and consider coastal communities and economic activities:

- Coastal evolution – how coastal processes affect the physical coast, its environment, accessibility and economic implications;
- Coastal environment - nature conservation, landscape and heritage, geology and water resources and their management;
- Coastal access and recreation – how the management of the coast for access and enjoyment improves quality of life, local economies and coastal communities.

Two case studies - Pensarn to Point of Ayr and the Dyfi Estuary – are examined to test the adequacy of existing information in relation to ICZM and climate change at a local level, and whether the information available is of use to address and plan for future climate change.

The case studies underline gaps in national data in relation to geoconservation and coastal access and recreation. Key issues affecting the ability of local and national operators to deliver their roles and responsibilities in relation to ICZM and climate change are also highlighted by the case studies:

- Communication – between local groups, between national groups, between local and national levels and the translation of scientific and technical information for policy and decision makers.
- Patchiness of data – determined mainly by local conditions. The level of detail required needs to be understood locally and nationally and reasons for patchiness understood.
- Scale – at which data is collected and information or advice given is not always appropriate at either national or local level.
- Integration – across traditional user groups to put into practice the ‘collect once, use many times’ maxim.

A proposed implementation plan sets out actions for CCW either alone or in partnership with others, and actions for others. Actions are presented under the three ‘themes’ and identified as relating to new research, information sharing, guidance or policy development.

CRYNODEB GWEITHREDOL

Comisiynwyd Atkins Limited (Atkins) gan Gyngor Cefn Gwlad Cymru i adolygu'r wybodaeth a oedd eisoes yn bod mewn perthynas ag effeithiau presennol newidiadau yn yr hinsawdd ar arfordir Cymru, ac effeithiau dichonol yn y dyfodol, gan ddadansoddi'r wybodaeth y byddai ei hangen er mwyn ymateb i newidiadau hinsawdd a chodiad yn lefel y môr, ac i roi cyngor yn eu cylch, o ran penderfyniadau mewn rheoli'r arfordir.

Diffinnir rheoli data a gwybodaeth fel un o "themâu" pwysau allweddol Gwneud y Gorau o Arfordir Cymru, Strategaeth yr ICZM (Rheolaeth Integredig ar Barthau Arfordirol) ar gyfer Cymru. Nod yr astudiaeth yw cynorthwyo'r Cyngor Cefn Gwlad i adolygu pa wybodaeth sydd yn bod ar hyn o bryd, ym mhle y cedwir y data, ac a ydyw'n fodd i wella dealltwriaeth o faterion megis adfer cynefin, datblygiad naturiol tirffurfiau, a goblygiadau ariannol newidiadau naturiol yn y draethlin dros gyfnod o amser. Ni chais ddyblygu adroddiadau diweddar sy'n cyfeirio at newid hinsawdd neu at Reolaeth Integredig ar Barthau Arfordirol yn y Deyrnas Unedig nac yng Nghymru; ni chais ychwaith roi dadansoddiad manwl o'r holl adroddiadau, data a gwybodaeth sy'n ymwneud ag effaith newid hinsawdd ar barth arfordir Cymru. Yn lle hynny, mae'n ceisio adnabod manteision gwaith newydd priodol ar gyfer cyflawni cylch gwaith y Cyngor Cefn Gwlad ac ar gyfer cyflawni Rheolaeth Integredig ar Barthau Arfordirol yng Nghymru.

Mae'r adroddiad yn adolygu ac yn cloriannu data o ran tair thema sy'n adlewyrchu gwerthoedd craidd y Cyngor Cefn Gwlad ac sy'n ystyried cymunedau a gweithgareddau economaidd yr arfordir.

- Newid yn yr arfordir - sut mae prosesau arfordirol yn effeithio ar yr arfordir ffisegol, ei amgylchedd, ei hygyrchedd a'r goblygiadau economaidd;
- Amgylchedd yr arfordir – cadwraeth natur, tirwedd a threftadaeth, daeareg ac adnoddau dŵr a'u rheolaeth;
- Mynediad i'r arfordir a gweithgareddau hamdden yno - sut mae rheoli'r arfordir ar gyfer mynediad a mwynhad yn gwella ansawdd bywyd, economïau lleol a chymunedau lleol.

Archwilir dwy astudiaeth achos - Pen-sarn i'r Parlwr Du ac Aber Afon Dyfi - i brofi pa mor fanwl gywir yw'r wybodaeth sydd yn bod o ran Rheolaeth Integredig Parthau Arfordirol a newid hinsawdd ar lefel leol, ac i brofi a yw'r wybodaeth sydd ar gael o ddefnydd wrth ymdrin â newid hinsawdd yn y dyfodol ac wrth gynllunio ar ei gyfer.

Mae'r astudiaethau achos yn tanlinellu bylchau yn yr wybodaeth genedlaethol mewn perthynas â geogadwraeth, â mynediad i'r arfordir ac â gweithgareddau hamdden. Maent hefyd yn tynnu sylw at faterion allweddol sy'n effeithio ar allu gweithredwyr lleol a chenedlaethol i gyflawni eu swyddogaethau a'u cyfrifoldebau mewn perthynas â Rheolaeth Integredig ar Barthau Arfordirol a newid hinsawdd:

- Cyfathrebu - rhwng grwpiau lleol, rhwng grwpiau cenedlaethol, rhwng lefelau lleol a chenedlaethol, a sut i egluro gwybodaeth wyddonol a thechnegol mewn modd sydd yn ddealladwy gan y rhai sy'n llunio polisiau a gwneud penderfyniadau.
- Data bylchog - a benderfynir gan amgylchiadau lleol yn bennaf. Mae angen deall, yn lleol ac yn genedlaethol, lefel y data sydd ei hangen, a deall hefyd y rhesymau paham y mae'r data'n fylchog.
- Graddfa – nid yw'r raddfa casglu data na'r raddfa darparu gwybodaeth neu gyngor bob amser yn addas, naill ai ar y lefel genedlaethol nac ar y lefel leol.

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- Integreiddio – ar draws grwpiau defnyddwyr traddodiadol, er mwyn gweithredu'r wireb 'casglu unwaith, defnyddio sawl gwaith.

Cynigir cynllun gweithredu sy'n rhestru gwaith i'w wneud gan Gyngor Cefn Gwlad, naill ai ar ei ben ei hun neu mewn partneriaeth ag eraill, a gwaith i eraill. Cyflwynir y gwaith dan y tair 'thema' a'i nodi fel gwaith sydd a wnelo ag ymchwil newydd, â rhannu gwybodaeth, â rhoi cyfarwyddyd ac â datblygu polisiau.

1 INTRODUCTION

1.1 Purpose of the report

Atkins Limited (Atkins) were commissioned by the Countryside Council for Wales (CCW) on 1 November 2007 to review existing information in relation to current and future potential impacts of climate change at the coast in Wales, analysing the information needed to respond to and advise on climate change and sea level rise in coastal management decisions.

The purpose of the study is help CCW to review what information currently exists, where data is stored, and whether it is really helpful in improving the understanding of issues such as habitat replacement, natural evolution of landforms and the economic implications of natural shoreline change over time. It seeks to help CCW with required communication on the resources likely to be needed (human and financial) in order to deliver CCW involvement in climate change aspects of ICZM, but also with CCW as a key partner in delivering climate change aspects of ICZM for Wales in the future. It also has a purpose to provide recommendations on priority areas for further climate change related work (e.g. research, policy development, guidance for CCW, CCW as a partner or solely for other parties) to address weaknesses in data and information availability identified.

The report is not intended to replicate recent reports that refer to climate change or ICZM in the UK or Wales, nor to provide an in depth analysis of all reports, data or information relating to climate change impacts on the Welsh coastal zone. It does seek to identify the benefits of appropriate new work (with a specific focus on climate change) for both delivering the CCW remit as well as the wider delivery of ICZM (by others) in Wales.

1.2 Integrated Coastal Zone Management (ICZM) and data management

Coastal lands, the foreshore and adjacent nearshore seas commonly comprise “the coastal zone”. It is a management term but it is also a description of the natural environment of the coast - “*an area of dynamic transition where land and sea interact and which includes both the landward margin and inshore waters*” (Atkins, 2004).

The coastal zone of Wales is dynamic and rich in wildlife, with nationally important landscapes and supporting a great deal of recreation opportunity. Decision-makers concerned with the management of the Welsh coast have a responsibility to protect and enhance these key assets wherever possible, whilst meeting the needs of local communities and the local economy. This is a difficult balance and must be underpinned by informed decisions which require robust and correct data and information to be available.

Integrated Coastal Zone Management (ICZM) provides a framework in which to make such decisions. It has been defined as a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones (EC Recommendation, 2000).

ICZM seeks, over the long-term, to bring together:

- the benefits from economic development and human uses of the coastal zone;
- the benefits from protecting, preserving and restoring coastal zones;
- the benefits from minimising loss of human life and property; and
- the benefits from public access to and enjoyment of the coastal zone.

There are eight standard principles of ICZM, as promoted by the European Commission (EC Recommendation 2000):

- Take a broad, holistic perspective (geographic and thematic);
- Take a long term perspective;
- Provide for adaptive management (responding to new information and conditions);
- Provide for local specificity
- Work with natural processes;
- Use participatory planning;
- Support and involve all relevant administrative bodies;
- Use a combination of instruments.

All of the above principles require the acceptance of change over time and the implications of climate change presents perhaps the largest and most challenging “changing agent” that faces coastal nations. It is of relevance to note that over a decade ago, work was undertaken as part of the EC Demonstration Project on ICZM (1998) which looked at information requirements for ICZM. It was concluded (in Doody *et al* 1998) that the key on-going problem in relation to the nature of information required for coastal zone management lies not so much in the provision or the content of information itself, but in the way it is presented to those who formulate and implement policy and take management decisions.

The application of science (including data models, collection and collation) must therefore involve more than just providing information on the state of the coastal environment, identifying indicators for assessing environmental change or developing mechanisms for monitoring and predicting the effect of policy and management options. Information must also inform the analysis of issues, help the user to ask the right questions and then provide signposts to where appropriate data can be found. This has important implications for all data providers, research workers and those attempting to define indicators and develop management tools.

Data and information management is defined as a key pressure “theme” in Making the Most of Wales’ Coast the ICZM Strategy for Wales (WAG, 2007 – known as the “ICZM Strategy” hereon in), which raises both opportunities and constraints for management of the Wales coastline. It identifies this “theme” as one which requires more coordinated thinking and action. Specifically, the ICZM Strategy sets out a requirement to: “*work with partners to identify gaps in information and initiate a programme of research to fill them*”. This study seeks to support CCW in the delivery of this aim through the interrogation of the established “Data Principles” which are discussed in more detail within the report.

1.3 Aims and objectives

The overall aim of this project is supported by the delivery of the following objectives:

- Summarise the key drivers associated with coastal matters that relate to CCWs remit.
- At a strategic level, provide a review and summary of the range of information available, of relevance to CCWs remit.
- Identify weaknesses in the knowledge base, guidance and policy that need to be filled in order to underpin effective advice and decision-making at the coast in the context of climate change.
- Use case studies to test the adequacy of existing information.

- Provide recommendations on priority areas for further work to address weaknesses in data and information availability.

1.4 Study limitations

The original Terms of Reference recommends the assessment of data and information from a variety of sources.

The authors have embraced the large challenge of reviewing as much information as possible within the programme time available for the study. This has involved telephone interviews, questionnaires, client meetings and internet searches to gather as much information as possible for subsequent analysis. With such a broad remit of data and information available, certain information sources may not have been fully interrogated. The priority has been to selectively review reports, information and datasets that either directly or indirectly influence the future delivery of the CCW remit (see Section 2).

2 ROLE OF CCW IN RELATION TO ICZM, DATA MANAGEMENT AND CLIMATE CHANGE

2.1 CCW corporate vision

CCW's corporate vision is for a country where everyone acts in ways that safeguard the natural environment because they understand its importance, both now and for future generations, in providing:

- sources of food, energy, water and other raw materials;
- opportunities for employment and recreation both on land and at sea;
- habitats for a diverse and abundant wildlife and a source of geological riches;
- a means of accommodating and adjusting to the impacts of climate change.

2.2 CCW corporate drivers

Preparing for and responding to climate change has been identified as a key corporate driver for CCW. Other corporate drivers that have relevance to achieving CCW's vision at the coast include (CCW, 2007):

- Preparing for and coping with radical changes in rural land-use/sea-use, including CAP reform and global food shortages.
- Social and economic change, including globalisation and demographic changes.
- Continuing loss of biodiversity and degradation of global ecosystems.
- Increasing emphasis on spatial policy and planning on land and at sea.
- Continued growth and diversification in recreational use of the environment and the increased recognition of its importance to the economy.
- An increasing emphasis on inclusion, participation, engagement and on delivering for citizens.
- Enhanced devolution and public sector reform.

These have not been developed in isolation and are created in response to key national and international drivers (Table 2.1).

Table 2.1 Key drivers for CCW's role and decision-making remit in relation to the coast (CCW, 2007)

International Drivers	UK Drivers	National (Wales) Drivers
IPCC Report; Ramsar Convention; UNESCO Man and Biosphere; The Aarhus Convention; European Landscape Convention; 6th Environment Action Programme 2002-12; Directive on Strategic Environmental Assessment; Habitats/ Birds Directive;	Energy White Paper Climate Change Bill; Stern Report; Marine Bill White Paper; Planning White Paper; Communities Bill; Equalities legislation; UK Biodiversity Action Plan; Wildlife and Countryside Act 1981; Countryside and Rights of Way Act 2000;	Wales Environment Strategy; One Wales; Climbing Higher: Sport and Physical Activity Strategy; Catching the Wave (WAG); Wales Fisheries Strategy; Wales Coastal Tourism Strategy; Convergence Programme; Wales Transport Strategy; Waste Strategy; 2020 Group Report; Planning: Delivering for Wales

International Drivers	UK Drivers	National (Wales) Drivers
European Liabilities Directive; Common Fisheries Policy Water Framework Directive (RBMPs); European Marine Strategy; INSPIRE initiative.	The Conservation (Natural Habitats, &c.) Regulations 1994 and 2007 amendment Countryside Act 1968; Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007; National Parks and Access to the Countryside Act 1949 ; Environmental Protection Act 1990; Environment Act 1995; Natural Environment and Rural Communities Act 2006; Access to Information Legislation (FOI, EIR, RPSI, DPA).	Sustainable Development Scheme and Action Plan; Wales Spatial Plans; Shoreline Management Plan/CFMPs; Community Strategies and LSBs; Coastal Access consultation; Interim Marine Aggregates Dredging Policy.

2.3 CCW strategic aims

To meet the drivers set out above, a number of strategic aims are being proposed by CCW for the period 2008 – 2012. These are focussed on better understanding of the value of the environment; to ensure that people are engaged in the environment, have a role in its management; and that the quality of wildlife habitats, species, geology, landscape and natural systems are safeguarded and enhanced.

- To safeguard and improve the quality of our wildlife habitats, our species, geology and landscapes and the natural systems that support them and ourselves.
- To ensure the value of the environment and the functions it performs are better understood, and that these are taken into account more fully when making decisions that affect our lives.
- To enable more people to have direct experience of the outdoor environment and to play an active part in its management.
- To refine and strengthen our own systems of governance and internal control, streamlining systems and collaborating with others to achieve shared outcomes effectively and efficiently.

2.4 Statutory and non statutory roles

CCW are the key statutory adviser on environmental issues in Wales. Under the terms of Part VII Section 130 of the Environmental Protection act 1990 CCW discharges functions:

- (a) For the conservation and enhancement of natural beauty in Wales and the natural beauty and amenity of the countryside in Wales, both in the areas designated under the National Parks and Access to the Countryside Act 1949 as National Parks or under the Countryside and Rights of Way Act 2000 as Areas of Outstanding Natural Beauty and elsewhere;
- (b) For encouraging the provision or improvement, for persons resorting to the countryside in Wales, of facilities for the enjoyment thereof and for the enjoyment of the opportunities for open-air recreation and the study of nature afforded thereby.

CCW is required to “*have regard to the social and economic interests of rural Wales*” in the discharge of its functions.

The reference in (a) to the conservation of the natural beauty of the countryside includes the conservation of its flora, fauna and geological and physiographical features.

CCW also have a general function to provide advice for the Secretary of State or any other Minister (UK Government and Welsh Assembly Government) on the development and implementation of policies for or affecting nature conservation in their area.

2.5 CCW and ICZM

CCW have no formal remit to deliver ICZM in Wales. This is the ultimate responsibility of the Welsh Assembly Government (WAG). CCW do, however, have an advisory role in the development of WAG policy, plans and strategies, including the Wales ICZM Strategy and the Wales Spatial Plan (with particular reference to delivering SEA). Some examples of how CCW are involved in advising on ICZM are described below.

CCW are represented on the **Wales Coastal and Maritime Partnership (WCMP)**, a national non-statutory advisory group made up of 28 organisations from the public, private and voluntary sectors having interests in the management of the coastal zone and maritime area of Wales. The Partnership is thus able to develop a view of coastal and maritime development issues based on the input of key stakeholders. The Partnership acts as advisor to WAG on coastal and maritime policy, encourages policy development that is integrated across sectors, and reflects the combined interests of all stakeholders.

CCW are involved in a number of important **Coastal Partnerships** such as Making the Most of the North Wales Coast, Pembrokeshire Coastal Forum (PCF), the Association of Severn Estuary Relevant Authorities (ASERA) and the Severn Estuary Partnership (SEP) who set up a specific working group on climate change.

CCW play a key role as consultees for **Strategic Environmental Assessments (SEA)**, including those undertaken for the Wales Spatial Plan and the Wales Coastal Tourism Strategy. With direct relevance to this project (climate change), there are six coastal groups responsible for the delivery of **Shoreline Management Plans (SMP)** in Wales, with responsibility for technical affairs affecting natural or artificial shoreline protection. Organisations that are affected by such technical considerations such as CCW are represented on the groups. This enables CCW to advise on the development of non-statutory Shoreline Management Plans. For the second generation plans there is a strong recommendation for Strategic Environmental Assessment to be undertaken. This should allow the wider sustainability issues associated with shoreline management strategic options to be examined. CCW will have a key role in the provision of data for the development of these SEAs and for the review of outputs.

CCW has an important role to play advising the Environment Agency Wales (EAW) on the delivery of the **Water Framework Directive (WFD)** requiring additional water quality monitoring and standards and the development of River Basin Management Plans (RBMPs). These will require integrated assessment of the implications of policy in the fluvial environment on the coastal environment and again require the development of SEAs. **Catchment Flood Management Plans (CFMPs)** are also an important delivery mechanism for WFD and overlap with SMPs in terms of their role in helping to deliver flood management. The overlap between SMPs and CFMPs does, however, cause confusion, particularly in estuaries.

2.6 CCW and data / information management

CCW is not required through statute to collate or manage data or information in relation to the coast. However, the availability and quality of data it holds or has access to are very important in its role as a statutory consultee and/or advisor on environmental matters. CCW generally does

not produce position statements but rather provides guidance on implementation of specific issues, e.g. guidance in delivery of aspects of the CROW Act.

With reference to nature conservation designations, CCW undertakes some monitoring as part of routine surveillance. In addition, CCW also collects information that is not necessarily related to the necessity to protect and enhance nature conservation interests, such as the All Wales Recreation Survey, although this is compatible with CCW's role in relation to the enjoyment of opportunities for open-air recreation.

2.7 CCW and climate change

The vision, role and remit of CCW means that it engages in climate change issues at many levels and in a variety of ways. A large part of this is in the organisation's advisory capacity but there is also an equally important practical role at a local level where CCW is charged with the management of sites or working with others to ensure sites have a favourable conservation status. The issues tend to fall under two main headings:

1. mitigation and;
2. adaptation in response to climate change.

On the theme of mitigation, for example, CCW is responding to proposals for renewable energy schemes in the coastal and marine environment, while in relation to adaptation, advice is needed on practical issues such as the construction of coast protection works or managed realignment schemes.

In providing advice and responding to higher level consultations such as the EU Green Paper on climate change, CCW needs to be well informed. To this end WAG has commissioned specific research such as 'Responding to our Changing Climate: Consultation on a Climate Change Adaptation Action Plan for Wales' (2007) and 'The New Approaches Programme to Flood and Coastal Risk Management' which both outline opportunities and implications for CCWs remit.

2.8 Appreciating the impacts of climate change on the coast

In light of the knowledge attained from this section, a summary overview of the likely climate change issues that may require specific (future) data and information to better deliver effective management is set out below. These are presented within three key headings, which are defined further in Section 3.2. This is designed to highlight the pertinent ICZM related issues that shall be analysed within later sections of this report:

2.8.1 Coastal evolution

The challenges and opportunities of climate change on coastal evolution are likely to include:

- Climate change may lead to increased risk of coastal flooding in low lying areas and coastal erosion in cliffed areas. Flood and coastal defences may need to be upgraded.
- Increased risk of coastal flooding from the sea and from land – due to an increase in the duration / intensity of rainfall events (especially in winter months and in low-lying urban areas).
- Loss of important habitat through coastal squeeze.
- Potential for saline intrusion into coastal abstraction plants and boreholes and associated loss of fresh and brackish water habitats.

- Increased risk of landslides / landslips
- Changes in habitat distribution
- Opportunity to create / replace habitats lost due to sea level rise / coastal squeeze and through changing approaches to coastal flood risk management (managed retreat).
- Creation of new habitats by altered erosion / accretion patterns
- Opportunities for diversification / changes to land management / farming practices

2.8.2 Coastal environment

The challenges and opportunities of climate change on the coastal environment are likely to include:

- Risk to coastal species intolerant to drought conditions.
- Impact on the biodiversity of coastal habitats and integrity of important saltmarsh / sand dune systems.
- Increased risk of sediment and pollution run-off into watercourses and estuaries.
- There may be higher concentrations of pollutants entering water courses during summer months due to reduced rainfall.
- Risk to species intolerant to waterlogged conditions.
- Risk of expansion of naturalised aliens into coastal waters.
- Species with a pronounced southern distribution are likely to spread into Welsh coastal waters.
- There is likely to be a loss of coastal and estuarine habitats due to increased coastal erosion.
- There is likely to be increased visitor pressure on the coastal environment.
- There may be an increased risk of oil pollution events / shipwrecks due to stormier conditions at sea.
- Changes to species distribution both up the coastline (changes to zonation) and along the coastline (movement of southerly species north).

2.8.3 Coastal access and recreation

In the short-term at least, climate change may present some benefits to the coastal tourism industry in Wales. Longer, drier summers and milder winters, may lead to a more year-round tourist season and indeed there is the potential that Mediterranean holiday destinations may become so hot that Wales may be seen as a preferential alternative. However, the economic advantages from increased visitor spend and employment opportunities may, without forward planning, lead to more environmental challenges and pressures on coastal infrastructure.

The challenges and opportunities are likely to include:

- Increased visitor numbers will put an additional demand on coastal recreational infrastructure (e.g. coastal path network) and transport infrastructure, leading to increased congestion and pollution.

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- Increased number of visitors as a consequence of warmer weather conditions pose a serious risk to the natural coastal environment and biodiversity e.g. disturbance of breeding grounds, increased erosion of coastal paths, etc.
- Increased visitor numbers may attract greater resources for coastal management.
- Increased awareness of climate change effects on the coast.
- Increased coastal tourism will increase the demand on service utilities.
- Coastal attractions will be vulnerable to sea-level rise and stormier conditions.
- Potential loss of natural assets e.g. beaches, wetlands.
- Threats to historical and coastal landscape / seascape features.
- Increased demand for water at coastal resorts in the summer months.
- Increased length of traditional 'summer' season.
- Increased opportunities to see more southerly distributed species / summer visitors e.g. basking shark, sunfish.

3 METHODOLOGY

A variety of tasks were undertaken to achieve the project objectives. These include the review of data under three coastal “themes”, consultation with key stakeholders at national and local level, and a more in-depth look at issues using two case study areas. The project team was guided in this work by a Project Steering Group.

3.1 Definition of data and information and geographic extent of study

A desk-top study of processed data was undertaken to develop an understanding of existing data and information related to climate change and of relevance to CCW’s vision, role and remit in relation to the coast.

The Terms of Reference (ToR) for this study specify that information should only be assessed in relation to CCW’s core remit. The term ‘information’ (for this study) has been interpreted in its broadest sense and is taken to include:

- data sources including their appropriate provision, acquisition, analysis and dissemination to support decision making;
- policy documents;
- guidance and advisory documents.

In order to provide a framework for this study, the coastal zone boundaries were generally considered as the area between the inland limits of coastal flood risk (taken as the boundary of 0.5% probability event), down to Chart Datum. However, given that there is interaction between processes and habitats across the seaward limit, a degree of flexibility is applied to this offshore boundary.

3.2 The Thematic Framework

Three coastal study “themes” were used to structure the information collected during the project.

Theme 1 – “Coastal evolution”: This theme incorporates how the coast will evolve over time. It considers the understanding of how natural processes influence the environment, its accessibility and the economic implications that a dynamic coast has for local communities and business alike.

Theme 2 – “Coastal environment”: This theme incorporates a range of sub areas linked to the natural environment including nature conservation (terrestrial and marine), landscape and heritage, geology and water resources. Effective management of these aspects ensures that the coastal environment maintains (and where possible improves) the quality of life for people and vibrancy of local communities.

Theme 3 – “Coastal access and recreation”: This theme incorporates access and enjoyment of the coastal environment in general. The effective management of these aspects ensures that appropriate coastal accessibility, where possible, improves the quality of life for people, the local economy and vibrancy of local communities.

These themes are appropriate within the study framework as they reflect CCW’s core objectives, and include consideration of associated local community and socio-economic issues. Sections 4 and 5 provide a review of information associated with climate change within the structure of these themes.

3.3 Consultation

The consultation element of this study involved the Steering Group members and a wide range of relevant stakeholders in Wales (Table 2) and focused on gathering comments on the following:

- The type of data/information that is required to help improve strategic decision making and advice along the Wales coast;
- Advice or programmes that could be introduced or produced to help improve knowledge and hence policy implementation with respect to adapting to climate change;
- How partnerships could be used more effectively;
- The current weakness in the knowledge base (data understanding), guidance (roles, responsibilities and procedures) and policy (auditing of information etc) that need to be filled in order to underpin effective advice and decision-making;
- Preferred future research projects and/or pro-active work that could be undertaken to help improve knowledge on adaptation to climate change for the Wales coast and enhance and raise the quality and future resilience of the coastal environment;
- Information availability of relevance to this study.

Consultees were contacted at a national level and local level (for the Case Studies) both through the despatch of questionnaires and follow up telephone interviews (related to case study sites – see Section 3.4).

Details of the questionnaire format are presented in Appendix A.

Table 3.1 National and case study consultees

National Consultees	Case Study Consultees
<ul style="list-style-type: none"> • Cardigan Bay Coastal Group; • CCW National Officer's; • Environment Agency Wales National Officer's; • Special Areas of Conservation Management Officer's; • ABP Ports; • Isle of Anglesey County Council; • Wales Coastal and Maritime Partnership; • Bridgend County Borough Council; • CADW; • Carmarthenshire County Council; • Swansea City Council; • Welsh Water; • Milford Haven Port Authority; • Monmouthshire County Council; • National Farmers Union; • Neath Port Talbot County Borough Council; • Pembrokeshire Coastal Forum; • Pembrokeshire Coastal National Park Authority; • Pembrokeshire County Council; • Royal Commission on the Ancient and Historical Monuments of Wales; • Severn Estuary Partnership; • South Wales Sea Fisheries Committee; • Swansea Bay Coastal Group; 	<ul style="list-style-type: none"> • Cardigan Bay Coastal Group; • CCW Local Officer's; • Environment Agency Wales Local Officer's; • Ceredigion County Council; • Conwy Borough Council; • Flintshire County Council; • North Wales and North West Sea Fisheries Committee; • Gwynedd County Council; • Snowdonia National Park Authority.

National Consultees	Case Study Consultees
<ul style="list-style-type: none"> • The Crown Estate; • The National Trust; • Wales Environment Link; • Wales Tourism Alliance; • WAG; • Wildlife Trust South & West Wales; • Ynys Enlli to Llandudno Coastal Group. 	

The findings of this exercise are presented in Section 6.

3.4 Selection of case study sites

One of the tasks set out in the project brief was to get a better appreciation of data and information to support coastal decision making in relation to climate change at both the national and local levels through case studies. A short list of seven locations was drawn up in consultation with the Steering Group and these were assessed against a number of criteria;

Short list locations

- Mawddach Estuary, Cardigan Bay;
- Pensarn to Talacre Point (North Wales developed coastline);
- Wiseman’s Bridge, South Pembrokeshire;
- Amroth, South Pembrokeshire;
- Poppit Sands, Teifi estuary;
- Taf / Towy / Gwendraeth Estuaries - Carmarthen Bay;
- Dyfi Estuary, Cardigan Bay.

Assessment criteria

Geographic Variance:

- Open coast or estuarine?
- Eroding or accreting?

Coastal Defences:

- Hard or soft defences?

Management Issues:

- Developed or undeveloped coast?
- Cross SMP cell / sub-cell coverage?
- Cross council boundary?

Environmental Issues:

- Designated or non-designated (landscape, heritage, geology, ecology)?
- Importance for recreation and access?

The conclusion, agreed by the Steering Group, was for the case studies to focus on; **Pensarn to the Point of Ayr** and **the Dyfi Estuary**. These two sites provide a contrast between estuarine

and open coast areas; the extent of hard defences; the density of coastal development; and the level of designations and importance for access and recreation. In addition, both sites cross local authority boundaries and span SMP management units, which could be considered as important elements for ICZM.

Case Study boundary extents (shown in Figures 5.1 and 5.3) were selected to present coverage of key CCW concerns in each area, reflect coastal process linkages where possible and to acknowledge flood cell extents or shoreline erosion limits.

4 INFORMATION ASSESSMENT

Information has been assessed for each of the three themes and six main questions identified earlier (see Sections 3.2 & 3.3) In all cases the emphasis is on elements relevant to CCW's vision, role and remit in relation to the coastal zone as described above.

4.1 Plans, strategies and policy

The following presents a summary assessment of key of some key plans, strategies and policies in Wales as outlined in Table 2.1 to test coverage of climate change issues.

4.1.1 Shoreline Management Plans (SMPs)

As discussed in Section 2.5 there are a number of SMPs covering the Wales coastline, which set a policy and strategic management framework for coastal management. The first generation of SMPs were critically reviewed by Government in 2000 and a number of shortcomings were identified. Most of these issues will be addressed by the second generation Plans, or SMP2s, which are currently under development. These revised SMPs will build upon up-to-date knowledge, including the potential impacts of climate change on shoreline evolution, to provide more informed policy and strategic management recommendations for the coast in Wales over the next 100 years.

WAG is funding the establishment of a national coastal monitoring centre, to be hosted by Gwynedd Council, which will provide a focal point for coastal data collection and support Welsh Assembly Government coastal management functions. The Centre is not, however, up and running yet, so it is unclear to what degree it will be able to support the development of SMP2s.

4.1.2 Water Framework Directive 2000

The EU Water Framework Directive (WFD) applies to all estuaries and coastal waters out to one nautical mile from baselines. It was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. With reference to this study, many of the aims of the WFD are relevant to the preparation of the next generation of Shoreline Management Plans (SMP2) for Wales. Specifically, these include the objectives to:

- prevent deterioration in status (i.e. the quality of a water body).
- aim to achieve good ecological status (GES) and good chemical status (GCS) or for heavily modified or artificial water bodies (HMWB or AWB);
- aim to achieve good ecological potential (GEP) and good chemical status (GCS);
- contribute to mitigating the effects of floods and droughts;
- achieve the objectives for EU protected sites.

A series of new statutory *river basin management plans* (RBMP), required under the WFD, will summarise the *programmes of measures* (actions) required to meet these objectives. The WFD programmes of measures are required to be cost-effective and, as such, it seems likely that there will be focus on identifying measures which contribute to meeting more than one objective. For

example, a coastal defence solution might mitigate the effects of flooding whilst also contributing to meeting Good Ecological Status (or improving ecological status) and to the objectives for a SPA or SAC.

RBMPs need to be prepared in draft by 2008. However, whilst there remain uncertainties about some of the details of the WFD, the broad principles are clear and it is therefore appropriate for Wales to endeavour to produce 'WFD compliant' SMPs for the Wales coast.

4.1.3 Wales: A Better Country 2003

WAG is currently working to extend access to the coast by 2008/09 as set out in "Wales: A Better Country". CCW began this process with an information-gathering study in September 2005 and, after consultation with a range of stakeholders focused on three designated exploratory areas, produced a report for WAG in March 2006. The report outlined a number of possible options on what form increased coastal access could take and how it could be implemented. Of note, however, is the exclusion of the consideration of climate change in this strategic document and advice provided by CCW. Updated advice from CCW to WAG on the creation of an All Wales Coastal Path will consider climate change issues.

4.1.4 Wales Spatial Plan 2004

The Wales Spatial Plan has been developed to ensure that decisions take due regard of wider spatial implications and that there is better co-ordination to promote sustainable development. As part of this aim it sets a strategic integrating agenda for the next 20 years. The plan considers issues associated with climate change, including risks to the Wales environment. Action includes the need to set forward a strategy to adapt to climate change and understanding risks to ecology and the human environment.

4.1.5 Environment Strategy for Wales 2006

In 2006, WAG produced the Environment Strategy for Wales, which sets out the strategic direction for the management of the environment in Wales for the next 20 years. The strategy devotes a chapter to climate change in Wales, which includes a baseline assessment of trends and impacts and mitigation and an adaptation strategy. The Strategy also includes an Action Plan, which sets out a number of specific actions where CCW are identified as being a partner or being the lead organisation for its delivery:

- Action 4: "WAG will inform our work on climate change by establishing a cross-sector group, which will provide advice on climate change action for Wales".
- Action 13: "WAG will identify a comprehensive list of measures designed to reduce flood and coast erosion risk and raise awareness amongst bodies with relevant flood and coast erosion risk interest. These measures will relate to infrastructure, catchment and shoreline management, education and awareness raising, modification of developments at risk (enhanced resilience) and flood warning and response".
- Action 14: "WAG will implement programmes of flood and coastal erosion risk management activities, to include those measures identified in Action 13, to address increasing risk";
- Action 16: "WAG will evaluate the contribution of TAN 15 to climate change adaptation".

- Action 27 – “WAG will work with key partners, including CCW, National Parks and local government – to increase public access to the coast of Wales”.
- Action 33 – “WAG will set priorities for landscape scale projects in order to build up the resilience of biodiversity to adapt to climate change, including habitat restoration and review the mechanisms that support this (CCW to be lead agency on this)”.

4.1.6 One Wales 2007

‘One Wales’ sets a national agenda for improving the quality of life of people in all of Wales’s communities, from all walks of life, and especially the most vulnerable and disadvantaged. Climate change is identified as a key challenge that needs to be tackled. A number of actions are set out over a four-year programme. Of relevance, is the proposed development of a Climate Change Commission for Wales, which will assist with the development of new policies and the creation of consensus on climate change.

4.1.7 Coastal Tourism Strategy

The development of a coastal tourism strategy was identified as a key action in the Wales Spatial Plan. A draft plan was issued for consultation in January 2007. No final strategy has yet been published. The draft Strategy sets out trends in coastal tourism in Wales and drivers of future demand. It is likely that the economic drivers will have changed somewhat since the publication of the draft Strategy, due mainly to the current economic situation and ‘credit crunch’.

The impact of climate change on coastal tourism is not examined in any detail in the draft Strategy, although it does touch on the impact of climate change on both the physical coastal environment and tourism patterns.

Of particular importance to CCW’s role are the sections on nature-related tourism, access and the All Wales Coastal Path, the development of coastal marinas (the draft Strategy lists 12 sites where new or existing marinas could be developed), managing the coastal environment and managing visitor pressure. CCW is not a lead partner for any of the 28 proposed recommendations set out in the draft Strategy, but is listed as a partner in the delivery for 12.

4.1.8 Climbing Higher - Strategy for Sport and Physical Activity 2005

The Strategy sets out the strategic direction for sport and physical activity in Wales for the next 20 years. This is of importance to CCW given their aim for promoting people’s enjoyment of the coast. However, this is a high-level document and it does not consider anything associated with climate change.

4.1.9 Charting Progress - An Integrated Assessment of the State of the UK Seas 2005

The UK Government and devolved administrations published its State of UK Seas Report entitled ‘Charting Progress’. This represented the first comprehensive, integrated assessment of the state of the seas across the UK Continental Shelf and forms the basis upon which Government will plan for delivery of its vision for UK Seas, underpinned by the Ecosystem Approach, set out in Safeguarding Our Seas (Defra, 2002).

The Charting Progress report produced regional assessments of progress towards UK Government vision for the seas including assessments that covered the Irish Sea. These

assessments do not focus specifically on Welsh maritime environment, nor implications of climate change on the coastal environment but provide useful background information and summarise the anthropogenic impacts that are currently considered important.

4.1.10 Wales ICZM Strategy

This Wales strategy has been developed in conjunction with the Wales Maritime and Coastal Partnership (WCMP), a partnership of all the key stakeholders with an interest in the Welsh coast and containing representatives from the public, private and voluntary sectors. This strategy (produced in 2007) aims to provide a management framework to facilitate integrated working on the coast by the different interests involved in managing the Wales coastal assets – with the aim of helping them ensure that these assets are maintained and enhanced for the benefit of present and future generations. It also sets out the links that must be made between diverse national and local policies and strategies so that the people involved in managing and using the coast can do so in a way that takes into account the needs of others. It is not, however, a ‘master plan’ for development on the coast.

Section 2 identifies climate change as being a key pressure on the Welsh coast today. Despite the good work undertaken through the UK Climate Change Impact Programme (UKCIP) which modelled a number of scenarios based on different emission projections, there is still uncertainty about the scale of climate change and how the impacts will manifest themselves on the coastal environment in Wales. In general terms the model suggests that Wales can expect: hotter average temperatures; an increase in the number of hot summers and dry summers and an increase in the number of extremely hot days; milder winters and a reduction in snowfall; an increase in winter rainfall; and a longer growing season.

The Strategy states that adaptation measures will be needed for Wales to help mitigate and respond to the effects of climate change. ICZM can potentially help to ensure that adaptation is arranged in a coordinated and holistic way so that changes made in one location do not have unintended effects elsewhere and that key stakeholders are appropriately consulted about the actions planned.

4.1.11 Responding to our changing climate: adaptation action plan for Wales 2007

This WAG action plan was developed as a continuation to the recommendations held in the Environment Strategy for Wales. The action plan sets out potential risks at the coast and a Climate Change Adaptation Action Plan with proposals for key CCW themes.

4.2 Coastal evolution

4.2.1 Reviewed data and information

There has been significant recent progress in the determination of how the coastline in the UK (including Wales) is reacting to contemporary processes. Key studies relevant to Wales are described below.

EUROSION (<http://www.euroasion.org/>)

The EU EUROSION project focused on delivering coastal policy recommendations to address coastal erosion risk and addressing the future impacts of climate change. The project establishes a comprehensive European-level GIS data repository at scale 1:100,000. This provides a consistent framework for integrating existing multidisciplinary data-sets produced at local, national and regional levels, including the status and trends of relevant features such as elevation

and bathymetry, infrastructure, hydrographical features, littoral geo-morphological aspects, sea level rise, driving forces etc. The database is part of the Geographical Information System of the European Commission (GISCO).

FutureCoast (<http://www.defra.gov.uk/environ/fcd/FutureCoast.htm>) (Defra, 2002)

FutureCoast was developed to inform the development of the second round of SMPs. The main outputs, reported in 2002, are improved understanding of coastal behaviour, assessment of potential future shoreline behaviour and a ‘toolbox’ of supporting information and data that can be used in future assessments of shoreline behaviour. The latter includes background thematic studies and the additional data sets and information generated. A series of Shoreline Behaviour Statements have been produced for the coastline around Wales, which describe the current understanding of coastal behaviour and the predictions of future coastal evolution at both the large-scale and local-scale, supported by maps. There are, however, questions concerning the appropriateness of the scale of divisions within FutureCoast. Coastal Behavioural Systems (CBS), for example, are too large to apply a single method of monitoring. Shoreline Behavioural Units (SBUs) are considered to be a more appropriate scale at which to establish and target monitoring programmes.

The Foresight Flood and Coastal Defence Project (<http://www.foresight.gov.uk>) (Evans, et al, 2004)

This project was commissioned to produce a long-term (30 - 100 years) vision for the future of flood and coastal defence in the whole of the UK that takes account of the many uncertainties. It considers how coastal flooding and erosion will change in the 100 years and the best options to respond to changes

In addition to these projects, a large amount of data and information is available on the physical environment in Wales. This can be used to help understand historic and current processes, determine trends in environmental change and for future forecasting with respect to climate change.

The 2005 report, *A Review of Coastal Monitoring in Wales*, concludes that current monitoring of the coast of Wales fails to make best use of the effort put in to data collection and, therefore, falls short of providing a coherent approach to the development of a better understanding of coastal processes and risk.

To improve the coherence of coastal monitoring, sharing of data and long-term support for coastal monitoring, the report recommends a three-tiered approach:

- Level A – national monitoring – WAG to fund and be responsible for the development, management and dissemination of this data. Delivery of data collection can be carried out through existing structures, due to lack of WAG resource and expertise.
- Level B – local authority level – WAG to fund. This would replace existing WAG-funded LA monitoring.
- Level C – localised, specific monitoring of individual defences – level to be determined by local coastal managers.

Furthermore, the report also clearly sets out national (Level A) monitoring priorities and recommended monitoring methods for each of the FutureCoast CBUs.

Table 4.1 provides examples of data availability in Wales.

Table 4.1 Data types for understanding coastal evolution in Wales

Data Type	Comments
<i>Physical parameters</i>	
MET Office Monitoring Marine	The MET Office undertake a wide range of monitoring utilising Marine Automatic Weather Station (MAWS) network buoys and an inshore buoy located at Aberporth and Turbot bank, Argo Project and the UK Voluntary Observing Fleet http://www.metoffice.gov.uk/research/ncof/oceanforecasting.html .
Proudman Oceanographic Laboratory (POL) Irish Sea Monitoring and Modelling Programmes	Extensive physical marine monitoring activity supported by detailed modelling http://cobs.pol.ac.uk/cobs/ .
Cefas Monitoring Programme	Monitoring includes the application of Wavenet buoy in Liverpool Bay. http://www.cefas.co.uk/data/marine-monitoring.aspx .
<i>Shoreline Evolution</i>	
Ordnance Survey Mapping and Admiralty Charts	Current and historic maps that allow changing coastal and marine morphology to be determined.
Shoreline Management Plans	A number of shoreline management plans cover the coastline of Wales running from Sub-cell 8a to 11a. These reports provide coastal process information, including trends and preferred future management policy.
LiDAR surveys and Digital Elevation Models	LiDAR surveys of Wales are carried out by the Environment Agency Wales and in partnership with local councils. Data can be used with Digital Elevation Models.
Topographic Surveys	Local authority led surveys of coastal topography. Collected over various timeframes with differing specifications and coverage.
Aerial Photographic Surveys	Current and historic photograph that allow changing coastal and marine morphology to be determined. More limited time series than historic mapping.
Local-scale modelling	A range of local-scale modelling is undertaken for focussed research – for example, to determine the impacts of development in the marine environment or to monitor designated sites.
<i>Flooding</i>	
Flood extents	Strategic Flood Risk Mapping available from the Environment Agency Wales that indicative fluvial and coastal flood extents across Wales.
<i>Coastal Defence</i>	
National Flood and Coastal Defence (NFCDD)	Database is not currently populated with all the revised datasets for Wales. Data are unlikely to form part of an initial co-ordinated national standard data package until the data migration teams collate the full datasets, but data would be available through Environment Agency Wales. Early progress on this database and validation of the spatial datasets associated with the defences is essential to the provision of national datasets on defences.
Defence Asset Inventories	Managed by local councils across Wales in varied data formats and specifications. Coverage of the coastline is incomplete as surveys on those areas where assets are located. Some Local Authorities adopt framework applications to manage data. Examples include, SANDS (Halcrow) and CERIS (Pembrokeshire).

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A number of initiatives / partnerships have been set up to help collate and disseminate information with respect to the physical environment and to help inform decision-making (Table 4.2).

Table 4.2 Key information collation initiatives

Initiative	Comments
The National Marine Monitoring Programme	Co-ordinates marine monitoring in the UK between a number of organisations. Aims to detect long-term trends in the quality of the marine environment, to ensure consistent standards in monitoring, to establish appropriate protective regulatory measures, to co-ordinate and optimise marine monitoring in the UK, and to provide a high quality key dataset for key variables.
PRISM	A series of computer models of the Irish Sea, provide predictions on wind and waves, currents, tidal water levels and storm surges. The project provides interactive maps to allow users to forecast conditions around the Wales coastline http://www.prism.ie/Home.htm .
European Directory of the Ocean-observing System (EDIOS)	A European Directory of the Ocean-observing System, providing a internet-based tool for searching information on observing systems operating repeatedly, regularly and routinely in European waters. The EDIOS directory contains metadata on European observing systems such as platforms, repeated ship-borne measurements, buoys, remote imagery, etc http://www.edios.org/ .
SeaDataNet	SeaDataNet aims to develop a standardised system for managing the large and diverse data sets collected by the oceanographic fleets and the new automatic observation systems. The objective is to network and enhance the currently existing data collation infrastructure in a virtual data management system http://www.seadatanet.org/ .
British Oceanographic Data Centre (BODC)	BODC is a national facility for managing and distributing physical data concerning the marine environment. Much of the metadata is available on their website. Of note, the Marine Data and Information Partnership (MDIP), has identified BODC as meeting best practice information standards and protocols for the management of oceanographic metadata http://www.bodc.ac.uk/data/where_to_find_data/ .
The NERC Data Discovery Service	The NERC Data Discovery Service allows metadata held within the NERC DataGrid (NDG) to be accessed http://ndg.nerc.ac.uk/discovery .
The National Centre for Ocean Forecasting (NCOF)	A strategic collaborative partnership between the Met Office and the Proudman Oceanographic Laboratory, Plymouth Marine Laboratory, National Oceanography Centre, Southampton and the Environmental Systems Science Centre at Reading. http://www.mba.ac.uk/MECN/ http://www.ncof.gov.uk/ .
Marine Environmental Change Network (MECN)	Collation of time-series data for the UK http://www.mba.ac.uk/MECN/ .

A WAG funded Wales Monitoring Centre, to be managed by Gwynedd County Council, should improve data collation in Wales. The Centre is likely to build upon work being undertaken by Coastal Groups and their recommendations for future studies, linking in with the needs for next phase SMPs. The intention is for this Centre to mirror the approaches being adopted for other parts of the English coastline. The current approach to coastal monitoring varies widely, in terms of scale, programme maturity, design approach, data management, analysis and funding status. Some programmes have been developed locally in isolation, whilst others are integrated. It is unclear how (or if) the recommendations set out in A Review of Coastal Monitoring in Wales are to be integrated into the development and operation of the Wales Coastal Monitoring Centre.

A number of effective coastal monitoring groups have already been established around the UK to help collate, standardise and drive coastal monitoring data collection and reporting. These

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include the South East, South West and North West Regional Management Groups. These Monitoring Groups are 100% funded by Defra; generally in 5 year phases. There is, however, an expectation that funding will continue into the future.

The key aim of these groups is to take forward a strategic regional coastal monitoring programme, to provide freely available data of consistently high quality to inform coastal management and future strategy. Data is managed nationally by the Channel Coastal Observatory (hosted by New Forest District Council) in partnership with the University of Southampton and the National Oceanography Centre, Southampton.

Project Boards for each of the groups provide overall guidance and direction for the regional monitoring programmes, and includes representatives of all the lead partners in each of the monitoring areas.

The key information “categories” covered by these programmes are:

- Exposure to wave attack;
- Vulnerability to flooding;
- Management strategy;
- Coastal geomorphology and geology;
- Defence type;
- Application of GIS to development of risk model.

In order to address risk the monitoring groups steer survey effort across the coast, which includes:

- Land Based Topographic Surveys;
- Airborne remote sensing topographic surveys;
- Bathymetric surveys of the nearshore sub-tidal zone;
- Wave Monitoring and modelling;
- Tidal Measurement.

The outputs of this work are reported upon on an annual basis. Table 4.3 is produced to better understand the working details on each of the monitoring groups and to enable discussion on the benefits of such an approach for the whole of Wales.

Table 4.3 Information on Regional Coastal Groups

Monitoring Group	Partners	Scope and Funding
South East Regional Coastal Monitoring Programme	Representative Coastal Groups include Standing Conference on Problems Associated with the Coastline (SCOPAC), South Downs Coastal Group and the South East Coastal Group. Other partners within these groups include Local Authorities, the Environment Agency Wales, Natural England and Defra.	Monitoring of 1000km of open coastline and estuaries between Portland Bill and the Isle of Grain. Programme commenced in 2002 with funding in place until 2012. This is expected to cost approx £2.7m over a period of five years.
South West Regional	Representative Coastal Groups include Cornwall and Isles of Scilly	Monitoring of 1000km of open coastline and estuaries between

Monitoring Group	Partners	Scope and Funding
Coastal Monitoring Programme	Coastal Authorities Group, South Devon and Dorset Coastal Authorities Group and the North Devon and Somerset Coastal Authorities Group. Other partners include Local Authorities, Natural England, the Environment Agency Wales and Defra.	Portland Bill and Sand Point, Somerset. The programme commenced in 2006 and is expected to cost approx £0.5m over a period of five years.
North Wales and North West Regional Coastal Monitoring Programme	Representative Coastal Groups include Liverpool Bay, North Western and Tidal Dee User Coastal Groups. Other partners include Local Authorities, the Environment Agency Wales and Defra.	The programme commenced in 2006 and is expected to cost approx £2.76m over a period of five years.

Total additional expenditure required for funding of monitoring activities over a five year period (in England) is estimated at £5.79m (Bradbury 2008). A further £0.84m is required to fund the Environment Agency component for Cell 11. Funding for the Welsh element of Cell 11 has been transferred to the Welsh Assembly though no agreement on annual budget has been set for this.

The development of these groups provides good lessons for the effective future delivery of the Wales Monitoring Centre and levels of resources required. Integration of initiatives in Wales that are already underway (Table 4.3), for example PRISM, is vital to ensure that duplication of effort is avoided.

4.2.2 Understanding the impacts of climate change

The monitoring of marine and coastal physical parameters in Wales, as identified in Table 4.1, has enabled long-term trend analysis to be undertaken. Such analyses have been used to identify the impact of climate change on the marine environment. The key findings that relate to Wales on a strategic level are summarised below.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that the rise in global sea level by 2100 will be in the range of 18–38 (lower level) to 26–59 cm (upper level), depending on the emissions scenario. In 2006, Defra released new guidance on sea level rise predictions for Wales. These values are provided in Table 4.4. It is possible that areas in North Wales that border the North West of England may have greater relationship to figures stated for NW England. Predictions for NW England are therefore also provided in Table 4.4.

Table 4.4 Annual sea level rise rates for Wales

Area	Net Sea Level Rise(mm/yr)				
	1990-2025	2025-2055	2055-2085	2085-2115	Previous Guidance Value
South West and Wales	3.5	8.0	11.5	14.5	5 constant
NW England	2.5	7.0	10	13	4 constant

Sea level rise will directly affect how the shoreline evolves by altering the conditions of tides and waves meeting the shore and also levels of possible flooding. However, given uncertainty over the impacts of factors such as ice-melt on long-term predictions of changes in sea level (MCCCIP, 2008) there is some inherent uncertainty in the potential effects of climate change on coastal evolution.

Existing data suggest that severe winds and larger mean wave heights are becoming more frequent (MCCIP, 2008). At the same time, the EUROSION project states that 23% of the coastline of Wales is eroding although MCCIP (2008) believe that this figure could be much higher as a significant area of the coast is artificially fixed by hard engineered defences. FutureCoast suggest that there is general steepening of beach profiles the majority of Wales, particularly where hard defences are in place (Taylor *et al.*, 2004). The Foresight Project suggests that there will be a continuation of erosion across Wales over the next 100 years.

As well as being a function of wider changing sea conditions, coastal evolution is a function of complex local factors including:

- Geology;
- Sediment type and supply;
- Capacity for landward migration, i.e. presence of fixed hard structures on the coast;
- Wave and tidal regime, including exposure;
- Interaction between coastal cells;
- Response of habitat to physical change; and
- Human impacts.

A detailed understanding of these is essential in determining the impact of climate change on the coastline of Wales.

The FutureCoast project has taken the assessment of local conditions forward across the Wales coastline and provides a strategic understanding of future shoreline evolution in response to climate change utilising many of the key data sources listed in Table 3. Subsequent more localised consultancy studies (private and public funded), that build on FutureCoasts work, are helping to improve understanding of coastal evolution in particular locations. For example:

- Identifying Biodiversity Opportunities to Inform the Shoreline Management Review (SMP2) – Carmarthen Bay Estuaries - ongoing work being undertaken by Atkins on behalf of CCW.
- Bristow and Pile, 2002. South Wales Estuaries Carmarthen Bay: Evolution of Estuarine Morphology and Consequences for SAC Management. CCW Report.
- Pye and Saye, 2005. The Geomorphological Response of Welsh Sands Dunes to Sea Level Rise over the next 100 years. CCW Report.

Such studies are useful for cross-reference with FutureCoast predictions and to build upon the local knowledge base.

It should also be understood, that whilst these studies seek to provide decision makers with better strategic understanding of coastal evolution along lengths of coast, the local variances of change are often not clearly known (i.e. specific habitat changes etc) and hence the communication of the findings to more local planners / managers still needs to be improved. Examples of this problem often arise where private funded studies on shoreline change (e.g. studies assessing shoreline change in front of private caravan parks within Barmouth Bay) are not in the public

domain and the set up of localised coastal models are not used to best strategic effect for the wider area.

4.2.3 Evaluation of data and information on coastal evolution

4.2.3.1 Strengths

There is a significant amount of baseline data available for the Irish Sea and the coastline of Wales that has allowed trends for coastal evolution to be established and therefore the impacts of this aspect of climate change to be identified. Equally, the delivery of locally specific research by CCW, referred to in Section 4.2.2 has proved very effective in determining implications of climate change on coastal evolution.

In addition, many initiatives and partnerships have been established to help collate, review and standardise data with most progress being made in the management of physical offshore marine data. Coastal Groups can help with the delivery of effective management decisions with respect to the coast and climate change while initiatives such as the Marine Data and Information Partnership (MDIP), are improving the way data is managed, which should lead to better quality and more accessible data.

Projects, such as FutureCoast, have greatly improved the understanding of climate change impacts on future coastal evolution at a regional level, however, this does not align well with national or local administrative boundaries and more local variances of change often are not clearly known (i.e. specific habitat changes etc) and require more work by local authorities to inform local decisions. Existing information will need to be built upon where possible and used by the next round of SMPs to develop more robust policies for coastal management.

4.2.3.2 Weaknesses

Understanding of how climate change is affecting physical marine parameters and the coast is improving but there are still gaps in knowledge. Such gaps have been identified by organisations like MCCIP (2008) and include the need consider the impacts of ice-melt on sea level rise predictions. Another issue is that sampling can be sporadic and uncoordinated, which provides gaps in the overall understanding of trends.

FutureCoast has made a significant improvement in the strategic understanding of climate change impacts on coastal erosion patterns, however there needs to be improvement in the quantitative assessment of how Coastal Behavioural Systems actually function at the local level (MCCIP, 2008) and the translation and communication of that material to local authorities.

In addition, although there are a number of partnerships and initiatives collating data around Wales, there are still issues associated with bringing information together between stakeholders on the coast. A key challenge is ensuring consistency in the type of data collected, its coverage and how it's reported to allow regional and all-Wales analysis and interpretation, while still enabling local authorities to target monitoring for specific local needs. The number of initiatives in place can also make it difficult to clearly define the roles and responsibilities of these groups and how each group differs in the data they are collating and providing.

It also seems that many initiatives are project led and it is not clear how data will continue to be collected or how future studies will be funded once projects are completed. The establishment of the Welsh Coastal Monitoring Centre should go some way to improving this situation, but there remain uncertainties regarding how long it will take to establish the Centre and what will happen until such time as it is up and running. There do not appear to be any transitional plans in place.

A high percentage of the data available is predominantly technical and academic, requiring the use of specific skills such as the ability to use GIS or coastal numerical models. Web-based platforms make information more accessible, however, there remains a need for education and capacity building to improve stakeholder understanding of technical information availability and how it can be used. Policy and decision makers are generally not technical specialists and the need to translate such information into plain English to enable it to feed into the decision-making process is vital. It will be difficult for politicians (local or national) to make decisions determining the long-term funding of monitoring programmes if they cannot see the need for or benefit of them.

There remains a lack of clarity on the actual measurements for sea level rise and hence predictions for the Wales coast have been made on a national level. This is being undertaken, (through the work of Proudman Oceanographic Laboratory) however, further clarity is needed on what figures should be used by planners, engineers and policy makers, in particular for North Wales, which is currently set a sea level rise figure (for example on the Wales side of the Dee Estuary) which is lower than on the English side of the Dee. Whilst acknowledged as only a small differential figure, the key issue here is being able to communicate a message that is understood by non-technical decision makers who need to know not only which figures are most appropriate for their area, but why there may be differences between areas, and to understand the concept of confidence in relation to the prediction. This remains a key weakness on issues relating to Coastal Evolution in Wales.

4.2.3.3 Opportunities

A significant amount of baseline and trend information is available for Wales meaning that it is possible to develop informed decision-making on the coast with respect to mitigating and adapting to climate change impacts.

The Wales Monitoring Centre, being established by Gwynedd County Council, should greatly aid in the collation and standardisation of physical coastal data in Wales. There is opportunity for Welsh stakeholders on the coast to engage with this Centre to promote the development of future focussed research that addresses adaptation to climate change and studies to address its potential impact. This could include the identification of those areas most at risk of flooding and erosion on a national level, possibly using a Wales coastal visual mapping platform against UKCIP scenario assessments. The capacity to build on existing information is high, particularly related to projects such as FutureCoast. There is also the opportunity to use locally specific studies to help inform wider decision-making at a national level.

4.2.3.4 Threats

Coastal evolution predictions are based on existing hydrodynamic and coastal landform datasets, which is of varying coverage (in space and time) and quality. There is then the need to set up strategically scaled numerical models which often fail to really improve knowledge on localised shoreline behaviour and landform evolution over short and medium term temporal scales. This means that there is often inherent uncertainty in the results, with continued recommendations for more real time data on the coast. To a degree, this might be addressed by the new Wales Monitoring Centre work, though it is proposed that CCW should be championing the need for new real-time shoreline data to have a multiple use purpose for more local situations so that synergies between the use of the data by different organisations can be capitalised on (e.g. use of physical data by CCW or for local conservation applications). This is important given that interrelationships in the marine environment are extremely complex and therefore difficult and costly to model at the local level.

4.3 Coastal environment

The following sub-themes have been identified for assessment within the Coastal Environment theme:

- Water Quality (temperature, salinity, nutrients and acidification);
- Nature Conservation (intertidal, terrestrial and sub-tidal ecology);
- Landscape and the Historic Environment ; and
- Geo-conservation.

4.3.1 Water quality

4.3.1.1 Reviewed data and information

A significant amount of biogeochemical data has been collected in relation to the Irish Sea over the last 100 years, although it should be noted that it is patchy in nature. Some of those programmes set out in Table 4.1 under “Physical Parameters” have also monitored parameters relevant to this theme. Further information that is available is presented in Table 4.5.

Table 4.5 Data types for coastal water quality in Wales

Data Type	Comments
Bangor University Monitoring Programme	The Menai Strait Database is a collection of the biogeochemical and physical parameters in the Menai Strait over the past 30 years. http://www.sos.bangor.ac.uk/research/msd/index.htm
Port Erin Marine Laboratory Monitoring Programme	Collection of data for over a hundred years for Port Erin breakwater Cypris station and Bayrnagh station. Regular transects across the 54°N parallel (the so called Port Erin Line) have also been monitored.
Environment Agency Wales Coastal and River Monitoring Programme	The Environment Agency Bathing Water and fluvial water quality monitoring data.
Department for Agriculture and Rural Development, Northern Ireland (DARDNI) Monitoring Programme.	Data collected from Irish Sea moorings.
Independent surveys	Monitoring data undertaken by independent researchers, e.g., monitoring undertaken by the Offshore Wind Power Industry along the North Wales coastline.

All of the organisations / initiatives listed in Table 4.2 above (see Section 4.2.1) also collate and disseminate biogeochemical information.

4.3.1.2 Understanding the impacts of climate change

Ongoing monitoring of marine physical parameters by initiatives such as those listed in Tables 4.2 and 4.5 have enabled long-term trend analysis to be undertaken. Such analyses have been used to identify the impact of climate change on the marine environment and to establish future responses. The key findings that relate to Wales on a strategic level are summarised below.

Since the mid-1960s the salinity of the Irish Sea shows no significant long-term trend of variation compared to other seas around the UK which show increasing salinity levels. Given that salinity is greatly influenced by precipitation, evaporation, ocean circulation and freshwater input, there is uncertainty on what future effects this may have MCCIP (2008). Studies also

suggest that that there is very little certainty on the impact of climate change on sea nutrients levels (MCCIP, 2008) due to the complexity of interactions that influence this.

There is greater certainty that global surface sea water temperature is increasing by between 0.2-0.6°C per decade with MCCIP (2008) noting that the temperature of the upper ocean (0-800m) to the west of the UK has been rising since the 1970s. Rayner *et al*, 2003, have reported that sea-surface temperature around the coast of Wales has increased by 0.3-0.4°C between 1982 and 2006. UKCIP report that there will be a continuation in the trend of surface sea temperature rises around the coast of Wales ranging from 1-2.5°C by the 2080s under different greenhouse gas emission levels.

Data also show that coastal waters around the UK are becoming more acidic due to the absorption of atmospheric carbon dioxide. This has led to reductions of surface pH by 0.1pH since 1750. Models have confirmed that these changes are likely to be as a result of the increasing atmospheric carbon dioxide levels that are also driving climate change (Blackford & Gilbert, 2007).

4.3.1.3 Evaluation of data and information on water quality

Strengths

The quality of Wales' coastal environment is generally very high. This is reflected in the high quality and wide diversity of the ecosystems and species found in and around the coastal waters, rivers and estuaries. A range of organisations, in particular the Environment Agency Wales and its predecessor organisation, the National Rivers Authority, have conducted extensive seawater quality monitoring and have worked closely with industrial and agricultural interests, water and sewage authorities and others to improve the situation on all fronts. This work is continuing.

A considerable amount of monitoring of water quality parameters has taken place in the Irish Sea providing a basis for trends to be established associated with the impact of climate. In particular, this has provided a high degree of certainty that sea temperatures and acidity levels are rising and will continue to do so under the influence of climate change. In addition, the data collected suggest that salinity levels in the Irish Sea are not showing any clear trends of increase or decrease over time or whether this is linked to increasing sea temperatures.

The Wales initiatives and partnerships, already outlined in Section 4.2.1, have aided in the collation, review and standardisation of data. This allows for more confidence to be set against data and makes information more accessible. Some Coastal Partnerships in Wales, such as the Pembrokeshire Coastal Forum, have set up a Topic group on Marine Pollution and Water Quality. This brings together relevant organisations to review the state of the marine environment at an informal level. Those parties involved are listed in Box 1.

Work by MCCIP (2008) has provided a good accessible platform to allow for a wide range of academic data to be collated and presented in more easily understood way.

Environment Agency Wales; Milford Haven Port Authority / Milford Docks Company; Pembrokeshire County Council; Department of Trade & Industry; Welsh Assembly Government; The British Oil Spill Control Association; D.V. Howells Ltd.; Pembrokeshire College; South Wales Sea Fisheries Committee; CORDAH; International Tanker Owners' Pollution Federation; International Maritime Organisation; Surfers Against Sewage; Marine Conservation Society; National Aquatic Litter Group; Keep Wales Tidy; Afordir Glan / Clean coasts; Marine Pollution Monitoring Management Group; West Wales Oil Pollution Advisory Group; West Wales Environment Group; Maritime & Coastguard Agency; Centre for Research into Environment and Health; the Darwin Centre; Welsh Water / Dwr Cymru; Marine and Coastguard Agency; Pembrokeshire Coast National Park Authority; Countryside Council for Wales; Defra, Radioactive Waste Management Advisory Committee

Box 1 Organisations and parties involved in water quality topic group within Pembrokeshire

Weaknesses

Whilst there is obvious progress in collecting information (as outlined above), there are still significant gaps in the understanding of the impact of climate change on salinity and nutrient levels in the Irish Sea and beyond. MCCIP (2008) have made a number of recommendations for addressing these uncertainties, including the need for improved sampling and further assessment on the potential influence of freshwater inputs, de-nitrification and more extreme marine process conditions on salinity levels.

Similar to the issues raised for Coastal Evolution above, water quality information needs to be interpreted and should be underpinned by improvements in data understanding, its potential for “multiple use”, improved communication to key decision and policy makers and capacity building so that stakeholders can contribute and understanding the implications of the information being collated. The link between policies and plans need to be better communicated and delivered, particularly with respect to delivering the objectives of WFD and whether SMP2 or RBMP policies, which shall be set for the Wales coast in the coming 12-24 months, are integrated in their outcomes.

Opportunities

The availability of a significant amount of baseline and trend information will support informed decision-making on the coast with respect to mitigating and adapting to climate change impacts.

There is also opportunity for research to improve the understanding of how climate change will impact upon marine water quality and the implication this will have for the coastal environment in Wales. This may best be targeted in conjunction with Environment Agency Wales in relation to delivering the objectives of WFD. For example, where there is a risk of significant contamination at the coast, for example due to waste residues (e.g. colliery waste, discharges) or to the erosion of waste tip sites, there may be an existing (or future) risk of failing to meet good chemical status. In such instances, measures (which could include coastal erosion control measures) are likely to be required to prevent deterioration in status. The possible role of (dual function) shoreline structures would need to be considered in the WFD RBMP and is therefore relevant to any future SMP in Wales.

In addition, any issues that require compliance to WFD, and hence the delivery (for example) of sustainable shoreline management policy options that are WFD compliant, may need focused attention. This “policy integration” along the Wales coast will require critical focus in the coming years and is an issue that CCW should seek to prioritise to help define ecosystem functioning in the marine environment. Water quality consideration will require attention as this

influences the ecology of the intertidal zone and nearshore waters in Wales. Impacts on nature conservation are discussed separately in Section 4.3.2.

Threats

The complexity of the marine environment means that certainty regarding the effects of climate change on water quality is difficult to predict. This is particularly relevant to the understanding of how sea nutrient levels will be affected. The key threats with respect to seawater quality and climate change relate to sea temperature, increased nutrient levels and implications of seawater salinity change on in-fauna or marine biota. Climate change will also affect physical changes in the ocean environment, impacting on ocean currents operating in the Irish Sea, water stratification and affecting ocean-driven weather patterns. Changing oceanographic processes will also impact on water quality, changing the way that nutrients are cycled locally between the surface and deeper waters and also on a larger scale, affecting prevailing currents important for bringing nutrients up from deeper waters or carrying coastal inputs away from shore.

The key threat of incomplete information on water quality may (for example) influence the process of identifying and designating Heavily Modified Water Bodies (HMWBs) which is important (amongst other aspects) to those involved in shoreline management, including CCW. This is because such designations will determine the ecological targets for the relevant water body(ies) and could, in turn, have implications for coastal defence decision making. This will also make the achievement of Good Ecological Status (or Potential) under WFD and Good Environmental Status under the Marine Strategy Directive harder to achieve and maintain.

4.3.2 Nature conservation

4.3.2.1 Reviewed data and information

There is a significant amount of data on coastal and marine nature conservation in Wales. This is primarily related to the monitoring and management of intertidal, terrestrial and aquatic habitats and species (Table 4.6).

Table 4.6 Coastal and marine data types for coastal nature conservation in Wales

Data Type	Comments
Intertidal biotope mapping	CCW managed intertidal biotopes surveys following JNCC methodology. Outputs include mapping of biotopes for the Wales coastline.
Terrestrial Coastal Habitat Surveys	A wide range of coastal habitat surveys have been completed for the Welsh coast, including collation of existing habitat inventories (coastal and maritime slope, dune) and NVC scale habitat surveys of a number of saltmarsh areas. Surveys have been managed by CCW with piecemeal inputs from private researchers and academic departments.
CCW protected sites information	Information includes citations, monitoring results, management plans, maps and boundaries. CCW have created a web-based mapping system, which allows easy access to protected site information http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx . A review of the management of sites has re-focussed the way CCW approaches site management. Key to the new approach is improved sharing of practical information relating to the state of sites and actions needed to improve site state. Sites have been divided into smaller management units to enable more targeted monitoring of state, actions and outcomes.
Marine Mammal Surveys	The Sea Mammal Research Unit (SMRU) conduct annual aerial surveys of grey seal breeding colonies, surveys of common seals during the moult period and annual cetacean surveys in south Wales. Seal surveys are supported by counts made by CCW, Dyfed Wildlife

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Data Type	Comments
	Trust and the National Trust. CCW also monitor cetaceans.
SeaWatch Foundation Data	Cetacean monitoring data, including sightings and population counts.
Cefas Fisheries Monitoring Programme	Cefas undertake fisheries surveys in the nearshore and offshore areas around the coast of Wales, including, e.g., monthly bio-toxin monitoring of shellfish fisheries.
JNCC Bird Surveys	Information includes Bird Census (every 15 years), Gannet Census (every 10 years) and Sea Bird Census (every 15 years) Monitoring Programmes.
WeBS database	Annual coastal surveys of over-wintering bird populations.
HABitat MAPping (HABMAP) for conservation and management of the southern Irish Sea	HABMAP aims to produce high resolution seabed habitat maps using data collation and predictive modelling methods.
Joint Nature Conservation Conservancy Councils (JNCC) Marine Nature Conservation Review mermaid database	Sub-tidal biotope survey information http://www.jncc.gov.uk/mermaid/ .
Protected species data	Local Council, Wildlife Trust and CCW held protected species data lists/.
MarClim	Data collated and collected by the MarClim project has been made available to a wider audience via the National Biodiversity Network Gateway (www.searchnbn.net) or by contacting the Marine Environmental Change Network (MECN) Co-ordinator (www.mba.ac.uk/MECN).

Many of the water quality monitoring programmes discussed above also monitor plankton levels in the coastal waters around Wales. A number of initiatives / partnerships have been developed on a national to international level to help collate and disseminate nature conservation information (Table 4.7).

Table 4.7 Key information collation initiatives

Initiative	Comments
Centre for Ecology and Hydrology (CEH) Informatics Programme	Programme that manages CEH collected data http://www.ceh.ac.uk/sci_programmes/env_info.html .
Biological Records Centre (BRC)	Provides a national focus for terrestrial and freshwater species recording (other than birds) BRC have created a database to collate information http://www.brc.ac.uk/ .
Data Archive for Seabed Species and Habitats (DASSH)	Data Archive for benthic survey data of both species and habitats http://www.dassh.ac.uk/ .
Collaborative Offshore Wind Research Into The Environment (COWRIE)	Provides focussed marine research for monitoring the effects of the Offshore Wind Farm industry. Studies of relevance include aerial bird surveys in Wales http://www.offshorewindfarms.co.uk/Default.aspx .
Mapping of European Seabed Habitats (MESH)	Data includes the collation of seabed habitat maps http://www.searchmesh.net/ .
National Biodiversity Network (NBN)	Collation of wildlife data for Wales using a searchable map database http://www.searchnbn.net/ .
Oceanbiogeographic Information System (OBIS)	Database of marine fauna and flora http://iobis.marine.rutgers.edu/ .
The Marine Life Information Network for Britain and Ireland (Marlin)	Marline provides a Sealive survey recording system, SEABED mapping tool and provides a great deal of information on marine habitats species, including their sensitivity to environmental change and preferences http://www.marlin.ac.uk/ .
Multi-Agency Geographic Information for the Countryside (MAGIC) database	Provides coastal related information through a searchable map format http://www.magic.gov.uk/ .

Initiative	Comments
Irish Sea Pilot Project	JNCC project that provides a collated understanding of the marine environment in the Irish Sea.
UK Biodiversity Action Plan (UKBAP)	Provides a range of information on habitats and species, particularly the location of key habitats and species across Wales.
Wales Biodiversity Partnership (WBP)	24 local biodiversity partnerships in Wales collate data of biodiversity for Wales and set actions for future management.

4.3.2.2 Understanding the impacts of climate change

There is a wide range of information available about the potential effects of climate change on nature conservation. This includes academic papers, along with attempts by MCCIP (2008) and Farrar *et al* (2000) to summarise effects and collate key sources of information. The Marlin database is a substantial resource for determining habitat and species sensitivity to environmental change.

The MarClim project is a good example of a multi-partner funded project (undertaken over a four year period) to create and investigate the effects of climatic warming on marine biodiversity. In particular the project aimed to use key intertidal species, whose abundances had been shown to fluctuate with changes in climatic conditions, as indicators of changes occurring in the intertidal and offshore.

Some of the key influences that climate change may have on coastal habitats and species identified by existing literature are listed below.

- Increased inundation of coastal intertidal and terrestrial habitats leading to changes to habitat distribution related to salinity tolerance.
- Impacts on increased inundation on species, including, for example, flooding of bird nesting sites and loss of seal haul out sites.
- Changes to geomorphology leading to loss (via erosion) or creation of intertidal and terrestrial habitats (via deposition of sediments).
- Coastal squeeze of intertidal habitats in areas where fixed structures are located to the rear of the foreshore that prevent landward migration of habitats.
- Stratification of coastal waters due to temperature change leading to impacts on the nutrient cycle and secondary effects on species.
- Increased turbidity of coastal waters resulting from more extreme weather conditions, which could cause disruption to the photosynthesis of marine flora with knock-on ecosystem effects. Increased turbidity combined with higher water temperatures could cause significant impacts on marine flora and fauna
- Warmer temperatures (atmospheric and sea water) could lead to a redistribution of terrestrial and marine species. For example, plankton distribution is seen to changing in the North-East Atlantic (MCCIP, 2008).
- Changes to salinity could lead to direct impacts on individual species and have wider ecosystem effects.
- Acidification could lead to impacts such as the reduction in the ability of calcareous (shelled) organisms to produce their shells or skeletons and effects on the growth rate, reproduction and development of eggs, juveniles and larval stages of some planktonic and benthic organisms.
- Changes to nutrient levels may have direct effects on sensitive species.

- Invasion of non-native species associated with warmer temperature and altered trophodynamic regimes.

One of the main issues associated with assessing climate change impacts on nature conservation is the fact that marine ecosystems are subject to extremely complex interactions and impacts are also influenced by local conditions. This means that there needs to be a detailed understanding of local baseline conditions, climate change trends and distinction of the effects of climate change from other natural or man-made variations. The quality, availability and accessibility of baseline data and understanding of the sensitivity, vulnerability and adaptability of marine habitats and species are crucial to this. The data listed in Table 4.1, does, however, provide a platform for this interrogation.

A number of specific studies have been carried out to determine climate change impacts on habitats and species in Wales. They include Pye and Saye (2005), referred to in Section 4.2.2, and Mieszowska *et al* (2005) who have assessed the influence of climate change on intertidal rocky shore biota. CCW are currently reviewing the potential for habitat creation in the Carmarthen Bay Estuaries related to long term trends in the physical environment. This report is to be complete by April 2008.

4.3.2.3 Evaluation of data and information on nature conservation

Strengths

There is a considerable amount of conservation information available for the Wales coastline. The initiatives in Table 9 have also helped to make data more accessible to users. These data provide a good platform to allow baseline conditions to be determined and to identify the potential impact of climate change. The refocusing of CCW's approach to the management of designated sites should further help to improve access to information and an understanding of the actions that need to be taken in designated sites and why. The need for a range of different actors to deliver improvements through the Wales Biodiversity Partnership (WBP) makes the sharing of, and access to, relevant information vital

The delivery of locally specific research by CCW has proved very effective in determining implications of climate change on habitats and species in the areas studied. This shows that it is possible to utilise baseline data effectively to determine future impacts.

Weaknesses

There is great variation in the time series of information available. This means that in areas where data collation is only relatively recent (e.g. intertidal biotopes and NVC surveys) it is difficult to establish long term trends supported by scientific evidence. In addition, many of the influences on nature conservation are linked to changes to the physical environment. Any uncertainty in the impact of climate change on the physical environment therefore has implications for understanding impacts on nature conservation.

A key issue associated with understanding the impacts of climate change on nature conservation is the ability to make distinctions with natural and man-made impacts. This can require assessments to be made on a local scale, which makes wider more holistic generalisations difficult.

There are significant gaps in the understanding of climate change impacts, particularly related to vulnerability and adaptation of habitats and species. MCCIP (2008) have identified knowledge gaps for assessing the impacts of climate change on plankton, fish, marine mammals, seabirds, intertidal species, seabed ecology and coastal habitats. This includes the need for improved and

synergised sampling, greater understanding of ecosystem linkages and the identification of key indicator/predictor species that can be used for monitoring climate change impacts.

Opportunities

CCW considers that a healthy marine environment is one that provides and will demonstrably continue to provide all the ecosystem services required by society. This includes aesthetic value and biodiversity as less tangible but still important goods that CCW expect from ecosystems. Ecosystems have an intrinsic ability to cope with a certain amount of change or stress and its ability to maintain its structural and functional integrity, when subject to stress, is typically described as its resilience. In practical terms, an ecosystem will continue to function under increasing pressure, whilst resilience deteriorates. At some point resilience will be reduced to such a level that significant, and possibly irreversible, change occurs to the system. The future opportunity to initiate studies that focus on “resilience” of habitats and using this information to assist management that is based on the Ecosystem Approach (e.g. the recent CCW report on “Highly Protected Marine Reserves”), should seek to avoid such change. Under the umbrella of an Ecosystem Approach, future research should be targeted towards better appreciation of those habitats and species believed to be least resilient to climate change, with outcomes being used being effectively used to develop management responses.

Threats

Uncertainty on the understanding of climate change impacts on habitat resilience means that there remains uncertainty on how nature conservation along the Wales coastline has been and will be affected by climate change. This poses a significant threat to regulators to ensure both effective communication of a common message to developers and decision makers in addition to ensuring compliance to statute imposed by WAG or by European Directive. For example, there may be a significant threat of fragmented policy making where there are coastal designation sites protected under EU legislation (Special Areas of Conservation, Special Protection Areas, protected shellfish waters, bathing waters, etc.). Whilst WFD aims for compliance with any relevant standards or objectives for these sites, the SMP should have a broadly similar aim, and the statutory nature of the WFD requirement lends weight to this requirement. It is therefore vital that CCW ensure that protected areas, relevant to the WFD, are properly identified in future SMPs and that SMPs use sufficient information to ensure that policies do not cause deterioration or fail to meet the site-specific objectives under certain climate change scenarios. SMP2 documents for Wales shall be seeking to recognise that the way in which policies on the ground are delivered and how these effect on the achievement of WFD or other aims. The application of an SEA approach to SMP2s should reduce the opportunity for SMP2s to conflict with other aims.

4.3.3 Landscape and the historic environment

4.3.3.1 Reviewed data and information

Table 4.8 sets out the key information that is available about landscape and historic environment in Wales. CCW has led the development of methodology for assessment of seascapes and tools to ensure seascapes are conserved as part of the assessments on offshore wind farms. This guide (Hill *et al* 2001) forms a summary of output from an 18 month research project involving CCW that brought together a range of experience from the public, private, and academic spheres on both sides of the Irish Sea. Reports were prepared dealing with historic and cultural matters, public perception of seascape, and the extent of national seascape units (Hill *et al* 2001).

Table 4.8 Data types for coastal landscape and historic environment in Wales

Data Type	Comments
CCW Landscape assessment and decision making process (LANDMAP)	A web based landscape tool, which provides information on local landscape character and designations.
CADW and Archaeological Trusts heritage data	Data includes Scheduled Ancient Monuments, soon to be developed NewHIS (Heritage Information System), Register of Historic Landscapes.
Countryside Agency	Local Countryside Character Area Landscape Assessments.
Local Authority Landscape Plans	National Parks and AONB Management Plans for designated areas.
Local Council Asset Survey	Local Authority asset surveys normally include a historic record of coastal morphological change.
Ordnance Survey Mapping and Admiralty Charts	Current and historic maps that allow changing coastal and marine morphology to be determined.
Aerial Photographic Surveys	Current and historic photograph that allow changing coastal and marine morphology to be determined. More limited time series than historic mapping.
Multi-Agency Geographic Information for the Countryside (MAGIC) database	Provides landscape information through a searchable map format http://www.magic.gov.uk/ .

4.3.3.2 Understanding the impacts of climate change

The understanding of how climate change will affect seascape, landscape and the historic environment is largely uncertain although studies such as Hill *et al* (2001) Farrar *et al* (2000) have identified a range of potential direct and indirect impacts. These are summarised below.

Climate change could affect the characteristics of the seascape/landscape as well as its appearance. A key impact will be from the effects of increased extreme weather and rising sea levels. Coastal erosion can be accelerated from increased storminess, and areas of land can be reclaimed by the sea should levels rise.

Climate change could result in changes in cultural behaviour, including patterns of settlement and social and economic organisation and land management with indirect effects on landscape and the historic environment.

As with nature conservation, the impact of climate change is also dependent upon local conditions, such as topography, current land management practice, local distinctiveness.

4.3.3.3 Evaluation of data and information on landscape and the historic environment

Strengths

Considerable effort has been made by CCW to assess the impact on seascapes of offshore developments. In addition, LANDMAP, provides a very good web-based platform for determining the key landscape and historic environment interest in Wales although significant gaps persist, which are set out below.

Weaknesses

Although data are available, it seems that there is little exchange and analysis of this data between stakeholders on the coast. It is also difficult to determine how the landscape and historic environment is being incorporated into future land use policies for the coastal zone. One significant gap, for example, is a Wales wide coastal landscape and seascape photographic survey.

There is currently limited understanding and certainty about how seascape/landscape and heritage will be affected by climate change in the future. This is especially true with respect to how cultural and land management practice will change over time. Uncertainties with respect to physical environmental change and identification of areas most vulnerable to change are particularly important in order to predict future impacts. Seascape, for example, may not be significantly altered by the physical change of the coast, yet if the physical change of the coast influences land use policy, and human usage of the shoreline, then the visual appearance of the coast (looking along the coast, windows to the sea or the view from sea to land) may well change.

Although responsibilities for the management of landscape and historic environment are defined there is some overlap between CCW and CADW, which means roles and responsibilities are complex. A strategic case for improving data management should be for the better incorporation of coastal archaeological data in order to meet a number of high level policy objectives, including SMP delivery for Wales. Such a strategic approach would involve collating all the readily available sources to form a consistent and mappable dataset, which could then be enhanced as part of a climate change “scenario setting” exercise of known and predicted risks.

Opportunities

Scenic and historic heritage resources are also important to conserve for the character and local distinctiveness of the coastal zone, particularly in Wales where the coastline is such an important focus for tourism. Wales Tourist Board / Visit Wales studies show more than half of visitors to Wales head for the coast, and that many of them come in search of clean, natural, scenic places. Poor coastal scenery may jeopardise the Wales economy as a holiday destination, as well as the cultural identity and quality of life. It is important, therefore, to recognise that in nature conservation, surveys of natural aspects of the environment do not tell the whole story and that surveys of the human environment must also be included into future integrated research.

There are opportunities for stakeholders to improve the collation, standardisation and dissemination of landscape and historic environment data for the Wales coastline. An enhanced coastal heritage dataset could set out priorities for adapting to climate change on a site by site basis. Information relating to the heritage potential of sections of coast, opportunities for research and policies to enhance the public access and education potential of appropriate sites could feed into and complement other datasets (such as those arising from the Coastal Monitoring Centre). Ensuring cultural and historic information is built into a routine monitoring programme is essential to help maintain and enhance the character of the Welsh coastline in a strategic, rather than ad-hoc fashion.

Threats

The greatest threat posed by climate change to the Welsh landscape and historic environment is a resistance to change by planners, managers, decision-makers and the wider public. Refusing to accept that climate change will alter the landscape, and prepare for those changes by making decisions about how the Welsh coastline should look in the future, risks losing the ability to make strategic choices and being forced to make reactive decisions based on events as and when they happen.

Key to adaptation is to take our understanding of the present situation, and through dialogue and consultation (by looking at good practice elsewhere), come up with future vistas or visualisations for each section of the Wales coastline. These future visions/visualisations may be very different to the present situation, but importantly without this exercise, one is unable to appreciate the possible adaptation options available to address climate change.

4.3.4 Geo-conservation

In Wales, CCW advises the Welsh Assembly Government about the management and conservation of Geological Conservation Review (GCR) sites/SSSI. It also advises landowners and tenants about all aspects of site management (including Potentially Damaging Operations), and informs local planning authorities about development proposals that may adversely affect these nationally important sites.

CCW provides advice on geosites through its Earth Science Officers, who can co-opt more specialist advice from academic and other sources when required. RIGS groups are responsible for advising the Welsh Assembly Government, local planning authorities, landowners, tenants and other relevant bodies about geosites of regional and local value. Although most site management issues are resolved through giving advice at the local level, more rarely CCW will provide advice at a public enquiry where the fate of a site will be decided in the public interest.

The information in the JNCC GCR database contains an inventory of over 3000 GCR sites, selected for around 100 categories (the GCR 'Blocks') encompassing the range of geological and geomorphological features of Britain.

In addition to the statutory conservation of geo-sites, a more consensual approach began to emerge with the development of the non-statutory Regionally Important Geological Sites (RIGS) scheme. RIGS groups are the key partnerships linked to geo-conservation on the coast in Wales. These groups exist to promote the conservation and sustainable use of important sites in Wales.

Table 4.9 provides examples of data available for geo-conservation in Wales.

Table 4.9 Data types for coastal geo-conservation in Wales

Data Type	Comments
Protected sites information	CCW protected sites information, including citations, monitoring, management plans, maps and boundaries http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx .
JNCC Geological Conservation Review Site Database	The JNCC-run GCR database contains an inventory of over 3000 GCR sites, selected for around 100 categories (the GCR 'Blocks') encompassing the range of geological and geomorphological features of Britain. Each 'block' has its own detailed GCR publication e.g. Coastal Geomorphology
CCW Local Geodiversity Action Plans	Plans that set out management action of important geological sites.

The GCR site-selection exercise for coastal geomorphology follows four categories ('GCR Blocks'), one for each of England, Scotland and Wales and one for 'Saltmarsh Geomorphology'; although three of the 'Blocks' are country based, comparisons were made to ensure that certain types of site occurring in each were not over-represented in a Great Britain-wide context.

In some cases, 'representative' sites were selected for the GCR as part of a group of related sites. Such a group of sites may show different aspects of one type of phenomenon, which shows significant regional variations in its characteristics, for example, sites with similar landforms have been selected from areas having different tidal ranges.

Most GCR sites are dominated by one coastal landform, especially in terms of their associated research significance. However, the selected GCR sites include a number that are complex in their assemblage of linked geomorphological forms, and so they have been classified as 'Coastal Assemblages'.

The geomorphology of the coastline is controlled by a complex interaction of factors – the dynamics of the coastal ‘cell’, geological controls (e.g. rock type and structures), the Pleistocene inheritance (isostatic and eustatic effects), sediment ‘budget’, tidal regimes as well as anthropogenic influence. It is the intention within the ‘representativeness’ rationale of the GCR to be able to demonstrate the interplay of these themes and their manifestations from the evidence present in the selected GCR sites. These themes can be thought of as providing a basis for GCR Networks, which link clusters of representative sites (more detail is contained in Appendix 2).

4.3.4.1 Understanding the impacts of climate change

Periodic checking of geosites is required to ascertain if they are in a suitable condition for their intended purpose (e.g. research, education, geo-tourism). If a geosite reaches the relevant standard, it is said to be in 'favourable condition'. CCW and their coordinating body, JNCC, have invested much time and effort in developing protocols and procedures for checking the condition of geological sites (GCR sites/SSSI). With regard to better understanding the impacts of climate change on such sites, monitoring is required to ascertain the condition of geosites. This currently varies from a short visit to determine if the site is still capable of fulfilling its intended use, to lengthy survey work to ascertain if the site's features and sub-features (e.g. individual beds, fossiliferous horizons, mineral assemblages etc.) are in optimal condition. Detailed work may involve the preparation of a site management plan to identify the condition of all parts of the site and outline measures for restoring or improving the site's condition.

The level of monitoring required often varies between a much-used research locality (which often requires in-depth monitoring to establish whether all key stratigraphic and fossiliferous horizons are accessible). On the other hand, a RIGS identified for educational use may well require a simple check to see if it remains safe and accessible for use. An appreciation of how this may change over time, under different climate change scenarios may be a useful exercise to follow.

From the previous section, it is clear that the condition of geological sites can vary (deteriorate or improve) according to a variety of natural processes and human influences. Site monitoring and surveillance can help to establish whether a site is in a suitable condition for its intended purpose. Although recommendations for site restoration can stem even from a brief monitoring visit, it is more usual to produce a detailed site management plan before trying to restore a failing site to 'favourable condition'.

For GCR sites / SSSI, CCW geologists assess the condition of a site, detail the preferred management and outline the nature of necessary remedial and restoration works. Common problems on sites include concealment of geological exposures by processes such as vegetation growth and the accumulation of scree or talus, and man-made problems such as fly-tipping. In such cases, remedial or restoration works might include selective clearance of scrub vegetation and/or removal of talus and tipped materials. Such works on GCR sites / SSSI always involves the expert involvement of a CCW geologist working closely with the site owner or manager. An external contractor may be employed to excavate or re-expose critical strata or features, and to re-establish adequate access to the site for research. CCW has a rolling programme for such site works. These are usually carried out in winter, outside the bird-breeding season, and also when vegetation is least dense. Such works may also be carried out in advance of a major research programme when international Earth Scientists may require full access to sites. It is also common for works of this kind to be carried out by volunteers from the geological community.

A key impact will be from the effects of increased extreme weather and rising sea levels. In particular, coastal erosion and sea level rise could lead to the loss of specific geological features

or stratigraphic assets. Exposure could, however, have beneficial impacts as new geological strata may be exposed for educational investigation.

4.3.4.2 Evaluation of data and information on geo-conservation

Strengths

Considerable effort has been put into gathering information about the geological interest on the Wales coastline, through the JNCC GCR database and the work on RIGS. This is a valuable resource for trying to predict the potential for the management of these sites and to better understand the potential impacts of climate change on such sites. The UK Geodiversity Action Plan (UKGAP) has been set up (2006) to reflect on how to develop a national-level Geodiversity Action Plan, what it may look like and aim to achieve and who would drive it forward. CCW are linked to the UK GAP and should (in partnership with others) help to provide a framework and shared direction for geological conservation that links national, regional and local objectives, targets and actions. A UK GAP is therefore seen as a positive mechanism to encourage partnership, influencing decision and policy makers and funding bodies, as well as promoting common standards.

Weaknesses

Although baseline data is available, there is little understanding of how geology is being affected outside of the protected sites managed by CCW. Some inclination can be drawn from the monitoring of shoreline evolution, but the linkage to geological interest is not usually considered in detail.

Many of the influences on geology are linked directly to changes to the physical environment. Any uncertainty with respect to the impact of climate change on the physical environment therefore has implications for understanding impact on geological interest. In addition, this understanding is further complicated by the difficulty of making a distinction between natural and man-made effects.

Opportunities

Although CCW and the voluntary sector have achieved much, there is a growing realisation that many other stakeholders have a role to play in geo-conservation. Local Geodiversity Action Plans (LGAPs) recognise this by establishing broad local partnerships with common aspirations for geo-conservation and the sustainable use of geodiversity resources. This is logical because, when considered as a resource, the geological landscape affects the lives of everyone through its influence on urban and rural development, land utilization and building practices.

There are therefore many opportunities for key stakeholders to improve the collation, standardisation and dissemination of geological data for the Wales coastline. There is also opportunity for new surveys and research to be undertaken, including for example the identification of sites most vulnerable to change and better predictive analysis of impacts in these areas, in light of coastal evolution assessments.

Threats

Whilst a qualified understanding of climate change impacts on geological interest is perhaps understood, there remains high uncertainty in relation to any quantified impacts that climate change may impose on geo-sites. This again poses a threat to the management of such sites in the future and also the capacity issues that key stakeholders in Wales (possibly linked to UKGAP) may need to consider for more effective future management.

4.4 Coastal access and recreation

4.4.1 Reviewed data and information

CCW are very proactive in providing advice to WAG on coastal access. CCW have good knowledge of statutory network of rights of way and types of access permissible, as well as other access such as open access areas. WAG recently instructed CCW to scope work on extending public access to the coast with recommendations on possible implementation options for the future. This derives from WAG's commitment in 'Wales: A Better Country' to extend access to coastal areas after the initial access to open country is established and by 2008/09. The Wales Coastal Access Improvement Programme, which is CCW co-ordinated and a key objective for CCW, will see £1.5 million of grant-aid distributed to coastal local and National Park authorities to improve access on foot, horse and pedal cycle; including projects benefiting people with restricted mobility. A key aim is the completion of an all-Wales Coastal Path. WAG is also currently considering the need for statutory coastal access provisions in the Marine and Coastal Access Bill, and has taken advice on CCW on this matter prior to a public consultation,

Table 4.10 provides examples of data available on aspects of coastal access in Wales.

Table 4.10 Data types for coastal access and recreation in Wales

Data Type	Comments
Wales Tourism Board	A wide range of information on coastal access and visitor information, including detail on paths, features of interest etc.
Ordnance survey	Explorer maps providing key information on coastal access paths etc
CCW Countryside Interactive Access Map	A web based tool, which provides information on coastal access across Wales.
CCWs 2002/3 Public Rights of Way Condition Survey	This work has been undertaken and is being reviewed by the Access team of CCW

4.4.2 Understanding the impacts of climate change

Most people use coastal access for beach activities, short walks and medium length walks. Most existing benefits derive from easy access within localities and there is great demand for circular walks and opportunities to enjoy beautiful parts of the coast. Although long-distance walkers are a very small minority, they also contribute significantly to the rural economy. CCW (2006) have reported that 72% of the open coastline and 32% of estuaries is accessible. This is made up of secure access (National Trust sites, Public Rights of Way etc), permissive access and access along the shore. About 5% of the coast is physically inaccessible due to development, such as docks, industrial sites and railway lines. About 5% is firing ranges with no, or limited, access. About 18% of the coastal edge has no access, despite being rural, physically accessible and not a firing range. With this in mind, there are particular issues in relation to CCW's role in facilitating, encouraging and advising on access at the coast and these are presented below.

Climate change and the impact this may have on the coast may raise uncertainties over the alignment in parts of the proposed Wales Coastal Path, where to define a suitable zone or "corridor" to enable future access. FutureCoast has provided an indication the likely shoreline evolution of stretches of the Wales coast, though specifics to determine access path widths (to adapt to future climate change impacts) are not well understood in this (access) context.

In terms of coastal recreation, Bowles Green Ltd (2005) identified three coastal activities – boating, climbing and canoeing – as having current high participation rate levels in Wales and hence are likely to have the highest priority management considerations. Coastal walking, cycling and horse riding can be added to this list as secondary main activities. The remainder of activities are pursued by relatively small numbers of participants. With these in mind, there are

some key management issues that may need to be considered regarding future visitor management of the coast and its recreational usage (in light of climate change, better summer temperatures, increased relaxation time and the demand of people for activity sports on the coast).

Spatial issues

- The most scenically attractive coastal areas are most likely to attract carrying capacity issues for specific activities (in particular beach activity, climbing, diving, surfing) as they will attract the highest numbers of visitors. However, these areas zones also have the poorest infrastructure (in particular road network) and the most sensitive habitats (particularly marine habitats).
- Certain coastal areas where the environment is, in the main, more robust should be considered further for a potential increase in the level of coastal recreational activities (e.g. the Millennium Coastal Park and Swansea Bay). This could have the dual benefits of bringing much-needed visitor spending and alleviating pressure on the more sensitive areas

Visitor and designation management issues

- Improved communication on coastal land ownership at sites is needed.
- The chief impacts on nature conservation designations appear to be where large numbers of visitors (mainly those present for beach activities) cause trampling and damage to dune habitat as they access beaches from parking areas;
- Disturbance to birds (cliff nesting birds, Scoter moulting in Carmarthen Bay) and seals from powerboats, cruisers and long range jet skis;
- Danger to seals from anglers casting from cliffs;
- Damage to dune habitat by quad bikes and other vehicles;
- In addition, the impacts of coasteering on nature conservation are not known, but are the subject of a current study by CCW;
- Noise from jet skis and other powered craft disturbing participants in quieter activities (visitor surveys show that peace and quiet is an important factor motivating visits to the area);
- Dog fouling on beaches and uncontrolled dogs;
- Danger to slipway users caused chiefly by congestion and the physical layout of the slipways;
- Danger to swimmers from boat users and jet skis at busy beaches;
- Danger to people from horses on beaches;
- Danger to other beach users from kite buggies and kite surfers.
- Long term loss of beaches and hence a recreational 'resource'.
- Damage to sites caused by recreational collection of species / items e.g. bait digging for angling, collection of shellfish for own consumption, species collection / rockpooling.

4.4.3 Evaluation of data and information on coastal access and recreation

4.4.3.1 Strengths

There is good information on the location of key access paths on the coast in Wales, and coupled with strategic information on shoreline evolution from FutureCoast, this provides a platform for assessing potential impacts of climate change on path routes etc. There is not, however, suitable information available to help determine coastal path “zones” for adaptation to climate change over time. With regard to coastal recreation, the Wales Tourism Board (Wales Watersports) has prepared a guide to Watersports and Sailing Activities in Wales (2008). In addition the Wales Coastal Tourism Strategy (2007) and the South West Wales Coastal Recreation Audit (Bowles Green Ltd 2005) identify a way forward for developing coastal recreational activities and tourism in Wales. Devising “action plans” for the delivery of such work is still to be undertaken, and when this is commissioned, it is highly recommended that an assessment of climate change adaptation is required to complement this work.

CCW has adopted an Integrated Outdoor Recreation Planning (IORP) approach to the provision of recreation opportunities in Wales, which applies the analysis of spatial information on the supply and demand of recreational ‘experiences’ to identify gaps in provision and, hence, opportunities for future development. To complement the existing data that exists, such as that routinely collected by Visit Wales, CCW has commissioned a number of other surveys.

In January 2008, CCW embarked on a year long ‘All Wales Recreation Survey’ of the recreational patterns of Welsh residents (not a survey of the use of the Wales recreational resource). The survey seeks to gather data on volume, frequency, types of activities, locations, distances travelled and demographics.

From the more social perspective, CCW has commissioned work to identify barriers, motivations and preferences in relation to informal outdoor recreation among groups which have been identified as current low participants. The review looks at findings from a range of quantitative and qualitative research both from within the UK and abroad in order to make recommendations for increasing participation among these groups specifically in Wales. It will also identify where there is relatively little evidence and where there is a need for primary research. The review of evidence will be completed in May 2008 and will inform a programme of primary research as well as methods for monitoring current interventions with disadvantaged groups.

4.4.3.2 Weaknesses

Despite the strengths raised above, in terms of delivering robust ICZM policies for Wales and subsequent actions, more work is required to address the localised impact of climate change on coastal access in Wales, as this is currently little understood. It is linked to understanding of impacts on coastal evolution and coastal environment and the response to changes by planners, land managers, visitors and local communities. This means that key linkages need to be made between these themes when determining how climate change will affect access along the coast (in terms of economic development, services required to manage increased visitors and the infrastructure and resources needed to deliver sustainable development. Although there is a good high-level understanding of the location of key access paths on the coast, the position of other assets that allow access or safeguard people (e.g. fences, stiles, frequency of lifeguard stations) are still not clear. There is also limited co-ordination of information that allows for the value of access paths, points and assets for people to be determined. The WAG funded ‘Wales Coastal Access Programme’ should help to address this issue.

Obtaining accurate and comparable data on coastal recreation participation rates either nationally or regionally for Wales is currently difficult to achieve. To compound this, different

organisations record information in different ways, using varying definitions. Previous data cited in other tourism reports is only based on estimates, some of which seem to differ greatly between different research projects (Bowles, King Green 2005) and with discussions with recreational bodies. CCW should seek to address this issue through a partnership approach if possible with relevant organisations (e.g.: Visit Wales).

The draft Coastal Tourism Strategy has as one of its four aims “*to improve the quality of the visitor experience*”, however, there is little information relating to experience or activity preferences in a changing environment. The draft Strategy proposes periodic visitor surveys as a monitoring index to measure progress towards this aim, but the proposed recommendations in the draft Strategy do not task any organisation with undertaking this work. The strategy does encourage the promotion of Integrated Quality Management (IQM) as an approach to managing tourism destinations. The approach includes monitoring the impacts of tourism on the local economy, community and environment to improve provision of services. If uptake of the IQM approach is patchy across Wales and / or the approaches taken to collecting data differ, the information will be of little strategic use across Wales as a whole. CCW is not identified as a partner in promoting the IQM process, although, that is not to say that they could not do so as part of their recreational functions.

4.4.3.3 Opportunities

There is a great deal of opportunity to better understand the impacts of climate change on coastal access and recreation in Wales. This requires new surveys and research to be undertaken, including for example the identification of sites most vulnerable to change and better predictive analysis of impacts in these areas linked to coastal evolution assessments. This could include the development of decision-making tool to understand relative risks in different areas, and make decisions on basis of acceptable levels of risks. This would need to consider the value of existing infrastructure and the long term impact to new access infrastructure.

Information on coastal recreation in Wales is inconsistent and in some cases lacking, with much reliance on anecdotal information which is predominantly subjective. One possible area of research, that would provide useful quantitative data to support a future coastal recreational audit, is a regular survey based on observation throughout the day recording the number of people present undertaking each coastal activity on each hour at all or a sample of the hotspot sites on two days of the year. It would be subject to weather, but it is felt that research of this nature would be valuable in establishing some reliable quantitative data for coastal recreation around Wales and from this, determine appropriate climate change adaptation strategies.

Research into activities undertaken at different sites and the creation of an ‘at risk’ register of sites would need to be supplemented with data on user demand and opinions to climate change mitigation / adaptation solutions in different areas. This would enable decisions on where future recreation and access sites should be to be made against a backdrop of both physical change and likely use of any future facilities. Such information could be forthcoming from the user surveys proposed by the draft Coastal Tourism Strategy, the periodic surveys carried out by Visit Wales and CCW’s own All Wales Recreation Survey. To be of any continuing use, such surveys would need to be designed so that the data from each can complement each other and would need to be carried out on a regular basis to provide information on changing use patterns and preferences.

4.4.3.4 Threats

Without more focused research and appreciation of the potential impacts of climate change on coastal access and the economic and environmental implications of increasing recreational

activity on the Wales coast, there is a real threat that decision makers are not going to be properly informed on how to propose sustainable policies dealing with future access, recreation and tourism along the Wales coast.

There is a need to establish studies that:

- Test climate change impact scenarios and the implications on visitor behaviour at the coast in the short to medium term future (e.g. changing weather patterns etc);
- Understand where “vulnerable” stretches of coast are for coastal path placement (erosion) or recreational activity (impacts of human water use on important marine species) in order to inform development / improvement of access and CCW’s advice on this to local authorities;
- Understand the relative recreational risks in different areas and make decisions on basis of acceptable levels of risks. There is also a need to factor into decision-making tools the value of future infrastructure needs (e.g. gate posts, disabled access to lifeguard stations) and the financial investment required;
- Understand the vulnerability of coastal visitors on beaches/cliff tops. This is especially important for developing approaches for statutory coastal access points, duty of care and occupiers liability issues for visitors and the completion of beach risk assessments for coastal resorts/beaches;
- Identify ‘key predictors’ or “indicators”, so that advice can be given and decisions made on basis of tool / process that uses indicator information to make best decisions.

5 CASE STUDY ASSESSMENT

The report thus far has considered existing national and regional data and has attempted to determine whether this is of relevance to addressing future climate change issues on the Wales coast (both to assist CCW's remit directly or for other partner organisations). Two case studies are now used to illustrate whether this information allows anticipated climate change impacts to be addressed at a local level and to then identify where improvements in information are likely to be needed.

This section summarises a series of ICZM related issues (already identified in Section 2.8) and interrogates what information currently exists to address that particular issue for each case area. It is not the purpose of the case study analysis to present a detailed overview of the particular ICZM issue nor how the issues should be addressed (or by whom). They are more to present a view on how managers, regulators and practitioners on the ground are using available information, and more importantly what they are using to make their decisions and whether this information is actually of use to address and plan for future climate change.

5.1 Case Study Site 1: Pensarn to the Point of Ayr

5.1.1 General site overview and ICZM issue analysis

This site consists of approximately 19km of open coastline running along the North Wales coastline northwards to the Dee Estuary spanning the local council boundaries for Conwy, Denbighshire and Flintshire (see Figure 5.1).

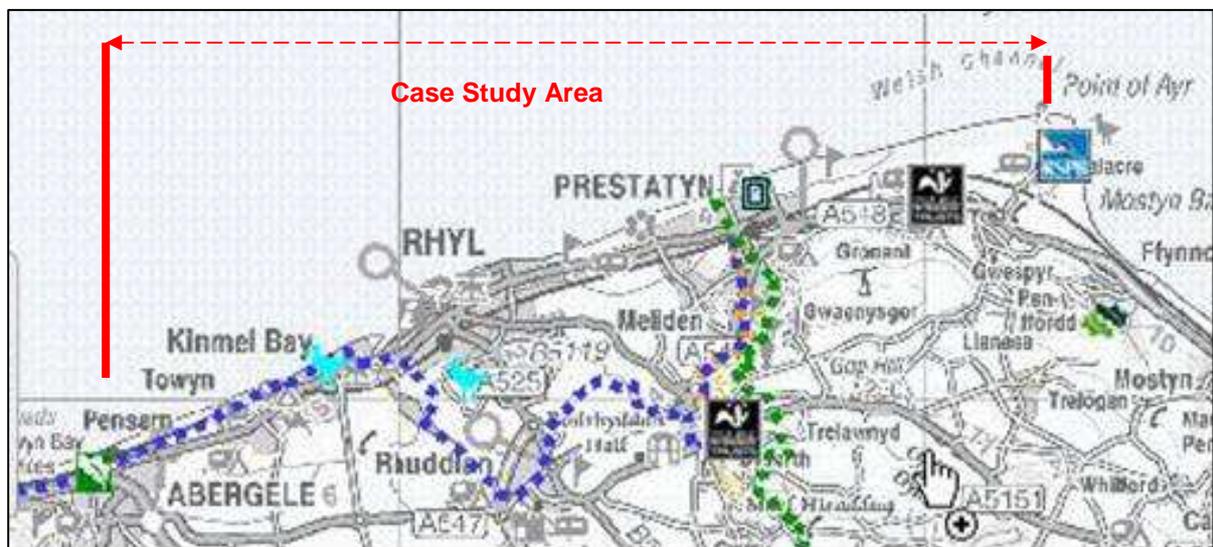


Figure 5.1 Case Study Site 1 - Pensarn to the Point of Ayr

In general, the case study coastline is straight and north-facing. It is almost entirely flat and predominantly sandy with some shingle at the back of beaches. The intertidal area is on average 0.5km wide at low water. The Clwyd estuary situated between Rhyl and Kinmel Bay provides an interruption to these open coast conditions, where intertidal mudflat and marshland is located. Much of the developed coastline is of great value to the tourism economy with parts being subjected to great visitor pressure. Other parts are equally valued for the open character of the landscape and their nature conservation or scientific value. In the past the Denbighshire coastline

has suffered from development pressures which have led to excessive and poor quality forms of development, most notably static caravans. The coastal strip is low lying and parts have suffered from tidal flooding. It is necessary to maintain effective coastal defence measures which work with and not against natural physical processes.

There are a series of ICZM related issues of relevance to this stretch of coast.

Firstly, the hinterland is densely developed and includes the coastal settlements of Towyn, Rhyl and Prestatyn which all include residential and commercial property, caravan parks, rail lines, car parks and road infrastructure and golf courses (Rhyl and Prestatyn).

Secondly, coastal recreation and tourism remains a major function of the area and this is reflected by the type of development located adjacent to the coast. Economic regeneration remains a key future focus for the area, which is addressed clearly within the 'Rhyl Going Forward' initiative, designed to help improve the attractiveness of the coastal area and to diversify economic functioning.

Thirdly, sustainable coastal defence management remains a key issue as the frontage between Pensarn and Prestatyn is largely protected by a series of sea walls, revetment and groynes. Whereas between Prestatyn and the Point of Ayr natural shoreline defences dominate with a 2km long dune belt. Littoral drift is dominated by a west to east movement of sediments, however, between Rhyl and Prestatyn the beach is thought to have lowered significantly since 1900, primarily as a result of human impacts, for example, sand extraction. Localised beach lowering is occurring at the toe of defences with low water mark being seen to be transgressing in front of defended areas along the Rhyl frontage. The case study area falls within the Great Orme to Solway Firth Coastal Cell No.11.

Fourthly, the hinterland is generally low lying and subject to flooding from the sea, with particular flooding problems noted between Pensarn and Towyn.

Fifthly, there is a nature conservation aspect to the area. East of Prestatyn, towards the Dee Estuary, the hinterland becomes more natural and is dominated by sand dunes in an area known as Gronant dunes (which are experiencing gradual recession). Development at Talacre is located to the rear of these dunes. The Gronant dune system comprises the most important natural environmental feature of the case study site, which is reflected through its designation as a Site of Special Scientific Interest (SSSI). The study site is also located adjacent to the designated areas of the Dee Estuary, but these areas have not been considered in this assessment. There are also some relatively small fragmented dune areas in patches along the coastline pinched between development and the foreshore and along the flanks of golf courses.

Finally, development in the offshore zone is dominated by the North Hoyle Offshore Wind Farm, comprising of 30 turbines located approximately 7.5km from Rhyl and Prestatyn. There are also proposals to develop a 300 turbine Gwynt-y-Mor wind farm just offshore of North Hoyle.

5.1.2 Information assessment

5.1.2.1 Coastal evolution

Summary review of the use of baseline data

Information on coastal defences in the area is available from Environment Agency Wales from the National Flood and Coastal Defence Database (NFCDD). This is the best common source of data on flood and coastal defences. Fields for recording data on defence location, type, standard of protection, condition and certain physical characteristics are available.

The monitoring does exist for the area as listed in Table 4.1, Section 4.2.1. This provides background information on changes to sea level and marine and coastal processes. Measurements taken in Liverpool Bay do provide accurate information for the North Wales coastline. In addition, baseline data is collected by local authorities and the Environment Agency Wales with respect to coastal morphology and topography though this information is stored within separate organisations and institutions. Local authorities and the Environment Agency Wales hold a variety of data sources including maps (current and historical), bathymetric charts (current and some historical), air photographs, Lidar data, beach profile data, published papers and reports (including shoreline management plans, outputs from FutureCoast and a 1999 HR Wallingford report on coastal processes across the study area) as well as unpublished reports.

Some of this baseline data has been used to help run models for studies related to the North Hoyle and proposed Gwynt-y-Mor offshore wind farms allowing for potential impacts of development to be determined. Such studies help to increase the understanding of coastal and marine processes at the case study site, though not necessarily help to determine impacts as a consequence of climate change. The conclusions drawn from the reports produced are accessible once these reports are placed into the public domain, e.g. as part of the consenting process. Without the need to produce a formal report, a high percentage of the data collected do not appear to be used by managers or regulators on the coast.

Understanding the impacts of climate change

General overview

Section 4.2.2 provides an assessment of the possible implications of climate change on coastal evolution. The following provides a detailed review of 3 key Data Principles, namely:

1. data understanding of climate change impacts at the study site,
2. roles and responsibilities of different organisations involved in data / information management and,
3. enabling technologies being used to collate, capture and store climate change related information.

Details on two of the Data Principles (Processes and Procedures and Audit) are NOT considered in the following review. This is because, at this level of interrogation, there would be similar findings. These Principles are considered further in Section 6.

Data understanding

Coastal change

In coastal defence matters responsibility is divided between local authorities (e.g. Denbighshire County Council) as coastal protection authority and the Environment Agency Wales. Policies (such as the Denbighshire Coastal Planning Zone) are created to safeguard natural sea defences and to avoid unnecessary or unjustified costs arising from the need to protect new development.

Although baseline information is collected at the study site, which helps to understand how the coast has evolved over the period of data collection, these assessments do not generally draw out the impact of climate change on coastal processes. This information is therefore only useful as a platform for subsequent interpretation. There are also disparate coastal process or modelling studies initiated by different authorities for their own needs, and not designed to be for wider use. Coastal modelling data is only generally available upon request (e.g. from the local

authority) and is collated, stored and presented in various forms; sometimes in hard copy format only.

This baseline monitoring data is key to the development of shoreline management guidance for the study site. The Liverpool Bay SMP sub-cell 11a (Liverpool Bay Coastal Group, 1999) collates baseline data in a way that is easily accessible and understood. The SMP provides information on aspects such as the morphology of the coast, wave climate, tide levels, extreme water level predictions, patterns of erosion and accretion, flood risk, current management practice and non-statutory coastal defence policies. These data are now relatively old, but will be updated within the second generation SMP for Liverpool Bay, which is already underway and encompasses the whole of cell 11 (Great Orme to Solway Forth). Decision-making using SMP first round information alone can therefore neglect recent understanding of shoreline evolution. This is because the SMP also does not consider future impacts of climate change and its usefulness is only in providing a platform for subsequent interpretation.

The EUROSION project provides some information on coastal evolution at the site, but it is considered to be too broad scale to provide a detailed understanding of evolution at the study site. In addition, some data on processes is relatively old and not representative of recent changes.

FutureCoast (2002) is the main source of information on future coastal evolution at study site. The data presented in the Shoreline Behaviour Statement for this area is nevertheless limited with only summary details provided and no quantification of the impacts of climate change. The predictions used to form conclusions are also unclear from the statement and thus of minimal use to decision makers and policy setters in North Wales. In addition, the assessment is fragmented into separate process units and does not seem to give any consideration of cross-cell linkages and impacts associated with changes in one cell on another cell. The project does, however, provide a platform for the understanding of the potential wider response of the coastline in the future with or without artificial defences in place. A particular gap in the FutureCoast assessment is the absence any assessment of future shoreline evolution for the Gronant dune system, although it would be expected that dunes would have increased supply of material from the west. This has been addressed by Pye and Saye (2005) who have stated that very little erosion of the Gronant dune system based on Expert Geomorphological Assessment (EGA).

Detailed modelling possibly provides the greatest understanding of future coastal evolution at the study site. For example, Pye and Saye (2005) have utilised models to determine future changes on the Gronant dune system. Where this information is not available there is very little detailed quantified understanding of coastal evolution as result of climate change.

Increased flood risk

The Environment Agency Wales Flood Risk Maps for this site, which are accessible from their website, also show the boundary of flood risk under different events, including a flood event that has a 0.5% or greater chance of happening each year. However, no information is available in the literature reviewed that provides an indication of the likely increase in flood risk at the site associated with climate change impacts.

There are also likely to be other studies undertaken for individual local authorities and / or the Environment Agency or relevance to the case study area. It is, however, difficult to locate such smaller-scale studies, as they are often undertaken for a single party and not made widely available.

Changes in groundwater hydrology

The only information available for changes in groundwater levels is an assessment of the Gronant dune system undertaken by Pye and Saye (2005). This study has highlighted potential

issues for the dune system based on wider assessments completed by van der Meulen (1990) and Carter (1991). No additional information is available on climate change impacts for the study site.

Knowledge of integrated impacts

Although baseline monitoring is undertaken and the SMP and FutureCoast provide some important information on coastal evolution at the study site, very little information is available on the integrated impact of climate change across the whole study site. Pye and Saye (2005) have applied expert geomorphological assessment to consider the impact of climate change on the Gronant dune system. Other models have been produced to determine the impact of offshore renewables development on the coastline of the study site taking climate change into account, but these are developed with specific aims and do not generally represent wider knowledge on climate change impacts across the study site. In addition, although outputs are available, data can be privately owned and thus not freely available to the wider community.

Roles and responsibilities

Ultimate responsibility for management and monitoring of the coast at the study site lies with WAG. Environment Agency Wales and Local Authorities have operational responsibilities only. Environment Agency Wales has responsibility for defending against flooding from the sea and for flood warnings as well as having a general supervisory responsibility over all matters relating to flood defence. Local Authorities have permissive powers relating to coast protection.

The responsibility for the collection and collation of shoreline evolution data is not within CCW's remit, (although it may do this type of research at protected sites, such as GCR sites) but the outcomes of such work are of direct relevance to the delivery of CCW's remit. CCW (as a partner) works to influence the design of shoreline monitoring exercises and this needs to ensure duplication of effort is avoided and that the "collect once, use many times" approach is administered wherever possible.

CCW's role is primarily in the consideration of climate change effects on the key themes identified within this report and in the provision of advice on decision-making for coastal schemes. CCW are represented as a key partner on Coastal Groups around Wales and therefore provide a view on important shoreline and coastal management issues occurring in the area. For example, CCW have the primary role in the management of the Gronant dune SSSI and therefore as part of this function, have commissioned separate studies to better understand climate change impacts (e.g. work by Pye and Saye (2005)). There are, however, problems associated with applying this approach to a non-natural (defended and developed) coastline.

Enabling technologies

Models provide an important mechanism for understanding climate change impacts at the study site. However, these need to be developed with specific aims and need to take scenarios into account for climate change impacts, development, responses and adaptation. The work by Pye and Saye (2005) provides a good example of how baseline data can be used in a simple model to assess future climate change impacts at the site.

Coastal practitioners and researchers (e.g. from Bangor University) are generally very quick to look at new technology and therefore lack of uptake in the use of new technology is often a minor issue, not currently limiting progress of coastal understanding. What does appear to be the limiting factor is the integration between 'requirements' and 'technology' to ensure the appropriate uptake and use of technology. There is a need to better understand the impacts of climate change on the Gronant dune system and what information new developers may need in order to better communicate the possible influence a development may have on the dune system to regulators. Regulators also need to better communicate the information needs of the

permitting system to developers. Recommendations are, therefore, based on minimizing this gap through improved communication (using new technology) of development plans and to make this explicit (e.g. provide guidelines) on the integration of the technology with ICZM process workflows.

5.1.2.2 Information evaluation

Table 5.1 summarizes the compliance of the key generic issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low category is assigned to each issue based on knowledge attained for the case study area to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

Table 5.1 Case Study Data Management Assessment Matrix for Coastal Evolution

Coastal Evolution	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Climate change may lead to increased risk of coastal flooding in low lying areas and coastal erosion in cliffed areas. Flood and coastal defences may need to be upgraded.	Medium / high	Medium	Low / Medium
Increased risk of coastal flooding from the sea and from land– due to an increase in the duration/intensity of rainfall events (especially in winter months and in low-lying urban areas.	Medium/high	Medium / high	Low / Medium
Loss of important habitat through coastal squeeze.	Low/medium	Medium / high	Low / medium
Potential for saline intrusion into coastal abstraction plants and boreholes.	Low / medium	Low / medium	Low / medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.1.2.3 Coastal environment

Summary review of baseline data

Water quality

Section 4.3.1.1 provides background on wider information availability for water quality in Wales, which also apply to this case study site. Measurements taken in Liverpool Bay, for example, those from the Irish Sea Coastal Observatory, provide regional information that directly relates to the study site. Surface water measurements relating to some water quality parameters are collected using instruments mounted on Norfolkline ferries and from fixed moorings and satellite monitoring in Liverpool Bay, but it is unknown from data reviewed whether there is any additional localised monitoring of nutrients, salinity and sea temperatures in the coastal and marine environment. There are, however, measurements of water quality undertaken by the Environment Agency Wales from rivers flowing into the Irish Sea, which allows river discharge of nutrients into coastal waters to be determined. Of relevance to the case study area are inputs from the River Clwyd.

Baseline marine monitoring suggests that water quality offshore of the case study site is generally good, although there are elevated levels of copper and mercury throughout Liverpool Bay. There does, however, seem to be a gap in localised data recording. However, there are a number of designated Bathing Water beaches located in the study area, including at Prestatyn, Rhyl and Kinnel Bay, which are regularly monitored.

Nature conservation

Information on protected sites for the area is available primarily from CCW. The MAGIC database also provides information on the location of designations at the study site.

CCW collect nature conservation data within the area, consisting of intertidal biotope mapping across the frontage, sand dune habitat and species monitoring in the Gronant Dune SSSI and Phase 1 habitat mapping, particularly for sand dunes. With the exception of monitoring studies at the Gronant Dunes SSSI, the time series of data collection is relatively recent or fragmented. There is limited intertidal habitat data available from JNCC's Mermaid database, but this is instead provided by CCW's intertidal surveys. In addition, marine mammal data is available from the Sea Mammal Research Unit (SMRU) and the SeaWatch Foundation; and coastal bird data is available from the British Trust for Ornithology WeBS database.

Of note to this area, is the large amount of recent nature conservation data collected for the North Hoyle and Gwynt-y-Mor offshore wind farms, where National Wind Power have undertaken a number of comprehensive surveys and monitoring in the marine and coastal environment (including the Clwyd Estuary) as part of their consenting requirements. This data is largely available to the public and statutory bodies. COWRIE also collates some relevant reports. These data are, however, limited to the general area of the proposed developments. The Irish Sea Pilot Project has also made significant progress in collating marine habitat and species data adjacent at the study site. Such data would not, however, be available in other areas that fall outside the Irish Sea Project area.

Nature conservation information for the study site is also available from many of the other sources listed in Table 4.6, including the National Biodiversity Network.

In the inshore subtidal zone of the study site, sedimentary communities consisting of bivalves and polychaetes dominate, particularly shallow *Venus* and inshore *Abra* communities. Polychaete annelids dominate around the study site, with molluscs and crustacea. The inshore zone provides nursery ground for plaice and sole and brown shrimp are also known to be abundant in the nearshore zone. The Rivers Clwyd and Dee provide migratory routes for salmonids. Marine mammals and elasmobranchs are also present but the area is not, however, thought to be particularly important for these species.

With respect to impacts of climate change, the Gronant sand dunes (SSSI) present the last surviving complex of north facing dunes in Wales east of Anglesey. The dunes contain nationally rare northern centuary, Portland spurge, white horehound and dune fescue. Kinnel dunes are also designated as a Local Nature Reserve (LNR) for their floral and faunal interest. The dunes also contain a rich assemblage of invertebrates comprising many nationally scarce species and Red Data book species. The intertidal shore is a mix of sandy beach and shingle shores and the ecology has been surveyed by Garwood and Foster-Smith (1991), CCW, and CMACS (2002).

The beach at Gronant is important for its breeding population of little tern (the only colony in Wales) and post-breeding population of sandwich tern, the latter also gathering at the Clwyd estuary. Cormorants are also present in these areas and a small population of scaup is known to be present at Towyn. The Clwyd estuary also provides habitat for other birds, including sanderling, turnstone, redshank, curlew, lapwing and snipe. The presence of these species has led to the Clwyd Estuary being a non-statutory designated local wildlife site.

With the exception of CCW's comprehensive intertidal survey, the majority of the data relating to nature conservation in the study area have been collected on an ad-hoc and patchy basis. Good data exist for locally, nationally or European designated areas but these are generally limited to the species or habitats for which the area has been designated and for which management measures are designed to target.

Landscape and historic environment

LANDMAP; and data from CADW and the Clwyd-Powys Archaeological Trust, provide information on the landscape and the historic environment. In addition, aerial photographic surveys are available for the study site. The three Local Councils also hold photographic surveys of the coast that relate to their coastal monitoring initiatives. Again, studies for offshore wind farms have provided landscape and visual assessments at the study site, including seascape assessments.

The most important landscape designation is the Clwydian Range Area of Outstanding Natural Beauty (AONB), which straddles the Denbighshire and Flintshire border extending to the urban edge of Prestatyn. The coastline is generally straight and can be separated into developed coast (between Pensarn and Prestatyn) and undeveloped coast (east of Prestatyn). In the developed zone the seafront is dominated by coastal defence features and seafront development (amusement parks, holiday villages, hotels etc). On the undeveloped coast the coastal landscape is more natural with open beach backed by an expanse of sand dunes and rough grassland.

Geo-conservation

The key source of geological information for the area is held within British Geological Survey maps and the JNCC GCR database. The shoreline east of Prestatyn consists of a complex of shingle bars, spits and ridges. There are no designated geological sites located in the study site.

Understanding the impacts of climate change on coastal environment

Water quality

Data understanding

The main issues appear to be related to increasing developmental pressure along the study area coast and the impact this may have on recreational or bathing water quality. Environment Agency Wales record bathing water quality for sites at Kinmel Bay (Sandy Cove) and at Prestatyn. This information is annually recorded and uploaded onto the Environment Agency website (<http://www.environment-agency.gov.uk/commondata/103196/257049?referrer=/yourenv/eff/1190084/water/213925/bathing>) however, the identification of trends in water quality as a result of climate change (e.g. temperature and salinity etc) are not clearly recorded. Data understanding of this matter requires more focused attention, possibly assisted by the strategic introduction of specific ICZM indicators to assist in climate change evaluation.

Roles and responsibilities

CCW have no statutory responsibility for assessing water quality at the site. Environment Agency Wales sample coastal water quality and discharges to sea, but these are not linked to the measurement of key climate change indicators. CCW, however, through their ecological monitoring programmes, could enhance their role on this aspect by improving knowledge exchange on ecological adaptation, which could be correlated to water quality impacts. Ecological monitoring could then provide a proxy for water quality in areas where water quality monitoring does not take place. Changes in ecology could highlight possible changes in water quality and monitoring resources could be redirected or targeted on areas where changes may be

taking place. Most climate change related research is undertaken as part of national monitoring initiatives, which are managed independently of CCW. That said, CCW's role in the delivery of future River Basin Management Plans (RBMPs) for Wales should help improve knowledge and data transfer and enable better linking of water quality monitoring with ecological monitoring.

Enabling technologies

Improved sampling methodologies and coverage in the Irish Sea will improve the understanding of climate change impacts at a regional level. The PRISM project is considering issues of water quality in coastal waters and developing tools that can be used to promote sustainable management and enhance environmental quality for both humans and wildlife. The usefulness of the outputs from this project for CCW is dependent on the focus of the research, which is not influenced directly by CCW. It is, therefore, difficult to influence the PRISM project in ways that may benefit CCW in the future.

Nature conservation

Data understanding

A significant amount of data is available for nature conservation, which provides a baseline for determining the impacts of climate change in the study area. However, the majority of impacts on nature conservation are as a direct result of changes to the physical environment and water quality. Data understanding of these aspects has been discussed in detail above. Limitation in this understanding, therefore, presents difficulties in determining the impact of climate change on nature conservation at the study site. In particular, little is known at the study site about the impacts of increased flooding and changes in water quality. Pye and Saye (2005) have considered the likely impact of climate change on the extent of the Gronant dune system. However, no information is available for other areas of the case study site meaning that impacts are difficult to predict outside of this small area.

In addition, no information is known to be available for the case study site for other climate change impacts, such as warmer temperatures and alteration to the distribution of habitats and species. Little is also known about the impact of invasive or non-native species that may result from climate change impacts.

Baseline information allows for assessments to be made, but is clear that specific research is necessary to understand local impacts. It is therefore stated here that the understanding of actual climate change impacts is very limited at the case study site.

Roles and responsibilities

CCW have the primary role for advising on nature conservation at the study site. In particular, CCW have statutory responsibility for the management, preservation and enhancement of the Gronant dune SSSI. CCW is responsible for the collection and dissemination of data to determine value, quality of key nature conservation interests; and to provide advice and guidance on the integrated management of the coast for preservation and enhancement of these features. The data collected provides a baseline for helping determine the impact of climate change. Effective understanding of impacts is dependent upon the understanding of the changing pressures on nature conservation at the site. As discussed, CCW influence how this data is collected (e.g. as a member of North West and North Wales Coastal Group) and they have taken forward focussed research to help understand how important sites should be managed in the future (e.g. Pye and Saye, 2005). However, baseline data collection for key climate change pressures is often undertaken by other organisations.

Enabling technologies

Many of the initiatives outlined in Table 4.6, have provided a strong platform for easy access to relevant data related to baseline nature conservation at the study site. In particular, the use of

web-based and GIS databases provide a significant amount of data for the study site. As raised previously, the main issue appears to be related to using the information to best effect to communicate findings on this matter to local councils and stakeholders.

Landscape and historic environment

Data understanding

An important climate change pressure on landscape and the historic environment is related to changes in coastal morphology. Limitation in this understanding therefore presents difficulties in determining the impact of climate change on landscape and historic environment at the study site. Pye and Saye (2005) have considered the likely impact of climate change on the morphology and extent of the Gronant dune system. Very little quantified information is available for the remainder of the study site.

In addition, no research has been undertaken at the case study site with respect to changes in cultural behaviour and land management and the indirect effects this would have on landscape and the historic environment.

Roles and responsibilities

CCW have the primary role for advising on the landscape at the study site and in the provision of guidance to ensure that key landscape features are maintained and enhanced. Local authorities are responsible for management. CCW collates and disseminates landscape information to determine value; and quality and in the provision of management guidance. The data collected provides a baseline for helping determine the impact of climate change. However, effective understanding of landscape impacts is again dependent upon the understanding of the changing pressures that may arise along the Rhyl and Prestatyn coastal frontage.

Enabling technologies

LANDMAP, in particular, has provided a strong platform for easy access to relevant data related to landscape and heritage at the study site.

Geo-conservation

Data understanding

The key pressure on geo-conservation on the coast is related to understanding how the coast will evolve. The absence of a designated geoconservation site in the study area means that limited data is available and this limitation in the understanding of geoconservation issues, therefore, presents difficulties in determining the impacts of climate change on geo-conservation.

Roles and responsibilities

There are no important geo-conservation areas in the study site. Therefore responsibility for consideration of geological or geomorphological interest is similar to that expressed for coastal evolution raised earlier.

Enabling technologies

Key technologies relate to those discussed under coastal evolution above. The main issue of improved communication of conservation values and importance to decision makers and local planners is perhaps the most important issue in North Wales.

5.1.2.4 Information evaluation

Table 5.2 summarizes the perceived compliance of the key generic ICZM issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low

category is assigned to each issue (based on knowledge attained for the case study area) to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

Table 5.2 Case Study Data Management Assessment Matrix for Coastal Environment

Coastal Environment	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Risk to coastal species intolerant to drought conditions.	Medium / high	Medium / high	Medium/high
Impact on the biodiversity of coastal habitats and integrity of important saltmarsh/sand dune systems.	Medium	Low / medium	Medium
Increased risk of sediment and pollution run-off into watercourses and estuaries.	High	Medium	Medium / High
There may be higher concentrations of pollutants entering water courses during summer months due to reduced rainfall.	High	High	Medium / high
Risk to species intolerant to waterlogged conditions.	N/A	N/A	N/A
Risk of expansion of naturalised aliens into coastal waters.	Low/medium	Low/medium	Low/medium
Species with a pronounced southern distribution are likely to spread into Welsh coastal waters.	Low	Low/medium	Low/medium
There is likely to be a loss of coastal and estuarine habitats due to increased coastal erosion.	Medium/high	medium	medium
There is likely to be increased visitor pressure on the coastal environment.	Medium/high	Medium	medium
There may be an increased risk of oil pollution events/shipwrecks due to stormier conditions at sea.	Medium	Medium	Low / medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.1.2.5 Coastal access and recreation

Summary review of baseline data

CCW's web based Countryside Access Interactive Map provides information on important paths in the area, whilst Ordnance Survey maps provide key details on how to gain access along the coast.

The North Wales Coastal Path, Sustrans route and Offa's Dyke Path are important coastal recreation routes in the study site. These are all located west of the Gronant dune system. The beaches of the study area also provide a key recreational resource in the area, with water based activities occurring such as bathing, sailing, windsurfing, jet-skiing, diving and angling are becoming increasingly popular in both Rhyl and Prestatyn.

Understanding the impacts of climate change

Data understanding

The seafront (and thus key tourist asset) is an integral part of the coastal planning zone (set by Denbighshire County Council) and is important both for its tourism and recreational role. Much work was undertaken by the former Rhuddlan Borough Council in restructuring the promenade of Rhyl following the broad concept provided by the ‘Promenade Master plan’ prepared by Derek Lovejoy and Partners. Denbighshire CC have re-assessed the long-term role, form and development of the Rhyl and Prestatyn seafront and promenades by creating a new strategy (following public consultation) which places greater emphasis on environmental improvements designed to complement the private sector attractions.

Using Denbighshire CC as a specific example of a planning decision maker (within the case study area), a series of Coastal Policies have been created to address issues within a purposely designed planning zone entitled the “Coast Planning Zone - CPZ”. The relevance to this study is that with substantial areas of low lying land on the Denbighshire coastal strip, an adequate system of coastal defence is essential in order to prevent the risk of flooding and coastal erosion to tourism focused economic assets. CPZ4 (Coastal Defence and Flooding) clearly states that development within the coastal planning zone (CPZ) will only be permitted where it would:

- i) not increase or transfer the risk of flooding or coastal erosion through its impact on natural coastal processes;
- ii) not prejudice the capacity of the coast to form a natural sea defence;
- iii) not increase the need for additional coastal protection works except where necessary to protect existing investment or development.
- iv) new coastal defence works should not have an unacceptable impact on the character, appearance and natural processes of the CPZ.

Whilst the above is creditable, the main information and data used for decision making is from the current SMP which has already been identified (within this report) as being fundamentally flawed in providing accurate climate change information and importantly, advice on social preferences (in relation to visitor needs for coastal access and recreation). There is no statement in current coastal policies (set by local authority planning authorities) that identify the need to adapt to climate change. There may be an assumption that because the SMP underwent public consultation that it accurately reflects stakeholder preferences.

To this end, the impact that climate change is likely to have on local coastal access and recreation issues within the study area is little understood. This is linked to limitations in the understanding of coastal evolution, likely changes to the coastal environment and how visitors actually wish to use the coast for recreational pastimes in the future.

Figure 5.2 shows the potential future pressures that may exist with regard to the management of coastal assets. Completed in 2007 this aerial view of the Drift Park shows the edge of the wheeled play area, the leisure paddling pool and toilets, the open air theatre, the mini golf course, the children's play area and the seaside gardens. Managing access and recreation is not a direct CCW-related issue for the majority of the case study site, although it is important throughout the site due to the possible knock-on effects of management decisions on protected sites such as the Gronant dune SSSI area. Council decision makers and local planners need to consider the wider implications of protecting existing coastal recreation sites in partnership with CCW to better acknowledge how best to plan and adapt existing and future coastal tourism and recreation

developments in the region without impacting on other coastal sites that may also be important to tourism and recreation or nature conservation.

Roles and responsibilities

Denbighshire and Flintshire Councils play a key role in the management of access and recreation on the coast. CCW, however, have an important advisory role on the development of policy for the protection and enhancement to recreation and access. Drift Park (Figure 5.2) in Rhyl is a classic example of a coastal based tourist asset that may be exposed to increased pressures of sea level rise over time.



Figure 5.2 Drift Park, Rhyl

Enabling technologies

CCW's Countryside Access Map provides good baseline data of key access on the coast. GIS mapping also provides baseline information for the area though this clearly needs to be combined with improved knowledge and information on changes to coastal evolution and potential impacts on recreational assets. Currently, this linkage does not exist.

5.1.2.6 Information evaluation

Table 5.3 summarizes the perceived compliance of the key generic ICZM issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low category is assigned to each issue (based on knowledge attained for the case study area) to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

Table 5.3 Case Study Data Management Assessment Matrix for Coastal Access and Recreation

Coastal Environment	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Increased visitor numbers will put an additional demand on coastal recreational infrastructure (e.g. coastal path network).	Medium / high	Low / medium	Low
Increased number of visitors due to warmer weather conditions pose a serious risk to the natural coastal environment and biodiversity e.g. disturbance of breeding grounds, increased erosion of coastal paths, etc.	Medium	Medium	Medium
Increased coastal tourism will increase the demand on service utilities.	High	Medium	Medium / High
Coastal attractions will be vulnerable to sea-level rise and stormier conditions.	High	High	Medium / high
Potential loss of natural assets e.g. beaches, wetlands.	Medium / high	Medium / high	Medium
Threats to historical and coastal landscape/seascape features.	Medium	Low / medium	Low/medium
Increased demand for water at coastal resorts in the summer months.	Medium / high	Medium	Low/medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.2 Case Study Site 2: Dyfi Estuary

5.2.1 General site overview

The Dyfi Estuary is the largest estuary in West Wales, discharging directly to Cardigan Bay. The estuary covers a total area of 1954ha. The river Dyfi meanders predominantly along the northern edge of the estuary (Figure 5.3). The topography of the north and south sides of the estuary vary significantly with land on the northern bank being significantly higher than the southern bank Aberdyfi is situated to the north at the mouth of the estuary. The south of the estuary is dominated by low lying agricultural land.

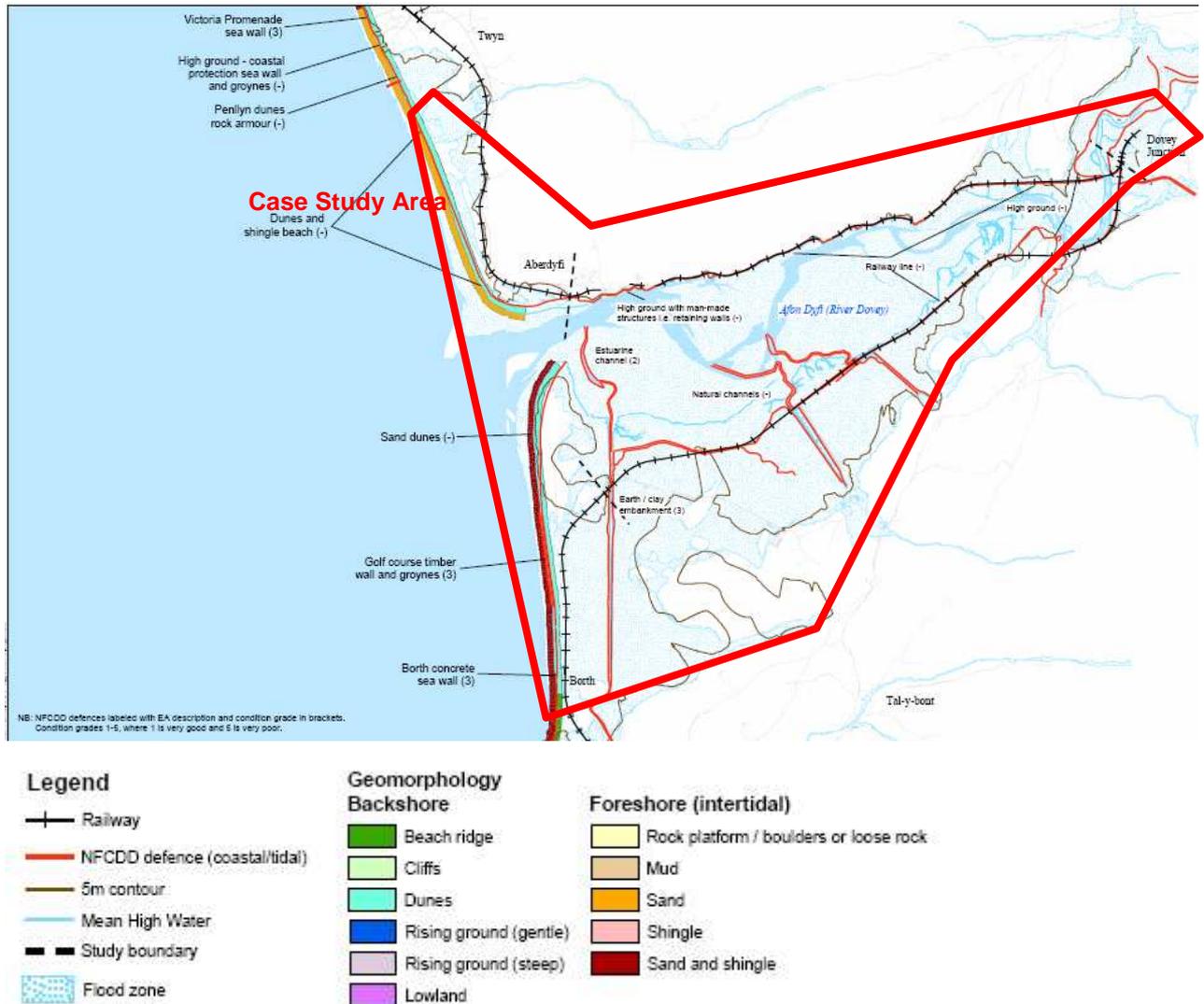


Figure 5.3 Case Study Site 2 - Dyfi Estuary

There are a series of ICZM related issues of relevance to this estuary.

Firstly, the estuary is generally accreting and described historically as a sediment sink. The predominant direction of fine material drift outside the estuary is northwards, up Cardigan Bay towards Porthmadog and the Pen Llyn. Closer to the shore, complex currents complicate sediment movement with sediments carried downstream in the Dyfi moving out to sea, whilst sediments coming from the south move into the estuary. This exchange at the mouth of the estuary has resulted in the formation of the Twyni spit, which plays a strategic role in the geomorphological composition of the estuary. Within the estuary there are extensive expanses of intertidal mudflat and saltmarsh, with sand dunes located at the estuary mouth on both banks. The spit therefore is an important landform feature in the evolution of these various important habitats within the estuary.

Secondly, and directly linked to the above, there are a number of important nature conservation designations in the estuary, including the Pen Llyn a'r Sarnau SAC, Dyfi Estuary SPA, Cors Fochno and Dyfi Ramsar site, Dyfi NNR, Dyfi Biosphere Reserve. In addition, for its landscape significance, the estuary is included within the boundaries of Snowdonia National Park.

Thirdly, there is a mix of land usage features within the study site including caravan parks (e.g. Ynyslas and Penhros) and recreational sites such as the Aberdyfi Golf Club. Aberdyfi as a settlement would encounter enhanced exposure with increased storminess and sea level rise.



Figure 5.4 River Dyfi (taken from Halcrow 2006)

Fourthly, strategically important rail infrastructure and key road transport routes (e.g. the A493) are present, with the rail lines currently located seaward of the 5m contour line and within the current EAW flood zone (see Figure 5.3). This feature includes both the Sutton Bridge Junction to Aberystwyth Line and Dyfi Junction to Pwllheli Lines. On the northern side of the estuary, the rail line has minimal set back area to retreat to (adjacent to cliffs) in the event of significant sea level rise (Figure 5.5).



Figure 5.5 River Dyfi North (west of Dyfi Junction - taken from Halcrow 2006)

Fifthly, as the southern side of the estuary is low lying and at risk from large scale inundation, there is a significant risk of inundation of Borth Bog and failure of the levy, which may result in substantial modification to an irreplaceable habitat (although new habitats could form i.e. grazing marsh may change to mud flat and salt marsh).

Finally, nearshore waters are also popular for water sports including activities such as jet skiing, water skiing, windsurfing, canoeing and dinghy sailing. In addition to this, powered watercrafts are launched into the estuary from Ynyslas. The recreational activities at Ynyslas are controlled by CCW. More passive recreational activities (coastal walks) are also important within the study area.

5.2.2 Information assessment

5.2.2.1 Coastal evolution

Summary review of baseline data

The monitoring of physical environmental data is as listed in Table 4.1, Section 4.2.1. This provides some background information on changes to sea level and marine and coastal processes. In addition, baseline data is collected by local authorities and the Environment Agency Wales with respect to coastal morphology and topography. As with Case Study Site 1, data sources included maps (current and historical), bathymetric charts (current and some historical), air photographs, LiDAR data, beach profile data, published papers and unpublished reports including shoreline management plans.

It is perhaps of most significance that the estuary lies outside of the area covered by FutureCoast, so statistics on lengths of areas, habitats and built assets vulnerable to coastal erosion are not available. Despite this, Halcrow (2006) believe that under an unconstrained coastal scenario, significant lengths of the built assets, including the railway line, may be exposed to erosion over a 100 year time scale.

Information on coastal defences is available from Environment Agency Wales from the National Flood and Coastal Defence Database (NFCDD). This is the best common source of data on flood and coastal defences. Fields for recording data on defence location, type, standard of protection, condition and certain physical characteristics are available.

Of specific relevance to this case study area, Halcrow (2005), have undertaken a detailed modelling assessment of the hydraulic conditions in the estuary and have assessed the potential impact of climate change on Cors Fochno, which covers a large part of the southern part of the estuary. This was a joint CCW and EAW funded contract. Correspondence with local CCW officers (for this project) has identified further key studies and monitoring that is carried out in the estuary, including:

- Automatic Weather Station installed in November 2006, which aims to monitor climate change impacts in the estuary. In addition, a privately run station is located 1km from Cors Fochno, which provides daily readings from 1980 to present.
- Water level monitoring undertaking in Cors Fochno since 1980.
- Ph.D. study in 2005 which has modelled peatland growth and development at Cors Fochno.
- Ph.D. study in 2007 looking at the application of the TELEMAC Modelling System to the Dyfi Estuary. This study is seeking to construct a physical parameters model to better interpret sand transport volumes and sedimentation rates in and around the Dyfi estuary. No outputs of this work are currently available.

- The School of Ocean Sciences (University of Wales, Bangor) in collaboration with CCW are about to commence new modelling work on the physical processes in the Dyfi estuary. A principal aim will be to model system responses to sea level change scenarios. At the time of writing, no further details were made available on the levels of accuracy (i.e. outputs) anticipated for the study though this does initially appear to be an important study for CCW.
- Pye and Saye (2005) undertook research into future climate change scenarios on the Dyfi dunes. This was developed further in 2006 by Pye and Blott who undertook research into contemporary coastal processes operating in the vicinity of the Aberdyfi Golf Club. The report provides an overview of the geomorphology, evolution and environmental context of the Aberdyfi coastal dune system and neighbouring coastal marshland. This considers (crudely) the implications of climate change on sand dune evolution at the area.
- Halcrow (2006) undertook a study (for CCW) to assess the Constraints Imposed on Future Shoreline Management by Rail Assets Adjacent to the Coast. The Dyfi Estuary was used as one of the case study areas for further interrogation. The study used predictions of coastal change to examine the extent to which railways may constrain designated environmental sites over the next 100 years. Estimates of coastal erosion were derived from Defra's FutureCoast project, whilst areas vulnerable to tidal flooding have been identified from Environment Agency Wales data.

Understanding the impacts of climate change

General overview

Section 4.2.2 provides an assessment of the possible implications of climate change on coastal evolution. The following provides a detailed review of 3 key Data Principles, namely:

1. data understanding of climate change impacts at the study site,
2. roles and responsibilities of different organisations involved in data / information management and,
3. enabling technologies being used to collate, capture and store climate change related information.

Data understanding

Changes to coastal geomorphology

Halcrow (2006) outlined their interpretation of coastal evolutionary outcomes in the estuary. River channels along the estuary will naturally alter position over time with fresh water, tidal flows and changing wave conditions, which in turn will affect sedimentation and erosion patterns. The actual nature of change will, however, be highly uncertain.

Future sea level rise will present significant estuary-wide and local impacts. Estuaries may undergo various responses to rising sea levels, including:

- complete sedimentary infilling (e.g. Pontee, 2005);
- *in situ* vertical accretion;
- landward translation (rollover) (e.g. Townend and Pethick, 2002); and
- increase in wave energies and erosion in locations upstream where long fetches exist.

These responses are likely to be governed by a number of controls including geological inheritance, the rate of sea level rise, sediment supply, longshore sediment transport, the

hydrodynamic flushing capacity of the estuary and the degree of wave exposure. Changes in one part of the estuary can also bring about changes either upstream or downstream regions.

As with Case Study Site 1, a great deal of baseline data exists, which provides a good platform for interpreting the impact of climate on coastal evolution. The North Cardigan Bay SMP (Gwynedd County Council, 1998) has collated baseline data in a way that is easily accessible and understood. Nevertheless, the usefulness of the SMP is limited by inclusion of relatively old data and exclusion of any useful consideration of climate change impacts. As with any baseline monitoring initiative, unless continually updated with regularly monitored shoreline data, its real use for decision makers is limited, as the current information can only ever be used as a platform for subsequent interpretation. As with Case Study Site 1, data held with EUROSION is again considered to be too broad scale to provide a detailed understanding of coastal evolution at the study site.

FutureCoast (2002) does not provide strategic information on future coastal evolution at the case study site. A number of modelling studies have been carried out in the estuary to address this issue, which possibly provide the greatest understanding of future coastal evolution at the study site. The following provides a summary of this work.

A joint CCW and Environment Agency Wales contract is looking into the assessment of climate change impacts at Cors Fochno (2005). Theme one of the study has included detailed investigation of the raised mire hydrology and the development of a new state-of-the-art hydrological model, enabling reliable determination of drainage impacts. For the study, climate change data was downscaled to the Dyfi area and used in conjunction with recent LiDAR topographic data to model potential flood scenarios over the next 40yrs. A second phase of work has drawn together all available map-based data sources into a GIS database, as well as carrying out detailed soils analysis across the reclaimed mire margins to enable a reconstruction of pre-disturbance habitat characteristics. The final phase of work, which is now underway, is investigating a range of possible management measures that might be employed to protect the core conservation interest and enable restoration of lost or degraded elements of the of the estuarine mire ecosystem, taking account of the current infrastructure of the area and potential climate-induced change.

Paul Morris (Queen Mary, London University) commenced a doctorate study in 2005 entitled 'Modelling peatlands as complex adaptive systems'. Field data from Cors Fochno is being used to develop computer models of peatland growth and development. This involves in particular, examination of fine scale variations in hydrological conductivity in the acrotelm, plus some work on evaporation and transpiration rates.

Jennifer Brown of UW Bangor, School of Ocean Sciences completed a Ph.D. study in 2007 entitled "Application of the TELEMAC Modelling System to the Dyfi Estuary" The project aims to construct a model of the physical parameters and sand transport and sedimentation in and around the Dyfi estuary. The modelling using the Telemac Modelling System will be used to evaluate the consequences of potential coastal management scenarios, including a proposed harbour (marina) development.

Professor Alan Davies of School of Ocean Sciences, University of Wales Bangor, in collaboration with CCW is about to commence modelling work on the physical processes in the Dyfi estuary. A principal aim will be to model system responses to sea level change scenarios.

Pye and Blott (2006) investigated coastal processes in the vicinity of the Aberdyfi golf links course. The report provides an overview of the geomorphology, evolution and environmental context of the Aberdyfi coastal dune system and neighbouring coastal marshland. It is intended to inform the decision-making process relating to the future management of this coastal area.

Pye and Saye (2005) have also undertaken an assessment of climate change impacts on the sand dune systems of the study site. Their work predicts that dune systems should remain relatively stable.

In addition, Ceredigion County Council is undertaking coastal modelling work to help determine sustainable coastal protection at Borth. This modelling should be available to the wider community once complete.

Increased flood risk

The Environment Agency Wales produce Flood Risk Maps for this site, which are accessible from their website and provide information on existing flood risk. Of note, the modelling work undertaken to determine sea level rise impacts at Cors Fochno provides a very good understanding of the impacts of sea level rise on flooding in this area. The proposed work by University of Bangor and CCW looking at climate change impacts in the estuary should greatly improve this understanding.

Changes in groundwater hydrology

The work carried out for Cors Fochno in 2005 included an assessment of climate change impacts on the hydrology of Cors Fochno.

Knowledge of integrated impacts

The work identified above provides an understanding of integrated impacts of climate change on some of the key environmental features of the estuary utilising modelling techniques. The proposed research, and that which is currently underway, will only help to improve this understanding if the results become accessible to decision makers (possibly through the second generation SMP process).

Roles and responsibilities

Ultimate responsibility for management and monitoring of the coast at the study site lies with the WAG. The Environment Agency Wales and Local Authorities have operational responsibilities.

The responsibility for the collection and collation of shoreline evolution data within the Dyfi estuary is therefore not within CCW's remit. However, CCW do have responsibility for advising on the management of the estuary due to the presence of important designated sites for nature conservation. CCW also has a direct role in the management of the Dyfi NNR. This has led CCW to promote pro-active research measuring climate change parameters and modelling of climate change impacts in the estuary. The focus of this research is related to CCW's core priority to ensure that designated sites are firstly protected and secondly (where possible) enhanced. CCW are represented on the Coastal Group for Cardigan Bay and therefore provide important advice on key shoreline management issues. It should be CCW's responsibility to ensure that the various ongoing research projects are made available to consultants, decision makers and policy setters for the second generation SMP for the Coastal Cell. Of specific relevance to CCW may be the initiation of a local pilot "Coastal Habitat Management Plan – CHaMP) for the estuary. It may possibly be more appropriate to design a precursor assessment of possible biodiversity opportunities (linked to managed realignment potential) in the estuary, in a similar manner to that being pursued within the Carmarthenshire Estuaries at present (Atkins 2008).

Enabling technologies

Models provide an important mechanism for understanding climate change impacts at the study site. Much research has been undertaken that directly considers the impact of climate change on the key features of the study site. Outputs from this works have also included GIS mapping.

Future modelling work is also being proposed to increase the understanding of impacts in the estuary.

Shoreline monitoring techniques, being proposed as part of the future Wales Monitoring Centre, should be making use of the latest technologies required to capture, store and disseminate coastal baseline information. It should be CCWs role to ensure that specific techniques or technologies required for coastal habitat or species analysis are included within the specifications to be designed for that Centre.

The continued use of LiDAR data in order to assess the level differences within the estuary are seen as critical to feed into modelling exercises including a more detailed analysis of tidal flows.

As an overview, Table 5.4 summarizes the compliance of the key generic issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low category is assigned to each issue (based on knowledge attained for the case study area) to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

5.2.2.2 Information evaluation

Table 5.4 Case Study Data Management Assessment Matrix for Coastal Evolution

Coastal Evolution	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Climate change may lead to increased risk of coastal flooding in low lying areas and coastal erosion in cliffed areas. Flood and coastal defences may need to be upgraded.	Medium / high	Medium	Medium
Increased risk of coastal flooding from the sea and from land– due to an increase in the duration/intensity of rainfall events (especially in winter months and in low-lying urban areas.	Low/ medium	Medium / high	Medium / high
Loss of important habitat through coastal squeeze.	Medium / high	Medium	Medium / high
Potential for saline intrusion into coastal abstraction plants and boreholes.	Low / medium	Low / medium	Low / medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.2.2.3 Coastal environment

Summary review of baseline data

Water quality

Section 4.3.1.1 provides background on wider information availability for water quality in Wales, which also apply to the case study site.

It is unknown from data reviewed whether there is any additional localised monitoring of nutrients, salinity and sea temperatures in the coastal and marine environment. There are,

however, some measurements of water quality undertaken by the Environment Agency Wales in the River Dyfi, which allows river discharge of nutrients into coastal waters to be determined.

Bathing water quality at the study site is generally good and as a result of this, the inshore bathing waters have been designated under the EC Bathing Waters Directive.

Nature conservation

Information on protected sites for the area is available primarily from CCW Phase 1 Intertidal Data MapInfo & Esri Shape files. The MAGIC database also provides information on the location of designations at the study site. CCW collect nature conservation data at this consisting of intertidal biotope mapping across the frontage, sand dune habitat and species monitoring and investigations on the status of Cors Fochno. There is limited intertidal habitat data available from JNCC's Mermaid database, but this is covered by CCW intertidal surveys. In addition, marine mammal data is available from Sea Mammal Research Unit and the SeaWatch Foundation; and coastal bird data is available from the British Trust for Ornithology WeBS database with annual wader surveys across the whole Dyfi estuary. Birds are also surveyed by the RSPB at Ynys-hir. Nature conservation information for the study site is also available from many of the other sources listed in Table 8, including the National Biodiversity Network.

The subtidal and intertidal areas of the Dyfi Estuary, together with some adjacent grazing marsh, are designated as the Dyfi SSSI for its biological interest. Important biological features are river channels and creeks, sandbanks, mudflats, salt marsh, invertebrates, breeding and wintering birds. Ynyslas and Cors Fochno are owned by the Countryside Council for Wales (CCW) and managed as the Dyfi NNR. Other parts of the SSSI are owned by RSPB and Montgomery Wildlife Trust. The whole SSSI and additional land on the southern shore are included within the Dyfi Biosphere Reserve. In addition, the estuary is also designated as and SPA for its wintering population of Greenland white-fronted goose, a Ramsar site for Greenland white-fronted goose, wigeon, intertidal habitats and raised mire. The Estuary is also included within Pen Llŷn a'r Sarnau SAC. In addition to this, the Royal Society for the Protection of Birds (RSPB) has a reserve at Ynys-hir.

Offshore, at depths greater than five meters below ordnance datum (OD), generally stable muddy sands characterised by the presence of the sea potato (*Echinocardium cardatum*) and razor shells (*Ensis* species) covers the area between Sarn Wallog to the south (Aberystwyth) and Sarn-y-Bwch to the north (Dysynni Estuary) (Brazier *et al.*, 1999). Within this area, directly in front of the mouth of the estuary, however, the sands are less muddy. This area of cleaner sand is dominated by the bivalve *Spisula elliptica* (Brazier *et al.*, 1999). Between zero meters OD and five meters below OD, a band of fine sand runs from Tywyn in the north to Borth in the south. This band of fine sand supports polychaete worms and amphipods dominated by the sand mason worm and the bivalve *Donax vittatus*. The subtidal channel within the mouth of the estuary and is an environment of mobile sediments. As a result of this unstable environment, it is unlikely to support a diverse or dense community (CMACS, 2001).

The intertidal sands and muds between the north and south shores of the estuary support a range of organisms and hold much of the conservation interest of the Dyfi Estuary as they support invertebrate animals upon which the fish and waterfowl populations associated with the estuary, feed.

Two sand dunes systems are located within the study area at Ynyslas on the southern mouth of the estuary and just west of Aberdyfi on the northern mouth of the estuary. The system at Ynyslas is far more extensive and covers an area of some 68ha exhibiting all stages in sand dune formation from fore dunes through mobile dunes and fixed dunes to the scrub vegetation dominated. In addition to this, the dune slacks support a rich orchid population. The Ynyslas

dunes also support a rich and unusual fungus population with many rare species including five species that are only found at this site across Britain. Furthermore, The Ynyslas dunes and Cors Fochno support important assemblages of mosses and liverworts, including 6 Red Data Book species, two nationally scarce species and an internationally important liverwort *Petallophyllum ralfsii*.

The relatively sheltered southern shore of the estuary within the study area supports a large expanse of saltmarsh fringing the intertidal muds and sands. A characteristic successional process of vegetation development is observed from the pioneer saltmarsh within the intertidal zone to the fixed grassland backing the marsh. The area of saltmarsh covers some 556ha (Huckbody *et al*, 1992) extending eastwards beyond the boundary of the study area and is reported to be one of the largest saltmarshes in Wales. A number of different saltmarsh communities are present including the common saltmarsh grass (*Puccinellia maritima*) community and sea rush (*Juncus maritimus*) community. The saltmarsh supports a number of species of duck and geese, particularly in areas of red fescue (*Festuca rubra*) and *P. maritima*, which are important for feeding and shelter. Saltmarsh creeks and pools are important habitats for juvenile fish.

Cors Fochno is an ombrotrophic raised peat bog, which is dependent on freshwater conditions for its conservation interest. It was originally an integral part of the estuary and dependent on saltwater conditions, but was separated off in an attempt to drain it and is now a freshwater environment.

The Dyfi Estuary is a designated nursery area for bass and an important nursery area for three species of mullet; the thick-lipped mullet, thin-lipped mullet and golden mullet. Other fish species of importance, known to occur in the Dyfi Estuary include the allis and twaite shads, the sea lamprey, the Atlantic salmon and the sea trout.

The wetlands and dunes are also important for populations of the dormouse, otter and polecat and the following reptile species; adder, grass snake, slow worm and common lizard (CMACS 2001).

Landscape and historic environment

LANDMAP and data from CADW and the Gwynedd Archaeological Trust, provide information on the landscape and the historic environment. In addition, aerial photographic surveys and historic maps are available for the study site.

The landscape settings of the two estuary shores are contrasting. The south shore is low-lying, with extensive views across salt marsh and grazing marsh to rising ground 2 km or more inland. The whole northern bank and coast of the study site is included within the Snowdonia National Park and rises steeply from the shore to heights exceeding 200m. The estuary has a classic funnel-shaped form with a meandering main river channel. The southern site of the estuary is outside of the National Park.

Geo-conservation

The key source of geological information for the area is held within British Geological Survey maps. In addition, the Dyfi SSSI is designated for its geological interest and the citation available from CCW describes the key features of interest for this area. Key earth science features are Pleistocene geology relating to depositional history, a submerged forest and peat bed the notable peat bog of Cors Fochno, together with coastal geomorphology, especially the formation of Ynyslas, the sand spit at the mouth of the estuary.

Understanding the impacts of climate change on coastal environment

Water quality

Data understanding

As with Case Study Site 1, trends in water quality and relationships to climate change are most clearly demonstrated by offshore measurements taken in the Irish Sea. No additional local assessments are undertaken to help understand the impacts of climate change for the study site.

Little is known about the impacts of changes in water quality and increased seawater or air temperatures. In addition, little is known about the impact of invasive or non-native species that may result from climate change impacts (e.g. introduction of more southern invasive species etc).

Roles and responsibilities

The roles and responsibilities at this study site are similar to those expressed for Case Study Site 1, although there are some slight differences with Network Rail having a specific role here in relation to the rail infrastructure.

Enabling technologies

The enabling technologies stated under Case Study Site 1 above also apply here.

Nature conservation

Data understanding

A significant amount of baseline data is available for nature conservation within the Dyfi Estuary, which provide a baseline for determining the impacts of climate change in the study area. In addition, there is a significant amount of information on coastal evolution, which can help to present a developing understanding of some impacts of climate change on habitats and species.

Halcrow (2006) indicated that 1,340ha of habitat is possibly subject to coastal squeeze by railways alone. This figure indicates, 518ha of saltmarsh, 362 of sand and 362ha of muddy sandy shore habitats are at most risk within the estuary.

Consequently, whilst baseline data does exist for many habitats and there have been some useful stand alone research projects that look into future predictions of sea level rise, it is concluded that the understanding of climate change impacts on specific habitats remains in its infancy. Additional modelling work, linked to continued baseline data collection on species adaptation observations, will certainly help towards planning for climate change impacts within the estuary.

Roles and responsibilities

CCW have the primary role for providing advice on the management of designated sites in the Dyfi Estuary, particularly the Regulation 33 advice in relation to the management of the SAC. In particular, CCW is responsible for the collection and dissemination of data to determine value, quality of key nature conservation interests; and to provide advice and guidance on the integrated management of the coast for preservation and enhancement of these features. As part of their management responsibility CCW are engaged in research to understand the impacts of climate change on sites of interest, with a current particular focus on coastal the Cardigan Bay Coastal Group. Within a partnership approach, CCW could seek to develop the Dyfi estuary as possible “pilot” site for a CHaMP to better understand the how coastal habitats are to evolve over SMP2 timescales. CCW are, however, developing a model of the estuary with the School of Ocean Science at Bangor University.

Enabling technologies

Many of the initiatives and partnerships outlined in Table 4.2 have provided good, relevant baseline data that is easily accessible. In particular, the applied use of models and web-based and GIS databases provide a significant amount of data for the study site.

Landscape and historic environment

Data understanding

An important climate change pressure on landscape and the historic environment is related to changes in coastal morphological appearance. The modelling work undertaken in the estuary has provided some understanding of impacts and future studies should help to improve this understanding. However, no research has been undertaken at the case study site with respect to changes in cultural behaviour and land management and the indirect effects this would have on landscape and the historic environment. Work associated with proposals to extend the area of the Biosphere Reserve to the whole catchment could be used to provide just such data.

Roles and responsibilities

The roles and responsibilities at this study site are similar to those expressed for Case Study Site 1 although there are additional responsibilities associated with the north shore of the study site forming part of the Snowdonia National Park. As such, the National Park has a role in the planning and management of part of the study site. The application of the Biosphere Reserve designation to the site also has implications for its management if the designation is to be retained.

Enabling technologies

The enabling technologies stated under Case Study Site 1 above also apply here.

Geo-conservation

Data understanding

Detailed modelling work has been undertaken to understand climate change impacts at Cors Fochno, which is the primary interest of the study site.

Roles and responsibilities

The Environment Agency Wales and Local Authorities have operational responsibilities.

CCW is responsible for the consideration of this information, particularly related to shoreline change associated with the Dyfi SSSI. CCW's wider role is similar to that expressed under Case Study Site 1.

Enabling technologies

There are no specific new technologies relating to the storage of GCR/RIGS data at the case study area. The current JNCC database remains the main information portal from a national perspective with local CCW offices being responsible for site description update. This is not a key issue within this area.

5.2.2.4 Information evaluation

Table 5.5 summarizes the perceived compliance of the key generic ICZM issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low category is assigned to each issue (based on knowledge attained for the case study area) to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

Table 5.5 Case Study Data Management Assessment Matrix for Coastal Environment

Coastal Environment	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Risk to coastal species intolerant to drought conditions.	Medium / high	Medium / high	Medium/high
Impact on the biodiversity of coastal habitats and integrity of important saltmarsh/sand dune systems.	Medium	Medium	Medium
Increased risk of sediment and pollution run-off into watercourses and estuaries.	High	Medium	Medium / High
There may be higher concentrations of pollutants entering water courses during summer months due to reduced rainfall.	High	High	Medium / high
Risk to species intolerant to waterlogged conditions.	High	High	Medium / high
Risk of expansion of naturalised aliens into coastal waters.	Low/medium	Low/medium	Low/medium
Species with a pronounced southern distribution are likely to spread into Welsh coastal waters.	Low	Low/medium	Low/medium
There is likely to be a loss of coastal and estuarine habitats due to increased coastal erosion.	Medium/high	medium	medium
There is likely to be increased visitor pressure on the coastal environment.	Medium/high	Medium	medium
There may be an increased risk of oil pollution events/shipwrecks due to stormier conditions at sea.	Low/medium	Low/medium	Low medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.2.2.5 Coastal access and recreation

Summary review of baseline data

CCW's web based Countryside Access Interactive Map provides information on important paths in the area, whilst Ordnance Survey maps provide key details on how to gain access along the coast. Local authorities are responsible for maintaining definitive maps of the rights of way network in their area.

Coastal recreational activity in the study site is centred in Aberdyfi, around the harbour and wharf facilities and the nearby Community Park and playing fields behind the promenade. Other recreational facilities include caravan parks and Aberdyfi Golf Club. Nearshore waters are also

popular for water sports and sailing. These water sports activities include jet skiing, water skiing, windsurfing, canoeing and dinghy sailing. Dyfi Yacht Club organises sailing events for dinghies and yachts. The Outward Bound Centre carries out water based activities for customers attending their courses. In addition to this, powered watercrafts are launched into the estuary from Ynyslas. The recreational activities at Ynyslas are controlled by CCW, where sea level rise will lead to the loss of the car park.

Gwynedd Council issues permission for over 150 moorings annually at Aberdyfi. Vessels, which include keel boats, power boats and dinghies usually, remain permanently moored between April to October.

Understanding the impacts of climate change

Data understanding

The impact of climate change on coastal access in the study area is little understood. The data understanding issues here are similar to those for Case Study Site 1 and nationally, in that there is limited information regarding how public attitudes and behaviours may change in response to climate change.

Roles and responsibilities

The roles and responsibilities at this study site are similar to those expressed for Case Study Site 1, with additional responsibilities for CCW in relation to the management role at the NNR and Snowdonia National Park's responsibilities for the northern shore area of the site.

Enabling technologies

The enabling technologies stated under Case Study Site 1 above also apply here.

5.2.2.6 Information evaluation

As an overview, Table 5.6 summarizes the perceived compliance of the key generic ICZM issues (raised in Section 2.8) against the 3 key Data Principles adopted for this project. A high, medium or low category is assigned to each issue (based on knowledge attained for the case study area) to help determine whether the issue requires high or low data management prioritization for the future (see Section 7).

Table 5.6 Case Study Data Management Assessment Matrix for Coastal Access and Recreation

Coastal Environment	Knowledge attained for the case study area		
	Data Understanding (within case study area)	Roles and Responsibilities (within case study area)	Enabling Technologies (within case study area)
Increased visitor numbers will put an additional demand on coastal recreational infrastructure (e.g. coastal path network).	Medium / high	Low / medium	Low
Increased number of visitors due to warmer weather conditions pose a serious risk to the natural coastal environment and biodiversity e.g. disturbance of breeding grounds, increased erosion of coastal paths, etc.	Medium	Medium	Medium
Increased coastal tourism will increase the demand on service utilities.	High	Medium	Medium / High
Coastal attractions will be vulnerable to sea-level rise and stormier conditions.	High	High	Medium / high
Potential loss of natural assets e.g. beaches, wetlands.	Medium / high	Medium / high	Medium
Potential loss of access to the water e.g. loss of car park at Ynyslas.	High	High	Medium
Threats to historical and coastal landscape/seascape features.	Medium	Low / medium	Low/medium
Increased demand for water at coastal resorts in the summer months.	Medium / high	Medium	Low/medium

High a high level of knowledge was attained for the case study area. Data management is, therefore, a low priority for the future.

Medium a medium level of knowledge was attained for the case study area. Data management is, therefore, a medium priority for the future.

Low a low level of knowledge was attained for the case study area. Data management is, therefore, a high priority for the future.

5.3 Case study conclusions

5.3.1 Data gaps

The examination of national issues and the two case studies highlight some significant data gaps in two key areas.

Geoconservation data

Geoconservation data is lacking at a national level and in both case studies, although data gaps are less pronounced at a national level simply due to the larger scale at which data is being examined.

The lack of designated geoconservation sites within the case study areas means that data is almost completely absent and consequently geoconservation issues are extremely difficult to take into account in relation to climate change and decision-making at a local level.

Landscape, seascape and heritage issues suffer from the same problem. A traditionally site-based focus for the conservation and protection of these resources means that there is a lack of strategic direction for dealing with the challenges posed by climate change at a larger scale. Should an area lack specific designated sites, it will also lack information regarding these issues and it will

be harder for local decision-makers and planners to integrate national policies with local issues to inform choices.

Nature conservation has seen a shift from site and species-specific designation, protection and management to a more holistic approach, focussing more on ecosystems and connectivity. The management of landscapes, seascapes, heritage and geological features should seek to learn how a more strategic approach might be beneficial, enabling decision-makers to take account of large scale issues such as climate change in the management of individual sites and to prioritise protection at local and national scales.

Coastal access and recreation

Both case studies lack information regarding local user and tourist attitudes to changes that may take place in relation to climate change and to the options available in adapting to / mitigating for such changes. Neither baseline information nor trend data exist, other than general qualitative data regarding tourist numbers. This lack of data at a local level in both case studies is mirrored by a lack of similar data at a national level. It is clear that if local authorities and national decision-makers wish to reflect the changing needs of residents and visiting tourists in response to climate change, information regarding those needs is vital.

It is possible that marine planning and the development of marine plans will improve this situation by enabling stakeholders to have a say in the strategic direction of marine and coastal resource use (including coastal access) and by better integrating land use planning with marine planning, but this is unlikely to specifically capture the needs of visiting tourists without additional information collected through, for example, visitor surveys.

5.3.2 Key issues

Data understanding, roles and responsibilities and enabling technologies are very similar in both case studies, and are likely to be very similar at this local level across the whole of Wales. The ability for operators to deliver their roles and responsibilities are, however, dependent on the extent to which the following key issues impact upon them.

Communication

Communication is a key issue at both local and national level. There needs to be better communication between different groups at both levels but also between the national and local levels. There are a plethora of stakeholder groups designed to aid communication between different stakeholders (as stated in Table 4.2 but also including groups such as Local Geodiversity Action Plan Groups, Local Biodiversity Partnerships, Coastal Groups, SAC Management Scheme groups), but they are often focussed around a specific issue or area.

SMPs are a good example of working beyond administrative boundaries, where local knowledge feeds up to regional and national priorities, but there seems to be little utilisation of Coastal Groups by Local Authorities to inform local decisions, other than through use of the SMP itself. The revised organisation of Coastal Groups for Wales (expected to be operational by October 2008) could form an important conduit for translating national and regional priorities down to a more local level.

A further issue concerns the way in which information is communicated. The translation of technical and scientific data and information so that it can be understood and used by decision-makers and stakeholders is highlighted in both case studies and at the national level. CCW has a

vital role to play here, as a statutory advisor and consultee to Government and decision makers and in communicating to the general public.

Patchiness

It is clear that there is a lot of data relating to the coastal and marine environment but that the coverage of that data is very patchy in both time and space. The Review of Coastal Monitoring in Wales highlighted this issue and the need for WAG to take national responsibility for key data (Level A and B data).

Patchiness is not just a national issue and the availability of detailed data at a more local level is very much determined by local conditions. In Case Study 1, there is good quality data relating to bird numbers in the areas where wind farm developments are proposed, but less data outside this area. In Case Study 2, there is excellent nature conservation data relating to the species or habitats covered by the SSSI designations in the site, but not a comparable level of detail outside of the designated areas.

It is highly likely that the level of detail required to make decisions does not need to be equal across the whole area, but the patchy distribution of data needs to be acknowledged and taken into account when decisions are being made. Furthermore, the reasons for the patchiness of the data need to be understood by the decision-makers and communicated to wider stakeholders. This is clearly linked to the way in which information is communicated (see above).

Scale

The scale at which data is collected and also the scale at which advice is given is not always appropriate. At a national level, data and scientific advice is not always on an all-Wales basis (e.g. MCCIP), leading to perceived anomalies in climate change prediction advice (e.g. the Wales side of the Dee Estuary sea level rise being lower than the English side of the estuary).

At a local level, the scale of information is not always aligned to Local Authority boundaries, making it harder for local decision-makers to set policies for the whole authority.

Whilst it is appreciated that natural processes and climate change does not respect man-made borders, the translation of data and advice to an appropriate scale for decision makers, whether nationally or locally needs to be improved. This can help to be addressed by ensuring data is comparable across Local Authorities and can be aggregated and disaggregated appropriately. It can also be improved by ensuring that advice is communicated at a scale appropriate to the issue being considered, whilst ensuring that decision makers are aware of larger scale issues.

Integration

This issue is raised time and again in both case studies and in the evaluation of data available at a national level. The principle of 'collect once, use many times' is well known but little put into practice.

Integrating existing data use across the traditional user groups (e.g. water quality monitoring, flood defence, nature conservation, economic development) will help to improve issues such as patchiness and fill data gaps. CCW has a clear role to play in improving integration of information as it has a role in nature conservation, recreation and education, but other key organisations need to be included within this improved integrated approach such as Environment Agency Wales, Local Authorities and WAG (e.g. Visit Wales).

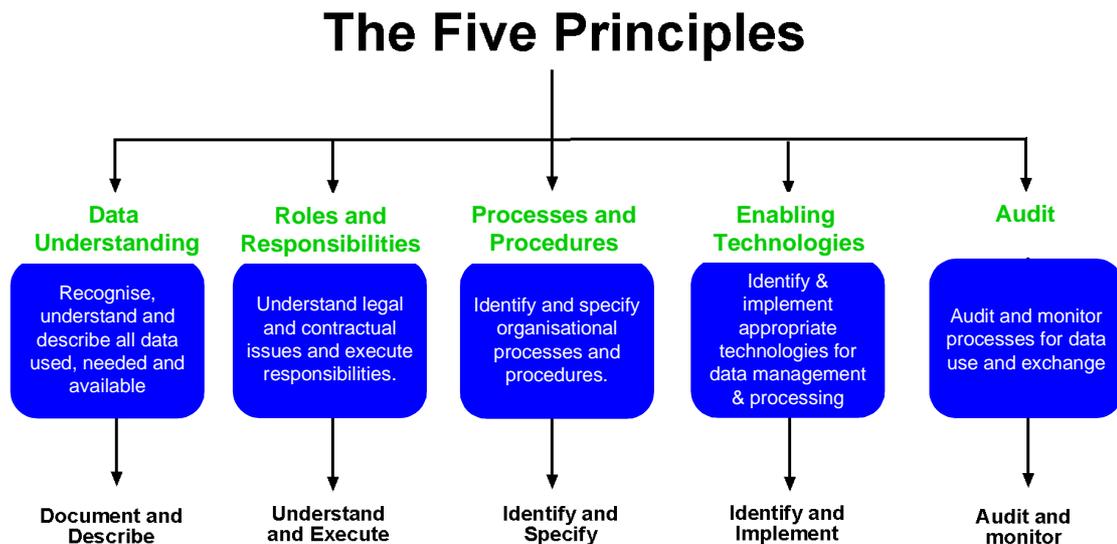
6 CONSULTATION RESULTS AND OUTCOMES

6.1 Introduction

A number of high-level questions were presented to both local and national stakeholders in Wales to assess information associated with climate change on the coast. The consultees contacted are presented in Section 3.3. A total of 20 responses were received, split between 13 national and 7 local consultees. This represents a total response rate of 38%. The questionnaire used is included in Appendix A for reference.

The following provides an overview of the findings of this exercise. The responses expressed by consultees have been grouped under the 5 generic “Data Principle” headings, of which 3 have been interrogated in detail within Section 5 (Case Studies) and used to help categorise priority actions for the future (within Section 7). As stated in Section 5, details on two of the Data Principles (Processes and Procedures and Audit) were not considered at the Case Study level, though are considered for strategic importance here. Figure 6.1 outlines the title of the five Data Principles.

Figure 6.1 The five data principles



6.2 Data understanding

6.2.1 Improving the knowledge base for improved policy guidance

More could be made of mitigation, avoidance and adaptation in both BAPs and CHaMPs, particularly the latter, and greater reference to connectivity is needed. A focus on the delivery of pilot CHaMPS (or something similar) around Wales is recommended (in addition to that underway currently for the Severn Estuary), although the costs associated with this will need to be assessed. This should consider uncertainties over the nature and scale of changes and the ways in which direct and indirect impacts may take effect. As a consequence, plans and policies are sometimes phrased in broad, generic terms to give greater flexibility. Improved knowledge

management approaches can reduce conflict between the short time horizons of decision-makers and the longer term horizons of climate change science.

There is a need for research institutes, regulators and decision makers to consider how climate change will affect the coastline of the 21st Century and beyond, so that communities can start making decisions now. There needs to be improved data on financial and economic implications on climate change on the coast. A wider dissemination and acceptance of the Stern Review with a ‘Welsh’ focus is recommended.

In addition, information on the distribution and likely future range of non-native species (invading species and introduced exotics) is currently poor and needs to be improved upon.

6.2.2 Development of an integrated “Asset at Risk” register

Consultees see the need for a climate change “Asset at Risk” register to help determine priority actions for the implementation of climate change adaptation policies in Wales. The main focus should be linked to improved understanding of coastal evolutionary trends and shoreline management policy setting. Specific areas of focus (as a pilot) could include historic assets, landscape / seascape features or specific habitats.

Better predictions of where significant coastal change is likely to take place, to allow for short, medium and long term planning of future land use, habitat replacement sites and subsequent management and cultural heritage sites are important to help determine “at risk” sites under threat. New information on improved understanding of the needs of certain marine species / habitats that are perceived to be at risk, and their required ‘climate adaptation space’, may also be useful. In addition, improved knowledge on the interactions with other species as a consequence of habitat displacement is required. Closer links with the Wales Biodiversity Partnership may be required to properly address this aspect along with improved links to information on changing economic land use and subsequent land ownership.

6.2.3 Initiating climate change scenario research projects

Consultees strongly believe it would be beneficial to focus on setting “scenario” based research to demonstrate specific implications and adaptation approaches for the future with the following suggested research based questions:

- With regard to stated climate change emission scenarios, which geographic areas of the Wales coastline are going to be most vulnerable to change?
- With regard to stated climate change emission scenarios, what options does Wales have to address the changes that will affect the most vulnerable coastlines?
- With regard to stated climate change emission scenarios, how much designated habitat is being lost to sea level rise/increased erosion?
- With regard to stated climate change emission scenarios, where are the most appropriate geographic locations for coastal habitat compensation?
- With regard to stated climate change emission scenarios, what implications will this have on coastal designation boundaries and recommendations for their alteration?
- With regard to stated climate change emission scenarios, which coastal defences would become un-economic or likely to need substantial upgrading / rebuilding (possibly addressed by SMP2)?

- With regard to stated climate change emission scenarios, how should coastal recreation, access and tourism development adapt to the likely natural and economic changes that may occur?

Developing the work of FutureCoast, particularly into estuaries, should be considered further for situations such as the Dyfi Estuary (possibly as a pilot area). This could be redesigned to elaborate on existing FutureCoast predictions that are currently based upon an assumption of an ‘unconstrained’ coast. This is a purely hypothetical scenario, which assumes an instantaneous total removal and discontinuation of present anthropogenic intervention throughout the shoreline of Wales. This scenario is not the same as the ‘do nothing’ or ‘no active intervention’ coastal defence policy option, which assumes that there will be a time period over which defences will gradually deteriorate. This is seen as being unrealistic in that defences are never likely to be wholly removed. Whilst the existing FutureCoast scenario provides an upper estimate of potential change, which is acceptable for potential hazard mapping at a coarse level, it is proving of limited use at a more local level. This obvious gap in knowledge should be addressed further.

6.2.4 Improved baseline data on beach response and sea level rise

Consultees see the need for regular and consistent shoreline monitoring for all coastal sub-cells in Wales. The onset of SMP2 and the future start up of the Wales Coastal Monitoring Centre (to be hosted by Gwynedd Council) will seek to formalise this process and recommend standardised processes and procedures for data capture to improve information dissemination on changing beach levels (and their rates of change) and hence reasons for beach steepening and flattening.

The need for more accurate predictions on future sea level rise, particularly for areas thought to be at risk of coastal flooding from sea level rise within estuaries (e.g. Dyfi, Severn and Dee) is prioritised along with the need for better understanding of climate change impacts on wave heights and storm surge events. The work by HR Wallingford (2002) within R&D Technical Report W5B-029/TR should be reviewed and updated with specific reference to Wales if at all possible. As a minimum, there should be improved communication of the findings of these studies from academia to decision makers (possibly through partnership mechanisms or research “portals”).

Improved information is needed on the impact of climate change coastal process parameters such as mean sea level, wave climates; extreme wave heights, littoral drift patterns, beach profiles, overtopping rates and breach probabilities. These will have implications for coastal recreation and access facilities within the wider theme of shoreline evolution.

6.2.5 Improved baseline data on social /heritage response to climate change

Coastal economic studies of the Wales coastal zone (in terms of the human environment) are needed to establish who values what, where and why. Consultees consider it important for CCW to recognise that surveys of natural aspects of the environment do not necessarily cover the social importance of such sites and consequently, surveys of the human environment must be improved and increased in frequency where possible. CCW are actually more active in this area than implied by the stakeholders, but perhaps the finding here again is communicating what research is actually being undertaken and by whom.

Very little is known about the archaeological potential of landscapes offshore. Improved knowledge of the palaeo-environment may assist with understanding coastal change as it is presently being experienced. The developing Heritage Protection Bill will enable such sites to be protected by legislation, which is currently not possible.

6.3 Roles and responsibilities

6.3.1 *Improving clarity on organisational roles*

With reference to climate change understanding, many professionals and decision makers are in need of better direction on their roles and responsibilities in relation to data management (independently or within a partnership). The main weakness is that no one organisation or partnership knows whether to take responsibility for taking decisions on attaining new valuable information on climate change impacts on the coast. There is little formal communication between bodies on this subject.

6.3.2 *Improve the role of partnerships*

Partnerships could be better used to establish what information is needed, who is currently collating it, and what gaps there are to establish research needs. National partnerships (such as WCMP) could be used to provide a clear audit of available Welsh information on the coast, although it is debatable if this is currently within the remit of WCMP and would be something that the Partnership would not be able to undertake with its current level of resources. A possible alternative would be for WAG to fund and undertake such an exercise, utilising WCMP and other national partnerships (e.g. WBP) as a conduit for the audit. From this, a partnership approach is better positioned to help formulate the content and extent of new information needed to avoid duplicate data collection exercises. An example of this is to combine marine geophysics and hydrographic surveys, which gather data at sufficient enough resolution to address both habitat mapping and underwater archaeological purposes. The “collect once, use many times” philosophy should be better adhered to in the future.

Coastal partnerships are well placed to facilitate greater interaction between practitioners, the public and the research community and to provide a platform for the dissemination of relevant scientific research. An example of good practice that was raised is the evolving Severn Estuary Climate Change Research Advisory Group (SECCRAG). SECCRAG brings together and opens up communication between the various parties, including scientists, policy makers, industry stakeholders and public interest groups. It aims to provide a forum to share data information promote collaboration, facilitate funding opportunities and develop a unified research agenda that will provide answers to management-relevant questions.

Many relevant partnerships are already in existence (e.g. marine SAC groups) and these should be built upon to ensure better co-ordination of research and knowledge management. The Coastal Groups of Cardigan and Carmarthen Bays already appear to be good models of working partnerships, though these are only really active during the development of SMPs. Coastal Groups are also best positioned to help gain consensus, through extensive consultation, on preparing visions for lengths of coast for the future. As visions are inevitably subjective, the role of the partnerships is key in acting as a conduit to all stakeholders.

Key roles that partnerships should consider taking forward are:

- Education – to ensure that all partners are fully aware of and take full account of the long-term consequences of sea level rise and climate change;
- Consensus building in relation to sustainable management of the coastline;
- Bringing together the level of resources necessary to address issues in a comprehensive manner;
- Encouraging buy in by all stakeholders and the acceptance of the inevitability of change and the need for meaningful long-term strategic goals.

Tasks to improve the role of partnerships in data management include:

- Identifying existing and successful coastal initiatives and through them using their existing stakeholder lists to reach out to appropriate people;
- Consultation with partnership members that have practical historic knowledge and information that could be used to identify natural changes that have historically occurred;
- Identifying where they perceive knowledge gaps to be. Members of partnerships offer specific skills and knowledge that could be utilised to undertake specific projects.

Again, the level of resource available for Partnerships to achieve these aims needs addressing. Should these roles and tasks be considered national priorities, it might be appropriate for national funding to be forthcoming to achieve these ends.

6.3.3 Better climate change impact and adaptation “message” communication

Climate change science will only be used effectively in ICZM if it is communicated clearly and effectively. Raising public and business awareness with predictive, but importantly, evidenced based examples of effects of climate change, is important to help increase wider acceptance of the reality and likely impacts of climate change. There is still a widespread reluctance to accept, or acknowledge the reality and potential seriousness (and urgency) of climate change.

There is, therefore, a need to develop existing links with relevant academics and their institutions, to promote and better disseminate and target research. One possibility would be the development of a Welsh forum of academic and coastal management practitioners to improve co-ordination and dissemination of research outputs. An obvious benefit would be the need for the public (and other stakeholders) to be informed of adaptation options in many different communicative ways. For example using computer graphics is an obvious tool that should be used more widely to present key messages (see Section 6.5). WCMP now has representatives from Welsh academic institutions on the Partnership, thus improving the level of academic input to the Partnership and links between academics and other coastal managers.

6.4 Processes and procedures

6.4.1 Need for plan for longer timescales

Consultees believe that information available from bodies such as the Environment Agency Wales and proposals for action by Welsh Water are very short term in their horizon scanning. Planning authorities are required to plan for a couple of decades ahead in development plan timescales, though built coastal assets are in place for a much longer period of time (circa 75 years on average). Consequently, more long-term forecasting to plan against building in “risk areas” (see Section 6.2.2) is required, which should be incorporated as part of the pending production of SMP2s for Wales.

6.4.2 Better research co-ordination at all levels

As research is undertaken by a number of institutions and commissioned by a variety of organisations, agencies and public bodies, it is not as well co-ordinated or disseminated as it perhaps should be. This has led to a fragmented and *ad hoc* approach to data collection in the coastal zone, which has hampered the development of adaptive approaches to climate change.

Certain WAG policies, such as those highlighted in the Wales Coastal Tourism Report (2007) require CCW to make some movement towards, and where possible work in liaison with,

developments and communities to arrive at mutually acceptable and sometimes mutually beneficial outcomes. This requires a plan for community involvement in decision-making.

The level of understanding and knowledge of coastal processes and their impacts / potential impacts and mitigation of accelerated change is variable amongst none experts/decision makers. More training is therefore needed on these aspects.

6.4.3 Create a central “data hub” for Wales

Datasets specific to the Welsh coast (impacts highlighted within the MCCIP annual report card) need to be brought together in one place and assessed so that any existing information gaps can be highlighted and targeted. Consultees confirm that a large amount of data exists, though it is not clear who owns the data and who has responsibility for its continued update. An example of this relates to the future Wales Coastal Monitoring Centre. Currently, Local Authorities are carrying out shoreline monitoring, yet there is no clarity (at present) on whether an authority will be charged with producing an overview of the annual datasets. Gwynedd CC, as proposed leaders of this initiative, would appear best placed to deliver this exercise, though no decision on resourcing this requirement appears to have been set (*pers comm* Gwynedd CC 2008).

New data required should be defined by the historic data already available in order to establish indicators of change and to identify valid change parameters that are usable by more than one stakeholder in Wales. Information collected today will have little value in the future unless common indicators are set to enable comparisons to take place with historic data. Without this framework approach, question will be raised over the validity of identifying climate change impacts.

Considerable amounts of data are collected by independently, by professional, commercial and amateur organisations, though this is often not properly catalogued or generally available. Processes to identify the relevance of this data could usefully provide historical information to compare against current and future records. Clarifying responsibility on audit procedures, data ownership and update is inherently linked to this. Commercial organisations may regard some data as of financial value, but this should not be an obstacle to recording its existence.

The role of the data initiatives under the UK Marine Monitoring and Assessment Strategy (UKMMAS) should go some way to improving the collection, storage, access and compatibility of UK marine and coastal data within various themed Data Archive Centres (DACs). At present three DACs exist for water column oceanography (held at the British Oceanographic Data Centre), hydrography and navigational data (held at the UK Hydrography Office) and for benthic marine life (held by the Marine Biological Association). It is important that any Welsh initiatives to co-ordinate relevant data do not duplicate this existing work. It may be possible for any Welsh “data hub” to become a DAC for the UK as a whole.

It is not clear how or if DACs will accommodate information from individual studies and this may be one area of work that could add value to the UKMMAS process in Wales by, for example, providing a database that coastal practitioners could upload and access information about individual projects to and from. Similar initiatives do, however, already exist in the form of CoastWeb (www.coastweb.info) and Encora. Rather than establish a Wales-only resource, it may be more useful to encourage Welsh coastal managers to become involved with these existing projects.

6.4.4 Improvements to data analysis and format

Although it is agreed there is a vast amount of information available on the Welsh coastal environment, it is often unclear how to best utilise this information in a format that is appropriate for policy advisors and decision makers to work with. Weaknesses are, therefore, very evident in data format requirements and how this needs to be shared. A good example of this occurs in cross border situations (e.g the Dee Estuary) when associated with the citation of new conservation designation sites. Where a designation crosses a border, CCW and Natural England need to produce two separate maps (for WAG and for Defra respectively) which are produced at two different scales. Consequently, the consistency of data presentation and the management of the outcomes (especially in terms of format and standardisation) are often patchy and incomplete. In cross border situations, this often results in duplication of effort and increased financial cost in terms of information collation. Improved clarity and detail is, therefore, needed on dissemination and access to information for decision makers.

6.5 Enabling technologies

6.5.1 Use of improved technology for visualisation purposes

Clear maps (using advanced computer graphics) of the projected effects of flooding and sediment movement should be available for each ‘coastal cell’ around Wales. More detailed and improved coastal geomorphology / coastal processes “visualisation” mapping, showing spatial areas at risk (updating where possible the work of FutureCoast) is a good exercise to complete as part of SMP2. This exercise could, for example, be piloted for a specific area with a focus on future coastal recreational activity.

Recommendations for CCW also focus on seeking to improve the wider use of LiDAR and SAR data in new research contracts to help in the development of longer term coastal adaptation strategies.

6.6 Audit

6.6.1 Supporting with securing external funds for research

Partnerships, both local and nationally, need a sponsoring organisation to be effective and produce good quality advice and basic data to identify research needs. They are best positioned to attempt to seek funding from national / international sources (INTERREG etc) to help prioritise and implement the research required for the Wales coast.

The obvious partnerships that could assist in this exercise include:

- Wales Coastal and Maritime Partnership;
- CCW / EAW Flood Risk Management liaison group; and
- SMP2 Coastal Groups.

The EU funding application process is, however, notoriously complex and administratively burdensome. Support, advice and guidance from a national level could improve the chances of partnerships in securing such funding and ensuring appropriate exit strategies are in place for when funding streams come to an end.

6.6.2 Auditing post event situations

There is a regular need to audit the outputs of the post-event situations on the coast (storm situations) and 'learn from them'. Talk and action for climate change remains difficult without decision makers really understanding what the outcome of a coastal storm event actually is on a length of coast. Therefore, there is a need for both improved forecast information and the need for improved information communication on coastal flood warnings.

The Environment Agency Wales current data warehouse concept of a National Flood and Coastal Defence Database (NFCDD) offers the facility to hold post event data and make it widely available to all users. It could, therefore, become the primary repository for coastal management related post event data. NFCDD is not, however, operational in Wales and CCW and the Environment Agency Wales need to work together on its development and consider what data should be included within the NFCDD and what should be held by CCW. Close collaboration is essential to ensure that, whatever the data split between NFCDD and CCW, both parties are able to access the others' data to improve integration of key datasets.

7 FUTURE ACTION PLAN

7.1 The way forward

7.1.1 Data understanding

New research

The growing sector of coastal access and recreation (incorporating tourism) appears to be in most need of research attention at this time. This sector lacks key information both about the level of current activities going on and user attitudes to change and future demand. This combined lack of information makes the sector very vulnerable to change and only able to act reactively, rather than to plan proactively.

An “Assets at Risk” register for the access and recreation sites around the Welsh coast would help to provide the framework for improved coastal data and information management in Wales, as well as acting as the portal for improving advice to coastal decision makers. This would, however, need to be supplemented with user experience and demand information so that decisions can be made not only based on what is at risk, but what is most important to protect (from a user perspective).

Collaboration, analysis, dissemination and information sharing

There is a need for CCW to champion the promotion of improved communication and learning between stakeholders and other interests on matters relating to climate change impacts on the coast.

It is clear from the study that many decision makers, who are not technical experts, need to be better informed of the likely opportunities and constraints that sea level rise and climate change are to pose along the Welsh coastline within the coming decades. Organisations also need to improve internal communications so that those with knowledge of climate change issues within, for example a Local Authority, can bring that expertise to bear on all relevant decisions and help to fully integrate policies across traditional boundaries between subject areas. CCW can play a role here by ensuring that local and national officers have good channels of communication and are, therefore, able to assist others by sharing their contacts and expertise. For example, a local CCW officer may know individual contacts in different departments of the Local Authority if this knowledge can be passed to national level colleagues, it can then be transferred to local officers in other areas of Wales and then on to contacts in another Local Authority. In this way, CCW can act as a ‘matchmaker’ between Local Authorities. Other national organisations with a network of local or regional officers (e.g. Environment Agency Wales, WAG) should also apply this approach, thereby improving communication across Wales.

There needs to be a better focus of attention on the cumulative nature of climate change impacts, acting together with other pressures. In addition, improved clarity on understanding the indirect effects of climate change along the coast is needed as this is currently weak (e.g. potential interactions between climate change effects and changes in land use, which will have implications for adaptation at the coast).

The role of the future Wales Coastal Monitoring Centre in improving collaboration and information sharing needs to be considered. It has the potential to act as a central repository of data but also as a focus for coastal data managers around Wales to come together to ensure compatibility of information, dissemination of findings and networking among local and national coastal data managers and policy makers. The Centre also has the potential to act as a focus not just for improved communication and collaboration by coastal data practitioners within Wales but as a focus for communication between specialists in Wales with those in the rest of the UK

and beyond. WAG, the Environment Agency, CCW and Local Authorities should consider how the Centre can link with other coastal data hubs and centres of excellence, such as the Proudman Oceanic Laboratory, Channel Coastal Observatory, etc. Delay in the establishment of the Coastal Monitoring Centre and decisions about what its role should be could lead to the current situation of patchiness, lack of collaboration and limited communication continuing. Until it is clear what the role of the Coastal Monitoring Centre will be, it will not be clear where gaps remain and who could or should fill them.

Improving data understanding will benefit the scientific community's intellectual capacity, but will also reap economic benefits due to increased efficiencies, reduction in duplication of effort and economies of scale achieved by enabling data across time and space to be compared.

The scientific benefits of improved data management and understanding can be summarised as:

- Improved information to support risk evaluation and assessment;
- Provision of data to support High Level Targets set by government;
- Improved information in relation to future shoreline planning etc;
- Better definition of coastal process behaviour;
- Better definition and understanding of landform and habitat change;
- Early identification of defects and problems and improved confidence in estimates of residual life expectancies for artificial defences;
- Improved understanding of historical and future shoreline evolution;
- Improved quality control and assurance of data collected.

The economic benefits of improved data management and understanding can be summarised as:

- Savings in field data collection – for studies, coastal strategies and SMPs;
- Efficiency savings - time arising from acquisition / checking of historical data;
- Cost savings - improved phasing of future schemes and works;
- Efficiencies in the management of monitoring – procurement, contract management, system development and refinement, maintenance of data value ;
- Increasing multi-functionality of data - data are made available for use by a wide range of bodies with different requirements and needs.

The environmental benefits of improved data management and understanding can be summarised as:

- Regional approaches are more able to detect changes to coastal biodiversity and help ensure that coastal management takes account of these trends;
- Strategic monitoring provides opportunities to further develop partnerships and allow organisations to share experience, expertise and data;
- mapping and monitoring at a larger scale can ensure that appropriate biodiversity monitoring is implemented across Wales.

The sum of these benefits can be encapsulated in the practical application of the maxim “collect once, use many times”.

How the Coastal Monitoring Centre and improvements in the collection and dissemination of technical data among specialists feeds information into policy development and the political process, in terms of the Welsh Climate Change Commission, Local Authority Sustainability

Champions, Wales Spatial Plan Area Groups, needs to be given consideration. It is this translation and communication of technical information to decision makers that is a key link in the chain that needs strengthening.

7.1.2 Roles and responsibilities

There needs to be a distinct improvement in encouraging better engagement of more stakeholders in Wales to address climate change impacts on the coast. For example, information on factors such as coastal flooding or erosion impacts at a local level, or recording coastal recreational activity impacts on the natural environment, are arguably best recorded by local people who have lived, worked and played in the area for potentially many years. These people can also provide valuable audit information on the effectiveness of ICZM on the ground. Encouraging these people to engage with the decision making process in the coastal zone is key to accessing the anecdotal information they hold.

Education is an important aspect of stakeholder engagement. Stakeholders need to be aware of changes in the approach to coastal management and the reasons why, as well as information about what changes are likely to take place. Stakeholders cannot be expected to understand or support the change from a 'hold the line' approach to a 'managed retreat' approach without fully understanding the reasons behind the change. Issues such as risk and individual actions also need to be communicated clearly. For example, what is the likelihood of inundation, what are the consequences, and what can individuals do to protect themselves and their properties?

There is a responsibility on Government and national advisers (such as CCW and the Environment Agency) to communicate information and policy in a way that enables stakeholders to make informed choices and to ensure they understand the consequences of those choices and does not create unintended consequences (such as a sudden drop in house prices or rash of properties being put on the market).

The study makes a clear recommendation for CCW to encourage the better use and role of public and private partnerships with local stakeholders when managing coastal datasets. This is not to say that CCW are not already doing this, but such a recommendation highlights the importance of this role for the future.

CCW, WAG and EAW can be more proactive and clear in how best to combine resources (internally and externally) when undertaking consultation and information dissemination (from academia to decision makers). Whilst adopting a partnership approach is seen as positive, it is also key to clearly nominate a lead organisation that is responsible for establishing responsibilities and protocols for collecting data on the extent and impacts of climate change on the coast. (The Environment Agency Wales may be best placed to undertake this under its regulatory role.) CCW, Operating Authorities and Professional Partners around Wales should be encouraged to collaborate in developing protocols for those items in which they have a joint interest.

Whilst there are existing mechanisms in place for capturing information about post storm events or beach profile related data, what appears to be missing is clarity between regions in terms of data collection. Wherever possible, CCW (either independently or in partnership with others) needs to regularly review mechanisms for involving stakeholders in data collection to assist local communities, rather than duplicating processes or systems that do not provide a service to local coastal communities in times of need. A better overall response to consultations may be achieved by engaging with different stakeholder groups in different ways e.g. interviews with recreational resource users at the point of use compared with postal questionnaires to local residents.

Finally, organisations within coastal groups with local experience and expertise in community involvement and consultation need to be used more effectively whenever possible in communicating the issues of climate change on the coast. Coastal partnerships have a wealth of stakeholder and community engagement expertise, while partners within partnerships may be able to target specific groups (recreational anglers or boat users, for example). Whilst not necessarily “expertise” (and subject to appropriate quality control measures), it is recommended that CCW and others (Local Authorities and the Environment Agency) investigate other approaches, such as using school resources, to undertake research on flooding frequency, coastal evolution or meteorological change around the Wales coast.

7.1.3 Process and procedures

The key conclusion regarding process and procedures centres on the need for improved data standards for baseline data collection to help understand the coastal change both now and in the future. In particular there are gaps relating to which standards are used, communicating this to the climate change community and supporting compliance to these standards. The Wales Coastal Monitoring Centre and UKMMAS data initiatives should help improve this situation. It is important that Local Authorities are made aware of these initiatives and the data standards required as soon as possible in order to accommodate any changes that may be needed to their own practices.

The wider Flood and Coastal Management community in the UK is looking towards metadata standards based on ISO19115 and Dublin Core (e.g. e-GIF). As the community is primarily dealing with geo-spatial data, the ICZM and climate change community should look to develop and maintain such a profile of ISO19115. Using this metadata standard should be mandatory for all ICZM related data activities, including those linked to shoreline management (e.g. Wales Monitoring Centre). The ICZM community should embrace the diversity of data standards currently in place and use this to establish a registry of ICZM and climate change data standards and the associated mapping between these standards. This includes common dictionaries for terminology. Once standards are agreed and effectively communicated, then procedures and policies to support their compliance can be issued.

7.1.4 Enabling technology

The key conclusion from this study is that the coastal data community in Wales is generally very quick to look at new technology and (lack of uptake) of new technology is a minor issue, not currently limiting ICZM progress. Indeed the UK is generally a leader in all aspects of the application of new technology to ICZM related studies. This includes enabling technology for data collection, processing and dissemination.

What is often the limiting factor is the integration between ‘requirements’ and ‘technology’ to ensure the appropriate uptake and use of technology. Issues regarding provision of training needed to use new technologies may also be at play here. Recommendations to CCW are therefore based on minimizing this gap through improved communication of technology development plans and to make explicit (e.g. provide guidelines) the integration of the technology with ICZM preferred outcomes to address climate change. For example the better and more consistent use of LiDAR and SAR data to develop coastal adaptation strategies.

7.1.5 Audit

There is no mechanism in place to regularly appraise the data needs of Welsh practitioners dealing with ICZM and climate change. This becomes an even greater problem in cross border

situations such as the Severn and the Dee estuary. In this study, data gaps were identified from the two case-studies used as part of this study (See Section 5) and this is a useful ‘snapshot’ to inform policy development on adaptation to climate change on the coast. What is more important is a mechanism to ensure a continual feedback from these studies to initiatives such as the proposed Wales Coastal Monitoring Centre and appropriate interim arrangements until the Coastal Monitoring Centre is operational.

The benefits of coastal data collections also need to be appraised alongside coastal data needs to ensure that the data being collected meets the required needs. If the data cannot be used to answer questions posed by climate change and coastal management, it is ultimately of little or no value. This presupposes that there is sufficient information about the data to enable such a value judgement to be made. If not, then the question is really one of the value of metadata. It is recommended that a simple screening tool is developed that takes as input ‘what is known’ about a dataset and from this infer a statement of its value / management needs.

What is less clear, however, is who is responsible for acting on the information provided by this audit process. CCW currently does not have an effective learning mechanism in place to understand what information is valuable and what information is not. The Environment Agency Wales have a Knowledge Management Strategy in place to provide a framework from which could be prepared an ICZM and climate change specific document.

Finally, the FCM process can only be audited on its outcomes and the study has identified there is insufficient data for this. Accordingly, recommendations are made to improve this, in particular a database of flood events.

7.2 Proposed implementation plan

The key recommendations from this study are summarised in Table 7.1 below. As per the Terms of Reference for the study, actions are divided into the following headings:

- CCW responsibility;
- CCW within a partnership;
- Other partner responsibility.

Future actions are also divided into the 3 project sub themes adopted for the study, namely:

- Coastal Evolution;
- Coastal Environment;
- Coastal Access and Recreation

Under each sub-theme, actions are further divided into those where CCW has a delivery role and those where CCW’s role is in influencing others.

Each action is colour-coded to indicated whether it relates to:

- New research (red)
- Collaboration, analysis, dissemination and information sharing (blue)
- Guidance (green)
- Policy development (black)

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Table 7.1 Key Recommendations

	Coastal Evolution	Coastal Environment	Coastal Access and Recreation	Strategic Actions
CCW responsibility	<p><u>Delivery</u></p> <p>R1 - Research into how CCW accommodate uncertainty and perfect information on the ability of species and habitats to adapt to climate change when developing future plans and policies.</p> <p>R2 - Research into habitats and species adaptation capacities to climate change.</p> <p>R3 - Research potential for economic implications of landward “transfer” of coastal habitats and species.</p> <p><u>Influencing</u></p>	<p><u>Delivery</u></p> <p>R4 - Research to examine likely future status of Natura 2000 sites and their need for flexibility in light of expected impacts of climate change to help inform future policy on the network (examine possible ways of strengthening ecological connectivity between areas of European importance for nature conservation).</p> <p>R5 - Initiate research into the environmental and economic costs / benefits of current agricultural use of drained floodplain wetland (notably peatland) in comparison to restored wetland utilisation (e.g. saltmarsh grazing or biomass production from native species such as reed or alder).</p> <p>R6 - Pilot / demonstration projects to take forward adaptation and strengthen adaptive capacity as well as exchange of experience on lessons learned in enhancing resilience to adverse effects of climate change upon biodiversity.</p> <p><u>Influencing</u></p>	<p><u>Delivery</u></p> <p>R7 - Detailed assessment of climate change risks and impacts on the proposal All Wales Coastal path (based on agreed climate change scenarios for short, medium and long term).</p> <p>R8 - Understand where “vulnerable” stretches of coast are for coastal path placement (erosion) or recreational activity (impacts of human water use on important marine species) in order to inform development / improvement of access, and CCW advise on this to LAs.</p> <p>R9 - Implementation of Integrated Outdoor Recreation Planning framework, incorporating research on supply and demand and forecasting of same. Must be shared with relevant policy developers and deliverers in WAG, LAs and EAW.</p> <p>R10 - Utilisation of climate change visualisation tool to help illustrate possible climate change scenarios.</p> <p><u>Influencing</u></p> <p>R11 - Clarity on the future role of tourism at the coastline and how climate change will impact upon coastal environmental assets (focused attention to update the Wales Coastal Tourism Strategy).</p>	<p><u>Delivery</u></p> <p>R12 - Climate change adaptation checklists / decision-making toolkits for spatial planners (environmental best practice).</p> <p>R13 - CCW guidance on Appropriate Assessments for marine and coastal developments – e.g. when and how to undertake AA.</p> <p><u>Influencing</u></p>

Red – new research

Blue - Collaboration, analysis, dissemination and information sharing

Green – Guidance

Black – Policy development

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	Coastal Evolution	Coastal Environment	Coastal Access and Recreation	Strategic Actions
CCW within a partnership	<p><u>Delivery</u></p> <p>P1 - New tools and methods need to be developed to explore policy choices and uncertainties in light of climate change. In particular, how to promote proactive adaptation policies such as managed realignment, as sustaining coastal ecosystems in a healthy status is more likely under these conditions.</p> <p>P2 - Clear identification of potential habitat replacement areas and managed realignment locations (as part of SMP2).</p> <p><u>Influencing</u></p> <p>P3 - Set clear “Vision Statements” for each section of Welsh coasts e.g. as part of SMP2 process. Visions might, for example, include retreating from some soft coastline to restart natural erosion processes there. These “visions” should then be shown spatially on maps as part of a specific “visualisation” project to aid ICZM delivery in Wales.</p> <p>P4 - Clarity on current and projected natural tidal limits (i.e. without floodbanks) over different climate change scenarios.</p> <p>P5 - Research to demonstrate the relationship between changing tidal boundaries and land ownership entitlements.</p> <p>P6 - Creation of a timeline showing likely sea level rise inundation along the coast.</p>	<p><u>Delivery</u></p> <p>P7 - Initiate a research (that is well-publicised) ICZM pilot project study area that leads towards the creation of a management plan which combines natural and heritage environment assets (e.g. Cardigan Bay).</p> <p>P8 - Inclusion of climate change adaptation in SEA of development plans, including the interaction of the policy or proposal with biodiversity and climate change (review of the work by Atkins (2003) and Levett-Therival (2002) with specific reference to Wales).</p> <p><u>Influencing</u></p> <p>P9 - Research to implement appropriate changes to the planning system and financial support that would compensate landowners for relocating assets out of the coastal flood plain.</p> <p>P10 - Examine role of climate change adaptation in River Basin Management Plans under WFD to identify potential future locations for climate change adaptation measures.</p> <p>P11 - Coastal Habitats Management Plans (CHaMPs) or something similar e.</p>	<p><u>Delivery</u></p> <p>P12 - Understand the vulnerability of coastal visitors on beaches / cliff tops. This is especially important for developing approaches for statutory coastal access points, duty of care and occupiers liability issues for visitors and the completion of beach risk assessments for coastal resorts/beaches.</p> <p><u>Influencing</u></p> <p>P13 - Take forward the work undertaken by the National Trust (Shifting Shores Project) and expand this approach to cover all non NT land in Wales.</p> <p>P14 - Water and beach risk assessments for tourism resorts and how these take on board climate change over time.</p> <p>P15 - Understand relative recreational risks in different areas, and make decisions on the basis of acceptable levels of risks. Also factor into decision-making tool the value of required future infrastructure needs (i.e. gate posts through, disabled access to lifeguard stations) and the subsequent financial investment required.</p> <p>P16 - Test the implications that climate change impact scenarios have on visitor behaviour to the coast in the short, medium and long term (e.g. changing weather patterns etc); (Input to WAG-led project)</p>	<p><u>Delivery</u></p> <p>P17 - Improved and more standardised use of GIS mapping and databases to provide information and, importantly, visualisation tools under various climate change scenarios for the entire Welsh coast (Welsh Data “Hub”).</p> <p><u>Influencing</u></p>

Red – new research

Blue - Collaboration, analysis, dissemination and information sharing

Green – Guidance

Black – Policy development

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	Coastal Evolution	Coastal Environment	Coastal Access and Recreation	Strategic Actions
Other partner responsibility	<p><u>Delivery</u></p> <p>O1 - Improved procurement and dissemination (free use) of LiDAR / SAR data to help towards elevation modelling of scenarios for coastal change.</p> <p><u>Influencing</u></p> <p>O2 - Guidance - WAGs TAN 14 on Coastal Planning should be updated.</p> <p>O3 - Model potential cost implications of moving houses / people / roads / railways etc to higher ground (intangible benefits).</p>	<p><u>Delivery</u></p> <p>O4 - The Marine Climate Change Impacts Partnership (MCCIP) needs to be regularly updated. This enables regularly monitoring of the state of the environment.</p> <p><u>Influencing</u></p> <p>O5 - Update existing baseline information with regard to heritage assets on the coast and how these may be impacted in the short, long and medium term.</p>	<p><u>Delivery</u></p> <p><u>Influencing</u></p> <p>O6 - A flexible funding stream needs to be introduced with funding focussing on delivering the relocation of assets out of coastal flood and erosion risk zones and compensation for changed land use. The funding regime would be designed to maximise habitat and landscape enhancement opportunities and in so doing encourage high quality tourism and the economic benefits associated with it.</p>	<p><u>Delivery</u></p> <p>O7 - Technical training for integrated climate change impacts and vulnerability assessment and environmental management under climate change.</p> <p><u>Influencing</u></p> <p>O8 - Community outreach studies to inform local people of recreational planning linked to future beach and water safety.</p> <p>O9 - Monitor relationships between local weather cycles and longer term patterns. Clarification is needed on the predictions of the full extent of sea level rise and then model appropriate responses.</p> <p>O10 - Wide involvement of partners in Wales Cross-Sector Climate Change Group.</p>

Red – new research

Blue - Collaboration, analysis, dissemination and information sharing

Green – Guidance

Black – Policy development

8 ACKNOWLEDGEMENTS

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9 REFERENCES

(NB: The data initiatives referred to in Tables 3-12 in Section 4 are not included in the following reference list.)

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APPENDIX 1: STUDY QUESTIONNAIRE

Supporting ICZM Delivery in Wales: Enhancing the Evidence Base for Coastal Decision Making in a time of climate change

Overview

Climate change has been identified as a key coastal pressure in the Wales ICZM Strategy and is a priority for determining what decisions should be made on the coast. The current Wales ICZM Strategy Action Plan (2006) sets out a requirement for CCW to:

- *Work with partners to identify gaps in information and initiate a programme of research to fill them.*

The overall aim of this project is to facilitate the delivery of CCWs actions under the ICZM Strategy in relation to information and knowledge at the coast.

CCW have commissioned Atkins to deliver a rapid review of the availability and accessibility of existing information that relates to the Welsh coastal environment with respect to climate change that is of relevance and interest to the remit of CCW. As part of this Atkins have been tasked with identifying the information that CCW needs in order to respond, analyse and advise on climate change and sea-level rise as part of integrated coastal management decision-making.

As a first stage in this process, we are engaging with key coastal consultees to determine the current status of information and to determine future needs.

CCWs Strategic Aims

Taken from the CCW Corporate Plan, the strategic aims of CCW for the period 2008-2012 are;

- To ensure the value of the environment is better understood, and that it is taken into account more fully when making decisions that affect our lives;
- To enable more people to have direct experience of the outdoor environment and to play an active part in its management;
- To safeguard and improve the quality of our wildlife habitats, our species, geology and landscapes and the natural systems that support them.

In discussion with CCW relation to this commission, three key themes have been identified for the coast as follows:

- Conservation (Nature, Geology, Landscape and Heritage);
- Recreation and Access;
- Shoreline Evolution.

These key themes therefore form the basis for assessing information associated with climate change.

Information Assessment

We have identified a number of key high-level questions with respect to assessing information associated with climate change which we wish to address. As key national stakeholders in Wales, we request your attention in providing us with some views on the following questions:

1. In your opinion, and with reference to current and future climate change **impacts**, what data/information is now required to help improve strategic decision making and advice along the Wales coast?

2. With regard to **adaptation** to climate change on the Wales coast, what targeted advice or programmes should be introduced or produced to help improve knowledge and hence policy implementation?

3. With regard to adaptation to climate change on the Wales coast, **how should partnerships be effectively used** to provide the necessary information for implementing climate change research projects?

4. With regard to climate change on the coast, what are the **current weakness** in the knowledge base (*data understanding*), guidance (*roles, responsibilities and procedures*) and policy (*auditing of information etc*) that need to be filled in order to underpin effective advice and decision-making.

5. What future research projects and/or pro-active work could be undertaken to help improve knowledge on adaptation to climate change for the Wales coast and enhance and raise the quality and future resilience of the coastal environment?

Response Deadlines

Atkins request your answers to the above, which are not intended to take more than 10 minutes of your time, by **Friday 18 January 2008**.

Please return your comments to Neil Cousins by email to neil.cousins@atkinsglobal.com or by fax on 01925 238500.

APPENDIX 2: GEOLOGICAL CONSERVATION REVIEW DATA

The GCR project identified 26 networks, of which 13 are in Wales.

Ultimately, some 26 networks were identified for the coastal GCR project.

1. Large-scale structural control: longitudinal and transverse coasts;
2. Small-scale structural control: caves, arches, stacks, geos, zawns;
3. Cliff forms and processes: plunging cliffs, slope-over-wall, hog's back, variety of rates of cliff retreat, differential erosion;
4. Exhumed and emerged forms: cliffs, benches;
5. Karstic development;
6. Structurally controlled;
7. Erosionally dominated;
8. Beach orientation: relation to wave direction, swell-dominated beaches;
9. Beaches undergoing erosion;
10. Prograding beaches;
11. Beach phases;
12. Pre-existing sediment sources, including pre-existing clasts;
13. Emerged ('raised') beaches;
14. Cliff-foot beaches;
15. Dunes: rock-based, gravel-based, restricted sources, sand plains;
16. Spits;
17. Barrier beaches;
18. Cuspate forelands and nesses;
19. Tombolos and tied islands;
20. Intertidal sediments;
21. Mudflats, ridge and runnel forms;
22. Saltmarsh morphology – creeks, saltpans, piping;
23. Machair;
24. Chines, truncated valleys, coastal waterfalls;
25. Fjords, rias, estuaries;
26. Restricted sediment sources and transfers, submarine barriers, sediment sorting