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A Framework for Coastal Research, Development and Dissemination (CoRDDi)

Report – SC090035/R

Flood and Coastal Erosion Risk Management Research and Development Programme

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

This report is the result of research commissioned and funded by the Environment Agency.

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Carrying out research, either by contracting it out to research organisations and consultancies or by doing it ourselves;

Delivering information, advice, tools and techniques, by appropriate dissemination of products.

Miranda Kavanagh
Director of Evidence

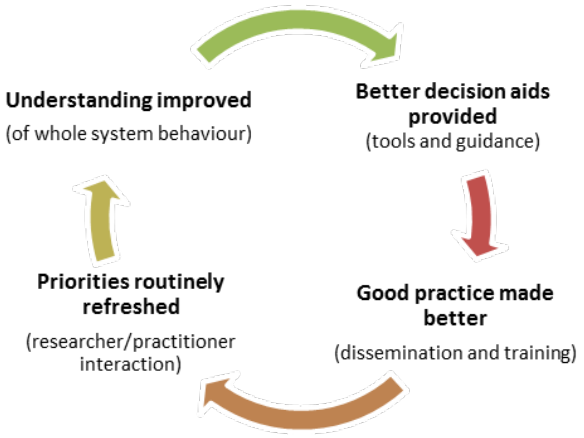
Executive summary

Deciding on the best ways to manage our coastline can be difficult. We face uncertainty in how our climate and population will change and we are still learning about the behaviour of coastal systems and the impact of our interventions. We must aim to meet the multiple and often competing needs of those who use the coast; maintain a strategic view whilst encouraging local ownership.

Over the last decade, significant steps have been made in our ability to manage flood and coastal erosion risk. These have been supported by a range of research and development (R&D) activities, from projects delivered jointly by the Department for Environment, Food and Rural Affairs (Defra)/Environment Agency through the Flood and Coastal Erosion Risk Management R&D programme and regionally funded research led by regional bodies, through to major UK and international consortia funded by the Environment Agency, research councils and/or the European Commission. This research has brought some major advances in the culture, science and practice of flood and coastal erosion risk management. However, much of the work has tended to focus on catchment flood modelling, asset management, and risk and uncertainty, and less on sea flooding and coastal erosion.

This report provides a vision for Flood and Coastal Erosion Risk Management (FCERM) research, development and dissemination. This includes managing risk and promoting opportunities, while recognising that a sole focus on risk management is limited and fails to maximise return on investment. In particular, the vision outlines a future where:

"Those with responsibility to manage coastal flood and erosion have access to useable tools and techniques that improve their ability to predict change.



The opportunities and constraints of change on all important aspects of coastal flood and erosion systems are understood and accounted for when making decisions. The decisions taken are fully integrated, nesting UK priorities through to action, and maximise opportunities and minimise risks efficiently and effectively.

There is rapid uptake of research and development outputs into practice, and practical experience and pilot studies routinely refresh research priorities."

The vision is supported by a Framework of **Co**astal **R**esearch, **D**evelopment and **Di**ssemination (CoRDDi) that is of relevance to all those with an interest in managing coastlines. Within the supporting Framework, four priority CoRDDi themes for action have been identified (as shown in the following figure). Within each CoRDDi theme, four sub-themes each contain priority areas with a list of potential issues/projects.

The proposed projects are collated from the results of a consultation exercise and recommendations discussed in the literature review. Each project is prioritised in the Framework schedule based on a two-stage process. Stage 1 prioritised each project based on the magnitude of its impact/benefit and urgency in improving coastal risk management. Stage 2 further prioritised the high-scoring projects by their ability to meet the aims set out in the vision.

The proposed Framework puts the emphasis on people and communities being empowered to help themselves, while maintaining the strategic nature of good coastal management.

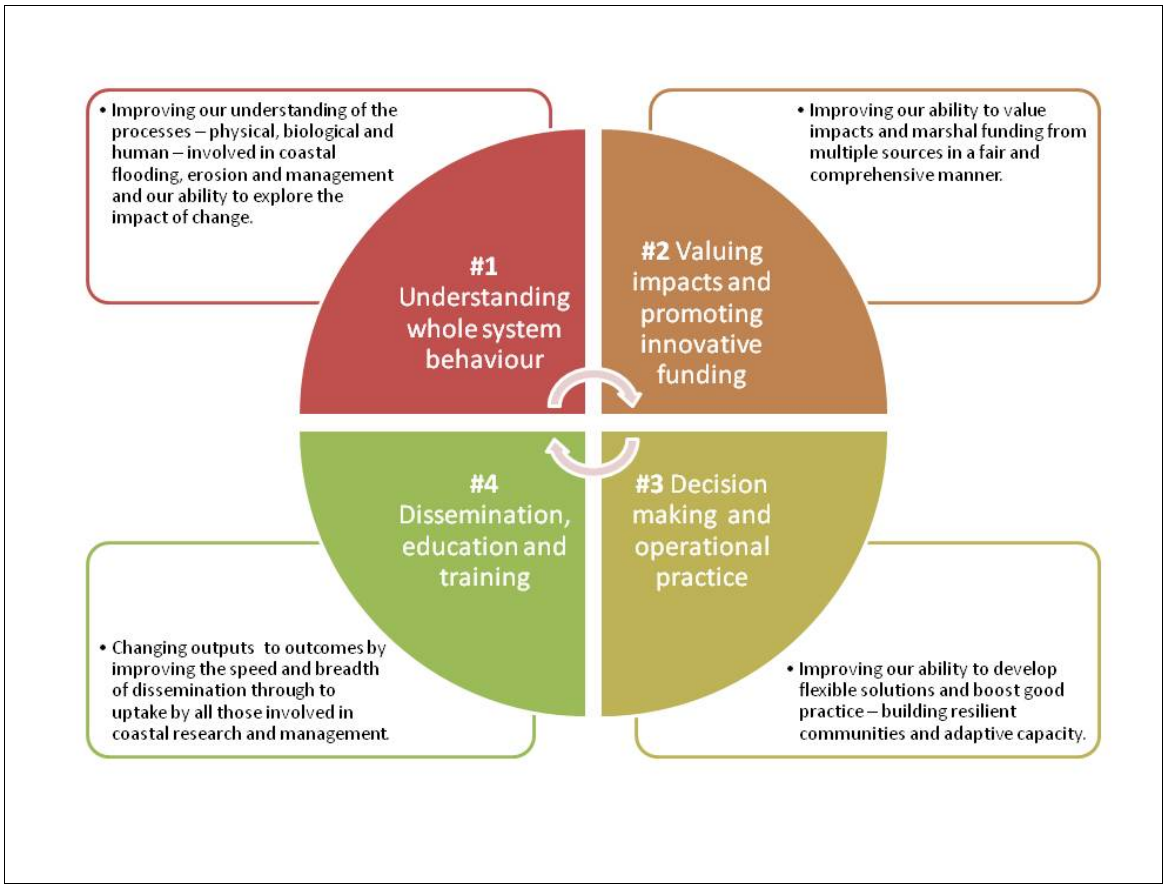


Figure A: Overview of four priority themes in CoRDDi. The CoRDDi Framework covers a range of activities from research (concepts and philosophies) through development (tools and techniques) to dissemination (guidance and manuals) which could possibly be funded by a variety of sources. Research Councils, for example, are most likely to support basic research; the Environment Agency, Natural England, Defra and others will be keen to support applied research and development; and regional coastal groups and the operational parts of the Environment Agency will support dissemination and take-up. A better ability to predict coastal change should lead to better decision making and management of the coast.

Acknowledgements

This report was produced as part of the joint Defra/Environment Agency Flood and Coastal Erosion Risk Management R&D Programme. Its development was steered by a Project Advisory Group (PAG) consisting of the following members: Alison Baptiste (Chair), Bryan Curtis, Sue Rees, Andrew Watkinson, Chris Vivian, Kevin Burgess, Robert Nicholls, Sarah Nightingale (part) and Dickon Howell (part).

Contents

1 Introduction

1.1 Background

Recent initiatives such as Foresight (2004) (and its associated Foresight Update, Evans et al., 2008), the Pitt Review (Pitt, 2008) and UKCP (United Kingdom Climate Projections) 09 (Lowe et al., 2009), all recognise that coastal areas will be at greater risk of sea flooding and coastal erosion from climate change and socio-economic changes in the future. Although progress has been made over the past decade in our understanding of the coast and how best to manage it, major challenges remain. These challenges include gaps in our knowledge of engineering and physical science, and our ability to convert this science into good practice, where dissemination, training and education have not always been given sufficient priority.

This Framework for **Co**astal **R**esearch, **D**evelopment and **Di**ssemination (CoRDDi) plays a pivotal role in setting future coastal initiatives. It links strategies that are currently under development as part of the *Living with Environmental Change* (LWEC) initiative particularly the recently published UK Flood and Coastal Erosion Risk Management Research Strategy with commissioned programmes and projects.

Deciding on the best ways to manage our coastline can be difficult. We face uncertainty in how our climate and population will change, particularly communities living along the coast. And we are still learning about the behaviour of coastal systems and the impact of our interventions. Although progress has been made in the last few decades, management of our coastline could be better.

Good and useable science, as well as supporting evidence, is essential for good management but requires the coordination of activities, funders and partners (Figure 1.1). To make a real difference to our understanding and management of the coast, the CoRDDi Framework strikes a balance between scientific rigour, user relevance and practicality.

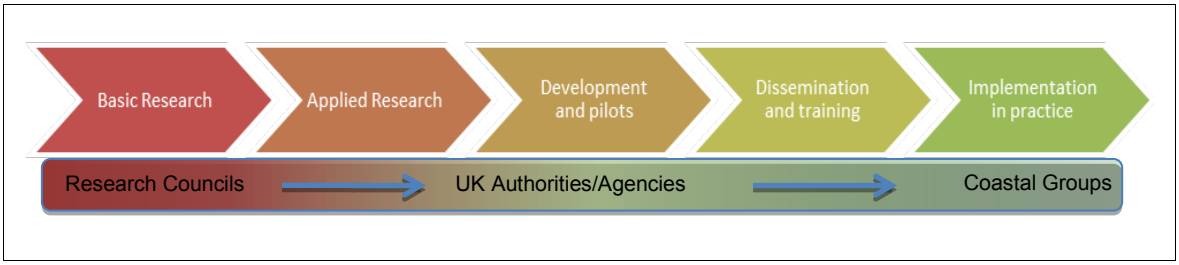


Figure 1.1 Activities and potential lead groups within the CoRDDi Framework

1.2 Report aims

This report develops a vision and framework for Flood and Coastal Erosion Risk Management (FCERM) research, development and dissemination (RDD) to improve flood and coastal erosion risk management in the short and long term by setting out a clear direction of travel. This framework:

i. **sets out a shared vision for coastal practitioners and researchers** by addressing user needs and academic developments;

ii. **provides a platform for researchers as well as funders and users of science** by maximising data and model sharing, and increasing the efficiency of research expenditure;

iii. **blends a spectrum of outputs** including basic and applied research, development of practical tools and techniques, and dissemination, education and training (increasing uptake of existing and future research outputs);

iv. **emphasises dissemination and take-up of outputs** by adopting a more progressive approach that uses:

- *demonstration and piloting*, where the Framework recommends piloting, development of case studies and dissemination to encourage uptake of the science;
- *tailored education and training*, to ensure research findings reach, and are of practical use to, end-users;

v. **enables funders and researchers to work efficiently and effectively** by identifying knowledge gaps and priorities, developing a five-year programme of prioritised activities, and maintaining a flexible programme that is regularly reviewed.

1.3 Target audience

This report is aimed at all those with an interest in managing flood and coastal erosion risk, including practitioners, research groups involved in the joint Department for Environment, Food and Rural Affairs (Defra)/Environment Agency R&D Programme and the wider LWEC partner network. It provides a framework for all levels of involvement, from researchers to organisations who may be called upon to contribute funding.

1.4 Report structure

Following this introductory section the report is structured as follows:

- Section 2: CoRDDi Vision – outlines the Vision of how coastal science will support coastal management in the future.
- Section 3: CoRDDi Framework - gives an overview of the principal research themes.
- Section 4: Management of CoRDDi Framework – discusses future governance of the Framework and its relationship with broader LWEC initiatives.
- Section 5: Theme priorities – gives more detail on the principal RDD themes and potential projects, including the process of prioritising work using a range of assessment criteria.
- Section 6: Indicative costed programme.

The main report is supported by a series of appendices:

- Appendix 1: Interests and requirements of different organisations and communities.

- Appendix 2: Results of end-user consultation process.
- Appendix 3: Policy drivers for flood and coastal erosion risk management.
- Appendix 4: Issues to be addressed within LWEC guiding strategies.
- Appendix 5: Annual score card.
- Appendix 6: Categorisation and prioritisation of needs/issues.

2 CoRDDi Vision

2.1 Summary

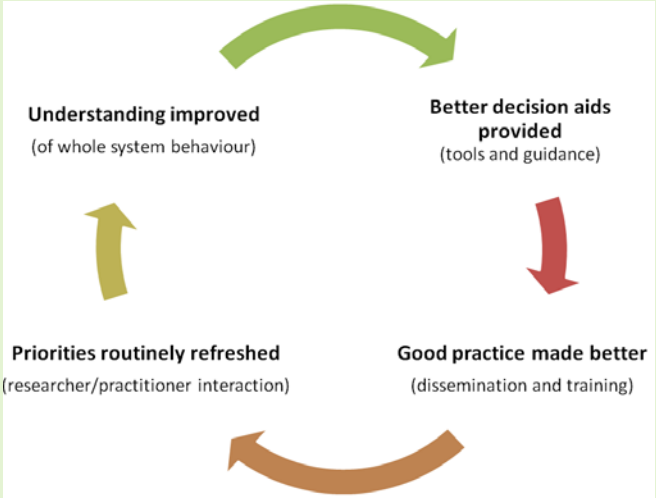
The vision for FCERM research, development and dissemination is described in Box 1.

Box 1 – The CoRDDi Cycle – A vision for FCERM research, development and dissemination

Those with responsibility to manage coastal flood and erosion should have access to useable tools and techniques that improve their ability to predict change.

The opportunities and constraints of change on all important aspects of coastal flood and erosion systems should be understood and accounted for when making decisions. The decisions taken must be fully integrated, nesting UK priorities through to action, and maximise opportunities and minimise risks efficiently and effectively.

There should be rapid uptake of research and development outputs into practice, and practical experience and pilot studies should routinely refresh research priorities.



The vision summarised in Box 1 takes into account the diverse interests and needs of practitioners, funders and researchers; the political context; a desire to foster collaboration within the coastal community; the need for flexibility to ensure continued relevance.

Successful delivery of CoRDDi relies on an ongoing dialogue between users and researchers. Barriers and solutions to collaboration and uptake of new methods are set out in the CoRDDi diagram below (Figure 2.1).

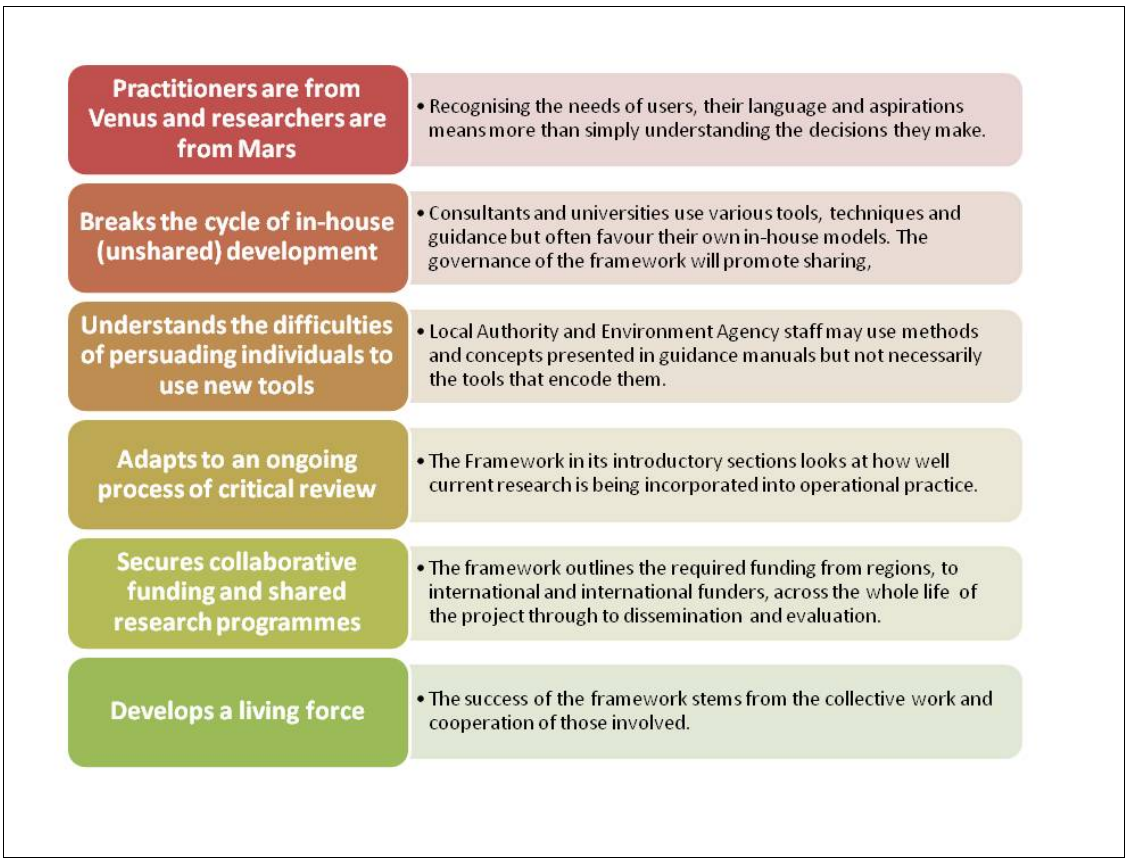


Figure 2.1 Examples of how CoRDDi Framework will break down barriers and encourage collaboration

2.1.1 Model for coastal risk management

Many of the desirable attributes of FCERM are characterised in Figure 2.2 and discussed in the section below.

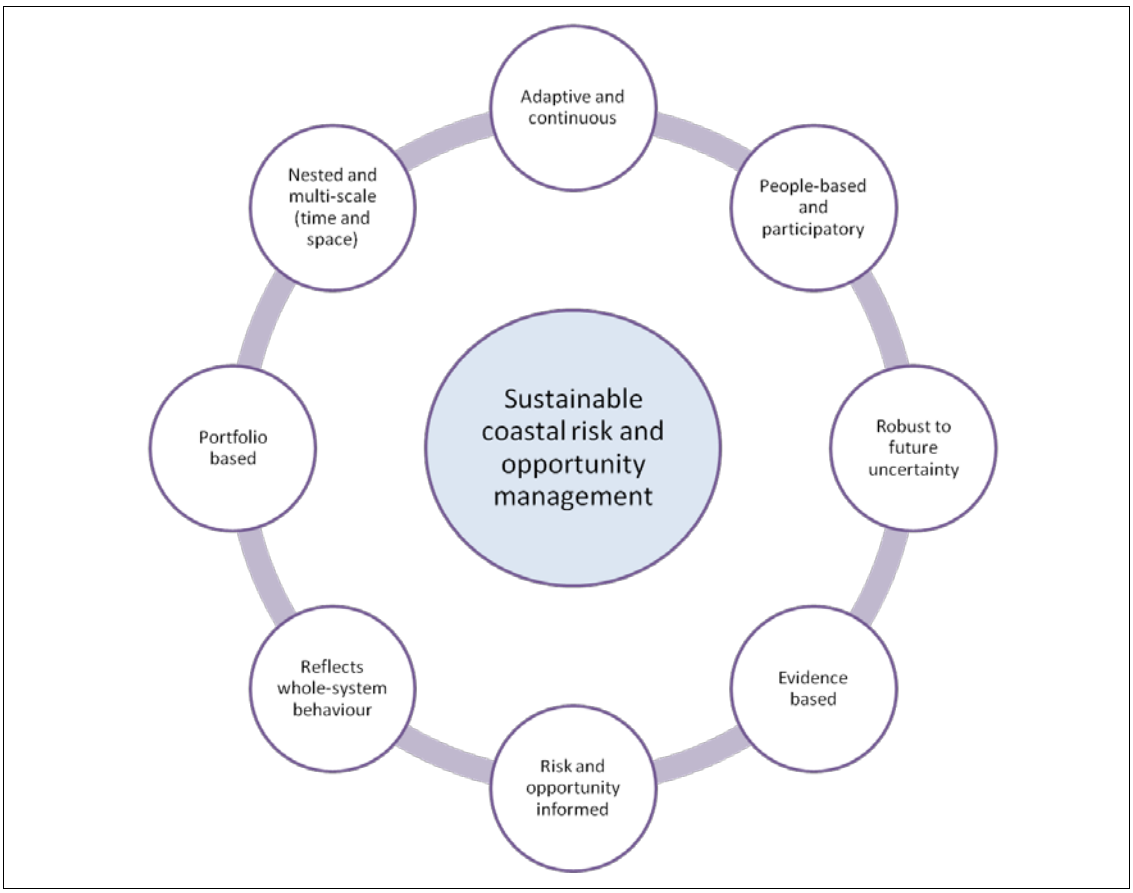


Figure 2.2 Attributes of sustainable coastal risk and opportunity management

Risk and opportunity informed: FCERM considers the probability of flood and erosion occurring and the consequences of these. It develops policy, strategies, schemes and other interventions and uses 'risk' as the rational basis for comparing management options. The environment, society and economy are interwoven with the management of flood and coastal erosion risk. A risk management paradigm is therefore limited and can often fail to maximise the return for the local community or the taxpayer. Creating multi-functional schemes that maximise opportunities for tourism and biodiversity, for example, forms an integral part of the decision-making and funding process in CoRDDi.

Reflects whole-system behaviour: The nature of and multiple processes and interactions taking place along the coast are beginning to be understood. Longshore, cross-shore and offshore interconnections and the relationships between human interventions and short-term and long-term change are all important considerations. Whole-system thinking is based on physical, biological and human considerations. Arbitrary sub-divisions of the coastal and tidal system, for example, by administrative divisions, should not be used as the basis for decision making.

Portfolio-based: Integrated management of the coast involves consideration of the widest possible set of actions that may reduce risk from sea flooding or coastal erosion or both. This includes measures to reduce the probability and consequences (exposure and vulnerability) of flooding and erosion, and generate social, socio-economic and environmental gains. Management strategies are developed by considering effectiveness, in terms of risk reduction and cost, but also maximising opportunities and equity. Decisions about the coast are not simply utilitarian but involve larger societal questions on the acceptability of abandoning communities or continuing to protect an unsustainable shoreline. Implementation of a preferred

strategy will involve coordinating the activities of more than one funding organisation and multiple partners and groups.

Nested and multi-scale (time and space): Coastal management cascades from policy decisions at national (UK) and regional scales, based on outline analysis and consultation, to detailed designs and projects, which require more in-depth analysis and intensive engagement with the local community. National or regional policy and plans based on an assessment of risk and local development plans provide the framework within which actions are implemented.

Evidence-based: Coastal management decisions often deal with scenarios that have not yet occurred and that rely on the quality of predictive modelling and expert opinion. Advances in modelling capability will be based upon empirical evidence, providing confidence in model application and a willingness to rely upon their results (with a transparency in the analysis and empirical evidence that is open to scrutiny by experts and the public).

Robust to future uncertainty: Uncertainty about the future is inherent in FCERM, and this uncertainty can limit management decisions. Gross uncertainty in sea-level rise and storminess, for example, as well as uncertainties in data and models are often significant at the coast. Structured recording of the uncertainties and associated uncertainty and sensitivity analyses provide crucial steps in making the right choices (ones that perform well in most foreseeable circumstances).

Adaptive and continuous: Within the field of FCERM, change occurs over a range of time and spatial scales due to a variety of processes. Predictive models may be able to represent these processes of change and support decisions. A commitment to monitoring the processes of change, including socio-economic change, will continue to advance the underlying evidence base. Decision makers will then feel equipped to deal with uncertainty and provide innovative solutions that are flexible and adaptable as the reality of the future unfolds.

People-based and participatory: A host of different groups and organisations have an interest and role in managing the coast. Successful management of flood and coastal erosion risk relies, fundamentally, upon integrated working and the active engagement of local communities in developing, funding and delivering coastal risk management. CoRDDi reflects through a desire to:

- **Ensure regional applicability**. Whilst providing a national framework for RDD, CoRDDi encourages regional initiatives to ensure that: (i) specific needs of regional coastal groups are met; (ii) a wider range of pilot sites and case studies are considered; and (iii) other regional and local bodies can link into the development of understanding in a particular location. Greater focus should be placed on regional initiatives, piloting and case studies and national lessons that can be extrapolated from this experience, particularly community-led initiatives.

- **Promote collaborative funding and a functioning research community**. Significant research effort is devoted to coastal issues by a range of funders with similar aspirations, but different agendas. This includes the joint Defra/Environment Agency R&D Programme, European Community Research, UK research councils, the private sector and research institutions as well as regional observatories and groups. Opportunities for collaborative or complementary funding should be promoted. Success here will reflect the willingness of the funding bodies to coordinate and compromise.

2.1.2 Diverse interests of different groups

To be useful to end-users, the CoRDDi Framework considers a range of implementation scales to provide outputs that support UK policy making to operational activities (such as engineering schemes and flood warning services). This necessarily includes supporting UK and local government and their agencies, but also intermediary users (such as consultants and technical staff) by providing tools and techniques applicable to a range of decision and analysis scales. Partners within the CoRDDi Framework are therefore diverse and range from government staff to practitioners and the public (Figure 2.3).

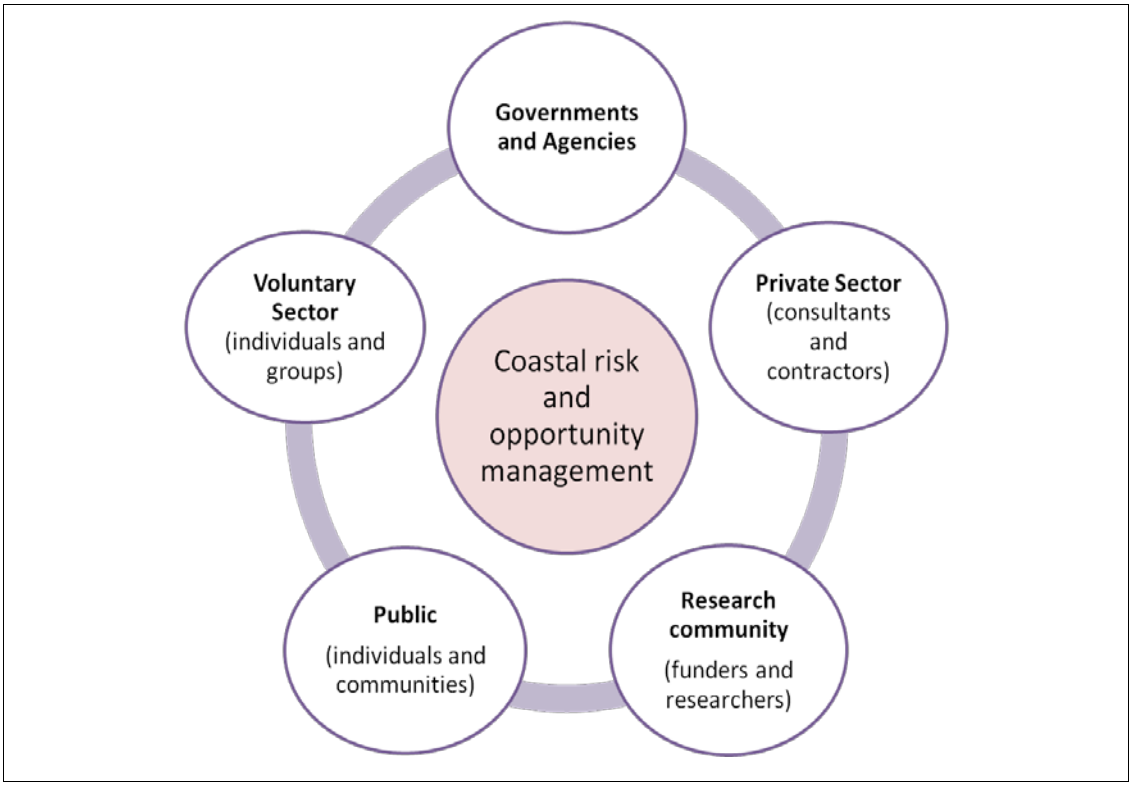


Figure 2.3 Different groups with an interest in CoRDDi

The interests of the main organisations within this diverse range of groups are discussed further in Appendix 1. Appendix 2 summarises the results of a consultation carried out under CoRDDi. A more detailed review of the consultation process can be found in Environment Agency (2010a) and a review of existing programmes in Environment Agency (2010b).

2.1.3 Political context

The CoRDDi Framework supports the process of change required to make progress in FCERM. A detailed discussion of the policies driving FCERM is provided in Appendix 3.

2.1.4 Collaboration within the coastal research community

A number of funders are active in coastal science and have strategic aims associated with FCERM and the management of our coastline. Better integration of science initiatives offers rewards including:

- **greater efficiency for each pound spent**, by maximising the use of existing research and multiple funding streams (and avoiding duplication);
- **greater effectiveness**, by providing a clear line of sight from basic research to practice;
- **academic innovation and practical applicability,** where academic innovation and practicality are not mutually exclusive. Often, it is lack of understanding of practical requirements by academia and lack of theoretical knowledge in practitioners that limits advances. Providing mechanisms to overcome these limitations will enhance both.

Although desirable, setting up this type of collaborative approach is not trivial. We do not propose a centralised process of pooling funding and distribution, but rather to promote integration through:

- **shared vision:** developing a shared vision for research priorities that can act as a focus for all funders to develop initiatives and projects;
- **an active process of updating knowledge and know-how:** evolve the common view through a continuous process of updating and review as the needs and demands of different groups change;
- **common rules of engagement:** often, barriers to collaboration result from inequitable sharing of (for example) costs, data, codes, tools and intellectual property rights. Mechanisms to ensure that these become facilitators of rather than barriers to collaboration will be vital to the success of the CoRDDi Framework.

The mechanisms and protocols of collaboration is a central theme of the LWEC Flood Research Strategy. The success of the CoRDDi Framework will hinge on building collaboration at UK, multi-funder, level. These challenges are discussed in more detail in Section 4.2 and elaborated further in Appendix 4.

2.1.5 Evaluation of success

The success of the CoRDDi Framework will need to be measured, demonstrated and routinely reviewed. The nature of the evaluation could, however, undermine collaboration. For example, research councils aim for academic impact with less emphasis on practical relevance or end-user uptake (although the Research Councils UK (RCUK) *Pathways to Impact* should address this). To be successful in drawing together funders and linking academic advance and practice, common measures for benefits, ranging from academic to practitioner goals, will need to be established and agreed. Setting these success measures is a challenge for LWEC partners as a whole.

A recommended reporting format is based upon the Marine Climate Change Impacts (MCCIP) Annual Report Card, which is a good example of how to synthesise the previous year's work in an accessible format (http://www.mccip.org.uk/annual-report-card.aspx). Score Cards could be produced for each theme within the Framework providing details on its current state and future implementation, in a format that can be readily assimilated by others. The Score Card template for the CoRDDi Framework is provided in Appendix 5.

2.1.6 Flexibility to ensure continued relevance

To stay relevant, it is essential that the Framework responds to changing user needs and innovation. By remaining flexible, the Framework can evolve and become self-perpetuating (not self-funding) to incorporate advances in understanding. A continuous discourse between researchers and users as well as managers, engineers and planners will be needed.

Maintaining relevance includes raising the profile of CoRDDi within the different coastal forums and publishing areas of success and failure. Bespoke coastal conferences that transcend sectoral groups are difficult to establish and run, but can stimulate innovation across all aspects of science and practice.

As part of CoRDDi, a Project Advisory Group (PAG) was set up to further the Framework. This Group will have an important role in the future implementation of the Framework and in reviewing and integrating future priorities.

3 CoRDDi Framework

3.1 Introduction

The CoRDDi Framework blends research, development and dissemination and seeks to generate useful outputs at each stage (Figure 3.1).

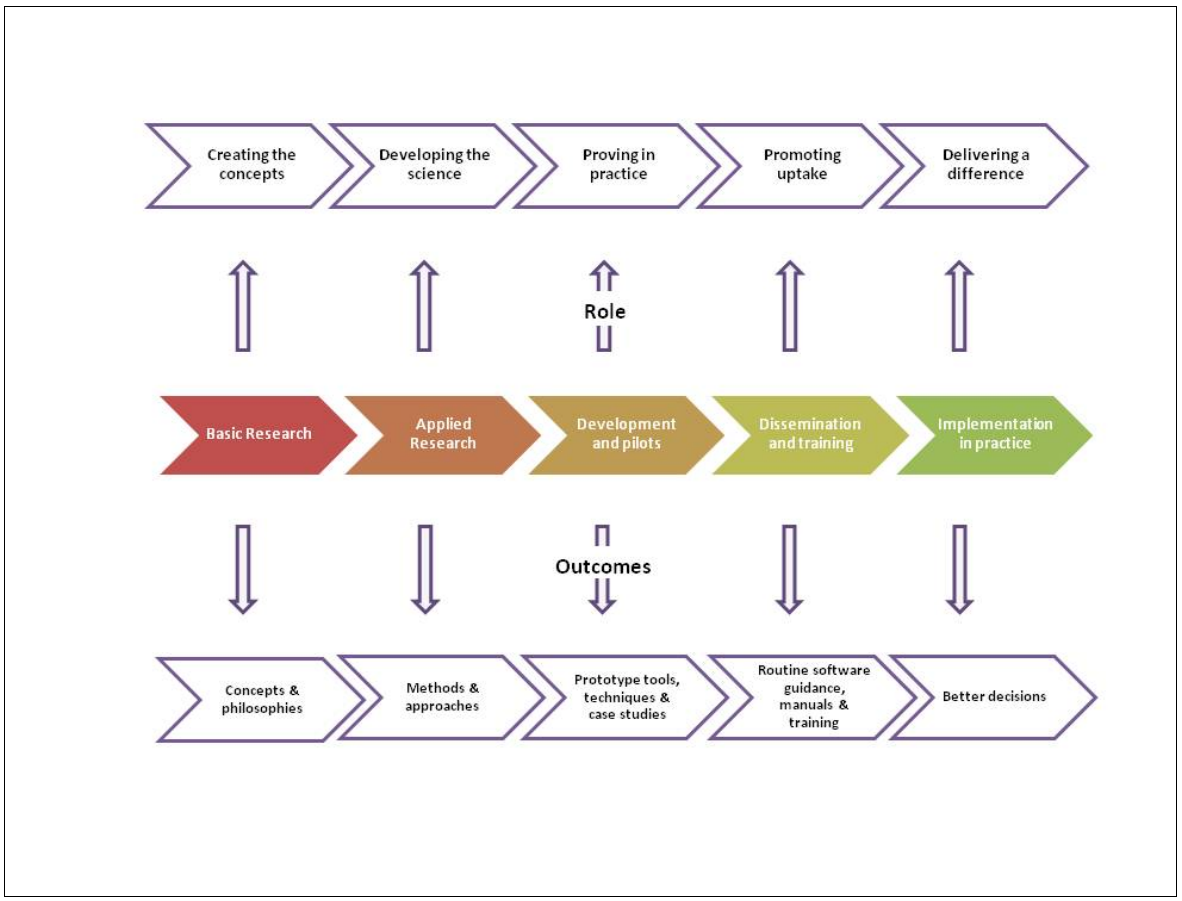


Figure 3.1 Outputs from each stage of activities in the CoRDDi Framework

The areas of activity are divided into four linked themes. The first two themes focus on developing the knowledge base, the third builds on this to improve decision-making processes and the fourth is an overarching programme of dissemination (Figure 3.2).

The Framework deliberately avoids traditional engineering, economic and environment terms, and climate change is not a separate theme. This reflects a desire to be integrated in the research and delivery of coastal management.

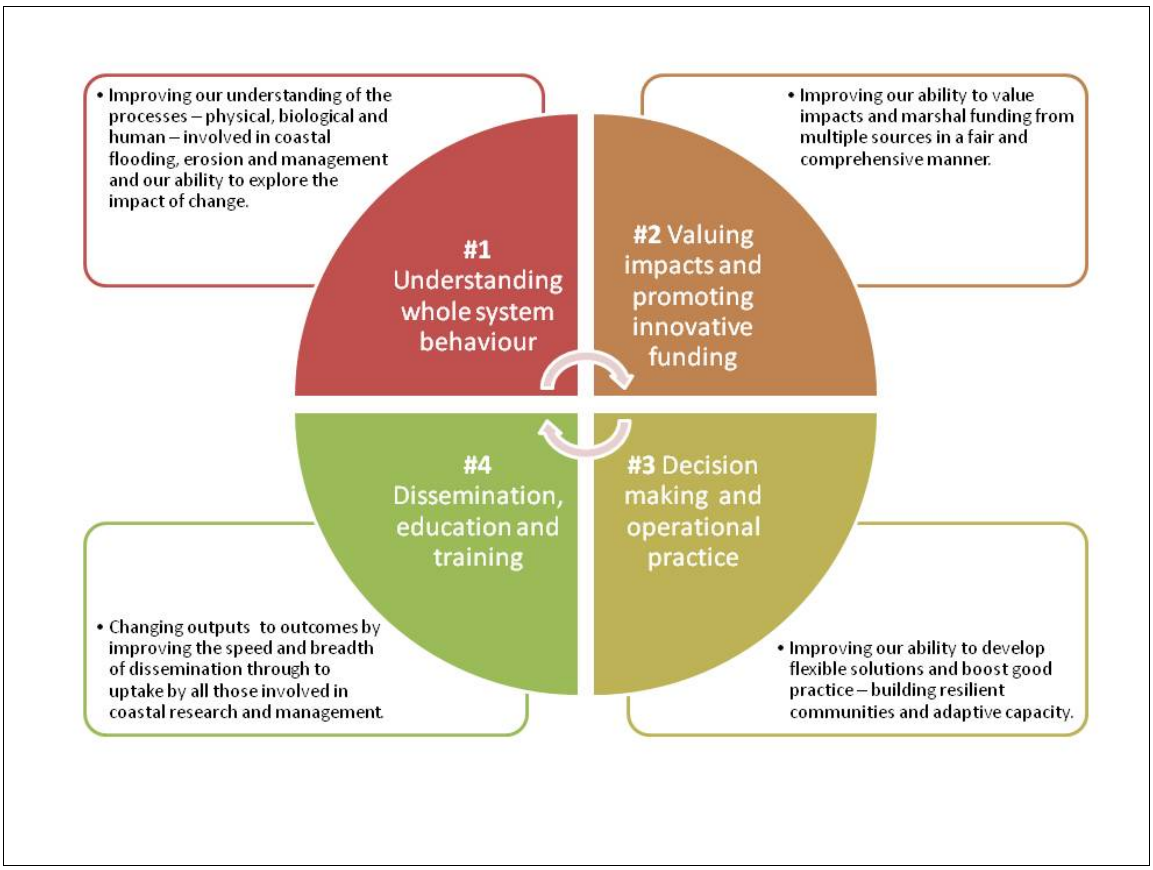


Figure 3.2 Overview of the four themes within the CoRDDi Framework

3.2 CoRDDi Theme 1 – Understanding whole-system behaviour

3.2.1 Drivers for Theme 1

Understanding the behaviour of coastal systems across multiple scales in time and space is a pre-requisite for good decision making. Shoreline and nearshore hydrodynamic and sedimentary processes (driven by weather), geomorphological behaviour (driven by these processes), ecological functioning and human intervention all contribute to a complex system of interacting mechanisms. From an understanding of these individual components we need to understand the system as a whole. Developing this understanding over temporal and spatial scales is fundamental to making better management decisions. Advances in science are essential to develop whole-system understanding by providing new concepts that integrate spatial and temporal scales and enable multi-functional approaches to be developed. The key aspects of CoRDDi Theme 1 are summarised in Figures 3.3 and 3.4.

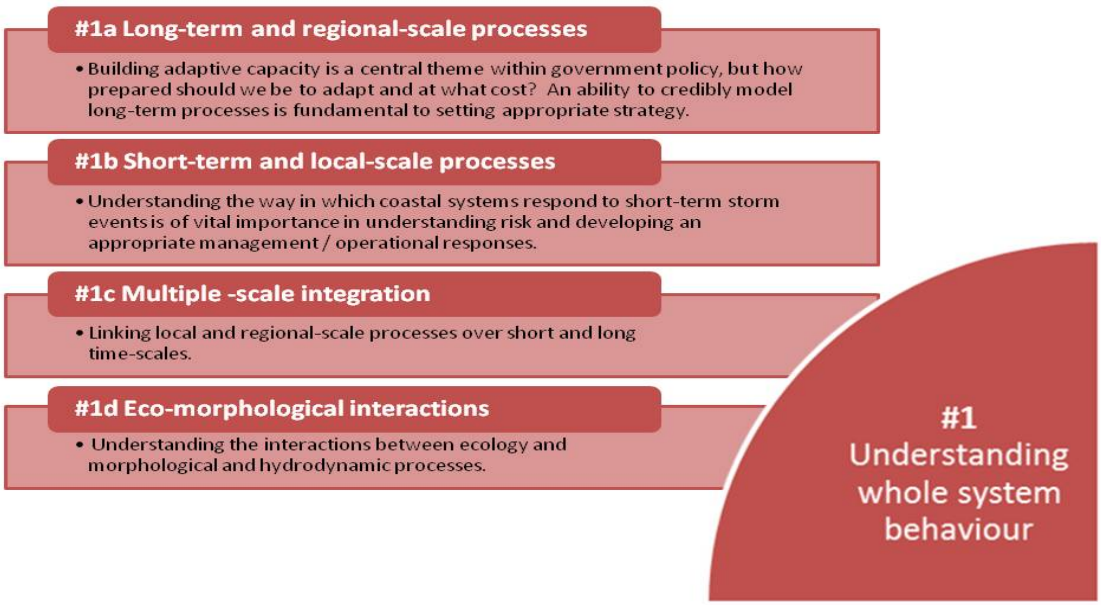


Figure 3.3 Overview of aims and objectives of CoRDDi Theme 1

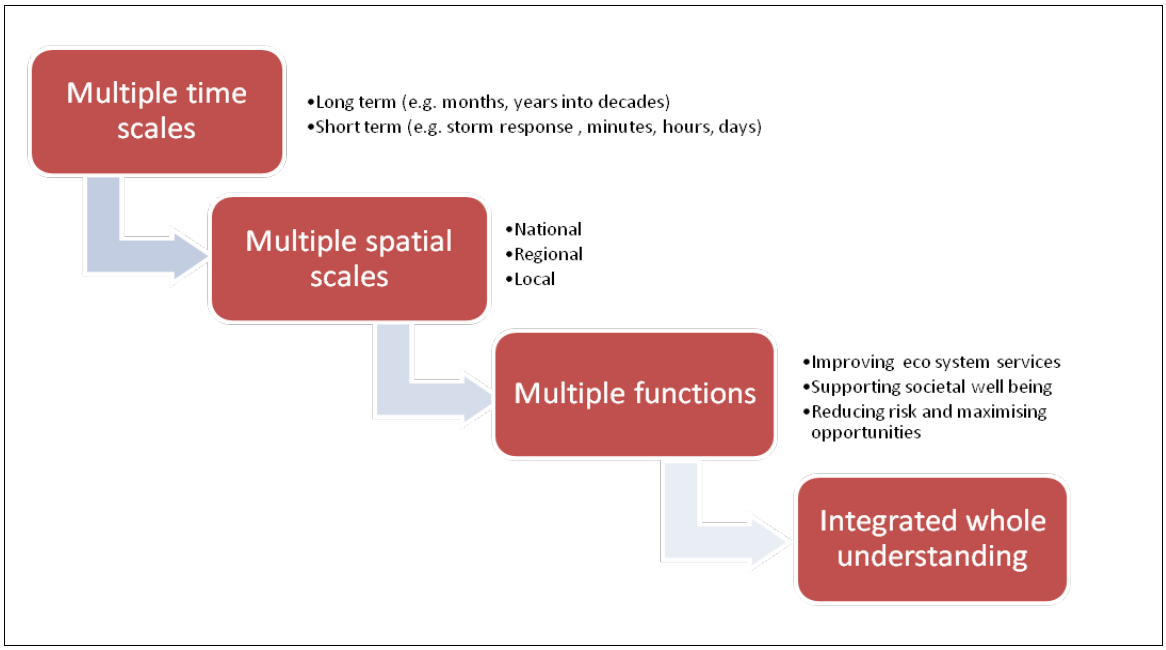


Figure 3.4 Multi-scale approach to understanding whole-system behaviour

3.2.2 Business case for Theme 1

The business case for pursuing CoRDDi Theme 1 is provided below. Details of the priority projects with this theme are provided in Section 5 and Appendix 6.

Table 3.1 Business case for CoRDDi Theme 1

Understanding whole-system behavior
Current level of understanding
In recent years, advances have been made in the development of more practical system models. To date, however, these models have been able to provide only part of the picture - in terms of a limited set of processes or an inability to resolve processes at a range of scales. The understanding embedded in existing system models also remains limited and the ability to develop whole-system models that reflect the interactions of all processes relevant to a decision at a range of scales remains a goal rather than a reality.
Impact of doing nothing
Existing conceptual/numerical models and approaches cannot be used to adequately explore future change and fail to support investments, given the uncertainty in the models and gross uncertainties in future climate and demographics. As a result, funding is poorly directed to existing model paradigms that fail to represent the whole system or capture the full range of plausible futures. These shortcomings will continue to limit development of multi-functional and multi-staged schemes.
Anticipated benefits of CoRDDi Theme 1
Better evidence should **prevent unnecessary expenditure,** where initial examples have already shown the benefits of a whole-system approach; the Thames Estuary 2100 pre-study estimated expenditure requirements to be approximately £4 billion, but through a whole-system approach this was reduced to £300 million. The Environment Agency's Long-Term Investment Strategy looks at investment at a national scale across all functions and is an important first step to providing a more structured and transparent assessment of funding needs.
Increasing multi-functional approaches with multiple beneficiaries– whole-system models enable specific drivers of risk and associated beneficiaries of action to be identified, providing an evidence base to support **multiple funding contributions**.
The history of coastal management is littered with poor decisions that failed to recognise important interactions or maximise benefits. These include (for example) the persistence of hold-the-line policies and siting of power stations in unsuitable locations (such as Dungeness Power Station on the eroding side of a mobile ness). A whole-system approach promotes more innovative solutions and helps **prevent unsuitable policies and actions.**
The decision maker gains confidence in **developing innovative solutions** in the face of future change with the use of green infrastructure in tandem with, where necessary, hard infrastructure (seawall and saltmarsh).
Risks to successful delivery
Cross-cutting
Lack of coordination in specifying and tendering research projects that fail to link more basic research to development.
Lack of understanding and commonality of vision within the research community leading to unusable and poorly focused outputs from individual projects.
The measures of success used to judge the research community continue to promote individualism and fail to generate a ‘big society’ of research.
Specific
Funding is not provided to support the research, development, IT and dissemination required for whole-system modelling, leading to a series of disconnected, unusable models that almost work, but don't.
Whole-system models become too complex to use and are only operated by a limited ‘inner circle’.
Level of expenditure (taken from the costed programme)
£2 million to £7 million over five years

3.3 CoRDDi Theme 2 – Valuing impacts and promoting innovative funding

3.3.1 Drivers for Theme 2

The coast is home to many, a work place and business asset to others, and a heritage and environment cherished by all. Coastal communities are exposed to potentially widespread and life-threatening floods (such as the 1953 storm) as well as erosion losses that can seldom be regained. The coast is naturally dynamic and ever-changing - it is this dynamism that supports important, but often fragile, habitats and species. As such, the coast and the risks it faces are unique. The diversity of coastal environments and flood and erosion impacts are reflected in the decision-making process, but remains a significant challenge. This aspect of Theme 2 is also an important driver for ecosystem services (part of Theme 1) and links with Theme 3 of the CoRDDi Framework (decision making and operational practice) described in Section 3.4.

The coast is an excellent example of multiple interests demanding multi-functional schemes; promoting harbour use, ecosystem gain and tourism, for example, whilst reducing risk. Public sector expenditure will be heavily constrained in the coming years and delivering value for public money will always be a priority. Spending is likely to increasingly be scrutinised in terms of the opportunities it promotes (for economies and the environment) as well as the risk it reduces. This will demand a better appreciation of the 'true' value of risks and opportunities and a more integrated view of the benefits achieved.

Defra is currently consulting on a new funding system for capital investment projects from April 2012. The new system builds upon the current set of outcome measures but introduces the concept of paying set amounts per outcome delivered – payment for outcomes.

Theme 2 of the CoRDDi Framework focuses on socio-economic and funding issues. The key aspects of this theme are summarised in Figures 3.5 and 3.6.

Figure 3.5 Overview of aims and objectives of CoRDDi Theme 2

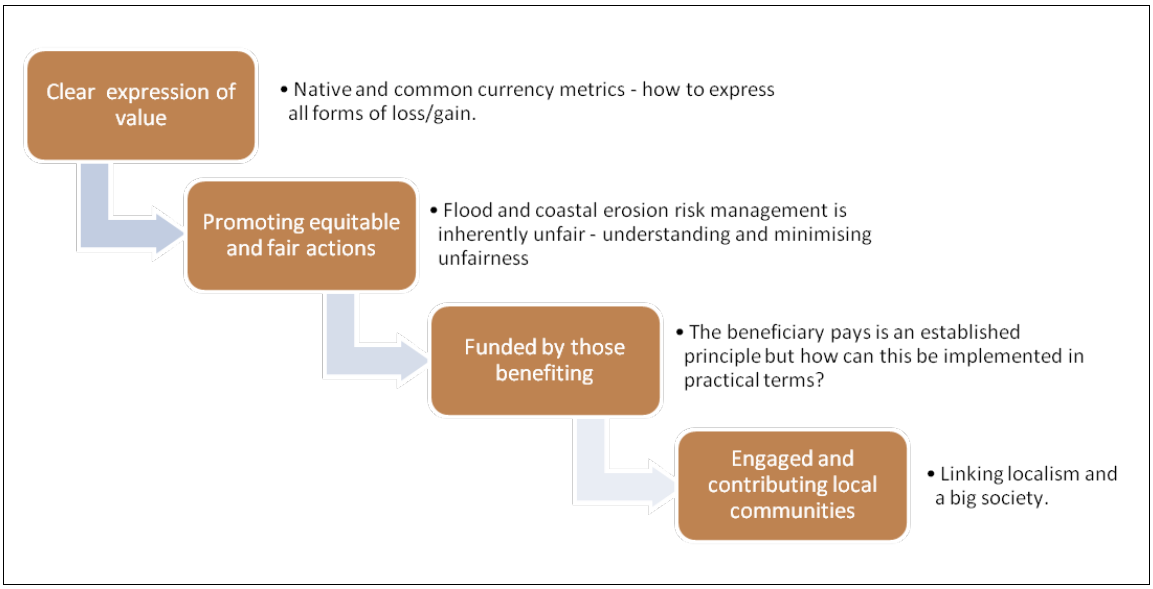


Figure 3.6 Structured approach to valuing impacts and promoting innovative funding

3.3.2 Business case for Theme 2

The business case for pursuing CoRDDi Theme 2 is set out below. Details of the priority projects with this theme are provided in Section 5 and Appendix 6.

Table 3.2 Business case for CoRDDi Theme 2

Valuing impacts and promoting innovative funding
Current level of understanding
Current understanding is functional. Well-established methods provide information on direct and, to some extent, indirect losses to the economy. However, we do not have a common currency of risk (monetised or otherwise) across the multitude of potential impacts and opportunities (wider economy, environmental impacts and ecosystem services, human health). We recognise that FCERM is neither fair nor equitable but have not fully agreed on how to address this.
Impact of doing nothing
Funding continues to follow the impacts that are most easily described, but these do not necessarily generate the greatest benefits/desired outcomes.
Our understanding of the winners and losers of FCERM expenditure remains basic and prevents evidenced-based targeting of multiple funding contributions. The public purse continues to be the primary support and private funding contributions are lower than they should be.
Under the Government's new capital funding scheme, instead of meeting the full costs of a limited number of schemes, the partnership approach to funding flood and coastal resilience means government money may be available towards the costs of any worthwhile scheme. Funding levels will be based on the number of households protected, the damages being prevented, and other benefits a project would deliver. Failure to represent these 'other' benefits could mean a reduction in funding.
Multi-functional schemes and projects fail to be promoted due to lack of understanding and ability to quantify benefits. The impact of failing to put in place multi-functional schemes would be narrow benefits (benefiting the few rather than the many).
Anticipated benefits
Greater range of sources of funding based on evidence of the **benefits accrued** by specific groups.
More multi-functional schemes - enabling **local regeneration** (West Bays joint harbour and coastal defence, Weston-Super-Mare promenade and flood defence) and **environmental enhancement** (Medmerry realignment which combines creating new intertidal habitat with flood defence; Alkborough which combines 440 ha of intertidal wetland creation with flood defence; Steart Peninsula which manages flood risk in a way that meets the needs of local people, as well as creating habitat) to be provided **alongside risk reduction**.
An ability to focus activities to **better achieve desired outcomes** - for example provision of integrated solutions that balance reducing risks with opportunity gains.
The ability to **appropriately invest** to manage rare high consequence events and meet legal obligations is understood (for example a major widespread surge, extreme sea-level rise, providing compensatory habitats), and the levels of investment are proportionate.
Investments are better targeted to reducing risks and **promoting opportunities that really matter** rather than those that can easily be counted.
Risks to successful delivery
Cross-cutting
Lack of coordination in specifying and tendering research projects that fail to link more basic research with development.
Lack of understanding and commonality of vision within the research community leading to unusable and poorly focused outputs from individual projects.
The measures of success used to judge the research community continue to promote individualism and fail to generate a 'big society' of research.
Specific

Inability to integrate the diversity of disciplines needed to value impacts.
An inability to express the outcomes achieved, leading to lack/loss of funding from beneficiary.
Level of expenditure (taken from the costed programme)
£1 million to £2 million over five years

3.4 CoRDDi Theme 3 – Decision making and operational practice

3.4.1 Drivers for Theme 3

CoRDDi Theme 3 focuses on building adaptive capacity within coastal policy, plans and actions. The rate of change in climate, demographics, political setting and the associated uncertainties present a major challenge to the decision-making processes and operational practice. All levels of decision making are included within this theme, with decisions based on improved understanding (tools and techniques) developed under CoRDDi Themes 1 and 2. CoRDDi reinforces the need for an integrated approach to decision making, both vertically, from UK-wide policy to local action, but also horizontally across ecosystem services, flood risk management and marine planning. The focus here is using the improved whole-system understanding and methods for valuing impacts and opportunities to make better choices in a transparent and participatory manner.

Figure 3.7 Overview of aims and objectives of CoRDDi Theme 3

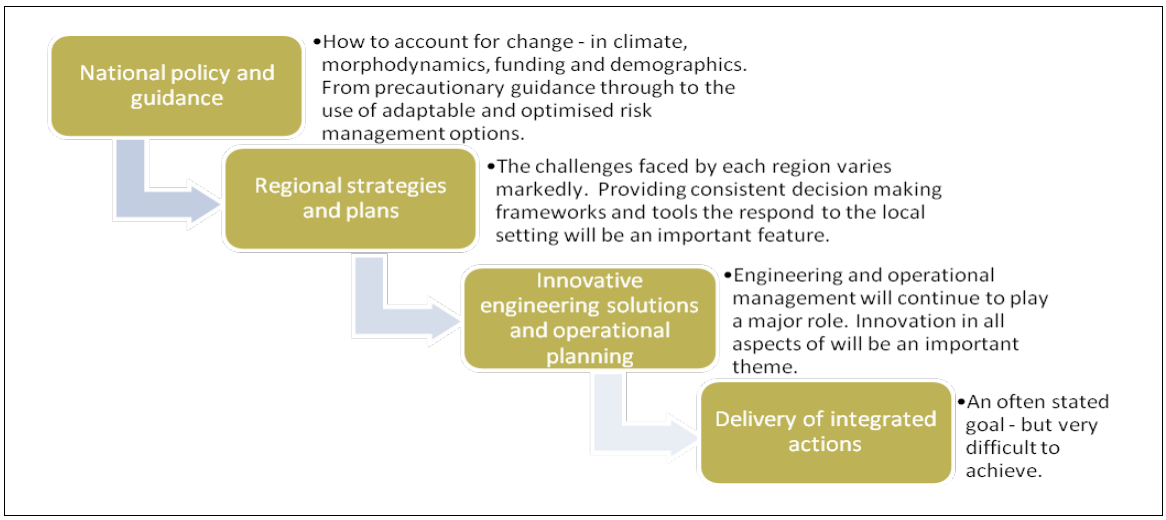


Figure 3.8 Structured approach to decision making and operational practice

3.4.2 Business case for Theme 3

The business case for pursuing CoRDDi Theme 3 is outlined below. Details of the priority projects with this theme are provided in Section 5 and Appendix 6.

Table 3.3 Business case for CoRDDi Theme 3

Decision making and operational practice
Current level of understanding
Adapting to coastal change is the challenge facing many coastal authorities and communities, made difficult by uncertainty in climate, funding and social change. Good progress has been made in recent years in large-scale and long-term planning (Foresight, Shoreline Management Plans, emergency preparedness planning including projects such as Watermark and progressive planning policies such as PPS25 and TAN15 based on well-publicised evidence on flood and coastal erosion risk, Coastal Habitat Management Plans and Marine Plans). However, Local Structure Plans remain relatively poorly connected to these wider activities, and spatial planning, decision making and adaptation are difficult to achieve locally. Progress is required to generate long-term and innovative solutions that integrate the various demands at the shoreline and within the coastal zone.
Impact of doing nothing
Disjointed and poorly integrated activities continue to be promoted, leading to poor use of resources and missed opportunities for multi-functional solutions.
Continued use of inappropriate/static extreme loads in design and decision criteria leading to over- or under-designed defences with limited capacity for change.
Non-adaptive solutions continue to be implemented leading to increased costs and disruption through repetition and removal, and legacy of poor decisions.
Roll back and set back continue to be difficult to implement due to lack of innovative thinking. Coastal habitats continue to be squeezed as a policy of 'hold the line' is maintained at an ever increasing cost.
Anticipated benefits
Reducing whole-life costs and unsuitable decisions as the use of real-option type decision technologies increasingly support the development of flexible strategies.
Better community engagement and ownership as new scenario testing methods help communities plan for change by highlighting what it might mean for them and future generations in clear meaningful terms.

Better strategies that are more efficient and effective in delivering desired outcomes. The development of risk assessment tools and optioneering methods/approaches for strategic planning purposes that include both flood risk and coastal change impacts.
Improved operational practices through improved guidance to practitioners.
Improved engagement with spatial planning reducing risk at source.
Integrated planning initiatives to maximise opportunities (accessing multiple funding and improving local ownership).
Risks to successful delivery
Cross-cutting
Lack of coordination in specifying and tendering research projects that link more basic research to development.
Lack of understanding and commonality of vision within the research community leading to unusable and poorly focused outputs from individual projects.
The measures of success used to judge the research community continue to promote individualism and fail to generate a big society of research.
Specific
The radical change in decision making that is required is underestimated and only taken on in a piecemeal fashion.
Reluctance to adopt complex and 'black box' approaches limit progress.
Only a handful change their mind-set while resistance to and misunderstanding of adaptive management continues.
Existing approaches are simply re-branded using the new taxonomy of adaptive capacity and integration - with limited innovation.
Level of expenditure (taken from the costed programme)
£1 million to £2 million over five years

3.5 CoRDDi Theme 4 – Dissemination, education and training

3.5.1 Drivers for Theme 4

The fourth theme within the CoRDDi Framework emphasises dissemination to a level not seen in previous studies (Figure 3.9). It seeks to better disseminate final outputs to encourage uptake and routine use, whilst keeping research outcomes under review in the light of experience gained through their application. This approach of progressive improvement will ensure the continuous development of new tools and techniques. It will also minimise repetition and re-invention, but will require a wide range of organisations to provide resources and fund activities.

Figure 3.9 Overview of aims and objectives of CoRDDi Theme 4

Each project within CoRDDi should have its own dissemination action plan based on the guidelines set out in Box 2. Alongside this will be dissemination of results from grouped projects at a higher level. Dissemination would need to be funded as a separate activity and could include lessons from pilots and case studies, presentations to coastal groups, development of a web portal or e-learning tools and publication of guidance. This would help promote uptake of the science and would provide additional mechanisms for accessing knowledge.

With planned dissemination aimed at defined users, the Framework will contribute greatly to operational delivery, provided enough resources are devoted to the initiatives. Links to training establishments and courses could strongly influence operational standards in the years to come.

Box 2 – Guidelines for dissemination at project level

Community and public engagement from the outset of the project through notices on websites, in newsletters and through coastal groups.

A dedicated website for the project set up with good links in search engines.

Regular updates of the website on results as the project progresses and notices to inform the posting of new results.

At least one interim public workshop or seminar held to discuss project progress and consensus on way forward.

If appropriate, case studies or pilots used to demonstrate the value of the work to the public and practitioners.

Each project to organise a training or education activity that draws together the final results of the project and highlights their value to the public.

If appropriate, establish an activity to train users in the tools.that have become available from the project

3.5.2 Business case for Theme 4

The business case for pursuing CoRDDi Theme 4 is listed below. Details of the priority projects with this theme are provided in Section 5 and Appendix 6.

Table 3.4 Business case for CoRDDi Theme 4

Dissemination, education and training
Current level of understanding
Recent years have seen big strides in archiving and sharing data on the coast (e.g. Channel Coastal Observatory) but much more could be done to enable data to be stored, accessed and reused.
The need for training and education is well understood but not always carried out, with limited links between practitioners, commercial researchers, academics and students. Good examples include CIRIA dissemination events and networks, and the increasing use of live meetings and webinars.
Dissemination and engagement has significantly improved in recent years. Useable software and guidance has proved successful with increasing use of standards and early involvement of target users; however, research and development continues to be wasted and re-invention often takes the place of innovation.
Impact of doing nothing
Low impact where good research is not used and low use where research is poor and not well targeted to user needs.
Good science fails to be converted into good practice.
Opportunities for maximising the transfer of knowledge between researchers and practitioners continue to be wasted.

Knowledge and expertise is lost from the increasingly diverse range of organisations involved in managing the coast.
Anticipated benefits
Better communication and **knowledge sharing** (for example, the Beach Management Manual brought together a wide range of funders, users and expertise).
Repetition and re-invention avoided, making room for **innovation**.
Evolution of **community codes** (through open source and open web sharing) **reduces costs** and promotes innovation.
Re-use of data including data from coastal observatories and national data management strategy and grey data (consultants, universities, insurers and the Environment Agency).
Clarity of intellectual property rights and **collaborative working** arrangements promoting joint funding and joint programmes (e.g. Flood Risk Management Research Consortium or FRMRC).
Risks to successful delivery
It is often difficult to guarantee funding for dissemination and take-up because an organisation prepared to offer funding may not be found.
Poor quality dissemination and/or software development leads to a loss of interest by community and user groups.
Lack of coordination leads to repetition in dissemination and fatigue in the recipients.
Level of expenditure (taken from the costed programme)
£1 million to £2 million over five years

4 Management of the CoRDDi Framework

4.1 Introduction

Recent years have seen a move to develop a coordinated approach to science. The *Living with Environmental Change* (LWEC) initiative provides this cohesion and all government funded-environmental research carried out by the Natural Environment Research Council (NERC), Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), Defra and the Environment Agency is included within LWEC. Executive management of LWEC is through the Partner Board with strategies on water, health and the economy. The CoRDDi Framework forms part of this process and hence must be set in the context of associated LWEC strategies. For example, CoRDDi takes its lead from the Flood Research Strategy currently being developed as an LWEC-wide initiative. The Flood Research Strategy will help to promote the idea of a community of research(ers) and practice(tioners). This hierarchy, and the focus at each stage, is summarised in Figure 4.1.

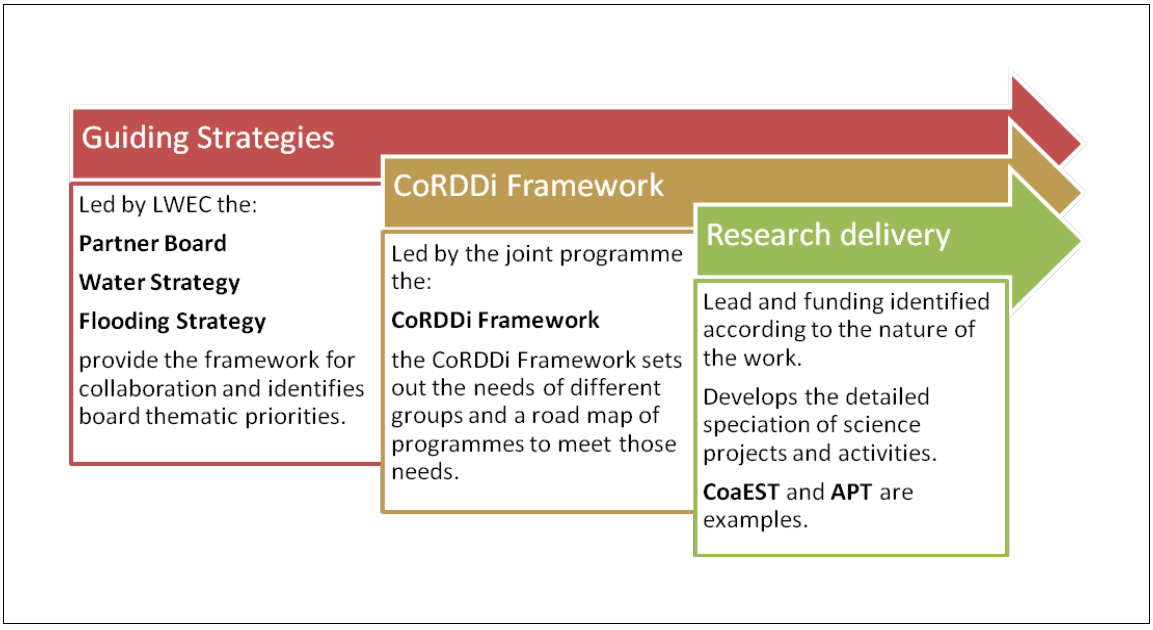


Figure 4.1 Summary of LWEC hierarchy of science strategies. CoaEST = Coastal and Estuarine System Tools. APT = Asset Performance Tools.

4.2 Issues to be addressed within the LWEC guiding strategies

A number of issues are best addressed at a higher level than within the CoRDDi Framework, with the LWEC strategies offering the best channels. Based on the consultation undertaken as part of the development of CoRDDi, the main characteristics of a successful collaborative RDD community are shown in Figure 4.2 and discussed in Appendix 4.

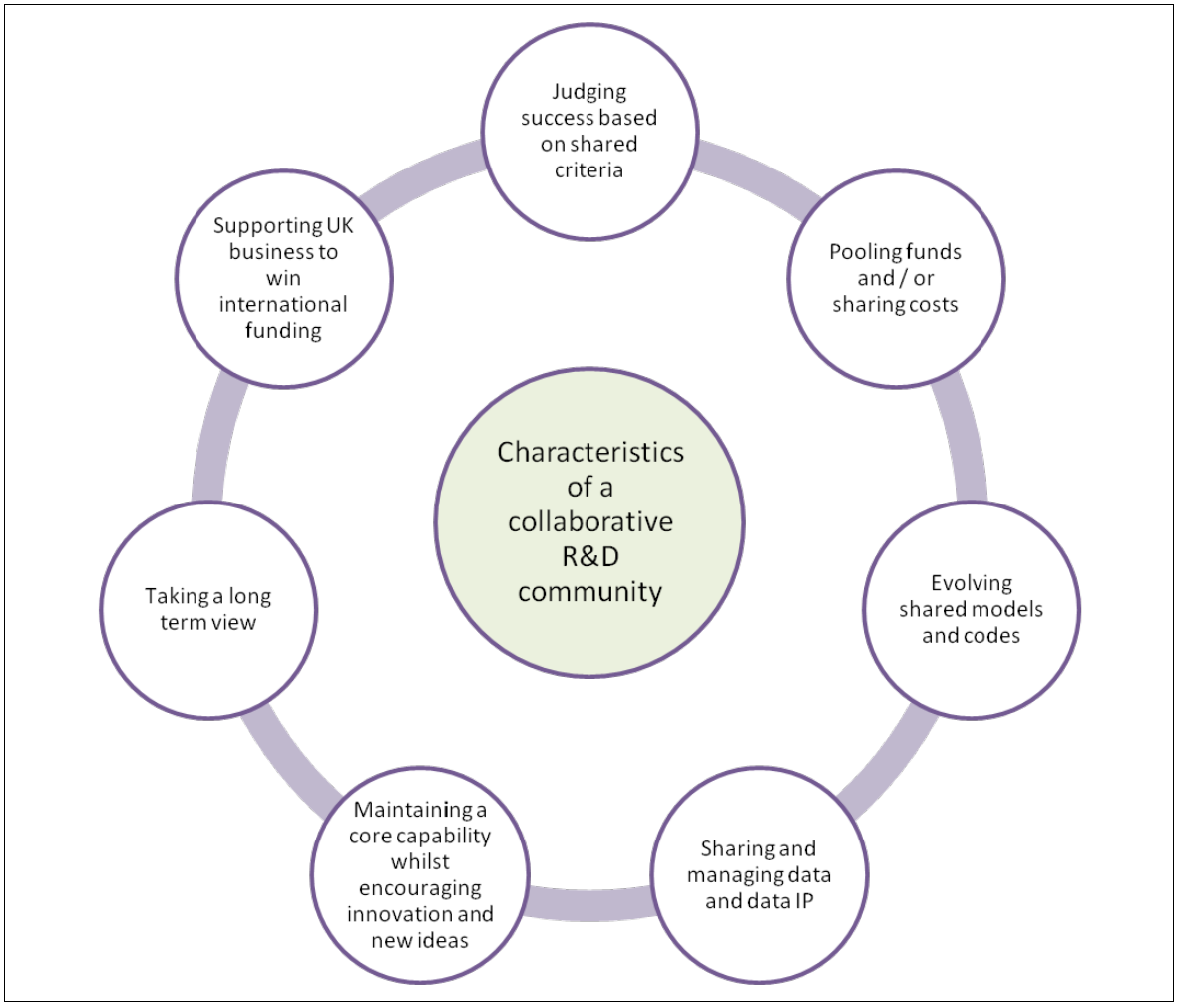


Figure 4.2 Characteristics of a collaborative RDD community

The Flood Research Strategy sets out the likely future governance structure of FCERM research in the UK. There is a clear need for research to be better coordinated across funding organisations, research councils and devolved administrations. Addressing this need will require a governance structure which can interface with or help evolve the joint Defra/Environment Agency FCERM R&D Programme.

The Flood Research Strategy is currently being designed around three core themes based on managing risk, where risk is a function of probability (likelihood) and consequence (impact). The three themes are:

- understanding risk;
- managing probability;
- managing consequences.

The Strategy outlines priority research areas for each theme. These are intended to form a crucial first part of the issues that need to be addressed by FCERM research over the next 20 years.

This Strategy not only sets out research priorities for the LWEC community, but also outlines the mechanisms by which research initiatives are prioritised and instigated. The LWEC Flood Research Strategy should build upon the strengths of the existing Joint Programme, whilst recognising the interests of all LWEC partners including the

research councils who need to focus more on societal, economic and environmental impact in addition to academic excellence when granting funding.

4.3 Governance: Joint Programme and CoRDDi

Until the governance arrangement is finalised in the Flood Research Strategy, the CoRDDi Framework should operate as follows:

i. **Coastal groups**: The proposed role of coastal groups would be to review the Framework as it progresses to ensure that the RDD capitalises on regional initiatives and vice versa. Regular presentations at coastal group meetings could be made alongside a more formal review through the Annual Score Card to ensure the direction of RDD is in line with coastal group objectives.

ii. **Joint Programme Theme Advisory Groups (TAGs)**: Each of the four current themes of the joint Defra/Environment Agency R&D Programme has a Theme Manager, who has day-to-day responsibility for the theme programme and a Theme Champion who provides overall direction to the theme. These two roles are supported by a Theme Advisory Group (TAG) providing input and review for their specific programme. Some CoRDDi projects are likely to be posted into the Joint Programme thematic structure. Hence, these representatives could act as intermediaries between CoRDDi and the Joint Programme .

iii. **LWEC partners**: A wide ranging group of organisations and individuals are supporting the development of the LWEC strategies. They could fulfil an important role in the governance and implementation of the CoRDDi Framework by aiding its dovetailing into the LWEC Flood Research Strategy. LWEC partners could provide impetus to the CoRDDi Framework to embed the concept of a community of researchers and practitioners. Regular dialogue between representatives of the LWEC community and the Framework managers would encourage integration.

iv. **Project Advisory Group**: At the outset of CoRDDi, a Project Advisory Group (PAG) was formed to define the Framework, help identify RDD gaps in FCERM, and provide advice. PAG members could provide the backbone of the review process as projects are commissioned. The PAG would be responsible for ensuring that the review process perpetuated the Framework, generating and prioritising new RDD as lessons are learnt.

4.4 Annual Score Card

The success of the CoRDDi programme will be formally reviewed as part of its ongoing management. Attributing societal and environmental benefits directly to investment within CoRDDi will be difficult, as such outcomes are likely to occur over longer timescales than the projects themselves. Monitoring benefits will form the basis by which further research funding within CoRDDi will be justified. An Annual Score Card has therefore been developed to form part of the annual review of the CoRDDi programme and the performance of the projects within it (Appendix 5). The Annual Score Card could be published as part of the Joint Programme newsletter.

As funders will use different criteria to judge the success of projects and programmes, a range of criteria (of interest across the spectrum of potential funders) has been

developed. These success criteria set targets for researchers. It is envisaged that the Score Card will be completed by the CoRDDi Board.

5 Theme priorities

5.1 Categorisation

This section sets out the priority topics for each of the four sub-themes (as shown in Figures 3.3 to 3.9), that in turn make up the four main themes of the CoRDDi Framework (as shown in Figure 3.2). For each topic, the needs/issues highlighted as important in the consultation process (Appendix 2) are listed and categorised based on three criteria (Table 5.1):

- suggested lead
- nature of the output
- cost

Table 5.1 Criteria used to categorise and prioritise the needs/issues under each theme

Suggested lead	Nature of the output	Cost
Research councils (RC)	Basic research (BR)	Low (L) < £100,000
National administrations (NA)	Applied research (AR)	Medium (M) = £100,000 to £250,000
Coastal groups (CG)	Development and pilots (DP)	High (H) > £250,000
	Dissemination and training (DT)	

A description of topic areas and the categorisation of needs/issues are presented in Appendix 6.

5.2 Prioritisation

5.2.1 Stage 1: Scheduling priority of needs/issues

For the prioritisation and scheduling of needs/issues within the CoRDDi Framework (Appendix 6), a two-stage approach was adopted. Stage 1 involved ascribing a scheduling priority. This process distinguished between ‘essential’ and ‘desirable’ needs/issues, between those of UK-wide significance and those of local value, and needs/issues to influence practice now against those needed at some stage in the future (for example, to inform future Shoreline Management Plans in five or ten years’ time). The original intention was to prioritise based on the following criteria:

- impact/benefit of the need/issue;
- whether addressing the need/issue fills a knowledge gap;
- the urgency of addressing the need/issue.

We soon realised that all needs/issues would address a gap in understanding; that is why they were identified in the first place. The assessment therefore focused on the other two criteria and a scoring system was developed based on the role of the need/issue in improving coastal risk and opportunity management. This scoring system is shown in Figure 5.1.

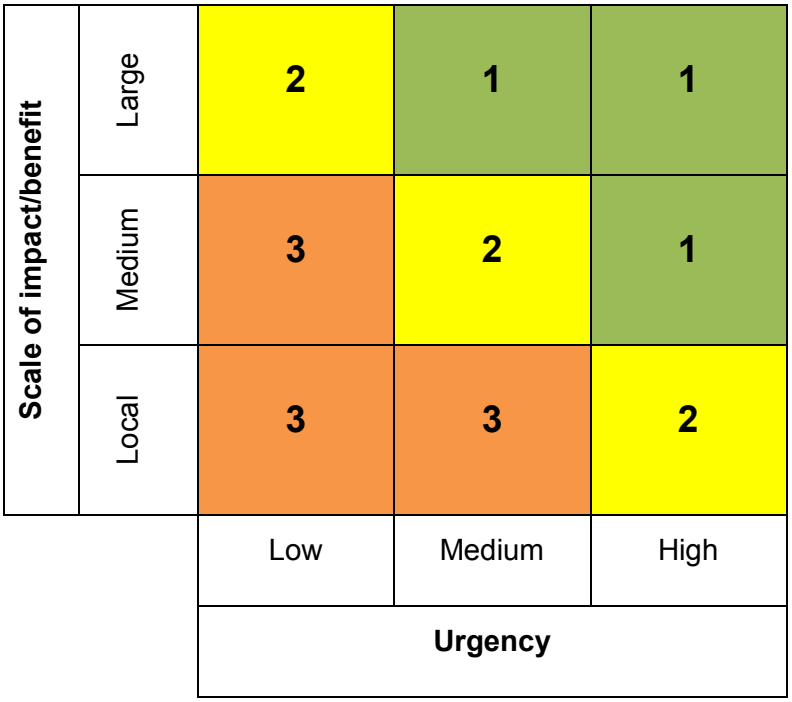


Figure 5.1 Scoring system for prioritising needs/issues

In this scoring system, large-scale initiatives are likely to have the greatest potential benefit (on the greatest number and widest range of beneficiaries) in the short, medium and long term on coastal risk and opportunity management, although the system also considers regional and local initiatives. To illustrate how the scoring system works, two examples are provided:

- Example 1: Engaging potential funding partners: this would have a large impact/benefit and would be of high urgency. On this basis, the project was ranked with a '1'.
- Example 2: Mechanisms for skills capacity building: the impact/benefit would be large (since it affects the industry as a whole) but at present there is greater skills availability than demand due to the downturn in the UK economic climate and therefore this project is (currently) of low urgency. On this basis, the project was ranked with a '2'.

5.2.2 Stage 2: Priority based on meeting the aims of CoRDDi

Once the needs/issues had been classified in Stage 1, they were then subject to a second stage of assessment to further differentiate between them, depending on their role in meeting the goals of the CoRDDi Framework and boosting data re-use and sharing. The attributes and scores used to prioritise needs/issues are described in Table 5.2.

Table 5.2 Attributes used to prioritise needs/issues

No	Attribute	Score	Description
1	Reflecting a bold aspiration for the future of flood and coastal erosion risk management	1 to 5	Opportunity to deliver multi-functionality
2	Covers the diverse interests of different groups (practitioners, funders and researchers)	1 to 5	Has a broad range of interested groups and will attract collaborative funding
3	Supports the political context	1 to 5	Greater weight on regional and locally funded projects where lessons can be extrapolated nationally
4	Fosters collaboration within the coastal research community	1 to 5	Achieves integration of science initiatives across a range of users
5	Success can be verified	1 to 5	Success has to be measured and demonstrated
6	Provides flexibility to ensure continued relevance	1 to 5	Has the capacity to respond to changing user needs and innovation
7	Data re-use and sharing	1 to 5	Data collected to national standards for archiving and use in other projects

The prioritised list of needs/issues is presented in Table 5.3 and a detailed breakdown and justifications of how the final list was produced are laid out in Appendix 6.

Table 5.3 Prioritised list of needs/issues

Theme	Number	Need/Issue	Suggested lead	Nature of the output	Cost	Stage 1		Stage 2								
						Scale of impact/benefit	Urgency	1	2	3	4	5	6	7	Total	Ranking
Theme 1	1.1	Update guidance on use of the most recent climate change predictions and models	NA	DT	L	Large	High	5	5	5	3	2	2	4	26	3
	1.2	Better understand ecosystem services provided by coastal habitats that benefit flood and coastal erosion risk management	NA	AR	M	Large	High	4	4	4	3	3	4	4	26	3
	1.3	Assess coastal defence vulnerability under the latest climate change projections	NA	DP	L	Large	High	3	5	4	2	4	2	4	24	5
	1.4	Develop tools to understand mixed beaches and their design criteria in management	NA	DP	M	Med	High	4	5	3	3	4	3	2	24	5
	1.5	Quantify the sensitivity of coastal recession at a national scale to the latest estimates of future sea-level rise	NA	AR	L	Large	High	4	5	2	2	3	2	4	22	10
	1.6	Assess the effects of latest climate change projections on waves and storm surges	RC	AR	M	Large	Med	4	5	3	1	4	2	3	22	10
	1.7	Improve the capability to predict long-term and regional-scale changes on the coasts and in estuaries	RC	AR	H	Large	Med	5	4	2	1	3	2	4	21	15
	1.8	Develop a tiered integrated framework for asset performance tools	NA	AR	L	Large	High	2	2	2	3	4	2	5	20	17
	1.9	Develop an asset performance data and coastal asset information management system	NA	DP	L	Large	High	2	4	2	3	2	2	5	20	17
	1.10	Understand the processes controlling rates of cohesive shore platform erosion	RC	AR	M	Large	High	3	3	2	3	2	3	4	20	17
	1.11	Improve understanding of the performance and differential transport of mixed beaches	NA	AR	M	Med	High	2	5	3	1	2	3	4	20	17
	1.12	Better understand the dynamic interaction between beaches and adjacent structures	RC	AR	M	Large	Med	2	3	3	3	3	2	4	20	17
	1.13	Provide guidance on options for managing cohesive shore platforms	NA	DT	L	Med	High	3	3	2	3	3	2	2	18	27
	1.14	Undertake a scoping study of the potential to link multi-scale models	RC	DP	L	Large	High	3	2	4	2	2	3	2	18	27
Theme 2	2.1	Define the value of ecosystem services in large-scale cost-benefit studies	NA	DP	L	Large	Med	3	5	2	5	4	2	1	22	10
	2.2	Develop methods for innovation in coastal defence schemes	NA	DP	L	Large	High	4	4	2	3	4	3	2	22	10
	2.3	Improve methods of attributing the benefits from flooding and erosion to people and the environment	NA	DP	M	Large	High	3	4	3	5	2	2	1	20	17

Theme	Number	Need/Issue	Suggested lead	Nature of the	Cost	Stage 1		Stage 2								
	2.4	Increase the engagement of potential funding partners	NA	DP	L	Large	High	3	5	1	5	4	1	1	20	17
	2.5	Develop a framework for systematic inclusion of social choice within the decision making process and procedures	NA	DP	L	Large	High	4	3	3	4	2	3	1	20	17
	2.6	Review best practice and lessons learned from existing mechanisms of community participation and develop guidance	NA	DT	L	Large	High	2	2	3	5	4	2	2	20	17
Theme 3	3.1	Provide guidance and case studies on practical adaptation measures for managing coastal change	NA	DT	M	Large	High	5	5	3	5	5	3	2	28	1
	3.2	Scope the potential to link National Flood Risk Assessment (NaFRA) and National Coastal Erosion Risk Mapping (NCERM) to provide an integrated national appraisal of flood risk and coastal erosion risk	NA	DP	M	Large	High	5	4	2	4	2	5	5	27	2
	3.3	Review the influences of SMP2 and PPS25 on land-use planning decisions	CG	DP	L	Large	Med	3	5	4	5	3	2	2	24	5
	3.4	Develop methods to integrate flood and coastal erosion risk management with marine spatial planning	NA	DP	M	Large	High	5	5	2	4	3	3	1	23	8
Theme 4	4.1	Create a web portal for hosting coastal RDD information	NA	DT	M	Large	Med	2	5	2	4	2	3	5	23	8
	4.2	Develop visualisation tools to communicate management concepts and uncertainty	NA	DT	M	Large	Med	3	4	2	4	3	2	4	22	10
	4.3	Review the quality of existing RDD data to guide future monitoring and storage	NA	DT	M	Large	Med	1	4	2	1	4	4	5	21	15
	4.4	Develop methods to communicate uncertainty and sensitivity to the public and practitioners	NA	DT	L	Large	Med	2	5	2	4	3	3	1	20	17
	4.5	Create a web-based guide to coastal morphological assessment	NA	DT	M	Large	Med	1	3	2	2	2	2	5	17	28

To determine the sensitivity of the final score to changes in the attribute scores, a simple sensitivity test was applied to the priority list of needs/issues. The list (29 needs/issues) was divided into two halves; higher ranked (14) and lower ranked (15) needs/issues. The total for each attribute was calculated for each half and compared. Attribute totals with the greatest difference between the two halves were considered to represent the most sensitive attributes. This process demonstrated that the ranking was most sensitive to attributes relating to *"a bold aspiration for the future"* and "*diverse interest of different groups"* and was least sensitive to "*data re-use and sharing*". The results of this analysis are shown in Table 5.4.

Table 5.4 Sensitivity of priority scores to changes in attribute scores

Attribute	Total for high scoring projects	Total for low scoring projects	Difference (sensitivity)
Reflecting a bold aspiration for the future of flood and coastal erosion risk management	54	38	16
Covers the diverse interests of different groups (practitioners, funders and researchers)	66	52	14
Supports the political context	40	36	4
Fosters collaboration within the coastal research community	48	45	3
Success can be verified	46	42	4
Provides flexibility to ensure continued relevance	38	36	2
Data re-use and sharing	43	46	-3

If new attributes are considered within the framework, Table 5.4 shows which of the existing attributes would have to be 'relaxed' to change the overall ranking.

5.2.3 Stage 3 – Priority projects based on needs/issues

The final list of needs/issues inTable 5.3 is the culmination of consultation and review followed by prioritisation based on the ranking criteria described in Stage 1 and Stage 2. Stage 3 of the process was to develop a set of fundable projects, each with objectives mapped against these needs/issues. The projects are sorted by theme, then by overall ranking (where projects incorporate several needs/issues, the highest ranked one is used). For each project, a cost is estimated based on the combined value of all the needs that are met by the project. Costs are divided into low (below £200,000), medium (£200,000 to £1 million) and high (above £1 million). These costs are used as a basis for the costed programme (Section 6).

Eighteen projects have been developed, providing a blend across the themes as summarised in Figure 5.2 and Sections 5.3 to 5.6.

Figure 5.2 Priority projects across the CoRDDi themes

5.3 CoRDDi Theme 1 – Understanding whole-system behaviour

The following tables describe potential projects under Theme 1 and their aims.

Table 5.5 Climate change impacts on coastal processes

<table>
<tr><td colspan="4">Sub-theme: Long-term and regional-scale processes
Priority topic area: Climate change</td></tr>
<tr><td colspan="4">Understanding the links between climate and coastal change remains an area in need of further research. Our understanding of climate change continues to evolve and coastal managers have formally been preparing for climate change within their plans, strategies and the design of flood and coastal defence schemes since the mid-1990s, based on Defra guidance and design allowances. Best practice and guidance will need to be updated as understanding of climate improves.</td></tr>
<tr><td colspan="4">Project title: Climate change impacts on coastal processes</td></tr>
<tr><td rowspan="5">Project needs/issues, score and ranking (Table 5.3)</td><td>Number</td><td>Score</td><td>Ranking</td></tr>
<tr><td>1.1</td><td>26</td><td>3</td></tr>
<tr><td>1.3</td><td>24</td><td>5</td></tr>
<tr><td>1.5</td><td>22</td><td>10</td></tr>
<tr><td>1.6</td><td>22</td><td>10</td></tr>
<tr><td colspan="4">Objectives</td></tr>
<tr><td colspan="4">Improve understanding of the vulnerability of man-made and natural defence systems to climate change</td></tr>
<tr><td colspan="4">Determine sensitivity of coastal recession to climate change</td></tr>
<tr><td colspan="4">Improve understanding of potential changes to waves and storm surge</td></tr>
<tr><td colspan="4">Publish updated practical guidance on climate change</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">Project cost: medium</td></tr>
<tr><td colspan="4">Lead: Joint NA/RC</td></tr>
<tr><td colspan="4">Outputs: Applied research, development and dissemination</td></tr>
</table>

Table 5.6 Ecosystem service benefits to flood and coastal erosion risk management

Sub-theme: Eco-morphological interactions **Priority topic area: Ecosystem goods and services**			
Coastal areas provide important ecosystem services, particularly natural protection from coastal or tidal flooding. A coastline that is eroding threatens these services and leads to the loss of land of economic and ecological value, human life and property. However, coastal erosion in one area may provide ecosystem services elsewhere, for example where cliff erosion creates beaches which, in turn, provide natural protection.			
Project title: Ecosystem service benefits to flood and coastal erosion risk management			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	1.2	26	3
Objectives			
Integrate understanding of eco-morphological and hydrodynamic processes			
Assess the benefits of wetlands and natural systems in providing flood and erosion benefits			
Examine the re-use of dredged material for the benefit of ecosystem services			
Comments			
Project cost: Low			
Lead: NA			
Output: Applied research			

Table 5.7 Behaviour of mixed beaches and their management

Sub-theme: Short-term and local-scale processes **Priority topic area: Behaviour of mixed beaches**			
Currently, guidance for shoreline managers on mixed beach landforms is limited and there is scope to provide more advice on management options. Although our understanding of processes has improved, gaps in knowledge could be filled by the CoRDDi Framework.			
Project title: Behaviour of mixed beaches and their management			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	1.4	24	5
	1.11	20	17
Objectives			
Understand the modes of differential sediment transport and influence of particle size distribution on processes			
Test the behaviour of a mixed beach compared to a gravel beach using case studies of two beaches			
Develop tools to understand design criteria for nourishment of mixed beaches			
Comments			
Project cost: Medium			
Lead: NA			
Outputs: Applied research and development			

Table 5.8 Coastal sediment systems framework and model development

Sub-theme: Long-term and regional-scale processes **Priority topic area: Geomorphological processes**			
The morphological evolution of coastlines and estuaries over extended timescales alters flood and coastal erosion risk, yet the tools available to understand longer-term morphological change are limited. Existing tools are rarely linked with asset and flood/erosion risk models, or indeed ecosystem models. To address this issue, the Coastal and Estuarine Systems Tools (CoaEST) project was commissioned to better understand long-term morphological change along our coastlines. CoaEST forms a central programme of research within CoRDDi. The main outcome of CoaEST has been to define the Coastal Sediment Systems programme in collaboration with NERC.			
Project title: Coastal sediment systems framework and model development			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	1.7	21	15
Objectives			
Systems modelling framework			
Development of behavioural geomorphic models			
Application			
Pathway to impact			
Comments			
Currently funded through the NERC Natural Hazards Theme supported by the Environment Agency			
Project cost: High			
Output: Applied research			

Table 5.9 Asset performance tools integrated tiered framework and data management

<table>
<tr><td colspan="4">Sub-theme: Long-term and regional-scale processes
Priority topic area: Whole-life performance of coastal infrastructure assets</td></tr>
<tr><td colspan="4">To optimise investment of limited resources, understanding the performance and cost of construction, maintenance, upgrading or replacement of flood and erosion infrastructure assets on a whole-life basis will be an increasingly critical component of good decision making. Understanding and quantifying the change in performance over time (for example deterioration rates) and optimising where and when to invest (taking account of whole-life costs) will be essential. Research priorities have recently been identified within the Asset Performance Tools (APT) study. Many of the findings of this study are relevant to the coast and form a central topic within CoRDDi. APT studies are broken down into a series of scheduled packages of work.</td></tr>
<tr><td colspan="4">Project title: Asset performance tools integrated tiered framework and data management</td></tr>
<tr><td rowspan="3">Project needs/issues, score and ranking (Table 5.3)</td><td>Number</td><td>Score</td><td>Ranking</td></tr>
<tr><td>1.8</td><td>20</td><td>17</td></tr>
<tr><td>1.9</td><td>20</td><td>17</td></tr>
<tr><td colspan="4">Objectives</td></tr>
<tr><td colspan="4">Develop an integrated tiered framework for coastal asset inspection, performance assessment and asset management planning (Package F of APT)</td></tr>
<tr><td colspan="4">Develop data and coastal asset information management systems (Package D of APT)</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">Project cost: Low</td></tr>
<tr><td colspan="4">Lead: NA</td></tr>
<tr><td colspan="4">Outputs: Applied research and development</td></tr>
</table>

Table 5.10 Understanding and managing cohesive shorelines

<table>
<tr><td colspan="4">Sub-theme: Long-term and regional-scale processes

Priority topic area: Behaviour of cliff, platform, beach and coastal protection systems</td></tr>
<tr><td colspan="4">Cliff recession and its relationship with the beach, shore platform and coastline position is a long-term issue at the heart of developing a sustainable approach to shoreline management. The lack of information on long-term coastal processes impedes decision-making. The current National Coastal Erosion Risk Mapping (NCERM) project offers a useful method, but it is limited in its regional and local applicability.</td></tr>
<tr><td colspan="4">Project title: Understanding and managing cohesive shorelines</td></tr>
<tr><td rowspan="4">Project needs/issues, score and ranking (Table 5.3)</td><td>Number</td><td>Score</td><td>Ranking</td></tr>
<tr><td>1.10</td><td>20</td><td>17</td></tr>
<tr><td>1.12</td><td>20</td><td>17</td></tr>
<tr><td>1.13</td><td>18</td><td>27</td></tr>
<tr><td colspan="4">Objectives</td></tr>
<tr><td colspan="4">Quantify the processes controlling rates of cohesive shore platform erosion</td></tr>
<tr><td colspan="4">Examine the dynamic interaction between beaches, cohesive shore platforms and adjacent coastal structures</td></tr>
<tr><td colspan="4">Provide probabilistic projections of future beach and shore platform levels</td></tr>
<tr><td colspan="4">Publish practical guidance on managing cohesive shorelines</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">Project cost: Medium</td></tr>
<tr><td colspan="4">Lead: RC with NA support</td></tr>
<tr><td colspan="4">Outputs: Applied research, development and dissemination</td></tr>
</table>

Table 5.11 Scoping and development of the potential to integrate multi-scale models and decisions

Sub-theme: Multi-scale integration **Priority topic area: Integration of multi-scale models**			
Whole-system models and integrated decision making need to move seamlessly from one notional scale to another; from policy to action and from local storm response to long-term regional change. To date, long-term broad-scale models and local storm response models have been typically developed and used in separate analyses. Providing frameworks that combine short-term response models within a broad-scale model offers significant advantages, but incorporating this into practice remains a challenge.			
Project title: Scoping and development of the potential to integrate multi-scale models and decisions			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	1.14	18	27
Objectives			
Develop a framework to integrate multi-temporal and spatial scale models (beyond simply data exchange)			
Develop the practical software and process support to the framework			
Demonstrate the practical application of the framework within a pilot study, including both policy and more local questions			
Comments			
Project cost: Scope (low) develop (high)			
Lead: RC			
Outputs: Development			

5.4 CoRDDi Theme 2 – Valuing impacts and promoting innovative funding

The following tables outline potential projects under Theme 2 and their aims.

Table 5.12 Valuing ecosystem services in flood and coastal erosion risk management

Sub-theme: Valuing impacts and opportunities **Priority topic area: Opportunity gain**			
Coastal management has traditionally focused on reducing risk. But to be successful and sustainable in the longer term, the management of flood and coastal erosion risk must be allied with broader development. The coastal environment is a good example where opportunities to enhance it go hand-in-hand with investments to reduce risk. However, various barriers exist to doing so, including funding mechanisms.			
Project title: Valuing ecosystem services in flood and coastal erosion risk management			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	2.1	22	10
Objectives			
Review of ecosystem services in large-scale cost-benefit studies to transfer lessons and promote good practice			
Develop an agreed means of promoting the value of ecosystem services within a cost-benefit analysis on an equal footing with traditional monetised benefits			
Provide a practical framework to enable the value of ecosystem services to be identified, expressed and reviewed			
Comments			
Project cost: Low			
Lead: NA			
Output: Development			

Table 5.13 Innovation in coastal defence schemes

Sub-theme: Promoting multiple and innovative funding **Priority topic area: Innovation and funding**			
The need to attract multiple sources of funding is a practical reality as central government funding is reduced and localism is promoted. This approach adopts the 'beneficiary pays' principle.			
Project title: Innovation in coastal defence schemes			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	2.2	22	10
	2.4	20	17
Objectives			
Develop methods to boost the value of coastal defence schemes such as regeneration/amenity, environmental enhancement (ecology, landscape, access) and renewable energy (micro-wind, wave power, etc).			
Build on the payment for outcomes framework to develop tools for assessing and demonstrating the flow of payments.			
Comments			
Project cost: Medium			
Lead: NA			
Output: Development			

Table 5.14 Attribution of benefits from flooding and erosion

Sub-theme: Valuing impacts and opportunities **Priority topic area: Valuing multiple benefits**			
Attributing the benefits to individuals, communities and organisations is the first step in providing the evidence base to secure funding. It is important to identify the beneficiaries of coastal management action, and the degree to which they benefit. The lack of good research currently reduces our ability to assess multiple benefits (and beneficiaries) and this undermines our ability to marshal multiple funding streams.			
Project title: Attribution of benefits from flooding and erosion			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	2.3	20	17
Objectives			
Enable benefits to be routinely disaggregated into specific beneficiaries, both in the short term and long term			
Identify beneficiaries and funders for future FCERM schemes			
Comments			
Project cost: Low			
Lead: NA			
Output: Development			

Table 5.15 Developing a framework for inclusion of social choice

Sub-theme: Supporting social justice and equity **Priority topic area: Social choice**			
A fundamental principle of sustainable development is that people should be able to contribute fully to the decisions that shape their own lives, and the future of their children and grandchildren. Developing methods and approaches to include social choice in the decision-making process is important.			
Project title: Developing a framework for inclusion of social choice			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	2.5	20	17
Objectives			
Develop framework for systematic inclusion of social choice in decision making			
Integrate framework within the 'Big Society' agenda			
Comments			
Project cost: Low			
Lead: NA			
Outputs: Development			

Table 5.16 Best practice in local participation

Sub-theme: Engaging local communities in both decisions and actions **Priority topic area: Encouraging local participation**			
Local participation in decisions made, and funding, monitoring and maintenance of measures, could be improved. This is not easily achieved and expertise is needed within public bodies to ensure local participation is effective. Existing mechanisms require review, and where necessary will need to be reformed.			
Project title: Best practice in local participation			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	2.6	20	17
Objectives			
Improve mechanisms of engaging local communities, building on Pathfinder projects			
Publish best practice guidance on local participation			
Comments			
Project cost: Low			
Lead: NA			
Outputs: Development and dissemination			

5.5 CoRDDi Theme 3 – Decision making and operational practice

The following tables describe potential projects under Theme 3 and their aims.

Table 5.17 Guidance on adaptation measures for managing coastal change

<table>
<tr><td colspan="4">Sub-theme: National policy (also regional and strategy planning)
Priority topic area: Policy development</td></tr>
<tr><td colspan="4">The new Planning Policy on Development and Coastal Change focuses primarily on the impacts of permanent coastal change. It links spatial planning with Shoreline Management Plans (SMPs, developed after PPG20 was written), and introduces a new evidence-based planning designation in the form of Coastal Change Management Areas (CCMAs). New tools developed under the CoRDDi Framework could improve the evidence base for CCMA decision making. Current tools are largely based on SMPs and recession data from the National Coastal Erosion Risk Mapping project. Adapting to coastal change is a task facing many coastal authorities and communities, made especially difficult by the uncertainty in predictions. The CoRDDi Framework could provide scenario-testing methods to help communities plan for change by highlighting what it might mean for them and for future generations.</td></tr>
<tr><td colspan="4">Project title: Guidance on adaptation measures for managing coastal change</td></tr>
<tr><td rowspan="2">Project needs/issues, score and ranking (Table 5.3)</td><td>Number</td><td>Score</td><td>Ranking</td></tr>
<tr><td>3.1</td><td>28</td><td>1</td></tr>
<tr><td colspan="4">Objectives</td></tr>
<tr><td colspan="4">Use knowledge gained from the Pathfinder projects to create practical guidance on coastal adaptation</td></tr>
<tr><td colspan="4">Develop new tools to improve understanding of the potential impact of climate change on coastal science</td></tr>
<tr><td colspan="4">Provide improved scenario testing methods</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">Project cost: Low</td></tr>
<tr><td colspan="4">Lead: NA</td></tr>
<tr><td colspan="4">Outputs: Development and dissemination</td></tr>
</table>

Table 5.18 Scoping study to develop an integrated national appraisal of flood risk and erosion risk

Sub-theme: Operational implementation and engineering innovation **Priority topic area: Operational practice**			
A better understanding of coastal processes and behaviour and the impacts of interventions gained from CoRDDi projects could improve operational practices and guidance to practitioners. Linking erosion and flood risk models and analysis and understanding of the relationship between flood and erosion risk are important components.			
Project title: Scoping study to develop an integrated national appraisal of flood risk and erosion risk			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	3.2	27	2
Objectives			
Build upon past studies (PAMS/RACE projects) to produce a unified coastal risk analysis			
Support the next generation of NaFRA, NCERM and UK Climate Change Risk Assessment (CCRA) with better physical representation and confidence in assessments			
Integrate the outputs with the results of the Pathfinder and follow-up projects			
Comments			
Project cost: Low			
Lead: NA			
Output: Development			

Table 5.19 Review of SMP2 and PPS25 influences on land-use planning decisions

Sub-theme: Better alignment and integration of local and national planning **Priority topic area: Better integration**			
Many organisations are involved in managing the coastline. Shoreline Management Plans and coastal strategies provide the link between FCERM and broader plans to manage the coastal zone. However, lack of engagement with spatial planning continues to increase flood risk. The CoRDDi Framework can boost the connection to the spatial planning process.			
Project title: Review of SMP2 and PPS25 influences on land-use planning decisions			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	3.3	24	5
Objectives			
Measure the success of SMPs and planning policies in modifying spatial plans			
Identify good and bad practice			
Provide guidance on how to integrate various planning instruments to generate sustainable change in high risk areas			
Comments			
Project cost: Low			
Lead: CG			
Output: Development			

Table 5.20 Integrating flood and coastal erosion risk management with marine spatial planning

Sub-theme: Regional and strategic planning **Priority topic area: Strategic planning**			
The Coastal Change Supplement (to PPS25) adopts a risk-based approach to development and flood risk; that is, to appraise the risk, identify areas at risk, avoid inappropriate development in those areas, manage the risk and mitigate its impact. The CoRDDi Framework could help in the development of risk assessment tools and optioneering methods for strategic planning that include both flood risk and coastal change impact.			
Project title: Integrating flood and coastal erosion risk management with marine spatial planning			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	3.4	23	8
Objectives			
Develop methods to incorporate FCERM in marine spatial planning			
Develop a pilot or demonstration project to test integration methods in Marine Plan Area 3 (east coast)			
Comments			
Project cost: Medium.			
Lead: NA			
Output: Development			

5.6 CoRDDi Theme 4 – Dissemination, education and training

The following tables describe potential projects under Theme 4 projects and their aims.

Table 5.21 Dissemination of CoRDDi outputs

<table>
<tr><td colspan="4">Sub-theme and priority topic area: Knowledge management and access</td></tr>
<tr><td colspan="4">A major failing in past years has been our inability to convert good science into good practice, partly due to lack of resources and underestimation of the effort needed. In the CoRDDi Framework, improved dissemination and a faster transfer of research results into practice is an important feature of individual projects and the Framework as a whole.</td></tr>
<tr><td colspan="4">Project title: Dissemination of CoRDDi outputs</td></tr>
<tr><td rowspan="5">Project needs/issues, score and ranking (Table 5.3)</td><td>Number</td><td>Score</td><td>Ranking</td></tr>
<tr><td>4.1</td><td>23</td><td>8</td></tr>
<tr><td>4.2</td><td>22</td><td>10</td></tr>
<tr><td>4.4</td><td>20</td><td>17</td></tr>
<tr><td>4.5</td><td>17</td><td>28</td></tr>
<tr><td colspan="4">Objectives</td></tr>
<tr><td colspan="4">Improve access through a web portal hosting and signposting coastal RDD information, tools and data</td></tr>
<tr><td colspan="4">Develop visualisation tools to communicate management concepts (including change and uncertainty) to professionals and public alike</td></tr>
<tr><td colspan="4">Develop non-technical methods to communicate uncertainty and sensitivity to the public and practitioners</td></tr>
<tr><td colspan="4">Develop a web-based guide to coastal morphological assessment</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">Project cost: Medium</td></tr>
<tr><td colspan="4">Lead: NA</td></tr>
<tr><td colspan="4">Output: Dissemination</td></tr>
</table>

Table 5.22 Review of data benchmarking and holdings

Sub-theme and priority topic area: Data archiving, access and benchmarks			
Monitoring required on national, regional and local scales could be commissioned through more formal links to the National Coastal Monitoring Programme and UKCMF. At the very least, data should be collected to national standards and stored in a central portal with metadata. Within the projects commissioned through CoRDDi, new data would be collected as necessary for the duration of the project. If these data were found to be useful at operational levels, funding could be transferred to continue monitoring through national or regional programmes. In the absence of a sponsor, the data would be deemed not of sufficient value to continue. The CoRDDi Framework could support formal links through more regional studies, piggy-backing on regional studies commissioned through the coastal observatories. This would reduce procurement costs and ensure that data is held for onward use at the observatories.			
Project title: Review of data benchmarking and holdings			
Project needs/issues, score and ranking (Table 5.3)	Number	Score	Ranking
	4.3	21	15
Objectives			
Review the quality of existing coastal RDD data to guide future data capture			
Develop methods to maximise re-use of existing data			
Comments			
Project cost: Low			
Lead: NA			
Output: Development			

6 Indicative costed programme

The proposed costed programme for priority projects is shown in Table 6.1. The programme is indicative only as requirements may change, but it represents the current position based upon presently identified needs.

Although the priority projects are expected to absorb a substantial amount of available funding, their timing needs to remain flexible to ensure optimum outcomes from annual budgets. As yet unidentified needs are likely to arise from new initiatives, new circumstances, or developments in ongoing RDD that influence future project thinking. While allowance is made for these in the programme (the empty blocks beneath each theme), the additional needs may affect the timing of particular projects and the profile of expenditure. Assessing these needs and thus any changes in priorities or budgets will be through annual evaluation of new proposals or proposed changes via the governance process set out in the CoRDDi Framework.

Table 6.1 Costed programme

Theme	Project	Rank	Year 1	2	3	4	5
1	Topic: Climate Change	3, 5, 10, 10	£200,000-£1 million				
	Project: Climate change impacts on coastal processes						
	Topic: Ecosystem Goods and Services	3	<£200,000				
	Project: Ecosystem service benefits to flood and coastal erosion risk management						
	Topic: Behaviour of Mixed Beaches	5, 17	£200,000-£1 million				
	Project: Behaviour of mixed beaches and their management						
	Topic: Geomorphological Processes	15		>£1 million			
	Project: Coastal sediment systems framework and model development						
	Topic: Whole-life Performance of Coastal Infrastructure Assets	17, 17		<£200,000			
	Project: Asset performance tools integrated tiered framework and data management						
	Topic: Behaviour of Cliff, Platform, Beach and Coastal Protection Systems	17, 17, 27			£200,000-£1 million		
	Project: Understanding and managing cohesive shorelines						
	Topic: Integration of Multi-scale Models	27			£200,000-£1 million		
	Project: Scoping and development of the potential to integrate multi-scale models and decisions						
2	Topic: Opportunity Gain	10		<£200,000			
	Project: Valuing ecosystem services in flood and coastal erosion risk management						
	Topic: Innovation and Funding	10, 17	£200,000-£1 million				
	Project: Innovation in coastal defence schemes						
	Topic: Valuing Multiple Benefits	17				<£200,000	
	Project: Attribution of benefits from flooding and erosion						
	Topic: Social Choice	17				<£200,000	
	Project: Developing a framework for inclusion of social choice						
	Topic: Encouraging Local Participation	17			<£200,000		
	Project: Best practice in local participation						
3	Topic: Policy Development	1	<£200,000				
	Project: Guidance on adaptation measures for managing coastal change						
	Topic: Operational Practice	2	<£200,000				
	Project: Scoping study to develop an integrated national appraisal of flood risk and erosion risk						
	Topic: Better Integration	5		<£200,000			
	Project: Review of SMP2 and PPS25 influences on land-use planning decisions						
	Topic: Strategic Planning	8		£200,000-£1 million			
	Project: Integrating flood and coastal erosion risk management with marine spatial planning						
4	Topic: Knowledge Management and Access	8, 10, 17, 29	£200,000-£1 million				
	Project: Dissemination of CoRDDi outputs						
	Topic: Data Archiving, Access and Benchmarks	15	<£200,000				
	Project: Review of data benchmarking and holdings						

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List of abbreviations

ALSF - Aggregates Levy Sustainability Fund

APT - Asset Performance Tools

CCRA – Climate Change Risk Assessment

CoaEST - Coastal and Estuarine System Tools

CoRDDi - Coastal Research, Development and Dissemination

Defra - Department for Environment, Food and Rural Affairs

EC - European Commission

EPSRC - Engineering and Physical Sciences Research Council

ESRC - Economic and Social Research Council

FCERM - Flood and Coastal Erosion Risk Management

FRMRC - Flood Risk Management Research Consortium

JNCC - Joint Nature Conservation Committee

LWEC - Living With Environmental Change

MCCIP - Marine Climate Change Impacts

NaFRA - National Flood Risk Assessment

NCERM - National Coastal Erosion Risk Mapping

NERC - Natural Environment Research Council

OpenMI - Open Modelling Interface

UKCP - United Kingdom Climate Projections

Appendices

Appendix 1: Interests and requirements of different organisations and communities

In developing the CoRDDi Framework a range of implementation scales are considered. For example, to be useful to end-users the development of specific outputs to support operational activities (such as engineering schemes and flood warning services) is emphasised. This includes supporting UK and local government staff and their agencies but also intermediary users (such as consultants and technical staff) with tools and techniques applicable to a range of scales (national, regional, local). CoRDDi partners range from central government to practitioners and managers and the public. The interests of the main organisations and groups are discussed below.

Governments and agencies

UK policy makers and regulators

The main policy makers and regulators of FCERM are:

- Department for Environment, Food and Rural Affairs, Defra (responsible for national policy on flood and coastal erosion risk management);
- Environment Agency (with a strategic overview of all flood and coastal erosion matters);
- Natural England and the Countryside Council for Wales (the Government's advisory bodies in England and Wales on the natural environment);
- Marine Management Organisation, MMO (promotes the Government's vision for clean, healthy, safe, productive and biologically diverse oceans and seas).

The policies promoted by these organisations of relevance to the CoRDDi Framework include the need to ensure FCERM is:

- equitable and fair for individuals and communities;
- sustainable, providing a balance between economic, social and environmental considerations;
- managed on the basis of geomorphological and physical processes, and ecological connectivity;
- robust to future uncertainty;
- contributing to the sustainable management of the natural environment while maximising benefits to society;
- strategic, with whole-system approaches to land and water management planning effective at the scale of the catchment and coastal cell;

- sustained, demonstrating progress towards adaptive management, including managed realignment in both coastal and fluvial environments, and more integrated flood risk management schemes that work with natural processes, involving creation of wetlands and washlands, and restoration of river and coastal floodplains.

Local government planners, engineers and coastal managers

Local government planners, engineers and coastal managers are practitioners at the 'sharp end' of FCERM. This sector needs the CoRDDi Framework to address practical coastal management issues with outputs of practical value. Reflecting their needs within the Framework implies that it should be:

- driven by particular problems to be solved or decisions to be made;
- regional in its applicability;
- communicated in a language that directly relates to the problem or decision.

Private sector (consultants and contractors)

Consultants and contractors translate policies into solutions. They are often innovators in methods and practice. To be relevant to these users the CoRDDi Framework must ensure that outputs are:

- useful and focused on the decisions made;
- useable and relevant to the way consultants and contractors work;
- well understood by consultants and contractors (who have ultimate responsibility for ensuring advice/structures are fit for purpose). Unless the tools and techniques provided by the research are proven and well described, their uptake will be restricted.

Persistent effort is required to change the practice of this group of users. Strategies for dissemination and exchange at project and theme level will be a vital component for this group.

Research community

Research funders

Living with Environmental Change (LWEC)

Living with Environmental Change (a coordinating vehicle for research, including FCERM, promoted through the UK research councils, particularly NERC and EPSRC) provides an important guide to the CoRDDi Framework. In particular, LWEC aims to:

- continue research and development in areas defined by end-users as being essential to the sustainable management of risks from sea flooding and coastal erosion risk management;

- undertake research and development in emerging areas consistent with flood and coastal erosion risk management strategy to assist end-users in their practical application of new approaches;
- maximise update of existing and future research outputs through improved dissemination;
- improve effectiveness of research, development and dissemination in coastal matters through coordination with other research programmes and organisations.

LWEC provides the overarching view of this research within the research councils (NERC, EPSRC and ESRC) as well as the joint Defra/Environment Agency R&D Programme. The impact of LWEC on the strategies of other organisations is not yet established; those most relevant to the development of CoRDDi are discussed below.

Environment Agency - Evidence Directorate Guide

The Environment Agency's Evidence Directorate sets the direction and management of the science within its research programme. On matters of FCERM it will increasingly take its lead from LWEC. The Environment Agency's Evidence Guide drives the provision of compelling evidence to shape decisions. The Guide highlights the role of research and innovation (R&I) as a core professional service that provides expert scientific advice to support policy and operations. It states that R&I will:

- provide the science needed to support the Corporate Strategy;
- ensure that business decisions are based on sound scientific evidence;
- provide a leadership role by highlighting new scientific issues relevant to the organization;
- develop innovative solutions and technologies to enable the business to do its job more efficiently and effectively;
- maintain and develop the Environment Agency's UK and international leadership roles on scientific issues of priority to the organization;
- work in collaboration with partners and develop relationships with academic organisations and public and private sector organisations.

Defra – Marine Research Programme

Defra's Marine Research Programme is organised into four themes:

- economic and social research on the marine environment;
- human pressures and impacts on the marine environment;
- state of the marine environment;
- science for integrated marine management.

Defra's commissioning of marine research is guided by the broad principles set out in the Marine Objective of 'using sound science responsibly'. An annual commissioning timetable, which sets out steps for commissioning work, is operated by the Marine and Fisheries Science Unit.

European Commission Research Strategy

The EC has a number of major programmes of relevance to the CoRDDi Framework. The EC is committed to collaborative research, and promotes this at regional scale (through instruments such as InterReg) and through generic research (through FP7 for example).

The areas of interest are wide ranging and include research across all aspects of coastal processes, climate change and socio-economics. To maximise value from the research completed within the CoRDDi Framework, its researchers should actively seek opportunities to use the numerous EC funding streams.

Regional Coastal Groups and Observatories

The Regional Coastal Groups (RCG) provide regional forums for organisations that have an interest in, or responsibility for, the management of the coast in England and Wales. The 11 coastal regions are mapped in Figure A1.1. Regional Coastal Groups have a strong interest in coastal science and provide valuable local context, research partnership and dissemination routes, and more generally, capability and interest that is often under-used in research and innovation.

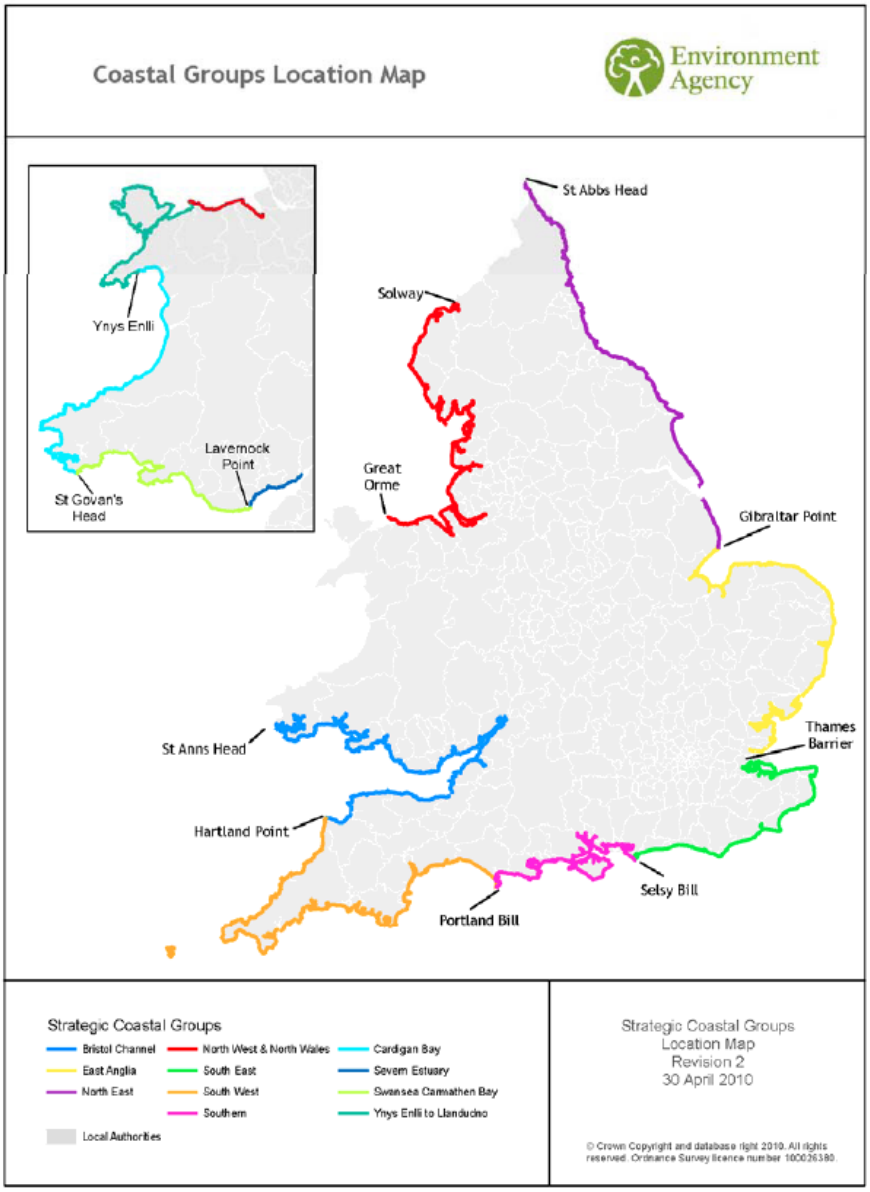


Figure A1.1 Regional Coastal Groups in England and Wales

Traditionally, most research effort has been directed towards UK-wide, generic problems. As such, bespoke research reflecting the diverse coastal settings around England and Wales has often been missing. Understanding the challenges faced at particular locations, and addressing these, will be a principle in the CoRDDi Framework. Equally, the complex and interwoven network of organisations with varying roles and responsibilities, and associated knowledge and capability, has not been fully appreciated by all researchers. Developing a better understanding of these roles is a vital prerequisite to fully meet the needs of end-users.

Regional Coastal Observatories (RCO), which are closely associated with the Regional Coastal Groups, provide repositories for coastal data. The RCOs have a strong and growing reputation for holding well maintained and easily accessible data. To date, however, the datasets are partial with a limited contribution to research commissioned outside of the RCGs.

Within the CoRDDi Framework the needs of these Regional Coastal Groups are promoted through:

- **Recognition of the need for regionally focused RDD** – UK-wide, generic RDD must be complemented with research targeted at specific needs of the different regions of England and Wales. This should be informed by the experiences of the RCOs, to help meet their needs and improve their operational activities.
- **Maximising use of data** – Through greater awareness of the role of regional coastal monitoring programmes and online resources of the RCOs (live repositories of coastal data and analytical reports), future research will be able to maximise use of existing data.
- **Dissemination of outputs** – Regional Coastal Groups should play a key role in the strengthened 'dissemination' component of the CoRDDi Framework, enabling research findings to be directly fed to end-users at more frequent intervals.

Researchers (academia and industry)

The research community is as diverse as the issues facing the coastline. The main areas where CoRDDi can support innovation and research are:

- **Better access to data and benchmark datasets** - Researchers and academics need access to quality assured (monitoring) data for research purposes. An essential element of the CoRDDi Framework will be to support the collection of data and maintain links between the RDD community and data collection/distribution agencies.
- **Highlighting knowledge gaps** - The CoRDDi Framework will highlight knowledge gaps and areas where limitations in practice or understanding restricts decision making. Once researchers understand these issues, they can begin to innovate usefully, and target their research.
- **Promotion of consortia** - Coastal problems tend to be multi-disciplinary, and so coordinated and collaborative research, through formal consortia or networks, engaging different disciplines and embracing links between socio-economic and physical-ecological aspects, can help advance science and practice. Consortia often provide excellent value for money. The CoRDDi Framework offers a platform upon which such collaborative actions can be built.

Public (individuals and communities)

The public will benefit from CoRDDi in two main ways:

- **Confidence in the science** - Members of the public, through community or neighbourhood involvement, generally seek reassurance and confidence that decisions will benefit them and the science upon which the decisions are based is sound. The CoRDDi Framework provides the public with a means of better understanding their coastal issues and the underlying science. Ultimately, the Framework should develop a persuasive evidence base, through case studies and pilots.
- **A means of engagement** - Communities and individuals increasingly seek to be engaged in decision-making and to be able to capitalise on opportunities. The CoRDDi Framework should enable neighbourhoods to

meaningfully contribute and take responsibility for coastal decisions. The Framework should raise awareness and improve capacity building for those at risk to make individual choices.

Appendix 2: Results of end-user consultation process

Stage 1 of the CoRDDi Framework included a wide-ranging consultation exercise. The four main strands to the consultation were:

- **user questionnaire** - to raise user awareness of the project and to identify future RDD user needs;
- **Project Advisory Group** - to draw on the RDD requirements of the members' respective organisations and their connections with other partners to identify RDD needs and strengthen knowledge exchange;
- **user workshop** - to establish and review user needs, and to allow those attending to be involved in setting the agenda for the future science;
- **interviews with targeted users** - two interview-style meetings with targeted individuals to obtain their views and to follow-up on issues raised in the previous consultation exercises.

Tables A2.1 to A2.3 summarise the results of the consultation. The results are collated into three tables that highlight the main issues raised in the consultation:

- Table A2.1: Approach – describes the potential 'attributes' of the themes and the components that consultees thought should be integral to each.
- Table A2.2: Outputs – describes how the themes should be delivered and in what format/media.
- Table A2.3: Technical content – a collation of responses on the themes (and sub-themes) of RDD the consultees would benefit from.

Table A2.1 Approach – Summary of issues and actions/solutions

Issues	Actions/Solutions
Ensure coastal RDD is guided by user needs and decision making	
Make sure communities feed into the definition of coastal RDD. Focus on end-user driven RDD in coastal and estuarine processes and change. RDD outputs should be focused on the needs of the practitioner or the coastal manager, not on the needs of the designer or the consultant. In a world where we are concentrating more on maintaining our assets rather than creating new ones, it makes much more sense to serve the needs of the coastal manager. Lack of applicability of RDD to operational matters. RDD for FCERM appears disjointed at present. There is no overall RDD vision or agenda for	Community/neighbourhood engagement and community-led approaches should be adopted. Web-based tools should be used to promote interaction between users. Themes focused on the needs of the practitioner with more engagement between practitioners and researchers. Proposals should be co-developed or reviewed by someone with the relevant knowledge. Coastal officers in the Environment Agency and RCGs should be used as conduits. Local authorities should be involved in the specification and procurement of coastal RDD. Minimum standards of best

coastal research that is designed, endorsed and supported by all the interested parties. There is a need for research proposals tailored to operational needs. Funders of research are not listening to local authorities at the procurement stage, leading to a lack of use of research outputs.	practice embedded in project and briefs from the Environment Agency and local authority programmes. Direct involvement of those with local/operational knowledge throughout the lifecycle of RDD projects. Engagement of Defra/Environment Agency with research funders to press for structural requirements for end-user benefits from coastal RDD projects.
Ensure applicability of outputs and encourage their uptake	
There are difficulties translating a practical problem into a research question that can be answered to resolve the problem. In many cases the products of research are good reference documents, but cannot be translated into something that can be readily applied. RDD projects address specific academic issues ('blue-sky') that have limited practical applicability to what people are faced with on the coast. The root cause of the problem may be that a proposal was well-received and relevant, but the project was side-tracked and findings didn't meet expectations. Research results should be sensitivity tested for their value in making management decisions. An expensive detailed study may not be required because a cheaper option equally resolves the problem and allows decisions to be made. The target user is not always clear so the science may be geared towards one audience to the detriment of another. The output is not complete or understandable and hence of little use to the practitioner. Seek to link local, regional and national research initiatives.	Engagement between researchers and end-users to promote identification of RDD priorities. Research should be relevant and based on a problem to be solved or decision to be made, and be communicated back in a language that relates to the problem. This research may be hierarchical in that some research feeds end-users who are developers, some feeds regulators, and some feeds the practitioner/operator. Users should have a role in the project development to ensure a link to their objectives. As a result, uptake of the products will be promoted within the user organisation. Credible representatives of the practitioner community (e.g. local authority coastal managers) should be embedded in the project team (potentially as project managers) or part of a steering group to keep the research on track (this would not apply to all areas of research). Design RDD themes to be multi-purpose, aiming to answer different questions for different people. For example, a modelling/monitoring project could help a maritime authority answer a local question whilst enabling academics to improve their modelling capability. The newly appointed Environment Agency area coastal engineers may be helpful in breaking down barriers and encouraging uptake (but they may need support and training).
Ensure users are engaged throughout	
Owners and operators are not	Facilitate engagement and communication with a wide range of

engaged/driven commercially. There needs to be a better network of practitioner interaction so that information can be peer-reviewed. More interaction between practitioners (UK and elsewhere) to better inform management practices, develop best practice and hence manage in a sustainable manner. The major problem is not the lack of research, but the 'gulf of understanding' and hence a lack of trust, between the research community, the practitioners, the education system (both school and university) and the general public. Local issues are generally resolved at a local level, and it is difficult to attract funding at a regional/national level.	partners, from national to neighbourhood and community level. Engagement built on outputs of Pathfinder projects. Partnership funding and staff representation on steering groups could be extended into the dissemination phases for at least a year after delivery of research outputs. Create respect and understanding between the various groups through active engagement. Engage practitioners along other stretches of coasts with similar problems to develop a research question.
Financing	
There may be potential problems engaging local authority officers given the way they are funded. Need for a clear picture of the required project financing.	Understand whether a local authority has the flexibility to backfill their post to cover their time. This issue should be flagged with the Regional Coastal Groups. Project financing should be made apparent across the whole life of project through to dissemination, benefits realisation and monitoring.
Integration of coastal RDD with monitoring and other research programmes	
There is an acknowledged need for long-term monitoring and measurement of the drivers for change (to understand links between morphology, process and design) but too little about how this can support RDD themes. Need for projects to use targeted monitoring data to test the validity of, and refine or improve, current design and maintenance techniques (valuable and cost-effective). Monitoring and observation is important due to operating authorities' lack of confidence in models. Incorporate good quality monitoring data into research to populate models with real data to calibrate, validate and test predictions. Always justifying waiting for new data instead of undertaking the work now with	Closer integration of existing and future monitoring data into coastal RDD. Focus on RDD activities that add value to outputs of monitoring programmes. Multi-purpose design of monitoring so that it meets the local need and can be used to support research. Use RDD themes to set up the framework and baselines for monitoring programmes. Integration of RDD themes with marine spatial planning (Marine Bill) and other initiatives (Environment Agency, Natural England). Review of historic data quality with a view to improving future data gathering; validation and calibration of models and methods. Embed data-driven models into

what is available. Puts off having to think of the actions and find the resources to fulfil those actions. There is a need to ensure that data collection (type, frequency) and the methods used to analyse the data are relevant to operators. Need to think about lead-in time for research in terms of monitoring; should monitoring programmes be started now with a view to carrying out the research in, say, five years' time?	monitoring programmes for rapid automation of coastal change projections. Data freely available at a one-stop shop (coastal observatory web portal) in a consistent format using standard platforms and quality assured. Links should be made with coastal observatory monitoring and the flood warning system under UK Coastal Monitoring and Forecasting (UKCMF) and associated monitoring. SMPs can be used to focus on areas where data is sparse or of poor resolution, and can help to identify management issues and prioritise where risk is greatest.

Table A2.2 Outputs – Summary of issues and actions/solutions

Issues	Actions/Solutions
Dissemination and accessibility of data and information	
Lack of a 'one-stop shop' for RDD results and products that is publicly accessible to all users at national, regional and local levels. Users need to know that the RDD outputs are readily available; they need to be well publicised and easily accessible, clear and understandable (via the web, on hard copy or on disc). Poor maintenance of websites, especially hyperlinks. There is no central portal for sourcing data and information on coastal RDD in the UK. Limited dissemination and take up of many R&D projects funded through previous programmes. Suggest that these all need to be catalogued and made available on the internet. Time lag for some products to become available, thus reducing relevance of case studies. There are many research programmes in the public domain but not all are readily	Communication and dissemination should be embedded in all themes and not be stand-alone. User friendly access through the internet; consolidate and categorise RDD using a continually maintained search engine or a simple expert (topic-led) decision tool that uses yes/no answers about the problem to direct the user to the relevant RDD or guidance. Develop a portal for coastal RDD information to describe the current position of coastal science and ongoing research. This would assist in the planning of RDD requirements and act as a central source of knowledge about partner and consortium initiatives. It could help to align research areas for the benefit of everyone and enable targeting of funding to under-resourced themes. Develop integrated web-based products linking databases and GIS layers. Dissemination should not require ongoing payment to other parties or the use of third parties.

available; ensure old (but valid) RDD accessible. Limited availability of older paper products and data (includes copyright issues, particularly of maps).	Ensure quick turnaround from project completion to dissemination. Archive previous research and scan old documents so they are readily available. Potentially disseminate information through the existing coastal observatories; review how coastal observatories (regional coastal monitoring) communicate to understand how effective they are as hosts for information (through their annual reporting mechanism). Single points of contact for each theme.
Reluctance to take up RDD results and products	
Some research is not 'trusted' or is not seen as academically thorough. Keep products up-to-date. Lack of integration of academic and consultant RDD and the static structure of any guidance. Within some reports, it can be very difficult to find key information. There seems to be reluctance to take up RDD results if they are simpler than standard engineering approaches which create a larger project for the contractor. Coastal engineering is inherently conservative (difficult to get users to adopt new methods and materials). Irrational risk aversion; rock groynes need not be designed like a revetment or breakwater, yet clients insist on 'fail-safe' structures. Practitioners will only take up and apply RDD if its use is mandatory or if they view it as useful. Communication and dissemination is not enough; should go further to embed research output into practice by other agencies. Better public relations and publication of work. Need visually compelling output which can be used to convince communities to adapt. Dissemination; needs to 'follow through'	Have research 'endorsed' by peer review or wider audience. Develop acceptance of research outputs through their application in pilot case-studies. Promote discussion across users to allow news of developments to travel. Publish reviews of guidance every year that integrate new results and how they can be used to update the guidance. Present results so that a range of potential users can make best use of it and be able to 'drill down' to the detail where needed. Limitations and assumptions of research should always be presented and non-technical summary included for public. Uptake can best be achieved if the practitioner is enthusiastic. Mandatory uptake is very much a second best option and difficult when many of the practitioners are not employed by the Environment Agency, and it will tend to restrict the use of good judgment. The output should be written in practical language and free of jargon. Projects which have held workshops and dissemination events have helped to improve uptake. Implement webinar dissemination events. The output should be promoted through established lines of communication such as ICE seminars, the annual FRM conference, Coastal Groups, and be

to uptake.	targeted at the desired user groups; if necessary, promotion should be handled by those competent to do so. NEECA/NCF briefs should have a section inviting consultants/contractors to suggest where innovation/best practice/R&D will be applied in their execution of the project.
Knowledge transfer and demonstration	
Practitioners don't necessarily have the skills to state their problems in the form of a research question. It could just as easily be stated that researchers don't understand practitioners' problems. Make sure practitioners understand the issues they face. Environment Agency area coastal engineers have a key role in the new coastal overview, but some do not have detailed knowledge of coastal engineering and may know little about the historical or ongoing RDD. Lack of awareness on part of client (reliance on consultant and not able to challenge) and lack of awareness on part of consultant. Training so end-users can use available tools. Demonstration projects/piloting to inspire confidence at a scheme scale. Comparison of available approaches through demonstration and pilot studies. Lack of either practical field experiments, or their results being circulated.	Training of communities/leaders in coastal change so they appreciate the issues they face. Training programme to make Environment Agency, local authority project managers, project executives and other users aware of the tools and guidance that Environment Agency science has developed for their benefit. Training could be done by e-learning, seminars, workshops, toolbox talks. Implementation of demonstration projects/pilots as a focus for RDD, to illustrate the benefit of community uptake and help make local decisions (Pathfinder projects form basis).

Table A2.3 Technical content – Summary of key objectives, needs and rationales

Theme - Coastal systems and processes			
Sub-theme	**Key objectives**	**Needs**	**Rationale**

CoaEST	Whole-system geomorphological understanding of linked open coast and estuaries. Whole-system sensitivity to climate change. Develop best practice tools and techniques to understand coastal systems as a precursor to prediction and to inform APT.	Documented separately within the CoaEST programme.	
Coastal processes	Response of sedimentary processes (morphology and budgets) and ecology (evolution of habitats) to future climate change. Potential impact of climate change on flood risk and coastal erosion risk.	Improved projections of rates of coastal change (morphology, erosion and habitats) given rising sea levels, changes in wind direction, storm-surge scenarios, and indicators of timescales of change (assess against UKCP09 scenarios).	An understanding of climate change and the likely impacts (based on the most up-to-date scenarios) on coastal sites will be needed to plan for the hazards that are likely to arise. Climate change is likely to lead to requests for further coastal defence (both new defences and upgrades to defences already in place) which will have implications for protection of habitats. Evidence to underpin adaptation decisions.
		Investigation of non-climate driven causes of coastal change.	Current methods used to predict coastal change, even without climate change, provide results that are highly uncertain. Methodological improvements would reduce this uncertainty to allow more informed decision making.

			Currently there are two separate tools for the national appraisal of flooding and of coastal erosion (NCERM and NaFRA respectively). These are not linked and do not fully take account of the influence of physical processes on down-drift coastlines. This does not therefore allow for the assessment of the potential impact of policy or management options on adjacent coastlines.
		Investigation of sediment transport processes (provenance, flux, sinks).	Resolve the contradicting views on use of sediment cells described below. Environment Agency, local authority and other frontages need to be linked so that management is on a sediment cell (or sub-cell) basis and not on political boundaries. Longer term goals should aim to move away from the sediment cell-based approach for managing the coastline as this implies no transport between cells, and more towards dynamic assessments.
		Improved data on sediments on coasts and in estuaries.	Sediment data collection could be improved to improve modelling capability and reliability, and to allow wider use and greater benefits to be realised.
		Improved understanding of the physical processes that affect flood and coastal erosion risk.	This forms the basis of decision making about what best to do to reduce risks to people and property.

		Scenario-driven RDD to determine flood and coastal erosion risks.	Risks are generally governed by extreme water levels (a statistical approach limited by length of data set) and coastal erosion rate (a measured value based on limited data sets). Scenario driven outcomes with monitoring to determine which scenario we are tending towards.
		Contributing physical/ecological linkages and ecosystem services provided by coastal habitats especially where these are linked to flood and coastal erosion risk management.	This is an important but very broad area. Here, the objective should be to focus down on those aspects of ecosystems that deliver services to assist in flood and coastal erosion risk management. For example, benthic flora and fauna can help in raising the shear stress at which bed sediments erode.
Asset performance tools	Develop guidance, tools and training for inspection and evaluation of asset performance. Support operating authorities in justifying their investment in monitoring, maintenance and capital works.	Documented separately within the Asset Performance Tools (APT) programme.	

Theme: Strategic planning (building adaptive capacity)

Coastal change adaptation	Develop robust and sustainable coastal management strategies.	Development and support for a wider range of adaptation approaches to follow on from the pilot schemes.	Whilst adaptation pilot studies are underway (Pathfinder), there needs to be a programme of science to support such approaches in future and use the outcomes of the pilots. Improved ability to present flexible adaptation strategies. Little information is available on adaptation options and solutions that could be used to provide guidance and case studies for practitioners and decision makers. The issue is how to manage change at the coast, in concert with local communities and regional planning. It raises all sort of 'sub-issues' such as social and financial equity, funding defence works, sustainability, decommissioning, realignment, uncertainty, model validation. Understanding time frames (and risk) and critical impacts/ thresholds upon which adaptation is dependent.
		Understanding societal impacts of adaptation options and working with the planning community.	Decision makers, ownership, social equity, compensation.
		Improve understanding and practical benefits of implementing sediment management principles.	Frameworks need to be established to determine the potential sources, transport pathways and sinks of additional beach nourishment due to sea-level rise (and all the ecosystem impacts).

			Analysis of beach management activity performance (how have the design conditions performed in practice?)
		Guidance on the implementation of managed realignment and no active intervention (including measures needed to maintain safety).	Develop and demonstrate approaches and their benefits to alternative land use in flood risk areas and to improve the take up of managed realignment and no active intervention policies in SMPs and strategies. Engage communities to adopt coastal adaptation strategies involving managed realignment. Develop alternative flood risk management policies, especially where more frequent overtopping/tidal inundation is expected.
		Guidance on management options for coastal landfill sites.	
Uncertainty and risk	Properly account for uncertainty in the management of coastal risks.	Prioritisation of effort in measurement (monitoring) of assets at risk.	Robust decision making under uncertainty as part of strategy development. Priorities need to be risk-based. Proportionality of impact and optimising investment in improvement.
		Technical manual with guidance on how to evaluate differing evidence about systems.	Different models give conflicting results, so evaluation and comparison is needed along with identification of critical links to make good choices.

		Better communication of uncertainty and risk to the public, to make it understandable and relevant.	Effective communication of uncertainty is crucial for good decision making and consensus building. The more concepts of uncertainty handling are developed, the more difficult, but more critical, it is to get the message across.
Socio-economics	Socio-economic related decision-making support to people who are vulnerable to flood risk.	Socio-economic analysis of schemes and strategies.	Better linkage to economic research to evaluate capital and maintenance costs of strategies and schemes. Better link with social/economists and planners to develop adaptation options.
		Better methods that the public accept, of valuing the costs of flooding and erosion (or both) to people and the environment.	Better, more consistent and more socially acceptable methods of cost-benefit analysis which account for intangible losses will improve decision making and promote consensus building.
		Valuation of ecosystem goods and services for large-scale cost-benefit studies.	Better guidance on the value of ecosystem goods and services will make cost-benefit analysis more consistent
		Communicating cost-benefit to communities.	Better communication of this approach should improve consensus building.

Appendix 3: Policy drivers for flood and coastal erosion risk management

International context

Millennium Development Goals

One of the eight millennium development goals is to achieve environmental sustainability. This means integrating sustainable development into policy and practice and reversing the loss of environmental resources. A primary factor in this goal is to provide a decisive response to climate change.

EC Directives

The requirements placed upon the CoRDDi Framework from the EC Floods Directive, Birds and Habitat Directives, Water Framework Directive and Marine Directives are covered below as translated into UK policies and legislation.

UK government policies

Flood and Water Management Act 2010

The Flood and Water Management Act provides an overview role for the Environment Agency in flood and coastal defence, and emphasises the role of regional groups, such as Regional Flood Defence Committees and Regional Coastal Groups. The CoRDDi Framework recognises this and:

- **Provides an overview and strategic direction**, being embedded between the *Living with Environmental Change* (LWEC) Flood Research Strategy and thematic programmes. This enables the CoRDDi Framework to link with UK policy and strategies and individual research projects.
- **Ensures regional applicability**, recognising the important role of Regional Coastal Groups and Regional Coastal Observatories, focusing on understanding their needs and identifying the contributions they can make to, and benefits they can gain from, CoRDDi.

Making Space for Water

The Government's strategic direction for FCERM is to implement a holistic approach, by taking account of all sources of flooding and erosion and by integrating FCERM with

other policies. The direction of *Making Space for Water* is reflected within CoRDDi through support for integrated erosion and flood risk management.

Marine and Coastal Access Act 2009

The Marine and Coastal Access Act ensures that systems will be put in place for sustainable development of the marine and coastal environment, delivering clean, healthy, safe, productive and biologically diverse oceans and seas. The CoRDDi Framework contributes to this by:

- **Encouraging integrated management of the coast** – recognising the influence that FCERM decisions can have on a wide range of portfolios.
- **Improving systems-based understanding** – considering multiple spatial scales and timescales as well as the ecological functioning of a coastal system.

Planning Policy

Planning Policy Statement 25 Supplement: Development and Coastal Change (2010) places emphasis on assessing the impact of coastal change and identifying areas at risk from such change to better avoid or manage risks or mitigate the residual impact. The CoRDDi Framework contributes to this by:

- **Improving understanding of, and predictive capacity in, coastal change** – covering a range of scales from short-term local through to long-term regional.
- **Strengthening links between research and practice** – enabling evidence-based and systems-focused outcomes to influence policy development, strategic planning and local implementation.

Environmental Policy

Environmental policy is largely predicated on avoiding deterioration in environmental assets (be they water bodies in the context of the Water Framework Directive, habitats in the context of the Habitats Directive or species in the context of the Birds Directive) and seeking opportunities for their enhancement. Meeting these goals heavily depends on understanding the links between the physical, chemical and biological elements of the coastal system. The CoRDDi Framework contributes to this through:

- **Improving systems-based understanding** – considering multiple spatial scales and timescales but also considering the ecological functioning of a coastal system and its response to coastal change or management intervention.
- **Improving our ability to adapt** – recognising that the governing factors influencing coastal change may vary over time (be they technical, economic, environmental, social or political) and that adaptation can be a suitable management technique in some situations.

Local government strategy

The Local Government Association, representing the views of local authorities, is committed to sustainable development. Fundamentally, this requires investment at the coast to promote opportunity as well as reduce risk. The idea of coastal risk and opportunity management is embedded with the CoRDDi Framework and expressed as a desire to:

- **Promote multi-functional schemes/investments** – where risk reduction is achieved in a way that promotes environmental and/or economic gain. This is not trivial to achieve in practice and only a few examples exist, such as construction of the surfing reefs in Bournemouth and the use of redundant BT cabling for breeding grounds for scallops in the Isle of Man. Developing the concept of coastal risk and opportunity management will require innovation in methods and decision processes.
- **Promote innovation in funding** – sustainability also encompasses the funding stream and ability of the funding stream to self-sustain; typically this means through multiple sources of funding. The CoRDDi Framework provides space for innovation in funding and investment in an attempt to move away from a central, single agenda route.

Environment Agency strategy

The Environment Agency's strategy consists of a hierarchy of documents. At the highest level, the corporate strategy is set out in *Creating a Better Place 2010-2015* supported by ten sub-strategies that show in more detail how the overall aims will be achieved for a range of areas, including FCERM. The Environment Agency's sub-strategy for FCERM is, in turn, guided by the Government's strategic direction for FCERM as set out in *Making Space for Water* (discussed above). Following on from these sub-strategies is a suite of documents describing the approach to specific activities in FCERM including the asset management strategy and the mapping, modelling and data strategies (see below).

The key aspects that relate to the CoRDDi Framework from each of the strategies are summarised below.

Corporate strategy - Creating a Better Place 2010-2015

The Environment Agency's corporate strategy (2010-2015) lists five areas of focus:

- act to reduce climate change and its consequences;
- protect and improve water, land and air;
- work with people and communities to create better places;
- work with businesses and other organisations to use resources wisely;
- be the best we can.

Within its corporate strategy the Environment Agency states that it will endeavour to ensure that flood risk and coastal erosion are effectively managed and people and property are better prepared and protected.

Flood and Coastal Risk Management sub-strategy

FCERM should contribute to all the areas of focus described above, but most notably to the aim to 'work with people and communities to create better places'. The Flood

and Coastal Risk Management sub-strategy highlights specific aims within FCERM, and states how these will be achieved:

- We, our professional partners and the public will have a greater understanding of flood and coastal erosion risk.
- We will work effectively with our professional partners and the public to manage risk and reduce the probability of flooding and coastal erosion.
- We will reduce the consequences of flooding and coastal erosion.
- Our flood and coastal risk management programme provides environmental benefits.

Modelling and data strategies

The Environment Agency has specific strategies for 'data' and 'modelling' that complement the higher level documents.

The data strategy commits to data sharing and good data management, and has three principles:

- We will recognise and value our data as an asset.
- We will manage our data so that it improves our decision making capability at every level.
- We will know what data we and other organisations need and we will acquire that data to common standards.

The modelling strategy mainly covers conventional hydrological and hydraulic modelling, with three key principles:

- We, and our partners, will understand flood and coastal risk from all sources, including the uncertainty involved in defining this risk.
- We will develop modelling in a justified, outcome-focused and coordinated manner.
- We will ensure we have the data, software, systems and skills needed to develop and maintain our modelling.

UK Coastal Monitoring and Forecasting

The UK Coastal Monitoring and Forecasting (UKCMF) is a partnership of public bodies (Environment Agency, Scottish Environment Protection Agency, Department of Agriculture and Rural Development Northern Ireland, Met Office, National Oceanography Centre, Centre for Environment, Fisheries and Aquaculture Science, British Oceanographic Data Centre and the Flood Forecasting Centre) who work together to provide a comprehensive coastal flood forecasting service. The UKCMF service ensures that people at risk of coastal flooding can be warned in good time and action taken to save lives and reduce the impact on homes, businesses, infrastructure and communities. The vision statements of UKCMF are:

- We will provide strategic coastal forecasts to support the current and future needs of those who provide coastal warnings.
- We will secure the future of the monitoring networks that underpin those forecasts and provide evidence for a managed response to the potential impacts of rising sea levels and climate change on communities.

UKCMF uses a network of tide gauges and surge models to provide UK-wide monitoring and forecasting. The primary purpose of the network is to develop forecast models, which will predict the effects of climate change on sea states and coastal processes. As well as promoting the service, and of specific relevance to CoRDDi, UKCMF is encouraging data and information to be widely used by allowing it to be openly available. The CoRDDi Framework will contribute by adding value to the outputs of the UKCMF by integrating its RDD activities with existing and future monitoring.

Appendix 4: Issues to be addressed within LWEC guiding strategies

A number of issues are best addressed at a higher level than within the CoRDDi Framework with the LWEC strategies offering the best channels. Based on the consultation undertaken as part of the development of CoRDDi (Environment Agency, 2010a), the main characteristics of a successful collaborative RDD community are shown in Figure A4.1, and discussed below.

Figure A4.1 Characteristics of a collaborative R&D community

Judging success based on shared criteria

Each funder uses different criteria to judge the success or otherwise of research and development projects and programmes. As such, when seeking collaborative multi-funded research, the success criteria used can either help to integrate research and practice or form a barrier to successful collaboration. Examples of success criteria include:

- academic papers;

- practitioner papers;
- publicity/awareness raising;
- knowledge transfer - researcher engagement/collaboration;
- knowledge transfer - consultant engagement/collaboration;
- community/public engagement;
- political engagement;
- further research funding on same topic;
- multi-funders;
- long-term review.

Pooling funds and/or sharing costs

Who does what, who leads which projects, how projects are steered and who will sign-off, own and be able to exploit the outputs, are all questions to be resolved. The clarity and content of the resolution will be an important facilitator of, or barrier to, successful collaboration. In developing this collaboration, the full range of LWEC partners will need to be engaged including not only the core membership but also the Joint Nature Conservation Committee (JNCC), Aggregates Levy Sustainability Fund (ALSF), Natural England and others.

Evolving shared models and codes

To understand the complex interactions at the coast, emphasis will increasingly be placed upon modelling not just physical, ecological and human parameters, but how these interact to affect whole-system performance. Modelling systems more accurately can be done in two ways: simulate everything in one large model or link smaller models together. The general trend is to adopt the latter approach and enable whole-system models to be developed using individual components developed by different people at different times.

Initiatives such as Open Modelling Interface (OpenMI) which provide a standard approach to model communication are gathering pace, but such standards can place undue burden on integrated probabilistic models. Initiatives such as Fluid Earth, hosted by HR Wallingford, provide a warehousing of individual components and software tools for linking OpenMI compliant models and visualising results. ReFrame, developed by Newcastle University, provides a web-based capability for developing whole-system models. Developing these initiatives into a network of model components capable of being integrated to reflect the demands of a particular decision-making process will be a crucial challenge.

Sharing and managing tools and software IP

Sharing and managing advances in knowledge and in computational codes and software are issues to be resolved. This will require a harmonisation of practice and policy across research councils, Environment Agency, regions, consultants and the EC. Community (web) based initiatives could be used to enable IP to be maintained by the

generator/funder, but shared (not necessarily freely) with a registered community, whilst leaving no ambiguity of ownership (a typical barrier to use). Multiple ownership would be tracked as further developments take place.

Sharing and managing data and data IP

A long-held view reinforced in the Environment Agency's data strategy is the idea of collecting data once and using it many times. Coastal observatories are good at sharing the data they have, whereas others are not. Much excellent researcher-collected data disappears from view and the governance should endeavour to ensure that this is re-used, stored and understood. This includes the 'raw' data, processed data and benchmarks.

Maintaining a core capability whilst encouraging innovation and new ideas

Programmes such as FRMRC and Environment Agency frameworks encourage likeminded and collaborative thinking and can (though not always) prevent re-invention. However, some argue that such approaches can limit creativity and innovation. Questions that need to be answered include:

- Will programmes such as FRMRC become the norm, where a core capability is supported in the medium to long term?
- Will research on a project-by-project basis be commissioned?
- If so, who will guide decisions on funding and direction?

Taking a long-term view

It may take a while before concepts became everyday methods and a practical reality. For example, many advances have been made in system risk and uncertainty analysis, but it will be some time before whole-system models, reflecting all sources and fully trusted, are commonplace. Governance should avoid recognise the need to continue to evolve (and not re-invent without good reason) tools and techniques.

Appendix 5: Annual score card

CoRDDi – Coastal Research Development and Dissemination

Annual Report Card

2012-2013
Compiled by the CoRDDi Management Team
Contact: Owen Tarrant

The CoRDDi Score Card will include 4 pages

Page 1 (this page) – A narrative on the performance over the previous year highlighting particular successes and areas for improvement (based on the evidence in the following pages)

Page 2 – An overview of the expenditure and the benefits achieved

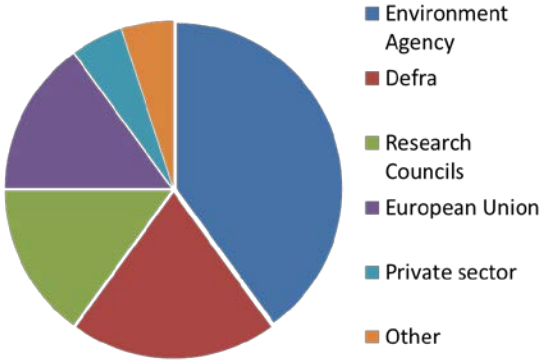
Page 3 - A focus on the contribution to good practice and academic excellence

Page 4 – A focus on the outreach activities

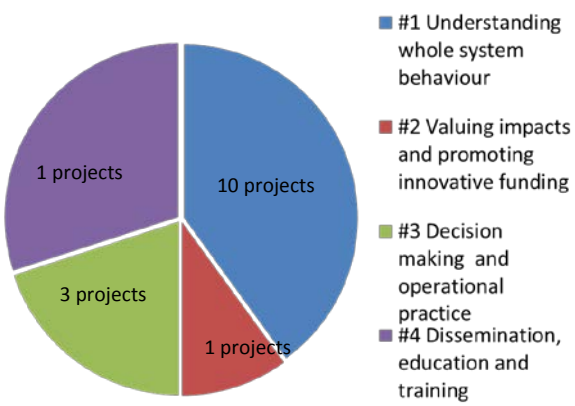
CoRDDi – Coastal Research Development and Dissemination

Page 2 – An overview of expenditure and perceived benefit

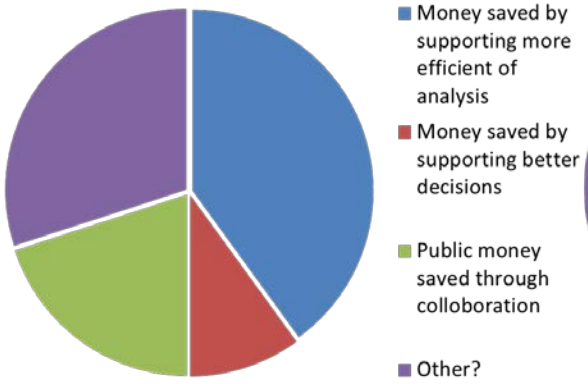
Money spent



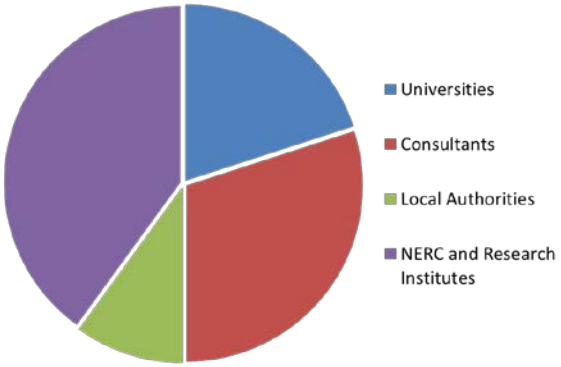
Spend by Programme



Where has value been added?



Who has been funded?



Management meetings held

Management of the CoRDDi Framework is through the CoRDDi Project Advisory Group. This group met four times in 2010/11

Total benefits and costs

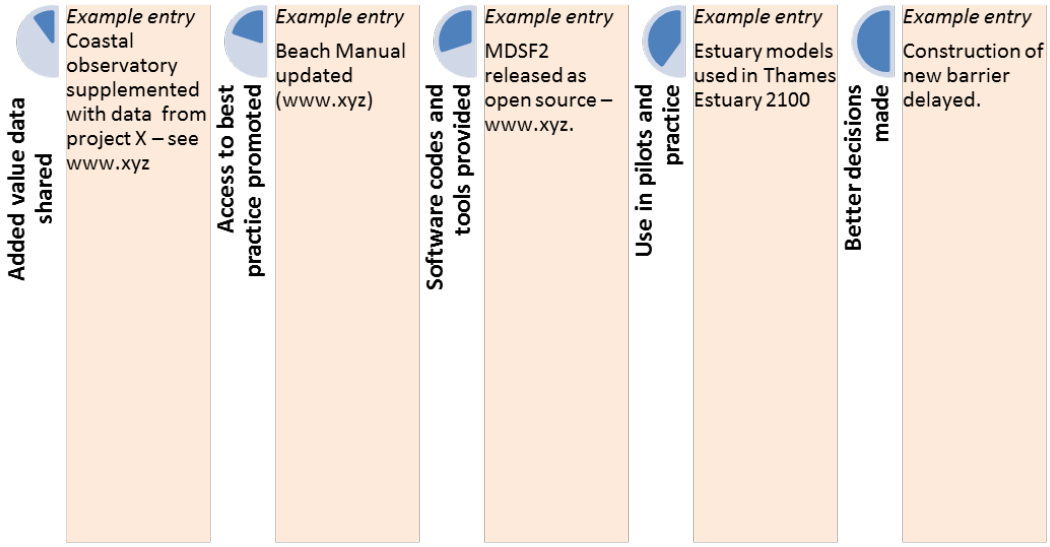
Year	Costs (£'000) in year	Benefits (£'000) in year	BCR
2012/13			-
13/14			0.5
14/15			0.7
15/16			1.5
16/17			1.5
17/18			5

For further information contact: Owen Tarrant

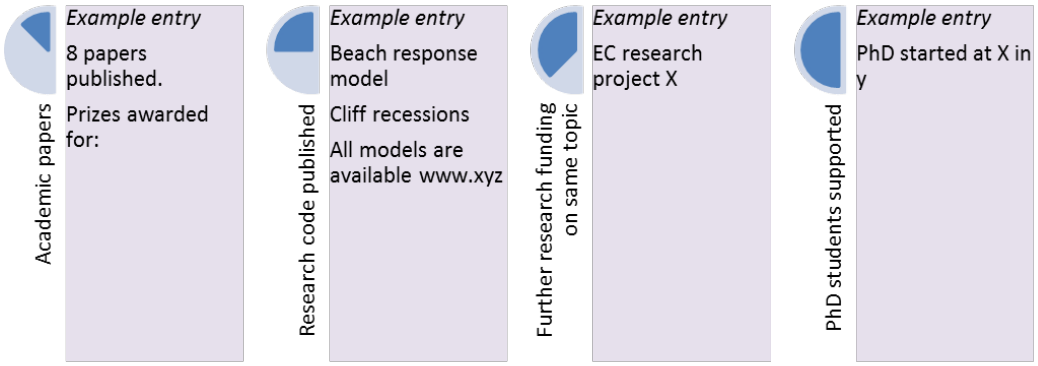
CoRDDi – Coastal Research Development and Dissemination

Page 3 - The contribution to good practice and academic excellence

Contribution to good practice **(degree of shading highlights perceived level of success)**



Contribution to academic excellence



Equivalent REF score

The equivalent REF score for research supported through CoRDDi = x (Target y)

For further information contact: Owen Tarrant

CoRDDi – Coastal Research Development and Dissemination

Page 4 - Outreach and dissemination activities

Research community

- Nationally
- Internationally

Knowledge transfer - Researcher engagement / collaboration

- ***Future professionals***
- Input to undergraduate course
- Input to post-graduate courses
- Young Engineer and Science events

Practitioners

- Knowledge transfer - Consultant engagement / collaboration
- Industry workshops - national
- Industry workshops - regional

Publicity / awareness raising

- Community / public engagement
- Workshops
- Pilot sites

Politicians and policy makers

- Contribution to the White Paper X

International agenda shaping

- Contribution to EC Directive

Collaboration

- No. of multi-funded projects
- Shared IPR generated, including:
- Shared data generated, including:

For further information contact: Owen Tarrant

Appendix 6: Categorisation and prioritisation of needs/issues

Theme 1: Understanding whole-system behaviour

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
#1 Understanding whole-system behaviour	#1a – Long-term and regional-scale processes	Climate change	Understanding the links between climate and coastal change remains an area in need of further consideration. Our understanding of climate change continues to evolve and coastal managers have been preparing for climate change within their plans, strategies and the design of flood and coastal defence schemes since the mid-1990s, based on Defra guidance and design allowances. It will be important to maintain and update best practice guidance as climate understanding improves.	Update the guidance on use of the most recent climate change outputs	Q	NA	DT	L	Large	High	1	5	5	5	3	2	2	4	26	Latest UKCP09 outputs need placing in context of guidance for FCERM officers. Understanding is important for practitioners and to inform the public of how the predictions are used. Has links to other UKCP09 projects.
				Assess coastal defence vulnerability under the latest climate change projections	Q, LR[1,2]	NA	DP	L	Large	High	1	3	5	4	2	4	2	4	24	This takes the science from UKCP09 and applies it to a practical assessment that could be of benefit across the wide areas of defended coastline. Has links to piloting and guidance need.
				Quantify the sensitivity of coastal recession at a national scale to the latest estimates of future sea-level rise	Q, LR[3]	NA	AR	L	Large	High	1	4	5	2	2	3	2	4	22	The RACE methodology, on which the national erosion risk maps were based, was developed five years ago, before UKCP09 and before the publication of recent developments in understanding of coastal response to sea level rise. There are opportunities to improve the ongoing generation of NCERM projections by updating the science on which they are based, and by using UKCP09.
				Assess the effects of latest climate change projections on waves and storm surges	Q, LR[1,2]	RC	AR	M	Large	Med	1	4	5	3	1	4	2	3	22	There is a limited understanding of climate change impacts on waves.
				Understand the response and resilience of natural systems to storms	Q	NA	DP	L	Large	Low	2									Potentially of significant value, but some work has been done in this area by Natural England and therefore the urgency is not as great as some other areas.

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
				Guidance on environmental indicators as a proxy for climate change for medium- to long-term FCERM decision making	LR[4]	NA	DT	L	Large	Low	2									Environment Agency Project Appraisal Guidance covers this. There may be a need to review how well the PAG is applied in practice before starting new research.
				Regional demonstrations of the potential scales of coastal morphological and ecological change due to future UKCP09 climate change projections	Q	CG	DP	L	Med	Med	2									Useful demonstrations but not immediate and can be incorporated into SMP2 or SMP3 process.
		Geomorphological processes	The morphological evolution of coastlines and estuaries over extended timescales akters flood and coastal erosion risk, yet the tools available to understand longer-term morphological change are limited. Existing tools are rarely linked with asset and flood/erosion risk models, or indeed ecosystem models. To help address this issue the Coastal and Estuarine Systems Tools (CoaEST) project was commissioned to better understand long-term morphological change on our coastlines. CoaEST forms a central programme of research within CoRDDi. The main outcome of the CoaEST project has been to define the Coastal Sediment Systems programme in collaboration with NERC.	Improve the capability to predict long-term and regional-scale change on the coasts and in estuaries	CoaEST	RC	AR	H	Large	Med	1	5	4	2	1	3	2	4	21	Contributes to improved understanding of whole-system behaviour with potential benefits across large geographical scales.
				Review of non-climate driven causes of coastal change	W	CG	DP	L	Med	Med	2									Changes such as geological or mining subsidence can affect coastal change and risk; this would be useful information to a restricted scale of application (certain 'types' of system).
				Regional updates of the systems mapping approach using latest climate change projections	Q	CG	AR	L	Med	Low	3									Futurecoast provided an initial basis for this and individual SMP2s should be building from this on a 'needs basis'.
		Whole-life performance of coastal infrastructure assets	To optimise investment of limited resources, understanding the performance and cost of construction, maintenance, upgrading or replacement of flood and erosion infrastructure assets on a whole-life basis will be an increasingly critical component of good decision making. Understanding and quantifying the	Develop a tiered integrated framework for asset performance tools	APT	NA	AR	L	Large	High	1	2	2	2	3	4	2	5	20	APT Inception project determined that this package needs to start as soon as possible because it will set the framework for subsequent packages to develop tools for inspection, risk assessment and asset management planning.

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
			change in performance over time (for example deterioration rates) and optimising where and when to invest (taking account of whole-life costs) will be key. Research priorities have recently been identified in the Asset Performance Tools (APT) study. Many of the findings of this study are relevant to the coast and form a central topic within CoRDDi. The APT studies are broken down into a series of scheduled packages of work.	Develop an asset performance tools data and coastal asset information management system	APT	NA	DP	L	Large	High	1	2	4	2	3	2	2	5	20	APT Inception project determined that this small project needs to support parallel work by the Environment Agency on restructuring its asset management information systems, which will happen in the short term.
				Asset performance tools methodology for location-specific and detailed visual inspection of coastal assets	APT	NA	AR	M	Large	Low	2									APT Inception project determined that this package is very important, but would be most effective if it builds on the integrated tiered framework, and if it can make use of results from FRMRC2. APT has programmed the first of its projects to start within one year of the tiered framework and run for about two years.
				Asset performance tools and coastal asset performance assessment	APT	NA	AR	M	Large	Low	2									APT Inception project determined that this package is very important, but would be most effective if it builds on the integrated tiered framework, and if it can make use of results from FMRC2 and other ongoing research. APT has programmed the first of its projects to start within one year of the tiered framework and run for about three years.
				Asset performance tools and coastal asset management planning	APT	NA	DT	M	Large	Low	2									APT Inception project determined that this package is very important, but would be most effective if it builds on the integrated tiered framework, and if it can make use of results from FMRC2. APT has programmed the first of its projects to start within

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
																				one year of the tiered framework and run for about four years.
		Behaviour of cliff, platform, beach and coastal protection systems	Although an episodic process, cliff recession, and its relationship with the beach and coastline position, is a long-term issue that is at the heart of developing a sustainable approach to shoreline management. The lack of information on coastal processes impedes decision-making. The current National Coastal Erosion Risk Mapping (NCERM) project's method provides a useful start but is limited in its regional and local applicability.	Understand the processes controlling rates of cohesive shore platform erosion	LR[5]	RC	AR	M	Large	High	1	3	3	2	3	2	3	4	20	Rates of lowering govern cliff retreat and beach function and are poorly understood. They are relevant along significant stretches of coast.
				Better understand the dynamic interaction between beaches and adjacent structures	LR[6, 7]	RC	AR	M	Large	Med	1	2	3	3	3	3	2	4	20	Where defences are present they are usually protecting valuable assets and therefore this research could have high 'impact'. Urgency is medium because existing research has been undertaken on seawall/beach and breakwater/beach interactions.
				Provide guidance on the options for managing cohesive shore platforms	LR[5]	NA	DT	L	Med	High	1	3	3	2	3	3	2	2	18	Robust management options for eroding cohesive shore platforms are required.
				Geomorphological audits and monitoring of dune systems to identify management strategies	LR[8]	NA	DP	M	Local	Med	2									This would be useful to have at some stage but not necessarily immediately and only relevant where dunes are present.
				Quantify regional sediment budgets for use in shoreline management	Q	CG	AR	L	Med	Low	3									Each SMP should be defining its own 'further study' needs.
				Simulate Holocene coastal response to sea-level rise	LR[9]	RC	BR	M	Large	Low	3									Whilst potentially of benefit across the UK, it is more a desirable than essential activity and individual schemes could consider such concepts if this was of importance to them as useful methods already exist.
				Improve numerical modelling to better understand cross-shore sediment transport at annual to	Q	RC	BR	M	Large	Low	3									Many beaches will experience cross-shore changes across such timescales but until datasets cover these

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
				decadal timescales																periods consistently and coherently, the calibration and validation of any models developed will be difficult.
	#1b – Short-term and local-scale processes	Behaviour of mixed beaches	Currently, the level of guidance for shoreline managers on mixed beach landforms is limited and there is scope to provide more advice on management options. Although our understanding of certain processes has improved, gaps in knowledge could effectively be filled by the CoRDDi Framework.	Develop tools to understand mixed beaches and their design criteria in management	LR[10, 11] AB	NA	DP	M	Med	High	1	4	5	3	3	4	3	2	24	High research importance but only in areas where mixed beaches are present, which does include notable geographical lengths with many assets at risk.
				Improve understanding of the performance and differential transport of mixed beaches	LR[10, 11]	NA	AR	M	Med	High	1	2	5	3	1	2	3	4	20	High research importance but only in areas where mixed beaches are present, which does include notable geographical lengths with many assets at risk.
				Develop optimum design slopes for nourishment of mixed beaches	LR[12]	NA	DP	L	Local	High	2									Important design issue that affects many recharged sand-gravel beaches.
				Guidance on options for managing mixed beaches	LR[10, 11, 12]	NA	DT	L	Local	Low	2									CIRIA Beach Management Manual (BMM) covers this to an extent, new guidance not needed until other mixed beach research completed. Feedback needed on whether the BMM provides enough information for more effective management.
	#1c – Multi-scale integration	Integration of multi-scale models	Whole-system models and integrated decision making need to move seamlessly from one notional scale to another; from policy to action and from local storm response to long-term regional change. To date, long-term broad-scale models and local storm response models have been typically developed and used in separate analyses. Providing frameworks that combine short-term response models within a broad-scale model, offers significant advantages, but incorporating this into practice remains a challenge.	Undertake a scoping study of the potential to link multi-scale models	W	RC	DP	L	Large	High	1	3	2	4	2	2	3	2	18	Needed to demonstrate proof of the concept and establish a way forward for more detailed research.

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
	#1d - Eco-morphological interactions	Ecosystem goods and services	Coastal areas provide important ecosystem services, particularly natural protection from coastal or tidal flooding. A coastline that is eroding threatens these services and leads to the loss of land of economic and ecological value, human life and property. However, coastal erosion in one area may provide ecosystem services elsewhere, for example where cliff erosion creates beaches which, in turn, provide natural protection.	Better understand ecosystem services provided by coastal habitats that benefit flood and coastal erosion risk management	Q, PAG, W	NA	AR	M	Large	High	1	4	4	4	3	3	4	4	26	An important first step in improving the role of ecosystem services in FCERM.
				Improve the evidence base for broad-scale ecosystem assessment	LR[13]	RC	AR	L	Large	Low	2									This project should follow 'delineation of ecosystem services that can assist FCERM' and therefore until that has been done is of lower priority - to be reviewed after that project is finished.
		Managed realignment	Managed realignment and habitat creation schemes have become an important coastal and estuarial choice in coastal management over the last 20 years and may have an important role to play in carbon mitigation. Little reliable predictive capability exists of either scheme performance or impacts over time, or of their carbon offsetting benefits.	Review opportunities for carbon sequestration in restored coastal wetlands	W	RC	BR	M	Med	Med	2									This is an important issue but only applicable where salt marshes are present and the driver is environmental not necessarily FCERM. Has links to other managed realignment project.
				Translate best practice coastal wetland restoration from the United States into UK managed realignment	W	NA	DT	L	Med	Med	2									Useful but only applicable to areas considered for wetland restoration.

[1]Defra/Environment Agency. 2003. UK Climate Impacts Programme 2002 Climate Change Scenarios: Implementation for Flood and Coastal Defence: Guidance for Users. R&D Project Record W5B-029/PR.

[2]Defra/Environment Agency. 2003. UK Climate Impacts Programme 2002 Climate Change Scenarios: Implementation for Flood and Coastal Defence: Guidance for Users. R&D Technical Report W5B-029/TR.

[3]http://www.bristol.ac.uk/civilengineering/research/systems/projects/probabilisticmodelling.html

[4]Defra/Environment Agency. 2003. Environmental Change Indicators (including those related to climate change) relevant to flood management and coastal defence. R&D Technical Report FD2311.

[5]Defra/Environment Agency. 2007. Understanding and Predicting Beach Morphological Change Associated with the Erosion of Cohesive Shore Platforms. R&D Report FD1926/TR.

[6]Defra/Environment Agency. 2005. Beach lowering in front of coastal structures. R&D Technical Report FD1916/TR.

[7]Defra/Environment Agency. 2008. Understanding the lowering of beaches in front of coastal defence structures, stage 2. R&D Report FD1927/TR.

[8]Defra/Environment Agency. 2007. Sand Dune Processes and Management for Flood and Coastal Defence. R&D Report FD1302/TR.

[9]http://www.tyndall.ac.uk/content/tyndall-centre-coastal-simulator

[10]Defra/Environment Agency. 2003. Development of Predictive Tools and Design Guidance for Mixed Beaches. R&D Final report, May 2003.

[11]Defra/Environment Agency. 2007. Influence of Permeability on the Performance of Shingle and Mixed Beaches. R&D Report FD1923/TR.

[12]Defra/Environment Agency. 2008. Practical Aspects of Executing Renourishment Schemes on Mixed Beaches. Science Report – SC030010.

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment

[13]Defra/Environment Agency. 2002. Broad Scale Ecosystem Impact Modelling Tools: Scoping Study. R&D Technical Report FD2108.

Theme 2: Valuing impacts and promoting innovative funding

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
#2 Valuing Impacts and Promoting Innovative Funding	#2a – Valuing impacts and opportunities	Opportunity gain	Coastal management has traditionally focused on reducing risk. But to be successful and sustainable in the longer term, the management of flood and coastal erosion risk must be allied with broader development. The coastal environment is a good example where opportunities to enhance it go hand-in-hand with investments to reduce risk. However various barriers exist to doing so, including funding mechanisms.	Define the value of ecosystem services in large-scale cost-benefit studies	Q	NA	DP	L	Large	Med	1	3	5	2	5	4	2	1	22	Needed to help explain the value of systems approach. Links with projects in Theme 1.
				Wider socio-economic analysis of capital and maintenance costs of strategies and schemes	Q, PAG	NA	DP	L	Large	Low	2									Needed for improved costing, but current approaches are working reasonably well and focus should therefore be on benefits more than costs.
		Valuing multiple benefits	Attributing the benefits to individuals, communities and organisations is the first step in providing the evidence base to secure funding. It is important to identify the beneficiaries of a coastal management action, and the degree to which they benefit. The lack of good research reduces our ability to assess multiple benefits (and beneficiaries), , and this undermines our ability to secure multiple funding.	Improve methods of attributing the benefits from flooding and erosion to people and the environment	LR[1]	NA	DP	M	Large	High	1	3	4	3	5	2	2	1	20	Important to identify beneficiaries and funders for future FCERM schemes.
		Real economic performance	The benefits within the economy that have been realised and the FCERM activity to which they are attributable are not understood, and hence lessons from the past have limited influence on appraisal methods and investment choices. Thus current post-project/scheme appraisals have limited usefulness in assessing the performance of past decisions to invest as they can give no indication as to whether they achieved the benefits postulated.	Appraise post implementation costs and delivered benefits	LR[2, 3]	NA	DP	L	Med	Med	2									Useful but not essential. Links to beach hindcast work.
	#2b – Promoting multiple and innovative funding	Innovation and funding	The need to attract multiple sources of funding is a practical reality as central government funding is reduced and localism is promoted. This approach adopts the 'beneficiary pays' principle.	Develop methods for innovation and added value in coastal defence schemes	W	NA	DP	L	Large	High	1	4	4	2	3	4	3	2	22	There is a need to go beyond the conventional scheme to incorporate other aspects (and funding contributors).
				Increase the engagement of potential contributory funding partners	GL	NA	DP	L	Large	High	1	3	5	1	5	4	1	1	20	Research is needed on how to engage with positive results.
	#2c – Supporting social justice and equity	Social choice	A fundamental principle of sustainable development is that people should be able to contribute fully to the decisions that shape their own lives, and the future of their children and grandchildren. Developing approaches that formalise the inclusion of social choice within the decision-making	Develop a framework for systematic inclusion of social choice within the decision making process and procedures	W, LR[4]	NA	DP	L	Large	High	1	4	3	3	4	2	3	1	20	Needed to fit in with the 'Big Society' agenda and assess the demands related to long-term risk management.

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
			process is important.																	
		Equality and justice	Social choice needs to be linked with the 'fair and equitable sharing of benefits', the social pillar of sustainable development that seeks to ensure that those who live within an area are able to share in the benefits (economic, social, and environmental) that result from the use made of its resources. Incorporated within this is the principle of social justice that seeks to ensure that adverse impacts of management decisions do not bear disproportionately on those already disadvantaged or marginalised, and that, conversely, the benefits from actions aimed at maintaining and restoring environmental quality reach those who need them most.	Understand societal impacts of coastal management options	LR	NA	DP	L	Med	Med	2									Impacts are largely determined on a scheme-by-scheme basis drawing on public consultation. Attitudes are so site/scheme-specific that this is considered useful but not essential.
	#2d - Engaging local communities in both decisions and actions	Encouraging local participation	Local participation in decisions made, and the funding, monitoring and maintenance of measures, could be improved. This is not easily achieved and expertise is required within public bodies to ensure local participation is effective. Existing mechanisms require review, and some may need to be reformed.	Review best practice and lessons learned of existing mechanisms for participation and develop guidance	Q, PAG, GL	NA	DT	L	Large	High	1	2	2	3	5	4	2	2	20	We need to identify the types of participation that are successful and those that are not, and how to improve the mechanisms. Would build on findings of the Pathfinders.
				Methods to engage communities to demonstrate the benefits of managed realignment as an adaptation option	Q, PAG	CG	DT	L	Med	Med	2									Important to future managed realignment schemes, but benefits of research restricted to managed realignment sites where there is public opposition, which are becoming scarcer. Links to wider projects on community engagement.

[1]Defra/Environment Agency. 2008. Who Benefits from Flood Management Policies. R&D Final Report FD2606.

[2]Defra/Environment Agency. 2006. Development of economic appraisal methods for flood management and coastal erosion protection. R&D Technical Reports FD2014/TR1, TR2, TR3.

[3]Defra/Environment Agency. 2006. The 'Sugden' Approach – Testing a Disaggregated Approach to Appraisal: Review of Recommendations. R&D Technical Report FD2018/TR2.

[4]Defra/Environment Agency. 2008. Social Justice in the context of flood and coastal erosion risk management: a review of policy and practice. R&D Technical Report FD2605TR.

Theme 3: Decision making and operational practice

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
#3 Decision making and operational practice	#3a - National policy	Policy development	The new Planning Policy on Development and Coastal Change focuses primarily on the impacts of permanent coastal change. It links spatial planning with Shoreline Management Plans (developed after PPG20 was written), and introduces a new evidence-based planning designation in the form of Coastal Change Management Areas (CCMAs). New tools developed under the CoRDDi Framework could improve the evidence base for CCMA decision making. The current tools are largely based on SMPs and recession data from the National Coastal Erosion Risk Mapping project. Adapting to coastal change is a task facing many coastal authorities and communities, made especially difficult by the uncertainty in predictions. The CoRDDi Framework could provide scenario-testing methods to help communities plan for change by highlighting what it might mean for them and for future generations.	Provide guidance and case studies on practical adaptation response measures for managing coastal change	Q, PAG, W	NA	DT	M	Large	High	1	5	5	3	5	5	3	2	28	Need for lessons learned and examples of good practice to be disseminated widely. Builds on Pathfinder projects.
				Guidance on management options for coastal landfill sites	Q	NA	DT	L	Med	Med	2									Important emerging issues across UK, but restricted in application to where landfills exist near the coast.
	#3b - Regional and strategic planning	Strategic planning	The Coastal Change Supplement (to PPS25) adopts a risk-based approach to development and flood risk; that is to appraise the risk, identify areas at risk, avoid development in those areas, manage the risk and mitigate its impact. The CoRDDi Framework could help in the development of risk assessment tools and optioneering methods for strategic planning that include both flood risk and coastal change impact.	Develop methods to integrate flood and coastal erosion risk management with marine spatial planning	W, PAG	NA	DP	M	Large	High	1	5	5	2	4	3	3	1	23	A must for coastal management.
	#3c - Operational implementation and engineering innovation	Operational practice	Better understanding of coastal processes and behaviour and the impacts of interventions gained from CoRDDi projects could improve operational practices and guidance to practitioners. Linking erosion and flood risk models and analysis and understanding the relationship between flood and coastal erosion risk are important components .	Scope the potential to link NaFRA and NCERM to provide an integrated national appraisal of flood risk and coastal erosion risk	Q, W	NA	DP	M	Large	High	1	5	4	2	4	2	5	5	27	National (England and Wales) scale assessments of linked flooding and erosion risk can be used to guide investment to strategically important areas. Links to the outcomes of the Pathfinders.
				Ways to link NaFRA and NCERM to provide an integrated approach to national flood risk	Q, W	NA	DP	H	Large	Low	2									Important, but needs to follow the Scoping Study. Priority should be reviewed after that study.

				and coastal erosion risk assessment																	
				Mechanisms for skills capacity building in delivery of flood and coastal erosion risk management	Q, PAG	NA	DT	M	Large	Low	2									Less important now than a few years ago due to downturn in economic climate.
	#3d – Better alignment and integration between local and national planning	Better integration	Many organisations are involved in managing the coastline. Shoreline Management Plans and coastal strategies link FCERM to broader plans to manage the coastal zone. However, lack of engagement with spatial planning continues to increase flood risk. The CoRDDi Framework can boost the connection to the spatial planning process.	Review the influences of SMP2 and PPS25 on land-use planning decisions	W	CG	DP	L	Large	Med	1	3	5	4	5	3	2	2	24	Can have a positive influence on the type and magnitude of future risks. Assessment of development practices in high risk areas.
		Maximising opportunity	SMPs and Coastal Strategies often tend not to work with other initiatives. Without this, multiple funding and local ownership of the results are difficult.	Review of wider opportunities arising from SMP2	Q	CG	DP	L	Large	Low	2									Each forward thinking Coastal Group is already doing this type of work and it is not necessarily a research project. Each SMP2 Action Plan should also cover this.

Theme 4: Dissemination, education and training

Theme	Sub-theme	Priority topic area	Description	Needs/Issues	Origin of project through consultation process	Suggested lead	Nature of the output	Cost	Scale of impact/benefit	Urgency	Scheduling priority	1	2	3	4	5	6	7	Total	Comment
#4 Dissemination, education and training	#4a - Data archiving, access and benchmarks		Monitoring required on national, regional or local scales could be commissioned through more formal links to the National Coastal Monitoring Programme. At the very least, data should be collected to national standards and stored in a central portal with metadata. This could be supported and delivered through the following mechanisms: Funding - Within CoRDDi, new data would be collected as necessary for the duration of the project. If these data were found to be useful at operational levels, funding could be transferred to continue monitoring through national or regional programmes. In the absence of a sponsor, the data would be deemed not of sufficient value to continue. CoRDDi could support a formal link through more regional studies, piggy-backing on regional studies commissioned through the coastal observatories. This would reduce procurement costs and ensure that data is held for onward use at the observatories.	Review the quality of existing RDD data to guide future monitoring and storage	W, PAG	NA	DT	M	Large	Med	1	1	4	2	1	4	4	5	21	Big investment is being made in coastal data collection and this work will determine how to maximise re-use of existing RDD data.
	#4b - Knowledge management and access		We need to create a dedicated web portal as a repository, dissemination and communication facility. Links to other websites (National Oceanographic Laboratory, Regional Coastal Observatories) will enhance its usefulness and help to create an impression of a much better coordinated and informed knowledge-base. This in itself will create the potential for learning and more interaction between scientific and public communities. Hopefully this will then help to generate greater interest and acceptance of the science and its outputs. Creation and maintenance of this 'portal' could be part of wider dissemination and publication of 'products'.	Create a web portal for hosting coastal RDD information	Q, W, PAG	NA	DT	M	Large	Med	1	2	5	2	4	2	3	5	23	Need to improve dissemination of RDD through a one-stop shop to ensure better take-up of findings. Links to the web-based guide to coastal morphological assessment.
				Create a web-based guide to coastal morphological assessment	W	NA	DT	M	Large	Med	1	1	3	2	2	2	2	5	17	Would help improve understanding of whole-system behaviour. Some training modules already exist and therefore not of highest urgency, but remains important. Should integrate with the Estuary Guide and provide support and guidance for Expert Geomorphological Assessment.
	#4c - Training and education		Training for users will be offered at two levels. Each project within CoRDDi will be required to provide training in an e-learning format accessible through a link to each project stored on the web portal. Training should also be provided in the form of a	Develop methods to communicate uncertainty and sensitivity to the public and practitioners	Q, W, GL	NA	DT	L	Large	Med	1	2	5	2	4	3	3	1	20	Communication of uncertainty is already carried out on a project-by-project basis but is not being done effectively. There is a need to improve

		package of learning around a particular theme. For example, with the Environment Agency's new flood and coastal erosion risk responsibilities, it requires most of its staff working in specialist areas to be better prepared with knowledge and information to assist them in their day-to-day activities. The training could be presented in one of numerous media, including e-learning, workshops, seminars and toolbox talks.																	public understanding of the issues in non-technical ways.
			Technical guidance on how to evaluate differing evidence from models about coastal systems	W	NA	DT	L	Large	Low	2									Interpretation is important, but this should be carried out via specific projects.
			Review of the need for themed training courses for users in flood and coastal erosion risk management	Q, PAG, GL	CG	DT	L	Large	Low	2									Existing training modules should be used and the need for this project re-evaluated based on user feedback of those modules (is existing training sufficient?).
	#4d - Routine software	The development and deployment of software for routine use is perhaps the most effective means of achieving uptake but one of the most difficult to do successfully. The development of useful software may require two or three projects or themes to be pulled together and a common strand of research pursued for many years. The maintenance and development of software, maintaining its scientific as well as operational capability, presents further challenges.	Develop visualisation tools to communicate management concepts and uncertainty	W, PAG, LR[1]	NA	DT	M	Large	Med	1	3	4	2	4	3	2	4	22	To gain wider acceptance of a changing coast and a need to alter our approaches to management in the future requires winning over the public. Visualisation is a critical element of this communication ensuring that members of the public are better informed.

[1] http://www.tyndall.ac.uk/content/tyndall-centre-coastal-simulator

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