

# A Framework for Coastal and Erosion Risk Management Science

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## Introduction

Good decision making at the coast is difficult, reflecting the uncertainty in future climates and demographics, a desire to deliver multi-functionality, the need to maintain a strategic view whilst encouraging local ownership, and the difficulties in understanding the behaviour of coastal systems and impacts of interventions. Often these challenges are set against a background of conflicting and competing management objectives. Although significant progress has been made in the last few decades with regard to the integrated management of our coastline, there remains a broad acceptance that more could and should be done.

Recent initiatives, such as Foresight<sup>i</sup>, and its associated Foresight Update<sup>ii</sup>, the Pitt Review<sup>iii</sup> and UK Climate Projections (UKCP) 09, have all identified that coastal areas will be at increasing risk of sea flooding and coastal erosion due to climate and socio-economic change. They also highlight the major challenges that persist in our understanding of the coast and how best to manage it. These challenges include gaps in our engineering and physical science understanding and also in our ability to convert good science into good practice. It is these later stages of dissemination and training that have often not been given sufficient priority to make a real difference and break down the barriers between science and uptake in practice.

Robust and practical science and the provision of sound supporting evidence, has long been recognised as a key means of moving practice forward and *much faith has been placed in science, technology and innovation as a means towards a sustainable and sustained economic recovery*<sup>iv</sup>. The provision of such science and evidence necessarily requires the co-ordination of a spectrum of activities ranging from basic ('blue skies') and applied research through to development and pilot testing, and then in to implementation. No one single element of this pathway can exist in isolation and if a real difference to our understanding and management of the coast is to be made, a correct balance must be struck between scientific rigour, user relevance and practicality. The Government's white paper on innovation<sup>v</sup> highlights the long and uncertain process that basic research often has to follow to make it to the marketplace, and places an increased emphasis on other sources of innovation including the creative application of tried-and-tested technologies and the role of design in developing innovative products and services.

A vision for the future of coastal research development and dissemination has been recently set out within the **Coastal Research Development and Dissemination (CoRDDi)** Framework. The framework has cross-government buy-in and is being promoted through the joint Environment Agency / Defra Flood and Coastal Erosion Risk Management R&D Programme<sup>vi</sup> in close association with the Living With Environmental Change (LWEC) partnership<sup>vii</sup>. Within the CoRDDi Framework a portfolio of coastal research priorities have been identified to support better delivery of Flood and Coastal Erosion Risk Management (FCERM). Priority areas for RDD over the next five years have been defined together with a clear direction of travel for longer term efforts. The CoRDDi Framework is aimed at all those with an interest in managing flood and coastal erosion risk, including practitioners and the research community. It provides a Framework for all levels of involvement, from researchers and research managers to user organisations who may be called upon to contribute to collaborative funding.

## Developing a Shared Vision

The starting point for the development of the CoRDDi Framework was to envision a desired future state for flood and erosion risk management at the coast. The vision (Figure 1) was developed from the following set of criteria/attributes:

- reflecting a bold aspiration for the future of flood and coastal erosion risk management;
- the diverse interests of stakeholders (practitioners, funders and researchers);
- supporting the political context and ‘direction of travel’;
- a desire to foster collaboration within the coastal community;
- where success can be verified; and
- providing flexibility to ensure continued relevance.

The vision outlines how the timely uptake of user-oriented research can assist with the future management of the coast. This includes managing risk and promoting opportunities, recognizing that a sole focus on risk management alone is limited, fails to maximize return on investment, and is not compatible with a notion of integrated management.

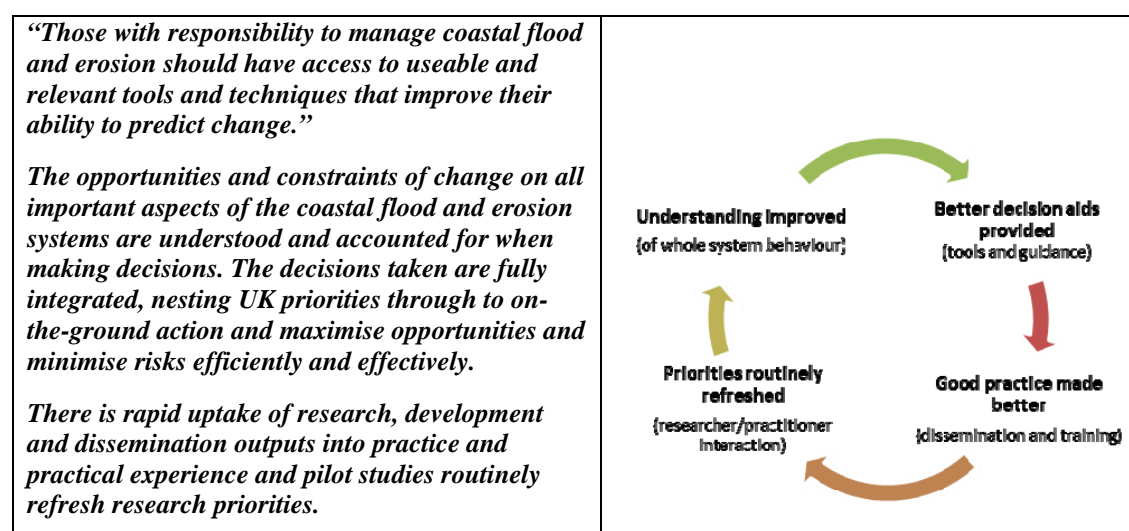


Figure 1. The CoRDDi Vision

## Strategic Context of Coastal Research

A cascade of strategies is currently in development to set out the direction of research aimed at supporting flood and coastal erosion risk management. At the top of this cascade is the LWEC initiative; a partnership of 22 major UK public sector funders and users of environmental research, including the research councils and central government departments. Its 10-year programme aims to optimise the coherence and effectiveness of UK environmental research funding and ensure government, business and society have the foresight, knowledge and tools to mitigate, adapt to, and capitalise on environmental change. LWEC is developing a series of strategies to provide high-level direction in the areas of water, health and economy.

Sitting within the LWEC initiative and under the broadly-based UK Water Research and Innovation Framework<sup>viii</sup> is the UK First Flood Research Strategy<sup>ix</sup> (Figure 2). The Flood Strategy continues to evolve but is currently designed around three core themes of i) understanding risk (ii) reducing probability (likelihood), and (iii) reducing consequence (impact).

The delivery of CoRDDi and the Flood Research Strategy will be managed by a team drawn from the LWEC Partner organisations. Their remit will be to deliver the benefits from the portfolio, maintain communications and governance arrangements across LWEC partners, manage risks and issues, facilitate an executive portfolio board and aid framework initiation. The CoRDDi Framework has a pivotal role in setting the future coastal research agenda. It provides a link between the higher-level strategies and their governance structures and specific programmes and projects of the commissioned research (Figure 2).

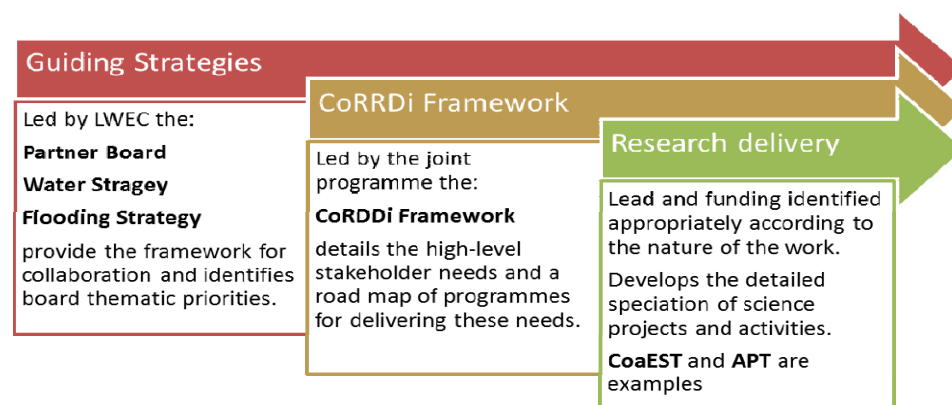


Figure 2. The relationship of the CoRDDi Framework to higher level guiding strategies and research delivery

## Aspects of the CoRDDi Framework

Throughout the development of CoRDDi, good science and supporting evidence was recognised as a key attribute for good decision making in relation to the management of coastal flooding and erosion. To support this goal, research, development and dissemination (RDD) extend across a spectrum of activities, from **basic** coastal research (in association with the National Environmental Research Council (NERC), the Engineering and Physical Sciences Research Council (EPSRC) and others), **applied** coastal research (in association with the European Commission), **development** of science into practical tools and guides (in association with the Construction Industry Research and Information Association (CIRIA) and others) and associated **dissemination** and **training** to promote take-up and improve ‘on-the-ground’ capability (Figure 3).

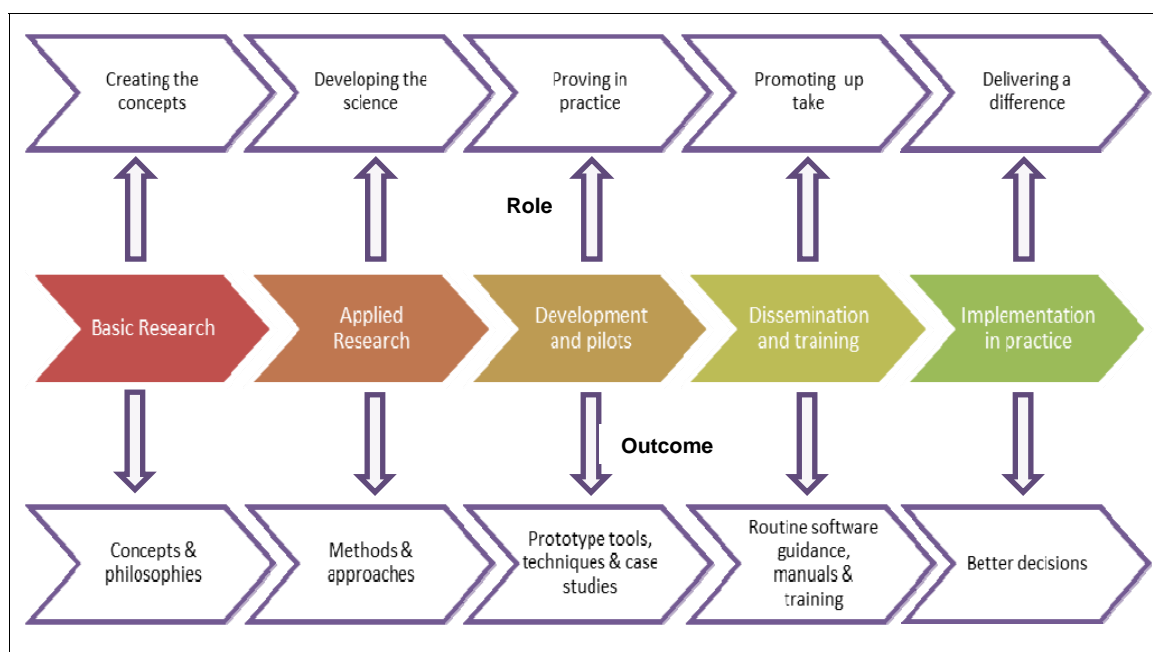


Figure 3. The CoRDDi framework will support all aspects of coastal science

## Research Drivers

Various funders are interested and active within the general area of coastal science and many have specific strategic aims and objectives associated with flood and coastal erosion risk management, and more broadly, management of the coast. Achieving better integration of the science initiatives across funders offers significant rewards, including:

- **greater efficiency for each research pound spent:** maximising the use of existing research and multiple funding streams (avoiding duplication);
- **greater effectiveness:** providing a clear and coherent line of sight from basic research through to practice; and
- **better academic innovation and practical applicability:** academic innovation and practicality are not mutually exclusive ideals; often it is simply the lack of understanding of practical requirements by the academic and the lack of understanding of theoretical knowledge by the practitioner that limits advances in either domain. Providing a mechanism by which each of these can come together will enhance both.

Although desirable, delivery of this type of collaborative approach is not trivial. CoRDDi was never envisaged to develop a centralised process of pooling funding and central distribution, but rather to promote integration through:

- **a shared vision:** developing a shared vision for research priorities that can act as a focus for all funders to develop and promote specific initiatives and projects;
- **an active process of update:** evolve this common view through a continuous process of updating and review as the needs and demands of stakeholders change; and
- **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 collaboration rather than barriers to collaboration will be vital to the success of the CoRDDi Framework. Without this facilitation, individual funders are likely to remain individual.

In lieu of the finalised governance arrangements which will be developed by the National Flood Research Strategy, CoRDDi will operate within the current arrangements in place to run the Joint Programme. These arrangements involve the Coastal Groups, the Joint Programme Technical Advisory Groups (TAGs), and the CoRDDi Project Advisory Group who will all play important roles in delivering the CoRDDi vision. Each group has an essential role in the prioritisation, review and monitoring of the research generated by the framework as it progresses.

To maintain continued relevance it is essential that the Framework should respond to changing user needs and innovation. Key to this is the ability to monitor and verify success and the benefits delivered. If this can be achieved it will enable the Framework to evolve and become self-perpetuating (not self-funding) to incorporate relevant advances in understanding and improved delivery. There will be the need for a continuous discourse between researchers and users as well as scientists, engineers and planners.

## Themes

The Framework comprises four themes; 1. Understanding whole system behaviour, 2. Valuing impacts and promoting innovative funding, 3. Decision making and operational practice, and 4. Dissemination, education and training (Figure 4). The first two themes are focused on developing the knowledge base and the third builds on this base to assist the decision-making processes. An overarching strand of the Framework focuses on theme-wide dissemination.

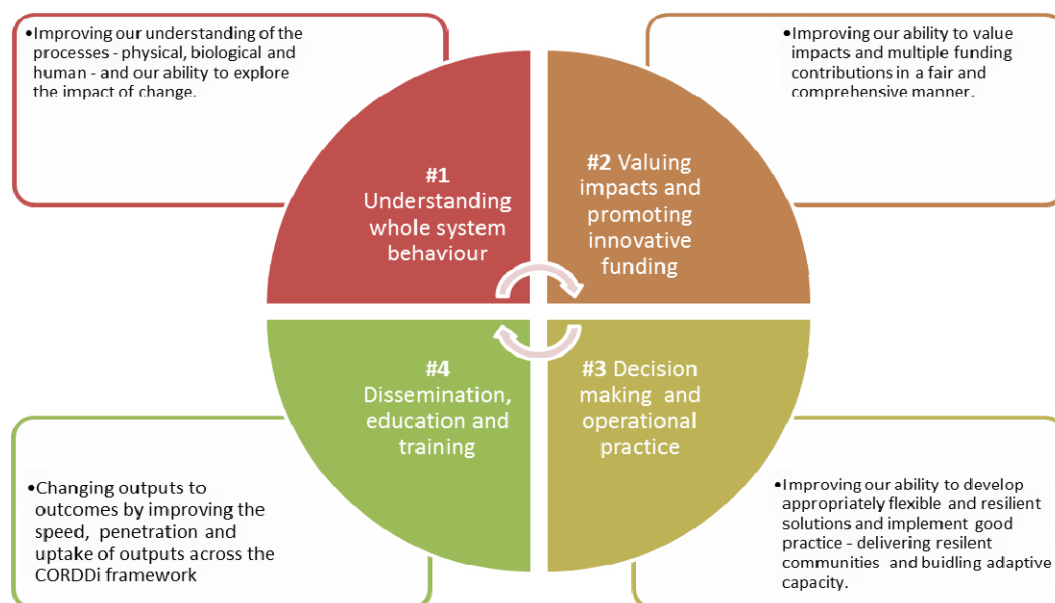


Figure 4. An overview of the four themes within the CoRDDi Framework

### Theme 1: Understanding whole system behaviour.

Understanding the behaviour of coastal systems across multiple scales in time and space is now widely acknowledged as a pre-requisite for good decision-making. Shoreline and nearshore hydraulic and sedimentary processes (driven by weather), geomorphological behaviour (driven by these processes), ecological functioning and human intervention at the coast all contribute to a complex system of interacting mechanisms. These linkages present significant challenges in terms of understanding individual components of the system and the system as a whole. However, developing this understanding over multiple temporal and spatial scales is fundamental to providing better management decisions. A significant and

important challenge for the CoRDDi Framework is to advance science to develop whole systems understanding in a practical and credible manner. This includes providing new concepts that integrate spatial and temporal scales and enable multi-functional, multi-options approaches to be developed.

### **Theme 2: Valuing impacts and promoting innovative funding.**

The coast is home to many, a work place and business asset for others, as well as 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. As such the coast and the risks it faces are unique. Consequently, the way in which the diversity of coastal environments and flood and erosion impacts are valued remains a significant challenge.

The coast is an excellent example of multiple interests demanding multi-functional schemes; promoting opportunities such as harbour use and tourism (for example) whilst reducing risk. Public sector expenditure is likely to be heavily constrained in the coming years, and delivering value for public money will be more important than in previous years. It is also likely that “value for money” will increasingly be scrutinised in terms of the opportunities it promotes for improvement as well as the risk it reduces. This will demand a better understanding of the ‘true’ risks and opportunities and a more integrated view of the ‘value’ achieved. Thus, Theme 2 of the CoRDDi Framework will focus on socio-economic and funding issues.

### **Theme 3: Decision making and operational practice.**

Theme 3 focuses on building adaptive capacity within coastal policy, plans and on-the-ground actions. The rates of change in climate, demographics and political setting, and the associated uncertainties, present a major challenge to the decision making processes and operational practice adopted. All levels of decision making are included within this theme, with decisions based on the improved understanding (tools and techniques) developed within CoRDDi Themes 1 and 2. The focus here is how to use this improved understanding to help make better more robust choices in a transparent and participatory manner.

### **Theme 4: Dissemination, education and training.**

The fourth theme within the CoRDDi Framework places emphasis on dissemination to a level not seen in previous studies. It seeks to deliver better dissemination from project inception through to delivery of the final outputs and on to uptake and routine use, whilst keeping research outcomes under review in the light of experience gained through its application. This approach of progressive improvement will provide a continuity of development of new tools and techniques that has occasionally been lacking to date. This will avoid repetition and reinvention, whilst continuing to provide room for real innovation (not repackaged theory). This is not a simple task and one that will demand a wide range of organisations to provide resources and fund activities.

## **RDD Prioritisation and Project Development**

Through a process of consultation with coastal managers, consultants and academics, a wide range of important issues for future research and development were identified. These were then prioritised to distinguish (i) ‘essential’ and ‘desirable’ projects; (ii) the scale of impact, i.e. those projects applicable nationally and those applicable to a specific location or region; and (iii) the urgency of the project, i.e. those aimed at supporting current practice and those

that will influence future action (for example to inform future Shoreline Management Plans in 5 or 10 years time). The simple scoring matrix used is shown in Figure 5.

Scale of Impact/Benefit	Large	2	1	1
	Medium	3	2	1
	Local	3	3	2
		Low	Medium	High
		Urgency		

Figure 5. Scoring system for scheduling prioritisation of needs/issues

The projects highlighted as priorities for the coming five years through this process are summarised in Figure 6.

<p><b>#1 Understanding whole system behaviour</b></p> <ul style="list-style-type: none"> <li>•#1a Long-term and regional-scale processes <ul style="list-style-type: none"> <li>•Climate change impacts on coastal processes</li> <li>•Coastal sediment systems framework and model development</li> <li>•Asset performance tools integrated tiered framework and data management</li> <li>•Understanding and managing cohesive shorelines</li> </ul> </li> <li>•#1b Short-term and local-scale processes <ul style="list-style-type: none"> <li>•Behaviour of mixed beaches and their effective management</li> </ul> </li> <li>•#1c Multi-scale Integration <ul style="list-style-type: none"> <li>•Scoping and development of the potential to integrate multi-scale models and decisions</li> </ul> </li> <li>•#1d Eco-morphological Interactions <ul style="list-style-type: none"> <li>•Ecosystem service benefits to flood and coastal erosion risk management</li> </ul> </li> </ul>
<p><b>#2 Valuing impacts and promoting innovative funding</b></p> <ul style="list-style-type: none"> <li>•#2a Valuing Impacts and opportunities <ul style="list-style-type: none"> <li>•Valuing ecosystem services in flood and coastal erosion risk management</li> <li>•Attribution of benefits from flooding and erosion</li> </ul> </li> <li>•#2b Promoting multiple and innovative funding <ul style="list-style-type: none"> <li>•Innovation in coastal defence schemes</li> </ul> </li> <li>•#2c Supporting social justice and equity <ul style="list-style-type: none"> <li>•Developing a framework for inclusion of social choice</li> </ul> </li> <li>•#2d Engaging local communities in both decisions and actions <ul style="list-style-type: none"> <li>•Best practice in stakeholder participation</li> </ul> </li> </ul>
<p><b>#3 Decision making and operational practice</b></p> <ul style="list-style-type: none"> <li>•#3a National policy planning / #3b Regional and high level strategy planning <ul style="list-style-type: none"> <li>•Guidance on adaptation measures for managing coastal change</li> </ul> </li> <li>•#3b Regional and high level strategy planning <ul style="list-style-type: none"> <li>•Integrating flood and coastal erosion risk management with marine spatial planning</li> </ul> </li> <li>•#3c Operational Implementation and engineering innovation <ul style="list-style-type: none"> <li>•Scoping study to develop an integrated national appraisal of flood risk and erosion risk</li> </ul> </li> <li>•#3d Better horizontal alignment and integration <ul style="list-style-type: none"> <li>•Review of SMP2 and PPS25 influences on land-use planning decisions</li> </ul> </li> </ul>
<p><b>#4 Dissemination, education and training</b></p> <ul style="list-style-type: none"> <li>•#4a Data archiving, access and benchmarks <ul style="list-style-type: none"> <li>•Review of data benchmarking and holdings</li> </ul> </li> <li>•#4b Knowledge management and access <ul style="list-style-type: none"> <li>•Provision of a sustained and effective dissemination of CoRDDI outputs</li> </ul> </li> </ul>

Figure 6. Priority projects across the Themes

## Challenges to Overcome and Ownership of Issues

The difficulties and barriers to the successful delivery of the CoRDDi Vision are not simply technical, but rely on an on-going and proactive dialogue with users and researchers alike. Some of these barriers and how they are addressed within CoRDDi are highlighted below in Figure 7.



Figure 7. The CoRDDi Framework will provide an on-going process of dialogue with practitioners that has a range of attributes

Some of the more prominent challenges that have been identified whilst developing the CoRDDi Framework that remain unresolved are;

**Judging success based on shared criteria:** Each funder has a different motivation and hence use different criteria to judge the success or otherwise of research and development projects and programmes. As such, when seeking to be provide collaborative multi-funded research, the success criteria used can either become a facilitator of integration between research and practice or indeed place barriers to successful collaboration.

**Evolving shared models, codes and software IP:** Developing modelling initiatives into a meaningful community based network of model components capable of being integrated to reflect the demands of a particular decision process will be a crucial challenge facing the coastal community. This will not only demand research but also strong governance to align research with the chosen approach.

**Sharing and managing data and data IP:** A long held view reinforced in the Environment Agency's data strategies is the idea to collect once and use many times. Coastal observatories are good at sharing the data they have, whilst others are not. Much excellent researcher-collected data is not in the public domain and the governance of CoRDDi needs to try and ensure this data is reused, stored, understood.



**Joint funding and/or cost sharing:** Who does what, who leads which projects, how the 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 to this issue will be important facilitators or barriers of successful collaboration.

**Maintenance of core capability whilst encouraging innovation and new ideas:** Programmes such as the Flood Risk Management Research Consortium (FRMRC) and Environment Agency Frameworks enable like-minded and collaborative thinking to be developed and can, but not always, avoid reinvention. Some argue that such approaches can limit creativity and innovation, so the RDD to be procured needs to ensure it gets the best from the research money spent.

**Taking a long term view:** It may take some time before concepts become stable methods and a practical reality. For example, many advances have been made in system risk and uncertainty analysis (e.g. RASP<sup>x</sup>, Tyndall simulator), but on-going effort is required to ensure such concepts are routinely used in practice and are fully trusted. The governance of CoRDDi should avoid short-termism and recognise the need to continue to evolve tools and techniques.

Although the development of a CoRDDi Framework can go some way to address the issues that are introduced above, the challenges highlighted are, in most cases, cross institutional and are common to many. Given that these issues are often generic it is arguable that they should be effectively tackled at the highest level, by LWEC. The on-going development of the LWEC strategies provides an ideal opportunity to address these and provide clarity to the research community. Without this clarity, collaborative research will remain an unobtainable aspiration. Recent years have seen the move across government to develop a co-ordinated approach to science.

## Annual Score Card

The success of the CoRDDi framework will be formally reviewed as part of its on-going management. Attributing societal and environmental benefits directly to investment within CoRDDi will be difficult, as genuine outcomes are likely to occur significantly ‘downstream’ from the projects. 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.

As each funder has a different motivation, and hence use different criteria to judge the success or otherwise of research and development projects and programmes, a range of criteria (of interest across the broad spectrum of potential funders) has been developed. These success criteria provide important targets for the researchers and therefore have been developed to be facilitators of integration between funders, researchers and practitioners.

## Conclusions

This paper details a Vision and Framework for **C**oastal **R**esearch, **D**evelopment and **D**issemination (CoRDDi) that outlines a portfolio of research priorities, including tools and techniques to support better delivery of Flood and Coastal Erosion Risk Management. The vision and framework are of relevance to all those with an interest in managing the coast. Four priority themes for action have been identified; 1. Understanding whole system behaviour, 2. Valuing impacts and promoting innovative funding, 3. Decision making and

operational practice, and 4. Dissemination, education and training. The first two are focused on developing the knowledge base and the third builds on this base to assist the decision-making processes. An overarching strand of the Framework focuses on theme-wide dissemination (Theme 4). Within each of these themes, both the longer-term direction of travel and more immediate opportunities for ‘quick wins’ are outlined. A prioritisation process has been undertaken to distinguish between the ‘essential’ and ‘desirable’ needs, between needs of national significance and those of local value, and those needs which are required to influence practice now, and those which will be required at some stage in the future. A set of coherent and fundable projects each with high level objectives has been mapped against the high priority needs.

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