Department for Environment Food & Rural Affairs

Llywodraeth Cymru Welsh Government

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Environment Agency

delivering benefits through evidence

Working with natural processes to reduce flood risk

R&D framework: initiation report

Report – SC130004/R1

Flood and Coastal Erosion Risk Management Research and Development Programme

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

This report is the result of research commissioned by the Environment Agency's Evidence Directorate and funded by the joint Flood and Coastal Erosion Risk Management Research and Development Programme.

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Evidence at the Environment Agency

Evidence underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us, helps us to develop tools and techniques to monitor and manage our environment as efficiently and effectively as possible. It also helps us to understand how the environment is changing and to identify what the future pressures may be.

The work of the Environment Agency's Evidence Directorate is a key ingredient in the partnership between research, guidance and operations that enables the Environment Agency to protect and restore our environment.

This report was produced by the Scientific and Evidence Services team within Evidence. The team focuses on four main areas of activity:

- **Setting the agenda**, by providing the evidence for decisions;
- **Maintaining scientific credibility**, by ensuring that our programmes and projects are fit for purpose and executed according to international standards;
- **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 making appropriate products available.

Miranda Kavanagh

Director of Evidence

Executive summary

A previous Defra-established multi-agency working group stated that working with natural processes (WWNP) means:

> ‘taking action to manage fluvial and coastal flood and coastal erosion risk by protecting, restoring and emulating the natural regulating function of catchments, rivers, floodplains and coasts’.

The overall aim of the WWNP research framework is to:

> ‘develop a comprehensive and prioritised programme of WWNP research, development and dissemination, which enables us to undertake FCERM sustainably, improving the environment for people and wildlife’ (WWNP Project Briefing Note, 2013).

The project is split into three stages. This report summarises Stage 1 completed in 2013, which included a review of existing data and evidence, a stakeholder workshop and an analysis of emerging research needs and gaps. It will inform Stage 2, which will refine the research gaps, and identify and prioritise R&D projects that could be undertaken by the joint Defra/Environment Agency Flood and Coastal Erosion Risk Management R&D Programme, other risk management organisations, public sector bodies, non-governmental organisations, academic institutions and other research funders. During Stage 3 (2014), the final report will be produced, independently peer-reviewed and published.

During the first stage of this project, a total of 41 research gaps were identified in a range of WWNP topic areas. These were then reduced to the following eight broader WWNP research gaps:

- understanding approaches to community and stakeholder engagement
- understanding cultural and institutional barriers to WWNP in flood risk management authorities
- guidance and/or training in WWNP for practitioners
- learning lessons from past pilot/case studies
- new studies to improve the WWNP evidence base
- national prioritisation of catchments for WWNP delivery
- collecting data about natural processes at a catchment scale
- developing more adaptive/ resilient green engineering technologies

Stage 2 of this project will refine these eight research gaps, confirm the research priorities, prioritise potential projects and define their objectives. Business cases/proposals will be produced for the 10 highest priority projects, as the starting point for a five year programme, and potential delivery and funding routes for each priority project will be identified.

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 consisting of: Andy Disney, Greg Whitfield, Lydia Burgess-Gamble (Project Manager) and Mark Ross (Project Executive) from the Environment Agency; Jenny Mant (RRC); John Oldfield (Bedford Group of IDBs and ADA); John Rees (NERC); Nicola Rimington (National Resources Wales); Peter Downs (BSG); Rob Cathcart (Natural England); Rob Collins (Rivers Trust); Ruth Ashton-Ward (Defra); Vicki Rhodes (LWEC) and Vince Carter (Forestry Commission).

Thanks are given to individuals and organisations that contributed to the data and evidence review as part of Stage 1 of this research including:

- Association of Drainage Authorities
- Bedford Group of Internal Drainage Boards
- British Geological Survey
- British Society for Geomorphology
- Chris Bown and Dr Emma Stevens (Black &Veatch)
- Professor David Sear, University of Southampton
- Department for Environment, Food and Rural Affairs
- Environment Agency
- Ece Ozdemiroglu (eftec)
- Economic and Social Research Council
- Professor Enda O'Connell
- Forest Research
- Forestry Commission
- Hutton Institute
- Living With Environmental Change
- Natural England
- Natural Resources Wales
- Natural Environment Research Council
- Dr Nicola Teague (Apem)
- Professor Philip James (University of Salford)
- River Restoration Centre
- Rivers Trust

Thanks are also given to those who attended and contributed to the Working with Natural Processes (WWNP) stakeholder workshop.

Contents

1 Introduction

1.1 Overview

The Working with Natural Processes (WWNP) research framework is a cross-cutting research area within the Joint Defra/Environment Agency Flood and Coastal Erosion Risk Management Research and Development Programme (the 'Joint Programme'). Figure 1.1 summarises the structure of this report and supporting documents.

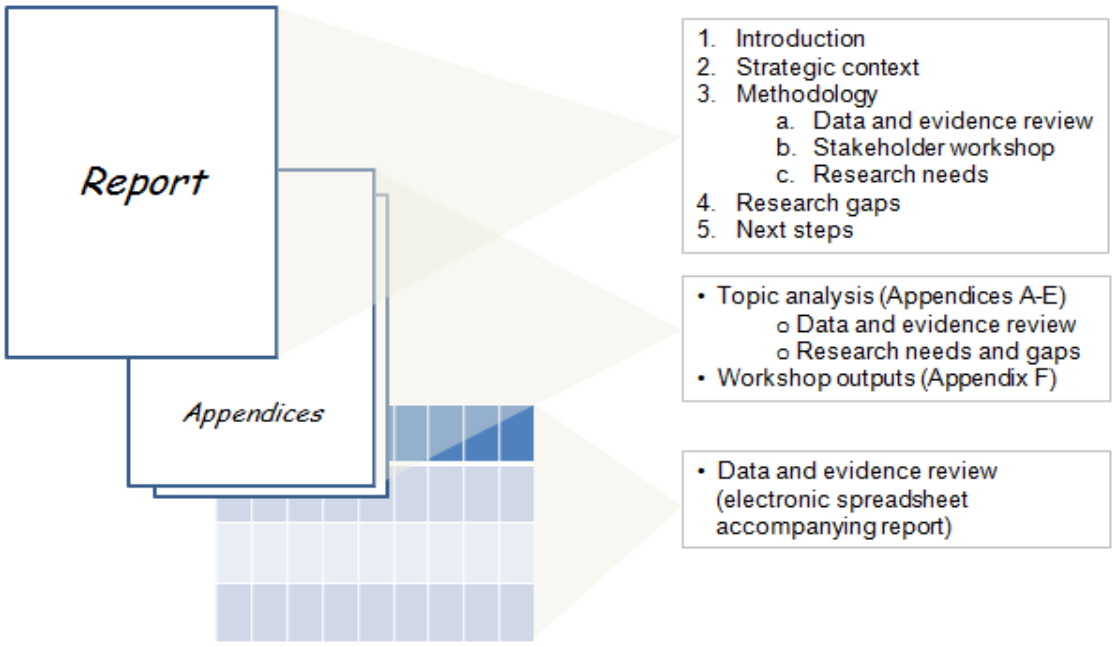

Figure 1.1 Structure of this report and supporting documents

There has never been a comprehensive review of WWNP research and development (R&D) to establish:

- what R&D been completed to date
- where the knowledge gaps are
- what the future research needs are

This project fills this gap and is being completed in three stages (Figure 1.2). This Stage 1 report includes a review of existing data and evidence, a stakeholder workshop and an analysis of emerging research needs and gaps. This report informs Stage 2, which will refine the research gaps, identify and prioritise R&D projects. During Stage 3, the final report will be produced, independently peer-reviewed and published.

In this report, the term WWNP is used to refer specifically to 'working with natural processes to reduce flood and coastal erosion risk'.

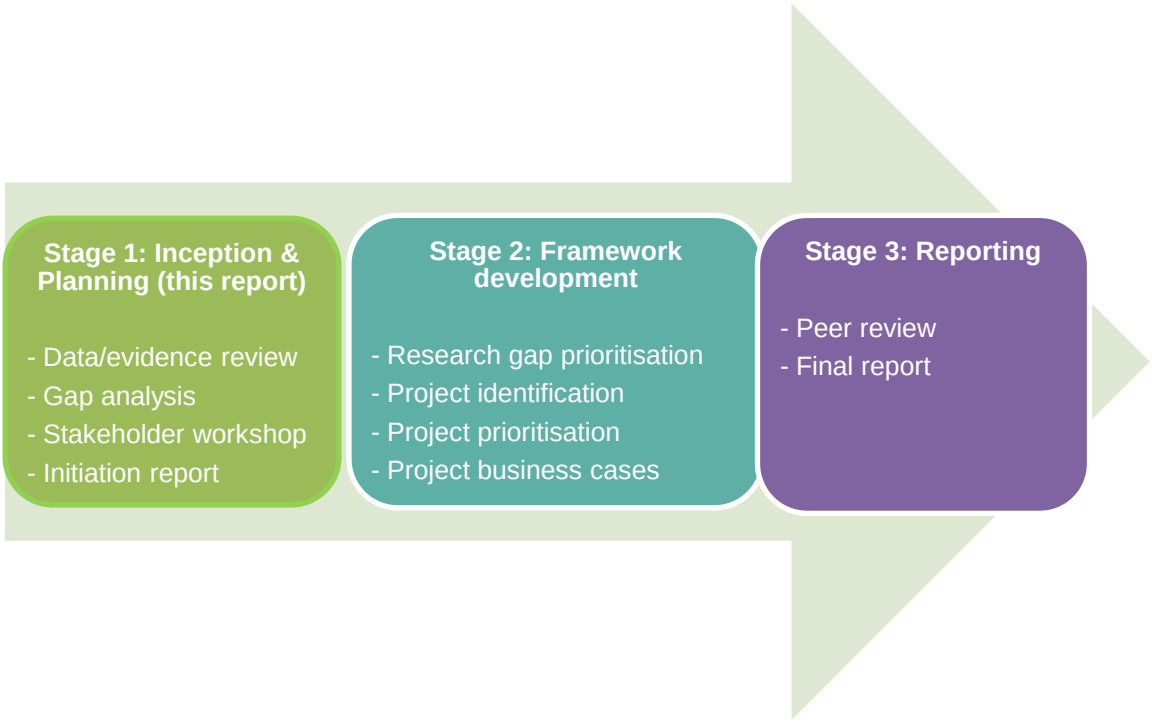

Figure 1.2 Stages in WWNP framework development

1.2 Aim and objectives

The overall aim of this project is to:

> 'develop a comprehensive and prioritised programme of WWNP research, development and dissemination, which enables us to undertake FCERM sustainably, improving the environment for people and wildlife' (Environment Agency 2013a).

The specific objectives of the project are to:

- **Stage 1**
  - **Review** a wide range of existing and on-going research and evidence used by the WWNP and flood and coastal erosion risk management (FCERM) community
  - **Identify** research gaps and needs
- **Stage 2**
  - **Develop** a prioritised research programme
  - **Develop** business cases for 10 research projects
- **Stage 3**
  - **Produce** final report and review

1.3 Background

WWNP is not intended as a replacement for traditional defences, because risk management authorities still need to ensure that they are reducing the impact of flood risk to people – including property, businesses and infrastructure. WWNP will help

ensure that FCERM is undertaken sustainably and as cost-effectively as possible. This will help to:

- minimise future costs to maintain and replace defences
- maximise the wider and multiple benefits to society such as other benefits to water quality, recreation and habitats

This is because WWNP helps to improve the environmental condition of rivers, wetlands and coastal areas, both urban and rural, generating wider benefits for local communities and the economy. It also provides the opportunity to help society mitigate and adapt to the impacts of climate change such as sea level rise, more extreme weather events and changes in land use.

Figure 1.3 summarises the main legislative and policy drivers of WWNP in FCERM. A main driver for WWNP came from the Pitt Review in 2008 after the summer 2007 floods. The Pitt Review concluded that flooding from a range of sources can no longer be managed by building ever bigger and harder defences in urban and rural areas. It also emphasised the need to 'work with natural processes' as part of a portfolio of responses to flooding (Pitt 2008).

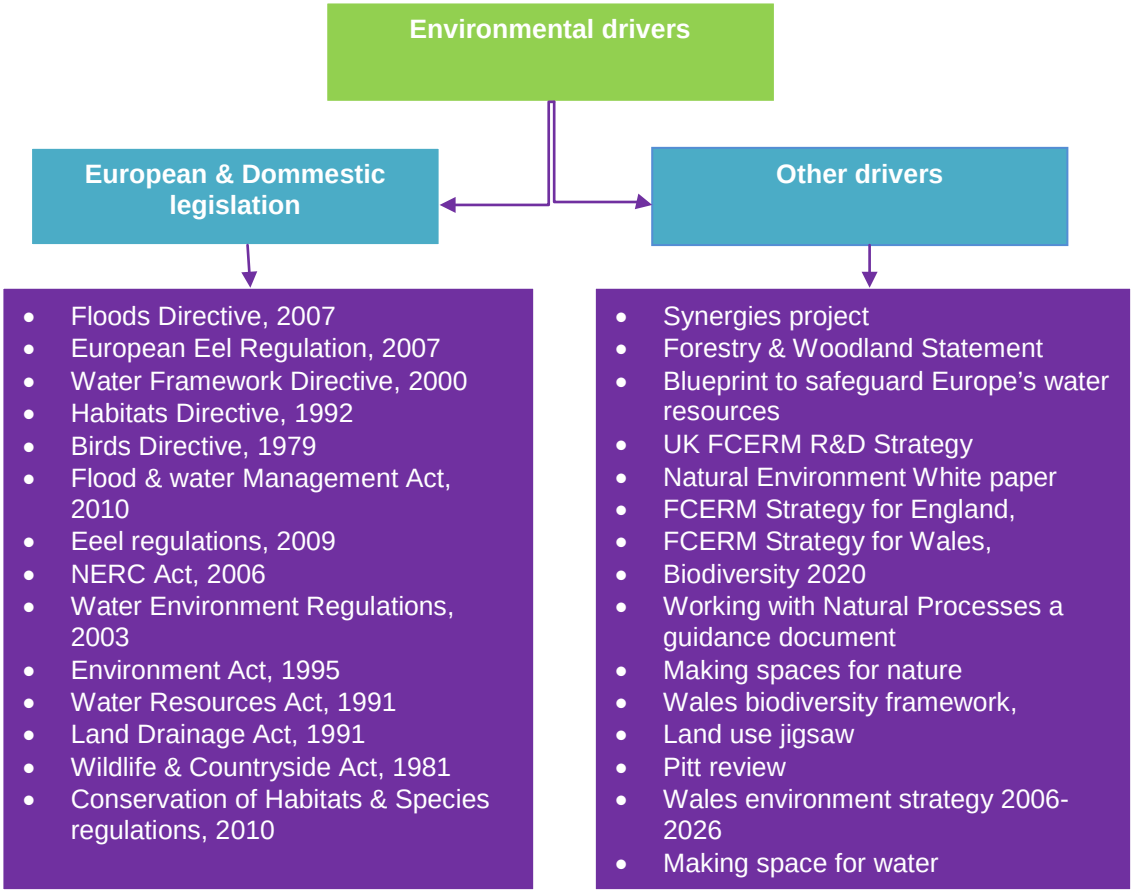

Figure 1.3 Main legislative and policy drivers of WWNP in FCERM

WWNP can help the Environment Agency achieve the goals of the legislative and policy drivers set out in Figure 1.3 by:

- reducing flood risk
- creating and restoring habitats
- enhancing biodiversity

- capturing carbon
- reducing sedimentation
- improving water quality

WWNP will also contribute to the Environment Agency's single integrated programme of achieving environmental benefits associated with FCERM activities (Environment Agency 2013b). This means that it will protect and improve the water environment using outcomes that meet shared objectives through integrated environmental planning at the catchment scale. This includes joining up river basin management plans, shoreline management plans and catchment flood management plans, and achieving a catchment-based approach. This single joined-up planning approach will help meet the requirements of the Water Framework Directive (WFD), Habitats Directive, Floods Directive and Eel Regulations, as well as more sustainable flood risk management.

The recently published final report on the Defra 'Synergies' Project (Hardiman and Cathcart 2013) identified recommendations for integrating outcomes across the Biodiversity 2020, Water Framework Directive and Flood and Coastal Risk Management programmes. These are likely to further establish how to implement WWNP at the policy level.

1.4 Definition

A Defra-established multi-agency working group defined WWNP as follows:

> 'Working with natural processes means taking action to manage fluvial and coastal flood and coastal erosion risk by protecting, restoring and emulating the natural regulating function of catchments, rivers, floodplains and coasts' (Environment Agency 2012a, p. 10)

For the purpose of this study WWMP includes the following topics:

- **ecosystem services** – including the ecosystem approach
- **fluvial and coastal geomorphology** – including sediment management and restoring natural processes
- **green engineering** – including mitigation measure and sustainable alternatives to hard-engineering
- **habitat and species management** – including managing vegetation, meeting biodiversity targets, fish and eel passage
- **natural flood management** – including catchment land management

WWNP takes many forms across a range of spatial scales and in different parts of catchments. For example, WWNP might include:

- replacing the use of hard materials such as concrete with sustainable drainage systems (SuDS) in urban areas
- restoring floodplains to store more water in rural areas
- creating managed flood storage areas by rivers or coasts

Effective WWNP approaches are likely to be very different in natural catchments compared to more modified rivers and coasts.

1.5 Vision for WWNP

At the WWNP stakeholder workshop held in September 2013, the 70 attendees were asked to help shape a vision for WWNP to reduce flood risk. They represented various institutions including:

- universities
- Environment Agency
- Internal Drainage Boards (IDBs)
- Association of Drainage Authorities
- environmental non-governmental organisations
- local authorities
- consultancies

Attendees were asked to identify words that define successful WWNP and barriers to WWNP. From the lists of words provided, ‘word clouds’ were produced for ‘successful WWNP (Figure 1.4) and barriers to WWNP (Figure 1.5). The size of words in the clouds is proportionate to the number of times they were referenced.

Successful WWNP was seen to be:

- integrated
- multi-functional
- sustainable
- (include) engagement
- (be of) value
- resilient
- (include) communication

Barriers to WWNP include:

- funding
- (lack of) understanding
- uncertainty
- risk
- policy
- (people’s) perceptions
- institutional barriers

Figure 1.4 'Successful' WWNP identified by stakeholder workshop

Figure 1.5 'Barriers' to WWNP identified by stakeholder workshop

2 R&D framework context

This section describes other research strategies and frameworks that link to WWNP. The WWNP research framework is being developed in close collaboration with these and not in isolation. Any research gaps and projects identified during the WWNP project are being cross-checked with those in related research frameworks and strategies to ensure WWNP complements other relevant research areas and programmes.

2.1 The Joint Programme

The Joint Programme is a partnership between the Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency, which serves all FCERM operating authorities and undertakes approximately £2.5 million of research each year. It was set up to ensure the government's investment in FCERM is based on reliable and sound evidence. It develops information and tools to help practitioners reduce and mitigate the impact of flooding on the UK economy and local communities.

The Joint Programme has three themes:

- Policy, Strategy and Investment
- Asset Management
- Incident Management

And four cross-cutting work areas:

- Local Flood Risk
- Coastal
- Reservoirs
- WWNP

The Joint Programme is an end-user oriented, applied research programme which is steered and peer-reviewed by relevant experts.

2.2 Living With Environmental Change

Living With Environmental Change (LWEC) is a partnership of 22 public sector organisations with representatives from the private sector forming part of a Business Advisory Board. LWEC aims to ensure decision makers in government, business and society have the knowledge, foresight and tools to mitigate, adapt to and benefit from the effects of climate change.

LWEC has produced and is implementing the UK FCERM research strategy (Moores and Rees 2011), which identified FCERM research priorities for the next 20 years. This strategy identified broad research themes and scored them in terms of their 'maturity' and 'urgency'. Maturity considers the amount and type of research completed per theme and whether new research is needed to bridge knowledge gaps. Urgency considers how soon we need research to be completed. LWEC assessed research needs and gaps against six PESTLE (**P**olitical, **E**conomic, **S**ocial, **T**echnological, **L**egal and **E**nvironmental) drivers.

Section 3 explains how the LWEC strategy has been used to identify research needs and gaps in this project.

2.3 Coastal Research, Development and Dissemination Research Framework

The Coastal Research, Development and Dissemination (CoRDDi) research framework is a cross-cutting work area in the Joint Programme (Environment Agency 2012b). It sets out coastal flood and erosion risk research priorities for the next five years.

CoRDDi identified research gaps and needs in four themes:

- understanding whole-system behaviour
- valuing impacts and promoting innovative funding
- decision making and operational practice
- dissemination, education and training

Within these themes, 18 priority projects were proposed to be implemented over a five year period. A number of these priority projects may overlap with priority research projects identified within this WWNP framework. Section 3 describes how overlapping research objectives between the CoRDDi and WWNP framework will be managed.

2.4 Local Flood Risk Research Framework

The Environment Agency has just started updating the existing Local Flood Risk research framework, another cross-cutting work area within the Joint Programme. The updated framework is at an early stage of development and potential synergies with the WWNP framework will be considered in Stage 2 of this project.

3 Methodology

This section summarises the methodology used in Stage 1 of the project which involved the three main tasks shown in Figure 3.1.

Figure 3.1 Stage 1 main tasks

For the purposes of this project, WWNP was split into five topics as identified by the Environment Agency during the scoping of the project:

- fluvial and coastal geomorphology (FCG)
- green engineering (GE)
- habitat and species management – including fish and eel passage (HS)
- natural flood management (NFM)
- ecosystem services – including the ecosystem approach (ESS)

This helped make the review of this large work area more manageable.

A range of experts and the Project Advisory Group (PAG), who had experience in one or more of these topics, independently reviewed work as it was completed.

3.1 Task 1 – Data and evidence review

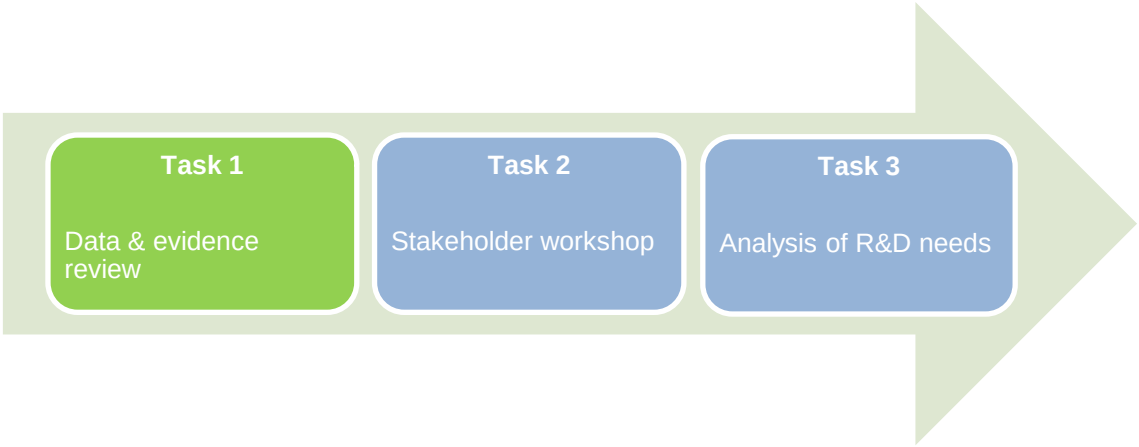

Figure 3.2 Task 1 – Data and evidence review

3.1.1 Purpose

The aim of the data and evidence review was to:

- **collate and record** evidence produced in the UK and overseas during the last 20 years
- **identify and link** to evidence in other research programmes such as LWEC, CoRDDi, research councils and research institutes
- **produce** a spreadsheet listing each piece of evidence (see section 3.1.4)

'Evidence' includes published and draft research reports, papers, tools, data, guidance and ongoing or planned research projects.

3.1.2 Principles

The data and evidence review identified completed, ongoing and planned research relevant to both WWNP and FCERM by following these key principles:

- **Focus on quality over quantity** by identifying the most widely used documents and research.
- **Target** evidence published only in the last 20 years (1993 to 2013).
- **Apply a consistent methodology** across all topics –including shared and clearly defined parameters and definitions.
- **Use time efficiently and effectively** so as not to get lost in detail.
- **Keep a transparent audit trail** for work done
- **Consult** specific individuals within organisations.

3.1.3 Sources of evidence

Lists of completed, ongoing and planned research projects were provided by crucial organisations such as:

- Environment Agency
- Defra
- Economic and Social Research Council (ESRC)
- British Society for Geomorphology (BSG)
- National Environment Research Council (NERC)
- Hutton Institute

- Centre of Expertise for Waters (CREW)
- Forestry Commission
- Forest Research
- River Restoration Centre (RRC)

This included published and draft research reports, papers, tools, data and guidance.

Online literature searches were also carried out and supplemented with information from topic leads – evidence used in everyday practice including reports, journal articles and guidance/manuals.

Stakeholders who attended the WWNP workshop also identified important references which they used. These were added to the data evidence register (see section 3.1.4).

The quality of the evidence collected and reviewed varies depending on the degree of peer review that each document has received. For example, published journal papers and reports are likely to have greater scientific credibility as they have been subject to a rigorous peer-review process.

3.1.4 Data and evidence register

As of 30 September 2013, a total of 525 pieces of evidence had been sourced, of which over 370 were considered relevant to both WWNP and FCERM. This evidence is recorded in the data and evidence register (DER), which is a Microsoft® Excel spreadsheet with three parts. Parts 1 and 2 are provided with this report while Part 3 was part of the project working process (see section 3.3.2):

- **Part 1 – Describes the evidence** – for example, title, authors, year published, current status and a short abstract
- **Part 2 – Categorises the evidence** – for example, data type, spatial application, policy relevance and target audience
- **Part 3 – Cross-references the evidence against identified research needs** – for example, R&D needs identified in LWEC's FCERM strategy, CoRDDi or at an internal Environment Agency workshop

The DER has been reviewed by the PAG and by external peer-reviewers.

3.2 Task 2 – Stakeholder workshop

Figure 3.3 Task 2 – WWNP stakeholder workshop

The WWNP stakeholder workshop held in September 2013 identified:

- **Evidence currently used** – for example, data, reports, toolkits and guidance
- **Research needs** – by discussing and exploring research questions developed by the project team (see section 3.3.1)
- **Research gaps** – current gaps that limit or prevent the achievement of WWNP
- **Project ideas** – which could potentially plug these research needs and gaps

Workshop outputs informed our developing understanding of the most important research gaps. They will also help to inform Stage 2 of this project – refinement of research gaps, identification and prioritisation of research projects.

3.3 Task 3 – Analysis of R&D needs

Figure 3.4 Task 3 – R&D needs

3.3.1 Identifying and summarising research needs

To identify WWNP research needs, a list of 13 research questions (Table 3.1) was were developed by reviewing:

- research priorities in the LWEC FCERM strategy (Moores and Rees 2011)
- WWNP research needs developed at an internal Environment Agency workshop (October 2012)
- WWNP research needs identified in a questionnaire completed by attendees prior to the WWNP workshop (September 2013)

These broad research questions were used at the WWNP workshop to facilitate discussions around research needs and gaps.

Table 3.1 WWNP research questions

Ecosystem services – including the ecosystem approach (ESS)
• ESS Q1) Are we able to effectively apply the ecosystem approach/ ecosystem services assessment to make WWNP possible? • ESS Q2) Are we able to accurately identify and assess the change in ecosystem services (qualitatively and quantitatively) and associated values that occur due to natural flood management techniques (for example, SuDS)?
Fluvial and coastal geomorphology (FCG)
• FCG Q1) Do we understand the value of sediments in natural flood and erosion protection in estuarine and coastal environments to allow us to identify solutions? • FCG Q2) Can we identify catchments where river morphology and FCERM are most likely to be sensitive to sediment dynamics at a range of scales to enable proactive management of sediment related FCERM issues? • FCG Q3) Do we understand the implications of sediment supply and dynamics for FCERM over a variety of timescales to enable us to manage sediment related issues sustainably?
Green engineering (GE)
• GE Q1) Are there effective techniques to apply green engineering solutions in FCERM?
Habitat and species management – including fish and eel passage (HS)
• HS Q1) How effective is FCERM habitat creation in meeting Habitats, Bird and Water Framework Directive requirements and the England biodiversity strategy? • HS Q2) How effective are we at being able to manage riparian, marginal and aquatic vegetation to reduce flood risk by using WWNP to achieve wider environmental and socioeconomic benefits? • HS Q3) How well are we able to measure and predict the range of FCERM and other benefits that small to large scale habitat creation/ restoration provides? • HS Q4) What methods are available to assess the habitat requirements of fish so as to meet FCERM and Water Framework Directive objectives? • HS Q5) What is our understanding of the effectiveness of engineered to more natural fish passage and screening techniques that might be used in achievement of WWNP to meet Eel Regulations and SAFFA (Salmon and Freshwater Fisheries Act) requirements?
Natural flood management (NFM)
• NFM Q1) What evidence is there to support the development and promotion of land use based flood mitigation at a range of spatial scales? • NFM Q2) Are there effective techniques to apply natural flood management in FCERM?

3.3.2 Identifying research gaps

A perceived research need is not necessarily a research gap. Once the steps above had been completed, each piece of evidence in the DER was cross-referenced against each of the research questions in Table 3.1. This helped identify any research needs **not** currently being answered by completed, ongoing or planned research – these were then defined as research gaps.

A graphical tool, referred to as 'the R&D spectrum', was developed and applied to help identify research gaps (Figure 3.5). This tool is based on the approach used to develop the LWEC FCERM strategy. This R&D spectrum was used to assess quickly whether available research in WWNP meets identified user needs or not. It assumes the following.

- Research starts out as an idea or theory (at the conceptual level) usually developed by a university or research institution (academic level).
- Research is then developed further by empirical testing and observation, and is subject to broader peer scrutiny.
- Finally the research becomes embedded in practitioner-level use via policy or legislative endorsement including manuals, handbooks and guidance.

In theory, research should progress through these three important stages before it can be confidently adopted for practical use – following the line of the blue arrow in Figure 3.5.

If the position of the blue arrow current research in WWNP is plotted, it is possible to establish:

- where it needs to be progressed to
- who needs to progress it
- how it needs to be applied to enable WWNP in practice

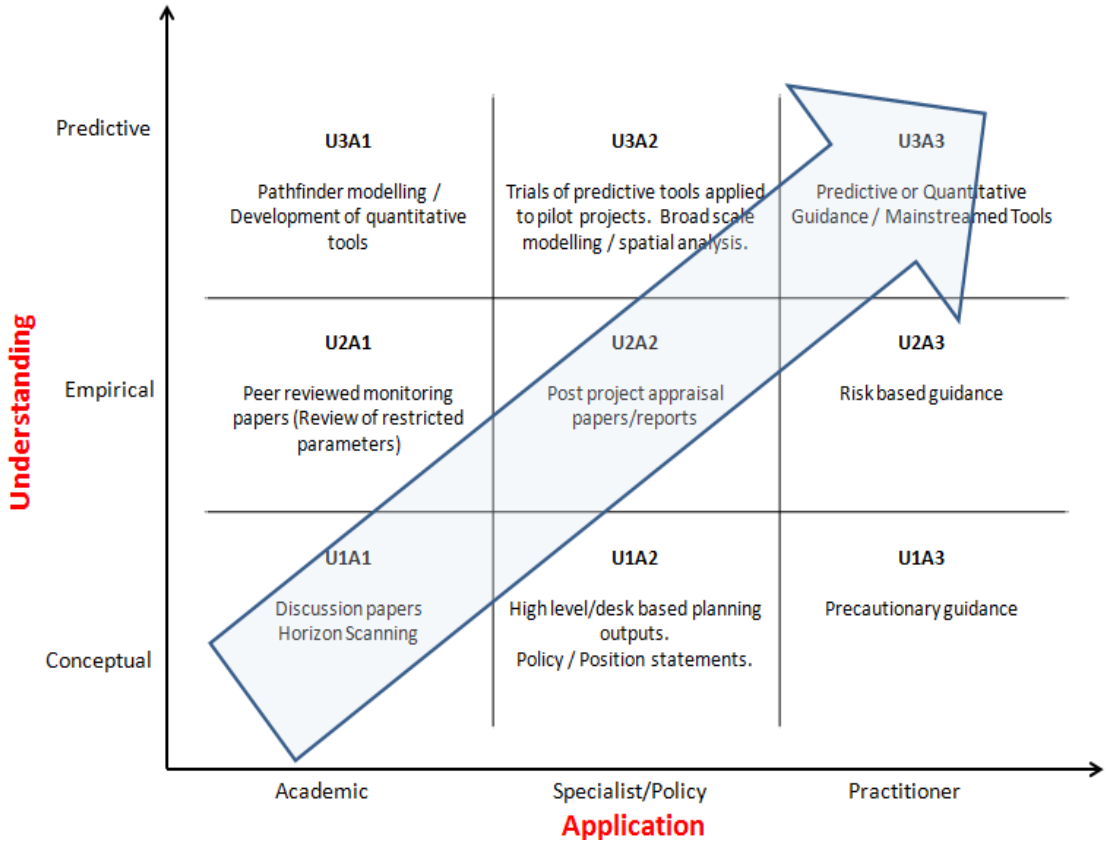

Figure 3.5 R&D spectrum and types of evidence

The following procedure was used to map existing evidence collected in the DER onto the R&D spectrum.

1. Each piece of evidence in the DER was **categorised** by:
    - **understanding** – whether research is conceptual, empirical or predictive
    - **application** – whether research is academic, policy/specialist or practitioner.
2. Each piece of evidence in the DER was **cross-referenced** to the research questions in Table 3.1. If considered relevant to the research question(s), the piece of evidence was given one of nine codes (for example, U3A2) based on its understanding and application categories (Figure 3.5).
3. Each piece of evidence was **colour-coded** to indicate how well it could help support the justification (or business case) for WWNP (red = poor, amber = partially, green = good, grey = not yet known),
4. **An R&D spectrum was populated for each of the research questions**. Figure 3.6 shows a hypothetical example of this. The size of each pie chart represents the number of pieces of evidence relevant to the question, and the colours and location on the spectrum as per the steps above.

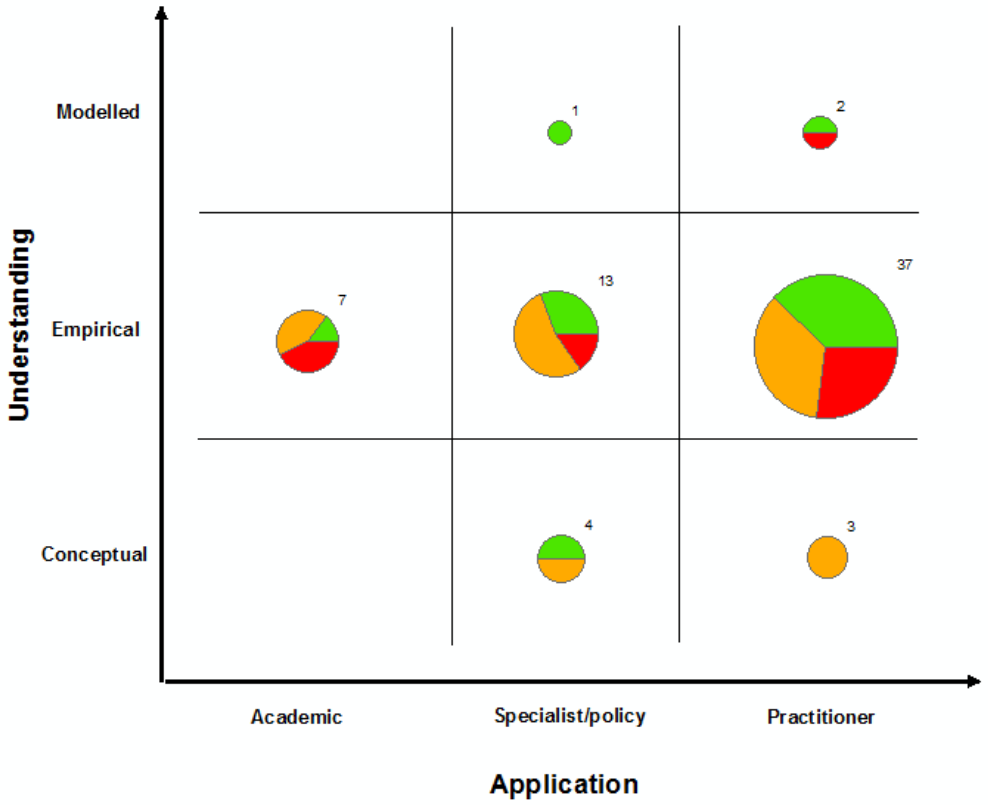

Figure 3.6 Example of a populated R&D spectrum

The analysis of the DER, R&D spectrums and stakeholder workshop outcomes identified 41 research gaps. Due to the nature of WWNP, many of these gaps overlap between the five topics.

The focus of the data and evidence review was on collecting evidence used in everyday practice including reports, journal articles and guidance/manuals. Most of these were identified by asking practitioners what they used. Such evidence largely populated the ‘specialist/policy’ and ‘practitioner’ columns in the R&D spectrums and reference to ‘academic’ evidence was less frequent. The ‘academic column’ was therefore supplemented by asking the topic leads and peer reviewers to identify relevant published journal papers and research reports that might not have been picked up. However, it was not possible to conduct a thorough academic literature search. Hence, the R&D spectrums are likely to under-represent the actual amount of academic literature of relevance to WWNP and FCERM. This limitation will be considered and managed in later stages of this project.

4 Research gaps

4.1 Summarising the research gaps

A total of 41 topic-specific research gaps were identified from the data and evidence review, and the stakeholder workshop. These were reduced to the following eight broader WWNP research gaps:

1. Understanding approaches to community and stakeholder engagement
2. Understanding cultural and institutional barriers to WWNP in flood risk management authorities
3. Guidance and/or training in WWNP for practitioners
4. Learning lessons from past pilot/case studies
5. New studies to improve the WWNP evidence base
6. National prioritisation of catchments for WWNP delivery
7. Collecting data about natural processes data at a catchment scale
8. Developing more adaptive/resilient green engineering technologies.

The 41 research gaps were grouped based on similarity in scope and scale. For example, all research gaps that showed a need to review/monitor pilot projects or case studies in different topics were grouped together.

Three more 'cross-cutting' research needs were also identified. These are:

- a better understanding of the full range of environmental and socioeconomic benefits provided by natural coastal systems
- a better understanding of the link between hydromorphological processes and habitats and species to support the application of the ecosystem approach to WWNP (particularly in heavily modified catchments)
- a better understanding of the potential range of effects that climate change will have on natural processes – this will enable develop more adaptive and resilient WWNP approaches to be developed

A preliminary description of the eight research gaps is given below. These will be refined in Stage 2 of this project. The final report (to be completed in 2014) will present a final and refined description of each research gap.

4.2 Research gap 1 – understanding approaches to community and stakeholder engagement

This research gap identifies the need to review different approaches to community and stakeholder engagement methods to put in place WWNP in FCERM, including:

- how to engage communities and stakeholders earlier in options identification and appraisal
- how to reflect the ecosystem approach in the community and stakeholder engagement approach (Principles 1, 2, 11 and 12 of the Convention on Biological Diversity; Secretariat 2004)

- what methods such as visual aids, software, group exercises and learning tools are available to use when communicating and collecting information
- how to encourage others to take on lead consultative roles
- what information do communities and stakeholders need to make more informed decisions
- how to reduce risk to those putting in place WWNP measures (for example, land owners, tenant farmers), that is, such as Payments for Ecosystem Services (PES), biodiversity or carbon offsetting, compensation
- setting out a standard choice of approaches to use depending on available resources/funding

This will help to:

- identify a wider range of FCERM options including WWNP earlier in the options identification process
- appraise the wider and multiple benefits of options to all legislative and policy drivers (for example, not just flood risk)
- enable a two-way communication process which both informs and educates everyone involved
- maximise the potential for innovative funding/implementation/maintenance of FCERM (for example, by payment for ecosystem services and partnership contributions)
- demonstrate the benefits of WWNP at a high level to policy and decision makers
- enable WWNP to be achieved faster and more efficiently (for example, changes to building regulations and planning policy)
- encourage alternative bodies leading on implementing WWNP to engage/lead consultation with communities and stakeholders
- communicate clearly to communities and stakeholders how WWNP will help them

4.3 Research gap 2 – understanding cultural and institutional barriers to WWNP in flood risk management authorities

The WWNP stakeholder workshop identified the significant barrier created by working in thematic or institutional silos. This research gap is about identifying cultural or institutional barriers, within and between different agencies, which restrict the use of WWNP measures in flood risk management and identifying ways to remedy this. There is a consensus that the barriers exist but the processes leading to those barriers, why they occur and how to break them down are not clear.

Practitioners felt that WWNP is rarely considered in FCERM options appraisal and that this is a barrier to putting in place more sustainable solutions to FCERM. This may be because there is a lack of research into evidence of demonstrable benefits.

The WWNP stakeholder workshop identified the need to:

- establish why the FCERM options appraisal process tends to identify a limited set of options which rarely include WWNP
- identify why local stakeholders and communities are not engaged earlier in the options identification process
- explore alternative governance options which could help break down barriers
- establish why decisions about WWNP usually fail to consider non-market values and are primarily based on market-based economic values
- identify what is holding back full consideration of WWNP techniques in FCERM
- demonstrate the multiple benefits of WWNP to decision makers

4.4 Research gap 3 – guidance and/or training in WWNP for practitioners

There is a great need to provide clear and concise guidance to practitioners to enable them to implement WWNP. This is not always a research gap but can be a signposting exercise to make practitioners aware of existing guidance. In other cases, practitioners know evidence exists but need either guidance to help them implement it, or to translate conceptual/empirical data from the academic/specialist arena into something useable in practice.

There is a research need to develop guidance that:

- indicates where to go for evidence to quantify, value and monetise change in ecosystem services associated with different approaches to WWNP
- signposts practitioners to proven tools and models to assess impacts of natural flood management at range of spatial scales
- identifies (with reasonable certainty) the best available evidence to quantify change in ecosystem services associated with different approaches to WWNP
- specifies the scales (geographical, ecological, hydrological) at which this evidence should and should not be used
- provides advisory scenarios for ecosystem services to help manage uncertainty
- identify when new data collection is likely to be needed because it is not known how ecosystem services are likely to change due to a WWNP measure
- identify what constitutes reasonable scientific certainty when using evidence to make assumptions about benefits of WWNP techniques in FCERM
- advises on how to demonstrate the wider environmental benefits and cost-effectiveness of WWNP

4.5 Research gap 4 – learning lessons from past pilot projects and case studies

The workshop attendees identified a need to revisit past pilot projects and case studies to understand the benefits achieved (if this is the case) and lessons learnt. They also felt such research should be regularly updated. Part of this need will be met by ongoing long-term projects and the understanding of this 'gap' needs to be refined in Stage 2.

Specific research needs identified included:

- models or tools to show long-term morphological change in estuary and coastal environments – work to fill this gap is partly in progress through the CoaEST and iCOAST research programmes
- evidence for the long-term effects of sediment change/dynamics (for example, dredging/de-silting) and their impact on FCERM maintenance regimes
- learning what benefits WWNP (for example, land use management changes) can achieve for FCERM in different types and sizes of catchments over different timeframes
- evidence to demonstrate how to meet multiple policy drivers
- improve understanding of natural ways of managing sediment and vegetation to benefit FCERM (for example, shading to reduce weed growth)
- identify the stakeholder and community engagement methods which have worked best (link to research gap 1)

4.6 Research gap 5 – new studies to improve the WWNP evidence base

Revisiting previous projects and case studies alone was not seen as sufficient to fill all research needs. New scientific studies are needed to:

- gather scientific evidence to show how the types of ecosystem services affected vary between different WWNP measures
- collect more evidence for ecosystem services for which how they change in response to different WWNP measures is not fully understood, focusing on those that might give the most significant values in economic appraisal (and so affect the cost-effectiveness of different options)
- develop methods to better and more consistently identify and quantify the benefits that habitat creation has achieved – this is essential to support future WWNP guidance/optioneering and business case development
- understand the FCERM benefits of sediment management along coasts and estuaries (for example, beach nourishment, sand dune management and saltmarsh creation)
- quantify the effect of different land uses on ecosystem services, sediment management and FCERM
- improve understanding of the long-term effect of different WWNP/FCERM approaches on sediment supply and dynamics

- understand how FCERM activities could benefit fish passage and habitats demonstrating the wider benefits of WWNP (for example, other policy/legislative drivers)
- gather evidence of the FCERM benefits of environmental/biological controls, woody debris and green engineering
- develop an understanding of the impacts of WWNP on FCERM at the catchment scale

4.7 Research gap 6 – national prioritisation of catchments for WWNP delivery

There is a need to map catchments nationally to identify those that would benefit most from WWNP measures. Working in priority catchments makes it more likely that evidence of the significant benefits of WWNP will be established, especially in terms of flood risk protection, diffuse pollution, sediment management and other ecosystem services. Prioritising catchments helps to achieve value for money and to demonstrate the actual benefits of WWNP to important decision makers.

Research requirements include:

- catchment profiling (geomorphologically and ecologically) to identify those most sensitive to changes in hydrological flow, sediment processes, diffuse pollution and land-use change resulting from WWNP/FCERM activities
- identifying where the greatest economic benefits could potentially be made so as to demonstrate the benefits of WWNP to decision makers

4.8 Research gap 7 – experimental integrated studies of WWNP in catchments

The workshop identified the need for test catchments to examine different land management and land uses, and various WWNP measures to observe changes in natural processes (in particular water flows and sediment processes) that benefit FCERM (in particular maintenance practices).

The test catchments should:

- include a range of land management/uses
- include a range of WWNP measures
- observe changes in natural processes
- assess whether WWNP reduces flood risk, and FCERM capital and maintenance requirements (for example, the impact of rural SuDS at catchment scale)
- provide learning opportunities to visiting researchers and practitioners
- learn from existing pilot projects and case studies, and build on these where possible

4.9 Research gap 8 – developing more adaptive/ resilient green engineering technologies

Research needs include:

- a review of currently available green engineering techniques
- an assessment of risk and uncertainty of the contribution of each green engineering technique to FCERM
- prioritisation and further development of green engineering techniques that can adapt more readily to future uncertainties (for example, climate change)
- a technical comparison of hard and soft WWNP measures (for example, at different return periods)
- consideration of how green engineering techniques work in combination and as mitigation for hard engineering to improve robustness/certainty
- advice for practitioners on the number and type of soft measures that are equivalent to one hard measure (in terms of contribution to FCERM).

4.10 Cross-cutting research needs

The following three 'cross-cutting' research needs were identified by stakeholders at the workshop. They are important to understand following the analysis completed so far. They include developing a better understanding of:

- the full range of environmental and socio-economic benefits provided by natural coastal systems
- the link between hydromorphological processes and habitats and species to support the application of an ecosystem approach to WWNP (particularly in heavily modified catchments)
- the potential range of effects that climate change will have on natural processes, thus enabling more adaptive and resilient WWNP approaches to be developed

These cross-cutting research needs relate to multiple research gaps. These links will be assessed during Stage 2 to ensure that these needs will be addressed by the WWNP research framework or by other ongoing research.

5 Summary and next steps

This report summarises the findings of Stage 1 of this project which has identified the priorities for the new WWNP research framework.

Figure 5.1 summarises what has been achieved so far (November 2013). Eight overarching research gaps (Section 4) and three 'cross-cutting' research needs have been identified.

Figure 5.1 Project achievements so far

Stage 2 of this project will:

- take forward and refine the eight research gaps – including cross-referencing to up-to-date CoRDDi research priorities and emerging priorities in the Local Flood Risk research framework
- confirm the research priorities – within topics and cross-cutting issues
- review the list of project ideas developed at the WWNP workshop against these priorities
- prioritise potential projects and define their objectives (Figure 5.2)
- develop an outline business case for 10 priority projects (as part of a five year programme)
- identify potential implementation and funding routes for each research project

Stage 3 reporting and communication of project outputs will be completed in spring 2014.

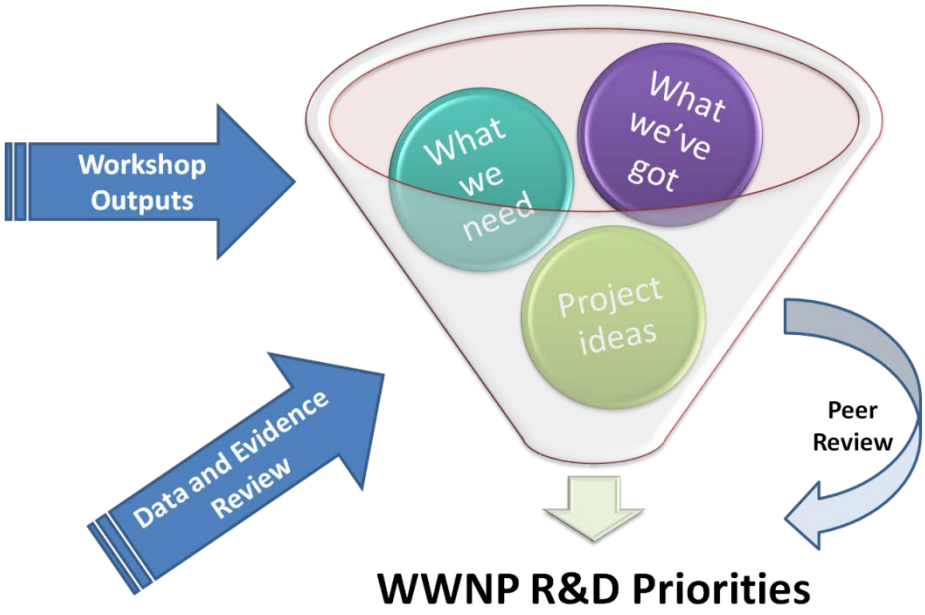

Figure 5.2 Establishing WWNP R&D priorities during Stage 2

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List of abbreviations

FCERM	flood and coastal erosion risk management
LWEC	Live With Environmental Change
R&D	research and development
SuDS	sustainable drainage systems
WWNP	working with natural processes

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