Greater working with natural processes in flood and coastal erosion risk management

A response to Pitt Review Recommendation 27

Llywodraeth Cymru
Welsh Government

NATURAL ENGLAND

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

defra
Department for Environment Food and Rural Affairs

National Trust

THE wildlife TRUSTS

RSPB

THE RIVER RESTORATION CENTRE
Working to restore & enhance our rivers

Environment Agency

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This report has been produced in response to Sir Michael's Pitt's recommendation that Defra, the Environment Agency and Natural England should work with partners to establish a programme through Catchment Flood Management Plans and Shoreline Management Plans to achieve greater working with natural processes. The Environment Agency was asked to lead a working group to oversee this work. The working group consisted of representatives from:

Defra	Paul Murby
	Alan Risby
Welsh Government	Nicola Edwards
Environment Agency	Wendy Brooks
	Duncan Huggett
	Sian Rowlands
	John Mosedale
Natural England	Rob Cathcart
	James LePage
Countryside Council for Wales	Chris Uttley
Representing Wildlife & Countryside Link	Carrie Hulme
	Jodie Bettis
	Kirsten Knap
National Trust	Mark Walsingham
	Phil Dyke
The Wildlife Trusts	Paul Wilkinson
	Michelle Claxton
	Helen Perkins
The Royal Society for the Protection of Birds	Rob Cunningham
The River Restoration Centre	Martin Janes

The working group was assisted by the National Farmers Union (Jenny Bashford), Country Landowners and Business Association (Derek Holliday), Forestry Commission (Mark Broadmeadow) and Forest Research (Tom Nesbit).

Preface

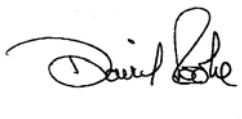
I'm very pleased to introduce the first national report of how natural processes can help manage flood risk in England and Wales.

This is a major piece of work that brings together the latest scientific, environmental and engineering knowledge in response to the Pitt Review and its recommendation 27. It describes clearly what greater working with natural processes means for managing the risks of flooding from rivers and the sea. It underpins future plans for flood and coastal risk management as well as helping partners work together to protect the public and property from floods effectively. At the same time it should do more for the environment.

The events of the summer of 2007 demonstrated the major impacts floods can have. Whilst more traditional approaches to managing floods such as building defences will continue to be vital for protecting people and property, the floods also reminded us of the importance of understanding how we can use the environment more effectively to manage the flood risks we face.

The scale of the challenge in managing these risks may be daunting, but this report means that the Environment Agency and the organisations and people we work with can meet it more effectively. We must also make sure we build a better relationship between those at risk and those who manage this risk to share in the solutions. Much more can be achieved by bringing all the interested parties together through the Environment Agency's strategic overview of all sources of flooding with a shared understanding of the risks.

We already do much to make sure flood risk management works with natural processes. While celebrating the advances that this report provides, it is important to remember that the evidence and skills to deliver some flood risk solutions through natural processes are still developing. This report is one step in an ongoing journey that we must take to ensure that our understanding of working with natural processes keeps pace with these changes.



David Rooke Director of Flood & Coastal Risk Management
Environment Agency

Contents

1 This report

This report is a summary of documents and views from the working group set up in response to Pitt Recommendation 27:"Defra, the Environment Agency and Natural England should work with partners to establish a programme through Catchment Flood Management Plans and Shoreline Management Plans to achieve greater working with natural processes"

The aims of the report are to:

- explain what natural processes are in flood and coastal risk management
- provide practitioners with a high quality basis for achieving greater working with natural processes
- help the UK Government, Welsh Government, Environment Agency, Natural England, Countryside Council for Wales, and others, to work more with natural processes.

Doing so will help us to manage flooding more effectively and achieve a wider range of goals including environmental requirements such as the Water Framework Directive.

1.1 How you can work better with natural processes:

The following summarises the eleven key conclusions in the report:

Strategic planning framework

- Develop more specific, targeted actions to take forward CFMP and SMP policies which aim to work more with natural processes [C1].

Government Policy and legislation

- Ensure project appraisal guidance is fully supported with information to help achieve more working with natural processes and multi-objective projects [C2].

Science, evidence and modelling

- Identify synergies and gaps in catchment analysis and planning tools and develop new tools as appropriate [C3].
- Ensure that catchment data and planning tools are widely available [C3].
- Maintain an up to date assessment of relevant research and use this to identify research priorities [C4].

Funding and incentives

- Improve joint working to ensure better targeting of land management incentive schemes [C5].
- Target land management advice to landowners on incentives schemes that can benefit flood risk management [C6].
- Find and use novel sources of funding to secure multiple benefits for communities such as biodiversity and amenity as well as flood risk management [C7].

Partner and community engagement

- Invest in dedicated community engagement and liaison integral to FCERM projects [C8].
- Involve communities in option development at the earliest opportunity so multi-functional projects can be identified and included in FCERM plans [C9].

Culture, skills and training

- Investigate the potential of existing flood storage areas for multi-benefit enhancements [C10].
- Develop training and guidance to improve working with natural processes and land management techniques as part of the portfolio of flood risk management measures [C11].

1.2 Background

Recommendation 27: *"Defra, the Environment Agency and Natural England should work with partners to establish a programme through Catchment Flood Management Plans and Shoreline Management Plans to achieve greater working with natural processes"*

It has long been recognised that more sustainable solutions to flood and erosion coastal risk management (FCERM) have to be found. The desire to see greater working with natural processes as part of that portfolio of responses was set out in both the UK Government strategy, *Making Space for Water,* and the Welsh Government's *New Approaches* programme. The need for continuing action was covered extensively by the Pitt Review. The recent Flood and Water Management Act (2010) and *The national flood and coastal erosion risk management strategy for England* include natural processes as one of the ways in which FCERM authorities might manage risk.

1.3 Overview of Pitt Review 2007

The Pitt Review: *Learning Lessons from the 2007 floods*, noted that flood and coastal risk cannot be managed by simply building ever bigger hard defences. Softer approaches, working with natural processes and rural land-use options can contribute to a more sustainable approach. The adoption of natural processes does not replace traditional defences, but can complement them and increase their capacity to deal with climate change. Working with natural processes may also bring benefits such as new habitats, enhancing biodiversity, carbon capture, sediment reduction and improved water quality.

Pitt concluded that rural land management approaches should be considered as part of the portfolio of measures to reduce flood risk and part of the programme to achieve more working with natural processes. Working with natural processes can have clear flood risk benefits at the catchment scale. Pitt accepted that land management change can also benefit *local* flood risk management. While the impacts at a catchment scale cannot currently be distinguished (especially during extreme precipitation events), evidence is emerging that land-use change may have an impact in smaller catchments (i.e. potentially up to 10km^2).

In addition to the use of land management and local storage, Pitt recognised the potential for increased use of floodplain storage in rural areas to slow the passage of flows downstream. However, care is needed to ensure that rural land use measures are carefully assessed, and flood risk management benefits demonstrated.

Working with natural processes is also relevant in urban areas. Pitt encouraged the Environment Agency and Local Authorities to work with developers and other partners to explore opportunities for natural solutions in urban areas. Flood risk can be managed in a sustainable way and also provide biodiversity and amenity benefits e.g. projects setting back defences alongside rivers and/or relocation of assets.

1.4 Government response to the Pitt Review

Government asked the Environment Agency to lead a working group to address the Pitt Review Recommendation 27. In addition, the following work has been done to investigate evidence of a relationship between land management and flood risk including:

- Analysis of historical data on land use and management change impacts on flood generation in England;
- A tool to identify the catchments in England & Wales where land management change is most likely to reduce flood risk;
- Work on the potential environmental benefits of flood storage in England;

- An evaluation of the effectiveness of Catchment Flood Management Plans (CFMPs) in England in achieving greater working with natural processes; and
- Guidance on working more with natural processes for FCERM projects in England & Wales.

Defra has also invested £1 million in demonstration projects to investigate the contribution land management change and working with natural processes can make to managing local flood risk while achieving wider benefits for the environment and local communities. The three projects are:

- Slowing the flow at Pickering, North Yorkshire (Forest Research led);
- Moors For The Future, in the upper Derwent Valley, Derbyshire (Partnership led); and
- Source to Sea*,* at Holnicote, Somerset (National Trust led).

The Pitt Review did not directly cover Wales, but the Welsh Ministers undertook to consider its recommendations and to implement them where appropriate.

1.5 The working group

The working group included the Environment Agency, Natural England, Defra (Flood Management, Food and Farming Group), Countryside Council for Wales, RSPB, National Trust, River Restoration Centre, Wildlife and Countryside Link and Wildlife Trusts, with additional help from the National Farmers Union, Country Landowners and Business Association, Forestry Commission and Forest Research.

The objectives of the group were to:

- Agree a definition of working with natural processes;
- Identify barriers to greater working with natural processes;
- Develop tools to overcome barriers to greater working with natural processes; and
- Identify ways of overcoming any continuing barriers to delivering greater working with natural processes.

2 What is working with natural processes?

2.1 Definition

Working with natural processes means taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating function of catchments, rivers, floodplains and coasts. This could, for example, involve using farmland to temporarily store flood water, re-instating washlands and wetlands to store flood water away from high risk areas or allowing cliffs to erode to provide sediment down drift.

2.2 Working with natural processes

In the context of FCERM, working with natural processes often means slowing down the flow of water (e.g. by re-instating flood plains that hold flood waters) or speeding up the flow of water (e.g. by removing unnatural obstructions), to prevent flood waters from causing harm.

Working with natural processes to manage flood and coastal risk may involve considerable intervention and be far from natural. For example a washland that relies on a regulated inlet and outlet on a previously drained and embanked floodplain is far from natural. However, it restores the regulating storage function of the floodplain, providing flood risk management benefits, but at the expense of naturalness. Such techniques protect, restore or emulate natural processes which regulate flooding and erosion and, in doing so, may provide other ecosystem benefits such as biodiversity, carbon storage, and improved water quality.

Natural processes operate across a continuum from mitigated engineering to full naturalisation (see Figure 1). They make space for water by reconnecting the river or coast with the floodplain and all have a part to play in the portfolio of responses to managing flood and coastal erosion risk. A wide range of examples where flood risk management is already working with natural processes can be found in supporting guidance to flood and coastal erosion risk management appraisal guidance[1]

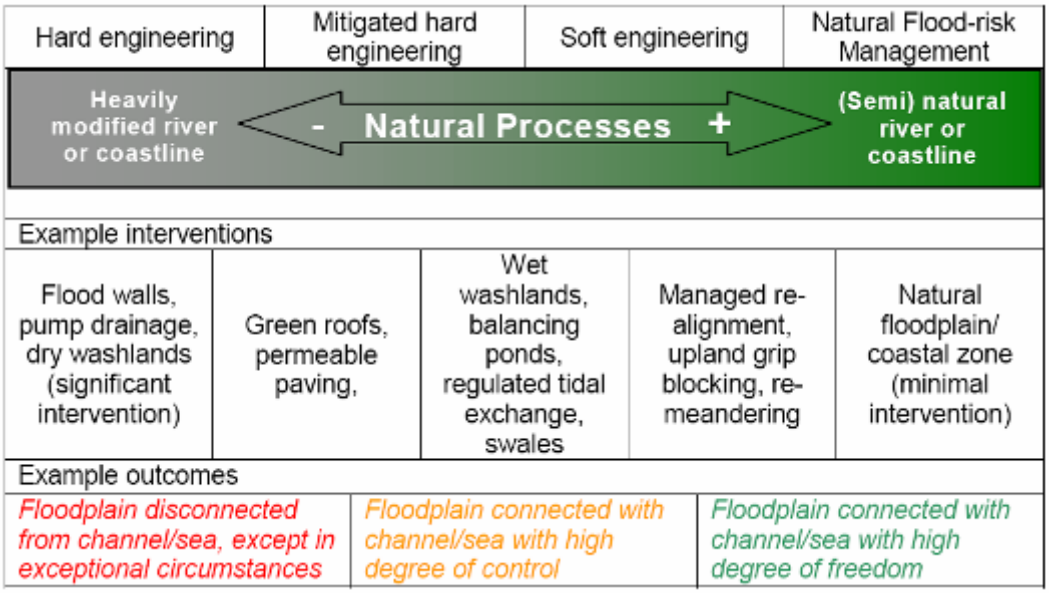


Figure 1: A conceptual model of working with natural processes[2]

[1] Working with natural processes to manage flood and coastal erosion risk

[2] Adapted from RSPB 2009 - Meeting the challenges of implementing the Flood Risk Management (Scotland) Act 2009

2.3 Why work with natural processes

All FCERM operating authorities in England and Wales are required to take account of natural processes and to work with rather than against them. The desire to see greater working with natural processes is clearly set out in the *National Flood and Coastal Erosion Risk Management Strategy for England* and also in the *National Strategy for Flood and Coastal Erosion Risk Management in Wales*. The need for continuing action is covered extensively by the Pitt Review. The UK Government is committed to progressing the review's recommendations[3] and Welsh Government has also committed to implementation where appropriate.

[3] The Coalition: our programme for government. May, 2010

3 The evidence

Working with natural processes can produce solutions that are more flexible and more resilient. In order to encourage greater working with natural processes it is important to understand the benefits that a range of solutions will bring. The following examples illustrate the benefits of working with natural processes.

3.1 Managed realignment

The creation of inter-tidal habitat through managed realignment is a common way of working with natural processes to achieve FCERM at the coast and inland. By deliberately breaching or removing existing sea walls or embankments, the waters of adjacent coasts, estuaries or rivers can flow onto the land behind.

Alkborough on the Humber estuary is a good example of how a managed realignment scheme will reduce flood levels. For a flood event with a 0.5 per cent chance of happening in any year (1 in 200) the scheme at Alkborough will reduce extreme water levels in Hull by more than 150mm. This mitigates the effects of sea level rise and in some locations will delay the need to improve defences within the estuary by up to 26 years. Alkborough is part of a wider plan for the Humber estuary which is anticipated to bring further reductions in water levels and provide sufficient new inter-tidal habitat to comply with the Habitats Regulations for the next 50 years[4].

Creating inter-tidal habitat like this can provide further FCERM benefits. Inter-tidal habitat reduces both wave height and energy quicker than bare mud or sand. This reduces the wave energy reaching defences and reduces both the risk behind the defences and the work needed to maintain the defences. Field studies at Stiffkey in North Norfolk show[5]:

	Sand flats	Saltmarsh
Wave heights decreased	15%	61%
Wave energy decreased	29%	82%

The precise extent of wave attenuation of salt marsh will depend on a range of factors and will be site specific. Factors include saltmarsh width, saltmarsh edge (cliff), topography, vegetation type and density, and even season. Managed realignment sites also provide other benefits such as key locations for fish breeding and nurseries.

3.2 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) reduce flood risk both at a development site and elsewhere in the catchment by replicating natural drainage processes. There are numerous varieties including detention basins (dry), retention ponds (wet), grassed swales, porous pavements, soakaways and 'green' roofs that store water within a building's own footprint. These interventions slow down and absorb surface water runoff and can create valuable habitats for wildlife while reducing flood risk to developments[6].

Manor Park, Sheffield (figure 2) is a good example where a series of ponds store water during flood events and also act to collect silt and intercept pollution. These ponds are designed to protect against a 1 in 30 flood event and provide improved areas for wildlife. They also provide social and economic benefits such as finance to public projects, environmental enhancement, community rehabilitation and visual interest. SuDS systems in public open spaces can reinstate lost wetlands and drainage pathways[7].

[4] Environment Agency, Humber estuary flood defence strategy – consultation document (2005), 15
[5] I. Möller, T. Spencer, J. R. French D. J. Leggett and M. Dixon; Wave Transformation Over Salt Marshes: A Field and Numerical Modelling Study from North Norfolk, England (1999), Estuarine, Coastal and Shelf Science,49, 411–426
[6] Pratt CJ (2004) Sustainable drainage: A Review of Published Material on the Performance of Various SUDS Components Prepared for The Environment Agency.
[7] CIRIA, RP922: Retrofitting Surface Water Management Measures [Paper 922/11] Draft case study review v1(2010), 32-38

Figure 2: Manor Park grass arena filled to capacity during the June 2007 floods

3.3 Flood storage

Flood storage areas are areas of land designed and operated to store flood water. Their purpose is to hold back flood water so the flow stays within bank in the downstream channels or to delay the timing so the flow is discharged over a longer time interval.

There are two main types of flood storage: off-line storage and on-line storage. Off-line storage is when flood water is removed from the channel and stored at the side of the river. This replicates the connection between a river and its floodplain. On-line storage is when flood water is stored in the river itself, for example, in a reservoir. This replicates the effect natural constrictions can have on a river holding back flow.

Flood storage is used widely by the Environment Agency with more than 145 square kilometres of flood storage in England and Wales[8]. The Upper Aire strategy explored the benefits of both on-line and off-line storage and showed that off-line storage at Bradley Ings (1.3 million cubic metres) could reduce peak flood levels at Kildwick by 280mm. On-line storage at Silsden and Kidwick Ings (1.7 million cubic metres) could reduce the peak flood levels at Stockbridge by 950mm, at Bingley by 500mm and at Leeds by 200-350mm for a flood with a 1% annual probability[9].

Floodplain storage can also be used locally. Strategically placed ponds and wetlands allow for the storage, slowing, filtering and infiltration of runoff at source. Farmers in the Belford Catchment, Northumberland, worked with partners to create on-farm storage ponds, in-stream wetlands and floodplain woodlands to help reduce the flooding in the town. Figure 3 shows results from one of the flood storage ponds at Belford. It shows the reduction in stream water level as the flood water is held in the storage pond.

[8] Environment Agency, Flood and Coastal Risk Management: Facts & Figures (2010), 4
[9] Environment Agency, Upper Aire strategy - Options appraisal report – Appendix C (2009), 22-26

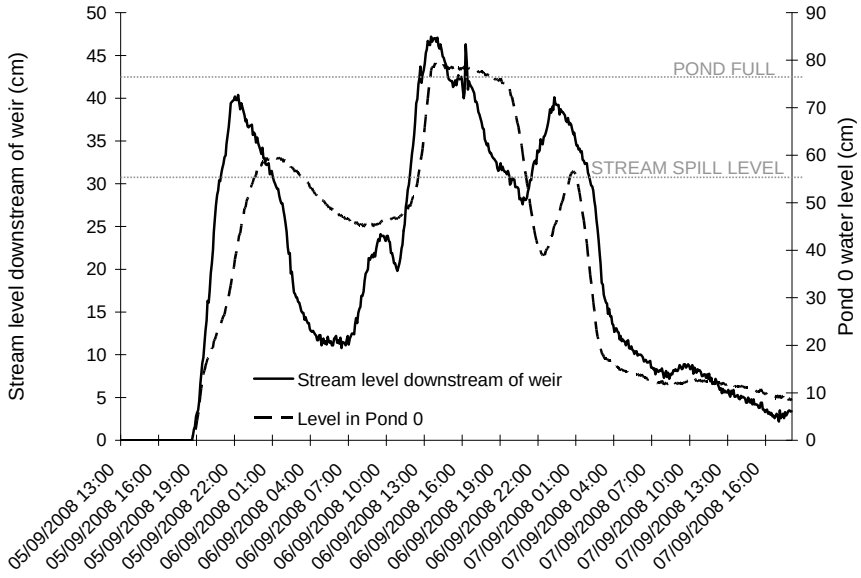


Figure 3: Pilot (Pond 0) and stream (downstream of diversion structure) water level from the 5-7th September 2008 flood event[10]

3.4 Floodplain reconnection

Floodplains are where rivers naturally store water during a flood. They can hold large volumes of water and release them slowly as the river falls back to normal height[11]. Channel straightening and defences have cut the connection between rivers and their floodplains. This connection is critical to maintain biodiversity and productivity, to reduce the force of flood waves and nutrient loads, to improve water quality, trap sediment on the floodplain and promote higher groundwater recharge rates[12].

An EU LIFE funded project to restore the floodplain function of the Upper Drava River in Austria demonstrated this connection. It improved the natural flood protection by widening the main channel, re-connecting the side channels and other storage areas, and restoring floodplain forests. These actions reduced flow velocity and bed scour, increased time to flood peak and increased the flood storage capacity by up to 10 billion cubic metres[13].

3.5 Channel Roughness

Plants and trees can increase the roughness of a channel and hold back flows, reducing flood risk downstream. Large wood from trees can also create habitat diversity in a river[14].

The Conveyance Estimation System (CES) is used by the Environment Agency to model the impact of vegetation on channel roughness. At the Great Eau, Lincolnshire, the CES was used to explore the relationship between seasonal vegetation cover, channel roughness and flood risk to select the most cost effective maintenance regime that worked with natural processes.

3.6 Soil Management

The speed and direction of water through soils is mainly determined by soil type and structure. Soil with good structure allows water to pass along fissures or through pores. Compacted soil loses these pores and fissures, making it more difficult for water to soak in. When water cannot drain into the soil, it ponds on the surface during rainfall, which can

[10] Taken from: Wilkinson, M.E., Quinn P.F. and Welton, P. (in review) 'Runoff management during the September 2008 floods in the Belford catchment, Northumberland'. *Journal of Flood Risk Management.*
[11] WWF (1986) Slowing the flow – a natural solution to flooding problems. WWF Scotland, Dunkeld.
[12] Holmes, NTH (1998), Chapter 22: Floodplain restoration, *United Kingdom Floodplains*, Westbury Publishing, Westbury, UK, pp. 29-41.
[13] A grassroots programme for change in the Drava River Basin (http://www.icpdr.org/icpdr-pages/dw0803_p_12.htm)
[14] H. Thomas & T. R. Nisbett, (2006) An assessment of the impact of floodplain woodland on flood flows; Water and Environment Journal

result in runoff. Water that isn't absorbed flows into the nearest watercourse, taking sediment, pesticides and nutrients with it. This pollutes watercourses and bathing waters. Large volumes of overland flow can also cause localised flooding.

Work by the Environment Agency has shown that soil compaction or “poor structure”, affects 38% of sites in the South West[15]. Trials in East Devon, demonstrated that freely draining soils with good soil structure typically have less than 2% runoff. However, compacted soils can have up to 60% runoff, leading to increased flood risk[16]. Following this work, local teams improved 220 acres of soil and put plans in place to improve a further 500 acres.

3.7 Sediment transport

Surface water run off carries sediments from the catchment and into the river network. These sediments can accumulate in the river channel reducing its ability to convey water. This can increase flood risk locally.

A study on the river Wharfe in Yorkshire showed that sediment accumulation over a relatively short period (16 months), had led to increase of 7% of the area flooded during a 1 in 2 year flood event[17]. Recent work has also shown that yields are likely to increase by up to 35% under climate change[18]. So this could become an increasingly important issue in future years.

A range of options are available for trapping sediment before it enters the river network. By trapping the sediment on the land, many of these options can provide a useful resource for local farmers.

3.8 Woodland Creation

There are three ways by which forests and woodland can provide a FCERM benefit. First, trees use more water than shorter vegetation and this reduces flood runoff due to increased evapotranspiration[19]. The effect is greatest for conifer trees but declines with the size of flood event. A complete cover of conifer forest may reduce peak flows by 10-20%, declining to <10% for large floods.

Second, rain soaks in more quickly to woodland soils. This reduces surface runoff and slows its passage to streams. Studies at Pont Bren in Wales found that infiltration rates were up to 60 times higher in woodland areas compared to grazed pasture[20]. Recent modelling predicts that woodland planting across a whole catchment could reduce peak flows by between 10-54%, while a reduction of 2-11% was possible from optimally placed woodland shelterbelts[21].

Third, forests and woodland create obstacles to flood flows by increasing the ‘hydraulic roughness’ of the floodplain. Woodland can slow down the water, promote out-of-bank flows in safe locations, increase flood storage and provide more time for issuing flood warnings. Modelling studies predict that floodplain and riparian woodland can reduce floods in downstream towns and cities, as well as enhance biodiversity, reduce diffuse pollution and promote carbon sequestration. However, trees planted in unsuitable locations can block channels and culverts and cause or exacerbate, flooding.

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[15] Smith, (2009) Maize Stubble & Run-off Problems, A South West Perspective. Richard Smith – Environment Agency.

[16] Smith, (2009) Land Use Soil Condition and Flooding in East Devon, Richard Smith – Environment Agency

[17] Lane et al (2007), Interactions between sediment delivery, channel change, climate change and flood risk in a temperate upland environment. Earth Surf. Process. Landforms 32, 429–446 (2007)

[18] McIntyre et al (In press), Land Use Management Effects on Flood Flows and Sediments – Guidance on Prediction. CIRIA

[19] Evapotranspiration (ET) is a term describing the transport of water into the atmosphere from surfaces, including soil (soil evaporation), and from vegetation (transpiration).

[20] Bird, S.B., Emmett, B.A., Sinclair, F.L., Stevens, P.A., Reynolds, B., Nicholson, S. and Jones, T., 2003. Pontbren: effects of tree planting on agricultural soils and their functions. Report to CCW, NAW and FC

[21] Jackson, B.M, Wheater, H.S., Mcintyre, N.R., Chell, J., Francis, O.J., Frogbrook, Z., Marshall, M., Reynolds, B., Solloway, I., 2008, The impact of upland land management on flooding: insights from a multiscale experimental and modelling programme, Journal of Flood Risk Management, Volume 1, Issue 2, pages 71–80, August 2008

Figure 4 shows modelling of the River Laver in North Yorkshire. Planting 40 hectares of floodplain woodland delays the flood peak on the River Laver so it is later than the flood peak on the River Skell. This reduces the flood risk In Ripon downstream[22].

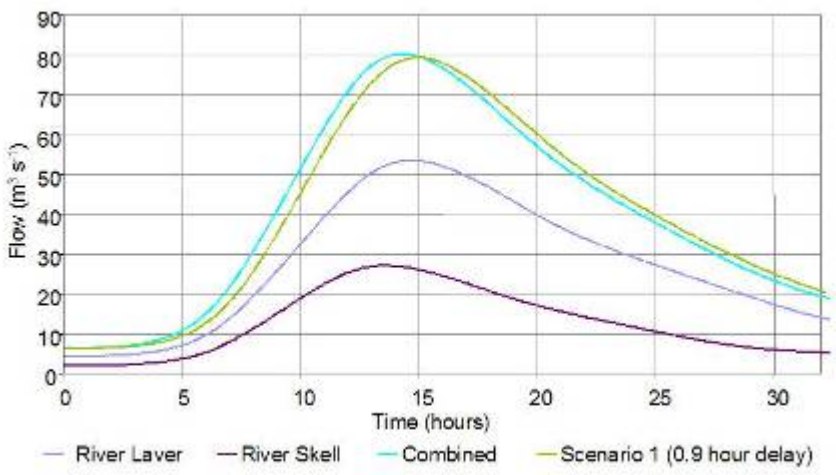

Figure 4: Effect of planting 40 ha of floodplain woodland (scenario 1) on the flood peak

3.9 Coastal erosion and deposition

Coastal erosion poses a much bigger threat to local communities than flooding. Coastal change is a dynamic process that involves both erosion and deposition. However by working with the coast we can reduce the impact of coastal erosion.

At South Milton Sands, coastal processes were used to protect a sand dune site[23]. South Milton Sands has 4ha of sand dunes, a small beach and extensive car parking. The wooden piling defences constructed in 1990 were at the end of their life and unsustainable in the long term. The National Trust worked with local partners to design a scheme so the dunes would evolve naturally. Over six years planning permission was obtained, the defences removed, the dunes re-profiled and local people helped plant marram grass [24]

Figure 5: Returning South Milton Sand Dunes to sustainable use (National Trust)

[22] Nisbet, T.R., Thomas, H. and Broadmeadow, S.B. (2008). Trees and Water – A Forestry Perspective. Journal of Practical Ecology and Conservation, 7(1): 100-103.

[23] Beach management manual – adaptive management (s16) – page 17

[24] CIRIA, Beach management manual – Section 16 Adaptive management (2010), 17-23

4 FCERM planning

Greater working with natural processes can be achieved at a Government policy, plan, or project level. The relationships, links and context are shown in Figure 6.

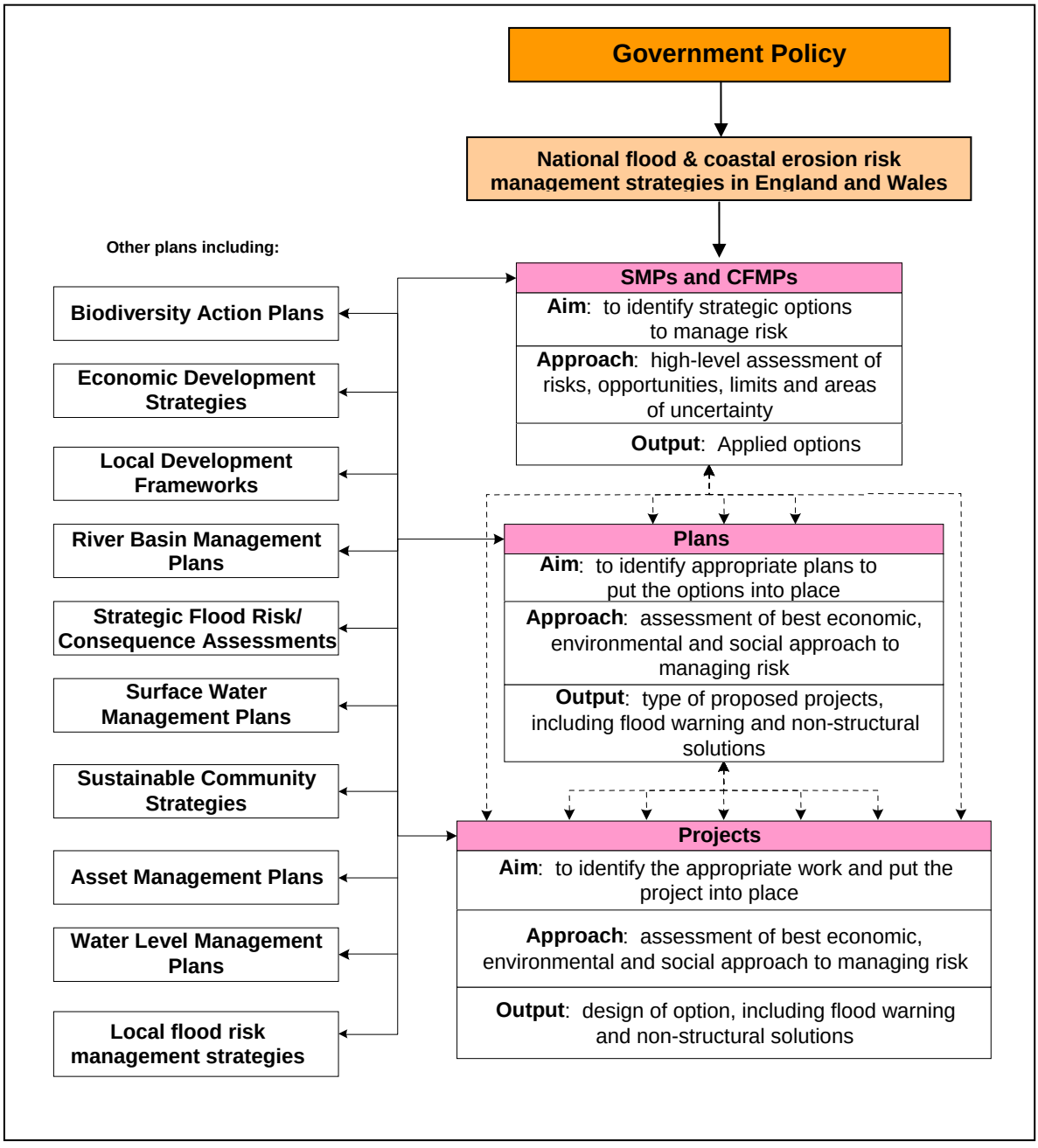

Figure 6: Flood and coastal erosion planning hierarchy (Environment Agency, 2010)

The Pitt Review confirmed that the existing FCERM strategic planning framework, Catchment Flood Management Plans (CFMPs) and Shoreline Management Plans (SMPs) already consider working with natural processes. However, the opportunities were not being maximised as the plans did not adequately promote working with natural processes as an alternative to more traditional options.

CFMPs and SMPs have identified opportunities at a catchment or coastal sediment cell scale to work more with natural processes for large-scale land use change or sea defence realignment. Some of the flood and coastal erosion risk management techniques that

work with natural processes (see the supporting guidance for project appraisal *Working with Natural Processes to Manage Flood and Coastal Erosion Risk*[25]) may be more applicable at a smaller scale to address local flood or coastal risk.

There are barriers to greater working with natural processes that need to be recognised and addressed. For example, there are few mechanisms to ensure CFMP actions for working with natural processes are implemented. One solution would be to correlate them with Environmental Stewardship and England Woodland Grant Scheme targeted priority areas in England, target areas for Glastir Higher Tier Scheme (HTS)[26] in Wales and, Forestry Commission England's opportunity areas for woodland creation.

Specific actions could be developed to implement CFMP and SMP policies where land use or management change is required to manage flood or coastal risk. CFMPs and SMPs must be a key consideration in developing local development frameworks to adopt the whole catchment approach to dealing with flooding issues. Opportunities for working with natural processes and achieving environmental opportunities should be identified in local flood risk strategies (being developed by unitary authorities and county councils).

Conclusion 1: A logical extension of the generic actions to work more with natural processes contained in CFMP action plans would be to develop more specific and targeted actions. Such work would align well with the actions proposed in the River Basin Management Plans' Programme of Measures.

[25] This is available as guidance to support the Environment Agency's project appraisal guidance. See http://www.environment-agency.gov.uk/research/planning/116705.aspx - A copy of the supporting guidance can be found at: http://publications.environment-agency.gov.uk/pdf/GEHO0310BSFI-e-e.pdf

[26] Glastir HTS is the new whole farm sustainable land management scheme in Wales which replaces all 4 previous schemes and will begin in 2012 (http://wales.gov.uk/topics/environmentcountryside/farmingandcountryside/farming/glastirhome/?lang=en)

5 Improving the way we work with natural processes

The Pitt Review identified a range of issues that limit greater working with natural processes. These can be summarised under a number of themes:

- Policy and legislation;
- Science, evidence and modelling;
- Funding and incentives;
- Partner and community engagement; and
- Culture, skills and training.

5.1 Government Policy and legislation

The Flood and Water Management Act 2010, sets out a risk based approach to managing floods and includes enhancing or restoring natural processes as a tool for managing risk. In addition Defra has issued new guidance on the appraisal of flood and coastal risk management. The new guidance addresses many of the issues which previously limited working with natural processes, such as screening out options working with natural processes early in the project appraisal process. It would be helpful to have additional guidance to encourage land management measures and the development of integrated, multi-functional projects with catchment partners.

There is a clear intention to broaden both the FCERM tools available and the way in which benefits should be appraised. However, it is too early to see how much these changes will result in more working with natural processes. Consequently, it is important that the performance of project appraisal and cost benefit analysis are monitored and reviewed as part of the post-project appraisal process.

Closer inter-agency working is required to facilitate the identification, prioritisation, development and funding of multi-functional projects. This could enhance integrated catchment management for a range of environmental benefits (such as biodiversity, water quality and carbon sequestration). A review of current methods would facilitate: the optimal alignment of strategic planning objectives; the exchange of technical information; the evaluation and promotion of projects with the potential to achieve innovative multiple benefits; and the creation of partnership projects.

Conclusion 2: Greater use of rural land use and land management solutions in the new appraisal guidance (which includes approaches that fit with the principles of working with natural processes) would help in the development of multi-benefit projects.

5.2 Science, evidence and modelling

Scientific understanding of how natural processes might contribute to FCERM is variable. The largest gap is the effect of land use change in catchments above 10km^2. This is due to a number of factors:

- Each catchment is unique, making the application of generic models difficult.
- There are few long-term datasets so the impacts of land use change and land management on mitigating floods, resource protection and biodiversity are not well understood.
- The modelling and monitoring approaches used to detect the impacts of catchment change cannot represent the complex hydrological processes.

Given these factors it is unlikely that a definitive answer to this question will be found any time soon. A more pragmatic approach is to focus on better understanding and

communicating the uncertainty so that practitioners use this in their decision making locally.

Tools are being developed to prioritise the location of land use management interventions. These need to be integrated to identify the opportunities to maximise funding and achievement. Existing tools such as the CFMP land management tool (See section 6.2) should continue to be developed and promoted to staff in the Environment Agency, local FCERM operating authorities and other interested parties.

Information and data sharing must improve, together with better dissemination of case studies and lessons learnt on working with natural processes. In England, there would be benefit in linking the Environment Agency's five year programme of FCERM works (medium term plan), with Natural England's Higher Level Stewardship targeting methodology (the Holdings Assessment Toolkit or HAT) and, potentially, the Forestry Commission's Woodland Opportunity Mapping approach. In Wales, agri-environment information and targeting for Glastir is already being correlated with FCERM objectives.

Maintaining a database of research into the benefits of working with natural processes and land use management for FCERM, would ensure that good practice is shared between funding bodies and planning and delivery organisations. The Flooding and Land Use Jigsaw research database (see section 6.1) is one option that could be kept updated with systematic reviews of research to provide an unbiased view of the evidence that exists. The database could then be used to inform research priorities and funding.

Conclusion 3: Integrated land and water management within catchments could be improved by:

- Identifying the synergies and gaps between the currently available catchment analysis and planning tools, and subsequently developing new tools as appropriate.
- Ensuring catchment data and planning tools are accessible to organisations involved in water and land-use planning and links are made between the Environment Agency's five year programme of FCERM works and Natural England's Higher Level Stewardship targeting methodology.

Conclusion 4: A database of research on the effects of working with natural processes and land management measures for flood risk management should be maintained. This could clarify what is known and help prioritize further research to fill knowledge gaps and avoid duplication.

5.3 Funding and incentives

Funding work that supports natural processes is particularly challenging as there is little catchment-scale evidence of the benefits and they are difficult to value. However, a more integrated approach to FCERM and Water Framework Directive planning and delivery, along with better alignment of government and other funding sources could encourage the use of natural processes and provide a cost effective way of managing local flood risk.

Government's agri-environment payments could encourage land use or land management change for FCERM benefits. Agri-environment schemes, such as Entry Level Stewardship (ELS) and High Level Stewardship (HLS) are short term (five to ten years) so the long term landowner commitment for FCERM benefits is difficult to achieve. In addition, FCERM benefits can only be achieved indirectly as a secondary objective to one of the five primary objectives. One way to address this might be to more actively target agri-environment support payments to land where schemes would also reduce run off and flooding, where there is sufficient evidence to do so.

ELS could make a significant contribution to the reduction of flood run off because it has a high level of uptake (currently 56% of the Utilised Agricultural Area). However, it is

untargeted and the land manager decides on the environmental improvements. Targeted advice to landowners on options such as creation of wet grassland, buffer strips and creation of reedbeds would make greater use of the existing flexibility within ELS, HLS, and the English Woodland Grant Scheme. There would be a benefit from investigating mechanisms for sharing objectives and priorities to target agreements more effectively at a local level (including woodland creation through the England Woodland Grant Scheme).

In Wales, Glastir's higher level scheme is being targeted to deliver key ecosystem services. A methodology has been developed to identify those catchments where land management interventions to reduce flood risk have the best chance of success. The methodology, based on research undertaken by the Flood Risk Management Research Consortium in the Upper Severn catchment, has been used across Wales and will be supported by local knowledge of flood risk from local FCERM staff. Glastir Project Officers, using maps produced by this method, will be able to liaise with local FRCM staff to ensure that any investment in land management intervention is targeted within catchments with identified flooding issues.

Increased alignment of funding for land use and land management with CFMPs and SMPs could increase opportunities for working with natural processes by:

- Updating Environmental Stewardship national targeting maps to reflect FCERM;
- Deploying catchment officers, similar to those used in the England Catchment Sensitive Farming Initiative to advise farmers and encourage group agreements to meet larger-scale solutions to flooding, climate change adaptation, and diffuse pollution; and
- Extending the Forestry and Flooding Opportunity Mapping approach being pursued in Yorkshire and the Humber[27] to other regions.

Other options include reviewing agri-environment scheme options for the next Rural Development Programme for England (2013) to reflect the range of land management measures that could contribute to flood storage and reduce run-off. The development of a new option to secure long term land use change with multiple benefits, such as flood and resources management, could also be considered under Pillar Two of Common Agricultural Policy. Single Farm Payments and Cross-Compliance requirements may also be beneficial but cannot be targeted.

Alternative funding mechanisms may be needed where agri-environment schemes do not provide the right level of incentive. Mechanisms such as Environmental Markets and Payments for Ecosystem Services (PES) are already being used to secure supply of a range of ecosystem services, including FCERM, in a number of countries[28,29]. The use of CAP funding could pump-prime community initiated land management FCERM projects or establish local markets for FCERM services. The Water Industry Price Review PR09 enabled water companies to invest in catchment management investigations beyond their own landownership for the purposes of delivering water quality improvements and resilience to drought. Where practicable, these catchment management projects and those in future investment plans, should take account of potential FCERM benefits.

[27] Opportunity Mapping for Woodland to Reduce Flooding in the Yorkshire & The Humber Conservancy, Final report to FC England, December 2008 (Samantha Broadmeadow & Tom Nisbet)

[28] National report of Switzerland on environmental services and financing for the protection and sustainable use of water-related ecosystems 2005.

[29] The Katoomba Group's Ecosystem Marketplace Reference Library: http://www.ecosystemmarketplace.com/

Conclusion 5: Targeting funding for land management measures and improving coordination could both reduce flood risk and provide wider ecosystem services. E.g. updating Environmental Stewardship targeting maps to reflect FCERM knowledge of areas where land management change could reduce flood risk and by learning from targeting approaches in Wales.

Conclusion 6: More targeted advice to landowners and occupiers, and proactive targeting of land suitable for agreements should increase the potential benefits for flood and coastal risk management under ELS, HLS and EWGS.

Conclusion 7: Novel sources of funding for projects, possibly through CAP, may help secure a range of benefits for local communities, such as flood and coastal risk management, biodiversity, and amenity opportunities. Mechanisms such as Environmental Markets, Payments for Ecosystem Services and the provision of flood risk management as an ecosystem service, are already being used in a number of countries and may have an increasing role as climate change increases flood risk.

5.4 Partner and community engagement

Communities and partners are often reluctant to support projects using natural processes to reduce flood risk because the benefits may not be that tangible or visible. In particular, short project timescales (typically three years for a hard engineered scheme) are at odds with the long timescales over which the benefits of working with natural processes can take effect. Measurable benefits on the ground may appear dubious, which can lead to scepticism of a real flood risk reduction. Landowners and farmers want to see demonstrations of successful change, not theoretical ideas, to gain confidence before making similar changes voluntarily. As a result of this complexity, FCERM project managers can be put off from developing projects that work with natural processes.

Engaging and communicating with partners and communities takes time and this can create tension with the pressure to complete projects. The technical language around FCERM and environmental work can create a barrier as can the multiple and potentially conflicting objectives.

There is wide spread acknowledgement of the need to improve community involvement and communications, and to working better with all concerned in flood and coastal risk management to understand and manage risk more effectively. This is particularly important for projects that seek to enhance working with natural processes as often they will rely on the goodwill and participation of local communities and a wide range of professional, public and agricultural partners.

Conclusion 8: It is important that partner engagement is integral to FCERM projects and resourced appropriately. Projects will benefit from including staff with skills in community liaison and involvement. Local Flood Partnerships could help identify opportunities for working with natural processes and multi-objective projects.

Conclusion 9: By sharing lists of FCERM candidate projects with partners at a local and/or catchment level, the identification of opportunities to develop them further as multi-functional and/or multi-partner projects would be encouraged. Partners could also identify multi-functional projects for inclusion in FCERM programmes where appropriate.

5.5 Culture, skills and training

Decisions on what options are appraised, the social, economic and environmental benefits and the value placed on wider multiple benefits will always be locally specific and subject to some degree of interpretation. To date conventional ways of dealing with flood and

coastal erosion risk have taken precedence. This is due to a lack of methods to assess new and potentially more uncertain options combined with a poor hydrological knowledge among land managers, regulators and advisers.

The skills, training and culture of staff involved in the management of flooding and coastal erosion is key important if opportunities for working with natural processes are to be achieved. Training and guidance must include information specific to working with natural processes in managing flood risk, such as the Land Use Management and Flooding Resource Pack (see section 6.8).

On-farm flood storage areas (figure 7) or enhanced wetlands and washlands were seen as key rural management solutions by the Pitt Review. The Review recognised the scope for increased use of floodplain storage in rural areas to reduce the transmission of flows downstream. It noted that the construction of engineered floodplain storage has been used for decades. There is strong support for greater use of this technique and others such as restoring the natural functioning of rivers.

Figure 7: In-ditch Willow Dam at Nafferton Farm *(Nafferton Farm, Proactive project, Newcastle University)*

Flood storage areas offer a way of managing flood risk and achieving a range of other benefits such as extensive agriculture, recreation and amenity, and nature conservation. These multiple benefits can be designed into new flood storage areas (figure 8) or retro-fitted to existing ones. Biodiversity opportunities must be identified early in scheme development so the flood-tolerance of different habitats can be used to inform the design and operation. Designing in extra capacity can ensure flood storage is not compromised by maintaining the wetness of the area and retro-fitting biodiversity benefits to flood storage areas with low biodiversity value can have significant impact.

The Land Use Management and Flooding Resource Pack was developed for land management advisors by the Environment Agency in partnership with Natural England. It helps advisors identify situations where greater working with natural processes could deliver effective flood and coastal risk management. Using it with existing training programmes could encourage greater working with natural processes through land use or land management change. For example, Natural England's newly-developed Entry Level Stewardship (ELS) Training and Information Programme (ETIP) will help ELS applicants identify options to improve resource protection and biodiversity on their land. Options identified as having run-off reduction potential could be developed into a flood risk management package and used locally by ETIP trainers to encourage uptake.

Figure 8: Flood Storage Area at Sutcliffe Park (Environment Agency)

Better advice and information is also needed on the potential benefits of Higher Level Stewardship (HLS) or Glastir (HTS) options for FCERM. Farm advisors within Natural England and the Environment Agency (e.g. catchment sensitive farming officers) and the private sector might benefit from bespoke training on FCERM and land management, and by having access to resources such as the recent Flood and Agricultural Risk Matrix (FARM) and Catchment Flood Management Plan (CFMP) tools for use with landowners at a smaller catchment scale (<10km^2).

Conclusion 10: Existing flood storage areas could be reviewed to identify those best placed to have multi-benefit enhancement measures (including for biodiversity) retro-fitted.

Conclusion 11: Awareness and understanding of the potential of working with natural processes and land management measures as part of flood and coastal risk management projects and wider multi-objective projects must improve. Developing appropriate training and guidance, including case studies of recent examples of working with natural processes (such as use of flood storage areas), would help highlight lessons learnt and best practice for landowner, community, and Local Authority engagement.

6 Initiatives to support greater working with natural processes

The Pitt working group has produced several reports and developed a number of tools to tackle the issues described in this report. These reports and tools were designed to help understand the barriers to greater working with natural processes and provide mechanisms to overcome them. Figure 9 shows how the tools can overcome several barriers.

TOOLS	*Science, Evidence and Modelling*	*Government Policy and Legislation*	*Funding and Incentives*	*Partner and Community Engagement*	*Culture Skills and Training*
The Land Use Jigsaw	■		■		
Land Management CFMP tool	■		■		
Defra Multi-objective projects	■			■	■
Analysis of historical datasets: FD2120	■				
Establishing a practical framework for projects	■			■	
Flood and Coastal Risk Management Appraisal Guidance		■		■	■
Working with Natural Processes supporting guidance		■			
Land Management and flooding resource pack					■
Flood Storage Area Project	■				■

Figure 9: Matrix of tools and Barriers

6.1 The Land Use Jigsaw

Improving the evidence base for using land use change and land management is addressed by the Environment Agency's Land Use Jigsaw. This tool brought together

research (including FRMRC2[30] and FREE[31]) and practitioner priorities to identify where the research gaps were and where future research work is needed. It lists questions set by technical advisors and practitioners along with a list of published and ongoing research. It also includes a summary of the strength of evidence for each intervention including what that evidence enables practitioners to do.

The Land Use Jigsaw suggests there are research gaps in relation to large catchment-scale impacts of land management changes such as good soil management. It also identifies research overlaps, such as grip blocking research, and areas that are well understood and may not need further research.

The Land Use Jigsaw is also an important tool for prioritising investment in land management changes. It helps to identify what level of funding, from agri-environment to FCERM grant-in-aid, land use management interventions could receive depending on the strength of the evidence. A simple five stage approach was developed which matches increasingly complex research questions to bigger commitments to deliver land use measures. This approach will help ensure that funding is directed towards land use management interventions with sufficient levels of evidence.

The Land Use jigsaw is still available for download from www.google.com/documents (username: land.use.jigsaw password: evidence), although it now needs some updating.

6.2 Land management CFMP tool

The Environment Agency's *CFMP land management tool* allows users to explore how changes in land use and land management can quantitatively affect the flood hydrograph. The effect of land use can be represented by changing the proportions of the broad land cover classes: managed grassland, cereals, horticultural/non-cereal crops, semi-natural (largely unmanaged) and woodland. The effects of land management change can be explored by changing the distribution of field condition. This includes soil condition, as it affects runoff generation, and land management practices, as they affect runoff from the field.

This tool can help target land management approaches that are most effective in reducing flood risk. By trialling scenarios this tool can determine the most cost-effective means of delivering flood risk and help prioritise work in the catchment to deliver the greatest benefits.

The report can be downloaded from the Environment Agency publications catalogue.

6.3 Defra Multi-objective projects

Defra's "*Flood Management Demonstration Project Scheme"* comprised three projects to demonstrate the impact of working with natural processes on flooding. The aim was to promote the contribution that land use and land management could make to managing local flood risk and helping to reduce flooding to communities. At the same time the projects promoted other benefits for the environment and communities: conserving biodiversity; enhancing the landscape; promoting carbon sequestration and improving water quality.

[30] The Flood Risk Management Research Consortium (FRMRC2) has been formulated to address key issues in flood science and engineering and the portfolio of research includes the short-term delivery of tools and techniques to support more accurate flood forecasting and warning, improvements to flood management infrastructure and reduction of flood risk to people, property and the environment. Work package 5 concerns land use management. More detail on the research can be found at: www.floodrisk.org.uk

[31] The Flood Risk from Extreme Events (FREE) programme aims to address what causes and propagates floods, therefore helping to forecast and quantify flood risk, and inform society about the likely effects of climate change. More detail on the research can be found at: www.free-uk.org

The three projects were:

- The National Trust's *Source to Sea* Holnicote Project in Somerset;
- The partnership project *Moors For The Future* in the Upper Derwent Valley, Derbyshire[32]; and
- The Forest Research led project *Slowing the Flow* at Pickering in North Yorkshire[33].

6.4 Analysis of historical data sets

Evidence of the impact of land use change on FCERM was investigated by the joint Environment Agency and Defra science project *Analysis of historical data sets to look for impacts of land use and management change on flood generation* (FD2120). The project sought to identify hydrological changes resulting from changes in land use and management. It aimed to develop and test methods for searching for evidence of the impacts of land use and management. It analysed historical datasets to determine whether any impacts of land use and management change on flood generation could be identified. It used hydrological and land use management data to feed into a modelling approach.

This work has shown that variability between years appear to dominate any long-term temporal trend that could be attributable to land use management changes, although this may be a result of the limitations of the data available.

The final report can be downloaded from: http://randd.defra.gov.uk.

6.5 A practical framework for integrating biodiversity

Combining flood risk management with biodiversity was explored by Natural England's internal project *'Establishing a practical framework for schemes which integrate flood risk management and biodiversity'*[34] This project suggests a framework to identify projects which have benefits for biodiversity and flooding.

As part of this project a multi-criteria toolkit has been devised to support 'options development' for integrated flood-risk management projects. This tool informs practitioners of flood risk and biodiversity measures, many of which attract funding, which can be drawn upon to develop options for delivery of integrated projects. It is designed to allow scheme partners to review combinations of measures to deliver a mix of flood risk and biodiversity benefit.

Case studies provide illustrations of good practice in the development and delivery of integrated projects.

6.6 Appraisal Guidance

The Environment Agency's *Flood and Coastal Erosion Risk Management Appraisal Guidance* (FCERM-AG) embraces greater working with natural processes when developing FCERM projects in England and Wales. This new guidance supports working with natural processes through the development of non-structural approaches that deliver multi-objective projects.

The guidance is a technical document primarily aimed at those who undertake and review appraisals of FCERM projects and plans. It has been designed to help practitioners to undertake appraisals that reduce the risk to people and property and deliver the greatest environmental, social and economic benefits in line with sustainable development principles. It encourages local engagement with those affected by flooding or erosion so

[32] http://www.moorsforthefuture.org.uk/making-space-water
[33] http://www.forestresearch.gov.uk/fr/INFD-7YML5R
[34] Natural England, in press

that full account can be taken of social, environmental and economic issues. The process of engagement is open and transparent to help build trust with the local communities.

Practitioners are also encouraged to identify and assess solutions that could provide wider benefits than just managing the risk of flooding or erosion. This includes the need to identify and assess sustainable, adaptable and flexible solutions that work with natural processes and undertake partnership working for wider benefits.

The guidance can be downloaded from the Environment Agency publications catalogue.

6.7 Working with natural processes supporting guidance

The working group recognised the need for information to support the new project appraisal guidance. The group commissioned the development of new guidance showing how FCERM projects can work more with natural processes. It defines what is meant by working with natural processes and outlines key reasons for doing this. It lists different ways of working with natural processes and gives real examples illustrating where working with natural processes has been successful. It will help project managers when selecting options and designing projects to decide which of the methods available will best help them to work more with natural processes.

The guidance will help those who commission and design FCERM projects or plans. It will also be of use to those who might want to influence such plans and projects so that opportunities for working more with natural processes are fully considered in project appraisal.

The guidance can be downloaded from the Environment Agency publications catalogue.

6.8 Land management and flooding resource pack

The Environment Agency hopes to develop a training pack in partnership with Natural England to improve working with natural processes. A land use management and flooding resource pack would help develop and practise the skills needed to identify situations where greater working with natural processes techniques could help achieve effective flood and coastal risk management. This pack would be useful for catchment sensitive farming officers, Environment Agency environment officers, Natural England agri-environment advisors, Welsh Government project officers and Wales Catchment Co-ordinators.

A training pack could help advisors identify and discuss possible solutions and communicate to landowners key messages in reducing flood risk. It could include land management practices that may be linked to flooding and help advisors be alert to recognising good practice and improve achievement of solutions on the ground. A training pack could identify underlying principles which could be applied in many situations and be adaptable for use by anyone working with landowners.

6.9 Flood storage area project

In response to clear support for greater use of flood storage areas and the development of multi-objective projects, the Environment Agency looked at how flood storage areas might contribute to national biodiversity and designation targets. The aim of the project was to understand better how flood storage could be operated to provide the desired standard of protection and increase biodiversity value that could be achieved.

A comprehensive database of flood storage areas was developed and the land use and biodiversity characteristics recorded on an interactive GIS. A flood storage area design guide has been developed including a model to estimate the costs. A scheme appraisal process is provided along with a ‘design decision flowchart’ for both impounding and non-

impounding flood storage areas. These can be used to introduce biodiversity design into both new and existing flood storage areas.

A copy of this report can be downloaded from the Environment Agency's publication catalogue.

7 Better ways of working with natural processes

This section can be used to improve FCERM approaches in all cases where natural processes are involved.

Strategic planning framework

- Develop more specific, targeted actions to take forward CFMP and SMP policies which aim to work more with natural processes [C1].

Government Policy and legislation

- Ensure project appraisal guidance is fully supported with information to help achieve more working with natural processes and multi-objective projects [C2].

Science, evidence and modelling

- Identify synergies and gaps in catchment analysis and planning tools and develop new tools as appropriate [C3].
- Ensure that catchment data and planning tools are widely available [C3].
- Maintain an up to date assessment of relevant research and use this to identify research priorities [C4].

Funding and incentives

- Improve joint working to ensure better targeting of land management incentive schemes [C5].
- Target land management advice to landowners on incentives schemes that can benefit flood risk management [C6].
- Find and use novel sources of funding to secure multiple benefits for communities such as biodiversity and amenity as well as flood risk management [C7].

Partner and community engagement

- Invest in dedicated community engagement and liaison integral to FCERM projects [C8].
- Involve communities in option development at the earliest opportunity so multi-functional projects can be identified and included in FRM plans [C9].

Culture, skills and training

- Investigate the potential of existing flood storage areas for multi-benefit enhancements [C10].
- Develop training and guidance to improve working with natural processes and land management techniques as part of the portfolio of flood risk management measures [C11].

8 Glossary of terms

Agri-environment payments	Payments made to landowners for undertaking management prescriptions that deliver environmental (and other) benefits
Biodiversity	Short for biological diversity - the variety of life forms, the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form.
Catchment	The area of land which 'catches' rainwater, snow etc and from which it drains into a reservoir, pond, lake, river or stream. Also known as a river basin.
Catchment Sensitive Farming	A land management approach which addresses diffuse pollution problems by reducing agricultural sources of pollution within river catchments to levels consistent with ecological requirements, through land management practices.
Carbon sequestration	A geological engineering technique for the long-term storage of carbon dioxide or other forms of carbon, for the mitigation of global warming.
Catchment Flood Management Plans	A planning tool through which the Environment Agency aims to work in partnership with other key decision-makers within a river catchment to explore and define long term sustainable policies for flood risk management
Common Agricultural Policy	The system of European Union agricultural subsidies and programmes which combines direct subsidy payments for crops and land which may be cultivated with price support mechanisms.
Cross-compliance	Part of the Common Agricultural Policy, cross-compliance links direct payments to farmers to their respect of environmental and other requirements set at EU and national levels.
Detention basins	A stormwater management facility installed on, or adjacent to, tributaries of rivers, streams, lakes or bays that is designed to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of a time.
Ecosystem goods & services	The resources and processes that are supplied by natural ecosystems, such as products like clean drinking water and processes such as the decomposition of wastes.
English Woodland Grant Scheme	A suite of financial grants administered by the Forestry Commission designed to develop the co-ordinated delivery of public benefits from England's woodlands.
Entry Level Stewardship	A voluntary, non-competitive scheme managed by Natural England, which includes Upland ELS, to encourage farmers across a wide area of farmland to deliver simple yet effective environmental management.
Environmental Markets	Market-based solutions designed to address environmental matters in an effective way.
Environmental Stewardship	An agri-environment scheme managed by Natural England, that provides funding to farmers and other land managers in England who deliver effective environmental management on their land.
Flood and coastal risk management	The management of risk (the probability of an event and its consequence) arising from flooding from rivers and the sea, and from coastal erosion.
Floodplain	The flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
Floodplain storage	The act of deliberately retaining or storing water on a floodplain during a flood event and subsequently its slow release back into a watercourse in order to reduce the risk of flooding.

Glastir	The new whole farm sustainable land management scheme in Wales which replaces all four previous schemes and will begin in 2012.
Green roofs	A roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane in order to absorb rainwater, provide insulation, create a habitat for wildlife, and help to lower urban air temperatures and combat the heat island effect.
Higher Level Stewardship	A grant scheme managed by Natural England which aims to deliver significant environmental benefits in high priority situations and areas. It is usually combined with ELS options, but involves more complex environmental management.
Holistic approach	An approach which looks at the whole picture because the totality of something is much greater than the sum of its component parts which cannot be understood by their isolated examination.
Hydrograph	A graph showing changes in the discharge of a river over a period of time.
Hydraulic roughness	Hydraulic roughness (e.g. caused by vegetation) along with obstructions, is a measure of flow resistance.
Hydrological processes	The processes which dictate the movement, distribution, and quality of water, addressing both the hydrologic cycle and water resources.
Integrated, multiple benefit projects	Flood and coastal risk management projects which include as a fundamental aspect from the outset, the achievement of other benefits (such as soil improvement, habitat creation) which are not directly associated with reducing the risk of flooding.
Managed realignment	The deliberate flooding of an area that was not previously exposed to flooding by breaching or removing flood defences, to achieve flood and coastal risk management benefits as well as other benefits (e.g. habitat creation).
Medium term plan	The Environment Agency's rolling five year flood and coastal risk management work plan for capital expenditure.
Partner	Persons or organizations (e.g. customers, the public), who are actively involved in the project or whose interests may be positively or negatively affected by the performance or completion of the project.
Payments for Ecosystem Services	Payments for ecosystem services, also known as payments for environmental services (or benefits), is the practice of offering incentives to farmers or landowners in exchange for managing their land to provide some sort of ecological service. These programmes promote the conservation of natural resources in the marketplace.
The Pitt Review	A Government review to learn the lessons from the flooding that occurred in summer 2007.
Porous pavements	A permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before it infiltrates into the subsoil. The porous surface replaces traditional pavement, allowing runoff (e.g. from acar park) to infiltrate directly into the soil.
Retention ponds	A type of constructed wetland that is designed to contain storm water or rain run-off from a small surrounding drainage area that would otherwise flow into other areas.
Riparian	The interface between land and a river or stream. From Latin *ripa*, meaning river bank. Varies considerably in size and occurs in many forms including grassland, woodland, wetland or even non-vegetative.

Runoff	The water flow that occurs when soil is infiltrated to full capacity and excess water from rain, snowmelt, or other sources flows over the land.
Rural Development Programme	The Rural Development Programme for England aims to improve the economic, social and environmental conditions in rural areas. It brings together a wide range of support schemes and programmes for the farming, forestry and primary processing sectors, rural enterprise and business development, diversification and rural tourism. It is partly funded through the European Agricultural Fund for Rural Development and through funding provided by Defra.
Sediment cell	A length of coastline, and its associated near shore area, where the movement of sediment is largely self-contained in discrete, functionally separate cells.
Shoreline Management Plans	A plan which presents a large-scale assessment of the risks associated with coastal processes, along with a long term framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner.
Single Farm Payment	Single Farm Payments (under the Single Payment Scheme) is the principal agricultural subsidy scheme in the European Union. Under the scheme farmers have greater freedom to farm to the demands of the market as subsidies are no longer linked to production, and environmentally friendly farming practices (known as cross compliance) are better acknowledged and rewarded.
Soakaways	A deep hole in the ground used for drainage into which storm water is discharged and from which it is gradually allowed to percolate into the surrounding soil without connection to any mains drainage or sewerage pipes.
Sustainable	The degree to which flood and coastal erosion risk solutions optimise the social, environmental and economic resilience in a way which is fair, affordable, and avoids tying future generations into inflexible and/or expensive options.
Sustainable drainage systems	Management practices and control structures (commonly in urban areas) designed to control surface water run-off as close to its origin as possible, before it enters a watercourse. A more sustainable approach which moves away from traditional piped drainage systems to engineering solutions that mimic natural drainage processes i.e. permeable and porous pavements, retention ponds, grass swales, shallow, grass-lined channels, soakaways, and filter trenches.
Swales	A low tract of land, especially one that is moist or marshy, designed to manage water runoff, filter pollutants, and increase rainwater infiltration by 'harvesting' runoff, and slowing it by spreading it horizontally across the landscape.
Utilised Agricultural Area	The total area used for crop production, described as : Arable land including temporary grassing and fallow and green manure, permanent grassland, land under permanent crops (e.g. fruit and grapes), crops under glass and other utilised agricultural areas.
Washlands	Parts of the river floodplain (especially at the downstream end), into which the river can flood temporarily. A kind of natural or semi-natural flood storage area which has the potential to form a wetland habitat.
Water Industry Price Review	Process of setting of price limits by Ofwat for the water and sewerage companies in England and Wales.
Working with natural processes	Taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating function of catchments, rivers, floodplains and coasts.

9 List of abbreviations

CAP	Common Agricultural Policy
CFMPs	Catchment Flood Management Plans
Defra	Department for Environment, Food and Rural Affairs
ELS	Entry Level Stewardship
ESPRC	Engineering and Physical Sciences Research Council
ETIP	ELS Training and Information Programme
FARM	Flood and Agricultural Risk Matrix
FCERM	Flood & Coastal Erosion Risk Management
Glastir HTS	Glastir Higher Tier Scheme
HLS	Higher Level Stewardship
NERC	Natural Environment Research Council
PES	Payments for Ecosystem Services
PR09	Periodic Review 2009 (Water Industry Price Review)
RSPB	Royal Society for the Protection of Birds
SMPs	Shoreline Management Plans
SUDS	Sustainable Drainage Systems

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For further information about the working group, contact:

Duncan Huggett
Environment Agency
Kingfisher House
Goldhay Way
Orton Goldhay
Peterborough
PE2 5ZR

Email: duncan.huggett@environment-agency.gov.uk