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# SID 5 Research Project Final Report

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## Project identification

1. Defra Project code: FD2602

2. Project title:
   FLOOD-ERA: A methodology to evaluate the effectiveness and efficiency of mitigation measures under the condition of different risk perception.

   NOB. This is the title of whole FLOOD-ERA project, of which this SID5 reports on just the England and Scotland resesarch

3. Contractor organisation(s): Middlesex University

4. Total Defra project costs (agreed fixed price): £ 55,716

5. Project: start date ..... 01 October 2006

   end date ..... 30th June 2008

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## Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.


**Background: The ERA-NET CRUE and FLOOD-ERA context**

We report here the results of the UK element of the FLOOD-ERA project. The overall FLOOD-ERA report covers all the work in four counties (Germany; Austria; England and Scotland).

FLOOD-ERA is one of the seven projects being mounted in the ERA-NET CRUE initiative. The Dresden Flood Research Centre (and Jochen Schanse) were the coordinators of FLOOD-ERA, reporting to the overall ERA-NET CRUE Coordinator (Sebastian Catovsky) at Defra UK. The coordination role of Defra UK under ERA-NET CRUE is itself funded by the ERA-NET Scheme under the 6th Framework Programme: Contract number: ERAC-CT-2004-515742.

**Framework, objectives and methods**

This research focuses on non-structural (i.e. non-engineering) measures to reduce flood risk (measures such as warning systems; insurance; spatial; planning; emergency response; etc). Flood risk management agencies such as England's Environment Agency and the Scottish Executive (and SEPA) are giving increasing attention to these measures, but they often appear difficult to implement.

The theoretical or conceptual framework for FLOOD-ERA is that decisions about using structural (SM) and non-structural measures (NSM) for flood risk management are made under particular policy, institutional and other 'contexts' that determine what decisions are made. One of the 'contextual factors' is the availability of appropriate methods by which to evaluate the effectiveness and efficiency of these measures; inadequacy here appears to stifle progress.

The following objectives have been set for the FLOOD-ERA research project as a whole:

- To categorise S and NSM in new and innovative ways;
- To develop an outline methodology for evaluating the effectiveness and efficiency of S and NSM;
- To analyse the context conditions that may influence the choice of S and NSM;
- To identify the site-specific effectiveness and efficiency of such measures and the influence of selected context conditions on their choice; and,
- To derive recommendations for the improvement of flood risk management strategies.

To cover all these items, a combined research design has been chosen with (i) policy and analysis through the scrutiny of documents, (ii) in-depth interviews of decision makers, and (iii) six case studies (in Germany, the United Kingdom and Austria). This Summary reports on just the UK research.

**Results and conclusions: policy analysis**

Comprehensive analysis has been undertaken (and reported) of flood risk management research and policy in England and Scotland. It would appear from the international literature that non-structural measures – however defined or categorised - are best developed within innovatory *mixes* of structural and non-structural measures, rather than as stand-alone options. Also, they cannot be expected to perform well without a concerted post-implementation learning and enhancement process. A multi-disciplinary approach is required in order to avoid the mistakes which others have made in the past (e.g. in the USA), to ensure a balanced approach and to avoid the default option always being a structural one.

Our conclusions are that non-structural flood mitigation measures warrant more focused attention from flood managers and decision-makers (i.e. politicians and civil servants at all levels) in Europe. Best practice found in Europe is to use innovative and subtle combinations of structural and non-structural measures in a balanced manner, and there is much to learn about and to apply, based upon this best practice.

We also suggest strongly – on the basis of the literature that we have reviewed - that the management contexts (and their institutional characteristics) in which flood risk management in general, and non-structural measures in particular, are embedded are particularly important. Thus institutional leanings and management attitudes to NSM are important to their successful promotion: they cannot “promote themselves” in the same way that structural measures can be “seen” to be successful (i.e. by holding back flood water). Non-structural measures will therefore need to be evaluated differently, according to (or relative to) the management context in which decisions about them are to be considered, not in an absolute sense.

**Results and conclusions: case studies in the UK [summary]**

**England.** In the English case study of the **Lower Thames**, the conclusions are that NSM are less efficient than SM, and are seen as likely to be less effective. The professionals engaged in this work do not see personal advancement coming from implementing NSM, and see evaluation problems with NSM that make them "suspect". The public wants full protection, rather than the lesser protection that NSM brings. Politicians appear to support this position, against the policy drive of Defra for a more balanced approach. Limitations on revenue expenditure also discourage NSM, which use this kind of finance, and the PAG project appraisal guidance favours SM rather than NSM in its approach and language. Transaction costs appear not be important either way.

**Scotland.** In the Scottish case study of the **River Clyde in Glasgow** the conclusions are that there appears to be a more pragmatic approach here, using whatever measures enhance risk reduction and at the same time meet the parallel goals of pollution reduction, and urban regeneration; the three are inextricably linked. Benefit cost technique constraints on using NSM are there, but do not seem to dominate. Most flood risk engineers are located in local authorities rather than a stand-alone Agency as in England. As a result they are more flexible in adopting flood risk measures and subject to fewer professional constraints in favour of SM. National policy in Scotland seems to put NSM measures on the same footing as SM, and the target of the Commonwealth Games in Glasgow in 2014 means that pragmatism and "getting things done" appears to be the dominant attitude.

**Overall conclusions**

We conclude from our analysis of all data collected that risk perception is not the impediment to the implementation of NSMs that we considered it might be at the outset of this research.

From what we have learnt, economic efficiency may be such an impediment, and that judging this efficiency is difficult and may be the reason for the low levels of measured efficiency. On the other hand it appears that most NSMs that we investigated are effective in the tasks that they are set, in terms of promoting public safety and the recovery from flood events. They are also effective at pre-flood risk reduction, especially spatial planning.

However, the levels of implementation of NSM appear often to be low. Take-up levels are often only poor. There are a number of reasons why this is the case, including professional biases, inadequate policy strength, limitations in the appraisal system, etc. However, where there is the commitment to implementing NSMs (as in Scotland) they can be implemented.

**Recommendations**

There are just four recommendations that follow from this research and its results. They could act as a focus for future work and action resulting from the research:

1. Government and its agencies need to reinforce and clarify their **policies** with regard to NSMs, so as to build more confidence in their development and implementation;
2. Government and its agencies need to ensure that the **appraisal system** for decision making, as it evolves, does not discriminate against NSMs as it appears to have done in the past;
3. Government and its agencies need to develop **better data and information on the costs of NSMs** against which to compare their efficiency and effectiveness
4. Government and its agencies need to work to remove **the other impediments** to the development and implementation of NSMs that we have shown inhibit their use, including professional opinions and preferences, funding arrangements, and the appraisal system and the data on the benefits of NSMs that it uses.

Edmund Penning-Rowsell; Dennis Parker; Tim Harries; Alan Werrity [July 2008]

## Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
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   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Transfer).

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### 1. Introduction

### 1.1 Background

The rationale for the report that this SID5 summarises is to document the results of the UK element of the FLOOD-ERA project. That report, separate from other FLOOD-ERA reports, is conceived as enabling us to give more detail here than is possible within the overall FLOOD-ERA report, which covers all the work in the four counties (Germany; Austria; England and Scotland).

In particular, we are able to give more detail of the policy context in which non-structural flood risk management measures are implemented in the UK, and to give much more detail of the English case study than can be covered in the full FLOOD-ERA report.

### 1.2 The ERA-NET CRUE and FLOOD-ERA context

FLOOD-ERA is one of the seven projects being mounted in the ERA-NET CRUE initiative (see below). The ERA-NET CRUE initiative is itself different from many other similar research projects is that its seven projects and their researchers are each funded by their national flood risk management agencies (in our case Defra/EA) but coordinated through an overall ERA-NET CRUE arrangement. This means that The Dresden Flood Research Centre (and Jochen Schanse) were the coordinators of FLOOD-ERA, reporting to the overall ERA-NET CRUE Coordinator (Sebastian Catovsky) at Defra UK. The coordination role of Defra UK under ERA-NET CRUE is itself funded by the ERA-NET Scheme under the 6th Framework Programme General Directorate for Research in the European Commission, Contract number: ERAC-CT-2004-515742.

### 1.3 Framework and objectives

The theoretical or conceptual framework for FLOOD-ERA is that decisions about deploying structural (SM) and non-structural measures (NSM) for flood risk management are made under the manifold contextual conditions of decision makers. One of the contextual factors is the availability of appropriate evaluation capabilities to determine the complex and partly uncertain consequences of this type of risk reduction measures. Evaluation problems can particularly arise due to a lack in indicators, criteria, methods, knowledge and data. Since there is already some experience in evaluating SM, the FLOOD-ERA research project is being carried out to investigate the evaluation and comparison of both kinds of measures, with an emphasis on NSM.

The following objectives have been set for the FLOOD-ERA research project as a whole:

- To position structural and non-structural measures within different typologies of flood risk reduction measures;
- To develop an outline methodology for the evaluation of the effectiveness and efficiency of structural and non-structural measures;
- To analyse context conditions such as the risk perception of decision makers with a potential to influence the choice of structural and non-structural measures;
- To identify the site-specific effectiveness and efficiency of such measures and the influence of selected context conditions on their choice; and,
- To derive recommendations for the improvement of flood risk management strategies.

To cover all these items, a combined research design has been chosen with (i) the systematisation of SM and NSM, (ii) a normative approach on the evaluation of SM and NSM, and (iii) a descriptive approach to analyse the context conditions of decision makers. Research encompasses the derivation of generic conceptual findings and empirical work in six European case studies in Germany, the United Kingdom and Austria.

## 2. Typologies of Non-Structural Measures (NSM)

### 2.1 Purpose

Chapter 2 in the main report examines non-structural flood management measures, the management concepts and contexts which surround them, and the positioning of these within the wider range of alternative flood risk management measures.

The purpose is to twofold. Firstly, it is to illuminate the various ways in which non-structural measures might be considered within the process of management decision making about flood risk management programmes. Secondly, it illuminates how programme and option choices with regard to non-structural measures are made, including the various factors that enter into management decision-choices involving them.

We initially consider non-structural measures at the individual, option level, but subsequently move more to the programme level. Here non-structural measures are considered in the context of the full range of flood mitigation measures including structural ones. Research into natural hazards in general is drawn upon because of its relevance to flood management.

We begin with the origins (i.e. genesis) of non-structural measures in order to understand the management context in which they first arose and evolved. Next we move onto more contemporary models of non-structural flood measures, again identifying the management contexts and motivations for them. Finally, we engage in some rethinking of non-structural measures by drawing together a picture of the management contexts in which they arise and are likely to arise in the foreseeable future. At the same time we identify the criteria that we believe are commonly used to evaluate non-structural flood measures.

### 2.1 Conclusions on NSM typologies ('systematisations')

Our conclusions from this analysis are that on-structural flood mitigation measures warrant more focused attention from flood managers and decision-makers (i.e. politicians and civil servants at all levels) in Europe. Best practice found in Europe is to use innovative and subtle combinations of structural and non-structural measures in a balanced manner, and there is much to learn about and to apply based upon this best practice.

It would appear from the literature that non-structural measures cannot be expected to perform well without a concerted post-implementation learning and enhancement process. They are best positioned within innovatory *mixes* of structural and non-structural measures, rather than as stand-alone options. A multi-disciplinary approach is required in order to avoid the mistakes which others have made in the past (e.g. in the USA); to ensure a balanced an innovative approach; and to avoid the default option always being a structural one.

We also suggest strongly – on the basis of the literature that we have reviewed - that the management contexts (and their institutional characteristics) in which flood risk management in general, and non-structural measures in particular, are embedded are particularly important. Firstly, we have seen that they are important in understanding why particular flood risk management programmes have been implemented in the past, and why they may have been successful or not. Secondly, they are important in working out the best means of promoting non-structural measures in the future. Thus institutional leanings and management attitudes to NSM are important to their successful promotion: they cannot "promote themselves" in the same way that structural measures can be "seen" to be successful (by holding back flood water).

Non-structural measures will therefore need to be evaluated differently according to (or relative to) the management context or contexts in which decisions about them are to be considered, not in an absolute sense. The mix of criteria used for evaluatory purposes will usually be determined therefore largely by the management context, and this will in turn influence the options finally selected. Some non-structural measures (e.g. those which address flood vulnerability) may well be best introduced and managed through the social agencies of the state rather than by flood risk management agencies. To achieve this requires a high level of inter-departmental understanding and sharing of flood problems which remains challenging in most country contexts.

## 3. The policy context in England

### 3.1 Introduction

Through the analysis of documents, and with supporting anonymised interview evidence, we seek to analyse and illuminate the national level policy contexts in which decisions about both structural and non-structural flood measures are made. There is a particular interest in our main report in non-structural measures, but it is often unhelpful to discuss them in isolation from structural ones.

The reader should note that this report does not cover the complete *legal* context to flood risk management in England (or in Scotland). To do this would make the report voluminous and thereby

lose sight of the prima aims: the analysis of the context of the possible implementation of NSM. However there are some points to be made:

- The powers in flood risk management are – in general - permissive powers, and the Environment Agency has few duties in this field;
- In similar vein, Defra at national government level again has permissive powers and few FRM duties;
- Funding for FRM, in general, now comes from national taxation rather than local levies (as was the case until 2004 when the 'block grant' was introduced);
- National FRM policy needs to be seen in the context of certain EU-wide obligations such as under the Water Framework Directive, the Birds Directive and other 'environmental' EU measures.

This means that whereas both Defra and the EA have discretion as to what measures to use in risk reduction (i.e. SM or NSM), they are constrained in what they do by a wider legal and institutional context (both nationally and in regard to the EU).

Notwithstanding this, currently in England the policy context is a fast-moving arena. Policies are rapidly evolving and subtle but important emphases and nuances are being introduced, almost on a monthly basis. This was particular so at the time of the writing of this part of the main report (late July 2007), when England was experiencing unprecedented serious urban riverine and urban storm water flooding, causing emergencies to be declared in some regions.

The interactivity between structural and non-structural flood measures is an important underlying issue within this study. In the past few years, England has been moving towards a 'flood risk management' strategy, which is replacing the previous strategy. The 'old' strategy might be described as 'urban structural flood defence with added non-structural ingredients'.

The new strategy is characterised by a focus on managing *both* flood probability and consequences more at the regional level than formerly. It has moved away from defending against floods towards a more holistic, strategic, catchment-based, cross-policy, integrated portfolio of approaches and methods.

Even so, England's brand of 'flood risk management' *practice* may still be criticised by some for elevating structural measures to a primary position and treating non-structural measures as secondary (e.g. Werrity, 2006). In reality, currently we can recognise threads of both the 'old' and 'new' strategies being considered and implemented, as those responsible for making decisions about flood measures juggle, and sometimes struggle, with the issues raised.

### 3.2 Assessment and evaluation: a FHRC view

For us, the key lesson here is that to fully comprehend flood risk management policy, and key policy decisions concerning flood measures, it is necessary to 'back up' into higher, broader level policies of Government where the roots of these policies exist and where the commitments to particular policy drives are formulated.

High level Government policies may reflect grass-roots ideas and initiatives, but the strongest policy drive usually comes from the top downwards. Policies are translated into lower level policies via policy documents and signals emanating mainly from Government, with Government seeking to detect lower level concerns which may influence the policy agenda.

A second key lesson is that in order to promote non-structural flood measures, it is often necessary in the first instance to inject germane ideas at much higher levels of policy.

With regard to the current policy context of decisions about flood measures in England, we have moved from a position, not many years ago, in which the dominant philosophy of flood management was structural flood defence, England's flood risk management policy has moved very significantly towards a much more balanced structural + non-structural position. Indeed, much of the research and development and innovative action now surrounds non-structural measures, possibly as it has become

clear that structural and technical answers are more and more limited in their effectiveness and acceptability.

Notwithstanding this movement, it remains difficult to determine where the balance of expenditure currently lies in terms of structural and non-structural flood measures. In the past the balance has been very much tilted towards structural flood defences where there is a large maintenance requirement. However, maintenance expenditure has fallen back somewhat in recent years (which is problematic as a large proportion of flood defences are not now up to the standards required), and there are signs that more funding is being directed towards a cross-departmental flood risk management agenda rather than towards a single 'flood defence' department (Defra) as in the past. The Government has pledged to spend £800 million per annum per 2011 on flood risk management, but we understand this is to cover all departments and not just Defra's expenditure. However, this suggests a movement towards a much more balanced structural/non-structural policy in terms of expenditure.

It has not been possible in this study to measure the strength of different policy influences deriving from the range of policy agendas we have discussed. For example, it is not possible to say how effective the policies of the ABI are in terms of promoting non-structural flood measures, or to say what impact climate change policy will have on flood risk management over the next twenty years. More detailed research would be needed to address these questions.

Nor is it possible definitively here to say that the sustainable development criteria cited in our review - such as local capacity building, local citizens taking responsibility, promotion of disaster resiliency, intra- and inter-generational equity - are being pursued effectively. There is a lot of emphasis on this approach, but the extent to which it is efficient and has an effect on policy development is not yet clear.

## 4. The policy context in Scotland

### 4.1 Introduction

Although Scotland has not experienced flooding as severe and as extensive as that which occurred in Yorkshire and on the lower Severn in July 2007, the policy context has been rapidly evolving in recent years. This can be attributed, in part, to increased public concern following major floods in Perth (1993), Strathclyde (1994), Elgin (1997 and 2002), Edinburgh (2000), Glasgow-Shettleston (2002) and Hawick (2005), growing awareness of the threats posed by climate change (Werritty with Chatterton, 2004) and the statutory duty to promote "sustainable flood management" in the Water Environment and Water Services (Scotland) Act, 2003. The requirement to transpose the new EC Directive on the Assessment and Management of Floods (2007/60/EC) into Scots law by December 2009 and growing dissatisfaction with existing domestic legislation on flooding has resulted in the proposed Flooding Bill in 2008. The draft proposals for this Bill are under consultation at the time of writing this report (Scottish Government, 2008c).

The statutory duty to promote "sustainable flood management" under the Water Environment and Water Services (Scotland) Act, 2003 triggered a lengthy debate on the definition and delivery of sustainable flood management as reported by the National Technical Advisory Group (Scottish Executive, 2004a) and the Flooding Issues Advisory Committee (Scottish Government, 2007d). This debate was embedded in the National Flooding Framework (2003) which embraced the four 'As' (Assistance, Alleviation, Avoidance and Awareness) and widened the range of flood risk measures available to flood risk managers from structural (Alleviation) to non-structural measures (Assistance, Avoidance and Awareness). During this period SEPA's Indicative River and Coastal Flood Map went live (in 2006) and an inventory of Scottish flood defences was published (Bassett *et al*., 2007). In sum, the main policy development between 2003 and 2008 has been to promote a more sustainable approach to flood risk management in which non-structural measures have achieved a higher profile, although structural measures have continued to dominate schemes brought forward by local authorities (e.g. the Water of Leith in Edinburgh in 2007).

### 4.2 The policy context: multiple interacting agencies

Under Scots law, the responsibility to protect a property from flooding initially falls on the owners of the properties affected. Beyond that individual responsibility, a number of public bodies also contribute to the management of flood risk:

- **Local authorities** bring forward and construct flood prevention schemes on non-agricultural land, assess and maintain urban water courses and (with the emergency services) co-ordinate emergency action during and immediately after floods. As planning authorities, local authorities are also responsible for controlling development in high flood risk areas.
- **The Scottish Environmental Protection Agency** (SEPA) is responsible for disseminating flood warnings via Floodline and is a statutory consultee on planning applications in flood prone areas. It maintains the national flood risk map and regulates the impact of engineering works on rivers (including flood alleviation schemes) via the Controlled Activities Regulations (CAR) required to regulate the water environment under the EC Water Framework Directive.
- **Scottish Water** provides the water supply and drainage infrastructure and manages surface water when it enters the sewerage system. In partnership with local authorities and the emergency services, Scottish Water also manages sewers flooding and its associated impacts.
- **Scottish Ministers** are responsible for developing national policy on flood risk management and for confirming flood prevention schemes under the Flood Prevention (Scotland) Act 1961.
- The duties of **Category 1 responders** under the Civil Contingencies Act 2004 are managed by eight strategic co-ordination units led by the relevant Chief Constable and local authority Chief Executive. These groups are responsible for developing detailed plans for all types of emergencies (including flooding) in their areas.

As noted in Werritty (2007) "the absence of a highly centralized system for flood management (akin to that maintained by the Environment Agency and DEFRA for England … can variously be seen as a weakness (poor strategic planning) or a strength (decentralised, locally-accountable decision-making)". There is now general agreement that weaknesses in the current system of flood risk management out-weigh its strengths. As the current consultation on the proposed Flooding Bill makes clear "many of the criticisms levied at current roles and responsibilities revolve around the 'grey' areas where it is unclear who is responsible for dealing with floodwater, whatever its source" (Scottish Government, 2008c, p. 23).

The new Scottish Government elected in 2007 has identified five strategic policy objectives (Scottish Government, 2007a):

- **"Wealthier and fairer**: Enable businesses and people to increase their wealth and more people to share fairly in that wealth.
- **Healthier**: Help people to sustain and improve their health, especially in disadvantaged communities, ensuring better, local and faster access to health care.
- **Safer and stronger**: Help local communities to flourish, becoming stronger, safer place to live, offering improved opportunities and a better quality of life.
- **Smarter**: Expand opportunities for Scots to succeed from nurture through to life long learning ensuring higher and more widely shared achievements.
- **Greener**: Improve Scotland's natural and built environment and the sustainable use and enjoyment of it"

Many of these resonate with the macro policy drivers identified by Parker (2007) at the UK level in *Her Majesty's Government's Policy Review* (Cabinet Office, 2006), although in detail the Scottish context and delivery will differ. Several of the Scottish Government's strategic policy objectives contain potential drivers for flood risk management policy. Thus the aspiration for sustainable economic growth coupled with safer places to live could trigger further expansion of the housing market potentially in flood risk areas. The promotion of a "greener" Scotland (as evidenced in the proposed Scottish Climate Change Bill) should strengthen the reference to future generations in the current definition of sustainable flood management. The quest to promote "safer and stronger communities" should enhance social capital and thereby increase resilience to flooding. A "healthier" Scotland will require the social dimensions of flood risk management to be given higher priority than at present.

## 5. Case studies: England

## 5.1 Introduction

The English FLOOD-ERA case study looked at an area of the Thames in outer London, where some 14,000 properties and perhaps 37,000 people would be affected by a 1 in 200 year flood. We have reviewed the economic analysis of schemes to reduce this risk that was performed, using standard benefit-cost techniques, to look at both the structural measures (SMs) and some of the possible non-structural measures (NSMs). Interviews were also conducted with ten stakeholders, including the engineers designing those possible schemes, a representative of the local community and a Member of Parliament for the area affected.

In terms of the FLOOD-ERA methodology that we are testing, the economic analysis showed that the SMs would be much more economically efficient than the NSMs, for a variety of reasons. They were also seen as more effective at reducing risk, although at very considerable cost (up to £42,000 per residential property taken out of key risk zones).

A number of context factors were also found to limit the consideration given to NSMs. Although NSMs comprise part of the current proposals for the area, the interviews revealed a strong, widespread and deeply ingrained preference for SMs. Flooded householders, flood defence engineers and local politicians all seem to agree that non-structural measures come a poor second to the option of keeping floodwater right away from populated areas.

The study also found that proposals for non-structural measures are hampered by two aspects of the current funding system: 1) the reliance of funding allocation mechanisms on efficiency calculations and the lack, for non-structural measures, of any agreed methods for making these calculations; 2) the fact that non-structural measures tend to be more dependent on revenue funding, while, in the current financial climate in England, it appears to be easier to gain approval for capital spending than for revenue spending.

The result is not that non-structural measures are rejected out of hand, but rather that they are less intuitive, harder to fund, and less likely to win political or public support. In consequence, it is perhaps inevitable that they often seem only to be seriously considered when no large-scale structural alternatives are available or seen to be viable.

## 5.2 The case study area

In 2003, a flood alleviation diversion channel was opened that took water out of the Thames upstream of Maidenhead and put it back in downstream of Eton, thereby reducing the risk of flooding in Maidenhead, Windsor and Eton, three towns to the south west of London near Heathrow Airport. Shortly after the opening of this channel, which was titled the *Jubilee River*, the area downriver of the channel suffered minor flooding. Local people and the media tended to blame the *Jubilee River* for the flood and – despite the findings of three enquiries that all found to the contrary – still do so. These circumstances provide an important part of the context for the area that was chosen as the English FLOOD-ERA case study.

Maidenhead, Windsor and Eton lie in Reach 2 of what is known as the Lower Thames, the non-tidal part of the Thames that is nearest the sea. The subjects of this study, meanwhile, are Reaches 3 and 4, downstream of Reach 2. The most recent search for a solution to the flood risk in these two areas began in 1989 and continues to this day, in what has become known as the Lower Thames Strategic Study, or the “LTSS”.

On adjoining parts of the Thames, these two reaches lie in what is an area of major economic growth. Close to Heathrow Airport and London’s orbital motorway (the M25), they have good public transport links into central London and are well served with green open space amenities, such as Runnymede Park, Windsor Great Park, numerous lakes and reservoirs and, of course, the Thames itself. As a result, the area is a popular residential and business zone, containing high value properties occupied by an articulate and politically-connected population, and there is continual pressure for more building and development.

Though demographically very similar, Reach 3 and Reach 4 are topographically very different to each other. In Reach 3, between Windsor and Walton on Thames, the floodplain is flat and expansive and many drainage ditches and small rivers feed into the Thames. This means that a one in two hundred year flood (1:200 years) would affect about 14,000 properties and 37,000 residents, and a 1:100 year flood would cause about £400m of damage[1], with flood waters lingering for at least a number of days and in some areas for one or two weeks. It also means that at times of flood the Thames spreads its tentacles into its hinterland along numerous convoluted routes, making evacuation planning complex and difficult. By contrast, in Reach 4 (Walton-on-Thames to Teddington), the river is more enclosed and the steeper gradient away from the river makes the floodplain markedly smaller and evacuation planning far easier. The situation has been summarised as below:

> *In total 14,500 properties and 36,500 people are at risk of being affected by flooding within the Lower Thames Floodplain (1:200 years).*
>
> *Estimated long-term (100 year) present value economic damages throughout the Lower Thames could be of the order of £0.4bn.*
>
> *If current flood management activities by the Environment Agency were to be discontinued (the so-called do-nothing scenario) some 20,800 properties and 50,000+ people would be at risk from flood effects, with potential long-term economic damages of some £1bn.*

It is considered likely that future flood flows could increase by 5-10% in response to future climate change over the next 50-100 years, with a precautionary figure of 20% presently forming the basis of many planning studies due to significant uncertainty. Whilst 5-10% may represent a relatively modest increase in flow, the impact on risk in the wide and flat floodplain of Reach 3 would need to be offset. Critically, key threshold levels within the floodplain topography, at which the area affected by flooding rapidly spreads, would be reached more often. *(Lower Thames Strategy Study Phase 3 – Draft Executive Summary. March 2007).*

### 5.2 Efficiency and effectiveness assessment of FRM in England

In England, the use of benefit-cost analysis (BCA) to appraise flood risk management measures is now completely routine, and has been since the late 1970s. This is not unusual there; central government requires such an approach for all government capital expenditure[2]. For flood risk management investment appraisal, detailed guidance is provided by Defra[3], and data sets for the benefits of flood risk reduction are available[4] to support the necessary analysis by the Environment Agency and others[5] of flood risk and the effects on it of different levels or standards of flood risk management.

In this respect flood risk management interventions are evaluated in England for their economic return from investment decisions at several different scales. First there is a national assessment, under the NaFRA system[6] following on from the Foresight *'Future Flooding'* and other national-level research[7]. Secondly, Catchment Flood Management Plans (CFMPs) look at flood risk in some 63 catchments in England and Wales, so as to prioritise the local investigations that would look at risk "hot spots" in particular geographical areas (such as the Lower Thames). The Thames CFMP is a good example of

[1] Environment Agency (2007). Lower Thames Strategy Study Phase 3: Draft Executive Summary. Revision A01, March 2007.

[2] HM Treasury: *The Green Book: Appraisal and Evaluation in Central Government*, January 2003.

[3] MAFF (2001). Flood and coastal defence project appraisal guidance. Four volumes. London: Ministry of Agriculture, Fisheries and Food.

[4] E.g. Penning-Rowsell, E., Johnson, C., Tunstall, S., Tapsell, S., Morris, J., Chatterton, J. & Green, C. The benefits of flood and coastal risk management: A manual of assessment techniques. London: Middlesex University Press.

[5] For example local authorities; Internal Drainage Boards.

[6] NaFRA reference: http://www.halcrow.com/nafra/info.html

[7] Evans E, Ashley R, Hall J, Penning-Rowsell E, Sayers P, Thorne C and Watkinson A (2004) *Foresight. Future Flooding, Volume I and Volume II*: Office of Science and Technology, Department of Industry, London.

such a regional/catchment approach[8]. Thirdly, individual 'schemes' are appraised in detail, looking at the flood risk reduction provided by different levels of intervention at different levels of capital investment or revenue costs. The Environment Agency has a national-level scrutiny system (by its National Review Group (NRG)[9]) that looks at all such project appraisals undertaken by its Regional or Area staff, and nationally by its NCPMS[10], and prioritises investment using criteria such as the priority `scoring system developed by Defra[11].

In theory this multi-level appraisal system covers both SMs and NSMs. However, the data on the risk reduction effectiveness of NSM is less well developed than for SM, although this is changing. Also Treasury rules in their 'Green Book'[12] preclude counting as benefits the effect of such NSMs (e.g. spatial planning) that are designed to prevent the future build-up of urban land uses (and high flood damage potential) in flood plain areas. This is because – the Treasury has argued – investment in flood risk management measures using that criterion would simply lead to subsidising that (mainly private) future development with public resources. So, for a variety of reasons, there is not a "level playing field" in respect of the evaluation of the efficiency and effectiveness analysis of SM and NSM.

### 5.3 A summary assessment of the efficiency and effectiveness of possible flood risk management measures for the Lower Thames

Our conclusion from the analysis of costs and benefits of a range of SM and NSM for the Lower Thames area is that it is clear that both SM and NSM can be effective and efficient in the Lower Thames area (Table 1), although in general the SM are more economically efficient that the NSMs, using current standard appraisal tools. However this result is bound to be highly site specific, and this research shows that it would be a false conclusion is it were deemed that all SNM were more economically efficient and effective vis-a-vis NSM irrespective of location and geography.

*Table 1: Summary economic analysis results for the Lower Thames case study area*

| ***Flood risk management element*** | ***(SM or NSM)*** | ***Effectiveness in Lower Thames context*** | ***Efficiency in Lower Thames context (with any BCR results)*** | ***Transaction costs in Lower Thames context*** | ***Results highly location specific ?*** | ***Comments*** |
|---|---|---|---|---|---|---|
| By-pass channels | **SM** | **High** (they would take many people and properties out of significant risk) | **High.** BCRs in the region of 1:4 to 1: 11. These results are bound to be highly site specific. | **Very high.** Major cost of studies, negotiations, etc. | Yes | BCA undertaken using standard methods but allowing for climate change (which has a large effect on the results here). |
| Flood forecasting and warning, | **NSM** | **Medium-high** | **Low** (damage saving small). BCR likely to be < 1.0. | **Initially high**, but not high now (sunk costs high) | No | BCA using damage saving may not be the appropriate measure of efficiency. Better perhaps to assess worthwhileness as the number of people warned, rather than the damage saving actions that then follow. |
| Community based protection | **NSM** | **Uncertain** | **Low-Medium.** BCRs in a range 1.75 to 2.2 (and up tpom8.0 very locally) | **High**. Complex local negotiation/ persuasion needed | Yes | Social surveys indicate public support |
| Flood insurance | **NSM** | **High** (but not universal) | **High** (insurance companies make money out of these policies so effective BCR for them is > 1.0) . | **Low** | No | Penetration is not uniform, despite a nationally available flood insurance system 'bundled' in with other household cover. Up to 50% of low socio-economic groups do not have insurance |
| Spatial planning | **NSM** | **High** (but only for curtailing the | Probably **very high** (i.e. the system is 'paid for' in its other uses) | **Initially high**, but not high | No | Does not assist with inherited risk. BCA under Treasury rules does not allow counting the avoidance of build up of |

[8] Thames CFMP: *Managing Flood Risk: Thames Region Catchment Flood Management Plan, summary document, Consultation, January 2007. http://www.environment agency.gov.uk/commondata/acrobat/geth0107bluseplr_1696122.pdf.*

[9] See: http://www.environment-agency.gov.uk/commondata/acrobat/guidancenote1_1826827.pdf . Accessed 14.8.09

[10] http://www.environment-agency.gov.uk/commondata/acrobat/progress_1697257.pdf. Accssed 12.4.08

[11] Defra Priority score system: **Defra** 2006 *Capital grant allocations for flood and coast l erosion risk management* (http://www.defra.gov.uk/environ/fcd/policy/grantaid.htm) Accessed 7 February 2006

[12] HM Treasury: *The Green Book: Appraisal and Evaluation in Central Government*, January 2003.

| *Flood risk management element* | *(SM or NSM)* | *Effectiveness in Lower Thames context* | *Efficiency in Lower Thames context (with any BCR results)* | *Transaction costs in Lower Thames context* | *Results highly location specific ?* | *Comments* |
|---|---|---|---|---|---|---|
| | | development of the floodplain in the future) | | now (sunk costs high) but "medium" – annual 'maintenance' costs | | future flood risk which is the *raison d'être* of the flood risk management role of spatial planning |
| Emergency planning and response | **NSM** | **Medium-high** (but untested) | **Very low** (very little damage saving). BCR assumed to be 1.0. | **Medium** – annual 'maintenance' costs | No | Public safety rather than efficiency is the criterion. Better perhaps to assess worthwhileness as the number of people assisted, rather than damage saving actions that then follow. |
| Resilience measures | **NSM** | **Uncertain** | **Medium - low**? BCRs only above 1.0 where flooding is frequent (i.e. > risk that 1:50 years) | **Medium – high** (large numbers of individual negotiations) | No | Parallel Defra research under way (Tim Harries) may clarify the benefits and costs more accurately. |
| Public education and awareness | **NSM** | **Low.** The pubic appears still slow to react, but this is a low risk area. | **Medium-High.** The benefits of the awareness raising programme seem high; people are aware of the risks that they face | **Low**; this is now a routine Environment Agency activity | Yes | Many benefits come through via other measures (i.e. the effectiveness and efficiency of forecasting and warning systems build on awareness campaigns) |

## 5.4 Assessing the Lower Thames 'context factors': The methodology we used

Understanding the 'context factors' affecting decisions to review or implement NSM is central to this research. Alongside an analysis of key documents and the economic analysis summarised above, the main method used to meet the objectives for this case study was the *depth interview* (which is also known as the *semi-structured interview*). This was our main vehicle for teasing out and understanding these context factors.

This method of data collection allows the researcher time and opportunity for in-depth exploration of the issues under investigation – i.e. by prompting respondents to elaborate on their comments and by probing the meaning of terms they use. Furthermore, unlike more structured approaches (such as the survey interview using questionnaires), it encourages interviewees to respond in a reflective manner and to be more dialogical (that is, to incorporate contradictory views and perspectives, rather than represent their position as unitary and consistent). As a result, it can reveal not only superficial information about the topic under investigation, but is also likely to uncover the hidden representations, discourses and assumptions that generally shape people's behaviours.

It is the nature of such interviews that they do not all follow the same trajectory. Although a standard topic guide is used, the order and manner in which each of the topics is introduced can vary and the focus of each interview will be determined as much by the interests and choices of the respondent as by those of the interviewer. This ensures that it is possible for themes to emerge that were not anticipated by the research team and it reveals to the researcher the elements of the topic with which respondents' themselves are most preoccupied. In this way, the structure of the interview is co-determined by the interviewer and the respondent and itself becomes part of the evidence.

Participants for these interviews were chosen so as to represent all of the actor groups that most influenced the design of the scheme. Some of these were known to the research team at the outset of the research. Others became evident in the course of the early interviews. In all, ten interviews with a total of thirteen respondents were conducted for this study.

The length of the interviews ranged from just half an hour (in the case of the graduate assistant at Halcrow) to 90 minutes (in the case of the regional flood defence manager). All interviews were tape recorded and fully transcribed.

The reader needs to note carefully that these interviews (and those in Scotland) report the attitudes and the perceptions of the interviewees alone. Indeed the method used is designed to record these. The evidence for these attitudes and perceptions is in the quotations used

(transcribed verbatim from the interview tapes), as in the main report. The researchers at FHRC are just reporting these attitudes and the perceptions, and it is not for us to question them or say whether we agree or disagree with then: we are simply the recorders of these opinions. Nevertheless we give some interpretation below.

### 5.5 Summary assessment: a FHRC interpretation

From these interviews, in summary, the experience of those involved in the LTSS suggests that the funding and appraisal system is not suitable for non-structural measures. In order to include NSMs in the LTSS, respondents felt that they currently had to 'bend' these systems to a purpose for which they were not designed.

Although none of the respondents admitted to being deterred by these difficulties, it is clear that the extra difficulty and complexity involved added to the cultural factors that predispose decision-makers to favour large-scale engineered options for flood risk management. Furthermore, it can be argued that the absence of suitable national systems for evaluating NSMs deprives them of the level of oversight and quality control from which more capital intensive SMs benefit. Even if such measures are included in the final scheme for the Lower Thames area, this quality control deficit may undermine their eventual effectiveness.

Given this evidence of an intrinsic bias against NSM, what can be done to encourage their adoption?

One clear message from this research is that decision-makers require either better empirical evidence of the effectiveness and efficiency of NSMs or else standard, agreed ways of approximating their key performance measures. The engineering culture amongst decision-makers may not change in the near future, but this change to appraisal arrangements would at least enable them to avoid having to make their own estimates of benefits and costs, and to avoid, therefore, the cultural discomfort and exposure to criticism that such estimates appear to carry.

Our interpretation of the interview results leads us to suggest that stronger messages in support of NSMs also need to be sent out by Defra and by central components of the Environment Agency. Although the CFMPs can act as a vehicle for encouraging a balance of SMs and NSM, this effect is undermined by the fact that both Defra's present High Level Targets and the new set of Outcome Measures are perceived as irrelevant to some of the key non structural measures. For example, the wording of the recently issued Outcome Measures document[13], by emphasising "improved standards of protection", implies that some non-structural measures (for example, improved penetration of household insurance, or the increased use of flood warnings) are of lesser importance. The progressive principles of *Making Space for Water*, this research suggests, need to be embodied in more concrete, formalised forms and need to be reflected in the language used by Defra and the Environment Agency in their key guidelines, as well as in aspirational statements of policy.

The very language and structure of the appraisal process is said by those we interviewed to enshrine, at present, an assumption of the predominance of structural measures, so it is little wonder – in our view - that this is reflected in the framings and representations used by decision-makers at the scheme level. PAG3 and the other appraisal guidelines, this suggests, should be revised so that they make more allowance for measures whose benefits (a) depend on unpredictable factors such as the agreement of individual householders and (b) will only be realised over a period of time rather than immediately.

Some consideration also needs to be given – we feel - to the rules on revenue and capital funding. At present, any scheme that consists of both revenue funding (i.e. for NSMs) and capital funding (SM) elements has to be put through two separate appraisal and prioritisation processes. In addition, the imposition of no-growth in revenue budgets disadvantages NSMs by requiring their revenue components to be funded either by reductions in other revenue expenditure or by the reclassification of

[13] Open letter from Hilary Benn, Secretary of State for the Environment, Food and Rural Affairs to Sir John Harman, Chairman of the Environment Agency. 'Comprehensive spending review (CSR) 2007 - flood and coastal erosion risk management allocations', 4 February 2008.

existing revenue expenditure as capital. Not only does this complicate the process of funding hybrid schemes, it also encourages the SMs and NSMs components to be seen as distinct from each other rather than as parts of a single 'package'.

Finally, there is the issue of the so-called 'engineering culture' and the argument that it inclines decision-makers toward SMs and away from NSMs options. On this question the chairman of the Thames Flood Forum indicated that the operation of the Forum – which he described as "in-depth strategic engagement" – had succeeded in persuading decision-makers to look more favourably on NSMs. Furthermore, in persuading opinion leaders amongst flooded households to weaken their insistence on large-scale protective measures, it had also reduced the pressure for NSMs measures that they exerted on the decision-makers. This suggests to us that intensive, facilitated engagement between the various stakeholders during the design process would make the consideration of non-structural measures more likely.

A second way of addressing this last barrier to NSMs that was suggested by the research concerns the composition of the teams of people who design and implement local flood risk management solutions such as the one being created for the Lower Thames. The discomfort felt by some engineers when they are asked to consider NSMs is to be expected, for such measures lie outside the disciplines within which they are trained and will often also lie outside the realm of their direct experience. The allocation of scheme design and option appraisal to more multi-disciplinary teams would seem to us to strengthen their capacity to give proper consideration to both SMs and NSMs.

### 5.6 Our conclusions

Flood risk is now seen firmly by most with the flood risk management community as probability times consequences[14]. The application of non-structural flood risk management measures, this study suggests, is being held back in England by a profound and continuing preference for probability management rather than consequence management. In the Lower Thames area, there appears to be a general consensus that what at-risk populations most want and what they deserve is to have are large scale engineered measures that prevent floodwater from coming anywhere near their homes. This belief, it seems, causes non-structural measures to be treated as a second best option and, hence, to be pushed down the list of priorities.

This view is not surprising. After all, those members of the local population whose voices are most often heard in the debate over flood risk are the ones who have been flooded and who are most keen to be protected. We judge that their view, therefore, is mistaken for the view of the population of the area as a whole, or even for the view of society – a perspective that seems to be supported by at least one of the local Members of Parliament.

Not only do decision-makers tend to be intuitively averse to setting aside flood defence in favour of non-structural measures, but the systems and procedures that they rely on encourage them to do so. Funding for capital work is often more difficult to find than funding for revenue-based non-structural measures, the benefit-cost calculations that still dominate option choice are ill-suited to non-structural measures, whose effectiveness is often unpredictable, and which often focus strongly on public safety rather than flood damage reduction, and which have no agreed methods for calculating efficiency.

If the principles of the Government's *Making Space for Water* strategy are to be successfully implemented, this series of conclusions suggest that a cultural change is necessary, by cooperation rather than coercion. According to one respondent, however, the current engineering culture is so deeply engrained amongst decision-makers in the Environment Agency that it will take a generation for them to change.

In the meantime, however, we judge that it needs to be made easier for those who do want to introduce non-structural measures to be able to do so. Defra's Outcome Measures, this study suggests, need to be changed so that they incentivise non-structural measures more effectively, and – in parallel -

[14] Evans E, Ashley R, Hall J, Penning-Rowsell E, Sayers P, Thorne C and Watkinson A (2004) *Foresight. Future Flooding, Volume I and Volume II*: Office of Science and Technology, Department of Industry, London.

restrictions on revenue funding need to be eased. In addition, either standard procedures need to be introduced to calculate the efficiency of non-structural measures or the benefit-cost test needs to be seen as just one test of an option, rather than – as at present – as the final arbiter over the implementation of flood risk management schemes.

## 6. The Scottish case study

### 6.1 Introduction and background

In Scotland the initial responsibility to protect a property from flooding falls on the property owner. Thereafter managing flood risk is widely distributed across a number of public bodies. Local authorities can bring forward and construct flood prevention schemes on non-agricultural land. They must also assess and maintain urban water courses and (with the emergency services) co-ordinate emergency action during and immediately after floods. The Scottish Environmental Protection Agency (SEPA) is responsible for disseminating flood warnings via Floodline and is a statutory consultee on planning applications in flood prone areas. It also maintains the national flood risk map and regulates the impact of engineering works on rivers, including those designed to reduce flood risk. Scottish Water, in partnership with local authorities and the emergency services, manages sewer flooding and its associated impacts.

Most of the current statutory powers and duties for these public bodies derive from legislation that was primarily concerned with fluvial flooding caused by rivers over-topping their banks. As a result, most of the flood prevention measures undertaken under the Flood Prevention (Scotland) Act 1961 have comprised structural defences typically on major water courses (Bassett *et al*., 2007). However, following the Foresight Study (Evans *et al*., 2004, Werritty with Chatterton, 2004) there is now greater recognition of non-fluvial flooding and especially pluvial (or urban) flooding caused by surcharging sewers combined with surface flow following intense localised storms such as that which occurred in Shettleston in the east end of Glasgow in July 2002.

However, as noted by the Pitt Review in England (Cabinet Office, 2007), the responsibility for managing urban flood risk is unclear. Thus Scottish Water is responsible for managing the discharge of surface water that enters its drainage systems from roofs and paved ground surfaces, but not runoff from roads which is the responsibility of the roads authorities (central and local government). In its current consultation on a Flooding Bill, the Scottish Government "wishes to ensure that urban drainage plans sit within a Local Flood Risk Management Plan and wishes to identify the most effective means to facilitate co-ordination of efforts to reduce flooding from surface water runoff and sewers" (Scottish Government, 2008b, para 3.43). The Glasgow Strategic Drainage Plan (triggered by the Shettleston flood) is viewed by many, including the Scottish Government, as an exemplar of how to achieve this co-ordination of efforts to better manage urban flood risk which is expected to increase significantly under most climate change models (Werritty, 2007).

The aims of this case study are:

- To outline structural and non-structural flood risk management measures in the Glasgow Strategic Drainage Plan (GSDP)
- To comment on the relative effectiveness and efficiency of structural and non-structural measures
- To explore the perceived relative merits of structural and non-structural measures within the GSDP

Following the 1 in 100 year storm in July 2002 which caused severe urban flooding in Shettleston, Glasgow City Council and Scottish Water came under intense public pressure to address urban flood risk across the city. However, since the urban flood risk in Glasgow involves sewer flooding as well as surface water flooding, water quality issues are also at stake. SEPA's most recent survey of water quality across Scotland in 2006 recorded the majority of Glasgow's water courses as being "moderate", "poor" or "severely polluted" (SEPA, 2008) due in part to stormwater discharges from Combined Sewer Overflows (CSOs). Furthermore, the sewerage system is operating close to capacity severely constraining urban regeneration, especially in the east end of Glasgow. Thus the urban flood risk in Glasgow is inextricably linked to water quality problems and these in turn are impeding vital urban regeneration.

## 6.2 The relative efficiency of structural and non-structural measures

As in England, the efficiency of flood risk measures in Scotland is based upon Benefit Cost Analysis (BCA) which provides the framework for project appraisal when flood alleviation schemes are brought forward by local authorities. The majority of such schemes are structural defences reflecting current legislation which privileges large scale engineering works.

The Scottish Government has recently revised its guidance to local authorities on project appraisal reflecting the recommendations of the National Technical Advisory Group on Flooding (Scottish Executive, 2004a) and the recommendations of the report on the social impacts of flooding (Werritty *et al*., 2007). Whilst continuing to recommend the use of BCA in project appraisal, it is recognised that there are some flood impacts that cannot be "readily valued in economic terms and others which … may not be given their full weight in the analysis" (Scottish Government, 2007b, para 2.4). Accordingly, within the constraints of the Treasury's Green Book (HM Treasury, 2003) due regard can be given to environmental impacts which may be assessed by continent valuation or social impacts which can be expressed in non-monetary terms.

As others have noted (e.g. Ashley et al., 2007), it is much more difficult to assess non-structural measures in terms of their efficiency. However, a recent project on assessing the benefits of flood warning has used multi-criteria analysis (MCA) to provide SEPA and the EA with a methodology and GIS tool "to capture the benefits of flood warning when appraising proposals for new flood warning services, and for modifying or upgrading existing services (Scottish and Northern Ireland Forum for Environmental Research, 2007, p. 4). The following MCA categories were identified and the following differential weights assigned:

- Risk to life and serious injury reduction (30%): intangible benefit
- Social impacts reduction (20%): intangible benefit
- Residential property damage reduction (15%): tangible benefit
- Business and agriculture damage reduction (15%): tangible benefit
- Flood defence operations improvements (15%): tangible benefit
- Infrastructure disruption reduction (5%): tangible benefit

The weights attributed to each category were based on the collective judgement of an expert panel and consultation with key stakeholders. Algorithms for deriving benefit scores for each category were provided enabling candidate sites for new or enhanced flood warning schemes to be ranked on a scale from 0-100. The method has been initially validated in pilot studies across 9 catchments in Scotland, England and Wakes. SEPA will be using this new methodology to inform the deployment of its next generation of flood warning schemes. The relative efficiencies of other non-structural measures have yet to be determined.

At a more strategic level, the National Technical Advisory Group (Scottish Executive, 2004a) developed a set of measurement indicators for measuring compliance with the five objectives of sustainable flood management (SFM), namely:

- Overall – meet need for flood resilience
- Social – enhance community benefit with fair access for everyone
- Environmental – protect and work with the environment, with respect for all species, habitats, landscapes and built heritage
- Economic – deliver resilience at affordable cost and with fair economic outcomes
- Future generations – allow for future adaptability, with a fair balance between meeting present needs and those of future generations.

These measurement indicators, which are claimed to be practical, transparent and auditable (Scottish Government, 2008b), can be used to prioritise funding when decisions have to be made on alternative proposals in project appraisal. Because of the diversity of metrics involved, the use of individual indicator scores may require the use of multi-criteria analysis, sustainability appraisal and/or social cost-benefit analysis.

### 6.3 Constraints and opportunities in delivering the GSDP

Semi-structured interviews were held with five flood risk managers representative of the key stakeholders in the GSDP plus two others involved in the development of policy and practice at a national scale and an academic with specialist expertise in urban drainage. The interviews were tape recorded and varied in length between 25 and 90 minutes.

One of the most striking findings from the interviews, echoed by many respondents, was that the GSDP provides a new way of working appropriate for delivering sustainable urban drainage in the 21st century: For one respondent the key challenge was that the agencies "come out of their silos" as only then could they develop the necessary joint "long term vision" to deliver a sustainable solution to urban flooding which will "make the land productive for the next 100-150 years". Whilst this is the aspiration, other respondents noted that this is not easily achieved given the inevitable institutional and funding barriers that inhibit collaborative inter-agency working.

Initially after the Shettleston flood there was

> *" a bit of a fight between Scottish Water and Glasgow City Council on who was responsible. Was it a sewer flooding problem? Was it a water course flooding problem?"*

However, once this was resolved, an effective partnership has evolved in which all the stakeholders seek to maximise opportunities for improving urban drainage as they become available. Commenting on what had been achieved by Scottish Water, Glasgow City Council, SEPA and Scottish Enterprise in the GSDP, one respondent claimed that:

> *"The work they have done together and the investment they have multiplied to do so has proved that this approach can actually work. And in terms of addressing issues in a strategic urban area, it's really the only way to go forward. There's no one agency that can do this in isolation".*

One example of this joined-up approach was the joint funding by Glasgow City Council and Scottish Water of a new trunk sewer in the Light Burn Catchment enabling a major CSO to be removed. This has reduced the flood risk, improved water quality and removed a major development constraint. But in other cases budgetary constraints and timetables have inhibited similar opportunities for joint investment. In these situations, funding targeted on addressing acute local problems fails to engage with larger strategic needs and potential synergies from joint working are lost.

When asked to comment on the relative merits of structural and non-structural measures within the GSDP most interviewees saw them as complementary:

> *"I don't have any preferences for whether we put in big trunk sewers or whether we put in SUDS, the bottom line is there are major known problems and deficiencies….. The strategy will be going to take many components and I … would agree that there must be non-structural elements".*

One interviewee went much further and, when asked for his views on the relative merits of structural and non-structural measures, replied;

> *"I see almost no place for structural measures whatsoever. I just don't think they are particularly relevant.*

But this was an isolated response. More generally the respondents were even-handed and pragmatic in their advocacy of structural and non-structural measures with neither being privileged above the other. Most interviewees felt that sole reliance on either set of measures would not meet the goals of the GSDP as reducing flood risk was only one of five inter-related objectives. A good example of the benefits of combining structural and non-structural measures is Scottish Water's strategy for reducing the number of properties on its flood risk register. Where a permanent structural solution (upgrading the sewer) is either too costly or likely to be significantly delayed by planning permission, Scottish Water will offer properties at risk temporary solutions based on fitting flood guards, air vent guards or

non-return valves to prevent or inhibit sewer flooding. The property is thus made resilient and can be removed from Scottish Water's flood risk register on the basis of an effective non-structural measure.

Delivering the long-term vision of the GSDP is a major challenge and the agencies involved often have to be opportunistic, relying on private investment by developers to achieve the goal of more sustainable urban drainage. It is fortunate that the nature and layout of proposed new developments can be constrained by the use of SPP7 (Planning and Flooding, Scottish Executive, 2004b) which covers "flooding from all sources" and which requires any new development to be "neutral or better" in reducing flood risk. Several interviewees commented that SPP7 had succeeded in promoting a more sustainable approach to urban drainage, and that spatial planning is now a key component in the GSDP toolkit. As a result, engineers and planners are working together much more closely and effectively in both Glasgow City Council and Renfrewshire Council. For example, instead of delivering urban drainage at the end of the project, engineers are now involved at an early stage developing surface water management plans prior to detailed plot level designs by planners and landscape architects. The result is not only reduced flood risk, but improved water quality, habitat enhancement and greatly improved urban amenity in locations where previously "green space" and "blue space" were strikingly absent.

Several interviewees commented positively on the opportunity afforded by the award of the Commonwealth Games to Glasgow and the inclusion of the GSDP in the Second National Planning Framework (Scottish Government, 2008a). One respondent argued that this unique opportunity should showcase the best in sustainable urban drainage with demonstration sites and best practice manuals for the rest of urban Scotland.

In 2005, as a result of limited additional funding, the GSDP was temporarily "paused". Instead of advancing the plan across the whole of Glasgow, it was decided to focus on the Clyde Gateway in the east end of the city. Part of the funding problem arises from a lack of flexibility in transferring resources between capital and revenue streams and the expectation that most structural defences have to reach stringent cost-benefit criteria and lengthy delays due to the planning system.

Both of these are set to change following a new system of local government funding by the Scottish Government. From April 2008 funding for flood measures will no longer be ring-fenced and largely funded by central government. Instead local authorities will be allocated a block grant which will include an allowance for flood measures. One respondent saw this as "liberating" as it would blur the distinction between structural and non-structural measures, remove the need to hit cost-benefit targets and provide welcome flexibility. However, this removal of ring-fencing and dedicated funding for flood measures also exposes future expenditure on flooding to political horse-trading as it competes at a local level with the budgets for housing, education, social work and roads.

One area where Scottish Water's priorities are potentially at variance with those of the local authorities is in their respective design standards. Whereas sewer systems are designed to accommodate a 1 in 30 year flood, for watercourses this is a 1 in 200 year flood. Major investment in upgrading the sewer infrastructure will mitigate the impact of relatively modest frequent floods, but have little impact of the rare extreme event. Surface water management plans must address the risks imposed by these rare events which, in some parts of the conurbation, represent a much more serious threat than sewer flooding.

### 6.5 Conclusions from the Scottish Research

The key elements of the GSDP are a commitment to partnership working and a willingness by Glasgow City Council, Scottish Water and SEPA to implement both structural and non-structural flood risk measures within an agreed overall strategy. This seems nicely to fit the model of cooperative working set out in Table 2.2 in the main report, in comparison with that Table's "coercion" dimension. It also meets the sustainable development criteria cited above:: local capacity building, and local citizens taking responsibility.

Although flood risk reduction is only one of five key objectives, it has been a major driver in the design of the masterplan for the whole conurbation and more locally in the Strategic Drainage Plan for the east

end of Glasgow. Initial disputes over who owned different components of urban flood risk have been replaced by a willingness to address the problem holistically at a strategic as well as local scale.

A mix of structural and non-structural measures is planned with structural improvements in sewer capacity operating alongside the removal of CSOs and the use of SUDS and attenuation ponds to reduce surface water flooding. Whilst the relative weights assigned to these solutions across the conurbation will vary, there is general agreement on the need for structural and non-structural measures. Once water quality issues have been addressed, regeneration can proceed with new sewer systems and surface water management plans ideally bringing the flood risk down to 1 in 30 in the sewers and 1 in 200 in the watercourses.

Non-structural measures are embedded in the GSDP both in their own right in reducing flood risk and as components in meeting other objectives (notably habitat enhancement and removal of development constraint). The local deployment of structural or non-structural measures is very pragmatic – what works best in given situations – neither being privileged over the other. Engineers are not wedded to 'hard' structural solutions, but willing to adopt 'soft' engineering and non-structural measures where appropriate. Individual agencies are emerging from their silos and looking for mutual benefits and 'joined up' solutions. Specialists are increasingly employed in inter-disciplinary teams (for example engineers and planners) in order to develop holistic, catchment wide solutions.

Funding is severely constrained and delivery on the ground is at an early stage. Developer-led opportunities are being seized but financial constraints on both Scottish Water and Glasgow City Council can inhibit strategic investments in new drainage infrastructure. Sometimes temporary measures (e.g. promoting flood resilience) become a substitute for capital investment. With Glasgow hosting the Commonwealth Games in 2014, the pace of delivery in the Clyde Gateway may accelerate, providing additional funding is made available. At present the GSDP is rather technocratic and agency-led with limited public engagement. Whilst some non-structural measures are well advanced (e.g. development planning, emergency action and watercourse maintenance) others (e.g. raising awareness and community engagement) are at a very early stage.

At a national scale, Scotland is pursuing a more holistic and sustainable approach to flood risk management at a catchment scale than England (Werritty, 2006). With only 100,000 or so properties at risk, lower levels of coastal flood risk and potentially higher levels of urban flooding, the emergence of a different and distinctive approach to flood risk management in Scotland is to be expected. It also reflects a more pragmatic and even-handed approach to structural and non structural measures pursued by key public agencies with a deliberate move away from undue reliance on large scale engineered solutions. The small number of well-networked professionals involved in flood risk management in Scotland may also have contributed to a more nimble response to the challenge of learning to live with floods. Whilst not consciously seeking to be different, Scotland's approach to flood risk management is increasingly divergent from that pursued in England.

In detail the GSDP provides a striking example of Scotland's new approach to flood risk management. It addresses an important area of flood risk which is likely to become more severe given climate change. In seeking to develop appropriate measures, it also endorses and gives substance to the principles of sustainable flood management currently being promoted by the Scottish Government.

## 7 Key findings: assessment and evaluation

### 7.1 Introduction: objectives

The objectives for the FLOOD-ERA research are repeated here for convenience:

1. To position structural and non-structural measures within different typologies of flood risk reduction measures;
2. To develop an outline methodology for the evaluation of the effectiveness and efficiency of structural and non-structural measures;
3. To analyse context conditions such as the risk perception of decision makers with a potential to influence the choice of structural and non-structural measures;

4. To identify the site-specific effectiveness and efficiency of such measures and the influence of selected context conditions on their choice; and,
5. To derive recommendations for the improvement of flood risk management strategies.

We believe all these objectives have been met in the whole FLOOD-ERA work, and 1, 3, 4 & 5 above were met in the UK research. Objective 2 is reported on in the main FLOOD-ERA report.

### 7.2 Summary: typologies of flood risk management measures

There is no single way of thinking about and categorising flood risk reduction measures that is universally useful.

Non-structural measures (NSM) are defined by antithesis: they are simply those measures that are non structural (i.e. engineering). This is hardly very illuminating. And, of course, some NSM involve structural elements, such as a weather radar system used to develop flood forecasts and warning systems. So maybe this SM vs. NSM differentiation is not very useful and should be dropped.

What we stress here is that the management and institutional system in which risk reduction measures are 'embedded' is particularly important, because it is these systems that promote high levels of performance, not the NSMs per se. The management goals (i.e. economic efficiency; public safety) will determine the criteria by which they are evaluated for their effectiveness and efficiency. This effectiveness and efficiency is therefore not an absolute, but contingent on the context of the measures and their implementation.

This mean that the aim of FLOOOD-ERA to assess effectiveness and efficiency is all the more difficult: it is not a static set of criteria and effectiveness and efficiency will depend as much on how these measures are implemented as their innate character.

What also comes from this research is the fact that NSM are part of a cooperative system of policy development and implementation: many elements have to work together and if there is one weak link in the chain, then the chain has no strength. What we have found, to pursue this metaphor, is that there are many weak links.

### 7.3 Policy contexts

Chapters 3 and 4 of the main report (and the parallel Sections above) show that the policy context of NSM is vital for their development and success. This applies as much to England as to Scotland.

But it is not just the FCERM policy context that is important - far from it. A key lesson from our research on the English policy context is that to fully comprehend flood risk management policy, and key policy decisions concerning flood measures, it is necessary to 'back up' into higher, broader level policies of Government where the roots of these policies exist and where the commitments to particular policy drives are formulated. The strongest policy drive usually comes from the top downwards. Policies are translated into lower level policies via policy documents and signals emanating mainly from Government, with Government seeking to detect lower level concerns which may influence the policy agenda. A second and related key lesson is that in order to promote non-structural flood measures, it is often therefore necessary to inject ideas in the first instance at much higher levels of policy.

England's flood risk management policy has moved very significantly in the last two decades towards a much more balanced structural + non-structural position. However this is difficult to quantify: it is difficult to determine where the balance of expenditure lies in terms of structural and non-structural flood measures, and this needs attention. More over, in terms of effectiveness and efficiency, it has not been possible in this study to measure the strength of different policy influences deriving from the range of policy agendas discussed above. For example, it is not possible to say how effective the policies of the ABI are in terms of promoting non-structural flood measures, or to say what impact climate change policy will have on flood risk management over the next twenty years.

The main policy drivers for flood risk management and the choice of flood measures in Scotland are:

- Housing
- Sustainable development
- Planning system
- Climate change
- Public engagement
- Resilience
- European Union Directives
- Flood risk management
- Insurance
- FRM research and development

This situation cannot be summarised here (see Chapter 4 of the main report and Section 4, above), but suffice it to say that the influences on FCERM policy are many and varied, and all appear to be encouraging the greater use of more NSMs than hitherto – or are at least neutral - in contrast to the situation in England.

## 7.4 The FLOOD-ERA case studies in the UK: Summary conclusions

### *7.4.1 England*

In the English case study of the Lower Thames, the conclusions are that NSM are less efficient than SM, and are seen as likely to be less effective. The professionals engaged in this work do not see personal advancement coming from implementing NSM, and there are evaluation problems with NSM that make them "suspect". The public wants full protection, rather than the lesser protection that NSM brings. Politicians appear to support this position, against the policy drive of Defra for a more balanced approach. Limitations on revenue expenditure also discourage NSM, which use this kind of finance, and the project appraisal guidance favours SM rather than NSM in its approach and language. Transaction costs appear not be important either way.

### *7.4.2 Scotland*

In the Scottish case study of the River Clyde in Glasgow the conclusions are that there appears to be a more pragmatic approach, using whatever measures enhance risk reduction and at the same time meet the parallel goals of pollution reduction, and urban regeneration; the three are inextricably linked. Benefit cost technique constraints on using NSM are there, but do not seem to dominate. Most flood risk engineers are located in local authorities rather than a stand-alone Agency as in England. As a result they are more flexible in adopting flood risk measures and subject to fewer professional constraints in favour of SM. National policy in Scotland seems to put NSM measures on the same footing as SM, and the target of the Commonwealth Games in Glasgow in 2014 means that pragmatism and "getting things done" appears to be the dominant thought mode.

## 7.5 Overall conclusions

We conclude from our analysis of all data collected that risk perception is not the impediment to the implementation of NSMs that we considered it might be at the outset of this research.

From what we have learnt, economic efficiency may be such an impediment, and that judging this efficiency is difficult and may be the reason for the low levels of measured efficiency. On the other hand it appears that most NSMs that we investigated are effective in the tasks that they are set, in terms of promoting public safety and the recovery from flood events. They are also effective at pre-flood risk reduction, especially spatial planning.

However, the levels of implementation of NSM appears often to be low. Take-up levels are often only poor. There are a number of reasons why this is the case, including professional biases, inadequate policy strength, limitations in the appraisal system, etc. However, where there is the commitment to implementing NSMs (as in Scotland) they can be implemented.

# 8. Recommendations

There are just four recommendations that follow from this research and its results. They could act as a focus for future work and action resulting from the research:

5. Government and its agencies need to reinforce and clarify their **policies** with regard to NSMs, so as to build more confidence in their development and implementation;
6. Government and its agencies need to ensure that the **appraisal system** for decision making, as it evolves, does not discriminate against NSMs as it appears to have done in the past;
7. Government and its agencies need to develop **better data and information on the costs of NSMs** against which to compare their efficiency and effectiveness
8. Government and its agencies need to work to remove **the other impediments** to the development and implementation of NSMs that we have shown inhibit their use, including professional opinions and preferences, funding arrangements, and the appraisal system and the data on the benefits of NSMs that it uses.

## References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

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