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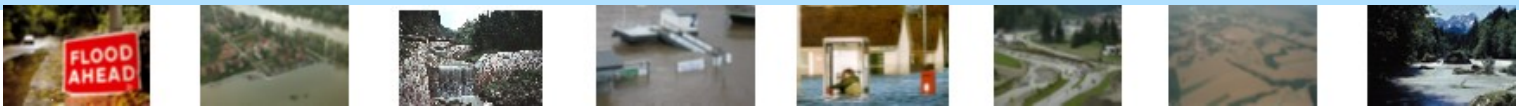

CRUE Research Report No I-1:

Systematisation, evaluation and context conditions of structural and non-structural measures for flood risk reduction

FLOOD-ERA Report for England and Scotland

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Project Contract No: ERAC-CT-2004-515742
Project Website: www.crue-eranet.net

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Published in October 2008

ERA-NET CRUE is 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

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1 Introduction

1.1 The report's rationale

The rationale for this report is to document the results of the UK element of the FLOOD-ERA project (see the **Annex** herein for the England and Scotland project's **Terms of Reference**).

This 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.

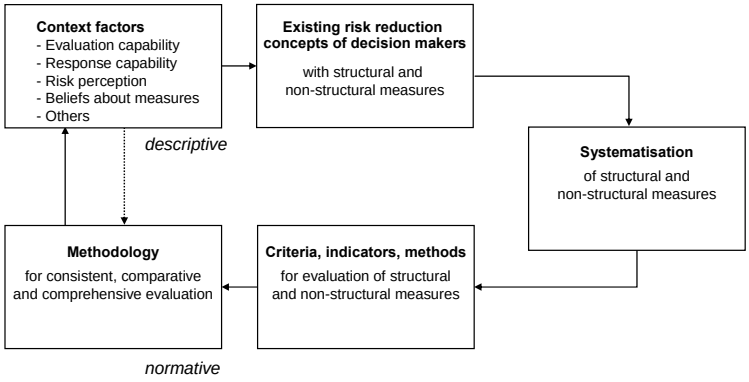
The theoretical or conceptual framework for FLOOD-ERA is that decisions about deploying structural (SM) and non-structural measures (NSM) for flood risk management are made under the manifold contextual conditions of decision makers. One of the contextual factors is the availability of appropriate evaluation 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:

- 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 (see Figure 1.1). Research encompasses the derivation of generic conceptual findings and empirical work in six European case studies in Germany, United Kingdom and Austria.

Figure 1.1: FLOOD-ERA: The key elements of the research design



1.3 The wider CRUE context: flood risk in Europe

In recent years, Europe has suffered a number of severe river and coastal floods that have caused loss of life and damage to property. The Rhine and Meuse floods occurred in 1993 and 1995, the Oder flood occurred in 1997, and there were large floods in northern Italy in 1994 and 2000, on the Elbe flood in 2002 and in the UK in 2000 and 2007. The Elbe floods of 2002 caused about € 15 billion of damage and the July 2007 floods in England about € 6.5 billion in damage. Both events were considered by many to be national disasters.

The UN estimates that 1 billion people live in the path of potential flood disasters, and flooding is the most widespread natural hazard in Europe. More river embankments and building on flood plains, as well as drainage improvements to provide more agricultural land, mean that heavy rain is less likely to soak away into the ground. Mountain deforestation also contributes to the risk of flash floods, which is increasing as weather patterns become more extreme. Coastal changes and rising sea levels are exposing the hinterland to flood risk: in the Netherlands, half the population lives below sea level. Flood disasters, such as from the central European rivers in 2002, caused loss of life, intense human misery and significant economic damage. Climate change is almost certainly increasing the risk of such catastrophes.

The scale of the problem in Europe has prompted government agencies to commission considerable research. Sometimes within a single country, several organisations, such as agricultural and environmental agencies, research councils and water boards, may carry out uncoordinated programmes. One of the aims of CRUE ERA-NET is to reduce this fragmentation by synthesising information on Europe's flood risk management research programmes and enabling partners to share insights into flood risk management. Flood processes and mitigation measures often apply to similar situations in different countries and a given flooding event can cross national frontiers. Co-operation within and between national programmes – on research, prevention and mitigation – should therefore enhance the effectiveness of flood management.

National EU governments have responded with research into flood risk management and mitigation, but there has been little coordination of their programmes. CRUE ERA-NET aims to introduce more structure within the area of European flood research by improving co-ordination between national programmes[1]. The vision for the CRUE ERA-NET action on flooding is to develop strategic integration of research at the

[1] http://www.crue-eranet.net/

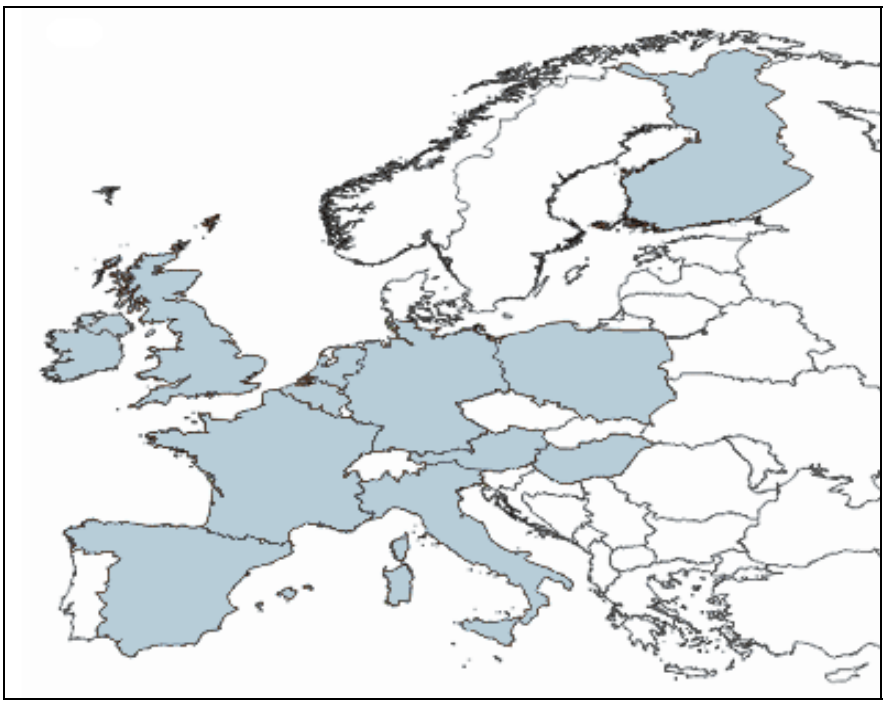
national funding and policy development levels within Europe to provide knowledge and understanding for the sustainable management of flood risks.

The CRUE network (Figure 1.2) has been set up to consolidate existing European flood research programmes, promote best practice and identify gaps and opportunities for collaboration on future programme content. Its thirteen partners come from most European countries that have been particularly badly affected by flooding. By supporting best practice and the spread of knowledge, they hope to improve flood management in their own countries and the rest of Europe.

Coordination within the CRUE ERA-NET should strengthen the European Research Area making it a more integrated structure. CRUE's network of funding organisations at national and international levels should prevent duplication of projects and help collaboration on planning. It will disseminate the results of nationally funded programmes and national calls for new proposals. Systematic exchange of information about good practice and past research results, and the promotion of relevant new research, should ultimately give greater security to all citizens who live in areas of flood risk.

The CRUE network could be an important tool for making European and national flood risk management policy. Policy-makers set the context and priorities for research, while the network's results should inform policy choices. Decisions are made about the sustainable development of river catchments and coastal defences. In the future, we should be able to manage Europe's many transnational river basins, such as the Rhine, the Scheldt and Tiska better as a result of the work of CRUE.

Figure 1.2: The CRUE network member countries



1.4 Constraints and limitations

This report needs to be seen in context. It reports on FLOOD-ERA results for just two countries (England and Scotland) and therefore cannot match the breadth of the main FLOOD-ERA report (Schanze *et al*

2008). Also the results cannot be separated from the limitations imposed by the data that could be collected in the timescale of the research, and the interviewees that were available to our researchers.

Nevertheless we believe that the results here show that the implementation of NS flood risk reduction measures is more complex than had hitherto being appreciated, and that extra effort is required if these measures are to stand alongside more traditional engineering measures and make a fuller contribution to making flood risk areas a safer place in which to live and work.

The nature of this 'extra effort' is elaborated in our conclusions and recommendations and focuses on policy makers and flood risk managers seeing NS measures as equally valuable in reducing flood risk when compared with the more traditional SM. In essence these NS measures need to be more professionally acceptable, more easily appraised, and more readily funded.

2 Systematisation of existing flood risk management concepts: Analysing management concepts at programme level for deploying non-structural measures

2.1 Introduction

This chapter is aimed at Workpackage 1, Activity 2, Action 1. It 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.

This report initially considers non-structural measures at the individual, option level, but subsequently moves more to the programme level. In this paper 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.

2.2 Genesis of research and practice in non-structural flood management measures

There is a very considerable body of international research knowledge and management experience in flood management measures. This body of knowledge and experience is characterised by different, and often unique, environmental and cultural experiential roots and settings. For example, measures may have been used for millennia in the Yangtze valley of China or the Ganges valley in India, and indigenous approaches to floods are centuries old in the swamps of the Mississippi delta in North America. As time passed, knowledge and practice has also evolved in an increasingly eclectic and intersecting manner. For example, Dutch experience of dike building and water management was transferred to areas around the North Sea basin such as the East Anglian fens in England, and also further afield to countries such as Bangladesh.

Today much of the richness in approaches to managing floods derives from the development of different disciplinary contributions and perspectives. These range from the engineering (Wright 1996) to the behavioural and communication science traditions (Quarantelli 1980, Rogers and Sorensen 1988); and from architectural (Davis 1981, 1986) to socio-cultural and anthropological approaches (Winchester 1992; Torry 1979). This diversity of disciplinary perspectives and approaches poses some of the most interesting questions regarding option choices for the future. Different disciplines commonly approach flood mitigation from very different angles which lead to different issues being of central concern. In turn this leads to radically different approaches to flood mitigation, and non-structural measures are a central element in this difference.

The earliest work to recognise a class of flood hazard reduction measures which could be collectively called ***'non-structural'*** originated in the United States in the 1940s and 1950s. This was the first attempt to systematise these measures. Non-structural measures emerged in a management context which was largely in opposition to structural measures. The latter had dominated US flood management policy under a ***flood control paradigm***. Two pioneers of flood management, a Geography professor named Gilbert White from the University of Chicago (and more latterly from the Institute of Behavioral Science, University of Colorado) (White 1945, 1964), and an engineer named James Goddard from the Tennessee Valley Authority (Goddard 1958, 1960) contributed to this development. Goddard (1969) developed the concept of ***floodplain management*** which importantly, and cleverly (so as not to antagonise engineers), embraced both structural and non-structural measures, rather than just promoting the latter.

White's approach to flood management was based upon an ecological philosophy (a personal life-long interest of his) which focused upon human adaptation, and ***human adjustment***, to the environment and the hazards it presented (Table 2.1). Although at this time ***'non-structural'*** measures were being employed on a piecemeal basis in other countries including in Europe, it was American geographers and engineers who first synthesised and differentiated programmatic options (e.g. those in the heading of Table 2.1) bringing together the theoretical range of choice of flood adjustments.

The next stage in the development of research and practice relating to non-structural measures witnessed a series of in-depth evaluations often focusing on ***particular*** **non-structural measures** (e.g. floodplain regulation -White et al. 1958, Murphy 1958; flood proofing- Sheaffer 1960; James 1965 – non-structural measures; Kunreuther and Sheaffer 1970 – flood insurance; McLuckie 1970 – warnings).

The management context of this era is important. It was becoming clear in the United States that many decades of investment into structural flood control measures was failing to control rising flood losses. Structural measures were championed notably by the US Army Corps of Engineers which had been committed to a 'levees-only' policy in the first part of the twentieth century (Parker 2000, 295-96). In retrospect the rise in flood losses reflected rapidly rising standards of living as well as problems with the reliance upon the flood control approach.

Non-structural measures gained currency as sole reliance upon structural approaches began to be discredited. White formulated recommendations to the US Congress on national flood plain management (US Congress 1966). This led to the sea-change in US flood policy which was the 1968 National Flood Insurance Act. Under the flood insurance management approach, federal flood insurance was only made available to those who owned properties in local areas which had agreed to adopt land use zoning ordinances.

The latter were designed to prevent further floodplain development. Since then, despite many problems, the federal flood insurance program has been a mainstay of US flood management policy. This reflects a more balanced structural and non-structural approach in the US. In this balanced approach 'flood control' is traditionally a federal concern, and the effectiveness of non-structural programs, partly except flood insurance, depends mainly upon state and local government initiatives. Even so, as demonstrated by emerging plans to address flooding problems in New Orleans after hurricane Katrina, all too often the '***default option***' continues to be structural measures.

Table 2.1: The theoretical range of human adjustments to floods (after, Porter 1978)

Modify the flood	**Modify the damage susceptibility**	**Modify the loss burden**	**Bear the loss**
Flood protection	*Floodplain management*	*Redistribute losses*	*Bear the loss*
Dikes	Land use regulation	Disaster relief	
Floodwalls	Urban renewal	Flood insurance	
Channel improvements	Government property purchase	Reconstruction grants	
Floodways	Subsidised relocation	Tax write-offs	
River diversions			
Reservoirs			
Watershed management	*Flood proofing*		
Terracing	Use of impervious construction materials		
Gully control	Land elevation		
Bank stabilisation	Construction on stilts		
Forest fire control	Installation of removable covers for windows and doors		
Revegetation	Closure of sewer valves		
Weather modification	*Emergency measures*		
Storm seeding	Flood fighting		
	Flood warning		
	Evacuation		

A significant distinction emerged during this period in research into flood management measures between ***individual*** and ***collective*** flood management measures (Kates 1970). This distinction was connected to interest in human perception of floods and flood risks, and the factors which led to individuals either taking or not taking hazard reducing measures (Kates 1962). In the United States, perhaps much more than in Europe, individual initiatives were to the fore. The pioneer spirit and philosophy often led to individual property owners taking their future into their own hands. They might typically raise their property on stilts or build levees around their own land lot. Today it is clear that floods may be most effectively managed by a combination of individual and collective measures. The balance between the two is usually strongly influenced by the dominant political culture. Political culture can be crudely characterised on a bi-polar scale (Figure 2.1). On such a bi-polar scale, England and Wales would probably be towards the right of centre (emphasising self-reliance and its facilitation by government and the flood defence agency; based upon a widespread property ownership culture). Many other European countries (e.g. Germany, The Netherlands) would be to the left of England and Wales, partly because property ownership is less popular in these countries. Also many continental European countries have developed a flood compensation culture where there is currently less emphasis on self-reliance than in England and Wales. In some respects, the US would be to the right of England and Wales, as might be countries in south-east Asia where for cultural reasons individuals have a tradition of self-help and where

governments have traditionally been inactive. Ultimately, however, such characterisations are inadequate. Countries evolve complex mixes and hues of collective and individual flood management policies which places them at various points on the scale rather than at just one location on it.

2.3 Subsequent management perspectives and concepts

Since the early systematisation of flood mitigation measures emanating primarily from North America, structural and non-structural measures have been categorised in a wide variety of ways. Penning-Rowsell and Peerbolte (1994, 6) sought to draw attention to the wide range of flood management options available to address the flood problems of Europe. The context was the mid-1990s and the EU funded EURO flood research project which started from the perspective that across Europe there was a patchwork of flood management policies and practices which badly needed to be understood and evaluated in order to identify best practices. Overall, Penning-Rowsell and Peerbolte observed that in Europe there had been many centuries of efforts to ***conquer*** the forces of nature, and that the public had begun to believe that, on the whole, Europeans were in ***control*** in the flood field. Secondly, they observed that the reality this belief was flawed and that Europeans were not in control. To draw attention to the alternatives to flood control, they therefore used a categorisation which distinguished between measures which control a) water b) land use and c) provide financial relief and loss reduction (Figure 2.2).

Parker (2000, 15) identified three separate hazard-producing factors which are important to recognise in mitigating floods: a) flood risk b) flood exposure and c) flood vulnerability (Figure 2.3). Again he did so in order to draw management attention to the alternatives to structural flood alleviation measures. He also wished to raise the profile of a perspective which presents floods as a predominantly human, rather than a physical, problem. This is because all too often human causes and response to floods receive far too little attention. ***Flood risk*** is best described by a combination of flood probability and flood consequences. ***Flood exposure*** is the people and property located in the floodplain, and the social and economic activities which a flood may disrupt within the floodplain and extending outside of it. Exposed properties and activities have different levels of ***susceptibility*** to flooding.

Figure 2.1: Contrasting political-cultures and collective and individual flood management measures

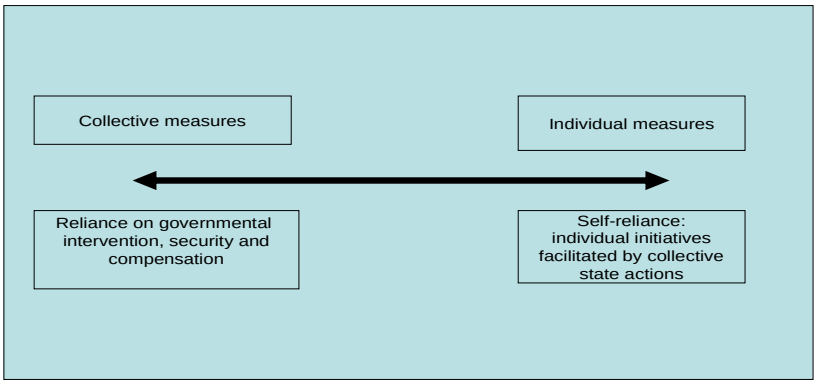
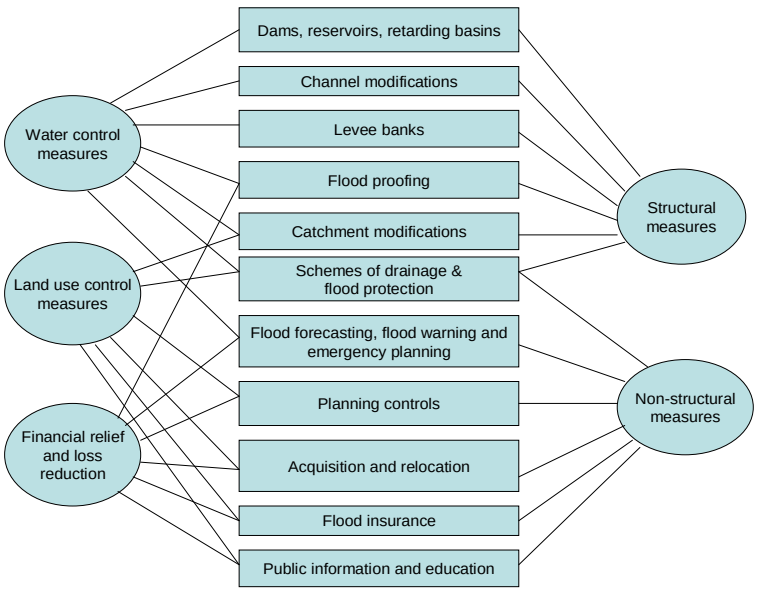


Figure 2.2: Flood mitigation measures categorised according to water control, land use control and financial relief and loss reduction potential (after Penning-Rowsell and Peerbolte 1994)



Flood vulnerability is often confused with flood exposure. But in social science, and cultural and development studies an important, particular and definite understanding of vulnerability has evolved which should not be ignored. Vulnerability is a social concept and refers to the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard (Blaikie et al. 1994; Cannon 2000; Winchester 2000; Parker 2000, 30). In general, flood mitigation has evolved initially by addressing flood risk, and subsequently flood exposure. Often flood vulnerability is weakly addressed by flood agencies, or totally ignored. This is mainly because social measures often lie largely or completely beyond their statutory remit and disciplinary competence. Secondly, measures to counter flood vulnerability are interpreted in a non-social or 'asocial' context, so that vulnerability becomes applied to buildings and infrastructure rather than the social characteristics of the flood-prone population. But Parker and others argue that the each of flood risk, flood exposure and flood vulnerability need to be addressed to successfully counter flooding problems.

Flood adjustments – both structural and non-structural - can be considered individually (as in Table 2.1) or at a programme or strategic level. Tobin and Montz (1997, 202) produced a programme level typology of natural hazard policies based upon three criteria: levels of government, means of achieving goals, and timing with regard to extreme events. Figure 2.4 illustrates how these elements fit together and represents the theoretical range of implementation strategies. The management context of this categorisation is the American governmental system. This has three tiers of government: federal, state and local. The action is concerned with how higher levels of government can influence lower levels of government into their chosen actions. The management context may be partially relevant to parts of Europe (e.g. Germany).

In practice some elements (i.e. blocks in Figure 2.4) are employed more than others. ***Three levels of government*** are identified but there could be more. Where policies are implemented through a partnership between levels of government, shared government or governance takes place. Recovery and relief are examples of ***post-event measures*** and warning processes are examples of ***pre-event mitigation***. The regulatory approach is concerned with standards and requires compliance. Mandates are orders or charges that may or may not be related to specific regulations. Program activities (as distinct from programmes) can be viewed as tactics available for executing an implementation strategy, and these can be mandated or cooperative in nature.

Figure 2.3: Flood mitigation measures categorised according to flood risk, exposure and vulnerability reduction potential (after Parker 2000)

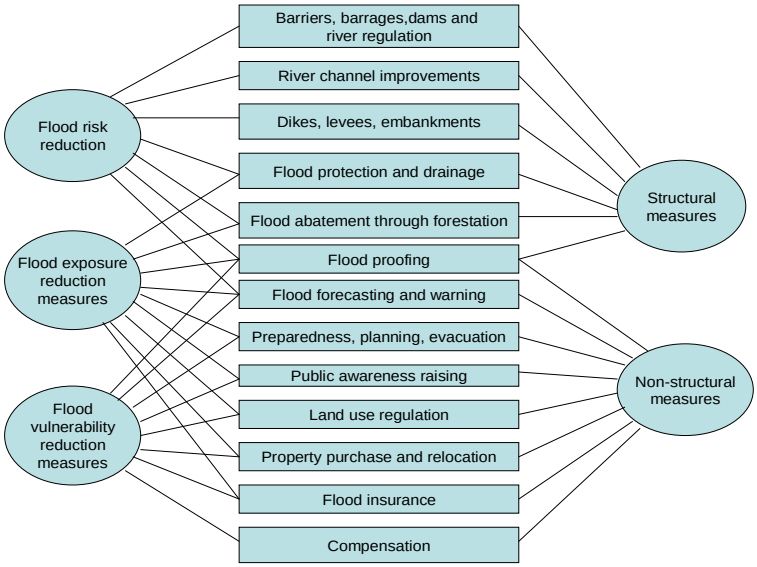
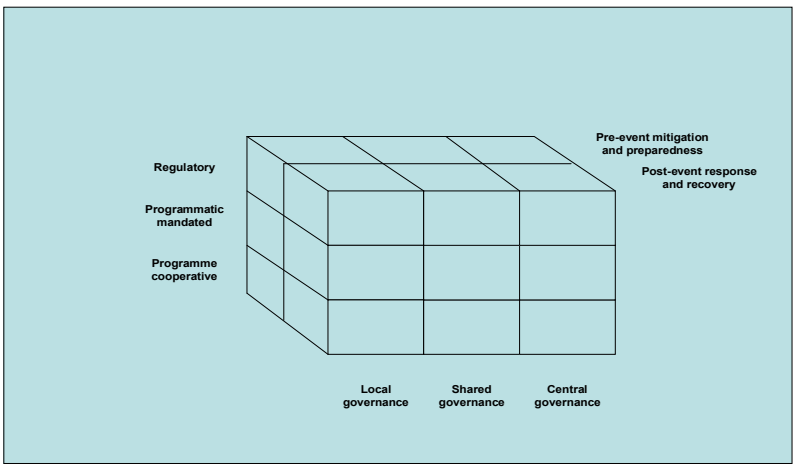


Figure 2.4: Types of natural hazard policy focusing upon the programme level and implementation (from Tobin and Montz 1997)



This inter-governmental management context comes across strongly in an international study of inter-governmental hazard mitigation. May et al. (1996) distinguished carefully between ***coercive*** *(i.e. mandatory)* and ***cooperative*** measures or policy designs for hazard mitigation including flooding (Table 2.2). Coercive policies are highly paternalistic. They build upon the idea that governments know the appropriate actions to be taken by lower level governments, and seek to compel these lower level governments to take action. On the other hand, cooperative policies are based on the idea that lower level governments should know best what measures to take. These ideas are discussed further below in relation to government policies and individual property owners.

Judging performance here is important to any evaluation of SM and NSMs: examining the outcomes that result in relation to the aims/goals of the measures. This '***performance***' is the management context of a recent study of non-structural flood mitigation options which has been completed as part of the Thames Estuary 2100 project for the Environment Agency (the flood risk management agency for England and Wales) (Environment Agency 2006). The idea, explored further below, is that non-structural measures differ in their performance (i.e. outcomes compared with aims/goals), and that these differences should be used to guide decision-making. In this study non-structural measures are also explicitly linked to a ***spatial planning context*** and are classified into three categories: they are those for a) managing flood events, b) spatial planning for existing development and c) spatial planning for new development (Table 2.3).

2.4 Recent management contexts and concepts

The most recent perspectives on flood mitigation measures have tended to cast them within wider management policy frameworks and initiatives. These wider policy frameworks are important management contexts in which approaches towards non-structural measures are set and shaped. They profoundly and subtly affect the direction from which management initiatives and momentums derive, how non-structural measures are considered in management terms, and the criteria used to evaluate them.

2.4.1 Vulnerability and sustainability analysis

One such approach arises from the critique of flood disaster vulnerability predominantly, but not only, in the developing world, and calls for a paradigm which centrally addresses ***vulnerability reduction*** through political change, reform of economic systems, and greater democracy and equity (e.g. Blaikie et al. 1994). Within such an approach non-structural measures, especially those associated with financial relief and resilience building, are central. Criteria such as protection of livelihoods, sustainability, resiliency, appropriate technology, ease of maintenance, and equity are much to the fore in this approach.

A second approach stems from the reassessment of natural hazards in the United States (Mileti 1999), and includes lessons drawn from experience with the 1993 Mississippi floods (Changnon 1993, 2000). This approach calls for ***sustainable strategies for flood mitigation*** (Myers and Passerini 2000). A third, and related, approach stems from changes in the paradigm environment of flood hazard reduction and the growth in interest in ***sustainable development***. Criteria such as acceptable levels of risk, local capacity building, local citizens taking responsibility, promotion of disaster resiliency, intra- and inter-generational equity are emphasised in this approach. A variety of hazard researchers and practitioners have concluded that models of sustainable development provide a basis for significantly reshaping flood hazard and disaster reduction strategies (e.g. Penning-Rowsell 2000; Handmer 2000; Godschalk et al. 1999; Burby 1998; Adger 1998).

Many of the underlying ideas were promoted by the Bruntland Report (World Commission on Environment and Development 1987) and the Rio Summit of 1992 and their forerunners.

Table 2.2: Intergovernmental hazard mitigation policy designs (after May et al. 1996, 4)

Features	**Coercive policy design**	**Cooperative policy design**
Role of lower-level governments (state, regional, or local)	*Regulatory agents*: Enforce rules or regulations prescribed by higher-level governments	*Regulatory trustees:* Develop and apply rules that are consistent with higher-level goals
Emphasis of intergovernmental mandate	Prescribe regulatory actions and process. Specify regulatory actions and conditions along with required process or plans	Prescribe process and goals. Specify planning components and considerations, along with performance goals
Control of lower-level governments	Monitoring for procedural compliance. Enforcement and sanctions for failing to meet deadlines, for not adhering to prescribed process, or for not enforcing prescribed policies	Monitoring for substantive compliance with more limited monitoring for procedural compliance. Monitoring systems for assessing outcomes and progress toward them.
Assumptions about intergovernmental implementation	Compliance is a potential problem. Need for uniformity in application of policies	Compliance is not a problem. Need for local discretion in policy development.
Source of policy innovation	Higher level governments	Lower level governments
Implementation emphasis	Inducing adherence to policy prescriptions and regulatory standards. Building 'calculated' commitment as a primary means of inducing compliance.	Building capacity of subordinates to reach policy goals. Enhancing 'normative' commitment as a primary means of inducing compliance.

Table 2.3: Categorisation of Non-Structural Measures employed in the Thames 2100 study (Environment Agency 2006)

Category	**Measures**
Managing flood events	Pre-event measures • Public awareness raising • Flood response planning • Flood response exercises • Business continuity planning • Contingency planning including the flood recovery phase
	Flood forecasting and warning • Detecting environmental conditions that cause flooding • Predicting how environmental conditions are developing • Forecasting flood levels and timing • Interpreting how communities are likely to be affected • Timely communication of messages to those who need warning of an impending flood
	Flood fighting • Property-level demountable/temporary defences • Emergency repair of failing defences • Emergency diversions of floodwater into green grids/local watercourse • Pumping water out of basements • Making breaches in secondary banks, informal flood defence walls etc. to lower flood levels
	Collective-scale damage avoidance actions • Formal/informal evacuation • Removal of assets, including cultural assets • Erecting temporary defences • Rescuing people • Opening rest centres • Traffic management measures, including road closures • Operating helplines • Moving resources into the affected area • Maintaining some degree of access • Turning power off to areas most badly affected
	Individual-scale damage avoidance actions • Moving valuables • Installing temporary defences • Installing sandbags • Moving cars • Avoiding travel through the flooded area
Managing Flood Losses	Land use management / spatial planning • Voluntary relocation • Encouragement for public purchase of property, and the need for punitive flood insurance premiums • Compulsory legislation to enable compulsory purchase of property
	Flood proofing • Permanent flood proofing • Temporary flood proofing
	Land use/spatial planning

Category	Measures
	• Planning guidance on flood risk areas • Design and specification to restrict new development in flood risk areas
	Building codes • General building codes • Individual property design • Development control rules
Flood recovery	Insurance, shared risk and compensation • Government programmes • Private insurance provision
	Health and social measures • Measures to reduce health and social impacts

They encouraged governments to incorporate sustainable development principles in national policies, and to make policy and practice linkages between natural hazard policies and sustainability.

2.4.2 Policies of making space for rivers ansd water

Recent flood mitigation policy initiatives have tended to emphasise finding ***ways of giving space for rivers and water***. For example, in England and Wales, the government's most recent flood management initiative is called 'Making Space for Water' (DEFRA 2005). The Netherlands has adopted a very similar policy of founded on the idea of making space for rivers. These ideas are not new but have been rediscovered during an era when their relevance has become heightened by various factors. These include population growth, migration, economic growth and climate change, and policy-makers are searching for 'new' ways of addressing these mounting issues. Interestingly, there was a huge debate in the mid-19th century about how to deal with flooding on the Mississippi river that involved a levees versus 'give the river its space' controversy. The levee lobby won (Barry 1998).

Discussions held in late March 2007 in New Orleans about the flood and hurricane management strategy to adopt for New Orleans in the post-Katrina era have been reconsidering the making space for the river approach. However, the current approach is almost totally based on restoring and improving the levee protection for the city, with non-structural measures currently receiving very little attention (Personal Communication with R. Burby, 3 April 2007). The making space for water/rivers initiatives, introduced in north-west Europe into some of the most densely-populated regions of the world, reflect a recognition of the apparent inevitability of climate change induced sea level rise and increased river discharges, and the need to find ways of accommodating both human activity and floodwater within floodplains and coastal flood zones. They therefore emphasise increasingly subtle and innovative combinations of structural and technological measures, and non-structural measures. They focus on wise use floodplains, flood storage, increasing resilience of both buildings and people to floods, improving local knowledge and capacities, and equity.

2.5 Rethinking non-structural measures from a management perspective

There is a constant need to rethink flood management concepts and strategies in order to bring about their evolution towards effectiveness. Also the management contexts in which such concepts are positioned are constantly shifting (Parker (2000, 295). Strategies which are believed to be effective can subsequently, and quite rapidly and disappointingly, be revealed as ineffective or inappropriate given

lessons from fresh flood experiences, post-flood evaluations and the emergence of new management paradigms and contexts which introduce new aims and criteria.

Figure 2.5 identifies some of the key management contexts which commonly surround and influence the consideration and/or implementation of non-structural flood measures. These management contexts all influence the direction from which initiatives emanate and the criteria (and weighting of criteria) used to evaluate flood measures. Clearly, climate change is currently a high profile management context. Figure 2.5 is not exhaustive and other management contexts, including economic integration in Europe, might be equally if not more important, depending upon circumstances. In England and Wales, addressing the requirements of those with special needs (i.e. the disabled, hard-of-hearing etc.) is a management sub-context in which a new multi-media flood warning dissemination system has been launched by the Environment Agency.

As post-event evaluation, or hindsight review, has become more common, so ***collaborative learning*** has become more important as a management context in which decisions are made about non-structural measures. For example, in the case of flood warnings and flood event management, collaborative cross-organisational learning has become crucial in addressing shortcomings of flood warning and emergency response systems. The critical review of the Environment Agency's flood warning system, and the related multi-agency emergency response, to the Easter 1998 floods in England and Wales is a good example (Bye and Horner 1998) which has created momentum for many improvements since these floods. Indeed, Australian flood warning researchers and practitioners have enshrined the process of collaborative learning within their concept of ***total flood warning systems*** (Emergency Management Australia 1999).

Integrated river basin management is an important management context in which flood mitigation measures, including non-structural measures, are considered in the large river basins of Europe such as the Rhine, Rhone and Danube. The EU's Water Framework Directive sets out expectations regarding river basin planning in EU member states and provides a basis for basin management plans in which flood risk management measures are to be embedded.

Economic and social regeneration is the management context in which flood risk management in the Thames estuary on Lee Valley in London (the latter being the 2012 Olympics site) is currently being considered. Economic and social regeneration is increasingly a management context within which flood mitigation is embedded.

The various management contexts shown in Figure 2.5 are linked in complex ways, and it would not be uncommon for non-structural flood mitigation measures in any area to be embedded within a number of management contexts at the same time.

The criteria which are commonly employed in evaluating non-structural measures (Table 2.4) are generally specified. In practice much will depend upon the particular circumstances in which the measures are being considered, and this location-specific context will usually draw in further considerations.

Figure 2.6 shows how management context influences the selection of evaluatory criteria, and how these in turn influence flood management programmes (there are two: A and B) and mitigation options.

Figure 2.5: A typology of management contexts in which non-structural flood measures are commonly considered and/or implemented

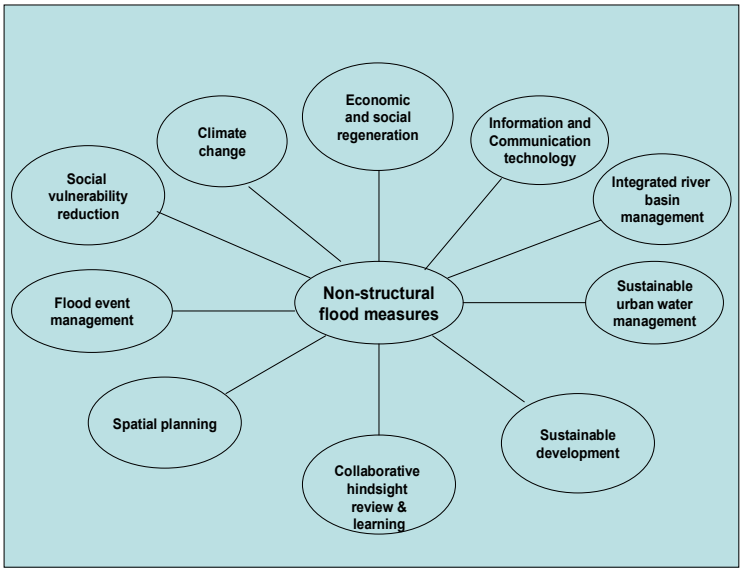
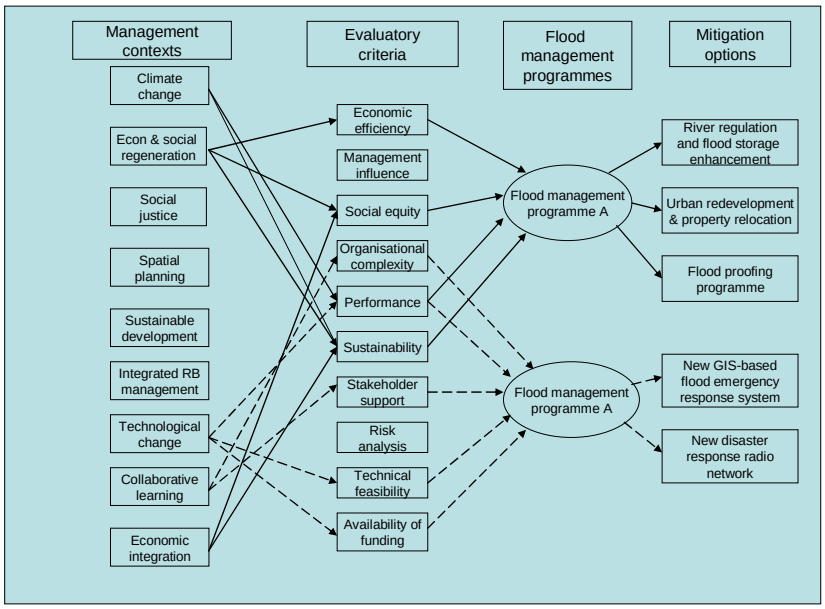


Figure 2.7 is '***management influence'*** typology of non-structural measures. In practice, flood risk managers and the political decision-makers above them, are often very concerned about the extent to which non-structural flood mitigation measures can be 'controlled' or 'influenced' by flood mitigation agencies. This 'colours' a) the extent to which non-structural measures are employed as opposed to structural measures and b) the non-structural options selected for implementation. ***Managed collective measures*** and ***levered behavioural measures*** are therefore often 'popular' with flood risk managers, but there is some reluctance to rely upon ***community-based measures*** and ***behavioural measures***.

Table 2.4: Criteria commonly employed in deciding upon deploying non-structural flood mitigation measures (with some commonly applied evaluation techniques in brackets)

- Fit with statutory duties and responsibilities *(legal judgements)*
- Fit with management policy context, goals and objectives *(techniques of policy analysis)*
- Feasibility, complexity and availability of funding
- Economic efficiency and effectiveness, and timing of implementation *(e.g. BCA; MCA; etc)*
- Environmental effects
- Social equity effects
- Technical feasibility
- Sustainability including maintenance costs *(e.g. whole life cost analysis)*
- Availability of any specialist expertise required
- Degree of management influence
- Locus of management
- Inter-organisational complexity
- Perceived performance and effectiveness *(e.g. in-depth interviews, such as for the case studies herein)*
- Data on performance and effectiveness *(e.g. in-depth interviews, such as for the case studies herein)*
-

Figure 2.6: How management context affects the selection of flood management programmes and options



Management interest is in 'transferring' behavioural measures into the 'levered' or 'managed' behavioural measures category by developing incentives for appropriate behaviours to be adopted. American flood risk managers adopted this approach when they made the sale of federal flood insurance to floodplain occupants conditional upon their local community accepting floodplain land use regulations, and this is one area where innovation in non-structural measures is always being sought.

A variant of the 'management influence' typology (Figure 2.7), concerns the extent to which the power to introduce and implement non-structural flood mitigation measures lies within the statutory duties and remit of the flood risk management agency or outside of it with some other agency (Figure 2.8). The distribution and boundaries of powers relating to non-structural measures (i.e. ***the locus of power***) is likely to vary somewhat between countries because their legal and organisational arrangements will differ, but will often be a consideration in whether or not to employ non-structural measures.

Figure 2.8 is based upon England and Wales. Here, flood defence and planning agencies are quite separate, and the planning agency has superior powers over land use planning decisions, including floodplain development controls. Control of flood warning dissemination has been moving from outside of the flood defence agency to inside it as a consequence of Ministerial decisions and therefore this non-structural measures is located somewhere in the centre of the power continuum in Figure 2.8 (in one region the police still disseminate flood warnings).

Figure 2.7: A 'management influence' typology of non-structural measures

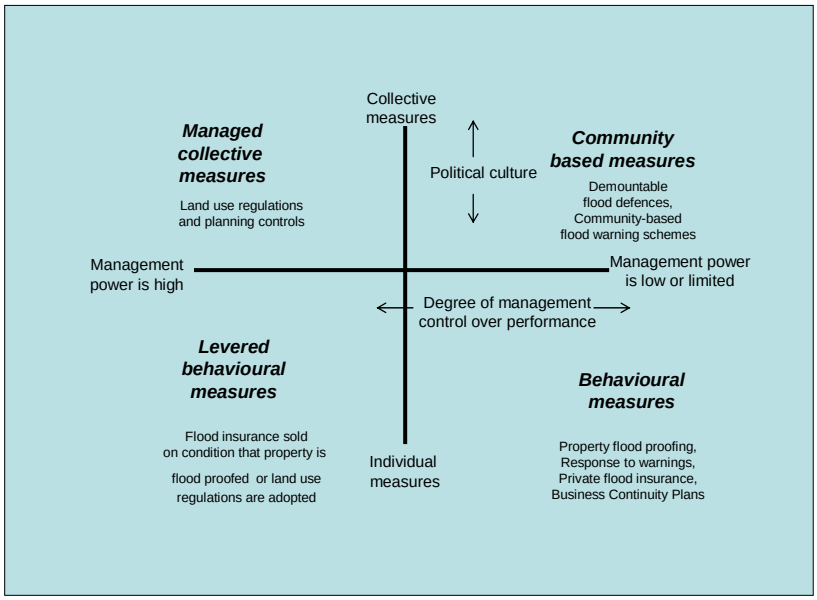
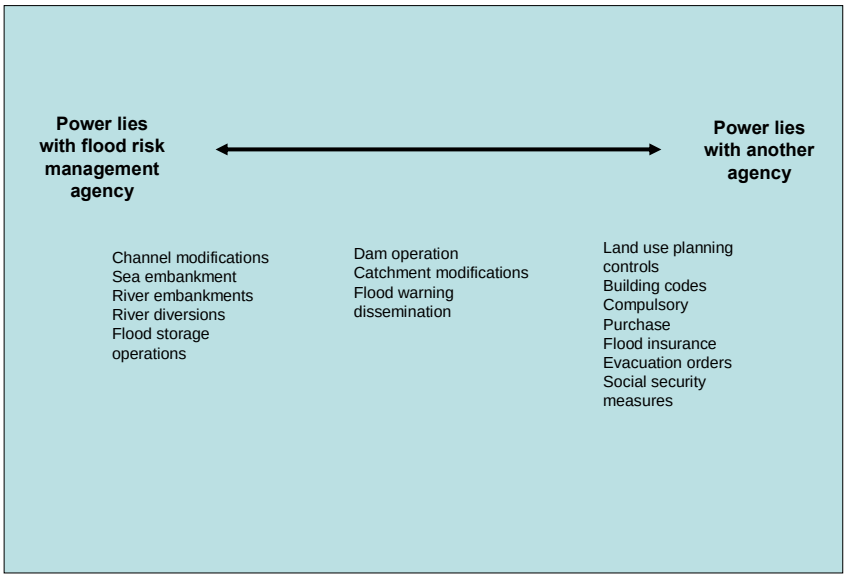


Figure: 2.8: Locus of power model of flood mitigation measures



Non-structural flood mitigation may sometimes come about as a consequence or side-effect of a policy initiative emanating from outside of the flood defence agency, and not aimed principally at flood risk management. This was the case in 1947 when England and Wales adopted a universal land use planning control system in which the building of most types of property became subject to planning consent. The motivation for this land use management policy was largely the prevention of urban centres coalescing and countryside protection. But these measures also provided an important means of controlling development in floodplains and have been responsible for slowing floodplain development.

Funding is a crucial management issue in flood risk management, and often constrains what can be achieved. Innovation in funding models for flood risk management has become a key concern, especially where there is insufficient funding available for measures to be implemented satisfactorily. Choice of flood risk management measure is often strongly influenced by funding feasibility. For example, in England and Wales funding for individual property flood proofing is difficult to find, and this has held back flood proofing compared with other measures such as large-scale engineering works. Figure 2.9 categorises flood risk management measures using two axes – funding source (private-shared-public), and whether measures are collectively or individually implemented. Non-structural measures are represented in all four quadrants of the diagram, and therefore there are four categories of such measures.

Flood mitigation is often viewed as a 'public good' because its provision is usually indivisible (e.g. a structural flood defence project for a town may provide flood protection for all rather than selected individuals). It is usually argued that funding for public goods should be publicly-sourced with the state taking the management lead. How far state funding should extend is always fairly controversial, and tends to differ from nation to nation. To take just one example relevant to the role of public funds for public goods, many EU states provide compensation for flood losses from their taxation-based public

funds. However, in England and Wales, with some very limited exceptions, the tradition is that public funds are not available for this purpose: this is not advocated as a role for the state and its public funds. Apart from tradition, in England and Wales the Treasury and DEFRA (the central government ministry with flood risk management responsibilities) would probably argue that such compensation unhelpfully interferes with the forces that discourage people from locating in flood risk areas, and is therefore counter-productive to flood risk management goals.

In management terms, in common situations where it is difficult to bring about change or to develop real momentum with a particular policy and its implementation, the concepts of ***coercion*** and ***cooperation*** extensively analysed by May et al. (1996) (see above) are very interesting. In financial terms coercive measures are usually considered to be ***transfer payments*** i.e. either taxes or subsidies ('sticks' and 'carrots'). This might be extended to ***financial penalties*** and ***incentives***, in addition to taxes and subsidies. Flood risk management measures can be considered solely from such perspectives (Table 2.5), but often such management approaches are under-developed or are politically infeasible to introduce.

Figure 2.9: Categorisation of flood mitigation measures according to funding sources and state/individual involvement

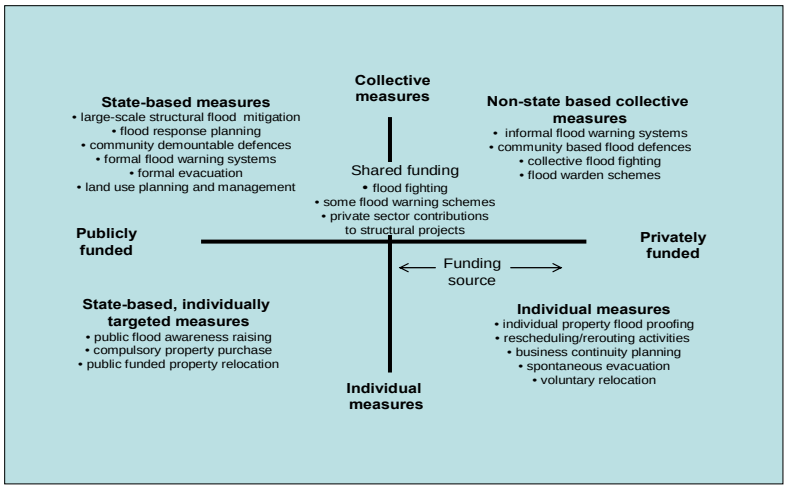


Table 2.5: Examples of possible flood management options considered from a transfer payment point of view [NB: these are not necessarily currently operational]

Flood management option	Possible tax or financial penalty	Possible subsidy or financial incentive
Structural flood mitigation project		Subsidy to flood risk management agency from central government, derived from general taxation
Land use zoning to protect floodplains from new development	Financial sanctions (e.g. fines) for local planning authorities not adhering to government rules or deadlines	Central government subsidised flood insurance provided to those individuals living in communities which adopt land use zoning regulations (as in the US Federal Flood Insurance program)
Discouraging continued location and occupation of floodplains	Floodplain tax levied on individuals locating and occupying flood plains	
Floodproofing		Lower insurance premiums provided by insurance companies for those individual property owners installing floodproofing measures to defined standards
Flood insurance		Government subsidised flood insurance schemes (as in the US Federal Flood Insurance program)
Compensation for flood losses		To individuals from government funds raised by general taxation

From a management perspective, the ***performance*** of flood risk management measures should be a significant factor in their selection and implementation. In the aftermath of events such as the Mississippi flood of 1993 (Changnon 1996), the Easter 1998 floods in England and Wales (Bye and Horner 1998), Hurricane Katrina and New Orleans (Daniels et al. 2006) post-event evaluations of the performance of flood mitigation measures has become very common. There is now a significant body of evidence on the performance of non-structural measures ranging from the federal flood insurance programme in the United States (May and Deyle 1998) to flood forecasting, warning and response systems in Europe (Parker and Fordham 1996), particularly in England and Wales (Parker et al. 2007). Table 2.6 provides one or many possible means of scoring the performance of non-structural measures which can lead to their categorisation into high, medium and low performance measures. However, when it comes to performance of these measures much depends upon a) local circumstances where the measures are deployed and b) the amount of energy put into implementing the measures and making them work to their full potential.

Table 2.6: An example of a performance evaluation method for non-structural measures which can lead to categorisation of measures by performance

	Performance variables					
Non-structural measure	Cost of deployment	Direct flood damage reduction	Indirect flood damage reduction	Intangible loss reduction	Public response rate	Affect on post flood recovery
Public flood risk awareness raising						
Flood warnings						
Flood fighting						
Evacuation						
Land use planning						
Flood proofing						
Flood insurance						

2.6 Concluding remarks

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.

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.

This section of this report has teased out some of the key characteristics and features of non-structural flood measures. It does so by categorising these measures in different ways, with the intention of leading to a deeper understanding of them.

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 (above) 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.

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3 Analysis of the policy contexts in England driving decision-making about structural and non-structural flood measures

3.1 Introduction

Through the analysis of documents, and with supporting anonymised interview evidence, this section of this report seeks to analyse and illuminate the national level policy contexts in which decisions about both structural and non-structural flood measures are made (see **Annex**). There is a particular interest in this 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 is particular so at the time of the writing of this report (late July 2007), when England has been 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 Policy contexts

In the previous report by Parker (dated April 2007 and entitled 'Analysing management concepts at programme level for deploying non-structural measures', policy contexts were introduced as 'management contexts' which might apply anywhere. These are a set of influences which commonly surround decisions about non-structural flood measures. In practice, there is little difference between management contexts and policy contexts, except that analysis of policy drills down deeper. A typology of these management contexts was introduced (Parker 2007, Figure 2.5) and is the starting point for this report which focuses upon England.

A **policy context** may be defined as follows:

'A field of influences which reflect an intention and/or course of action, or a set of closely inter-related intentions and/or courses of action, aimed at achieving a particular goal'.

These influences not only reflect intentions and courses of actions, but deeper underlying philosophies about the world, or change of the world. A context maybe considered as a web or a matrix overlaying and constraining or driving decisions, or it may be described as an agenda. We employ the concept of **policy agenda** below.

Policy agendas or contexts may be considered to be well or under developed, reflecting their state of evolution. Equally, policy contexts may provide a strong set of guides, drives and limits or a weaker, more ill-defined set. Policy contexts may also be 'direct' and 'frontal' in terms of their influence upon decisions, or they may be 'indirect' and 'oblique'.

Policy contexts should be viewed hierarchically. If we consider the highest level to be the European Community policy context, then we can distinguish national, regional and local level policy contexts, with each level interacting with other levels, often in top-down and bottom-up modes. Often, however, lower levels within this hierarchy are translations of higher level policy contexts. In this report we focus only upon the national policy context level, but it is important not to lose sight of the importance of policy contexts created at other levels.

This is especially so at this time in the UK where decision-making is being passed down – in a conscious process of devolution - to regional and city level governments. It is also important to recognise that in the flood risk management field there is a tension between national, regional and local decision-making.

In this respect, traditionally in England, decisions about flooding and flood management have been viewed as regional or local, with riparian owners and Regional Committees having a particular input (the latter supported by a legal role enshrined in legislation). However, more recently during the era of the Environment Agency, which contrary to wider trends has engaged in some centralisation of power at their now enlarged Headquarters level, some of this decision-making has been wrestled out of the hands of regional and local interests and placed in national hands. We would see a prime example of this being the decisions on the allocation of the 'block grant' for schemes being vested with the Agency's National Review Group (the NRG) rather than – as before – with the Regional Flood Defence Committees. Others would see that the (national) Agency is asserting a proper national perspective in priority determination.

National level policies have their own hierarchical structure. Figure 3.1 shows this, emphasizing that FRM policies tend to be subordinate to (and intended to be supportive of) wider goverment policy aims. The precise policy making foci for FRM in the UK (e.g. the Parliamentary EFRA Committee, etc) are not

included here, but are important at the 3rd tier level. Within the hierarchy, policies of very broad scope tend to be positioned at the top of this hierarchy, and policies with a narrower scope tend to be second or third order policies. Second and third order policies can sometimes be changed around depending upon the purpose of the analysis, and viewpoint.

'**Policy signals**' are very important and can be very effective in influencing decision-making. Each tier of policies contains policy signals which managers should respond to and which often set the latest management agendas at lower levels. In the race to get ahead, pro-active managers are alive to these policy signals and take them on board rapidly. Whether or not management is pro-active, reactive or inactive depends upon the management culture within key institutions.

National level policies can also be considered in the following way:

- government policies (policies of Government departments);
- policies of executive non-departmental government bodies (e.g. agents of Government such as the Environment Agency); and
- policies of national non-governmental organisations, such as the Association of British Insurers.

The policy field is also characterised by **overlapping policy agendas**. Figure 3.2 is an example from England.

Figure 3.1: Hierarchical relationships between national policies and the contexts which they create

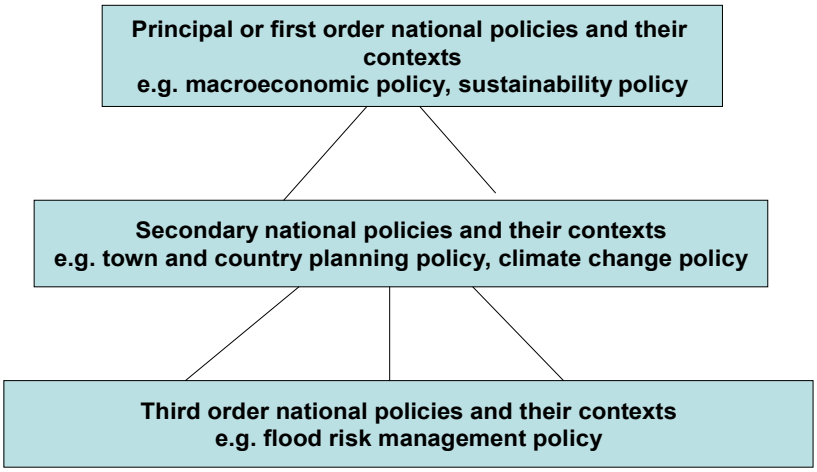
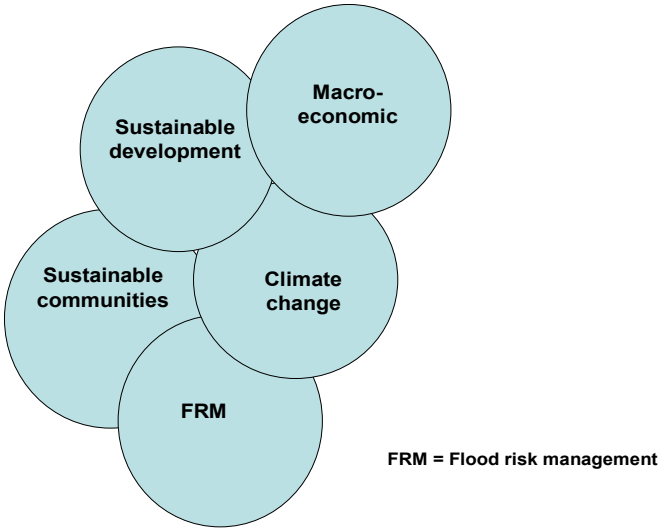


Figure 3.2: An example of overlapping policy agendas from England



A problem confronting policy analysts is that policies may be written and spoken, or just spoken and unwritten. This report focuses upon written policies, with some supporting interview evidence. Ministerial statements and other relevant materials which are reported in printed form (including web-based form) are drawn upon where appropriate.

3.3 The policy context environment in England

To understand the principal policy contexts of flood risk management, and the choice of flood measures, in England we can first turn to the Government's current (2007) policy review (Figure 3.3). Here we can view the ways in which the English Government perceives the current policy agenda; comprising eight areas of policy. In most of these areas of policy, it is possible to begin to identify the drivers of current flood risk management policy. For example, economic dynamism is generating economic growth and demand for new housing, some of which is likely to be located in flood risk areas. The environment and energy agenda is centrally about adapting to climate change, including climate change leadership, which has crucial ramifications for flood risk management in the future. The balance between the rights and responsibilities of the State (the public services) (e.g. to resolve flood problems) is a key issue in flood risk management with strong bearings upon the choice of structural and non-structural flood measures. Building trust is a key issue in flood risk management, and in making non-structural measures such as flood warning systems, work effectively. Engaging stakeholders in policy choices (the public engagement agenda) is, as we will see below, strongly reflected in the latest flood risk management strategies. Equity and protection and preparedness are also key issues.

Figure 3.3: Her Majesty's Government Policy Review 2007: principal issues in the policy review (http://www.cabinetoffice.gov.uk/policy_review/)

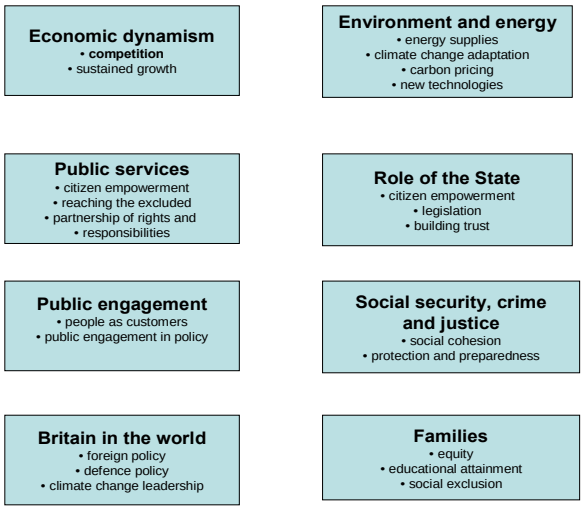
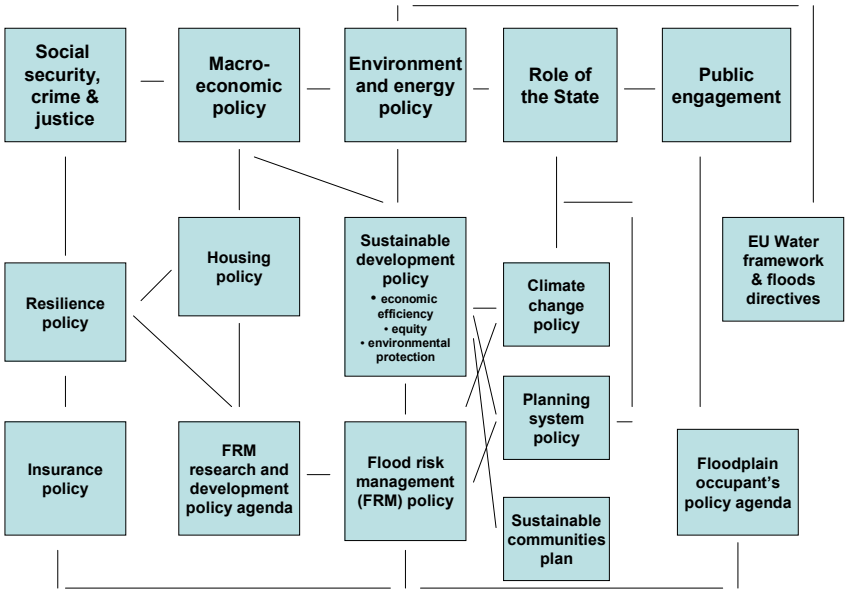


Figure 3.4 takes this analysis one step further and identifies the principal policy contexts which have direct influence upon flood risk management. The policy contexts shown in Figure 3.4 are almost all inter-related in multiple and complex ways, and Figure 3.4 does not pretend to be other than a very simple presentation of one perspective on these policy contexts and their inter-relations.

Figure 3.4: The main elements of the policy context environment of flood risk management and the choice of flood measures in England



In the sections below we explore each policy context below the top tier in Figure 3.4.

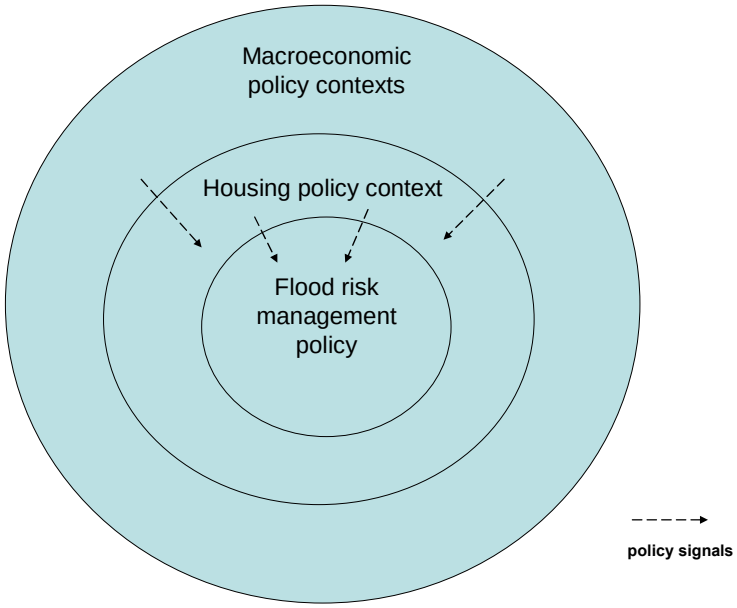
3.4 The housing policy agenda

In the UK macroeconomic policy is the key policy context in which housing policy is positioned. In turn housing policy is a critically important context for flood risk management (Figure 3.5). This is because there is a history of building new homes in floodplains (Parker 1995), and currently new housing proposals also involve greenfield and brownfield floodplain locations. Housing development is thus one of the key factors in driving flood loss potential upwards.

One of the Government's overall aims is to achieve and maintain macroeconomic stability which includes achieving a low rate of inflation. To achieve this, house price increases (which have been rising at 2.4% per annum on average for the past 30 years), and which have been rising by much more than this average in recent years contributing to macroeconomic instability, must be kept low. The Government has aimed to achieve this partly by increasing the supply of housing.

Currently, the Government's principal housing policy statement is 'Planning Policy Statement 3 (PPS3): Housing' (Communities and Local Government, 2006). The Government's objective for housing policy is simply stated. It is to ensure a decent home for every individual in the country under a 'Homes for all' banner (HM Treasury and Office of the Deputy Prime Minister, 2005). Since the 1960s the number of homes being built in the UK has been on a downward trend, but after 2001 house completions started to increase with a 20% increase in 2004 compared to 2001. However, in 2006 the number of housing starts in Britain fell to the lowest since 1924.

Figure 3.5: Nested policy contexts: macroeconomic, housing and FRM policy contexts



The current emphases in the Government's housing policy are upon increasing:

a) the supply of high quality new homes;
b) the affordability of homes; and
c) sustainable housing (houses which minimise environmental impacts).

PPS3 was developed in response to the Barker Review (HM Treasury, 2004) which recommended a step-change in housing delivery through a more responsive approach to land-supply at the local level. In 2004 the Barker Review of Housing Supply concluded that to bring the real price trend in UK housing in line with the EU average of 1.1% per annum, an extra 120,000 houses might be required each year. If this is achieved then problems of affordability would be decreased but there would still be a requirement for £1.2 to £1.6 billions of investment per annum for additional social housing to meet future needs. The Government's 'Sustainable Communities Plan' (Office of the Deputy Prime Minister, 2003) also concerns increasing the supply of affordable housing.

The Government's Policy Planning Statement (PPS1) entitled 'Delivering Sustainable Development' (Communities and Local Government, 2005) sets out the strategic role of planning in delivering sustainable development. This means ensuring that housing policies help to deliver sustainable development objectives, in particular, seeking to minimise environmental impact, taking account of climate change and flood risk. The latter does not mean that new development will not be allowed in flood risk areas, but that improved flood defences and flood risk management, including building resistance and resilience measures, need to be considered when developing floodplain land for housing.

PPS3 requires Local Planning Authorities and Regional Planning Bodies to develop Local Development Documents and Regional Spatial Strategies which contain an evidence base to support the delivery of sufficient land for housing to meet the community's need for more homes. The evidence base is set out in a Strategic Housing Land Availability Assessment (Communities and Local Government, 2007). Essentially, these assessments require local and regional planning bodies to identify as many housing

sites as possible, to assess their housing potential and the deliverability of housing at each site taking into account constraints.

The Government is seeking at least 4.4 million new homes in the UK by 2016. This was first announced in January 1998 (http://news.bbc.co.uk/1/hi/uk/politics/50935.stm). In 2005 the housing target for London and the South East of England was adjusted upwards from 900,000 to 1.1 million new homes, but it was envisaged the less land would be used because the Government is also expecting higher density dwellings. An important trend in housing supply is the increasing density of new housing developments. This has increased from 25 dwellings per hectare in 1997 to 39 dwellings per hectare in 2004.

Because new housing starts fell to 84 year low in 2006, in July 2007 the Prime Minister, Gordon Brown, announced measures to raise the annual target for new homes from 200,000 to 240,000 (http://www.davidosler.com/2007/07/gordon_brown_and_housing.html).

In the South East of England a major sub-region targeted for new housing development is the land surrounding the Thames Estuary – an area labelled as 'The Thames Gateway'. This area has been targeted for economic and social regeneration as historically the east of London has been an area of poverty and disadvantage, and much brownfield land is available for development, much of it within the area liable to tidal flooding and possible sea level rise associated with global warming and other processes such as land subsidence. 120,000 new homes, possibly rising to 200,000 new homes, are planned for the Essex and Kent riverside areas (Blair inspects green brownfield regeneration in Thames Gateway, 1 April 2005; (http://www.edie.net/news/news_story.asp?id=9725&channel=0).

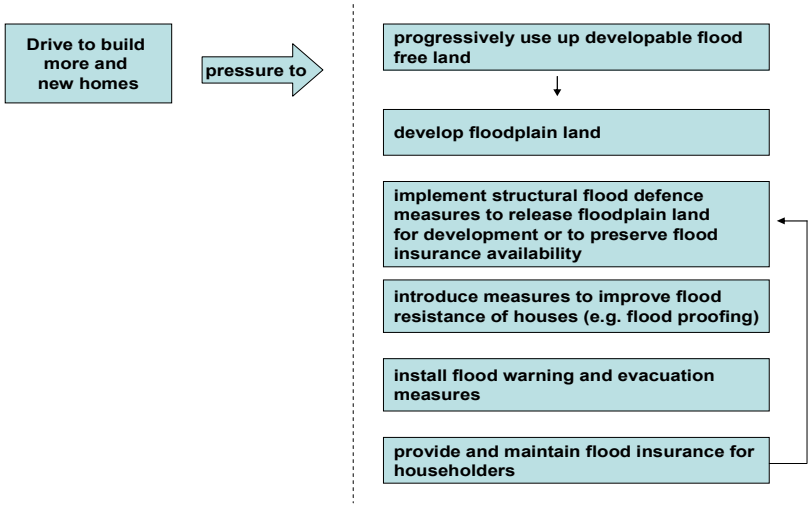
Policy influences upon flood risk management

Housing policy influences flood risk management mainly by placing pressure on flood prone land to be developed. As developable flood-free land is developed, the supply of flood-free land decreases generating increasing pressures to develop flood prone land (Figure 3.6). These pressures are felt particularly in populous and densely-populated regions such as London and South-East England.

This is especially the case given that there are many other purposes for which land is protected from development. In the UK, green belt policy (designed to prevent settlements from coalescing and to protect the countryside) is a key form of protection against housing and other development. The designation of Sites of Special Scientific Interest is another example. Flood risk management policies must take account of existing floodplain development where asset values (and thus potential flood losses) are steadily increasing, and also planned and likely development on floodplains in the future. Flood risk management must also take account of likely climate change impacts on flood flows, which may cause floodplains to expand at their margins bringing some existing flood-free development into the floodplain, and also sea level rise which can have a similar impact.

Housing policy impacts upon flood risk measure decision-making in a number of significant ways. Perhaps the strongest influence currently is in the direction of providing more defences against flooding, either through structural protection works or other measures such as beach replenishment to increase the effectiveness of coastal defences. The degree to which housing policy influences the choice of non-structural measures is difficult to gauge.

Figure 3.6: How new home building influences floodplain land development and flood measures



One case concerns the sustainability policies of government which are becoming more influential. The Government has issued a Code for Sustainable Homes (Communities and Local Government, 2006). This is a code of standards for building of sustainable houses intended for developers and builders. It contains standards for carbon emissions, water efficiency, thermal insulation and other measures including measures to reduce flood risk. The Code advises the use of resilient construction where necessary to mitigate flood risk, and also the building of car parks and access routes above flood levels. Currently, this code is rather new and voluntary, but it seems likely that in due course elements of it will become part of the national Building Regulations which provide a potentially strong regulatory regime for house building and refurbishment. Indeed, there is an important opportunity to incorporate flood proofing standards (small scale structural modifications which are generally categorised as non-structural measures) into these regulations, and the momentum appears to be in that direction.

Because houses are located in floodplains, and because there has been a build up of homes in floodplains in England over time, and because flooding of homes without warning is unacceptable, a great deal of emphasis has been put on expanding the coverage of, and improving, flood forecasting and warning systems. These now extend to about 80% of England for riverine flood warnings, and considerable attention has been given to improving warning communication and warning response in recent years. Public flood and flood warning awareness raising measures are now organised on a systematic basis in England where there is an annual budget currently running at approximately £2m for this purpose.

Increasing flood insurance claims and new housing development in floodplains is generating concern amongst insurers in England. They point out that one in four planning applications (i.e. for new developments, some of them houses) where the Environment Agency objects (often on grounds of flood risk) still go ahead (http://www.continuitycentral.com/news02169.htm). Through the Association of British Insurers they are demanding higher levels of investment in structural flood defences in order that flood insurance can continue to be widely available in England (http://www.insurancejournal.com/news/international/2007/05/17/79777.htm). Interestingly, here the pressures of new housing development in floodplains are leading the representatives of major providers of a non-structural flood measure (i.e. flood insurance) to call for more structural flood measures (Figure 3.6). At the same time this emphasis on “protection” from the ABI – and hence SMs – may itself be a barrier to the acceptability and the adoption of other NSMs.

3.5 The sustainable development policy agenda

The Government's strategy for sustainable development is set out in 'Securing the future: delivering UK sustainable development strategy' (HM Government, 2005) (Table 3.1).

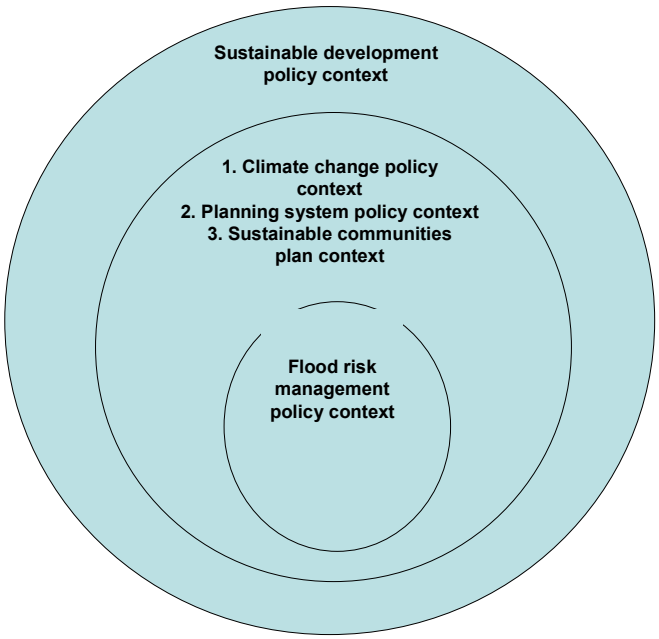
This strategy is no different from a policy and it provides a broad, cross-departmental context in which other national policies are positioned (Figure 3.7).

The Government has also developed a Sustainable Communities Plan (Office of the Deputy Prime Minister, 2003). It is a key policy in guiding economic and social regeneration objectives, and the plan interacts with a number of flagship regeneration policies such as The Northern Way and the Thames Gateway.

Table 3.1: Key points from the UK Government's strategy for sustainable development 'Securing the future' (launched 7 March 2005)

- Strong international and societal dimensions.
- Five principles: 1) living within environmental limits; 2) ensuring a strong, healthy and just society; 3) achieving a sustainable economy; 4) promoting good governance; and 5) using sound science responsibly.
- Four priorities: 1) sustainable consumption and production; 2) climate change and energy; 3) natural resource protection and environmental enhancement; and 4) sustainable communities.
- A new indicator set, outcome focused, with commitments to look at new indicators of well-being.
- A new approach to community engagement and influencing behaviours; to help people live more sustainable lifestyles.
- A continued drive to improve resource efficiency and to reduce waste.
- Strong support for innovation.
- Sustainable community strategies linked to local development frameworks
- All central government departments to produce sustainable development plans

Figure 3.7: Nested policy contexts: sustainable development, climate change, planning system, sustainable communities and FRM policy contexts



3.5.1 Policy influences on flood risk management

There are many aspects of this cluster of policies which either indirectly or directly influence flood risk management. They will also affect future decisions about structural and non-structural flood measures.

'Securing the future' (HM Government, 2005) sets important, broad policy guides for flood risk management, rather than specific measures. Without mentioning them, it guides thinking towards both structural and non-structural flood measures, but especially the latter. Central is the goal of building a strong and sustainable economy which provides prosperity and opportunities for all. This requires, amongst other things, competent management of flood loss potential and flood losses. This is because flood losses can reduce annual GDP by several billions of Euros.

The strategy's goal of reducing the country's greenhouse gas emissions is broadly targeted at reducing climate change impacts such as flooding. The strategy signals an intention to take account of natural systems through use of an ecosystems approach. This has important implications for runoff management contributions to reducing flood risks, amongst other things. 'Securing the future' includes policies aimed at intensifying efficient use of resources, and this will include effective floodplain management. Significantly, it also points to the need to bring about behaviour change. This means not only encouraging people to live more sustainable lifestyles, but also to change their flood risk behaviours – now a key element of current flood risk management policy in England.

The strategy states that environmental and social costs should fall on those who impose them. The polluter-pays-principle is one of the principal means of achieving this. However, this policy statement could also be interpreted to mean that those who choose to live in floodplains should cover their own flood damage costs through obtaining private flood insurance. This is close to the current policy adopted in England. The strategy emphasises the need for innovation. The Code for Sustainable Housing, which includes some flood resistance measures, is an example. More generally innovative demountable flood defences, and related flood exclusion devices, are being developed and are now in wide use along the

river Severn in England. These need to be further developed and applied elsewhere in England where feasibility studies are being undertaken (e.g. in the Lower Thames valley to the west of London).

The Sustainable Communities Plan (Office of the Deputy Prime Minister, 2003) is concerned with increasing the supply of affordable housing, economic and social regeneration, and reducing inequality. It does not have direct significance for flood risk management in England, with the important exception that it links to the Thames Gateway project which involves significant development in the Thames estuary including in floodplains.

The three pillars of sustainable development adopted by the UK Government are economic, social and environmental. Next we take each in turn.

3.5.2 Economic efficiency

The pursuit of national economic efficiency has been a very important policy context for flood risk management for over fifty years in England. Government has consistently required flood defence agencies to demonstrate value for grant-aided (i.e. a government) subsidy derived from the tax-payer investment by undertaking benefit-cost appraisals of capital flood defence schemes.

This requirement is set out in HM Treasury policy documentation (e.g. HM Treasury 1991), notably the latest policy statement which is the 'Green Book' (HM Treasury 2003). These documents also address other criteria such as environmental protection and social distributional factors and the values and weightings to be ascribed to them. Further specific policy guidance is provided in the Project Appraisal Guide (PAG) series, especially PAG3 (Ministry of Agriculture, Fisheries and Food 1999).

The requirement to demonstrate that a flood defence project is nationally economically efficient has meant that, broadly-speaking, only those projects for which a favourable (and in practice very favourable) BC ratio have been supported. This is still the case, despite moves to broaden the basis of investment appraisal towards a range of criteria, termed Outcome Measures.

The vast majority of flood defence projects which were eligible for grant aid have been relatively large, capital schemes of a structural nature, although certain flood warning schemes have also qualified for grant aid (mainly for the flood detection aspects). This strong leaning towards funding availability for economically efficient structural projects is still a feature of England's flood management policy, but Government is promoting the idea of funding a wider range of measures, such as flood resilience measures (many of which are property-specific structural measures). Evidence presented later herein (Chapter 5) suggests, however, that NSM are less obviously economically efficient than SM, and are unlikely to pass the BCA test of a BCR of 5:1 and therefore enter the lists of 'schemes' to be funded in the future.

3.5.3 Equity

Equity is one of the three pillars of sustainable development around which England's latest flood risk management strategy is based. The policy aspirations found in MSFW include a focus on social justice goals, and suggest a move towards greater equality of opportunity in the implementation of flood risk management options.

The issue of equity also translates to some extent into issues surrounding vulnerability. MSFW acknowledges that pursuing the social justice goal will led to questioning of current funding arrangements for flood risk management (because the equity issue concerns who pays i.e. the taxpayer, and who benefits i.e. those living in floodplains); to changes in project appraisal guidance, and many other possible

shifts in policy over time. Treasury weightings (HM Treasury 2003) have been one method advocated by Defra whereby the social justice aspects of FRM schemes have been addressed.

Johnson et al. (2007) analyse the various models of social justice which might be applied to flood management policy in the UK, and the degree to which current approaches to structural and non-structural measures are equitable under these various models. They conclude that non-structural strategies appear to offer greater scope for adhering to the principles of equality and vulnerability in their design (excepting flood insurance and homeowner adaptation) and that further progress in this direction will require a change in the FRM funding regime. This would then place minor works and non-structural measures (excepting insurance) on a similar footing to that currently provided for major structural strategies.

3.5.4 Environmental protection

Managing flood risks to deliver the greatest environmental benefits is an important goal within the Government's sustainable development policies. Flooding can either be beneficial or harmful to sites of designated environmental importance such as SSSIs, Natura 200 sites and Scheduled Ancient Monuments.

The Government aims to take appropriate measures to protect these assets. MSFW embodies the idea of widening river corridors and areas of inter-tidal habitat, and the concept of multi-functional wetlands that provide wildlife and recreational resources and reduce the coastal squeeze on habitats like saltmarsh. On the whole, environmental protection goals may lead to either structural or non-structural measures, but non-structural measures (such as managed realignment and property/community relocation) may be favoured in some cases where structural defences are incompatible with environmental objectives.

3.6 The planning system policy agenda

Land use planning is clearly of central importance in managing floodplains and floods. Here there are several interrelated, nested policies forming an overall planning policy context for flood risk management policy (Figure 3.8). One of the key non-structural flood measures is land use management. Planning Policy Statement 1 (PPS1) is entitled 'Delivering Sustainable Development' (Office of the Deputy Prime Minister, 2005). It translates the Government's higher level sustainable development policies into national policies on different aspects of land use planning in England. PPS1 sets out the overarching planning policies on the delivery of sustainable development through the planning system. These policies complement, partly overlap and interlock with other national policies, but do not replace or override them.

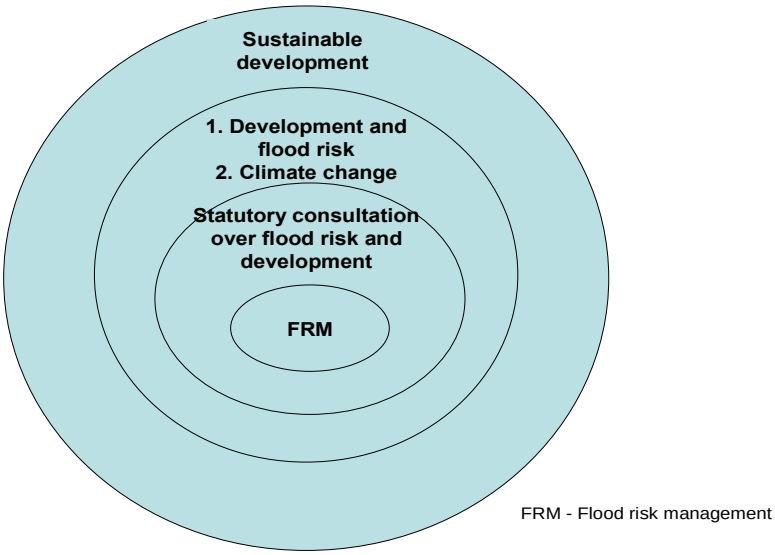
The strategic planning framework for England is further explained in Appendix 1. Statutory Development Plans are explained in Table 3.2. Policies set out in PPS1 are directed at regional planning bodies in preparing regional spatial strategies, by the Mayor of London in relation to the spatial development strategy for London, and by local planning authorities in preparing local development plans. They are material to decisions in individual planning applications, including those affecting floodplains.

Planning Policy Statement 25 (PPS25) entitled 'Development and Flood Risk' is a sub-set of PPS1 and expands policy on development and flood risk in particular. It aims to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk. This policy sets out detailed procedures for appraising flood risk, and managing and reducing flood risk.

PPS25 is the latest in a series of planning policy documents, dating back to the late 1940s, from central government aiming to avoid unwise development in floodplains in England. Experience, and research evidence (e.g. Parker 1995), has shown that in England, despite these planning policies, floodplain development has been unstoppable. Substantial floodplain development has taken place, and only the

pace of this development appears to have been affected. A key problem has been the availability of sufficiently high quality flood risk information at the local level and its communication to the parties involved in floodplain development and its control.

Figure 3.8: Nested national development and flood risk policies forming an overall policy context for FRM



PPS25 has been designed to replace PPG25 Communities and Local Government 2001). The rationale for this new policy statement is illuminated in a summary of an interview undertaken in September 2005 with a senior planning official from the Office of the Deputy Prime Minister (Inset 1).

Table 3.2: Statutory Development Plans

Development plans are statutory planning policy documents that focus on land development and protection set within the context of wider social, economic and environmental trends and considerations. They reflect national and regional planning policy, and make strategic provision for long term use of land and buildings, providing a framework for local decision-making and reconciliation of competing development and conservation interests.

Under the Town and Country Planning (Development Plan) (England) Regulations 1999 (Statutory Instrument No. 3280), the now old-style statutory plans were defined as a unitary development plan, a structure plan, a local plan, minerals local plan or a waste local plan. Under the new development planning system introduced under the Planning and Compulsory Purchase Act 2004, there will be two new-style statutory development plans: a) the Regional Spatial Strategy (RSS) and b) the Local Plan referred to as Local Development Documents.

The Statutory Development Plan currently comprises the Regional Spatial Strategy, the Local plan, the Minerals Local Plan, the Waster Local Plan and the Structure Plan. The Local Plan and Structure Plan is currently 'saved' for a 3 year period or until it is replaced.

DCLG Circular 04/2006 entitled 'The Town and Country Planning (Flooding) (England) Direction 2007' (Department for Communities and Local Government, 2006) reinforces new consultation arrangements which must take place between local planning authorities and the Environment Agency (England's flood management agency) over proposals for major development in flood risk areas. This Circular reinforces PPS25.

Inset 1

From an interview with a senior planning official from the Office of the Deputy Prime Minister, 1 September 2005 (Recorded verbatim)

'Flooding is one of our main priorities, we currently have planning guidance in PPG25, we're in the process of revising that. We had a consultation last summer in parallel with DEFRA's consultation on the wider government's making space for water initiative, and that consultation was about the need to revise PPG25. On the basis of that… we decided that we did need to revise PPG25 and we need to clarify the message… the policy message was right but it wasn't getting to a wide enough audience and local authorities were'nt taking it sufficiently into account in planning decisions.

So what we're aiming to do with PPS25 is to strengthen the guidance, clarify it, and particularly strengthen the guidance on flood risk assessment, and the application of the sequential test, which are all geared to minimising flood risk to development. So I think there's a fundamental point of view, where we fit into this is communicating flood risk to the planning and development industry, and particularly to local authorities and their planning function'.

'We see very much the strategic local authority area flood risk assessment as being the sort of key to miscommunication of flood risk because it provides enough detail to derailed development planning at the local level and provides a framework within which developers can take development forward.. '

Policy influences on flood risk management

PPS1 (Office of the Deputy Prime Minister, 2005) expands on 'Securing the future', and introduces a number of general flood risk policies. These focus on non-structural approaches, especially land use management and resilient and adaptable buildings. The emphases are on providing a better quality of life for everyone; prudent use of natural resources; making suitable land available for development; and efficient resource use. The goals are to deliver "safe, healthy and attractive places to live" (p. 7); development plan policies which take account of "the potential impact of the environment on proposed developments by avoiding new development in areas at risk of flooding and sea level rise" (p. 8). The statement says that "key objectives should include ensuring that developments are sustainable, durable and adaptable (including taking account of natural hazards such as flooding.." (p. 14).

PPS25 (Communities and Local Government, 2006) is entirely about managing decisions about floodplain development proposals, and includes policy guidance on property relocation. The policy comprises a risk-based approach; the framing of policies for the location of development which avoids flood risks where possible; reducing flood risk from new development through location, layout, design and by incorporating sustainable urban drainage systems; and making the most of the benefits of green infrastructure for flood storage. This policy document sets a number of decision-making principles, as well as detailed procedures. For example, it says that:

"where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, LPAs should consider whether there are opportunities in the preparation of LDDs to facilitate the relocation of development, including housing to more sustainable locations at less risk from flooding" (p. 4) (LDAs are local planning authorities and LDDs are local development documents).

Circular 04/2006 (Department for Communities and Local Government, 2006) reinforces the point that on 1 October 2006 the Environment Agency was made a statutory consultee for planning applications where flood risk is a key issue (this consultation requirement was introduced by Statutory Instrument 2006/2375 (SI, 2006). Local planning authorities have a duty to consult the Environment Agency on all applications for development in areas of flood risk or where critical drainage problems exist, other than minor development. This is a significant tightening up of land use management measures for flood risk areas.

In England the planning context in which flood risk has been considered until comparatively recently has tended to be a rather narrow 'land use planning' one which has tended to limit the interest and awareness of planners in flood and other risks. Several trends are, however, now leading to a broader planning context in which planners are having to engage much more with environmental risks. The first is a shift from narrow 'land use planning' to a broader 'spatial planning' approach in which social, economic and environmental (including flood risk) issues have to be integrated. In England the development of a spatial planning context is relatively recent and is associated with the growth of strategic, regional level planning authorities, especially the Regional Assemblies (Appendix 1) which have a broader oversight of risk and social and economic development. The second is the Water Framework Directive which is forcing planners to treat environmental issues on the same level as social and economic ones. The development of this context is illustrated in an interview with a planning consultant (see Inset 2).

3.7 The climate change policy agenda

Climate change policy can be positioned within sustainable development policy (Figures 3.7 and 3.8). The Stern review (HM Treasury, 2006) has assembled the scientific evidence which makes it clear that human activity is changing the world's climate, and will have rising costs for national as well as global prosperity. 'Planning and Climate Change' (Communities and Local Government, 2006) is a supplement to PPS1, and is currently at the consultation stage. It sets out how spatial planning should help shape places with lower carbon emissions and resilient to the climate change now accepted as inevitable. The implications for flood risk management are twofold, but this policy focuses upon the first. First, the drive to reduce carbon emissions can have a beneficial long term effect in reducing flood risk. Second, where

Inset 2

From an interview with a strategic planning consultant, 13 July 2005 (Recorded verbatim)

'The impression that I've had is that regional assemblies are far more receptive to trying to take on board this idea of risk than they ever have been in the past. I mean in part I suspect this is the change from land use planning to spatial planning which does encompass a much wider agenda, and particularly in the sense that it does tend to give much more weight to the social and economic background of the areas in question than you ever did in the past.

I mean I've seen enormous cycles of this over the years, periods when governments have taken the view that planning simply was narrowly defined land use and all the rest of it, forget the social and economic considerations, to other periods where, you know, they've actively encouraged social and economic considerations to take a far higher profile than perhaps they have in the past.

The environment has never quite been in the same league as social and economic considerations in planner's minds, and one can understand that, but they are having to do this and again I think the Water Framework Directive is really going to be quite a major influence on the way that they do take environmental considerations on board'.

flood risk is worsened by climate change, planning needs to take account of these effects. The Government intends that sustainability appraisals will shape appropriate spatial strategies, and it is moving towards a common methodology for such appraisals. Through the Code for Sustainable Homes, and by setting a timetable for further strengthening of Building Regulations, the Government is aiming to set policies that provide clarity for achieving zero carbon development.

Policy influences on flood risk management

'Planning and Climate Change' recognises that climate change could mean more extreme weather events for the UK, leading to more flooding and rising sea levels leading to coastal realignment. However, the influence of the climate change policy context on FRM is primarily indirect (Figure 3.9). A practical example of how climate change policy is linked to flood risk management policy and how it may influence planning decisions is given in an interview with a senior official from the Environment Agency (Inset 3).

3.8 The public engagement policy agenda

In Chapter 2, certain criteria were set out as to how to judge the implementation of sustainable development. In particular, criteria such as acceptable levels of risk, local capacity building, local citizens taking responsibility, promotion of disaster resiliency, intra- and inter-generational equity were emphasised in that approach. All these require public engagement, and in general the UK government has been making great efforts in this direction.

An important strand in Government thinking and policy is now, therefore, public engagement to ensure that public services are delivered to 'customers' to high standards. The Government believes that the public services are so crucial to the daily experiences and life chances of individuals that questions surrounding responsibilities and standards of delivery must be debated more directly than hitherto. In 2007, a White Paper *entitled Creating Strong and Prosperous Communities* – still the subject to consultation - provides guidance to local authorities and their partners on creating strong safe and prosperous communities, specifically relating to new legislation introduced in the Local Government and Public Involvement in Health Act 2007. The guidance covers, Local Strategic Partnerships, Sustainable Community Strategies, the new duty to involve, Local Area Agreements, the revised best value regime, and commissioning. Also in 2007, the Government established five regional Citizen's Forums feeding into a Citizen's Summit in March 2007.

Inset 3

From an interview with a senior official from the Environment Agency, 14 March 2006 (recorded verbatim)

'Very difficult actually because planning is, well, we say planning is a system which thrives on certainty, it does not recognise uncertainty, but it does'nt really know what to do with it when it sees it. Now, two key issues I guess, one is climate change and the second one is a precautionary principle. What's interesting about PPS25 is one of the bits where it is weaker is that PPG25 used to have quite a specific reference to precaution, with in principle the PPG, sorry PPS25 does'nt, and that's one thing we've been critical in terms of assignation.

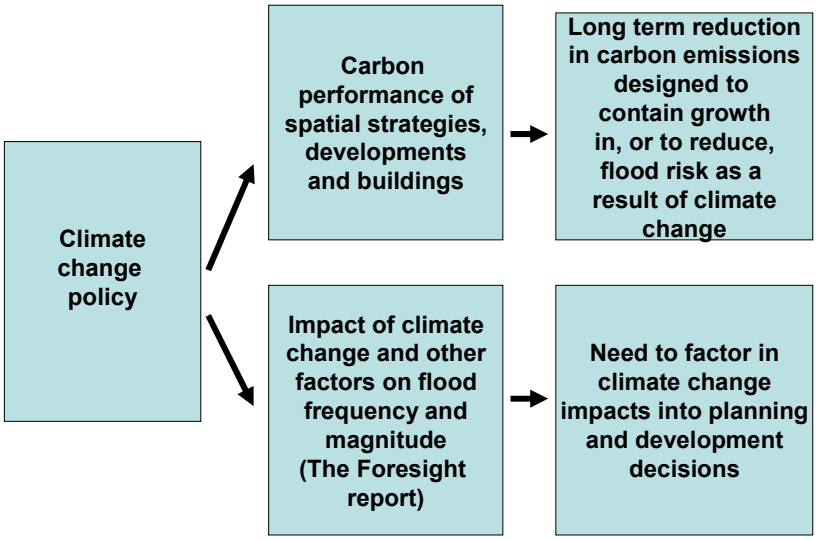
And the second one is how you build climate change in, and there's a rough table in terms of what you need to take into account, but we've actually said that needs to be… you know, there needs to be more than that, and we've provided some more details on that and advice to ODPM as to what we think needs to be taken into account, but really we hope that some of that uncertainty will be picked up by doing some strategic flood risk assessments and not actually moving the flood risk assessment to that scale, and building in climate change factors will help, albeit with a degree of uncertainty but there's no point in planning for a situation now, when in particularly coastal communities, if, in 50 years time there will may be a policy that will therefore you know develop, which appears to be stable now not necessarily stable in 50-100 years time.

Foresight has been very influential, the foresight report we use a lot, and is very helpful in showing we're on a progression and actually things look like they're going to get worse, and so that we use a lot as a tool to sort of raise people's awareness and our climate change team have done something based 'Time to Get ready the Climate's Changing, Time to Get Ready' which is actually a description of some of the more recent dramatic events like Boscastle and Carlisle and saying we've made some prediction on what climate change will do, here's an indication of what might happen.

So we're trying to build pictures for people so they can understand what this sort of means, and then building that into decision making when the pressure is on for regeneration, or rebuilding a community. That's where the difficulty lies particularly where you put that into the political arena'.

Notes: the Foresight report is Evans *et al*. 2004. Boscastle and Carlisle are the locations of severe flooding in England in 2004 and 2005.

Figure 3.9: The indirect influence of climate change policy on flood risk management



The kinds of questions addressed in these Forums include:

- how can public services improve customer care ?;
- should people be encouraged to improve their own lives and their communities ?
- what level of state intervention are people willing to accept ?
- where is the line between legitimate state intervention and a 'nanny state' ?
- is there a need for clearer rights and responsibilities for people and Government ?
- how would people react to a more explicit expression of what they can expect from the state, and in return, what they accept responsibility for ?
- what should automatically be a state responsibility ?

There is much government action in parallel directions. For example, the Community Development Foundation (CDF) is a non-departmental public body sponsored by the Department for Communities and Local Government (DCLG) and a registered charity. The CDFs mission is to lead community development analysis and strategy that will empower people to influence decisions that affect their lives. Their work cuts across Government Departments, regional and local public agencies and the community and voluntary sectors. They also operate at European and international level. CDF aims to build engaged, cohesive and stronger communities by:

- advising government and other bodies on community involvement, civil renewal and community cohesion;
- supporting community work of all kinds through networks, links with practitioners, funding and management of local projects;

- carrying out research, evaluation and policy analysis to identify good practice in all aspects of community development;
- training, conferences, publications and consultancy.

Policy influence on flood risk management
At first sight, this comprehensive government agenda might appear to have nothing to do with flood risk management or decision-making about non-structural flood measures, but this is far from the case. It is, however, 'background'. But it is important background because the policy signals which emerge from the debate about these issues will have fundamental significance for the manner in which flood risks are managed in the future. Relevance to flood risk management lies in the following issues.

- The nation's principal flood defence agency is the Environment Agency; it provides a public service; and so the expectations that customers have about the delivery of flood defence measures are important. Expectations will include customer care.
- How should the public be engaged in making decisions about flood risk management ?
- What is the role of the state versus the role of the individual in flood risk management, and where does the responsibility of the individual and state divide ?

These issues are fundamental to the choice and delivery of flood measures. For example, whether or not the responsibility lies with individuals to purchase flood insurance, or whether they should rely upon government compensation for damage caused in floods, is a key question underlying flood insurance and compensation. There are currently widely different answers to this question in England and other parts of Europe. The extent to which the Government believes that those living in flood risk areas should manage their own flood risk is also a closely related key issue. It determines whether or not behavioural change is pursued as an objective in flood risk management and this fundamentally influences the importance of public information and education campaigns about flooding. It also affects how flood warning systems are designed and delivered.

Stakeholder engagement
At a tier lower than the Government's public engagement policy are policies which translate public engagement into stakeholder engagement policies. The Department for Environment, Food and Rural Affairs (Defra) has one such policy which it has been consulting over (Defra, 2004). 'The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management' is part of the wider 'Making Space for Water' policy initiative which is central to flood risk management in England (see below).

The potential impacts of flood and coastal erosion risk management upon a wide range of stakeholders has resulted in a long history of involvement. However, this involvement has not always been inclusive in the past (for example the agricultural community has been foregrounbed).

This new Defra policy imitative seeks to correct this situation and to develop an improved approach to stakeholder engagement. Its success will be important to the development of better implementation of NSM.

Policy influence on flood risk management
Stakeholder engagement policy has subtle effects upon flood risk management and decision-making about flood measures. For example, it could provide the basis for greater sharing of responsibility for flood risk management between the state's flood defence agency and individuals. In turn this could alter the balance between the use of structural and non-structural measures. It can also influence decisions about the measures to be deployed.

3.9 The resilience policy agenda

The resilience movement (i.e. UK Resilience) is a Cabinet Office cross-departmental policy initiative which arose following the events of 9/11 and other emergencies, including flood emergencies in Britain (http://www.ukresilience.info/). These events demonstrated the need for a more integrated approach to emergency preparedness, response and recovery. The key legal framework is the Civil Contingencies Act of 2004 which established regional and local resilience forums through which the key players in emergency response are expected to coordinate their activities.

Policy influence upon flood risk management
Flood emergency preparedness and response, together with flood forecasting and warning, is a key non-structural flood measure. However, it also has clear linkages to the operation of fixed flood defence structures and temporary flood barriers, which are crucial to defence against floods.

New legislation and the resilience movement has given greater weight and prominence to this cluster of flood measures. It has strengthened the role and potential effectiveness of non-structural flood measures. One way in which it has achieved this is through the wider promotion and take-up of business continuity planning which is a potentially important way of reducing flood losses.

3.10 European Union Directives policy agenda

Two EU Directives are particularly relevant to this analysis:

- the Water Framework Directive (WFD); and
- the new EU Flood Assessment and Management Directive (EC 2007).

The purpose of the WFD (EC, 2000) is to establish a framework for the protection of the water environment and associated environments. It requires Member states to create river basin districts and to develop river basin management plans.

The 'Floods Directive' lays down a framework for reducing risk to human health, the environment and economic activity associated with floods. It will require Member states to undertake flood risk assessments for each river basin district and associated coastal zones to identify areas of potential flood risk. It will require maps of flood risk areas to be produced showing the extent of expected flooding, the numbers of people at risk, the economic activity affected, and the potential for environmental damage from flooding of certain major installations. Flood risk management plans must be prepared and coordination is required across international boundaries to produce a single plan where appropriate.

Policy influence on flood risk management
The WFD encourages a holistic, ecological approach to the management of water and associated resources, including catchments, floodplains, wetlands and coastal zones. It does so by fostering a river basin management approach, and in turn such an approach encourages the full range of management options including all structural and non-structural flood measures to be considered. MSFW (see below) reflects WFD thinking and philosophy.

The Environment Agency produces Catchment Flood Management Plans. These give details of flood management policies in particular sub-areas within catchments. They set out both structural and non-structural flood measures opportunities (http://www.environment-agency.gov.uk/subjects/floods/1217883/1217968/907676/).

The new EU Floods Directive will place more emphasis upon non-structural flood measures, such as using natural floodplains as retention areas for floodwaters, avoiding construction of houses and commercial properties on floodplains, adapting future developments to flood risk, and boosting flood

preparedness and public knowledge about how to react in the event of flooding. In support of this, FLOODsite, the largest flood research project in Europe, is expected to deliver integrated flood risk analysis and management methodologies. The CRUE project is also expected to produce results, including on non-structural measures.

In England there is a view that the 'Floods Directive' is initially focused upon collecting the kind of flood risk information which is available in England. The view in England is that there is a need to move on from collecting information to changing people's flood risk behaviour, using as many techniques as possible to change behaviour. This view is illustrated in an interview with a senior official from the Environment Agency (Inset 4).

3.11 The flood risk management policy agenda

The latest Government policy for flood risk management in England is entitled 'Making Space for Water' (MSFW) (Defra, 2004a). This Autumn 2004 policy document was published a policy consultation paper. Following the subsequent consultation exercise, the Government published its first response in March 2005 (Defra, 2005). This response took account of the Foresight Future Flooding report (Evans et al., 2004).

Since then, a number of policy documents have been published under the MSFW banner by Defra (e.g. Defra, 2004b), including the Environment Agency's consultation document entitled 'Strengthening our strategic approach to sea flooding and coastal erosion management (Defra, 2006). MSFW is currently anticipated to be a 20 year strategy (Table 3.3). The organisational arrangements for flood risk management in England are briefly explained in Appendix 2. The review of strategic approaches to sea flooding and coastal erosion management (i.e. Defra, 2006) is a review of responsibilities for these areas rather than a review of approaches taken making decisions about flood measures. It is concerned with consultation over proposals to give the Environment Agency lead responsibility in these areas in future.

A significant change in policy emphasis
MSFW takes its policy guides and signals from 'Securing the future' (HM Government, 2005) and marks a significant change in Government flood management policy. Flood management policy in England has gone through a number of changes in recent years. For many years the country's flood policy was known as 'land drainage' policy (Penning-Rowsell *et al*.,1986) in which the emphasis was upon subsidised draining of wet, rural, agricultural soils to improve food productivity – a post second world war preoccupation. Urban flood alleviation was often secondary in this policy context.

However, during the 1980s this 'land drainage' policy came into some disrepute as 'food mountains' accumulated in Europe, and as loss of ecologically important wetlands through drainage to enhanced agricultural intensification became a major political/environmental issue. At this juncture a new flood policy was developed which emphasised urban and coastal flood alleviation. This policy was known as 'flood defence' and strongly emphasised structural flood measures, although the environmental movement in favour of soft rather than hard structural measures made a significant impact. 'Flood defence' remained the primary flood management approach until the early 2000s. However, by then a number of non-structural solutions had gained currency, especially flood warning and response systems.

Although MSFW has introduced major changes in flood risk management, currently much of the language and terminology used in the sector remains 'old style'. For example, the Environment Agency's main executive committees which allocate funds for flood risk management are called 'Flood Defence Committees'. In Defra the 'fcd' acronym is still used.

Inset 4

From an interview with a senior official from the Environment Agency, 1 September 2005 (recorded verbatim: see Note 1)

'I think for the future what I'd just say is that we probably have some of the, if you look across Europe, we've probably got some of the best information there is at the national level. We've got the, with the proposed European Flood's Directive coming out with a big focus on sort of information and awareness, but the big thing in all of this is that we want action; we don't just want information to generate awareness for the sake of it, you know, we're talking here in this whole debate about people taking action and unless that happens we've failed and so it's about that step from the steps to me from information to awareness and from awareness to action and behaviour that we see as the key challenges for the future.

It's very much of the sort of Water Framework Directive and lifestyle changes that many people, I suspect will be needed. But you know to me those are the main sorts of directions that we see, that the European's see unfolding based around information, awareness. We've got things like the House Information Packs that are struggling to get onto the scene, incorporating flood risk. The Agency offers a service; it has a pilot running with a number of solicitors; I don't know if you know on they're providing information so that the solicitors don't need to ask us but they can interrogate, they're signed up you know corporately shall we say, but if they want to know information on a particular property they can interrogate our databases and get a report back that tells them about flooding, waste and other items'.

Notes:

1. *The main thrust here is that information is becoming more readily available and this is affecting relations between the Agency and the general public, but not without some problems.*
2. *House Information Packs (HIPS) were introduced during 2007 in England. To sell a house, house vendors are required to produce a HIP, if their house is above a certain size, which contains a range of information about the house including its thermal insulation quality and any risks to which is may be prone.*

Table 3.3: Key overarching principles in the Government MSFW flood policy (2005)

- A more holistic approach to FRM – a whole catchment and whole shoreline approach consistent with the EU's Water Framework Directive
- Research on climate change to make a key contribution, and current allowances for climate change will be reviewed
- All stakeholders at all levels of risk management to be involved
- A better balance to be sought between the 3 pillars of sustainable development (economic, social and environment) in risk management
- A risk-driven approach
- Better risk information will be pursued, including better data on the consequences of flooding
- Flood warning and flood awareness activities to be expanded (to address the social pillar)
- Measures to improve resistance and resilience to flooding to be pursued (to address the social pillar)
- An effective and pragmatic approach to be taken to considering the impact of flood risk in the land use planning process
- Greater use of rural land use solutions such as creation of wetlands and washlands, and managed realignment of coasts and rivers; and priority research on the role of rural land management techniques (e.g. cultivation practice and woodland creation) (to address the environmental pillar)
- More space will be made for water through appropriate use of realignment to widen river corridors and areas of inter-tidal habitat, and of multifunctional wetlands
- Support for the concept of integrated management of urban drainage
- Flood risk management will be embedded across a range of Government policies, including planning, urban and rural development, agriculture, transport, nature conservation and conservation of the historic environment

MSFW policy influence on flood risk management

MSFW seeks a much more balanced structural/non-structural approach, and has a great to say about introducing non-structural measures. Government expenditure on structural flood defences and their maintenance is still set to grow, but non-structural measures are now being seriously pursued. A series of projects is currently underway to take each of the MSFW policies forward. Defra's High Level Targets (HLTs) support MSFW and are important in policy delivery (Defra, 2005a), as Outcomes Measures (Defra, 2006). Defra (2005B, p14) states:

"There will be a **mix of policies** designed to minimise the creation of new risks (by the way development policy is implemented in areas of flood risk) to manage risk and to increase resistance and resilience…… The public will be more aware of flood and coastal erosion risks and empowered to take suitable action themselves where appropriate".

The policy goes on to state that:

"The true costs of providing, and not providing, flood and coastal defences and other measures will be reflected to a greater extent than at present in individual and commercial decision-making" (Defra, 2005, p15).

Under the sub-heading of 'social justice and community well-being: broadening our risk management tools' the policy states that

"even within the improved flood risk management framework to be introduced under this strategy, there will be cases where investment in capital schemes will not be justified. In such cases and in line with its policies on social justice, the Government recognises that there is a need to consider extending the risk management tools available, in particular to take account of the needs of smaller rural or dispersed communities. Subject to further work on the legislative and funding implications, consideration will be given to the expansion of available risk management tools to include:

- expansion of **flood warning and flood awareness**; and
- development of **measures to promote resistance and resilience to flooding**" (Defra, 2005, p20).

The new policy on resistance and resilience measures, anticipates that both new and existing buildings will need to be addressed, and that the incentives for property owners to make buildings more resilient need to be addressed. In May 2007 the Government announced a 750,00 Euro pilot grant scheme to encourage flood resilience and invited stakeholders to propose further sites to test approaches to providing grant aid for resilience and resistance solutions (http://www.defra.gov.uk/environ/fcd/policy/strategy/rf1rf2.htm) (Bowker, 2007).

The Government intends to make information on flood risk more widely and continuously available. The aim is to **raise awareness and to increase preparations within communities for changing flood risks** from climate change. Community partnerships are seen as a potentially effective means of pursuing this aim. The policy identifies the following which will be pursued (Defra, 2005, p35):

- evaluation of different models for integrated long-term community awareness management spanning the different streams of community and stakeholder engagement, including developing Local Community Action partnerships;
- exploiting the full potential of new techniques for visualisation and demonstration of alternative futures to involve stakeholders in contributing to the debate about realistic alternatives;
- the development of community education tools through local partnerships;
- the development of Home Information Packs (HIPS) and the inclusion of flood risk as a standard search (HIPS are being required in England for house sale purposes in future);
- exploring how live flood warning and rainfall/river/tidal level forecasts can be incorporated into the Environment Agency's website for public use;
- developing educational tools addressing issues surrounding flooding; and
- encouraging NGOs to assist in promoting flood risk information.

The Government intends to develop and expand **flood warning systems** (Defra, 2004b, 2005, p36). This will partly involve improving flood forecasting, and seeking to extend flood warnings from fluvial and coastal events to pluvial, flash flooding and to flooding from sewers and groundwater. It also partly involves increasing flood warning lead times where feasible, and ensuring that receipt of warnings is effective and that effective warning responses follow.

In the late 1990s a system of flood warning codes was been adopted in England. It replaced the former colour coded flood warning system which experience revealed was widely misunderstood and interpreted differently by emergency response organisations. The terms 'Flood Watch', 'Flood Warning' and 'Severe Flood Warning' are now used to indicate different levels of flood severity, and they are associated with icons, specifically worded descriptions and advice (Appendix 3).

The Environment Agency's Flood Warning Investment Strategy (Environment Agency, 2003a) sets out the Agency's approach to flood warning; its investment targets and its related levels of service targets. Two levels of service targets have been set for 2011:

- **coverage** of the country by flood warnings: measured as the proportion of at risk properties offered an appropriate flood warning service;

- **appropriate action**: measured as the proportion of people taking appropriate action in response to flooding.

The coverage target is 80%, and the appropriate action target is 75%. Current results of the Agency's performance monitoring process for these flood warning performance measures are in Appendix 4. They reveal a steady improvement in performance over time. Extracts from interviews with two senior Environment Agency managers indicate the approach being taken (Inset 5).

Further detail about the Environment Agency's flood warning and flood awareness raising policies is found by drilling down into the Agency's 'Work Instructions'. There are two Work Instructions (i.e. instructions to Agency staff) which are useful in this regard: 'Work Instruction (Flood Warning Levels of Service)'(Environment Agency, 2006a) and 'Work Instruction For the definition of Flood Risk, Flood Warning and Flood Watch Areas' (Environment Agency, 2005). The latter sets out the Agency's detailed national policies for defining 'flood risk flood warning areas' (FRFWAs) and for assigning them to one of ten flood risk categories based upon flood probability and the number of properties at risk in each area. The categorised flood risk for each FRFWA area subsequently determines the level of service target for each FRFWA broken down into five components. Details of these and the Agency's flood warning levels of service methodology are found in the first Work Instruction (Environment Agency, 2006). They five components are:

- flood detection and forecasting equipment;
- water level monitoring;
- forecasting model standards;
- warning dissemination approaches and methods; and
- flood risk communication approaches and methods.

Inset 5

From interviews with two senior Environment Agency officials, March 2006

We are 'trying to get a level of consistency and approach to the way we deliver and develop flood incident management services across England and Wales to establish national standards, national procedures and national processes. With the aim of becoming a more effective and efficient deliverer of the service, which is what we're about. I mean all of our business is geared towards responding to an incident, to a flood. So everything that we do in our day job is about how we're going to respond to a flood incident'.

'I think in the business case for Floodline Warnings Direct we are aiming to offer the service to about 800,000 over the next five or six years, so that's the target we're aiming for. The other big change is that we've I think consistently found it difficult to get people registered for a free flood warning service and there are various reasons for that, people feel, you know, that it might put a blight on their property, they don't understand the risk that they face, perhaps, and don't take it seriously enough, or are just a bit suspicious about Government organisations having their contact details or whatever, so we are now trialling a pilot for .. rather than opting people on to the system, we're going to put .. we've identified about eight areas across the country where we're going to put people at risk of flooding on to the system and they have to opt out and we're going to…. we're trialling that to see, to understand, what the issues are and how the public react and that's going on at the moment'.

For example, the Agency's policy for a FRFWA categorised as high risk is for maximum levels of service. This dictates that the class of weather radar data required is 2A; raingauge density must be 3 gauges per 100km^2 ; the maximum distance of a water level monitoring gauge can be above the upstream boundary of a community receiving a service is 1 km; the false alarm rate must be <20%; the probability of detection must be >80%; direct flood warnings will be given to each at risk property by telephone, fax, e-mail etc. using a computerised warning system; and standards are laid down for flood risk communication. The maximum flood risk communication requirements include regular mail-shots reminding people to update their details on flood warning systems; an invitation to register on the Agency's automatic warning system; information about the level of risk; the Floodline (dial and listen telephone service) quick dial code; what to do after a flood warning is received.

For lower levels of flood risk categorisation, levels of warning service are stepped progressively downwards. For example, the minimum flood risk communication standard is that public notices must be displayed in public places, and this will be supported by local flood awareness surgeries and direct mailings to households if considered appropriate.

Emergency response to flooding will receive further attention under MSFW (Defra, 2005, pp36-38). The Environment Agency will compile a register of catchments where the potential speed, depth and velocity of flooding could cause extreme risk to life. These are called 'rapid response catchments'. Policies for flood awareness information for these catchments will be subsequently reviewed. Beyond this the Government intends to make sure that lessons are learned from emergencies and that capabilities are expanded. Regional and local resilience teams will be drawn into these plans.

Defra's new Outcome Measures consultation document (Defra, 2006b) now includes measures of delivery of certain non-structural flood measures. For example, Outcome Measure C1 is inappropriate development in flood and coastal erosion risk areas. Proposals are to measure this by the number of planning applications permitted by Local Planning Authorities, where the outcome is known, against a sustained objection from the Environment Agency on risk grounds, as a percentage of the total number of applications to which the Agency sustained an objection on flood risk grounds. Similarly, there are proposed Outcome Measures on contingency planning by emergency responders, and the percentage of households and businesses offered appropriate flood warning.

The **Environment Agency's flood risk management policy** is set out in its 'Strategy for Flood Risk Management (2003/4 - 2007/8) (Environment Agency, 2003b), and no doubt will be refreshed shortly. The approach springs from the Agency's Corporate

Table 3.4: Key points from the Environment Agency's Flood Risk Management Strategy 2003/04 – 2007/08 (EA, 2003)

- a change of thinking from ***defending*** to ***managing*** floods;
- a future strategy that focuses upon a strategic approach to flood risk management which moves the emphasis from flood defence to flood risk reduction;
- prevention of inappropriate development that could increase flood risk;
- whole life-cycle management of flood defence infrastructure to ensure highest performance and return on investment;
- streamlining of activities to manage floods, including flood planning, flood forecasting and warning, flood event management, flood event recording and reporting, after-care and recovery;
- effective communications to support policies; and
- improvement of business efficiency and effectiveness.

Strategy, then entitled 'Making it Happen' (subsequently entitled 'Creating a Better Place' (Environment Agency, 2006b)).

FRM policy influence on flood risk management
As with MSFW, the policies in this strategy also strongly signal a move towards much greater use of non-structural flood measures.

3.12 The insurance policy agenda

In England flood insurance is provided to householders as a standard element within private household structure and contents insurance policies Many people living in and outside of floodplains therefore possess flood insurance cover, although a significant minority do not purchase or maintain their household insurance cover. There is no government based insurance system in England, and this has been the case for many years. The recent history of flood insurance in England, and the changing context in which the flood insurance industry has found itself, is summarised in an interview with an insurance industry manager (Inset 6).

The private insurance industry is represented by the Association of British Insurers (ABI). The ABI's policy is set out as a Statement of Principles in a document published specifically on flooding in 2002 (ABI 2002a, 2000b) and is as follows:

- full access to a competitive market for insurance for the vast majority of homeowners and businesses;
- improved security for those who live and work in high risk areas;
- new provision for those who wish to sell their homes and businesses in high risk areas;
- better use of new solutions to make properties insurable, even in high risk areas where improvements to flood defences are not planned; and
- a clear incentive from Government and local authorities to continue to invest in flood and coastal defences, addressing the wider economic costs of flooding.

This Statement of Principles identified the 1.3% annual probability (1:75 years) as the limit at which insurers can offer premiums within the normal range available on the competitive market for household insurance (ABI 2002a). The Statement also indicates that insurers will work with customers in locations with a flood risk higher than 1.3% to see how alternative damage management strategies could make a continuing level of flood insurance possible.

The ABI's policy was further elaborated in 2006 (ABI 2006) as follows:

"members want to continue to offer flood insurance as standard – unique in the developed world – as widely as possible. But this remains dependent upon adequate risk management. Insurers are committed to continuing insurance cover where the Government is able to improve flood defences to an adequate standard within five years" (ABI 2006).

In following this policy the ABI is clearly indicating the following key points:

- flood insurance provided as standard cannot be taken for granted: it could be withdrawn in future;
- continuation of standard household and business flood insurance is dependent upon a) adequate risk management and b) improved flood defences which is linked currently to a demand to increase flood defence expenditure; and
- the ABI expresses a presumption which is in favour of structural flood defences, at least as the prime approach to flood risk management.

The ABI states that the Government estimates annual flood damages in the UK to average £2.3 billion per year (approximately Euros 3.45 billion). To manage this risk the ABI believes that spending on structural flood defences needs to rise from the level in July 2006 (£570 million per annum) to £750 million per annum by 2011. In fact during 2007 the Government announced it's intention to spend £800 million per annum in a cross-department approach to flood risk management.

The ABI does not entirely base its policy on flood risk management on structural flood defences, although it currently clearly considers them to be the dominant solution (ABI 2004). The ABI argues that Government policies on house building and infrastructure development, as well as commercial property development, are increasing flood risk through locating developments in flood risk areas. Therefore, it also supports a number of non-structural policies (ABI 2006) including:

- tighter land use policies to exclude inappropriate development in flood risk areas;
- the rolling out of flood warning systems to 80% of homes in flood risk areas; and
- improved flood risk modelling and mapping so that people can make their own decisions about managing flood risks.

The ABI also supports the building of flood resilient homes (ABI 2004b; ABI/National Flood Forum, Undated).but has not gone as far as to offer risk premium discounts to encourage adoption of flood resilience measures.

Inset 6

Interview with a senior insurance industry manager, 14 October 2005 (Recorded verbatim)

'Yes. So basically what happened, the history of insurance is that up to the mid 60s flood insurance wasn't part of your household contract and in the 60s the government said 'we'd like it to become part of the standard insurance, and if you do that, insurers, we will build flood defences that protect properties, so that you're not taking an unfair risk, but we'd like it to be just market rate. So, up to 98 that's what had happened. The only trouble was, unless you'd had a claim, you did'nt know that an area was bad. You know, yes everybody knows that York has floods, but unless you've actually had a claim as an insurer, you would'nt know that 2 Acacia Avenue was a problem one. And after 98 the government said 'its unfair that people don't know that they have a flood risk', so the Environment Agency put together the Indicative Flood Plain Map. So in 1999 when that came out, that was the first map any insurer had ever seen that represented flood risk. 2000 floods happened, and (a) the map did'nt really show us necessarily the areas that had flooded, but worse the government said 'flooding's going to get much worse than it is, 10 fold worse in the next 100 years, and some properties are'nt defendable, its just not economic to defend all the properties. At which point the insurers had to stand back and say 'well if you'r not going to protect them, we need to actually understand the risk we're running better than we do and with the Indicative Flood Plain Map it basically said 'you're in' or 'you're out' of the 100 year flood plain. Well, that does'nt really do it for an insurer. How do I, you know, if there are people who have floods every other year ? Well, how do I know that you flood every other year rather than once in a century ? I don't, I can't. You know it's not something that's available to me. So we tried talking to the Environment Agency and pointed out that insurers have a very different need to a lot of other people, and the answer was basically 'and who are you exactly and what the hell do you think you're asking for ?, and so we started on our own. So, I came back and I walked in and two days after they'd signed a contract with Intermap to acquire a height model, because one of the keys as far as we were concerned was, you have to know the height above sea level before you put the flooding on, so that you actually work it at property level. And my boss said 'go forth and flood model' so I have spent the last 3 and a half years of my life building a flood model of England and Wales'.

3.13 The floodplain occupant's policy agenda

Floodplain occupants (e.g. residents) in England and Wales are represented by the National Flood Forum (NFF) (http://www.floodforum.org.uk/flood_forum) which was established from a single local flood action group in January 2002. The NFF is a Company Limited by Guarantee and was funded by the Environment Agency for the first three years of its existence, but the NFF is run by people who experience flooding themselves. The NFF is linked to about 60 local flood action groups around the country. The objectives of the NFF are to stimulate and assist in the creation of community groups in areas at risk from flooding in order to give them a strong voice locally and nationally. It seeks to provide resources, facilities and a forum for all those affected by flooding; and seeks to promote ideas and best practices of self-help to combat flooding effects. It also seeks to create close working relations with flood defence agencies and the insurance industry.

NFF policy influence on flood risk management
The NFF's main policy is 'flood resilience through partnership' and it tends to emphasise small-scale, engineering and other modifications to buildings which are generally classified as non-structural measures (i.e. resilience or flood proofing measures). NFF promotes this approach is partly responsible for introducing and endorsing it. NFF's objectives emphasise a) self-help; b) awareness-raising and education; and c) flood protection products and services. These products and services are listed in the NFF's 'Blue Pages' and include modular slot-in barriers, mechanically assisted cantilever systems, hinged and sliding floodgates demountable barriers, vent covers, window barriers, sewage backflow prevention valves, drying products and many other such products which may be used to make a property more resilient to flooding.

3.14 The FRM research and development (R&D) policy agenda

The Government's research and development policy agenda looks forward to a vision of a new era of flood risk management, the main elements of which are described above in Section 1. It is a key policy influence on the future of flood risk management in England. Defra's flood and coastal erosion risk management research and development programme comprises four main areas:

- strategy and policy development;
- flood risk assessment and modelling;
- sustainable asset management; and
- incident management and community engagement.

In each of these areas there is a strong emphasis upon not only maintaining and improving the standard of structural flood defences, but also upon making a great deal of progress in encouraging non-structural measures. For example, the research and development programme emphasises land use planning, raising public awareness of flood risks, formulating and issuing flood warnings, increasing the use of resilience measures, improved building regulations and other non-structural measures.

3.15 Assessment and evaluation: a FHRC view

This concluding section is concerned with the following questions.

1. What may be learned from this study of policy contexts and its evidence base?
2. What may be stated about the current policy context in which decisions about both structural and non-structural flood measures are made in England ?
3. What may be stated about the comparative influences of different policy agendas upon decisions about structural and non-structural flood measures in England ?

3.15.1 Lesson from this study of policy contexts

For us, the key lesson 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.

3.15.2 The current policy context of decisions about flood measures in England

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.

It is 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.

3.15.3 The comparative influence of different policy contexts or agendas

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. 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 Section 2.4 - 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.

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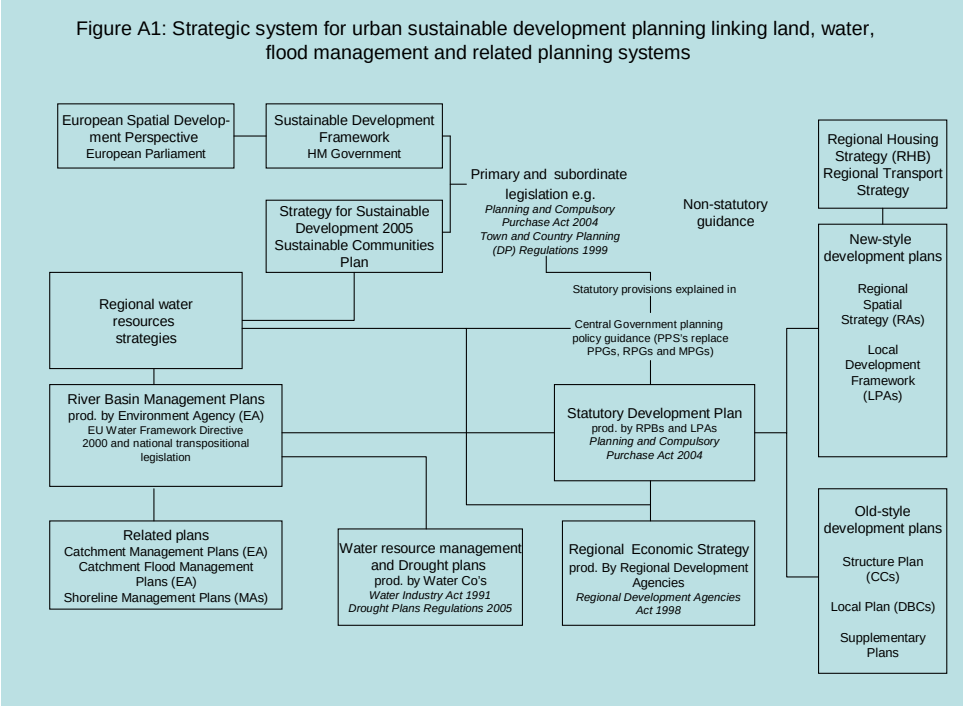
Appendix 1: The organisation of the strategic planning framework in England

The strategic system for urban sustainable development planning, which links land, water and related planning systems together, is shown in Figure 3.10. This figure shows the national framework based upon policies set out in legislation. It also shows on the one hand with the European level of governance, and on the other hand with the regional layer of governance and planning (which the Government refers to as local governance). The relevance for flood risk management is that it is often these spatial planning systems that determine the exposure and vulnerability of those at risk from flooding, and in this the implementation of NSMs, not what flood risk managers themselves can achieve alone. Moreover, in England flood risk managers work within catchments (through Catchment Flood Management Plans and Shoreline Management Plans) and the boundaries of these do not coincide with the boundaries to which spatial planners work.

Figure 3.10: Strategic system for urban sustainable development planning linking land, water, flood management and related planning systems.



Under town and country planning legislation (i.e. Town and Country Planning (TCP) Act 1990; TCP (Development Plan) Regulations 1991; TCP (General Permitted Development Order 1995; TCP (General Development Procedure) Order 1995) local authorities (LAs) (Figures 3.11 and 3.12) must prepare statutory development plans for a ten year period. These plans consist of: a) structure plans, b) Unitary development plans, c) local plans, d) Mineral Plans, and e) Waste Local Plans.

Under the Local Government Act 2000, English LAs must prepare Community Strategies for promoting or improving the economic, social and environmental well-being of their area and contributing to the achievement of sustainable development. The Department of Communities and Local Government (DCLG) gives guidance to LAs on preparing these strategies. The Planning and Compulsory Purchase Act 2004 applies to regional and local planning bodies who have a duty to exercise their functions with the objective of contributing to the achievement of sustainable development and to have regard to national policies and guidance from Ministers in fulfilling the duty. The duty introduced a new planning framework and requires regional and local planning bodies to prepare regional and local spatial plans which contribute to sustainable development achievement. These plans are currently (January 2007) being developed.

Regional Assemblies (RAs) (e.g. the West Midland Regional Assembly) are voluntary, multi-party and inclusive bodies which have been established in each of the eight English regions outside of London (Figure 3.13). They are established under the Regional Development Agencies Act 1998 (where they were referred to as regional chambers). The RAs are the bodies that Regional Development Authorities (RAs) must consult in preparation of its regional economic strategy. They are designated in accordance with the Planning and Compulsory Purchase Act 2004 as the Regional Planning Body for the region with a duty to prepare a regional spatial strategy which includes a transport strategy and a regional waste strategy. They have a role as the voice of the region and can prepare regional strategies, such as regional sustainable development frameworks, taking the lead role in some regions. They also take responsibility since September 2006 for the work of Regional Housing Boards. Thus RAs are now Regional Planning Bodies and take an overview of regional housing markets producing Regional Housing Strategies and advising Ministers on the distribution of resources for affordable housing schemes (delivered through Housing Corporations). RAs also scrutinise the work of the RDAs (Communities and Local Government 2006).

Under the Regional Development Agency Act 1998, nine Regional Development Agencies (RDAs) were created. Their primary duty alongside others is to further economic development and regeneration; promote business efficiency, investment and competitiveness; promote employment; and to enhance skills relevant to employment. They have a duty to contribute to the achievement of sustainable development, where it is relevant to do so. Ministers, including from DCLG, may give them guidance. When first formed RDAs saw their sustainable development contribution falling mainly around the economic pillar, but some have since developed processes to minimise environmental aspects of their operations (some going on to formulate sustainability appraisals). The starting point for all RDA activity is the Regional Economic Strategy (RES) which are required to be subject to a Sustainability Appraisal. There are a number of other strategies which underpin RDA activity including Regional Sustainable Development Framework (a Department for Environment, Food and Rural Affairs initiative) and Integrated Regional Strategies (an ODPM initiative). These strategies overlap and there is currently some confusion about which takes precedence. The parts of RES for which RDAs are responsible are implemented through a Corporate Plan for each RDA. Corporate Plans for 2005-08 have been prepared in the light of guidance from Ministers (the Tasking Framework).

Figure 3.11: Local Authority County Council boundaries

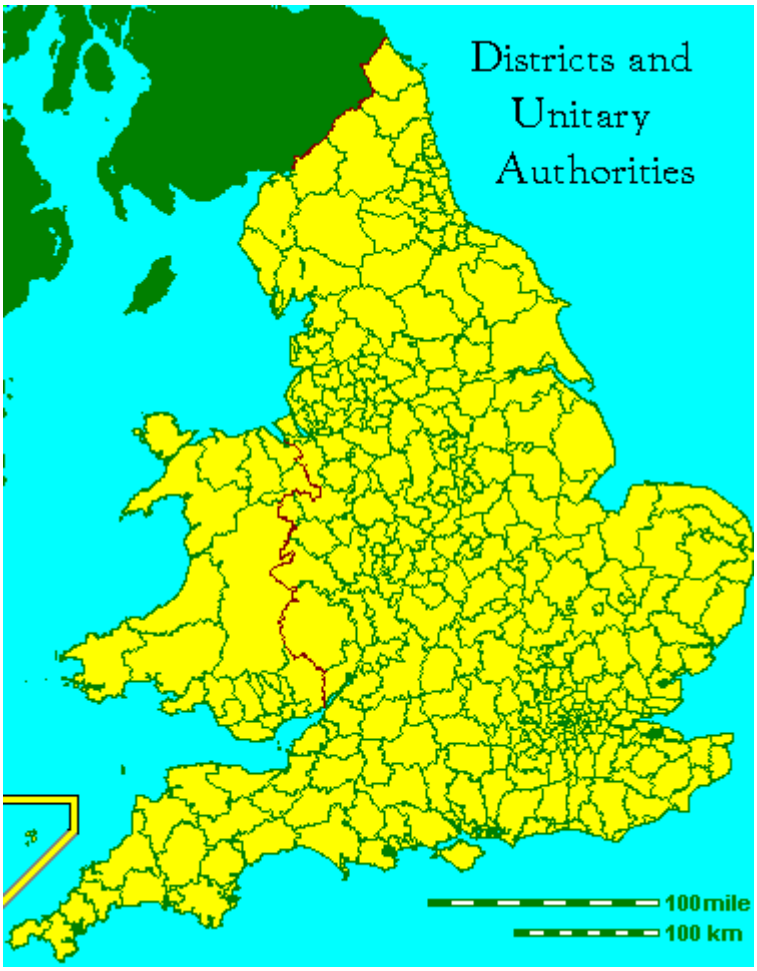


Figure 3.12: Local Authority District and Unitary Authority boundaries

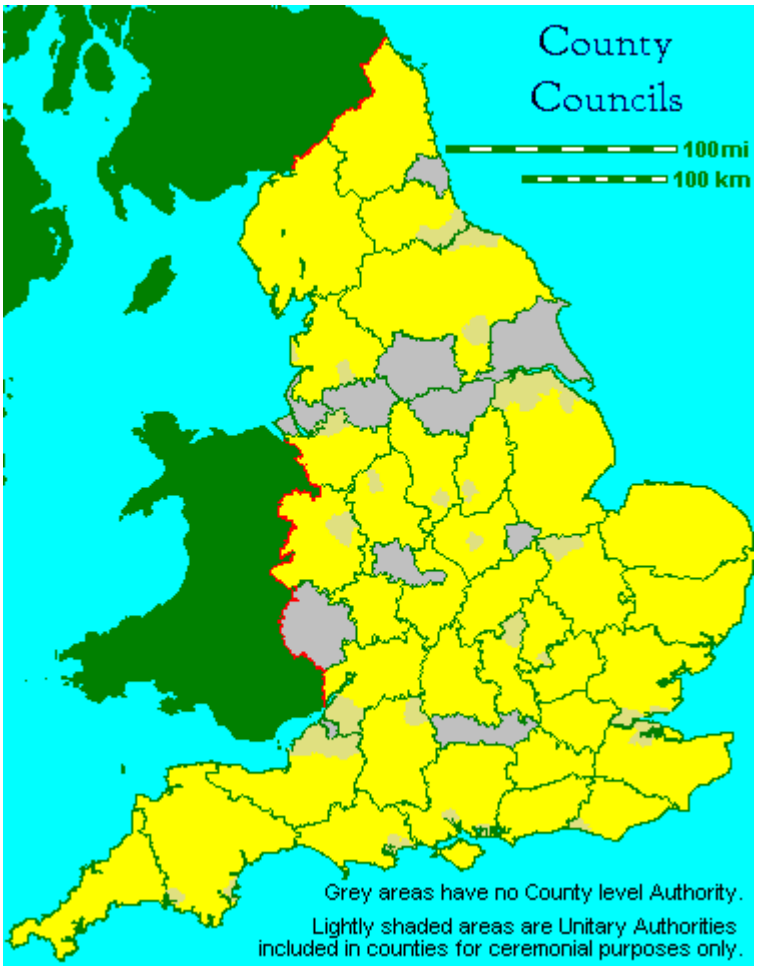
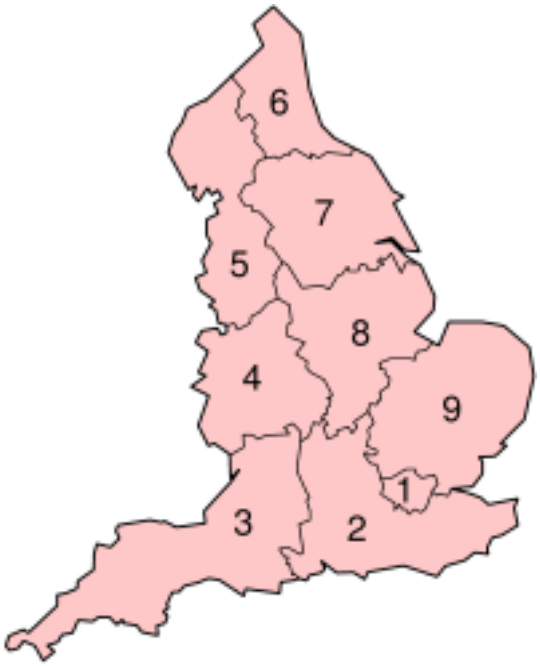


Figure 3.13: Boundaries of the Regions of England



1. London
2. South East England
3. South West England
4. West Midlands
5. North West England
6. North East England
7. Yorkshire and the Humber
8. East Midlands
9. East of England

The regions are also known as Government Office Regions. These regions are those for Regional Assemblies and Regional Development Agencies.

Appendix 2: The organisation of flood and coastal erosion responsibilities in England

The role of Defra

The Department for Environment, Food and Rural Affairs (Defra) has overall responsibility for flood and coastal erosion risk policy in England. Defra also funds most of the Environment Agency's flood management activities in England, and gives to the EA a 'strategic overview' role, working at a catchment level.

Defra provides grant aid on a project by project basis to the other flood and coastal defence operating authorities. These are local authorities which have flood defence responsibilities on non-main rivers, and Internal Drainage Boards which have responsibilities in low-lying rural areas.

Defra provides funds to support investment in capital improvement projects to manage flood risk and coastal erosion, which are often interrelated.

The changing supervisory role of the Environment Agency

The First Government Response to *Making space for water* indicated that the Environment Agency should adopt a strategic overview of all flood and coastal erosion risk management issues. This will ensure that a holistic approach to risk management is taken and provide a focal point for the public on all sources of flooding.

A Defra project is exploring the precise arrangements for that strategic overview examining the different options and where the benefits would lie. This includes reviewing the current legislative and institutional arrangements of how flood and coastal erosion risk management is currently being addressed, and will consider the impacts of Integrated Coastal Zone Management, the Water Framework Directive, Catchment Flood Management Plans and Shoreline Management Plans.

Coastal

In December 2007, Phil Woolas, Minister of State for the Environment, set out the implementation plan for the Environment Agency's Strategic Overview for all sea flooding and coastal erosion risk management.

Under the approach which Ian Pearson announced in June 2007the Environment Agency will become the lead organisation for all flood risk management while management of coastal erosion risk will remain with local authorities under an Environment Agency strategic overview. The Environment Agency will:

- Become responsible for managing and quality assuring the production of all Shoreline Management Plans.
- Assess all risk, prioritise risk management programmes, allocate and manage Government funding for work programmes.
- Ensure the effective procurement, delivery and future management, operation and maintenance of all capital works (with local authorities continuing to propose and deliver work on the ground, where they have the skill and expertise to do so effectively, under Environment Agency's strategic oversight).
- Be given powers, concurrently with local authorities, to undertake coast protection work including, having powers to refuse approval for new coastal erosion works and to remove existing defences or build new defences, where this is necessary to fulfill the objectives of, or can be justified under, the Water Framework Directive.

The Regional Flood Defence Committees' role will be extended to embrace coastal erosion (and they will also oversee all sea flooding, including that currently undertaken by local authorities). To reflect this widened remit, representatives of relevant coastal groups will be brought onto the Regional Flood Defence Committees. Regional Flood Defence Committees will not, however, have levy raising powers in relation to coastal erosion as this would represent an unfunded new burden on local authorities.

Coastal Groups will be reconstituted to become larger (and hence fewer) and more strategic organisations with fully inclusive membership and consistently strong representation from the Environment Agency. There is a substantial implementation programme to be taken forward, and officials have worked closely with Environment Agency and local authority colleagues in drawing up a detailed implementation plan.

A Project Board, comprising officials from Defra, Environment Agency and the Local Government Association, has considered proposals for the form of the Environment Agency Strategic Overview and as key members of the Project Board the Environment Agency and the Local Government Association have helped steer the approach of this project. They have been fully involved in developing models, agreeing the scope and context of evidence gathering work.

In helping to take forward our consideration, Defra has also had several discussions with representatives of the coastal local authorities representative organisations including the Local Government Association's Coastal Special Interest Group, the Coastal Group Chairmen (who collectively represent all coastal local authorities) and the Local Government Technical Advisors Group.

Inland

By giving the Environment Agency a strategic overview for inland flood risk management, a different Defra project aims to improve governance, funding and delivery arrangements. It will enable a more holistic and sustainable approach to flood risk management with robust, evidence based decision making, effective stakeholder engagement and democratic input, best value from investment programmes and the best use of technical expertise.

Evidence will be gathered from the existing framework of flood management delivery bodies to identify where there are limitations in the Environment Agency's existing supervisory duty and any gaps in flood risk mapping. This analysis of will inform the development of proposals to address these issues and improve the Environment Agency's strategic overview. The proposals will apply equally in rural as well as urban issues, define the legal powers required to change the Environment Agency's role and lead to a full consultation with stakeholders in order to secure Ministerial agreement to the final proposals. An implementation plan will define how and when any changes will be brought into effect.

Though this is primarily a Defra project it will also seek to identify how any revised responsibilities fit in with the Welsh Assembly Government's Environment Strategy. In summary, this project will aim to tackle the following issues:

- All forms of inland flooding other than localised domestic flooding (for example from plumbing failures) including the risks posed by climate change.
- Consideration of cross-government issues.
- Current roles and responsibilities of all bodies involved in inland flood risk management
- Reviewing the effectiveness of the existing Environment Agency supervisory duty
- Future roles and responsibilities of delivery agents and their relationship with the Environment Agency in the context of their overview (for each form of flooding).
- Legal considerations, levers and powers required to enable an effective strategic overview role.
- The role of Regional Flood Defence Committees in relation to the EASO (Inland).
- Details of the relationship between the Environment Agency, local authorities, the Highways Agency, Ofwat and water companies for the management of pluvial flood risk in urban areas.

- Wider roles and responsibilities for the Environment Agency for cross-cutting functions such as strategic planning, awareness raising and being the first point of contact for the public, informed by the *Making space for water* project looking at improved flood warning.
- Proposals for how, when and by whom any required changes should be taken forward, having regard for the practicalities of implementation and providing a clear programme.
- Review risk mapping requirements and responsibilities.
- Take account of other *Making Space for Water* projects insofar as they might affect the recommendations of this project and the Water Strategy as a possible vehicle for delivery of initial outputs.
- Impact Assessment including an estimation of costs to the Environment Agency and other delivery bodies as appropriate.
- Funding to deliver new burdens and implement legislation.

In terms of timetable, in February 2008 Hilary Benn launched a new Water Strategy for England, along with an accompanying consultation on improving surface water drainage. Surface water flooding was a major issue during the summer 2007 floods so Defra is developing this aspect of the Environment Agency's new strategic overview as a priority.

The Environment Agency Strategic Overview for Inland Flood Risk Management (EASO (Inland)) project is drawing upon evidence from a number of Making Space for Water projects. In particular Defra will look to the conclusions and recommendations from the Integrated Urban Drainage pilots (HA2) to inform development of this project. For this reason, initiation of the EASO (Inland) project was deferred somewhat but is now getting underway. Its primary aim will be to develop an overview for the Environment Agency that will improve governance, funding and delivery arrangements.

Appendix 3: Flood warning codes, icons and associated advice

Flood Warning Codes currently used in England and Wales

Watch – Flooding of low lying land and roads is expected. Be aware, be prepared, watch out!

Warning – Flooding of homes and businesses is expected. Act now!

Severe Flood Warning – Severe flooding is expected. There is extreme danger to life and property. Act now!

Clear – Flood Watches or Warnings are no longer in force for this area

"Information you can act on."

Flood Watch

Flooding is possible, and the situation could worsen, so:
- Watch water levels
- Stay tuned to local radio or TV
- Ring Floodline on 0845 988 1188
- Make sure you have what you need to put your flood plan into action
- Alert your neighbours, particularly the elderly
- Check pets and livestock
- Reconsider travel plans

Flood Warning

Flooding is now expected, so put your flood plan into action:
As with Flood Watch plus
- Move pets, vehicles, food, valuables and other items to safety
- Put sandbags or floodboards in place
- Prepare to turn off gas and electricity
- Be prepared to evacuate your home
- Protect yourself, your family and others that need your help

Severe Flood Warning

Severe flooding is now expected:
As with Flood Warning plus
- Be prepared to lose power supplies - gas, electricity, water, telephone
- Try to keep calm, and to reassure others, especially children
- Co-operate with emergency services and local authorities
- You may be evacuated

Appendix 4: Flood warnings: new performance measures for 2006/07 to 2010/11

FRM CORPORATE LEVEL OF SERVICE MEASURES

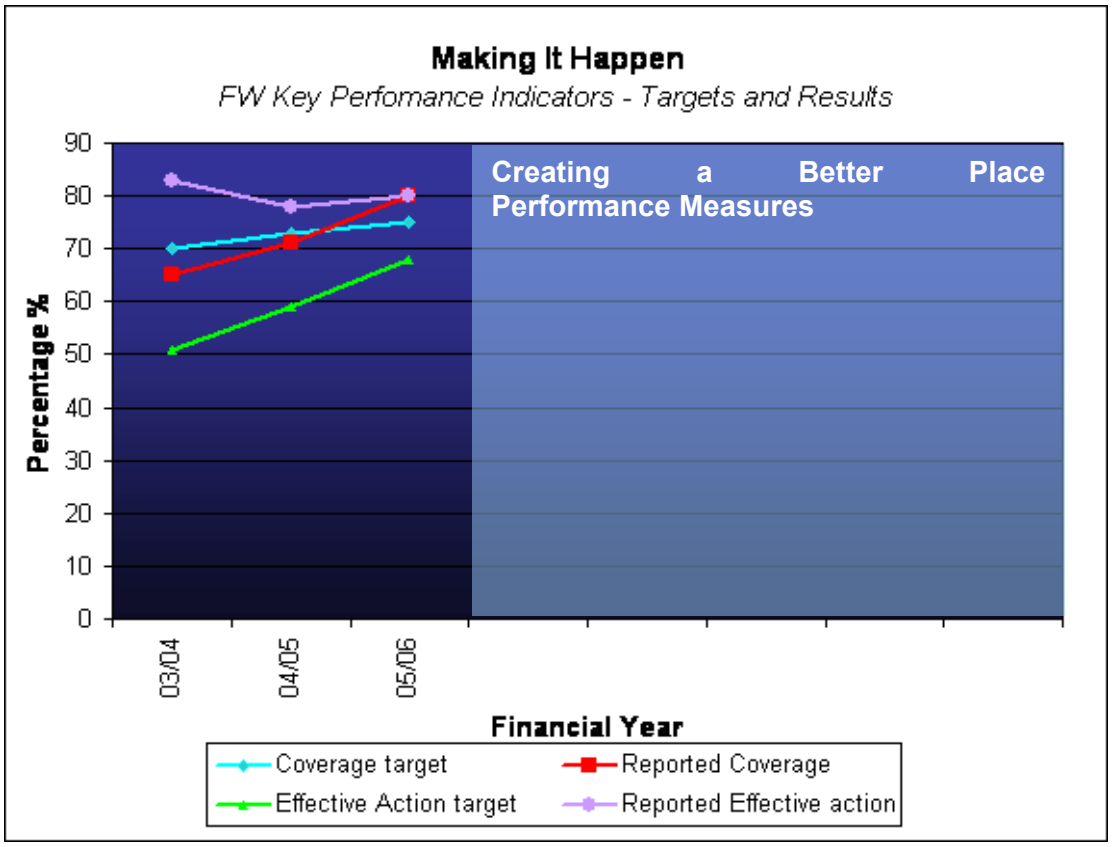
FRM SL3 Proportion of at risk properties (within EFO) offered an appropriate flood warning service

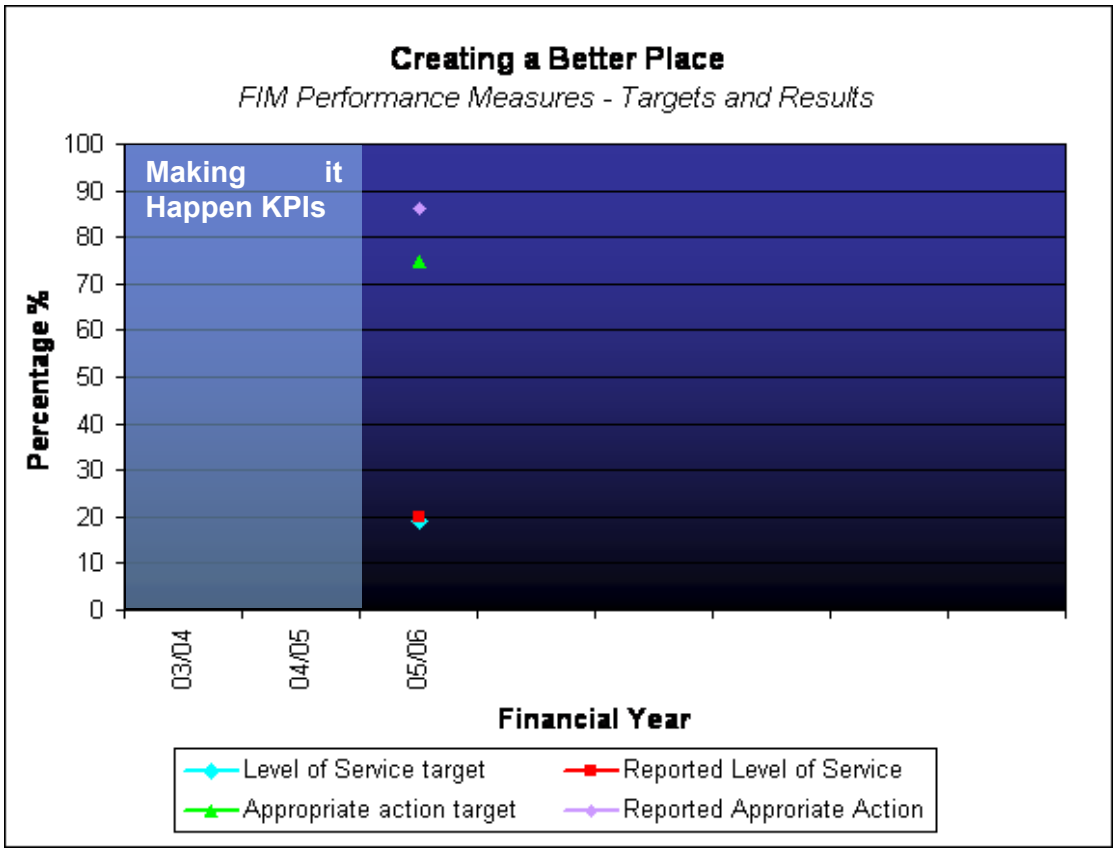
FRM SL2 Proportion of people taking appropriate action in response to flooding

Summary: Agency Wide Targets and Performance from 2003/04 to 2005/6

	Performance Measure or KPI	Target or Report	03/04	04/05	05/06
Old KPI	Coverage target	TARGET	70	73	75
Old KPI	Reported Coverage	report	65	71	80
Old KPI	Effective Action target	TARGET	51	59	68
Old KPI	Reported Effective action	report	83	78	80
3	Level of Service target	TARGET			19
	Reported Level of Service	report			20
2	Appropriate action target	TARGET			75
	Reported Approriate Action	report			86

06/07	07/08	08/09	09/10	10/11
78	78	79	80	80
75	78	82	85	85
43	60	67	75	80
75	75	75	75	75


Making It Happen
FW Key Perfomance Indicators - Targets and Results
Creating a Better Place Performance Measures
Percentage %
90
80
70
60
50
40
30
20
10
0
03/04
04/05
05/06
Financial Year
Coverage target
Reported Coverage
Effective Action target
Reported Effective action


Creating a Better Place
FIM Performance Measures - Targets and Results
Making it Happen KPIs
Percentage %
100
90
80
70
60
50
40
30
20
10
0
03/04
04/05
05/06
Financial Year
Level of Service target
Reported Level of Service
Appropriate action target
Reported Approriate Action

4 Analysis of the policy contexts in Scotland driving decision-making about structural and non-structural measures

4.1 Introduction

This report is written as a component of Work Package 2: the country study Scotland and is intended to complement an analysis of the policy context for the decisions on structural and non-structural measures in England (Parker, 2007). The overall aim of this report is to analyse and comment on national level policies in Scotland which drive the decision-making processes in flood risk management. Both structural and non-structural measures are included reflecting the range of options currently deployed in managing flood risk.

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 in Scotland

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.

Scotland is a highly urbanized society with 82% of the population living in settlements of more than 3,000 people but occupying only 2% of the land area (Scottish Natural Heritage, 2002). In June 2006 the population of Scotland was 5,116,900 (General Registrar Office for Scotland, 2007). This represents an increase of around 25,000 since 1996 with the largest increases being reported in West Lothian, East

Lothian and Stirling. By contrast, Eilean Siar, Dundee City and Inverclyde experienced the largest decreases during the same period. This localised pattern of declining population in rural areas and urban areas still experiencing a contracting labour market is likely to continue. By contrast, the most recent projections by the General Registrar Office for Scotland (2007) show the total population of Scotland rising each year from 5.12 million in 2006 to 5.37 million in 2031 before declining after 2031 to 5.19 million in 2056. This is a striking reverse of recent trends.

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

Each is now examined in turn.

4.3 Housing policy

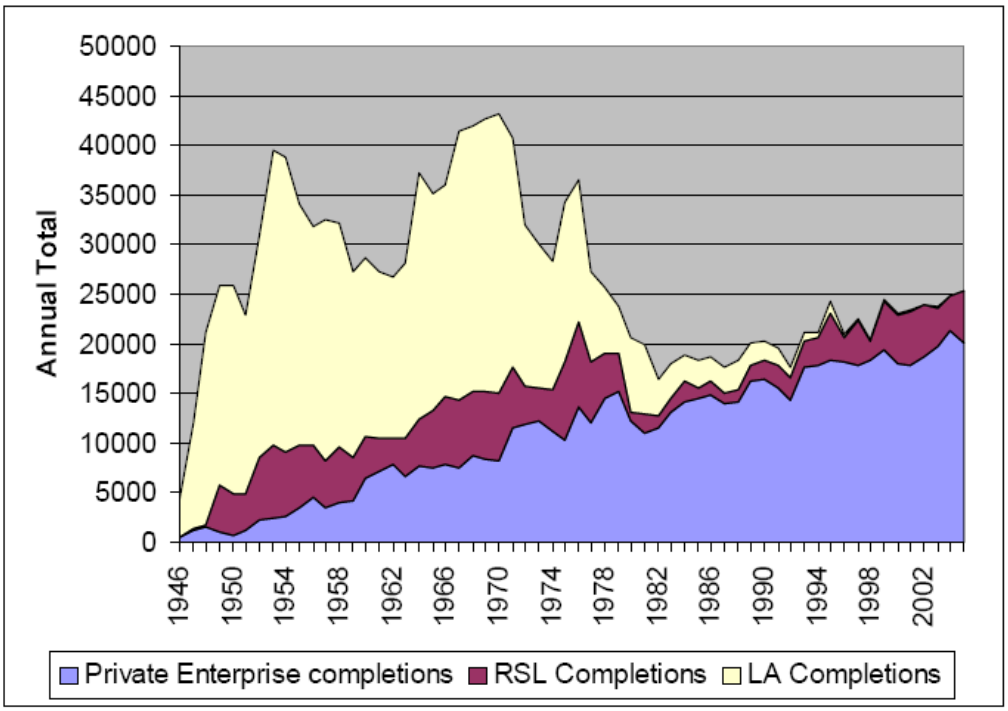
The recent *Scottish Housing Market Review* (Scottish Government, 2007b) examined the operation of the Scottish housing market and covers some of the same ground as already consider in the *Barker Review* (HM Treasury, 2004) of the UK housing market.

The long-term trend in house prices in Scotland has been one of annual increases of around 1.5% - lower than the UK as a whole where prices have increasing between 2.0 and 2.5% per year. However, since 2000 house prices in Scotland have risen by 12% (or around 2.8% per year) well above this long-term average. Increasing prosperity and a decline in household size has also caused the absolute number of households to grow and, given projected increases in population up to 2031, this trend is likely to continue in the medium term and will place further pressure on land prices. By 2004 the cost of land designated for residential building had risen from £0.54 million per hectare (2002-03 prices) to £1.37 million per hectare. Much higher prices in 2004 have been reported for Edinburgh (£3.4 million per hectare) and Glasgow (£2.2 million per hectare). But Aberdeen has experienced lower rates of growth and land values in Dundee have broadly remained static over the same period.

The current housing stock of 2.4 million is currently being increased by around 19,000 houses per year (Figure 4.1) and the new build rate is higher than in the rest of the UK, although population growth has been at a slower rate. However, it is difficult to judge whether this supply is adequate to keep up with rising demand, especially in areas such as Edinburgh and Lothian where household growth has exceeded growth in the housing stock

Figure 4.1: Annual housing completions: 1945-2005 (Scottish Government, 2007b)

Figure 23: Annual Completions – 1946 – 2005



Source: DCLG Table 246

The new government's housing policy is set out in *The Future of Housing in Scotland: A Discursive Document* (Scottish Government, 2007c) in which an annual target of 35,000 new homes per year by 2015 is set. This is a rate that has not been exceeded since the 1960s and early 70s (Figure 4.1). First time buyers are to be encouraged into the housing market via a Low-cost Initiative for First Time Buyers (LIFT). Of particular relevance to flood risk management is the expectation that this is to be based on a mix of "expanded, or new, stand-alone settlements that are sympathetic to Scotland's landscape and environment" and incentives to local authorities to build new social housing. Scotland's policy on green belts is set out in *Scottish Planning Policy 21: Green Belts* (Scottish Executive, 2006) in which the strong presumption against inappropriate development in green belts is restated. This should be set alongside *Scottish Planning Policy 3: Planning for Housing* which states that "sites likely to be at significant risk from flooding including those on the functional flood plain should not be developed for new housing" (Scottish Executive, 2003, p 9) in order not to increase areas that require flood alleviation schemes. Overall, it seems likely that pressure on floodplains for new housing development will increase over the short- to medium-term.

4.4 Sustainable development.

At a UK level the strategy for sustainable developed is set out in *Securing the future: delivering UK sustainable development strategy* (DEFRA, 2005a). Since many aspects of sustainable development involve devolved powers, the UK government and the Devolved Administrations have also published *One Future – different paths: The UK's Shared Framework for Sustainable Development* (DEFRA, 2005b) in which the following four aims identified in the 1999 strategy for sustainable development are re-affirmed:

- social progress which recognises the needs of everyone;
- effective protection of the environment;

- prudent use of natural resources; and
- maintenance of high and stable levels of economic growth and employment.

The UK government and the Devolved Administrations also set out agreed priorities in each of these areas and have agreed to monitor key issues on a UK basis.

Delivery of these aims is monitored by the Sustainable Development Commission (SDC) an advisory Non-Departmental Public Body jointly appointed by the four United Kingdom administrations. The role of the SDC (which reports directly to the four administrations) is to advocate sustainable development across all sectors in the UK, review progress towards it, and build consensus on the actions needed if further progress is to be achieved.

Current Scottish policy on sustainable development is summarised in *Choosing our Future: Scotland's Sustainable Development Strategy* (Scottish Executive, 2005) with the following priorities:

- **Sustainable consumption and production**: achieving more with less. This includes reducing the inefficient use of resources, looking at the impact of products and materials across their whole lifecycle and encouraging people to think about the social and environmental consequences of their purchasing choices.
- **Climate change and energy**: securing a profound change in the way we generate and use energy, and reducing greenhouse gas emissions.
- **Natural resource protection and environmental enhancement**: protecting our natural resources, building a better understanding of environmental limits, and improving the quality of the environment.
- **Sustainable communities**: creating communities that embody the principles of sustainable development locally.

The delivery of these priorities is the responsibility of the Greener Scotland Directorate within the Scottish Government created in 2007 to deliver the strategic policy objective of a Greener Scotland

Implications for flood risk management

There are key differences between England and Scotland in the degree to which sustainable development is a policy driver for managing flood risk. The need to have regard to sustainable development is a high order policy objective for the Environment Agency in England and is implicit in DEFRA's *Making Space for Water* (2006). By contrast in Scotland, economic, social and environmental sustainability plus inter-generational equity are explicit in, and underpin many aspects of delivering sustainable flood risk management (Scottish Executive, 2004a; Werritty, 2006). At the time of writing, this has resulted in a Scottish Government consultation on flood risk management in which promoting sustainability is a key priority.

4.5 Planning system

4.5.1 The new planning system

The planning system in Scotland is currently in a state of flux. Current planning procedures dating back to 1974 and based on the two-tier system of regional structure plans and local plans are being phased out. Criticised for being cumbersome, slow, inflexible and too bureaucratic, this system has been streamlined in The Planning etc. (Scotland) Act. (2006). This Act , which represents the biggest reform of

planning since the early 1970s, and quite possibly since the establishment of the Town and Country Planning System in 1947, provides for:

- a new hierarchy of categories of development – national, major, local and minor; and,
- the establishment of single tier local plans.

Other important changes are an enhanced role for the National Planning Framework (NPF) for Scotland; an increased role for supplementary guidance in the determination of planning applications; a tightening of the grounds on which planning appeals can be made; and, the decision not to introduce third party rights of appeal.

Under the new system only local authority-wide local plans will exist, as is anomalously the case at present for Dumfries & Galloway. Within the four major city regions (Edinburgh, Glasgow, Aberdeen and Dundee) additional strategic development plans will be produced to address key land use and infrastructure issues, which by their nature, cross planning authority boundaries. A good example of this is the Metropolitan Glasgow Strategic Drainage Plan. It is anticipated that the new planning system will be more streamlined, more adaptive to change, and far easier to keep up to date than that which it replaces.

One of the few areas of continuity from the old planning system to the new is the role played by Scottish Planning Policies (SPPs) and Planning Advice Notes (PANs). The former provide statements of the Scottish Government's policy on nationally important land use and planning matters, the latter provide practical advice on best practice and innovative implementation. SPPs will continue to be material considerations in any planning application and important documents in the formulation of development plans.

Although The Planning etc. (Scotland) Act 2006 was passed nearly two years ago many of its provisions are still to be implemented. The old system of development plans has yet to be replaced and the Scottish Government has still to clarify the reach of city regions. Additional guidance and documentation on implementing the new system at the local level has also yet to emerge.

4.5.2 The current planning system

The existing planning system is outlined in SPP1: *The Planning System* (Scottish Executive, 2002) which documents the key principles and priorities which guide policy formulation and the decision making process. Key agendas which underpin delivery of the planning system are sustainable development (see above), protecting and enhancing environmental quality and environmental justice (see below). At the national level spatial planning is defined by the *National Planning Framework* (Scottish Executive, 2004b) which is being updated and consulted on by the Scottish Government at the time of writing (Scottish Government, 2008a). It is anticipated that the second National Planning Framework will be published in late 2008. It will provide the opportunity for a national debate about Scotland's long-term spatial development and will make provision for the designation of national developments. Planning applications deemed to be of national importance will be considered by the Scottish Parliament, not the relevant local authority or authorities. A reporter will be appointed to consider the application and then Parliament will decide to either grant or refuse planning permission.

The two most important planning instruments related to managing flood risk are SPP7 (*Planning and Flooding*, 2004) and PAN69 (*Planning and Building Standards Advice on Flooding,* 2004). The key policy recommendations in SPP7 (Scottish Executive, 2004c, summary) are:

- "new development should not take place if it would be at significant risk of flooding from any source or would increase the probability of flooding elsewhere.
- the storage capacity of functional floodplains should be safeguarded, and works to elevate the level of a site by landraising should not lead to a loss of flood water storage capacity
- where built up areas already benefit from flood defences, redevelopment of brownfield sites should be acceptable but greenfield proposals will extend the area of built development at risk and should preferably be considered in the light of alternatives through the development plan process."

SPP7 also provides a Risk Framework which characterises areas for planning purposes by their annual probability of flooding and gives the following planning response (Scottish Executive, 2004c, summary):

- "Little or no risk area (less than 0.1% (1:1000)) - no general constraints.
- Low to medium risk area (0.1% to 0.5% (1:1000 - 1:200)) - suitable for most development but not essential civil infrastructure.
- High risk areas (0.5% (1:200)) or greater - not suitable for essential civil infrastructure; but in built up areas protected by flood prevention works most other development should be acceptable; undeveloped and sparsely developed areas are generally not suited for most development".

SPP7 also suggests that every Council convene a Flood Liaison and Advice Group (FLAG), or combine with other Councils to do so, possibly on a catchment basis. FLAGs are non statutory advisory groups of public and private sector representatives, convened by Councils in an informal setting to share concerns and knowledge and to provide advice on a wide range of planning and other flooding issues.

PAN 69 (Scottish Executive, 2004d) provides background information to key stakeholders on the water environment and the factors which cause flooding. Its typology of floods is wide-ranging and includes river-based and coastal floods and floods caused by surcharging sewers and rising groundwater. It also contains advice for local authorities on managing flood risk via development plans, dealing with planning applications and the promotion of flood alleviation schemes. Advice is also given on the impact of floodwater on buildings and materials, flood resistant materials and guidance is provided on obtaining building warrants. If it seems likely that a proposed development could result in increased flood risk, planning authorities must consult SEPA before granting planning permission. Should the planning authority intend to grant permission for a development on a site where SEPA has identified a significant flood risk, Scottish Ministers must be notified.

4.5.3 Implications for flood risk management

The first *National Planning Framework* (Scottish Executive, 2004b) reported on long-term under-investment in water and drainage infrastructure in the Glasgow conurbation and areas in west-central Scotland. As a result, economic development and urban regeneration is inhibited in areas where urban flood risk is a concern. The second *National Planning Framework* (Scottish Government, 2008a) addresses this concern, in part, by including the Glasgow Strategic Drainage Plan as one of nine prioritised infrastructure projects designed to support sustainable economic growth while protecting the quality of the natural and built environment. Given that one of the other nine projects comprises the facilities and infrastructure to support the 2014 Glasgow Commonwealth Games, it is likely that the Glasgow Strategic Drainage Plan will see a steady release of resources over the next decade.

The present system of planning approval for local authority flood alleviation schemes is unduly cumbersome. Under the 1961 Act, before submitting a scheme for approval by Scottish Ministers, local authorities must advertised the new or improved flood defence and notify any interests affected by the scheme. But in addition to this confirmation process, flood alleviation schemes also require planning permission. In most cases Scottish Ministers are involved in both processes, albeit to different time

periods. There is clearly a need to simplify these overlapping processes. A Scottish Government proposal, currently under consultation (Scottish Government, 2008c), is that either Ministerial confirmation should carry planning permission or a local authority based process would lead to deemed planning consent.

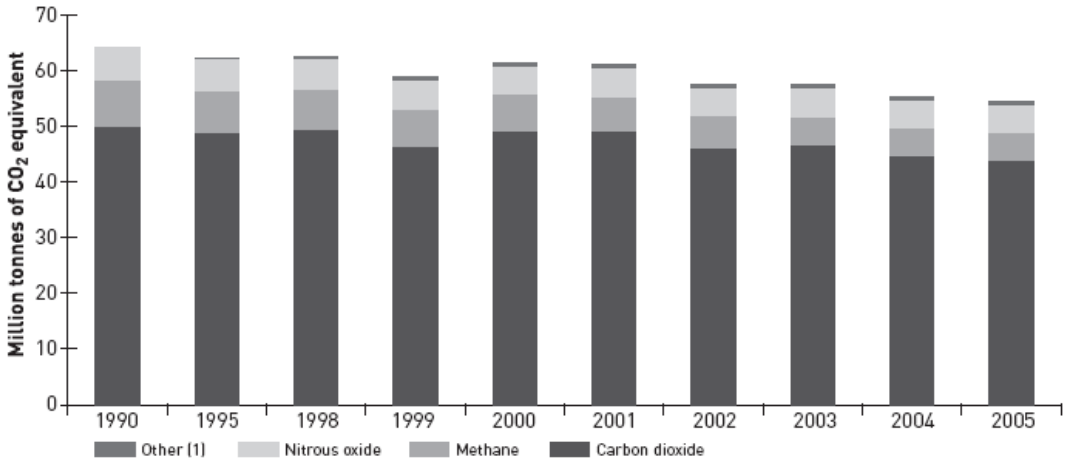
The implementation of the new planning system in Scotland will impact on flood risk management mainly via a streamlining of local authority plans and a simplified procedure for obtaining planning permission for flood alleviation schemes. The role of key SPPs and PANs is likely to remain as before although, as with the National Planning Framework, these will undergo further revision following the proposed Flooding Bill.

4.6 Climate change

Policy related to climate change in Scotland is complex and rapidly changing reflecting increasing concern about reducing greenhouse gas emissions (as proposed in the Scotland Climate Change Bill), managing potential impacts and the drive towards more renewable sources of energy. The drivers for policy making in this area operate at international, national and local levels.

The key determinant of policy at the international level is the UN Framework Convention on Climate Change (1992) which came into force in 1994. The Convention requires countries to gather information on greenhouse gas emissions and cooperate in launching strategies for adapting to the expected impacts of climate change. However, until the Kyoto Protocol (1998), the Convention included no legally binding agreements. This changed when the Protocol was ratified in 2005 as a result of which the EU agreed to reduce its greenhouse gas emissions by 8% against 1990 levels by 2008-2012. The UK component of that EU target is a reduction of 12.5%. Scotland emitted 54 million tonnes of greenhouse gases in 2005 equivalent to an overall reduction of 15.4% compared to 1990 levels (Figure 4.2).

Negotiations are already underway to set new, more challenging targets driven, in part, by the *Stern Review* (HM Treasury, 2006) which found that if nothing is done to mitigate climate change, conservative estimates of the impacts could cost the equivalent of 5% of global GDP each year. Noting the adverse impacts of climate change and the much reduced costs of stabilising greenhouse emissions at 550 parts per million by 2050 (only 1% of global GDP according to the *Stern Review*), the UK government is proposing a reduction of 60% in CO_2 emissions by 2050 in its Climate Change Bill. The comparable target in the Scottish Climate Change Bill is an 80% reduction in CO_2 emissions (Scottish Government, 2008c, p. 48).



(1) Hydrofluorocarbons, perfluorocarbons and sulphur

Figure 4.2: Net green house gas emissions taking account emissions and removals [Mt CO_2e: 1990-2005} (Source, Scottish Government 2008c, p. 21)

4.6.1 Implications for flood risk management

Climate change influences flood risk management in three ways. Firstly, the warmer wetter Scotland predicted by climate scientists (UK Climate Change Impacts Programme, 2002) will increase winter flood risk in the west of Scotland and the potential for summer flooding in cities. Sea-level rise, potentially coupled with more frequent and severe storm surges, will also increase the risk of coastal flooding. Secondly, successful mitigation of greenhouse gas emissions (as envisaged in the UK and Scotland Climate Change Bills) and greater reliance on renewable energy by 2050 will lessen this increase in flood risk. Thirdly, even if the least threatening Foresight scenario for future flooding is adopted (Evans *et al*., 2004), adaptation and learning to live with locally enhanced flood risk will become a major policy driver. The consequences of this are already apparent in the *National Flooding Framework* (2003) and the development of sustainable flood management (Scottish Executive, 2004a). Taking together, these policies document a shift from an historic reliance on structural defences towards a more balanced mix of flood risk measures incorporating many non-structural elements. Adapting to climate change will give greater prominence to non-structural measures as the costs of structural measures increase with rising standards of protection.

Individual elements within this new approach to flood risk management also explicitly have regard to climate change. Thus the Risk Framework in SPP7 (Scottish Executive, 2004) includes an allowance for climate change in defining high risk areas in floodplains where there is a presumption against development (annual probability of 0.5% or 1:200). One of the principles that underpin sustainable flood management, as defined by the National Technical Advisory Group (Scottish Executive, 2004a) is an explicit reference to “taking account of uncertainty, including climate and societal change”. This is essential if the “future generations” objective of sustainable flood management is to be met.

4.7 Public engagement

Public engagement and the need to ensure that the delivery of public services is of a high order can be traced back to the *Rio Declaration on Environment and Development* in 1992 (United Nations Environment Programme, 1992) in which Principal 10 states that “each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes”.

Accordingly governments are required to encourage public awareness by making information widely available. More recently this has been further strengthened by the United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters adopted in 1998 in Aahaus (the Aarhus Convention). Sustainable development requires high levels of stakeholder engagement and environmental protection requires government accountability, transparency and responsiveness. This democratises the delivery of environmental policy by envisaging a new level of public participation in decision-making and by imposing new obligations on public bodies in terms of access to information and justice.

Reflecting these obligations, Scotland's Strategy for Sustainable Development is based upon the principles of environmental justice with the goal that all people should be enabled "to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations" (Scottish Executive, 2005). In terms of delivery, environmental justice involves fairness in the distribution of the factors affecting environmental quality and fairness in providing the information and opportunities for involvement in decision-making. At a local level it recognises that the pressures of poor environments are often felt by the most deprived and vulnerable communities who tend to be excluded from environmental decision-making.

4.7.1 Implications for flood risk management

The definition of sustainable flood management implicitly includes a reference to environmental justice in both its social objective ("enhance community benefit, with fair outcomes for everyone) and its reference to future generations ("a fair balance between meeting present needs and those of future generations") (Scottish Executive, 2004a).

Flooding was also explicitly addressed in terms of environmental justice in the Sustainable Development Strategy *Choosing our Future* (Scottish Executive, 2005) which includes the objective of "protecting communities from flooding, which may have a disproportionate impact on low income families". The need to progress this objective was addressed in the *Social Impacts of Flood Risk and Flooding in Scotland* report (Werritty *et al*., 2007) commissioned by the Scottish Executive in 2006 which quantified tangible and intangible flood impacts and demonstrated that most vulnerable individuals and communities were exposed to higher levels of flood risk.

SEPA's recent provision of new flood warning schemes on the Clyde, Irvine and Kelvin will also help address this objective as many of the 14,000 properties now covered will include vulnerable individuals and communities.

4.8 Resilience

The goal of sustainable flood management is "to provide the maximum possible social and economic resilience against flooding**"**– resilience here being defined as the "ability to recover quickly and easily" (Scottish Executive, 2004a).

Since resilience can be thought of as the inverse of vulnerability, there is a clear link to the promotion of environmental justice reported on above. At the community level resilience is a function of social capital which can be either built up or destroyed by flooding (Werritty *et al.,* 2007). At the individual level resilience increases with greater knowledge of flood risk, better levels of preparedness, higher take up of insurance and acceptance of personal ownership of flood risk.

For communities where structural flood defences will never be an option, resilience is directly related to the effective take up of non-structural measures. But public acceptance of these measures is often guarded slowing down their effective take up.

4.9 European Union Directives

Two EU Directives stand out from a plethora of directives related to the water environment (see Appendix 1 for a list other directives included in the Scottish Government's Strategic Environmental Assessment on sustainable flood management):

- The Water Framework Directive (2000/60/EC)
- Directive on the Assessment and Management of Floods (2007/60/EC)

The primary objective of the Water Framework Directive (WFD) is to "protect, enhance and restore all bodies of surface water with the aim of achieving good surface water status by 2015"). Only incidentally concerned with managing floods and droughts, the prime function of the WFD is to protect the water environment. Delivery by member states is via a series of river basin management plans in which departures from good status are reported, measures to promote good status identified and progress reported.

The new *Directive on the Assessment and Management of Floods* aims "to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity" (European Commission, 2007, article 1). Inland river floods and marine floods around the coast are covered (although sewer systems floods may be excluded) with initial reporting by 2015 (as with the WFD). Having drawn up a preliminary flood assessment which identifies river basins and coastal areas at risk of flooding (by 2011), member states must then produce flood risk maps (by 2013) followed by flood risk management plans which focus on prevention, protection and preparedness (by 2015). Given the commitment in the WFD for holistic, catchment-wide river basin management, the Floods Directive requires member states to co-ordinate their flood risk management plans with river basin management plans, potentially via a common competent authority. As with river basin management plans, public participation and stakeholder engagement must be explicitly incorporated into flood risk management plans.

4.9.1 Implications for flood risk management

One of the provisions of the Water Environment and Water Services (Scotland) Act 2003 which transposed the WFD into Scot's law was the creation of a statutory duty to promote sustainable flood management.

Five years on, sustainable flood management has been defined and explored in depth by the National Technical Advisory Group (Scottish Executive, 2004a) and the Flooding Issues Advisory Committee (Scottish Government, 2007d). Recommendations from both advisory groups have informed the proposed Flooding Bill which will transpose the 2007 EC Floods Directive into Scot's law. Unlike the UK Parliament, devolved administrations in Edinburgh have chosen to use primary legislation to enact the provisions of both EC Directives. In so doing they have reviewed the current usage of structural and non-structural measures and have expressed a strong preference for a more holistic, catchment-based approach to flood risk management.

The four A's (Awareness +Avoidance + Alleviation + Assistance) which help deliver the National Flooding Framework closely correspond to the Flooding Directive's requirement that flood risk management plans focus on prevention, protection and preparedness. In this regard, the approach of the Scottish Government mirrors that of the EU, favouring as it does a balanced portfolio of measures with non-structural approaches providing credible alternatives to structural engineering-based schemes.

4.10 Flood risk management

Flood risk management is now a fully devolved area and its development in Scotland is independent from that in England and Wales. The main drivers of flooding differ significantly (see Werritty with Chatterton 2004 for details) and, even before devolution, this meant that Scottish legislation was very different from that operating across England and Wales. Only modest provision for land drainage has meant there are no public bodies akin to the Inland Drainage Boards in England. Local authorities are the only public

bodies which can bring forward flood prevention schemes but only on non-agricultural land. Given a coastline dominated by high cliffs and cut into resistant bedrock, rapid erosion and increased flooding along the coast is a much lesser hazards than in England. As a result there are only seven local authority coastal flood defences for the whole of Scotland (Bassett *et al.,* 2007) and the overall threat posed by coastal flooding is only now being assessed (Ball *et al*., 2008).

A strategic approach to flood risk management has only recently begun to emerge in Scotland (Werritty, 2006). This reflects the fragmented approach to managing floods which stems from piecemeal legislation which has developed over many years. A series of government advisory groups have repeatedly criticised the lack of clarity in identifying current roles and responsibilities for managing floods before, during and after they occur (Scottish Executive, 2004a; Scottish Government, 2007d). One of the key proposals in the proposed Flooding Bill is to designate SEPA as the new competent authority for flood risk management coupled with more clearly-defined roles for the responsible authorities (local authorities, Scottish Water, Forestry Commission and SNH). In order to understand existing and proposed flood risk management policy in Scotland, an outline of current duties and responsibilities is provided below.

At present, under The Flood Prevention (Scotland) Act 1961, the only public bodies with powers to bring forward flood prevention measures are the 32 local authorities but this is restricted to "watercourses, barriers and similar flood defence works, … and … may only be of use in instances of river or tidal flooding" on non-agricultural land. In addition to these discretionary powers, under a 1997 amendment to the Act, local authorities have a duty to assess and maintain watercourses to reduce flood risk and are required to publish a biennial report of flooding incidents and measures taken to mitigate the impacts, but again only on non-agricultural land. Measures beyond maintenance and repair are classed as flood prevention schemes and these, when initiated by local authorities, require confirmation by the Scottish Ministers. Hitherto schemes approved by the Scottish Government have attracted 80% grant, but from April 2008 funding of flood prevention schemes will be included in the local government block grant. It remains to be seen whether this removal of ring-fenced funding, which has recently accelerated the development of flood prevention schemes, will inhibit local authority spending on flood risk management and undermine the strategic whole-catchment approach proposed in the proposed Flooding Bill.

SEPA's responsibilities under The Environment Act 1995 are focused on its discretionary powers to undertake flood warning across Scotland. This it discharges via operating a number of formal flood warning schemes (in partnership with local authorities and selected police forces) and the operation of Floodline which includes 24 hour Flood Watch cover for the whole of Scotland. SEPA, as custodian of the Indicative River and Coastal Flood Map, also has a duty to advise planning authorities on any potential flood risk associated with proposed new developments (see section on the planning system above). In addition to this direct engagement with flood management, SEPA is also the regulator for engineering works under the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) in compliance with the requirement of the EC *Water Framework Directive*. Authorisation under the CAR regime is now required for most structural flood risk measures. Should SEPA be designated as the competent authority for flood risk management as envisaged in the proposed Flood Bill, its current role will be greatly enhanced. However, unlike the Environment Agency in England, it will not be responsible for designing and implementing flood prevention schemes as that duty will remain with local authorities.

Scottish Water's responsibilities for flood risk management are governed by The Water Industry (Scotland) Act 2002 and the Sewerage (Scotland) Act 1968. These provisions have proved difficult to enforce on account of the interaction between surface water derived from roofs and paved ground surfaces (the responsibility of Scottish Water) and surface water originating from runoff from roads (for which the Scottish Government and local authorities are responsible). Further complications arise in assigning responsibility for urban flooding when sewage is released into floodwaters following surcharge from the sewerage system. These issues, similar to those raised in the Pitt Review following the 2007 floods in England (Cabinet Office, 2007), are being addressed in the Glasgow Strategic Drainage Plan which, for the first time, brings together Scottish Water, local authorities and SEPA into an urban water partnership. Unlike the situation in England where water supply and drainage are privatised utilities, Scottish Water remains in the public sector and is regulated by the Water Industry Commission.

The eight strategic coordinating groups which handle all types of emergencies under the Civil Contingencies Act 2004 provide the final set of public bodies with flood risk management responsibilities These groups of category 1 responders, led by the appropriate Chief Constable and local authority Chief Executives, make detailed plans for all types of incidents in their area and can call upon all the emergency services as required. Desk studies and exercises are regularly undertaken to ensure the highest levels of expertise in dealing with emergencies including flooding.

Having outlined the duties and responsibilities of the public bodies engaged in flood risk management, the key policy issues at a national level are now reviewed. The fundamental concept underpinning current flood risk management is the promotion of sustainable flood management as required under the Water Environment and Water Services (Scotland Act, 2003. The definition of sustainable flood management, its objectives and underlying principles is reported in Boxes 1 and 2. The key elements of sustainable flood management are:

- Enhancing resilience as the overall objective, but balancing this against locally variable economic, social and environmental needs
- A strategic whole-catchment approach in which reducing flood generation in rural areas (natural flood management) is combined with mitigating the impacts of flooding in urban areas
- A balanced portfolio of structural and non-structural measures to deliver the 4 As (Awareness +Avoidance + Alleviation + Assistance)
- A proactive rather than a reactive assessment of flood risk covering all types of flooding (surface (pluvial), sewer, river, groundwater, estuarine and coastal)
- Transparency, inclusiveness and community engagement in managing flood risk
- Long-term sustainability acknowledging future uncertainties.

These elements are broadly consistent with implementing the EC Floods Directive for which, in the proposed Flooding Bill (Scottish Government 2008c, p. 9) SEPA will be required to:

- “undertake preliminary flood risk assessments (PFRA) to create a national picture of flood risk in Scotland, by 22 December 2011.
- undertake Flood Risk and Hazard Mapping for those areas identified through the PFRA as being at significant flood risk by 22 December 2013.
- produce strategic Area Flood Risk Management Plans that will coordinate flood risk management objectives and measures across catchments, or groups of catchments,
- and set the framework in which measures are delivered or planned for at a local level by responsible authorities i.e. local authorities and others” .

Although SEPA will have overall responsibility for ensuring compliance with the Flooding Directive, delivery will still lie with the local authorities. Accordingly, in the proposed Flooding Bill (Scottish Government 2008c, p.10) local authorities will be required to:

- “develop detailed Local Flood Risk Management Plans, prepared in co-operation with the other responsible authorities, which will set out in more detail the measures required to manage the local flood risk.
- continue to assess the condition of water courses and maintain them so as to substantially reduce the risk of flooding
- continue to publish biennial reports of instances of flooding and measures taken
- take on new powers to carry out such flood risk management measures
  as may appear to them to be necessary or expedient for the protection of any land or property in their area”.

At present local authorities are responsible for enforcing the Reservoirs Act 1975 in Scotland. Subject to consultation, the proposed Flooding Bill will transfer this responsibility to a new single enforcement authority.

The emergence of sustainable flood management as the ruling paradigm for managing flooding in Scotland over the last few years has been remarkably prescience given new EC Flooding Directive. In promoting a strong form of sustainability in its definition of sustainable flood management, the Scottish Government has been both ambitious and radical (Werritty, 2006).

Box 1: Sustainable Flood Management – definition

The proposed definition of SFM is:

"Sustainable flood management provides the maximum possible social and economic **resilience*** against **flooding****, by protecting and working with the environment, in a way which is fair and affordable both now and in the future."

(* where '**resilience'** means 'ability to recover quickly and easily'. The Scottish Government uses it to deliver the 'four As': **Awareness** +**Avoidance** + **Alleviation** + **Assistance**.)

(** '**flooding'** means all types of flooding: surface (pluvial), sewer, river, groundwater, estuarine and coastal).

Sustainable Flood Management – objectives

The proposed objectives for SFM are:

Overall – meet needs for flood resilience.

This objective should be met by integrating the following needs:

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 with fair economic outcomes;
Future generations – allow for future adaptability, with a fair balance Between meeting present needs and those of future generations.

Box 2: Sustainable Flood Management - principles

The following are the proposed principles setting out how the objectives might be Delivered

1. **[Strategic Approach]** Sustainable flood management (SFM) should reflect a strategic approach both nationally (across Scotland) and locally with links to the River Basin Management Plan Process and with phasing where appropriate. It should take account of the 2003 Act principles of co-ordinated management to achieve relevant objectives for all water bodies, and the planning policy contained in SPP7. It should use strategic environmental assessment and sustainability appraisal as they are introduced into Scottish methodology.

2. **[Responsibilities]** All stakeholders should be actively engaged in and share responsibility for achieving SFM. They are expected to collaborate constructively to meet the SFM objectives, with the lead taken by the appropriate party(ies) according to their statutory, legal, common law or commercial role(s).

3. **[Options Appraisal]** Sustainability issues should be considered from the earliest stages of investigating options. The options considered for flood management should include, through to full evaluation, at least one option that represents a 'most sustainable benchmark', addressing all four 'A's: Awareness, Avoidance, Alleviation and Assistance, even if regulatory or legal barriers appear to block implementation . Decision-making tools will include, but not be limited to, Cost Benefit Analysis and should make the 'values' applied explicit.

4. **[Uncertainty]** A long-term view of sustainability means acknowledging and taking account of current uncertainties - including current data and models - and future uncertainties (see Objective 5). Flood risk should be expressed clearly. It also requires explicit consideration of the implications of flood events that exceed design limits.

5. **[Multiple Benefits]** SFM should seek opportunities for multiple benefits, but also cover costs and frequency of loss (economic, rural, landscape or amenity enhancement), wherever possible and seek other relevant funding sources.

6. **[Openness]** The whole SFM process should be transparent; and there should be a common, shared source of information, from which all stakeholders can access and learn.

7. **[Democracy]** SFM should promote effective community engagement. Decisions should be taken at the local level, as far as possible, and reflect local community 'Agenda 21' or similar sustainability objectives. Parties should plan and manage to achieve community consents without the cost and delay of a Public Inquiry.

8. **[Simplicity]** Implementation of SFM should be understandable, aim for ease of delivery, and promote continual learning, and sharing of knowledge.

The accompanying sets of principles and measurement indicators to evaluate performance are also innovative, although both have yet to be tested in practice. The route being taken by Scotland in managing flood risk is significantly different from that in England. This reflects the different weights

attached to the key drivers (Werritty with Chatterton, 2004) and the very recent emergence of a more strategic approach to managing flood risk. Scotland has also benefited from lower levels of flood risk and less inertia in taking on board the challenges of climate change and sustainability spelt out in the Foresight project on Future Flooding.

4.11 Insurance

Since the early 1960s flood insurance, bundled with household cover, provides an effective form of non-structural adjustment by mitigating the direct economic losses caused by flooding. At present the Association of British Insurers' *Statement of Principles* (ABI, 2002) commits insurers to continuing to offer flood insurance to existing customers where their properties are protected to a 1 in 75 year or worse risk of flooding or where there are plans to enhance protection within 5 years. Subject to this qualification, cover continues to be offered but individual households in high risk areas face rapidly rising premiums and large excesses as insurers seek to recover from rapidly rising claims (Werritty *et a*l., 2007). Thus following the summer 2007 floods in England and insurance claims exceeding £3 billion, the UK government and ABI are reviewing the *Statement of Principles* focusing on a better understanding of flood risk based on current maps, the promotion of resilience and preventing inappropriate development in high risk areas (ABI, 2008).

In general the ABI regards structural defence as the preferred method for managing flood risk (ABI, 2004), but non-structural measures such as more rigorous zoning of land use on floodplains, the extension of flood warning systems to 80% of threatened households and improved mapping of flood risk are also viewed positively (ABI, 2006). Whilst supporting the building of flood resilient homes, the ABI has yet to endorse this measure by reducing premiums or offering higher levels of re-instatement following a flood. This is likely to impede the take up of flood resilience measures currently being trialled by DEFRA at selected locations in England.

Although the insurance market largely operates at a UK level, there are aspects of flood insurance in Scotland which differ from that operating in England. The level of flood risk is proportionately lower in Scotland with around 77,000 residential and commercial properties at risk from inland flooding in Scotland (Werritty *et al*., 2002,) and around 27,400 at risk of coastal flooding in Scotland (Kemeling, 2007). This compares with around 907,000 properties at risk in England and Wales. The flooding threat posed by storm surges around the coast of Scotland is also lower (e.g. the impact of the1953 surge in the North Sea was much less on the east coast of Scotland than in East Anglia) and this is likely to continue given climate change. Continued glacio-isostatic adjustment following the melting of the last Scottish icesheet around 16,000 years ago will also moderate sea-level rise locally and its associated flood risk (Werritty, 2007).

Some of the socio-economic drivers affecting flood insurance in Scotland also differ from those in England. For example, although the changing demographics of the Scottish population will intensify the demand for new housing (35,000 homes per year by 2015) the pressure to locate these in high flood risk areas is less than in England. The implementation of planning controls via SPP7 (Scottish Executive, 2004c) has been more successful in constraining unwise developments in high risk areas than has the implementation of PPS25 (Communities and Local Government, 2006) south of the border (Crichton, 2005). The social impacts of flooding have recently been investigated in a report to the Scottish Executive (Werritty *et a*l., 2007) and the findings are being incorporated into new guidance for local authorities when they bring forward flood alleviation schemes for approval by the Scottish Government. This inclusion of social benefits in the cost-benefit analysis required of such schemes appears to be more flexible than in the current methods used for project appraisal in England (Crichton, 2005).

The creation of Flood Liaison Advisory Groups by each local authority, as stipulated in SPP7, has resulted in a more proactive response to flood risk management by local authorities, insurance companies and SEPA. The role of such local advisory groups looks to be strengthened in the proposed

Flooding Bill. The take up of contents insurance by 91% of households living in flood risk areas in Scotland is close to the 93% for UK as a whole (Crichton, 2005.) But this reduces to around 75% for social tenants and has lead to the promotion of 'pay-with-rent' schemes by many local authorities and housing associations. Some local authorities have co-ordinated systems for providing sand bags and removable flood guards with as many 60% of flooded households in a recent survey reporting some degree of flood proofing (Werritty, *et al*., 2007).

4.12 Flood risk management research and development

The Scottish and Northern Ireland Forum for Environmental Research (SNIFFER) provides a research and knowledge management service on flood risk management, on behalf of the Scottish Government for Scottish stakeholders. One of the main tools for delivering this service is the Research Information Service for Flood Risk Management (RISE) website which provides a knowledge inventory of flood risk management research across the UK and Europe of relevance to Scotland. In addition to managing its own programme of R&D projects, SNIFFER also co-ordinates the input of Scottish interests to the Engineering and Physical Sciences Research Council's Flood Risk Management Research Consortium and the CRUE ERA-NET (Co-ordination of the research financed by the European Union on flood management). Since 2006 SNIFFER has hosted the annual Flood Risk Management Conference which has attracted a wide range of delegates from most stakeholder groups.

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R&D on flood risk management is also promoted by other public bodies including SEPA, SNH and the Scottish Government and NGOs such as WWF-Scotland and the RSPB. Scotland's universities also undertake extensive research on flooding variously funded by the Engineering and Physical Sciences Research Council (mainly via its Flood Risk Management Research Consortium), the Natural Environment Research Council, and the Scottish Alliance for Geoscience Environment and Society. The UNESCO Centre for Water Law, Policy and Science at Dundee University, the School of the Built Environment at Herriot Watt University and the Macaulay Institute in Aberdeen all have specialist research expertise on flood management.

Much recent R&D on flooding has focused on re-balancing the mix of structural and non-structural measures. Thus SNIFFER has funded research on the benefits of flood warning schemes, and better capture of information on flood impacts and has contributed to several CRUE projects on non-structural measures. The Scottish Executive commissioned the recent report on the social impacts of flooding report and WWF-Scotland has promoted natural flood management via its Flood Planner project.

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5 Structural and Non-Structural Flood Risk Management Measures in the Lower Thames Area, England

5.1 Summary

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.

Figure 5.1: Flooding in Windsor in the nineteenth century [Illustrated London News 1891]

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 Introduction

There is a clear recognition amongst the bodies with lead responsibility for flood risk management in the UK that large engineering projects such as barriers and diversion channels are no longer always an adequate or appropriate response to flood risk. As the Government's strategy for England puts it, if the concept of sustainable development is to be "firmly rooted" in all decisions about flood risk management, then full account needs to be taken of social and environmental considerations, as well as of economic factors[2] (Defra 2005 p14). As a result, whereas in 1993 the Environment Agency's flood strategy only listed flood warnings and flood defence as its priority aims[3], its sponsoring department, the Department for Environment, Food and Rural Affairs (Defra) now urges the use of an "integrated portfolio of approaches" (ibid p15) that includes smaller-scale engineered solutions as well as non-engineered measures.

Although such measures (which are collectively termed 'non structural measures' or 'NSMs' in this chapter) are in use across England, there is a widespread perception that they still form a weaker part of the "portfolio of approaches". The independent review of the 2007 floods[4], for example, argues that planning controls in flood risk areas are not rigorously enough applied (p41) and that there is a lack of a clear policy for the use of temporary and demountable defences (p57). It also suggests that property-level risk mitigation measures are insufficiently promoted, citing research[5] that indicates that less than 6% of at-risk householders who have never been flooded have implemented even the simplest of such measures.

[2] Department for Environment, Food and Rural Affairs (2005). Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England. London: Defra Publications.
[3] Environment Agency (1993). Strategy for flood and coastal defence in England and Wales: Executive summary. http://www.defra.gov.uk/environ/fcd/pubs/stratsum.htm.
[4] Pitt, M. (2007). Learning lessons from the 2007 floods: An independent review by Sir Michael Pitt. London: The Cabinet Office.
[5] Harries, T. (2007). Householder responses to flood risk: The consequences of the search for ontological security. PhD thesis. London: Flood Hazard Research Centre.

5.3 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.

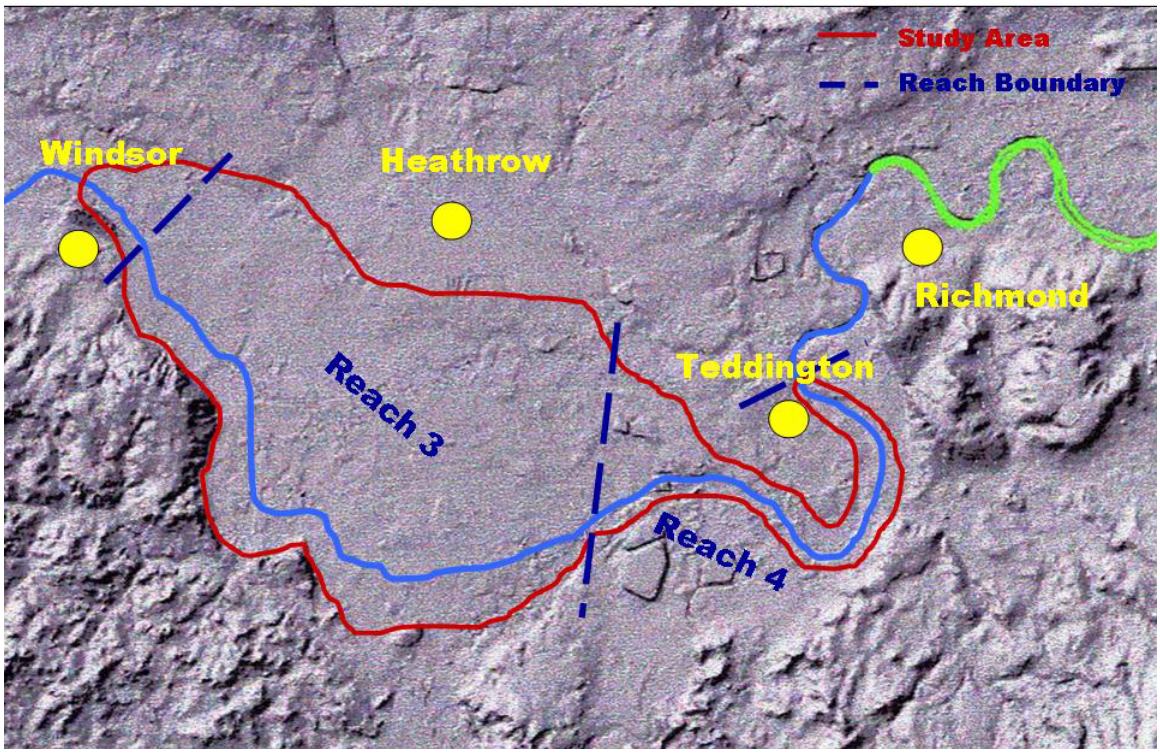
Maidenhead, Windsor and Eton lie in Reach 2 of what is known as the Lower Thames, the non-tidal part of the Thames that is nearest the sea. The subjects of this study, meanwhile, are Reaches 3 and 4, downstream of Reach 2. The most recent search for a solution to the flood risk in these two areas began 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 (see Figure 5.1).

Figure 5.2: Reaches 3 and 4 of the Lower Thames[6]

[6] Taken from Environment Agency (2007). Lower Thames Strategy Study Phase 3 – Draft Executive Summary. Revision A01 – March 2007.



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[7], 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)*

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

5.4 Flood risk management in the case study area

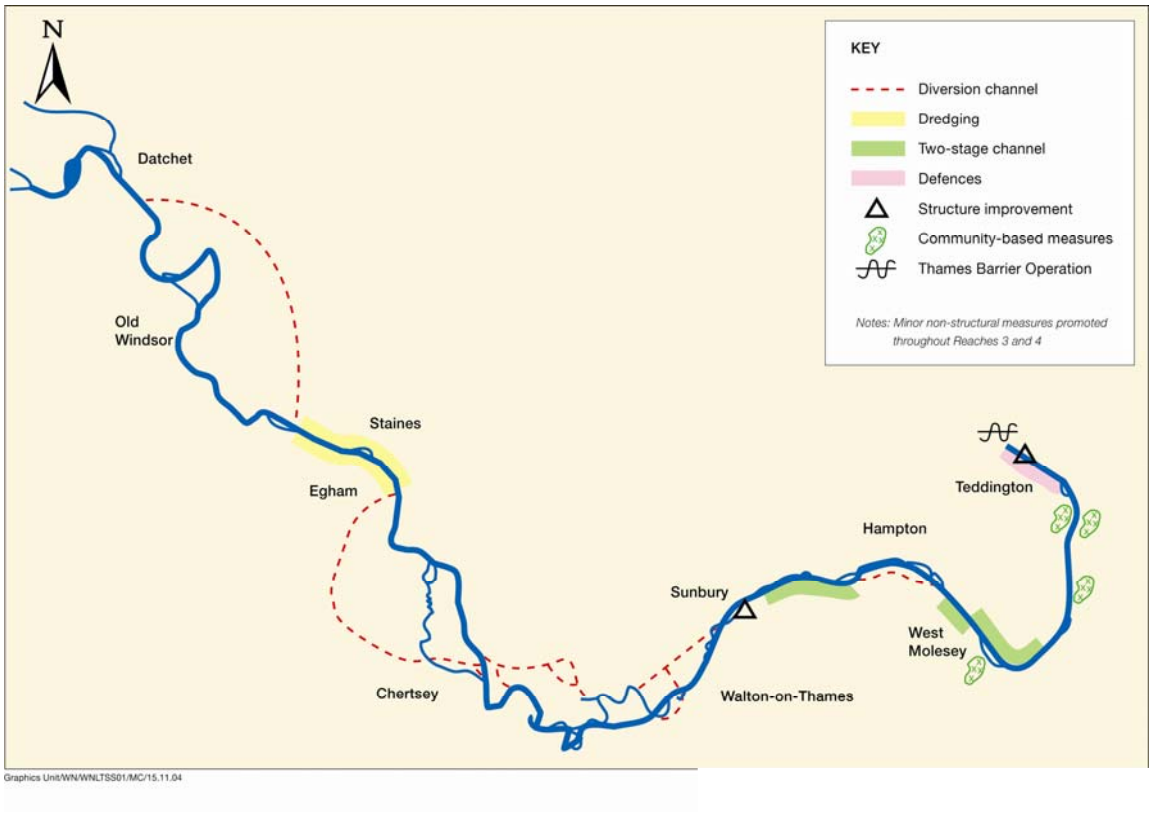
Although approximately £2m has to date been spent on studies for the LTSS, no agreement has yet been reached on the design of a flood risk management 'package' for the two reaches in question. Plans for flood alleviation channels and re-profiling of the river-bed (deep dredging the river) have been 'on the table' since 1992 but for numerous reasons – and in spite of the huge value of the assets they would protect – these plans have not tended to be seen as sufficiently economically efficient.

The costs of any structural scheme here are high for several reasons. The areas through which diversion channels would need to run are all densely populated or are Biodiversity Action Plan (BAP) areas or are otherwise environmentally designated. To minimise disturbance of these areas, the proposed channels for Reach 3 were routed through landfill sites, making excavation more expensive and introducing the risk that pollutants might leach into the channels. Furthermore, the Thames itself is environmentally important. It is a source of macrophytes, which are a staple food for two designated bird species in the area, and the stretch of the river in Reach 3 where re-profiling was proposed is inhabited by a rare *Red Book* listed[8] breed of fresh water mussel. These factors delayed the development of options in Reach 3 and added to the number of separate studies that had to contribute to the LTSS.

By the early part of this century, although the Environment Agency did not envisage any more major flood defences being constructed in the region "in the immediate future"[9], the calculated benefits of a structural scheme in Reach 3 were beginning to look more positive vis-a-vis studies undertaken a decade or so earlier. Changes to the Treasury approved discount rate and up-dating adjustments to the flood damage potential data sets in Middlesex University's '*Multicoloured Manual*'[10] that is used to estimate damages, and a new model of lows floods flows (in the 10-year range), all increased the potential flood damage savings that a structural scheme could offer. Rejected in the 1990s for having too low a benefit-cost ratio, the idea of a structural solution for Reach 3 was therefore revived in 2002. At the present time[11], although the problem of the suppressed river mussel has not yet been resolved, there is a sense amongst the Environment Agency and its consultants that a structural solution to the flood risk between Windsor and the estuary might yet be within reach.

Figure 5.3: Outline of one of the scheme designs for Reaches 3 and 4. The diversion channel to the north of this area is Channel 1; the two channels elements to the south are Channels 2 (north of Chertsey) and 3 (between Chertsey and Sunbury).

[8] The *red list* is a categorisation created by the World Conservation Union to denote the world's most threatened species of wildlife (http://www.iucnredlist.org/info/introduction).
[9] Environment Agency (2007). Managing flood risk: Thames region catchment flood management plan, summary document. Consultation, January 2007. Bristol: Environment Agency.
[10] 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. (This is the guide used by Environment Agency staff and their contractors when calculating scheme benefits).
[11] Mid-2008



In Reach 4, meanwhile, the political, social and economic costs of routing a diversion channel through such densely populated urban areas were deemed unacceptable and it was decided fairly early in the study that some alternative solution needed to be found.

In summary, it can be said that the LTSS was, from the very beginning, fraught with problems. As a result of the popular belief that, during the 2003 floods, the *Jubilee River* had protected Reach 2 at the expense of Reaches 3 and 4, local residents and some politicians in Reaches 3 and 4 wanted their own equivalent diversion channel. Reach 2 is a more affluent area than the others, and the more vocal residents of these other reaches represented the *Jubilee River* as 'protection for the rich', and used the social justice argument to support their demands for equivalent protection for themselves.

At the same time, the £100+m cost of the *Jubilee River* was deemed expensive and the channel has been seen by many flood risk management professionals as relatively ineffective (vis-a-vis its design standard) and as providing poor value for money. Whereas the benefit-cost ratio for similar channels in Reaches 3 and 4 had previously been assessed as less convincing than that for Reach 2, changes in the rules for calculating benefit:cost ratios introduced a new sense of optimism in 2003 onwards about the possibility of winning funding for such a scheme in Reach 3.

5.5 Aims of the case study

The most high profile aspects of the LTSS have always been the proposals for large-scale, engineered measures. The aim of this FLOOD-ERA investigation was to reveal the roles played in the design of the scheme by the consideration of other types of flood risk management measures, and to understand the factors that influenced the allocation of these roles. A range of types of measures was considered in this respect:

- Resilience measures – property-level measures that would slow the ingress of water into individual homes and businesses (for example, floodgates or airbrick covers) or that would reduce the damage caused by ingress and speed recovery from the flood (for example, flood resistant flooring or kitchen units)
- Community measures – local level flood defence measures, such as embankments or demountable barriers, which would protect whole streets or groups of properties
- Flood forecasting and warning – enhancements to the existing flood warning system, for example, by the installation of additional river gauges or by changes to the specificity and delivery of warning messages
- Emergency planning and response – improvements to plans for evacuation and the maintenance of essential services
- Floodplain spatial planning controls – the introduction of tighter restrictions on building or rebuilding in areas at risk of flooding and, in particular, along known conveyance routes.

In this chapter, these are the measures that we see as "non-structural", following more or less normal UK practice in this field[12]. However, in terms of other views as to the typology[13] of SM and NSMs in the FLOOD-ERA research community generally, it could be argued that some of them are, in actuality, equally as 'structural' as the diversion channels and the proposed re-profiling of the riverbed in Staines. However, labelling all of the above as 'non-structural' ('NS') reflects the categorisation used in the LTSS itself, in which they are bundled under the single term of "flood plain management" (or "FPM") and are contrasted with the larger-scale structural ('S') measures.

With regard to these NSMs, the specific goals of this case study were:

1. To provide a context to our interview results ("2", "3" and "4" below) by showing the results of efficiency and effectiveness analysis of (a) the different SMs and NSMs that could be deployed in the Lower Thames area, and (b) comparing theses results between those Structural and Non-Structural measures.
2. To identify the actors who have most influenced the extent of the incorporation of NSMs into the scheme.
3. To identify the personal, institutional, contextual and process issues influencing their position in scheme design.
4. To understand how the effectiveness and efficiency of these measures are perceived by decision makers in the LTSS.

The first of these is now considered, below.

5.6 Efficiency analysis of flood risk management measures 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[14]. For flood risk management investment appraisal, detailed guidance is provided by Defra[15], and data sets for the benefits of flood risk

[12] E.g. Penning-Rowsell and Peerbolt (1994).
[13] "Typology" is the work in common UK usage here; "Systematisation" is the word that other FLOOD-ERA researchers have used.
[14] HM Treasury: *The Green Book: Appraisal and Evaluation in Central Government*, January 2003.
[15] MAFF (2001). Flood and coastal defence project appraisal guidance. Four volumes. London: Ministry of Agriculture, Fisheries and Food.

reduction are available[16] to support the necessary analysis by the Environment Agency and others[17] 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[18] following on from the Foresight *'Future Flooding'* and other national-level research[19]. 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 such a regional/catchment approach[20]. 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)[21]) that looks at all such project appraisals undertaken by its Regional or Area staff, and nationally by its NCPMS[22], and prioritises investment using criteria such as the priority scoring system developed by Defra[23].

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 (see below). Also Treasury rules in their 'Green Book'[24] 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.

[16] 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.
[17] For example local authorities; Internal Drainage Boards.
[18] NaFRA reference: http://www.halcrow.com/nafra/info.html
[19] 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.
[20] 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.*
[21] See: http://www.environment-agency.gov.uk/commondata/acrobat/guidancenote1_1826827.pdf . Accessed 14.8.09
[22] http://www.environment-agency.gov.uk/commondata/acrobat/progress_1697257.pdf. Accssed 12.4.08
[23] 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
[24] HM Treasury: *The Green Book: Appraisal and Evaluation in Central Government*, January 2003.

5.7 An assessment of the efficiency and effectiveness of possible flood risk management measures for the Lower Thames

5.7.1 The efficiency and effectiveness of possible structural measures

The primary SM investigated for the Lower Thames is the series of by-pass or diversion channels shown in Figure 5.3. These are to be designed to take flood waters away from the main channel and from the urbanised floodplain, and discharge it further downstream. Given that the Thames here is a navigation controlled by locks, the diversion channels have to by-pass the locks that control waters levels, so as to generate the 'head' that will allow the diversion channels to operate. The idea is very similar to the *Jubilee River* that does the same for the towns of Maidenhead, Windsor and Eton upstream[25].

As indicated above, the efficiency (and the effectiveness) of these proposed diversion channels has been exhaustively investigated[26] and Tables 5.1 to 5.4 give the latest results (put to the NRG in 2008). The benefits are assessed as flood damages and indirect losses avoided by the necessary schemes and the investment that they would require, using the techniques and data that have become the standard methods for this type of BCA in England over the last two or three decades[27]. These methods gauge the present value of flood damages to be avoided owing to that investment (PV damage and NPV), the average benefit:cost ratios for different scenarios/schemes (Av BCR), and the incremental benefit:cost ratios (IBCR) for assessing the choices between different standards of flood protection/defence.

What Tables 5.1 to 5.4 show is that these diversion channels, appraised in this way, show very high levels of economic efficiency, with benefit:cost ratios exceeding 10:1 (allowing for the effects of climate change on flood flows (Table 5.4)). They also are effective in reducing the flood risk for many of the people and property otherwise affected.

However, any decision based on these results is not an easy one. The most economically efficient of the proposals (D4) is the one that protects fewest people, leaving 75% of the 13,100 1:200 year floodplain properties unprotected and providing virtually no protection to the areas upstream of Staines (where, ironically, the flooding in 2003 was most serious) (Table 5.5). The scheme that protects most people (D2) involves routing the northernmost channel through a Special Protection Area (SPA), through contaminated landfill sites (creating a cost penalty), and requires dredging the Staines reach that contains the small population of the Depressed Water Mussel *Pseudanodonta complanata*[28], which would be destroyed. It would also cost an additional £117 millions or Euros c. 150millions (see summary in Table 5.5).

5.7.2 The efficiency and effectiveness of possible non-structural measures in the Lower Thames

5.7.2.1 Flood forecasting and warning

[25] For a controversial view see; http://www.jubileeriver.co.uk/
[26] Halcrow 2006. Cost Benefit Study of initial CBO areas, Lower Thames Strategy, Phase 3, November 2006, Swindon: Halcrow Group Ltd
[27] MCM and PAG reference: see footnote 14 and 15.
[28] Aldridge et al. 2006.

For the Lower Thames, flood forecasting and warning is a primary NSM. It enables the Environment Agency and other emergency responders to bring themselves to a state of readiness to manage a flood incident, including operating any control or diversion structures that can reduce flood peaks. It also allows the Environment Agency to warn members of the public at risk from flooding.

The efficiency of flood warning depends upon the flood damage reducing actions which the flood management agency, other emergency responders and members of the public are able to take in response to a flood forecast and a flood warning. Focusing here upon public warning response only, recent empirical research in England and Wales (Parker *et al.*, 2007) reveals that a comparatively small proportion of total flood damage potential is likely to be saved by members of the public (in this case predominantly householders) moving damageable household inventory out of the path of floodwaters (Table 5.6). The values in Table 5.6 take into account the limited effectiveness of flood warning response, as well as the limited effectiveness of the flood warning service and the availability of householders to receive warnings. Effective response was achieved by only 55% of those receiving a warning with a lead time of < 8 hours, and 71% of those receiving a warning with a lead time of > 8 hours.

Table 5.1: Flood damage savings generated by householders moving inventory items out of the path of flooding on receipt of a flood warning (assuming total potential damages are a mean of £30,000 per residential property)

Description of damage or damage saving	%	Damage in £
Total potential damage	100	30,000
Total potential damage saved by: < 8 hour warning > 8 hour warning	 4.46 5.75	 1,337 1,726
Potential inventory damage saved by: < 8 hour warning > 8 hour warning	 8.57 11.06	 1,337 1,726

Note: Total potential damage is damage to the structure and inventory of houses

Source: Parker *et al.* 2007.

Indications of the likely flood warning lead time on the Lower Thames can be derived from the experience of the summer 2007 floods which severely affected towns along the Thames, but which did not cause flooding in the Lower Thames. In the inter-related severe rainfall, surface water flooding and main river flooding events, the public were generally alerted to the flood risk by media broadcasts giving a minimum of three days' notice of severe rainfall on several occasions (The Pitt Review, 2007). This was followed by about 80% of those experiencing main river flooding receiving at least two hours notice of this flooding (Environment Agency, 2007a).

In some cases the flood warning lead time will have been much in excess of 2 hours, and generally those living in the Lower Thames were able to follow the progress of the flood wave downstream to their reach over several days. If flooding is forecast, warnings are issued using a set of four codes, namely Flood Watch, Flood Warning, Severe Flood Warning and All Clear. Usually a Flood Watch is declared days before a flood, although sometimes warnings may escalate rapidly to higher levels. Warnings are issued to the public using a multi-media warning dissemination system, *Floodline Warnings Direct,* using a range of communication media, and are also broadcast on television and radio. On the basis of recent experience, for the purpose of this analysis we assume that 60% of Lower Thames floodplain users received > 8 hours warning, and the remaining 40% received < 8 hours warning.

The Environment Agency's Lower Thames Strategy (Environment Agency, 2007b) optimistically assumes flood warning benefits of 8.5% of potential damages, which is approaching double the values from Parker *et al.*'s (2007) research referred to above. It also estimates that flood warning benefits could rise to 16.6% by 2012 if the Agency is successful in persuading more floodplain users to respond, and to respond effectively to flood warnings. A generalised application of this range of values is given in Table 5.7 using the warning lead time assumptions above, and for the 13,100 properties in the Lower Thames area. The 'Do minimum' scenario referred to in Table 5.7 assumes minimum actions are taken by the Environment Agency to reduce flooding, such that only 10,977 of the properties are affected.

Table 5.2: Estimated annual average flood warning damage savings in the Lower Thames area using three different percentage savings values (Do Minimum scenario)

Flood return period	No. of properties affected	Estimated event damage £	Annual average damage £	Percentage damage saving % - using each of the 3 values given above	Estimated total damage saving £ (i.e. AAD x lead time %)
5	344	3,727,206	0	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	0 0 0
10	1,321	11,335,155	753,118	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	39,418 64,015 122,005
20	3,338	36,869,534	1,958,235	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	102,494 166,450 317,234
50	6,366	103,007,884	4,056,396	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	212,312 344,793 657,136
65	7,333	132,161,543	4,599,095	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	240,717 390,923 745,053
100	8,721	175,233,376	5,426,697	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	278,172 461,269 872,125
200	10,977	260,828,492	6,516,852	(4.46 x 0.4) + (5.75 x 0.6) 8.5 16.2	341,092 553,932 1,055,730

Expenditure on flood warning in the Thames Region for the financial year 2005/06 was £2 million (Environment Agency, 2007b, p116). The Agency calculates that 3.7% of the properties at risk from flooding in the region are within the Lower Thames area, so that the pro rata expenditure for this area is £74,000 per year. The benefits of flood warning therefore appear to outweigh the costs. However, the effectiveness of flood warnings is limited by the proportion of property which is moveable on receipt of flood warnings, by the effectiveness of the warning service in reaching the public, by the availability of people to respond and by their knowledge of appropriate damage saving responses to warnings.

5.7.2.2 Community based flood protection

Community based flood protection (CBFP) measures are an emerging form of flood defence which include a) communal measures including local ground raising, permanent flood wall/bund and demountable barrier protection for groups of properties, and b) individual property protection measures comprising flood boards/gates and orifice capping measures only (these are two types of 'dry proofing' measures). CBFP measures may be suitable for specific sites, but in the case of the Lower Thames area there are a number of difficulties that may prevent use, including land access and ground conditions which constrain feasibility. The Lower Thames Strategy Study identified 661 (in Reach 3) and 190 (in Reach 4) of the most vulnerable properties where these measures are considered to be most appropriate. In Reach 4 these properties are in three 'pilot sites', whereas in Reach 3 the properties are the 'initial sites' which would be targeted in the strategy. It is therefore possible to extend feasibility studies to additional properties in due course (Environment Agency, Thames Region, 2006; Halcrow, 2006). For

example, in Reach 4 some 1,026 properties have been identified as potentially suitable for these measures.

The costs and benefits of CBFP measures have been analysed in detail in the Lower Thames Strategy Study, but for 'pilot sites' and 'initial sites' only (Table 5.8). Costs are based upon capital costs, maintenance costs and other expenditures arising from ground investigation, design, land negotiations and legal costs.

Table 5.3: Benefit-cost analysis of community based flood protection measures in Lower Thames 'pilot sites' (Reach 4) and 'initial sites' (Reach 3)

Reach	CBFP measure type	No. of properties	PV costs £ 000s	PV benefits £ 000s	B:C ratio
3	Communal	96			
	Individual	565			
		661 (total)	10,476	23,201	2.21
4	Communal	78			
	Individual	112			
		190 (total)	3,400	5,951	1.75

The costs associated with individual protection measures are based on supplier's prices for fitting such measures to individual medium-sized houses. The cost included for installation of flood boards and airbrick covers is £3,000 per property, assuming that replacement of protection products takes place every 30 years at the same cost. Costs are calculated over a 50 year period at a discount rate of 3.5%. Flood damages are assessed using Multi-Coloured Manual data (Penning-Rowsell *et al.*, 2005) using house type and age categories which predominate in the Lower Thames floodplain, and both direct and indirect damages are included. Benefits are based upon the average annual damage calculated from the potential flood damages in the 5, 10, 20, 50, 65, 100 and 200 year floods.

Table 5.8 indicates that, on the basis of analysis of the pilot and initial sites (comprising a total of 851 properties), CBFP measures are economically efficient, but not as economically efficient as say, flood diversions channels. However, the economic efficiency of these measures varies considerably from area to area within the floodplain and B:C ratios range from 0.29 to 8.6. In one area the measures may be efficient but not so in another area. When disaggregated, the B:C ratio for the communal schemes in Reach 4 were all below unity. In Reach 4 individual dry proofing measures showed a range of cost benefit ratios from 0.42 to 8.6. The B:C ratio for individual dry proofing measures may be significantly improved with specific targeting of high risk properties. The communal measures would exclude floodwaters and would require flood storage compensation to be provided, the costs of which are not taken into account in the BC analysis shown in Table 5.8. However, the flood storage required would be small unless extensive use of communal measures is employed. No compensation works are required for individual protection measures.

In effectiveness terms, communal measures provide more protection than individual property measures, but sometimes raise issues about safe escape routes. Dry flood proofing offers limited protection and is most suitable only for short duration flooding.

5.7.2.3 Flood insurance

Flood insurance is a mechanism for spreading flood risk and its cost over time, and is provided by the private insurance industry in the UK. Here there is a tradition of providing both structure and contents flood insurance as a standard part of overall household and business insurance policies, rather than as stand-alone products. However, in 2002 the Association of British Insurers (ABI) set out an important

modification to its traditional approach in a Statement of Principles (ABI 2002a, 2002b). This Statement of Principles identified the 1.3% annual probability (1:75 years) as the limit at which insurers will offer premiums within the normal range available on the competitive market for household insurance. The Statement also indicates that insurers will work with customers in locations with a flood risk higher than 1.3% to see how alternative damage management strategies could make a continuing level of flood insurance possible. The ABI's policy statement also made it clear that insurers are committed to continuing insurance cover where the Government is able to improve flood defences to an adequate standard within five years. The ABI believes that spending on structural flood defences needs to rise from the level in July 2006 (£570 million per annum) to £750 million per annum by 2011. During 2007 the Government announced its intention to spend £800 million per annum in a cross-department approach to flood risk management.

In the Lower Thames there is a high level of house ownership (87%) and 67% of 207 sampled residents interviewed in 2005 confirmed that they currently possessed household contents insurance incorporating flood insurance cover (Flood Hazard Research Centre, 2006). The potential effect of flood insurance is complex. Its availability, and the relative security it provides, may generally encourage the continued occupation of inappropriate existing developments, but where availability and/or premiums reflect the true risk of flooding, flood insurance may act in the opposite direction.

In some circumstances flood insurance may also act as a deterrent to taking damage-saving actions on receipt of a flood warning, especially where new-for-old insurance policies are possessed, but recent empirical evidence from England and Wales suggests this not to be a significant issue, at least in the UK (Parker *et al*., 2007). Clearly, the behavioural effects of providing flood insurance need to be carefully considered in the design of insurance products. As part of the NS measures for Reaches 3 and 4, it may be possible to continue to provide flood insurance cover for properties with a flood risk higher than 1.3% if community or individual resilience measures can be introduced. Also it is proposed to hold discussions with the ABI to ascertain whether incentives can be provided in some cases for the installation of community of individual based protection measures in order to generate reduced insurance premiums.

In theory, the costs of flood insurance should be borne by those choosing to live in floodplains and, generally, the insurance industry is seeking to adjust its availability and price to reflect this. However, currently there is little to no price differential between most household and business insurance policies containing flood cover, so that to some extent the flood-free are subsidising the flood-prone. The costs to the nation of flood insurance are very difficult to identify, but increasing expenditure on flood defence to enable flood insurance to be continue to be offered appears to be the principal cost. The benefits of providing flood insurance are increased financial security of those living in floodplains, and decreased stress and anxiety as a result.

5.7.2.4 Spatial planning

Spatial planning comprises the methods employed largely by Government and the public sector to influence the future distribution of activities in space. Influencing the use of space in and around floodplains is a primary NSM. The Government's *Making Space for Water* flood risk management strategy (Department for Environmental, Food and Rural Affairs, 2004) and the Department for Communities and Local Government's (DCLG) planning policy for development and flood risk (PPS25) (DCLG, 2006) are key related policies. They involve the principle of planning new development in a way which incorporates measures for avoiding inappropriate development in floodplains; directing appropriate land uses to zones of lowest flood risk and mitigating damage potential through appropriate layout and design of developments and infrastructure. They also involve creating flood storage areas and safeguarding land from inappropriate development which may be required in the future for flood management including for flood storage purposes.

For spatial planning measures to be effective, a successful partnership is required between flood management and spatial planning agencies at national, regional and local levels, and this partnership needs to extend also to architects, developers and builders. A central plank of PPS25 is flood risk assessments at the regional, strategic (i.e. local) and site-specific levels, as well as the planning application and consent process.

Spatial planning is therefore principally concerned with avoiding inappropriate future extra use of flood risk zones. However, opportunities to relocate inappropriate existing development to either zones of lower flood risk or to risk-free locations, and to incorporate flood resistant design conditions into redevelopment projects, can contribute to reducing the consequences of flooding to existing land uses. There is, of course, a long history of development of the Lower Thames floodplain – it being so close to and part of West London. This result is that the floodplain is already heavily and densely developed, so much so that even a series of islands in the Thames – highly flood prone - are intensively built upon for residential purposes. Indeed, some would argue that the Lower Thames floodplain is 'congested' with development; as well as with highly valued areas of green, amenity space such as large parks, and areas of conservation and heritage value (e.g. Sites of Special Scientific Interest).

In these circumstances the role of spatial planning in flood risk management must focus upon the following:

a) avoiding any further inappropriate development in the floodplains where the scope for this is limited;
b) requiring permissible extensions to existing properties to be constructed to flood resistant standards;
c) avoiding intensification of inappropriate land uses at existing flood risk sites;
d) requiring redevelopment of existing property to be constructed to flood resistant standards and ensuring that redevelopment does not exacerbate the flood risk elsewhere;
e) ensuring that replacement infrastructure is constructed to flood resistant standards and working with the flood management agency and infrastructure providers to ensure that critical infrastructure is protected from flooding and can continue to operate during flooding;
f) ensuring that existing areas of green space within the floodplain are not encroached upon by development and, where they are used for flood storage, that these areas are maintained;
g) safeguarding from future inappropriate development any areas of potential flood storage which currently may be largely undeveloped; and
h) progressively working towards a more rational territorial organisation of land uses and infrastructure within and beyond floodplains to ensure that their dependence upon floodplain location is reduced in the long term (this may involve some relocation of properties and/or infrastructure where opportunities arise).

The benefits of spatial planning are likely to be incremental over time, and are likely to be in the form of a) avoidance of an accumulation of future flood damage potential that would be added to existing flood damage potential; b) reduction in all categories (e.g. direct, indirect, intangible) of potential flood losses; c) increased resilience of existing properties and land uses to flooding; and d) reduction of flood peaks where additional areas of flood storage can be found and brought into play.

The costs of spatial planning are largely the additional or marginal costs of taking flood risk into account in the strategy and plan decision-making process, and in the development control and planning consent processes. These processes all exist within planning authorities irrespective of flood risk management requirements and therefore taking account of flood risk does not add a great deal of cost.

However, the Environment Agency also incurs costs associated with planning consultations, a significant proportion of which are flood related. Over the 3 year period 2004-2006 the Environment Agency (Thames Region, SE Area) incurred £140,000 of costs for dealing with planning applications in Reach 4, and the equivalent cost for Reach 3 is likely to be £280,000 (Environment Agency, 2007b). The benefits

of a spatial planning approach to flood risk management can be large and relatively short term where a floodplain is largely undeveloped, but this is not the case in the Lower Thames. Here the benefits of spatial planning to flood risk management are only likely to be significant in the medium to long term and relate the life-times of developments (say where a development as a 40 or 50 year life-time), but over the medium to long term the benefits can be appreciable.

5.7.2.5 Emergency response

Emergency response during a flood is action taken by official agencies or unofficial bodies, including business companies and individuals, generally aimed at mitigating its adverse impacts by reducing the extent of the flood event, or its severity, or by affecting the 'receptors' of the flood. Emergency response can be planned, or unplanned and pro-active or reactive, but generally the beneficial impacts are likely to be greater where an anticipatory approach which is appropriately both pro-active and reactive is taken.

Under the Civil Contingencies Act 2004, and accompanying non-legislative measures and Regulations, flood emergency response involves front-line 'Category 1 Responders' (the Environment Agency, the 'blue light' emergency services, local authorities and National Health Service bodies), as well as 'Category 2 Responders' such as transport and utility companies who all coordinate their responsibilities through Regional and Local Resilience Forums.

The Environment Agency's responsibilities are set within what it terms 'flood incident management' (which also embraces flood warning) and include assessing local flood risks and informing emergency planning activities, putting in place Business Continuity Management (to ensure that the flood management agency's flood management activities are not themselves interrupted by flood effects), and sharing, cooperating and rehearsing for flood emergencies with other responders.

As with the costs of spatial planning for flood risk management, the costs of flood emergency planning and response are limited to the additional, marginal costs of planning for and responding to civil emergencies in general (i.e. most of the costs are incurred irrespective of the flood threat because of the need to plan for and respond to other types of emergencies). Based upon a detailed analysis of the 2000 floods in England and Wales, Penning-Rowsell and Wilson (2006) calculate that flood emergency costs applicable to flood project appraisals are 10.7% of the economic property losses. In these floods most of the costs were incurred after the flood event, particularly by highway authorities and the Environment Agency, and also during the event where most of the costs fell on local authorities and to a lesser extent on the Environment Agency. The benefits of flood emergency response are unknown because research has not yet been undertaken which isolates them. It seems likely, however, that judgements are made by those managing emergency response services that are likely to keep costs broadly in line with benefits (i.e. a B:C ratio of approximately unity), but currently there is no way of corroborating this.

5.7.2.6 Flood resistance and resilience measures

Flood resistance and resilience measures may be applied to houses, buildings used by businesses and infrastructure, such as roads, railway lines or electricity sub-stations. In the UK the term 'flood resistance' has now become identified with the design and construction of a building in order to prevent floodwater entering and damaging the building and its fabric. This may also be referred to as 'dry proofing'. The term 'flood resilience' is the design and construction of a building based upon the principle that floodwater will enter the building but, through careful design, the impact of flooding is reduced to a minimum. This is such that the structural integrity of the building is maintained, services can quickly be restored, and post-flood drying and cleaning are facilitated. This may also be referred to as 'wet proofing'.

The benefits of adapting developments to flood risk are equivalent to the flood damages and losses avoided when floods occur. There may also be a reduction in flood related anxiety and stress, and linked ill-health, experienced by occupants when floods occur and as a result of the perceived threat of floods. This is particularly the case when adaptive measures remove the need for families to move out of homes for long periods of time. Buildings may be safer and more secure, reducing the risk of injury and even

death. Where businesses are concerned, increased building resistance and resilience can reduce direct flood damages (i.e. those caused by physical contact of floodwater with buildings and their contents) thereby reducing consequential losses such as loss of trade. This is because businesses will be able to return to normal trading more rapidly than would otherwise be the case.

The costs of utilising flood resistance and resilience measures depend firstly upon whether the measures are incorporated in new builds *ab initio*, or 'retrofitted'; and secondly, upon the particular design, composition and size of buildings. Some general cost estimates relating to the costs of retrofitting rather than *ab initio* circumstances are available. Installing resistance measures in an existing house is likely to cost from £3,000 to £10,000 according to a Department for Environment, Food and Rural Affairs/Environment Agency (2007) scoping study, although an earlier study by the Association of British Insurers (2003) indicated significantly higher potential costs.

The ABI concluded that for shallow flooding below the damp proof course, some measures are worthwhile, such as replacing oak floorboards with treated softwood, replacing mineral insulation with closed cell alternatives, and removing ash from below quarry tiled floor and replacing chipboard with treated floorboards. However, most other measures could not be justified in 'retrofit mode' in terms of the large number of repeat floods which would be required to repay the initial investment. In deeper floods rising above floor level, many more of the measures were justifiable in terms of costs and benefits. In this study, only the tangible costs of flooding were taken into account. Provisional findings from research being conducted for the Department for Environment, Food and Rural Affairs by ENTEC UK Ltd (2007) indicates that houses need to be in the 1 in 50 (or more frequent) floodplain before B:C ratios rise above unity.

At the time of writing, the jury is still out on the costs and benefits of flood resistance and resilience measures. However, two flood resistance measures (flood boards/gates and orifice capping measures) incorporated into individual property flood protection measures in retrofit mode were revealed above to be economically efficient, and are to some extent effective (i.e. they may only slow down floodwater ingress), in some sub-areas of the Lower Thames. More evidence of the effectiveness of other dry proofing measures as well as wet proofing efficiency and effectiveness is awaited. Overall, it appears that resistance and resilience measures have a contribution to make to reducing flood risk in the Lower Thames, but economic viability depends very much on local circumstances. The effectiveness of these measures is also partly dependent upon property occupiers maintaining them over time which cannot be guaranteed.

5.7.2.7 Public education and awareness

Public education and awareness underpins a number of the NS measures discussed above, including flood warning response, individual property flood protection measures, other property level resistance and resilience measures, and flood insurance purchase. The costs of raising public flood risk awareness and improving the public's knowledge of how best to respond to floods and flood warnings are therefore contributions to the costs of these measures, the benefits of which are already discussed above.

The Environment Agency mounts annual public flood awareness campaigns, and its flood warning investment strategy is, in particular, closely related to the provision of flood risk, flood warning and flood warning response information. Direct mailings of flood information to residents are employed. A focal point for flood information is the Environment Agency's website and its *Floodline Warnings Direct* service.

A number of complementary measures are being used to raise public flood awareness. The National Flood Forum was set up in 2002 and aims to give communities and individuals who have been flooded or who are at risk of flooding, support and information. Local flood action groups, of which there are several in the Lower Thames, also play an important role in raising awareness. Many selling houses are now required by the Government to produce House Information Packs (HIPs) for use by house buyers, and these packs could in future contain information on flood risk.

The aim of all of these strategies is to encourage members of the public to take practical self-protective action. However, the infrequent nature of flooding makes it difficult to sustain awareness and preparedness. Social surveys undertaken in October/November 2005 indicate that in Reach 4 residents are moderately aware of the risk of flooding, and that this awareness is heightened for those living on islands in the Thames (Flood Hazard Research Centre, 2006).

The costs of public flood education and awareness initiatives are difficult to isolate and quantify partly because, as illustrated above, there are now a number of different elements and some of them are integral to other NSMs. It is understood that in recent years the budget for the Environment Agency's public flood awareness campaign in England and Wales has been approximately £2 million. However, this is likely to significantly underestimate of the total cost of public flood education and awareness initiatives, and there is no breakdown which allows the cost related to the Lower Thames to be estimated. In comparison to the likely costs, the benefits of public flood education and awareness are likely to be large in an area such as the Lower Thames.

The effectiveness of public flood education and awareness is reduced by residential mobility (i.e. people whose flood awareness is raised move from flood risk areas and are replaced by those whose flood knowledge and awareness is usually low); by complacency which sets in during periods of no or low flood activity; and by a range of other factors (such as other competing household priorities). For this reason, public education and awareness raising needs to be a continuous process.

5.8 Summary: efficiency and effectiveness of possible flood risk management measures for the Lower Thames

It is clear that both SM and NSM can be effective and efficient in the Lower Thames area (Table 5.9), 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 5.4: 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	**NSM**	**Medium-high**	**Low** (damage saving small). BCR likely to be <	**Initially high**, but not high now	No	BCA using damage saving may not be the appropriate measure of efficiency. Better

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***
warning,			1.0.	(sunk costs high)		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 development of the floodplain in the future)	Probably **very high** (i.e. the system is 'paid for' in its other uses)	**Initially high**, but not high now (sunk costs high) but "medium" – annual 'maintenance' costs	No	Does not assist with inherited risk. BCA under Treasury rules does not allow counting the avoidance of build up of 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)

5.9 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 provided 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 (see Table 5.10).

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.

Table 5.5: Participants in the interviews for this research

Name	Affiliation	Description	Role in the LTSS
Mike Cope	Halcrow Ltd	Project manager. A chartered civil engineer	Modelling, engineering and option appraisal.
Stuart Suter		Previous project manager. A chartered civil engineer.	
Tom Bryant		Graduate Assistant. Working towards chartered civil engineer status.	Conducted the economic appraisal of some of the non-structural options
Graham Piper		Customer-side project manager. On long-term secondment from an engineering consultancy, Atkins. A chartered civil engineer.	Monitors the work of the consultants and ensures the Agency receives project 'deliverables'. Also consults expert advisers.

Ian Tomes	Environment Agency	Area Flood Defence Manager for the area covering the lower Thames. By training, a quantity surveyor.	The person with key responsibility for finding a flood risk management solution to the flood risk problem in the lower Thames area.
Colin Candish		Regional Flood Defence Manager, Thames Region. A chartered civil engineer.	Instrumental in the development of Thames Catchment Flood Management Plan
Peter Ryder		Chairman of the Regional Flood Defence Committee for the Thames Region. Physicist by training. Ex Deputy Chief Executive and Director of Services at the UK Meteorological Office.	Member of LTSS steering group that endorses decisions taken by Ian Tomes and gives the strategic steer.
Dave Cotterell		Member of the national Flood Risk Investment and Funding team ('NRG')	Responsible for approving applications for money to fund future development of the LTSS. Would also be responsible for reviewing the final scheme design.
Tom Crossett	Thames Flood Forum	Chair of Thames Flood Forum until December 2007. Ex Chief Scientific Officer for Fisheries and Food at the Ministry of Agriculture, Fisheries and Food. Also, ex chief executive of the Campaign for Clean Air.	
John Horne	Defra	Regional Engineer for SE England until 2005. A chartered civil engineer.	Had ultimate responsibility for approving any scheme design.
Phillip Hammond	The Conservative Party	Member of Parliament for the constituency of Runnymede, which includes part of Reach 3. Shadow Chief Secretary to the Treasury.	
Edmund Penning-Rowsell	Flood Hazard Research Centre	Professor of Geography and Head of the Centre	Consultant to Halcrow Ltd and architect of the *Multicoloured Manual*, the 'rulebook' (with the PAG series) for the benefit-cost analysis of flood risk management schemes
Simon McCarthy		Research Fellow with a background in sociology and psychology.	Consultant to Halcrow Ltd. Designed and analysed a survey of resident attitudes to NSM in Reach 4

Even when respondents were assured that none of their comments or views would be reported in such a way as to be attributable to them, the nature of the study made it unrealistic to promise anonymity. It is quite likely, therefore, that some of the respondents will have been conscious of the public nature of this research and may have responded in such a way as to present themselves or their organisations in as positive a light as possible.

5.10 Interview results[29]

Three key themes were identified in the interviews that appear to adversely influence the likelihood of non-structural measures being adopted: the influence of professional cultures; the influence of external groups; and systems, procedures and structures. These are discussed in the next three sections below.

5.10.1 The influence of professional cultures

The first of these factors is the influence of organisational and professional culture. The majority of those who have been involved in the design of the LTSS are qualified civil engineers. This, it appears, may have resulted in a culture that is biased towards large-scale, engineered solutions and against some of the non-structural (NS) measures. It is not being suggested that this bias is intentional. However, the nature of the engineering training and the kind of people it attracts are both likely to indicate such a bias, as is the institutionalised culture of organisations that have developed to meet objectives with an engineering focus. This is revealed both overtly, in the views expressed by respondents, and covertly, in the language they use to express these views.

Overt expressions of the 'engineering culture'. What we are calling the 'engineering culture' is expressed in several ways in the interviews. Most importantly, structural solutions are described as the "traditional way" of tackling flood risk. According to one respondent, some people in flood risk management consider it "unacceptable", in many instances, to consider NSMs. Most respondents made a less absolute point, saying that it was instinctive to think first of large engineered solutions but that other options would be considered if no viable structural measure was forthcoming or if structural measures were deemed insufficient by themselves and needed "underpinning" by other approaches to flood risk management.

The issues of scale and materiality are important here. "Big problems" are represented as needing "big solutions", with the term "big" implying the idea of something physical, tangible and unitary. NSM, being "bitty" and therefore less monolithic than SM, fail to meet this criterion. Whereas a single diversion channel would relieve some of the risk for thousands of households, it might need many hundreds of resilience measures to achieve the same goal. This is represented as providing a less uniform and more uncertain outcome, a characteristic that is itself presented as inconsistent with the engineering discourse, in which success or failure is constructed in polar terms rather than in gradations:

> "There are days when I think this is absolutely… we're trying to sort of… We're on a hiding to nothing here, that this is too… You know, the sums of money involved are too frightening for people and the (Defra) priority score is too low. And there are other days when I think, no, actually, you know, this might… we might pull this off. It might be possible. I think we're very nervous of big civil engineering projects in this country".

[29] The reader needs to note carefully that these interviews 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). 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.

As the above quote indicates[30], there is something grand and heroic in the representation of the large engineered solution. The person who is able to pursue such an option can represent himself as courageous compared to those who are "nervous" of large projects and for whom the large sums of money involved are "too frightening"; and success is described as "pulling it off", which also suggests heroic triumph over adversity. Engineers, as another respondent says, prove themselves to their fellows by doing engineering rather than by implementing NSMs. Furthermore, they gain most respect and status by building something big, lasting and visible rather than by implementing smaller engineered measures such as local, demountable flood defences or schemes to introduce property-level protection.

As a result of the interest they generate and also as a result of their greater conceptual simplicity, such projects are also represented as easier to implement:

> "With a structural solution you can set up a project team; they're very focused, they've got three diversion channels to build, it's big civil stuff, there's lots of big contractors around who welcome the opportunity to get involved. And you know there's lots of public interest around it, it's almost self-generating in terms of public interest, media, any messages you want to get out. It's a bit like the Olympics, you know, it's dead easy because they're tripping over themselves to want to know what's going on and so on and so forth. […] It's clear what you're delivering, it's clear what the outcome should be, there's a discrete project team set up to deliver it. I think with the flood plain management component, yes, you could set up a project team, [but] it's going to be far more of a challenge to engage people about what it is you're seeking to achieve. It's not necessarily going to be as…people aren't going to be so bought into it in terms of they're going to be suspicious about whether it's going to deliver any benefits at the end of the day. Whereas they know a big diversion channel will deliver benefits, there's no doubt about that, it's been proven in other parts of the country, you know, are you really going to be able to improve flood forecasting and warning and emergency planning to the extent that it makes a real difference? There's some judgement things in there."

The greater conceptual simplicity and prestige of structural measures, it can be seen, have the potential to prejudice decision-makers against NSMs options. This is perhaps not surprising amongst decision-makers who have been trained as engineers, whose professional development is likely to be helped more by experience of engineering than it is by experience of implementing NSM, and whose employers are primarily known as providers of infrastructure.

5.10.2 Framing and representational effects.

As well as being revealed, above, in overt statements about what should or should not comprise the components of a flood risk management strategy, the engineering culture is also evident in the framing given by some respondents to discussions about flood risk management and in the representations of NSMs and SMs that they use.

Most important of these, perhaps, is the framing of the decision making process as being a question of either constructing a large, physical defence or 'doing nothing'. Implicit within this framing is the idea that NSMs count as doing 'nothing'. This was evident in several ways. One respondent asserted that the traditional response to a flood risk situation was to design a 'scheme', but that the term 'scheme' had become synonymous with structural measures and that, as a result, NSMs were often not regarded as proper responses. Others used the framing without any apparent awareness that they were doing so. Embedded in the following passage of talk about the role played by local authorities, for example, is an

[30] All interviews were tape-recorded and professionally transcribed. These sections are extracts from the interview dialogue.

implied equivalence between being able to implement the structural part of the LTSS and being able to do anything at all (see the highlighted parts of the text).

> There hasn't…it hasn't got to the stage where we are saying, 'Well actually **we need £250,000,000 to deliver this** and it's a definite goer.' That'll be the real test. Then when we've got to the stage where the strategy is approved, the thing becomes much more real…then [the local authority chief executives] are really going to have to start nailing their colours to the mast. […] This is a big issue for them and their constituents if you like so it's high up their political agenda and there aren't too many options around what can be done for these people, so it is, you know, it is still high on their radar in terms of **if we can do something** they're quite interested and **if we can't** then they're left with a very difficult issue as far as the risk to their constituents is concerned.

Structural measures are again represented, in this case, as doing "something" and NSM, by implication, again as "doing nothing". NSMs are not seen as a substitute for SMs and are "not the same kind of animal". Indeed, rather than being described as solutions to the flood risk, NSMs are depicted as only playing a supporting role to the main, structural measures: the diversion channels and the riverbed re-profiling (dredging). One respondent describes in some detail the three phases of the LTSS study without even mentioning NSMs: they are represented as peripheral to the main 'act', which is seen to be the large-scale, engineered solution.

NS measures are also given a less concrete framing than the structural measures. In the documentation for Phase 3 of the LTSS (Environment Agency 2007) and in the comments of some of the respondents they are bracketed together under the common heading of "Flood Plain Management", a categorisation that obscures the character of its individual components. One of our interviewees admitted to the inadequacy of this clumping together of all the various NSMs under one heading when he described the Flood Plain Management component of the LTSS as "that FPM thing" and a "rag bag of different measures" and says that it is "not a good descriptor".

These framing effects may, in part, be the result of uncertainty about the effectiveness of NSMs. These are variously described as "unproven", "fluffy", "woolly" and "reliant on people's [correct] behaviour"; and the evaluation of their effectiveness is described as impossible to calculate and as a "finger in the air job".

Catchment Flood Management Plans (CFMPs). The introduction of the Thames Region Catchment Flood Management Plan (CFMP), one respondent argued, was beginning to reverse the bias towards SMs and to undermine the engineering culture. This plan, it was argued, gave substance and "political" weight to notions that were otherwise unsupported by tangible incentives.

However, compliance with this aspect of the CFMP was voluntary and was said to rely on persuasion, so change was only occurring slowly. According to one respondent it would take a generation for the engineers who are responsible for flood risk management policy to fully take on board the Government's *Making Space for Water* agenda by considering NSMs as anything but second best.

This view is supported by the comments of participants in this case study research, who, though agreeing with the need for a richer mix of flood risk management methods and a lesser reliance on large-scale engineered solutions, continued to reveal a cultural preference for SMs.

5.10.3 The influence of other external groups

Whereas the Thames Region CFMP was mentioned as an influence in favour of NSM, two factors were represented as actually or potentially reinforcing the traditional engineer's view of NSMs. One of these was the perceived views of the public; the other was pressure from local politicians.

Public opinion. When 'pushed' to justify their preferences for structural measures over NSMs ones, decision-makers tended to fall back on the discourse of public opinion. This seemed – in their constructions of their arguments – to take precedence over discourses of public policy. Public opinion, in other words, was attributed more influence than the messages in the Government's *Making Space for Water* strategy and it was said to be people's conception of the preferences of the public that "guides your first thought of what to look at".

There are a number of possible explanations for this accordance of influence to public opinion. One explanation is the apparently more effective and persuasive manner in which public opinion is communicated. Whereas central policy statements favouring NS measures are described as lacking force and substance (see below), residents groups are "articulate" and "adept at political action" and make decision-makers feel exposed and vulnerable ("we're at the end of that, in all the public surgeries"; "people were tearing each others' eyes out at the first two Thames Flood Forum meetings"; "Halcrow are terrified of the Flood Forum").

A second reason for decision-makers' deference to their conception of the public view is their representation of their own accountability. Although they sometimes depict themselves as independent experts making technical decisions, they also see themselves as accountable for those decisions to the public:

> Interviewer Aren't you kind of, as the 'experts', supposed to do what is expertly judged right?
> Respondent 1 You would think so.
> Respondent 2 Yes.
> Respondent 1 I think those days are long gone and I think we are accountable much more for what we do and how we do it and we have to bring people along with us, otherwise it just doesn't work these days.

The definition of 'the public' to which they seek to make themselves accountable seems, however, to be limited almost exclusively to those who have been flooded. For example, in the following passage, the respondent limits his conception of the 'public' to those on the floodplain and even – until prompted to reconsider his view – to those who have actually experienced a flood.

> Interviewer Who does that really mean when you say 'the public'?
> Respondent 1 The individuals who are affected by the […] It's predominantly those who are affected by the flooding. I don't think the population outside of the flood plain are that bothered.
> Interviewer For example there are some who wouldn't have been affected in 2003 but who would be at risk?
> Respondent 1 Yes, okay. It's all the people living in the flood plain.

In reality, however, not even all of those who have been flooded are included in the section of 'the public' whose views are taken fully into account. As one respondent admits, it is in reality only a small subsection of the flooded public – the "vociferous ones" – whose views need to be taken into account. There appears to be no sense of accountability to the wider public and to the question of whether their interests might be better served by more sustainable NSMs. Public opinion is reduced to the views of those flooded residents who communicate with the decision makers most forcibly. As a result the influence of policy-makers at Defra (who, after all, are supposed to represent the interests of the public as a whole) is reduced in favour of the preferences of a relatively small group of floodplain residents. The respondents seem confident in their knowledge of the preferences of this group: they want the water to be kept away from their homes and they would not understand NSMs and do not want them.

The views of this small subsection of flooded householders seem to be projected on to the wider public and state. Thus, for one respondent, it is the whole of "society and Government" who expect floodwaters to be kept right away from homes and businesses:

> …if, actually, for the same money or not a lot of extra money, you could've just pushed all that water down to somewhere else then my experience is that that's generally the way that the voters or the taxpayers would've wanted it to have gone.

Respondents often supported this argument by asking the interviewer whether he would prefer to have the water kept away from his home or to have better resilience, better flood warning systems, better evacuation procedures etc ("What would you prefer?"). This was asked in such a way as to imply not only that the answer arose out of a generally shared attitude and therefore obvious, but also so as to imply that the preference of individual at-risk householders should determine the content of flood risk management schemes.

A third and final reason for emphasising the needs of those who have been flooded is the perception that the implementation of measures will be easier if they are actively supported by local people:

> I'd rather work with communities who are up for it, who are interested, who do want to work with us, where there is a real sense that actually they can benefit and we can make a difference by working together […].

Such support, this quote implies, is only likely to come from people who have been flooded. This group, therefore, are the constituency that is being looked to. Without their support, it is said, flood risk managers will be "on a hiding to nothing":

This, for two reasons, implies large, structural flood defence schemes. Firstly, because support is represented as more easily won for a single, large construction than it is for a project that demands the collaboration of many thousands of households – such as, for example, an improved flood warning service, which requires people to register, or a resilience scheme, which requires people to agree to the adaptation of their properties. Secondly, because (as already argued above) people who have been flooded are assumed to prefer flood defence over all other measures.

Managing public opinion. According to the chairman of the Thames Flood Forum, the initially confrontational, aggressively pro-SMs stance of local groups of flooded residents and community representatives had been transformed into one in which members of the groups "accepted the reality" of likely funding restrictions for SMs and "were happy to talk about NSM". While not representing an enthusiastic conversion to NSMs (after all, "people who've recently been flooded [will continue to] just want flood defence"), this nonetheless suggests a softening of attitudes and a reduction of the initially intense lobbying of decision-makers to prioritise SMs.

According to this respondent, this change was the result of repeated, face-to-face contact between representatives of residents groups, local authority members and Environment Agency staff. After a difficult start, the meetings of these groups, it is claimed, became more constructive and members become more amenable to suggestions that they change their attitudes to non-structural measures. This process, therefore, was able to reduce the adversarial aspects of the relationship between the decision-makers and representatives of the public and to also reduce, therefore, the pressure on the former to bend to the preferences of the latter for SMs solutions.

Decision-makers themselves represent the role of the Flood Forum somewhat differently, describing it as a means of trying to "contain the influence" of the key protagonists, to "brigade" them and to "educate" them.

Politicians. According to one decision-maker, the matter of scheme design is treated by politicians as a mainly technical one and they see active intervention, therefore, as offering few opportunities for political gains. The engineers, according to this representation of the situation, find the 'best' structural solution to the problem and decisions on funding are then made according to well-defined, rigorous and therefore very defendable process (the appraisal and prioritisation processes). In this way, the objectivity of the

design and selection of flood risk management schemes is preserved and politicians, in the words of one decision-maker, are prevented from "muddying the waters".

This argument raises an interesting question with regard to NSMs. Lacking any rigorous processes for their appraisal (see below), decisions on non-structural measures could less easily be described as objective and, presumably, might be viewed as more exposed to political criticism. In other words, the lack of agreed and standardised methods for selecting and assessing NSMs mean that their introduction into 'a scheme' could to seen to risk the politicisation of the whole scheme design process.

Furthermore, the validity of this claim is hard to determine. Although most local politicians were said to have had minimal involvement in the development of the LTSS, one Member of Parliament for the area had what he described as "fairly regular meetings with the Environment Agency". His aim in these meetings, he said, was to help the Agency better to understand the views and needs of his constituents and, in turn, to help his constituents understand the complexities of the engineering involved in meeting those needs. This statement of intent, although apparently neutral, includes a presupposition that calls into question his objectivity, for it assumes that the main goal of the strategy will be flood defence rather than non-structural measures. Like most of the respondents, he assumes that large-scale structural measures are preferable to non-structural alternatives.

5.10.4 Systems, procedures and structures

Alongside the cultural and representational issues described above, there is the question of the compatibility of NSMs with the systems, procedures and structures that exist within the Environment Agency and Defra. The general feeling amongst the respondents was that these had been designed with large-scale engineered projects in mind and were not always suitable for NSMs. This, it was argued, hampered the development and implementation of such measures and encouraged a continuing over-dependence on engineered solutions.

5.10.4.1 Capital vs. revenue costs.

One key aspect of the differences between SMs and NSMs is the greater dependency of the latter on revenue funding rather than capital funding. This, because restrictions on revenue funding (according to one respondent) are tighter than those on capital spending, makes it more difficult to finance NSMs. Two tactics were mentioned for circumventing this potential barrier to NSMs. The first of these was to raise funds from the local levy[31], which has traditionally been free of many of the centralised controls. The second was to shift existing expenditure on asset maintenance on to the capital budget, thereby making space in the revenue budget for ongoing non-structural measures. As a result of the need for such tactics it was predicted that the funding of the NSMs portions of the LTSS would "get complex". Furthermore, it appeared that the greater flexibility of the local levy was about to be curtailed. The Agency, it was said, was about to insist on the Defra's economic project appraisal guidelines[32], the so-called *PAG3* guidelines, being applied to the levy, when they had previously applied exclusively to applications for money from national sources (i.e. from Defra).

At the same time, the manner in which flood risk management options are appraised could, in theory, be perceived as advantageous for non-structural measures. Although Defra and the Agency are currently piloting the use of *multi criteria analysis* in project appraisal and design, most decision-makers remain steeped in the practice of benefit-cost analysis[33] and consider benefit-cost ratios to be the prime

[31] Raised by the Regional Flood Defence Committee from local authorities in its area.
[32] Riddell, K. & Green, C. (1999). Flood and coastal appraisal project appraisal guidance: Economic appraisal. A procedural guide for operating authorities. London: Ministry of Agriculture, Food and Fisheries.
[33] According to a comment made by John Chatterton, an independent consultant on benefit appraisal and

determinant of decisions over option choice. In the calculation of these ratios, future costs are discounted. Non-structural options, having costs that are less front-loaded than structural options, will therefore seem more attractive. However, the recent downward revision of the discount rate by the HM Treasury has reduced this effect and none of the respondents presented it as a positive advantage of NSMs options.

5.10.4.2 The role of PAG3.

Indeed, according to the respondents, the PAG3 guidelines, like other guidelines and procedures, seemed to have been written primarily for capital projects and to be less than suitable for projects with major revenue elements. Not only did the language of the guidelines assume the primacy of large-scale capital projects, but so too did the appraisal method embedded within it.

Key to this perceived procedural bias is the important role given to calculations of efficiency and effectiveness and the emphasis put on the reliability of these calculations[34]. In only two instances did respondents claim to have any access to techniques for making such calculations. In the first, a decision-maker spoke of having been provided with evidence about the *effectiveness* of planning restrictions in restraining the development of floodplains. However, as Treasury rules exclude the prevention of future increases in risk from benefit-cost analyses (see above), this information is likely to have been of little use in calculating cost-benefit ratios. In the sole example of the use of an *efficiency* estimation technique for non-structural measures, the technique was described as "a finger in the air job" and the manner of its description suggested doubt over its suitability and discomfort over its use:

> The numbers might be wrong in a way and well…they're based on your best estimate and on allowing for allowances which are sort of, although the number you are using is maybe not correct, you know, it might be 20% off or something […] I'm sure that even if you had data on it, it would be based on a small sample of houses on a very specific flood plain elsewhere, and would not apply to another flood plain.

The heart of the problem is the perception that there is no standard, agreed method of calculating efficiency and effectiveness for non-structural methods of flood risk management[35]. This seems to leave decision-makers feeling that they cannot perform cost-benefit estimations for non-structural measures without breaking with best-practice guidelines and exposing themselves to criticism.

5.10.5 Transaction costs

These doubts over the reliability of evaluation procedures undermine the potentially favourable impact of a (somewhat surprising) assumption that set-up costs and transaction costs[36] would be lower for non-structural measures than for structural measures. Furthermore, their impact on decisions about strategy

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project assessment, in a course attended by one of the authors in January 2008.

[34] See, example, the teaching material used in the training of appraisers ("Investment Appraisal for Flood Risk Management and Coastal Defence Schemes", Flood Hazard Research Centre, January 2008), which indicates that the "robustness" of efficiency and effectiveness measures is central to good practice.

[35] At FHRC we would agree with this. For example, the sequential incremental BCR test in PAG3 is desikgned to look at different stmdards of protection, but this concept fits poorly with NSMs. What is the "standard of protection" of an insurance scheme; or a public education strategy; or a spatial planning approach to reducing the build up of flood damage potential in the future owing to 'encroachment' on to the floodplain. And it is not just language or data availability: the whole PAG3 approach is focused on flood probability reduction, rather than risk reduction; ojn flood defence, rather than flood risk management. That is not surprising: that is the era from which it is derived.

[36] The evidence indicates that in a subjective estimation of the relative transactions costs of structural and non structural measures, only monitoring and enforcement costs are thought to be higher for non structural measures.

design seem to be reinforced by an assumption that non-structural measures would only be moderately effective when compared to the building of diversion channels (where these were viable).

Interestingly, both the first of these assumptions match our own evaluation of non-structural measures, which rates the effectiveness of non structural measures as generally mixed and only 'high' in the cases of insurance and spatial planning (see Table 5.9). Our assessment of the transaction costs was that these were indeed lower than for SM, and in some cases "Low" (public education and insurance), although one does wonder whether there is good agreement about what transaction costs really means, especially when so many of these costs are "sunk" in the past (see Table 5.9).

The difficulties presented by these doubts, it was said, would be less serious if there were clear policy level support for NSMs. Although there was a feeling that there was such support, there was also a frustration that this support was too often not translated into hard policy and guidance. There was agreement, for example, with the claim by the independent review of the 2007 floods that there was a need for clear guidance on the use of demountable defences, and it was felt that there was a need for guidance on the encouragement of property-level measures[37]. It was also argued that Defra had failed to enshrine its theoretical support of NSMs in its High Level Targets and in the priority scoring system that is used to determine which project proposals gain funding. This, it was said, threw doubt on the real strength of support for NSMs[38].

5.11 Summary assessment: a FHRC interpretation

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

[37] This is currently under development. See the implementation programme for the Government's *Making Space for Water Strategy* at http://www.defra.gov.uk/environ/fcd/policy/strategy/rf1rf2.htm
[38] See Footnote 29.

Outcome Measures document[39], 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 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 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.

5.12 Our conclusions

Flood risk is now seen firmly by most with the flood risk management community as probability times consequences[40]. The application of non-structural flood risk management measures, this study suggests,

[39] 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.

[40] 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,

is being held back 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 (see Table 2.2). 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 - 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.

Department of Industry, London.

Table 5.6: Properties to benefit from option D2 or D4

[Diversion Channels 2 & 3 = Option D4) and Channels 1, 2 & 3 = Option D2]

Flood Risk 'Betterment' (i.e. properties moved to lower flood risk band)	D2 / D4 Reduction in Flood Affected Properties					
	Baseline			With Climate Change (+20%)		
	Exist	D2	D4	*Exist+20%*	D2	D4
To > 1 in 20yrs (5% annual probability)	*3270*	2760	2300	*6700*	4440	3050
To > 1 in 75yrs (1.33% annual probability)	*7130*	4725	3250	*10200*	4380	2860
To > 1 in 200yrs (0.5% annual probability)	*9875*	4240	2770	*14600*	6000	4000

Table 5.7: People to benefit from option D2 or D4

[Diversion Channels 2 & 3 = Option D4) and Channels 1, 2 & 3 = Option D2]

Flood Risk 'Betterment' (i.e. people moved to lower flood risk band)	D2 / D4 Reduction in Flood Affected Properties					
	Baseline			With Climate Change (+20%)		
	Exist	D2	D4	*Exist+20%*	D2	D4
To > 1 in 20yrs (5% annual probability)	*8200*	6900	5750	*16800*	11100	7600
To > 1 in 75yrs (1.33% annual probability)	*17800*	11800	8100	*25500*	10950	7150
To > 1 in 200yrs (0.5% annual probability)	*24700*	10600	6900	*36500*	15000	10000

Table 5.8: Economic Benefits of flood risk reduction in the Lower Thames - Options D2 or D4 (showing increment D4 to D2)*

Baseline Scenario	PV Damage	NPV	Av BCR	IBCR
Do Nothing	804			
Do Minimum	408	392	112	
Asset Replacement	286	509	54	20
Option D2	132	593	4.1	1.46
Option D4a	171	609	6.6	2.00
Option D4b	184	585	6.3	1.76
Option D2a	132	593	4.1	0.82
Option D2b				0.36

*Benefits and incremental benefits from implementing Diversion Channels 2 & 3 (Option D4) and Channels 1, 2 & 3 (Option D2)

Notes:
1. Options D4a and D4b assume range of between 66% (4b) to 75% (4a) of benefits achieved by D2.
2. D2a and D2b relate the increment from D2 to the related D4 (a/b) option alternative.

Table 5.9: Economic Benefits of flood risk reduction in the Lower Thames - Options D2 or D4 (allowing for 20% increasing in flooding due to climate change)*

Baseline with Climate Change	PV Damage	NPV	Av BCR	IBCR
Do Nothing	1392			
Do Minimum	n/a	n/a	n/a	
Asset Replacement	570	812	88	n/a
Option D2	263	1163	7.1	2.92
Option D4a Option D4b	341 368	1111 1064	11.2 10.7	3.99 3.52
Option D2a Option D2b	263	1163	7.1	1.62 2.21

*Benefits and incremental benefits from implementing Diversion Channels 2 & 3 (Option D4) and Channels 1, 2 & 3 (Option D2)

Notes:
3. Options D4a and D4b assume range of between 66% (4b) to 75% (4a) of benefits achieved by D2.
4. D2a and D2b relate the increment from D2 to the related D4 (a/b) option alternative.

Table 5.10: The results of the appraisal of major engineering options for flood risk reduction in the Lower Thames (Source: Halcrow et al., 2006)

	Option 1 (D2a)	Option 2 (D2b)	Option 3 (D4a)	Option 4 (D4b)
Scheme summary	Diversion channels 1, 2 and 3 plus dredging the Staines reach	Diversion channels 1, 2 and 3 only	Diversion channels 2 and 3 plus dredging of Bell Weir reach	Diversion channels 2 and 3
Total cost (£m)	225	200	143	108
Cost:benefit ratio	1:3.02	1:3.10	1:3.51	1:4.27
Number of properties taken out of high risk (1:20 year)	2,891	2,764	2,441	2,295
Number of properties taken out of insurance embargo area (1:75 years)	5,302	4,725	3,435	3,249
Cost per property protected (taken out of insurance embargo area)	£42,400	£42,300	£41,600	£33,200
Defra priority score	11	12	13	15
Properties left unprotected (1:75 years)	59%	64%	74%	75%

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6 Analysing risk perceptions of decision makers regarding the Glasgow Strategic Drainage Plan, Scotland

6.1 Introduction

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

6.2 Background – case study area

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.

6.3 The development of the Glasgow Strategic Drainage Plan (GSDP)

Within a few months of the Shettleston flood, it was recognised that a partnership and a joint strategy was needed if all three issues were to be addressed concurrently. The result was the GSDP managed by a Steering Group comprising Glasgow City Council, Scottish Water, SEPA and Scottish Enterprise Glasgow, with Glasgow City Council chairing the Group. The objectives of the GSDP were quickly identified as:

Flood risk reduction

- Water quality improvement
- Removal of development constraint
- Habitat improvement
- Integrated investment planning

In formulating the GSDP, the Steering Group gave particular emphasis to reducing the risk of widespread flooding from surcharging sewers and surface runoff. The nature and severity of this risk had been dramatically demonstrated during the 30 July 2002 flood in the east end of Glasgow when over 500 properties were flooded generating losses of around £100 million. It was also accepted that the frequency of such events was likely to increase given climate change. The link between urban flooding and water quality was seen as a direct consequence of open channels being converted into culverts many years ago and the discharge of stormwater from CSOs into these watercourses. As a result many urban watercourses in Glasgow will struggle to achieve "good status" by 2015 as required under the EC Water Framework Directive (European Commission, 2000).

In terms of urban regeneration, the lack of capacity in the sewerage system and the tendency for piecemeal development has meant that constraints in the drainage system are impeding the development of brownfield sites and much needed regeneration. This in turn has meant fewer new green urban spaces and opportunities for improved habitats. The GSDP is thus exploring the possibilities of "de-culverting" watercourses and installing attenuation ponds which would not only enhance amenity but also provide valuable new habitat for wildlife. Success in achieving these improvements in the urban water environment will require an integrated approach to investment planning by all GSDP partners working to a common timeframe.

One of the GSDP's initial challenges was recognition by Glasgow City Council and Scottish Water that a joint strategy was needed to address urban flood risk. This is graphically illustrated by Scottish Water's analysis of the flood volumes recorded at Elmvale Row, Springburn during the July 2002 storm estimated at 6000 m^3 from overland flow, 6000 m^3 from sewer flooding and 1000 m^3 due to high ground water levels

(Figure 6.1). Responsibility for managing the resulting urban flooding (in this case inundation to a depth of 1.2 m) is shared between Glasgow City Council and Scottish Water, but existing legislation is unclear in terms of how this should be done (Scottish Government, 2008b).

The following stages have thus far been completed

> Stage 1: Catchment wide initial studies and initial Strategic Drainage Plan for the east end of Glasgow (April 2004)
> Stage 2: Initial Strategic Drainage Plan for the 4 Waste Water Treatment Works catchments; Clyde Water Quality and Urban Pollution Management; and pilot Surface Water Management Plan (August 2005)

6.3.1 Structural measures ('hard' and 'soft' engineering)

In Stage 1 of the GSDP Scottish Water appointed consultants to undertake an initial catchment-wide study and to report on an initial Strategic Drainage Plan for the east end of Glasgow in the area served by the Dalmarnock Waste Water Treatment Works. In focusing on an initial Strategic Drainage Plan for the east end of Glasgow and the Light Burn area (Figure 6.3), five main problems were identified (Akornor *et al*., 2004):

- Flooding at Cardowan Road and Shettleston Road caused by a lack of capacity in the trunk sewer and the Light Burn downstream which is heavily culverted.
- CSO impacts at Edinburgh Road and Shettleston Road. Modelling a 5 year return period 2 hour duration design storm yielded >75% of the flow in the Light Burn as originating from 2 of the CSOs in the catchment.
- Development constraints upstream of the Light Burn area (affecting 790 proposed new homes at Garloch Road) with severe economic, social and environmental consequences. Glasgow City Council estimates that £1.5 billion worth of new development is affected by drainage constraints across the whole catchment.
- Habitat and amenity issues. The Light Burn is 85% culverted and many of the remaining open sections are straight, steep sided concrete channels with high fences preventing public access. De-culverting the Light Burn and restoring the habitat (as recommended by SEPA) plus the use of Sustainable Urban Drainage Systems (SUDS) both in new developments and retrofitted sites can create valuable "blue spaces" in urban areas and enhance amenity.
- Future uncertainty in terms of the impact of climate change requires an allowance for predicted increases in rainfall by the 2080s. Drainage design needs to allow for such changes in design rainfall events.

In 2004 the proposed solutions for these five problems (which can be seen as symptomatic for urban drainage across much of Glasgow) were structural measures embracing both 'hard' and 'soft' engineering, combined with non-structural measures focused on spatial planning, water course maintenance, emergency action and improving flood resilience.

The 'hard' engineering solutions comprised:

- Re-routing existing sewer flows through an interceptor tunnel from Edinburgh Road to Carntynehall Road. This would remove all three CSOs which currently discharge into the Light Burn. Estimated cost: £4.2 million
- An offline storage tank with a capacity of 21,500 m^3 adjacent to the Edinburgh Road CSO with a design standard of 1 in 30 years (sewer flooding) and 1 in 100 years (watercourse flooding). Estimated cost: £21.5 million
- Storm/Foul flow separation by removing the stormwater from the combined system and routing the flows via SUDS schemes to the Light Burn. Estimated cost: £13.6 million

'Soft' engineering solutions comprised:

- Retrofit SUDS exploiting significant areas of both greenfield and brownfield sites in the catchment.
- Watercourse solutions include the use of attenuation ponds and de-culverting buried watercourses

Although these solutions are described as here as 'soft' engineering, some respondents in the interviews reported on later, see these as non-structural measures.

Stage 2 of the GSDP included a catchment-wide master plan which recommended that the 120 separate drainage areas operated by Scottish Water be re-grouped into 27 hydraulically discrete catchments for which combined drainage plans would be developed (Page *et al*., 2005). Each of these drainage plans would then be amalgamated in Waste Water Treatment Works catchment plans for each of the 4 WWTWs (Dalmuir, Dalmarnock, Daldowie and Sheildhall: see Figure 6.4 for locations). Piecemeal solutions to local problems were deemed to be unviable and uneconomic and a cross-catchment holistic masterplan thought essential if a strategic plan for the whole of Greater Glasgow was to be developed

In 2005 the cost of the initial GSDP masterplan was estimated at £1.4 billion for which special funding would be required. Scottish Water's 8 year investment plan from 2006 (Q&SIII) does not include strategic stormwater infrastructure investment. Glasgow City Council can only bring forward Flood Protection Orders under the 1961 Act for which funding hitherto has favoured traditional structural defences on main rivers. As a result, Glasgow City Council and Scottish Water are pursuing a range of alternative funding sources including the Scottish Government which has identified the GSDP as a priority in the second National Planning Framework (Scottish Government 2008a).

Since 2005 the Steering Group and Technical Groups have focused on delivering the Clyde Gateway Integrated Water Plan as the first phase of delivering the GSDP. In 2006 it was also agreed that the remit of the GSDP should be widened to include other local authorities in the Glasgow conurbation and the Metropolitan Glasgow Strategic Drainage Partnership now includes other stakeholders including the Scottish Government and the Glasgow and Clyde Valley Structure Plan. This has enabled work on the GSDP to be viewed within the wider contexts of strategic planning for the Glasgow conurbation and delivering the objectives of the EC Water Framework Directive (European Commission, 2000) via SEPA's Clyde Area Advisory Group.

6.3.2 Mix of structural and non-structural measures

Many of the initial studies undertaken on behalf of Scottish Water focused on structural measures to reduce urban flood risk, but a suite of non-structural measures already exist and new ones are being developed. These non-structural measures, which have usefully been listed and assessed in the ERA-NET CRUE project on Risk assessment and Risk Management in Small Urban Catchments (Ashley *et al*., 2007) are itemised in Table 6.1.
Some non-structural measures, already implemented by Glasgow City Council, are explicitly embedded in the GSDP (Development Planning; Economic Instruments; Planning and Management; Street storm/drain/culvert/watercourse maintenance). Others are currently operational and relate specifically to emergency planning before and during a flood (Sand Bag Delivery; Flood Risk Emergency Plans; Strathclyde Emergency Co-ordination Group, Dwellers with special requirements register; Resilient Communications Network).

A third group of measures currently in place (Weather Warning Systems; Flood Risk Maps; GIS database) are jointly undertaken by SEPA and Glasgow City Council. At present Met Office models provide a 6 hour warning of heavy rainfall on a 4 km grid which is of limited use for predicting urban flooding. But this is set to change with predictions on a 1.5 km grid which, when combined with suitable

2-D inundation models, should improve warnings for urban flooding. Similarly the current SEPA Indicative River and Coastal Flood Map does not include pluvial flooding in urban areas. But again with increasing LiDAR coverage and rapidly improving inundation models, local authorities are increasingly well-equipped to identify hotspots and model surface water flows.

Enhancing flood resilience at the level of individual properties is not included in Table 6.1, but is a key element in Scottish Water's policy on managing sewerage floods. Temporary measures designed to reduce the risk of internal flooding includes the use of flood guards, air vent guards or non-return valves offered to customers in properties at highest risk. By directly dealing with customers, this can also be seen as engaging with the public and raising awareness.

But as Ashley *et al*., (2007) note, more generic measures designed to raise awareness and community engagement are weakly developed in the GSDP at present. This criticism is accepted by the Steering Group which is currently developing a Communication Strategy as part of the GSDP. It is hoped that a higher level of individual awareness of flood risk and better engagement with communities will follow. Increasing the take up of flood insurance (especially amongst in the most vulnerable communities) is being actively promoted by the Scottish Government with the providers of social housing being encouraged to promote 'pay-with-rent' schemes. But this also has yet to have a high profile within the GSDP.

6.4 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.

6.5 Results from interviews with senior flood risk managers

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.

6.5.1 Factors influencing the choice of structural or non-structural measures

The mix of structural and non-structural measures in the GSDP reflects local circumstances (both threats and opportunities) and the evolution of flood risk management policy at the national level. Both have played a major role in shaping the development of the GSDP.

The initial trigger for the GSDP was the Shettleston flood in 2002. Scottish Water and Glasgow City Council came under intense pressure from MSPs, local councillors and flood victims to address the problem of urban flooding which for some communities had been a persistent problem for many years. But this “wake up” call also provided an opportunity to address four other pressing agendas – water quality improvement, removal of development constraint, habitat improvement and integrated investment planning – alongside flood risk reduction. At an early stage in the development of the GSDP a mixture of structural and non-structural measures emerged in order to address all five objectives.

For two of the interviewees this balance has shifted over time. In their professional judgement, non-structural measures are capable of delivering improved water quality and flood risk reduction with minimal

reliance on structural measures. The more representative view would be that both structural and non-structural measures are needed to deliver the GSDP. The next section explores the circumstances under which both can optimally be deployed.

Also influencing the mix of measures adopted in the GSDP was a change in national flood risk management policy (Werritty, 2006) triggered by the need to promote sustainable flood management as specified in the Water Environment Water Services (Scotland) Act 2003. Growing dissatisfaction with the Flood Prevention (Scotland) Act 1961 (seen by one interviewee as "moribund" in its privileging of structural measures and flood alleviation schemes) was a major impetus in the development of sustainable flood management.

As a result of work on defining and operationalising sustainable flood management (Scottish Executive, 2004a, Scottish Government, 2007a), non-structural measures have been given an increasingly high profile in the National Flooding Framework which represents current Scottish Government policy on flood risk management. Thus the first three of the 4 'As' (Assistance, Avoidance, Awareness and Alleviation) in the National Flooding Framework are non-structural measures. Several respondents noted that the new EC Directive on Flooding (European Commission (2007)), with its requirement that flood risk management plans focus on prevention, protection and preparedness, also gives non-structural measures a key role in mitigating flood impacts.

Given the above, many respondents saw the adoption of non-structural measures as crucial in delivering flood risk management tailored to 21st century needs. Across Scotland, non-structural measures are viewed as an equal partner with structural measures and certainly not second best as reported in the Lower Thames Study.

6.5.2 Constraints and opportunities in delivering the GSDP

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.

6.5.3 Managing public opinion

Immediately after the Shettleston flood in 2002 flood victims, local politicians and community groups were very vocal in demanding effective action. But, with the passage of time this has become muted and the views of local groups have yet to be formally included in the decision-making process. As a result, those components of non-structural measures which relate to raising awareness and community engagement (Table 6.1) are under-developed in the GSDP. But as Newman *et al*., (2007) have noted, local capacity building is essential if non-structural measures are to be effectively delivered and taken up. Several respondents directly involved in delivering the GSDP noted this deficiency and reported that a Communication Strategy was being developed in order to help fill this gap.

More generally it was reported that when consulted, the public favours structural over non-structural measures, a finding supported by other studies (Werritty *et al*., 2007). But when it is explained that such measures will never be justified in cost-benefit terms, there is a willingness by some community groups to accept non-structural measures as a realistic alternative.

6.5.4 Professional cultures

One of the major findings from the Lower Thames Study was a marked antipathy towards non-structural measures by the engineering profession which variously saw them as "second best" and "unproven". In Scotland the view of the engineering profession is strikingly different.

> Interviewer: It's very interesting to hear an engineer like yourself espousing non-structural measures with the passion that you have used. Do you think across the engineering profession in Scotland there is a greater acceptance of going down the non-structural route?
>
> Respondent: Absolutely. I'd be very clear on this.
>
> Interviewer: South of the border, engineers think that the only way they can obtain professional esteem is to go for large expensive flood defence schemes.
>
> Respondent: I've said that if you want to make your name in the EA you build big flood schemes.
>
> Interviewer: To make your way in Scotland, what's the alternative?
>
> Respondent: You probably join a consultant and do interesting much smaller scale schemes …. with interesting environmental solutions.

Interviewer: So in terms of prestige, career development and professional standing, non-structural measures are much more credible in Scotland?

Respondent: Yes, now that you say that I think that is the case.

It was clear from all the interviews with chartered engineers that there is a much greater commitment to and enthusiasm for non-structural measures than in the Lower Thames study. In part this reflects the experience of engineers in local authorities who, working alongside planners, have taken up the opportunities for flood risk management provided by SUDS and surface water management plans. It also reflects the impact on flood risk management professionals of the many discussions and consultations on sustainable flood risk management promoted by central government over the last four years. It is now widely accepted in Scotland that a portfolio of sustainable flood risk measures should include non-structural solutions.

6.6 Conclusions

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 comparison with that Table's "coercion" dimension. It also meets the sustainable development criteria cited in Section 2.4: 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.

6.7 References

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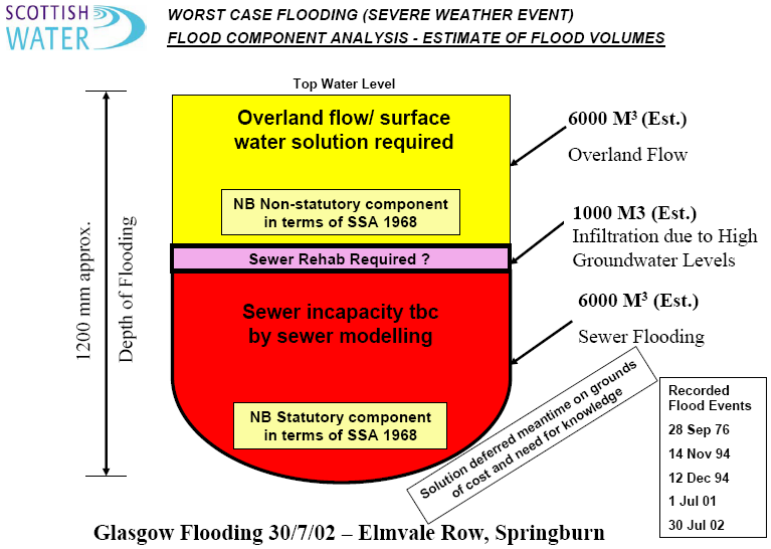
Figure 6.1: Estimated components of the flood volumes at Elmvale Row, Springburn, July 2002 flood (source: Scottish Water).



The GSDP is a long-term plan with four stages programmed up to 2014 (Figure 6.2)

Figure 6.2: Development stages of GSDP (SEPA, 2007)

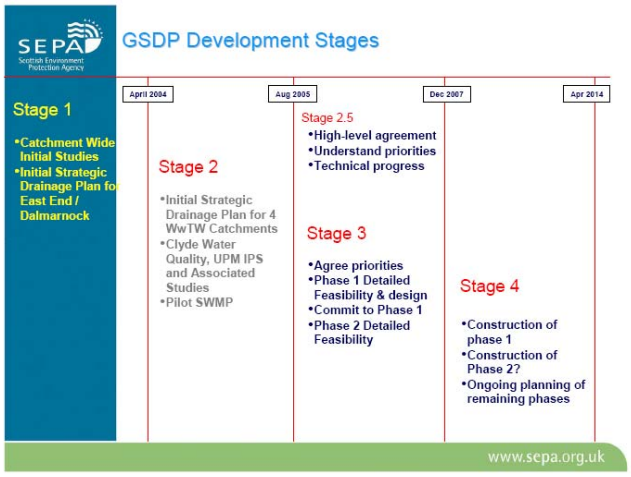


Figure 6.3: Light Burn Case Study Area: east end of Glasgow (Akornor et al., 2004)

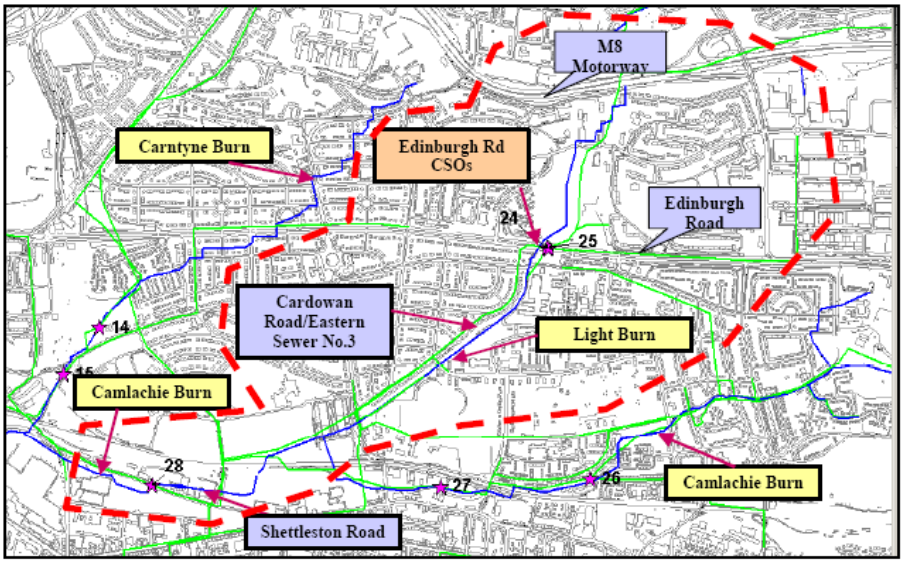


Figure 6.4: Glasgow Strategic Drainage Plan with the four catchments for the Waste Water Treatment Works (Page et al., 2005)

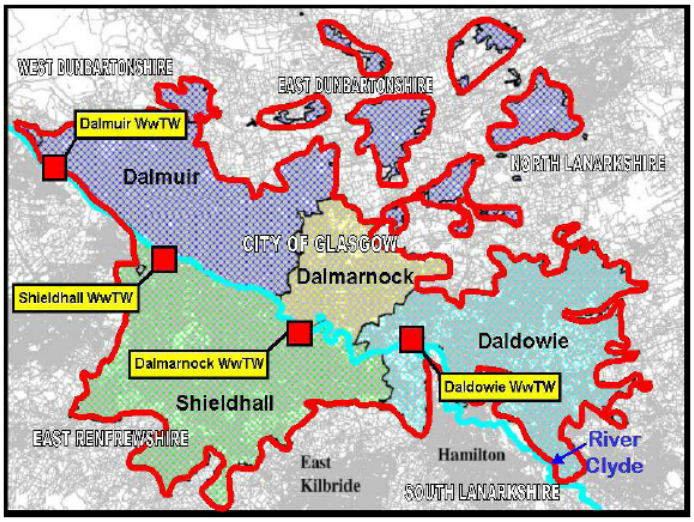


Table 6.1: Non-structural flood risk measures relevant to GSDP (Ashley et al., 2007)

Group	Non-structural response (NSR) measure
Pre-flood (prevention) measures	Weather Warning Systems
	Flood Risk Emergency Plans
	Sand Bag delivery
	Co-ordinating Emergency Authority Jurisdiction Boundaries
	Development Planning (PPSs in Scotland)
	Awareness Raising/ Improving Information for all Stakeholders
	Decision Support Systems
	Dwellers with special requirements register
	Economic Instruments
	Flood Risk Maps
	GIS Database
	Planning & Management
	Public Education/ Persuasion
	Stormwater direct/re-use
	Street storm/drain/ culvert/watercourse maintenance
	Regulation
During flood measures	Strathclyde Emergency Co-ordination Group (SEGC) Helpline
	Awareness Raising/ Improving Information for all Stakeholders
	Decision Support Systems
	Resilient Communications Network (RTN)
	Dwellers with special requirements register
	Individual Measures
	Flood Risk Maps
	GIS Database
Post-flood measures	Individual Measures
	Insurance
	Awareness Raising/ Improving Information for all Stakeholders
	Public Education/ Persuasion
	Recording System Memory

7 Assessment and evaluation

7.1 Introduction

The objectives for the FLOOD-ERA research were listed in Chapter 1. They 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.

In terms of these objectives, the first is covered in Chapter 2 herein, and the second is covered in the parallel Joint Report from all three FLOOD-ERA partners. The third and fourth objectives are tackled, for England and for Scotland, in Chapters three to six herein. The fifth objective is covered in this Chapter and, of course, also in the Joint Report.

7.2 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 is not very useful and should be dropped.

What we stress here (Chapter 2) 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 (see Table 2.2): 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 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 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), 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.

7.6 Recommendations

There are just four recommendations that follow from this research and its results:

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.

Annex: FLOOD-ERA Country Studies "England" and "Scotland": Terms of Reference

The country study shows the issues involved in managing flood risk where there is pre-existing flood defence infrastructure, but a new philosophy that moves toward flood risk management, rather than flood defence, with the use of non-structural measures. Analysis will exploit the results produced elsewhere (e. g., Foresight, FLOODsite; the EPSRC's FRMRC). However, it clearly departs from this research through focusing on non-structural measures and through expanding the effectiveness/efficiency and risk perception analysis.

NOTE: The country study will encompass both England and Scotland (with any useful cross-references to the situation in Wales). In reporting on this work, however, we will ensure that there are separate sections on (a) results from the research in England and (b) results from the research in Scotland [see list of Milestones and Deliverables]. Given budgetary constraints, however, it is likely that the research and the results for Scotland will be less extensive than those for England.

Activity 1: Analysing risk perception of decision makers

Action 1: Document analysis : Due to the more centralised institutional structure of flood risk management in England and in Scotland (vis-à-vis Germany, for example) document analysis will focus on documents and related sources (e.g. consultation results) at the national policy level especially with regard to non-structural measures and the responsibilities of different public organisations (e.g. catchment managers, warning agents, spatial planners).

Action 2: Expert interviews : 10 semi-structured interviews with key decision-makers in public organisations with flood-risk management and related responsibilities will be undertaken at national and local/regional level for England. In Scotland 6 semi-structured interviews will be undertaken. Focus will be put on the choice mechanisms used to selected flood risk management measures.

Activity 2: Systematisation of flood risk management concepts and site-specific measures

Action 1: Analysing management concepts at programme level : To systemise management concepts and measures, FLOOD-ERA distinguishes between three "high-level" flood risk management options: (1) *Continue present practice of structural measures*, (2) *integrated flood defence management mainly with structural measures*, (3) *integrated flood risk management with non-structural and structural measures:* This option includes development control, which will reduce risk but also have the potential to lower costs. This Action will analyse the existing and likely future balance between these options, focusing on the Making Space for Water policy initiative and its results to date, and similar policy initiatives in Scotland.

Action 2: Analysing site-specific measures In a case study (yet to be selected) there will be examples of both structural and non-structural flood risk management measures. If, for example, thye3 case study were to be the Thames Estuary, these would include measures such as the Thames Barrier and other related structural defences, and non-structural measures such as flood warning systems, land use planning and flood awareness programmes. In this Action, the choice mechanisms for the different measures will be analysed, using both documentary sources and information from selected

meetings/interviews. A similar exercise will be undertaken in Scotland, but at a lesser scale of analysis (commensurate with budget constraints)

Activity 3: Evaluation of effectiveness and efficiency of non-structural and structural measures

Action 1: Evaluation of effectiveness : For a selected case study site (to be decided), flood risk management measures based on spatial planning and engineering are evaluated regarding the likely or actual effectiveness of non-structural and structural measures.

The measure of effectiveness to be used here is the extent to which the flood risk management problem at the site can be alleviated by the measures in question (judged for example by some metric such as the return period of the scheme or the number of people taken out of selected risk bands).

Action 2: Evaluation of efficiency : Measures of Action 2 are compared by means of cost-effectiveness analysis and benefit-cost ratios. Costs are estimated based on direct costs of conducting the measures in question (e.g., construction costs) and indirect costs.

It is likely that this will not take the form of a new benefit-cost test for the site in question, but will build on existing analyses or be indicative only, depending on the site chosen. For example, if the Thames Estuary were selected, then there is some high-level BCA analysis to draw on. If another site were chosen there may be no such analysis available and an approximation process would be used.

Action 3: Identification of transaction costs : Two methods will be used to identify transaction costs of spatial planning and structural measures. First, a literature and document analysis will be performed to identify different forms of transaction costs. Second, there will be a co-operation with activity 1 in order to use the interviews on risk perception also to qualify the existence and significance of different forms of transaction costs. As a result, different forms of transaction costs will be listed.

Action 4: Overall evaluation of the measures : The results of actions 1-3 will be combined in this action in order to come to an overall scientific evaluation of the measures that have been analysed.

Activity 4: Comparison of existing and possible new concepts regarding effectiveness and efficiency.

In this Activity decision processes and their results in practice, as revealed in the study on risk perception in **Activity 1**, will be compared with the results of the site-based evaluation undertaken in **Activity 3** (and *vice versa*).

Differences between 'theory' and 'practice' (i.e. the ideals as revealed by the interviews and the results 'on the ground' from the site study(ies), and reasons for them, will be analysed and discussed.

From this, recommendations will be given as to how the specific choices and choice mechanisms in the circumstances in the site(s) chosen for the 'site study(ies)' could be modified in order to take the scientific criteria developed in Activity 3 more into account.