DEPARTMENT for ENVIRONMENT, FOOD and RURAL AFFAIRS

CSG 15

Research and Development

Final Project Report

(Not to be used for LINK projects)

Two hard copies of this form should be returned to:
Research Policy and International Division, Final Reports Unit
DEFRA, Area 301
Cromwell House, Dean Stanley Street, London, SW1P 3JH.
An electronic version should be e-mailed to resreports@defra.gsi.gov.uk

Project title	The Advantages and Disadvantages of adopting Consistent Standards for Communities
DEFRA project code	**FD2009**
Contractor organisation and location	HR Wallingford Ltd Wallingford Oxon OX10 8BA
Total DEFRA project costs	£ 60,000
Project start date	07/01/02
Project end date	31/03/04

Executive summary (maximum 2 sides A4)

Current methods of design and appraisal for flood defence can lead to varying levels of protection. This can occur nationally or regionally (for example, between different schemes) or within communities. There is a concern that the adoption of different defence standards within a community is undesirable, and an alternative approach should be sought in order to provide consistent standards of defence for communities.

The purpose of the project is to examine the advantages and disadvantages of adopting a policy of consistent standards of flood alleviation for communities, make recommendations for any changes in future appraisal guidance and identify any further research required to reduce areas of uncertainty.

A total of nine different definitions of 'consistent standards' have been identified. Four of these were rejected as not being practical options. The other five have been applied to seven case studies to identify the advantages and disadvantages of such approaches. The five criteria are as follows:

- Economic efficiency
- Population efficiency, intended to protect as many people as possible
- Equal cost per property
- Equal threshold of flooding, using a range of threshold standards
- Equal vulnerability, in which vulnerable people are protected.

The evaluation of these criteria included an assessment of the following:

- Impacts on people
- Impacts on the community
- Effects of larger floods
- Economic impacts, including cost per property and total cost of different options.

The results have been used to clarify some key issues and suggest some different approaches that might be considered by stakeholders. One primary conclusion follows from Sen's observation that the achievement of one form of equality tends to preclude the achievement of another form of equality. Consequently, there is no criterion which can be mechanically applied and which will result in universal happiness.

A second conclusion is that, rather than seek an alternative criterion such as a consistent standard of flood alleviation, it may be more helpful to look at and to seek to address the wider policy issues of how we may best achieve a sustainable flood risk management policy within the context of integrated catchment management over the longer term.

Scientific report (maximum 20 sides A4)

The scientific report exceeds 20 pages. A contents list is therefore provided together with the Conclusions and Suggestions arising from the project.

CONTENTS

CONCLUSIONS

The driver for this study was the possibility that changing the decision criterion would remove, or significantly, reduce the problems of making choices as to whether flood alleviation works should be provided and, if so, as to what standard of flood protection should be provided. The overall conclusion is that no such simple and painless solution exists to the problem. But in addition a number of lessons and conclusions have been drawn as to the policy issues involved in flood risk management and those lessons may turn out to yield a better way forward.

Choices are always difficult precisely because adopting one option necessarily precludes simultaneously adopting an alternative course of action. Those choices also become particularly sharp when the choice involves individuals suffering and we know the suffering that flooding causes to those affected. In consequence, we may seek to gain a better understanding of what a choice involves, and we may hope to find a better option, but it is less likely that we will be able to make choices easier solely by adopting a different decision criterion.

The problem of choosing a decision criterion is somewhat circular in that we need decision criteria by which to select the decision criterion. In discussing the basis for selecting a criterion, it was argued that a balance has to be struck between type 1 errors, not undertaking a scheme when one should have been undertaken, and type 2 errors, undertaking a scheme when one should have not been undertaken. There it was suggested that there might be four conditions which resulted in a type 1 error:

1. The flood risk has been increased by development higher up the catchment: no clear examples of this case were found but in several cases, the scheme undertaken will increase the risk to other properties. Here, it is not the criterion but the scheme, and more particularly the nature of the option adopted, that results in this error.

2. Non-economic efficiency criteria. No direct evidence of concerns as to socio-economic regeneration were evident in the case studies.

3. In one of the case studies, there is a clear social and economic connection between the different areas. The economic efficiency criterion fails to take account of that connection.

4. That a criterion may discriminate against the poor and in favour of the better off. That it is density of loss per unit length of defence that has a major influence on the economic viability of a scheme tends to argue against this claim. regions.

It was suggested that Type 2 errors occur when a scheme:

1. Worsens a flood problem up or downstream. A number of the proposed schemes would do so, although the impact is generally small. Only the economic efficiency criterion could directly take account of those impacts.

2. Has significant net negative environmental impacts. No reports of such effects were found. Only the economic efficiency criterion has the potential to take account of both negative and positive environmental impacts.

3. Will fail to deliver the anticipated flood alleviation benefits. Concerns were expressed about the reliability of one scheme which depends upon manually installed flood proofing measures. The incorporation of reliability engineering techniques into the analysis is most readily done when the economic efficiency criterion is applied.

4. Entails an excessive cost. Local data on property prices was not obtained but a cost per property in one instance of £200,000 is suggestive that this cost would exceed the value of the property protected. Criteria other than the economic efficiency criterion would require auxiliary rules to take account of excessive costs.

5. Negatively impacts upon the performance of the catchment as a whole. Not surprisingly, no scheme was in the form of a 1960s 'river improvement' which converted rivers into a culverts. Conversely, none of the schemes can be claimed to have contributed directly towards the achievement of the objectives of the Water Framework Directive. A number of the schemes further fix existing throttle points in the system in place. None of the criteria directly take account of such concerns.

6. Is implemented because of political pressure. Severe flooding, particularly if it is unexpected, can produce a very powerful local reaction for the provision of flood alleviation works even though they may be difficult to justify compared with other flood risk areas. This is particularly a problem when a large event exceeds the capacity of existing flood defences.

It was argued earlier that the decision criterion must be capable of consistent application. The vulnerability criterion is weak in these terms because of the problems of defining exactly what is vulnerability. It is open to the argument that someone else is also vulnerable.

The general conclusions that can be drawn from the case studies are:

- There are a number of generic options for riparian flood defence (source control, storage, increasing conveyance of flood flows, separation between river and property). In each case study area, a range of such options were considered but for reasons of feasibility or cost, the option selected in the majority of cases was a flood wall or embankment. This non-random sample of schemes implies that dikes or flood walls will often be the best or only viable option.

  It would helpful to determine whether the apparent preponderance of dikes/walls over other methods (i.e. source control, storage and improvements in conveyance) is a consequence of the comparative effectiveness of the different methods, their relative cost or financing issues, physical constraints, limitations within the framework of project appraisal, or result from treating a local problem rather than taking a catchment perspective.

  Those other methods have advantages both in terms of managing all floods rather than just some and in providing a reduction of risk to most of those at risk of flooding. They would remove many of the problems of providing a consistent standard of flood defence within a community but the differences within a catchment and between catchments would probably remain. Some of the problems just listed can be fixed (e.g. with the framework of project appraisal, adopting a catchment approach rather than a local approach, in financing) relatively easily. But physical constraints and comparative effectiveness cannot.

- The physical reality of different exposure to flooding in different parts of any catchment means that it is difficult to achieve equality of standard. There are uncertainties in hydrological design and water level prediction during different events as well as physical constraints and environmental and social factors.

- The impact of 'larger than design' floods varied between the case studies. Narrow protected areas on large rivers would flood quickly and completely once the design standard was exceeded. Wide floodplains on smaller rivers would only partially flood, and there would be a high level of residual protection for many properties. The majority of the protected areas in the case studies were small compared with the size of the river.

- In considering the flood plain, three distinct regions can be distinguished:

  1. Throttles: narrow points which limit the maximum flow and create backwater effects
  2. Other sections of the floodway
  3. Flood storage areas

  A number of the flood problems in the case studies occur at a throttle point and there is consequently a danger of fixing the throttle point at a time when it might be argued that adapting to climate change will probably require widening throttle points. A major problem in adapting will be historic areas, including conservation areas, and particularly old bridges.

  Culverts are a further type of throttle that are susceptible to higher flood risks in the future, particularly bearing in mind the risk of blockage.

- Schemes studied which involved dikes or walls did have the effect of increasing the depth of flooding to be expected elsewhere on the catchment, generally by a quite small amount (i.e. 50 mm) but in one case by 300 mm. In this latter case, providing protection to one part of a community would increase the depth of flooding to the other part of the community which was to be left unprotected. What the implication in terms of changing the probability of flooding was not assessed. It is implicit in FCD PAG3 that such effects should be included as a cost in assessing the proposed flood alleviation scheme but the wider issue of equity is obvious.

- The potential increase in flood loss as a result of 50 mm increase in depth of flooding varies, for the average house, between £120 and £10,000 – the larger figures being for situations where the 50 mm increase will result in flooding now occurring just above floor level (Figure 1). This means that an increase in the number of properties that flood in a particular event has a much greater influence on event losses than an increase in depth of flooding to properties that already flood in more frequent events.

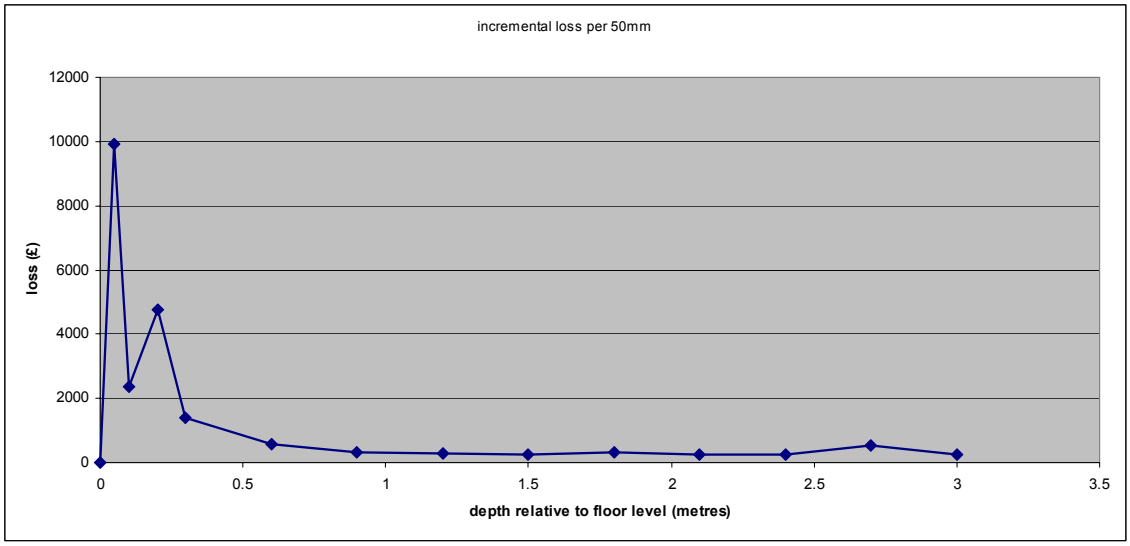

Figure 1 The incremental flood loss arising from an increase in the depth of flooding of 50mm

- In a number of cases, development has occurred relatively recently and the granting of planning for that development must be questioned.

- As a result of the high costs of protection observed in the first case studies undertaken, in the subsequent studies we used flood proofing as a fallback option, subject to the concerns that we discussed in Section 3.7.3. Whilst this appears to be a convenient option, particularly as it encourages 'self-help', there are many pitfalls.

- When the cells that were not provided with protection are considered, the problem is not a lack of benefits but the extent of the costs of providing protection. In many cases, the costs of protection would be very high indeed (in excess of £70,000 per property). For comparison, the cost of a hip replacement averaged £3,755 in 1998/1999 (National Audit Office 2000). Allowing for inflation in health care costs, a rough figure of £4,000 per hip replacement is not an unreasonable. Hence, to justify some of the proposed projects, it has to be argued that reducing the flood risk to a property is 15-20 times more effective in reducing suffering than undertaking a hip replacement.

- In some cases, it would almost certainly be cheaper to buy and demolish those properties rather than provide flood defence. These costs are high even in some cells where it was economically efficient to undertake works. Table 1 summarises the results and Table 4.1 gave the current market prices of dwellings in different regions. Table 2 provides an indication of the effectiveness of flood defences in the case studies.

Table 1 Cost per property by standard of protection that would be offered

Case study	Cost per property (£'000)		Standard of protection offered (%)	Region
	Residential	All		
A	80-115	60-90	1.0-2.0	West Midlands
B	16-23	13-17	0.5-1.0	South East
C	44	37	1.0	South East
D	16-17	14-15	0.5-2.0	Yorks and Humber
E	120	90	1.3	Yorks and Humber
F	230-250	60-70	0.5-1.0	Yorks and Humber
G	5.3	4.6-5.2	1.0-2.5	North West

Table 2 Costs and effectiveness of flood defences

Case study	Region	Length of defence (km)	Cost per unit length of defence (£m / km)	Properties protected per km of defence
A	West Midlands	0.6	17.3	287
B	South East	0.7-1.5	5.3 – 6.2	350 – 410
C	South East	2.7	1.9	52
D	Yorks and Humber	3.3	1.5	110
E	Yorks and Humber	1.0	4.9	53
F	Yorks and Humber	2.05	2.7	45
G	North West	N/A	-	-

- The next obvious question is: why are costs so high in these cases? Although statistical analysis of the full data set has not yet been completed, Figure 2 does show the importance of loss per unit length of a dike or wall in determining the cost per property. The cost of works varied over the range of about £1,000 to £7,000 per linear metre; in consequence, the density of properties per unit length has to be quite high if the cost per property is not to be very high.

- The cost per property as the standard of protection was increased varied between the schemes; most commonly, there was a high fixed cost of installing any standard of protection, the incremental cost of adopting a higher standard then tending to fall. But, in a few cases, it was cheap to provide a low standard of defence but costs rose markedly if a higher standard defence was to be proposed.

- Town centres were often covered by more than one cell in the case studies, usually because they were either side of a river crossing point. Consideration might be given to protecting cells that cover the centre of towns on opposite sides of a river for a variety of reasons including economic efficiency (Case Study E), community function (Case Study F), and avoiding an increase in risk in part of the town centre (Case Study D).

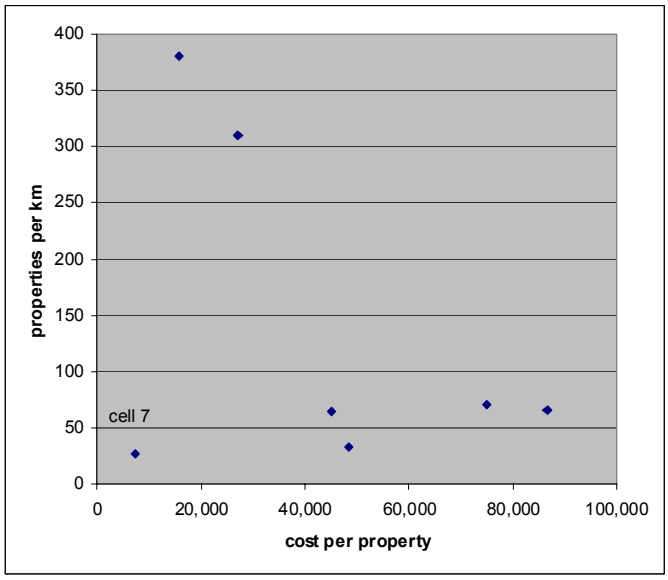

Figure 2 Case study B: Costs per property by cell

- Opportunities exist for local funding to support flood defence funding, particularly in Case Study G which has large areas for potential regeneration involving both the local authority and developers.

- The case studies did not cover the issue of whether some properties would flood as a result of surcharges from sewers, or whether flooding as a result of local drainage problems would continue within areas protected from flooding from the river. Schemes were generally designed to avoid an increase in flooding from this source.

- In none of the case studies was there clear evidence that land use changes elsewhere on the catchment had resulted in a marked increase in the risk of flooding. The important parameters here are the proportion of the catchment across which that change takes place and the location within the catchment of the land where the change occurs. Intuitively, therefore, such a change is most likely to be found in small catchments, particularly small urbanising catchments.

At this wider level, two policy concerns emerged:

1. In some cases, particularly around throttle points, providing flood defence in the long run is likely to be unsustainable.
2. The unit costs of providing conventional defences in some areas are very high and can exceed the market value of the property concerned.

Neither of these concerns is directly addressed by the choice of the decision criterion; both need addressing.

SUGGESTIONS

In this context, it is not appropriate to make recommendations to the stakeholders but it is appropriate to try to clarify what we consider to be the lessons learnt so far.

Defining a decision criterion to determine the design standard of protection to be provided in a particular area is a classic example of what Rittel and Webber (1973) described as a ‘wicked problem’. One aspect of a ‘wicked problem’ is that it can be defined in a number of quite different ways, “the information needed to understand the problem depends upon one’s idea for solving it”; another, that ‘solving’ one problem can simply result in another aspect coming to the fore. Hence, a useful strategy can be to seek to define the problem and hence the solution in a different way. Amongst such options are:

1. If communities could part fund flood alleviation through their own resources then the question of a consistent community standard would not arise. It arises precisely because any works are currently funded directly or indirectly through the general taxpayer. The problem would not change but the community itself would have to confront the problem of whether to provide different standards in different areas or increase the charges they imposed upon themselves. The current review of local government funding provides one route to establishing such a means of local financing.

A hypothecated charge for catchment management is an alternative model. In neither case would the charge be specifically for flood risk management; in the former case, it would be available for the local authority to spend as it saw fit and in the latter case, it could be spent upon any aspect of catchment management that would contribute towards the achievement of the objectives of the Water Framework Directive which does refer to flooding. The simultaneous advantage and disadvantage of this approach would be that it forces the difficult decision on to the community itself.

2. There is a danger of being trapped into a cycle of protecting what is there where undertaking that protection becomes increasingly more difficult and expensive as flood flows increase as a result of climate change. The implication is that we should decide now which parts of the flood plain will have to be evacuated in order, in particular, to ease throttle points. The difficulties relieving with throttle points is that in some cases, those throttle points occur at the historic points of settlement and, in others, the local community lacks developable land outside of the flood plain.

   Achieving the good ecological quality objective of the Water Framework Directive depends not just upon water quality but also upon both the flow regime and the geomorphological form of the channel. Achieving a geomorphological form that will support a diverse ecosystem requires space; the sheet piled banks or concrete trapezoidal channels have been forced on flood defence engineers in part because constricted space in urban areas does not allow any other options. Therefore, it may become necessary to buy some buildings on the flood plain, demolish them, and convert that land to a use that allows the river to be managed more readily.

   The problem is finding an acceptable mechanism to fund such works whilst simultaneously avoiding 'planning blight'. In areas qualifying for structural funds, it may be possible to acquire land in this way as part of a strategy of regeneration. However, in some of the case study areas, there is a shortage of land that is not on a steep slope. As the size of commercial properties increases, the average size of large warehouse now being 50,000 square metres, the pressure on flat land will increase so that communities which lack any useable flat land will decline. That flat land tends to be on flood plains. Hence, banning all development on flood plains and abandoning existing development may mean the decline of some established communities.

3. There is a move to encourage flood awareness and self help amongst the public in flood risk areas. One aspect of this initiative is the use of flood proofing for individual properties (or groups of properties, using 'pallet barriers'). An approximate figure for the cost of flood proofing a domestic property is £2,000 per room. In some parts of the case study areas, flood proofing would almost certainly be a cheaper option that the options considered. In this approach, the general option would be to provide flood proofing with other options only be adopted if they provide better value for money. There are problems with flood proofing, notably that a difference in the water head of more than about a metre is sufficient to cause partial or complete structural failure of a masonry constructed building. Thus, potentially flood proofing may create a risk to life and in the USA, it is recommended that evacuation accompanies flood proofing. Flood shields and similar devices should therefore be labelled with a safety warning as to the dangers of seeking to modify them to provide protection against a greater depth of flooding.

   Secondly, putting barriers across openings requires labour (and takes time so requiring a significant warning lead time) and around 15% of the population have mobility difficulties. In turn, the reliability of flood proofing may be quite low. Thirdly, if the duration of flooding or ground conditions are such that water starts to enter through the ground and up through the floor, then flood proofing will not provide complete protection. Fourthly, it provides a consistent standard of protection against the depth of flooding but it does not provide a consistent standard of protection in terms of the probability of flooding.

4. Alternatively, the ABI commissioned research from BRE on the additional costs that would result from repairing flooded dwellings in such a way as to reduce the susceptibility of those buildings to flood damage. Given the very high cost of some of the options considered in the case studies, such reconstruction may be a cheaper response.

5. The move to integrated catchment approaches and catchment flood management planning may lead to new approaches to flood defence and flood risk management. For example, the use of strategic flood storage and flood warning may be preferred to local solutions. This provides opportunities for greater consistency in flood defence standards although, for reasons given elsewhere in this report, consistent standards over a wide area are very difficult to achieve.

6. The prioritisation of funding between new schemes and existing defences will depend both on the needs associated with existing defences and policies for future flood management. As existing defences come to the end of their design lives, options exist to upgrade, downgrade or maintain the standard of defence. Such decisions will depend on the outcome of this and other studies into flood risk management. The criteria developed in this study would be equally

applicable to such situations. The results of this study indicate that there will not be a single approach that achieves an optimal solution in every case.

When a choice between alternatives is easy, it is no longer a choice. Equally, because a choice involves a sacrifice one thing for another, it is necessarily painful. We can decide what pain is worth bearing for what gain to whom but we cannot escape the pain which must be borne by someone. Consequently, there is no criterion which can be mechanically applied and which will result in universal happiness.