Lessons learned

Autumn 2000 floods

Environment Agency

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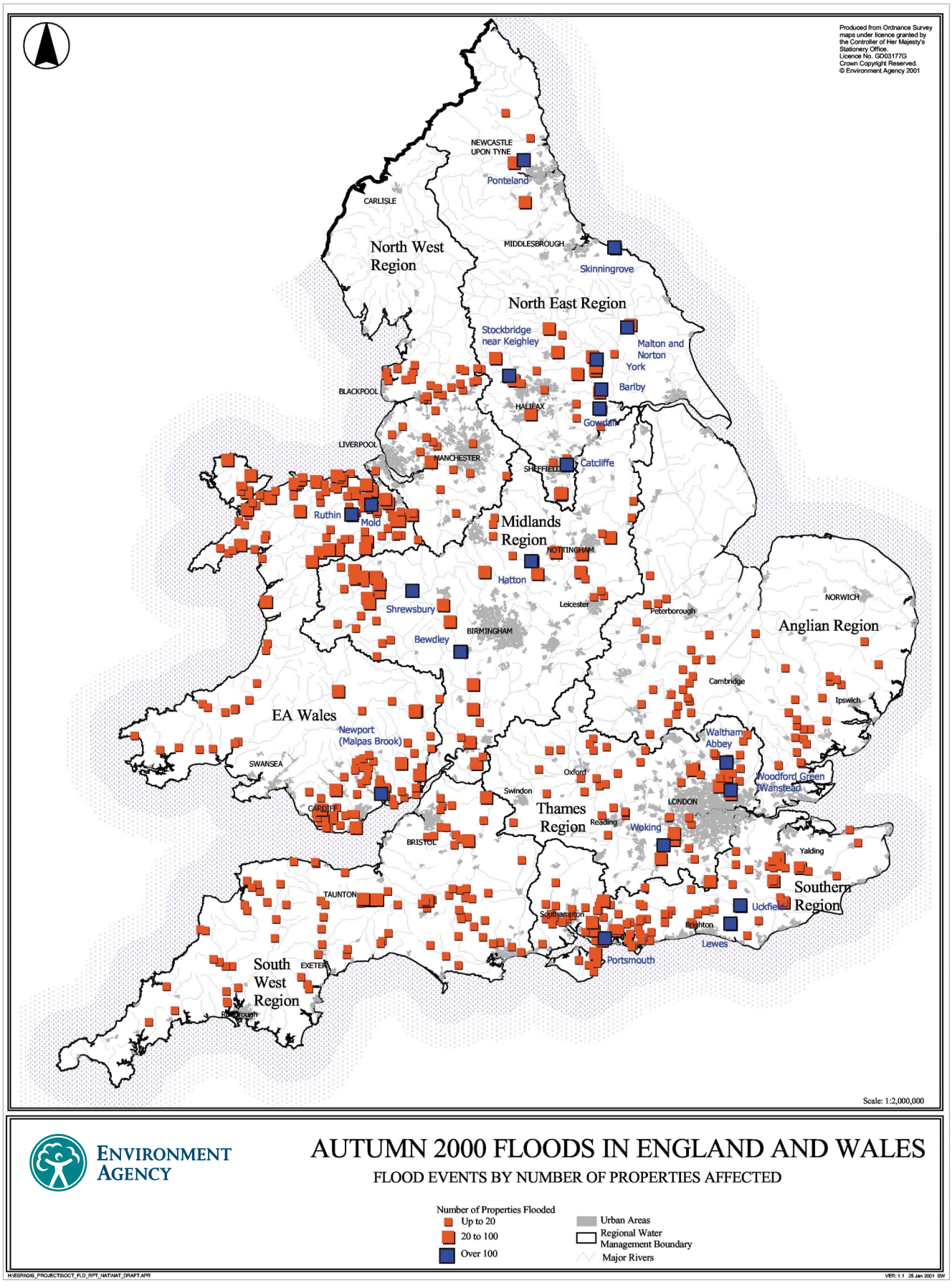

ENVIRONMENT AGENCY

AUTUMN 2000 FLOODS IN ENGLAND AND WALES

FLOOD EVENTS BY NUMBER OF PROPERTIES AFFECTED

Number of Properties Flooded
- Up to 20
- 20 to 100
- Over 100

- Urban Areas
- Regional Water Management Boundary
- Major Rivers

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Foreword

Sir John Harman

The Deputy Prime Minister John Prescott MP described the severe weather and flooding that dramatically disrupted parts of the country in the autumn of 2000, as a wake up call to the impacts of climate change.

The country for a time saw its road, rail, air and sea transport infrastructure severely disrupted.

Flooding became widespread and prolonged and we saw many communities both devastated and traumatised as their homes and personal possessions were inundated and in some cases destroyed by floodwater.

This report has been produced in response to a request from the Minister for Fisheries and the Countryside, Elliot Morley MP.

Its recommendations are a challenge to the Government, Flood Defence Committees, the Agency and all its professional partners to respond to that wake up call.

Sir John Harman
Chairman
Environment Agency

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Executive summary

The evidence suggests that the Agency, in partnership with local authorities and emergency services, has moved a long way towards delivering the "seamless and integrated service of flood forecasting, warning and response" called for by the Minister, Elliot Morley after the Easter 1998 floods. The Autumn 2000 floods challenged the adequacy of current design standards and demonstrated the confusion of responsibility for managing the wide variety of flood problems and also the need for a high degree of contingency planning in the public sector and by utility companies. Much therefore, remains to be done to ensure a robust response in future and to improve the standards of protection for many communities. The Agency will continue to direct its efforts to achieve these goals.

Autumn 2000 was the wettest on record across England and Wales for over 270 years. Recurrent heavy rainfall in October and November caused prolonged, extensive and in places repeated flooding. The flood levels in many places were the highest on record. In many locations there had been no previous record of flooding. 10,000 properties were flooded at over 700 locations and there was widespread disruption to road and rail services. The total costs are of the order of £1.0bn.

Some places have been flooded two or three times or at worst five times in the last year. Many people will not be able to return to their homes for several months and aftercare groups have been formed to assist traumatised communities. The impact of these floods could have been worse. 280,000 properties benefited from the successful operation of flood defences. A wide range of organisations worked together on extraordinary emergency actions, including placing an unprecedented 2.5 million sandbags to save a further 37,000 properties from flooding.

Forecasting and warning systems, newly implemented in September 2000, worked well but follow through studies are intended to identify further improvements to an accelerated timetable. The use of automated warning systems also worked well and the Agency will be campaigning for wider acceptance of this approach.

It is impossible to guarantee flood protection. There are many locations where an engineering solution is impractical and others where permanent work could lead to considerable damage to the environment. Even where a flood defence is provided there will be occasions when conditions are so severe that the defence is overwhelmed, which occurred during these floods.

Many major incident plans were implemented by local authorities, with Gold and Silver Control Centres operational. This shows a need for best practice to be developed and adopted consistently. The statutory and financial basis of floods emergency planning by local authorities needs to be placed on a sound basis. This should feature in the current Home Office review.

The public were confused by responsibilities for different sources of flooding (surface waters sewers, streams, major rivers) and need a single source of reliable information. A rationalisation of responsibilities is recommended. The Agency Floodline should be developed as a one-stop-shop source of flood information.

Climate change could make such extreme floods more frequent. The investment rules need to be revised to enable priority to be given to defences that can be progressively developed to respond to the emerging pattern of climate change.

These same investment rules need to give full weight to the social and the health impacts of flooding as well as the frequency.

Overall, no matter how good the investment decision process, adequate investment is needed to both create and maintain defences. A significant increase is needed. Funds are also needed to enable the rapid establishment of a database of assets and their condition. The poor condition of many defences is a cause for serious concern.

The Government provided emergency funding relief to flood defence committees. This should be put on a permanent footing for future years.

These floods have devastated the lives of thousands of people, disrupted the lives of far more and at a substantial economic cost. The following recommendations should should enable the Agency and its partners to reduce the risk of those living or working in flood prone areas in the future.

Recommendations and actions

The Agency recommends a number of further actions for itself, its professional partners and Government as follows:

Public confusion and information

The attribution of responsibility for the management of watercourses posing a significant flood risk needs to be reassessed in order to resolve the current confusion. (2.1)

Floodline should be expanded to provide a one-stop-shop information service for flooding. (4.2.3)

(These would need to be done in partnership with local authorities and others).

The Agency recommends that Government should require flood risk information to be included in future property searches and recorded in the proposed "Sellers Pack". (6.1)

The Agency will use all available information, to catalogue the flooding that took place in autumn 2000, the local causes of this flooding and how solutions or responsibility for action can be successfully attributed. (2.1)

Flood warning

The Agency is measuring the performance of dissemination systems by public opinion surveys undertaken by independent research contractors in a sample of the flooded areas.

The Agency believes that arrangements are needed that assure funding for a strategic 10-year campaign to promote increased flood preparedness across society and in vulnerable groups. (4.4.4)

The Agency will review the existing Flood Warning Investment Strategy in the light of these floods. The results of follow-up research will be brought together over the summer for a report in October 2001. The review will include costed options for more rapid and extensive delivery of flood warnings. (4.2.1)

The Agency will, in parallel with the planned review of flood forecasting and warning performance, work with all professional partners to: (4.2.1)

- Identify opportunities to warn properties in high risk areas not included in the current systems;
- Consider accelerating investment to arrive at a consistent standard of service founded on best practice.

The Agency and the Met Office will undertake a joint review of weather forecasting performance relative to flood forecasting need. (4.1.3)

At times it proved difficult to do more than communicate the critical information such as location of warnings, likely impact and advice. A preliminary review of how information was gathered has identified some best practice, which would add substantial value. This preliminary study will support a more in depth review that will be completed by September 2001. (4.4.6)

Risk assessment and contingency planning

The latest IPCC Report confirms that climate change is developing more rapidly than previously predicted. More extreme weather events will become more frequent.

There is an urgent need to put flood emergency planning on a sound statutory and financial footing. (4.3.3)

The review of central Government emergency planning initiated by the Home Office should identify and promulgate best practice for Gold and Silver control centres. (4.3.3)

The Agency together with its professional partners should conduct contingency planning for prolonged, extreme nation-wide flooding, and report on the implications. (4.3.1)

A programme of local and regional flood emergency exercises will continue. MAFF should reconsider the timetable of a major coastal flood exercise until the lessons learned from autumn 2000 are implemented. (4.3.3)

The Agency recommends that Government consider introducing a multi-organisation emergency planning structure. This would be able to co-ordinate flood warning and flood emergency plans and ensure they are robust enough to operate for extreme flood events as recommended by the Flood Defence Emergency Response[16] report. (4.3.3)

The Agency and local authorities should jointly: (5.5)

- Develop a policy for the provisions of sandbags;
- Investigate joint call-off contracts for the supply and distribution of filled sandbags
- Assess the capacity to supply large numbers in an emergency.

The Agency, local authorities and the National Health Service should carry out flood risk assessments and prepare contingency plans for their assets in flood risk areas. (2.3)

Water and Power Utilities, Railtrack and the Highways Agency should carry out flood risk assessments and contingency plans for their assets in flood risk areas. (2.7)

The Agency should review the operational policy for pollution risks from industrial sites in flood risk areas and report on the generic options for managing these risks in future in October 2001. (4.3.2)

During flood events the Agency's streamlined reporting arrangements should be used within Government. (4.3.2)

The Agency will undertake a review to establish 'best' working practice, including training needs, to gain maximum benefit from this experience. (4.3.2)

Investment needs

Condition of existing defences

There is an urgent need to have an understanding of the state and adequacy of existing defences. This could be achieved by either: (5.4)

a) central funding to the Agency to enable us to carry out such a survey to common standards; or

b) create a power for the Agency to require information from all owners responsible for existing flood defences; or

c) create a power of direction to enable Government to require all organisations, public and private, who are responsible for flood defences to undertake surveys and make them available to the Agency.

It should be noted any of the above options would require resources to be made available. Some might significantly modify the permissive powers under which all operating authorities currently work.

The Government should fully fund the creation and maintenance of a database for storing information on the nature and state of all flood defences irrespective of ownership. (5.4)

The Agency will use the experience from the floods to review the accuracy of the results from the condition surveys of its own flood defences. (5.4)

Investment decisions

The Agency's experience is that the decision making framework that supports investment needs to take into account more than the benefit/cost ratio. Social impact, health, frequency and scale of flooding are all key issues. In addition it should support consistent standards of defence within each town. The Agency is producing a report on these issues for discussion with the Ministry in autumn 2001 (6.5.3)

The options appraisal should encourage the construction of flood defences that can be easily modified, through incremental changes, in response to growing confidence about the impacts of climate change, thereby maximising the efficiency of future investment decisions. (6.2)

The production of catchment flood management plans, whilst welcomed, should not lead to a delay in the completion of schemes for flooded communities. Government should agree procedures as a matter of urgency to enable the assessment and, where appropriate, the execution of urgent works in advance of catchment flood management plans. (6.5.1)

Government should recognise that there is a need for a significant increase in funding for flood defence on a planned basis as indicated by MAFF's research. This is needed to improve flood warnings, secure a reasonable condition for present assets and improve the overall standard and extent of flood defence. (7.1)

The Agency will produce a report on the relevance of the medium term plans produced by the Flood Defence Committees in relation to the experience of communities flooded since April 1998. (7.1)

The Agency will continue to investigate innovative approaches for flood defences and for flood proofing properties, through field trials and its research and development programme. (6.1.1)

Funding

Government should confirm that the simple formula used this winter for emergency relief funding will apply to Flood Defence Committees in future. (7.2)

The Agency, with others, will prepare an assessment of the total costs incurred as a result of the autumn floods and in the emergency response to them. (7.2)

1. Introduction

This post incident report, prepared by the Environment Agency, was commissioned in October 2000 by the Minister for Fisheries and the Countryside, Elliot Morley, MP. The findings of this report give the Agency, together with its professional partners, local authorities and emergency services, the opportunity to learn from these floods in order to deal more effectively with equivalent or more extreme events in the future. It will also inform future debates and contribute to developing the ongoing relationships the Agency has with its professional partners, government and the general public. It examines: -

- The extent and severity of the flooding
- The causes of the flooding
- The effectiveness of flood warning and emergency responses
- The performance of the defences

The recommendations of the Independent Review (Bye Report)[1] commissioned following the 1998 Easter Floods led to the Agency's response and subsequent implementation of a two year action plan to address the lessons learned (Easter Floods Action Plan). This included the establishment of a National Flood Warning Centre to lead development of flood forecasting and warning systems. A new four-stage flood warning dissemination and communication programme was implemented, high profile public awareness campaigns launched and major flood defence operational changes made.

The response of the Agency, local authorities and emergency services in autumn 2000 would indicate that all agencies, in partnership, have moved a long way towards delivering a seamless and integrated flood warning, response and recovery service. The extreme weather of autumn 2000 was a severe test and this report identifies areas for development and collaboration in the short, medium and long term with recommendations based on the lessons learned from these flood events. More detailed reports will be published separately for each region of the Agency.

Following a wet spring and early summer, autumn 2000 was the wettest on record for over 270 years. Repeated heavy rainfall in October and November caused significant and extensive flooding over large areas of England and Wales. These floods were multiple events affecting different parts of the country at different times within such a short period and in at least two cases so severely as to stretch and test the whole system. In spite of this in the main the systems coped. Flood warning arrangement developed since 1998 worked well. Flood defences successfully prevented the flooding of 280,000 homes and emergency actions averted catastrophic flooding in South Yorkshire.

Just under 10,000 homes and businesses were flooded causing damage, trauma and distress to thousands. Train services were cancelled, major motorways closed, and power supplies disrupted. The overall social and economic cost to individuals, commerce, industry is yet to be finalised, however, the current understanding of insurance claims and damage to agriculture is already in the order of £1.0bn. Those affected by flooding are still living with the consequences. Recovering from the damage of having floodwater within a property is a long process and can mean that people will not be able to return to their homes for several months. Sadly, there are instances of some properties being flooded two or three times. The exceptional flooding incidents all over England and Wales left hundreds of people with uninhabitable homes.

The Prime Minister, the Deputy Prime Minister and other ministers visited many of the worst affected areas during the autumn 2000 floods. Adjournment debates and statements followed in the House of Commons about the floods, the impact of climate change and the performance of flood defences and warnings.

The agency, working with MAFF, has a well-developed R & D strategy broadly covering flood defence, flood warning and climate change. The lessons learned from the autumn floods will be incorporated into this work programme as appropriate.

[1] *Independent Review of Easter 1998 Floods (Bye Report) October 1998*

2. The Impact of the floods

2.1 The impact on society

These floods were unique in that a series of exceptional rainfalls affected different parts of the country at different times and in many cases more than once. They were the cumulative effect of rainfall that was unprecedented during the last 270 years and affected almost 700 locations across England and Wales as illustrated in the map at the front of this report. A summary of principal locations where in excess of 20 properties were flooded is shown in table 1.

Some key figures are:

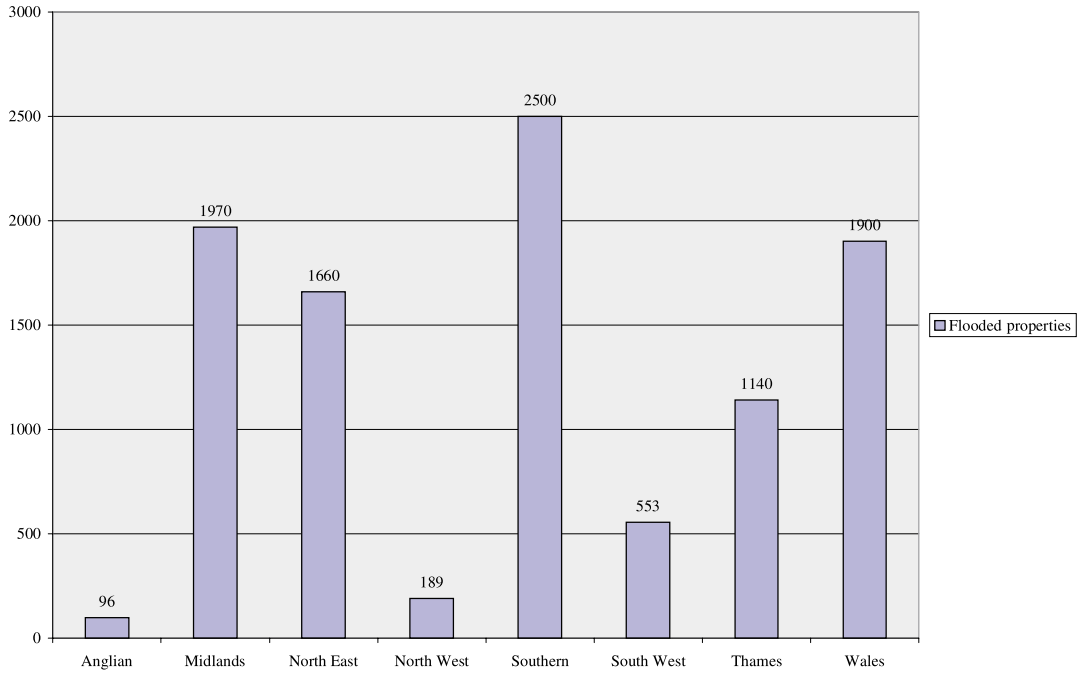
~ 280,000 homes were protected by flood defences

~ 37,000 homes narrowly avoided flooding

~ 10,000 homes were flooded; a regional breakdown is shown in figure 1.

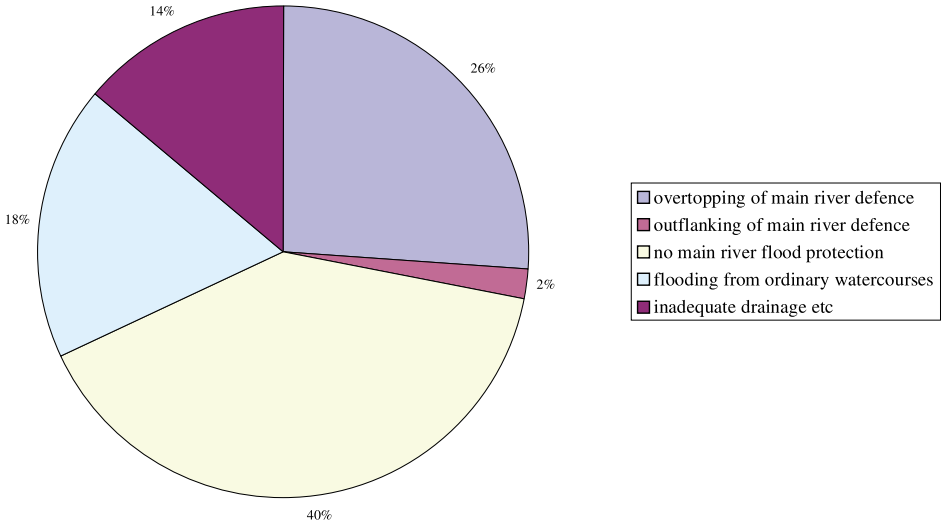
~ 11,000 people requested to evacuate

Figure1 - Regional summary of flooded property



Incidents of frequent flooding include:

		October	*October / November*	*November*
Kent Yalding, Lamberhurst & Robertsbridge	Yalding and Lamberhurst - flooded five times in total during 2000	9th – 14th 29th – 31st		5th – 8th
Shropshire Bewdley Shrewsbury	Bewdley and Shrewsbury - flooded ten times in the last ten years		31st – 4th 31st – 3rd	8th – 9th 7th – 8th
North Wales Ruthin		30th		6th – 10th
Yorkshire Malton & Norton	Malton and Norton – severe flooding in 1999			1st, 3rd , 9th



The experience of the autumn 2000 floods for many people is difficult to contemplate. There are instances of some places being flooded two or three times this autumn or at worst five times in the last year.

Recovering from the damage of having floodwater within a property is a long process. Many people will not be able to return to their homes for several months.

The Agency's preliminary assessment of flood locations suggests that approximately:

- 28 per cent of flooding problems were due to overtopping, outflanking or failure of defences;
- 40 per cent were where no defences exist;
- 32 percent were due to flooding from ordinary watercourses, inadequate local surface water drainage and third party defences.

Historic investment in flood defences secured protection for 280,000 properties. However, the floods were so severe that 37,000 of these properties only narrowly avoided flooding. Of the 10,000 properties that were flooded 58 per cent were in locations where there were no flood defences.

This assessment provides early support for the national priorities of both Government and the Environment Agency to target investment toward improving the ability to provide accurate flood warnings.

There will always be the risk that a flood greater than that experienced so far will happen. Consequently it is essential that processes that provide timely flood warnings are in place to trigger robust flood emergency incident plans for all major flood risk locations. Flood emergency plans helped local authorities and emergency services to advise 11,000 people to evacuate their homes. Some of these homes did flood and others avoided flooding but the risk of people remaining in them was considered too great.

These floods demonstrated the extent to which flooding may be caused by inadequate surface water drains and other non-arterial sources and the need for a better understanding of the mechanisms of all flooding; surface water systems are not designed to handle high-risk rainfall events.

The floods also reinforced the need to have a clear understanding of who should take responsibility for resolving flooding problems in these different locations. The conclusion from the Agency's experience in handling the variety of enquiries to Floodline, and that of local government in dealing with problems during the floods, is that historic decisions that attribute responsibility for different watercourses have, in some locations, little relevance to the communities that they now drain. The complex assessment of who should resolve a problem is of no value to someone who needs help to deal with a flooding problem and does not know where to turn for advice and support.

The attribution of responsibility for the management of watercourses posing a significant flood risk needs to be reassessed in order to resolve the current confusion.

The Association of British Insurers (ABI) estimate that storms and flood damage claims for last autumn will total between £700 and £750 million. The ABI is analysing these claims and this will help the Agency understand how solutions or responsibility for action can be attributed.

Table 1 - Summary of principal locations where in excess of 20 properties were flooded and the cause of flooding

Cause of Flooding (as presently understood)	*River 'Designation'*	*Locations Affected*	*Region*	*No. of properties flooded*
Overtopping of Agency defences	Main river	Stockbridge near Keighley	NE	100
		Barlby	NE	152
		Ponteland	NE	125
		Bingley	NE	58
		Rhydymwyn	W	74
		Waltham Abbey	T	130
		Wanstead	T	230
		Uckfield	S	100
		Lewes	S	800
		Lamberhurst	S	30
		Wallington	S	47
		Hatton	M	142
		Burton	M	40
		Sub-Total		**2028**
Outflanking of Agency defences	Main river	Tadcaster	NE	30
		Rawcliffe, York	NE	86
		Sub-Total		**116**
No flood protection	Main river	Malton and Norton	NE	169
		York city centre	NE	51
		Naburn	NE	44
		Knaresborough	NE	41
		Ripon	NE	43
		Weybridge	T	90
		Woking	T	100
		Yalding	S	25
		Robertsbridge	S	75
		Shrewsbury	M	230
		Ironbridge	M	50
		Bridgnorth	M	30
		Bewdley	M	140
		Worcester	M	80
		Newark	M	6
		Ilkeston	M	50
		Upton	M	50
		Sub-Total		**1314**
Washland barrier bank breach	Main river	Gowdall	NE	**105**
Failure of third party defence	Main river	Skipton	NE	**27**
Non main river flooding (from ordinary watercourse)	Non main river	Skinningrove	NE	200
		Fulford, York	NE	25
		Newport	W	130
		Mold	W	181
		Ruthin	W	250
		Sub-Total		**786**
Local drainage and surface water problems	N/A	York (incl. Bishopthorpe)	NE	50
		Catcliffe	NE	110
		Selby	NE	25
		Lanchester	NE	30
		Mirfield	NE	40
		St Asaph	W	35
		Portsmouth	S	200
		Ryde	S	80
		Havant	S	38
		Headcorn	S	45
		Derby	M	56
		Sub-Total		**709**
		Total		**5085**

Leading insurers have indicated to government that over the next two years they are looking for a significant improvement in flood risk management.

The Agency will use all available information, to catalogue the flooding that took place in autumn 2000, the local causes of this flooding and how solutions or responsibility for action can be successfully attributed.

There should be an assessment of the total cost to the nation of these floods, which can be used to update data on damages and support future investment decisions.

2.2 Evacuation of people

Across England and Wales about 11,000 people were requested to evacuate their homes and several residential homes were evacuated. The most serious evacuation was patients from the Worcester Royal Infirmary.

The Agency, local authorities and the National Health Service should carry out flood risk assessments and prepare contingency plans for their assets in flood risk areas.

The evacuation of properties was initiated and supervised by police and local authorities. There were several reports that some people did not leave their homes or move to designated rest centres set up by local authorities. At one location residents were requested to leave their homes on three separate occasions because there was a clear risk of flooding. The earth embankment retained river levels, which were between 1.5 and 2.0m above the level of the village streets. At a public meeting after the river levels fortunately had receded, residents questioned the Agency on the issuing of evacuation notices because no flooding had actually occurred.

2.3 Impact on people

Many public meetings were held in flooded locations, although in some instances the Agency decided that for a short while it had to concentrate its limited resources on carrying out the emergency repair and initial assessment work. News releases were issued following public meetings. Letters and emails have been received from MPs, individuals and collectively from parish councils and other community organisations.

In addition several MPs have used adjournment debates to raise specific problems affecting areas in their constituencies (flooding in Lewes in Sussex, the Vale of York, Portsmouth, Gowdall and Somerset).

Aftercare groups have been formed in affected areas such as Lewes where a Flood Recovery Group has been formed to assist traumatised communities. Children have been deeply affected by the loss of toys and pets and are being counselled and helped by educational psychologists. There are reports of children becoming anxious in rainy weather and on hearing news of impending rainfall.

There are plans for Agency staff to visit schools and communities during the coming spring and summer to inform people about the Agency's responsibilities and to help the public understand and action the message. *"Flooding. You can't prevent it. You can prepare for it".* These messages will need to be delivered very sensitively in many areas. Three months after these flooding incidents, many people are not back in their homes and the distress to them and their families continues. The tension of living with friends and families increases over time. It is expected that the results of the three independent studies into the health effects of the Banbury and Kidlington flooding in 1998 and the Todmorden flooding in 2000, commissioned by the Agency in 1998 and 2000 will be mirrored many times at many locations as families try to recover from the devastating flooding of autumn 2000. Brief details of the Agency's R & D programme can be found in Annexe A.

Any further studies following flooding will take place only after contact has been made through the Agency area offices with local authorities and voluntary services to ensure a co-ordinated approach.

2.4 Disruption to business

The longer term impacts on manufacturing, commerce and farming are unlikely to be clear for some time. A number of businesses are known to have been closed for months. Some had cleared up after the first wave of flooding only to be inundated a second time.

A small number of reported examples of disruption to businesses as shown below, illustrate the financial implications on local economies:

Rotherham:	Three businesses on one site suffered sales losses estimated at £5million. At the end of December there were still 100 out of the total workforce of 400 unable to return to their normal place of work.
Stockbridge:	Four businesses on one site suffered combined damages to properties of approximately £250k. All four were closed for a two-month period.
Shrewsbury:	Indications are that two major chain stores lost in excess of £1 million of business in the busy pre-Christmas period.

Significant areas of farmland were flooded in Wales, central and north-east England. The total loss to the farming industry is estimated at £500 million[2]. A National Farmers Union on-going survey reveals that losses on individual farms range from a few thousand pounds to £250,000 with many farmers fearing for the future of their businesses.

2.5 Disruption to infrastructure

There was major disruption to the country's transport system with many minor and major roads and motorways being closed together with railways covering south west, southern, central and northern England and in south and north Wales. However, much of the disruption to rail services was perhaps not immediately apparent due to the rail disruption following the Hatfield rail crash of 17 October 2000. Railtrack have estimated that they will be faced with an exceptional charge of £20 million, net of insurance, to cover the cost of infrastructure repairs, delays and compensation following the flooding.

Several water companies had problems with water sources due to power cuts, pollution of ground water or surface water flooding. Although no known serious pollution problems arose, power was lost at many sites therefore affecting the water supply. Many small installations are not provided with standby power generators. A limited number of companies were forced to introduce "boil water notices" to customers and a number of water treatment works were shut down as a precautionary measure.

The greatest problem was sewer flooding where the degree of inundation was well in excess of design standards for both intensity and duration of rainfall and sewers could not operate as designed. A number of wastewater treatment works across the country were severely flooded and treatment was in effect halved.

Electricity substations were flooded and had to be shut down. In Lewes extensive power cuts lasted up to six days. Bus services were severely disrupted and many schools were closed.

Other notable impacts include:

- Disruption to major and minor roads across many counties
- Stretches of the M1, M3, M20, M23 and M25 were shut
- A361 North Wessex, between Burnbridge and East Lopey flooded for one month
- Train services to the West Country suspended for days as main line closed
- Branch line services disrupted throughout southern England
- Main line services closed between Tunbridge and Ashford
- Nottingham to Newark line closed
- Keighley to Shipton line closed
- Lewes station closed
- Malton station closed
- Cardiff to Bridgend and Shrewsbury to mid-Wales rail line closed
- Great Northern and Eastern Railway experienced bridge and track-side flooding at Doncaster and between Darlington and Durham on 8 and 9 November
- The East Coast Main Line was closed for nearly a week to allow divers to inspect bridge structures.

The level of disruption experienced during these floods needs to be carefully examined.

Water and Power Utilities, Railtrack and the Highways Agency should carry out flood risk assessments and contingency plans for their assets in flood risk areas.

[2] *NFU President Ben Gill , press release, 5 January 2001*

3. How the floods developed

The extended period of flooding was the cumulative effect of a series of "waves" of rainfall, which crossed the country over a seven-week period. Catchments soon became waterlogged, with the result that until the cold and drier weather followed, rivers responded rapidly to even modest rainfall and threatened or caused further flooding. Many of the rainfall storms would have been severe enough, as isolated events, to have caused flooding, but the cumulative effect led to repeated flooding in many places and to prolonged flooding in others.

3.1 Rainfall

In autumn 2000 England and Wales experienced a succession of weather systems bringing prolonged rainfall to many areas.

	October	*November*
Wales, South West, Central and Northern England	29th and 30th	2nd, 5th, 6th
Southern England	9th - 12th, 15th – 18th	5th and 6th

The quantity and intensity of the rain that fell during this period was exceptional in many places.

The Met Office has announced that, with 503mm, it was the wettest autumn (September- November) since records began in 1766 and 196 per cent of the 1961-90 average.

Month	*Rainfall in mm*	*Wettest since*
September	133	1981
October	188	1903
November	182	1970

In southern England the highest rainfall total was on 11 October 2000, when over 130mm fell in 15 hours at Plumpton in East Sussex, equivalent to a 1 in 300 year return period. By contrast the rainfall pattern for the Southern Pennines and North York Moors in the North East and the Welsh Mountains had an equal amount of rainfall but over a longer period of time.

Location	*Rainfall in mm and days*	*Return Period*
Southern Pennines	237mm in 14 days	~ 130 years
North York Moors	241mm in 14 days	~ 400 years
Llanfyllin	205mm in 14 days	~ 100 years
Pen-y-Coed	295mm in 14 days	~ 100 years

In Wales exceptional rainfall was recorded over 11 days on the River Dee Catchment at the following locations: -

Location	*Rainfall in mm and days*	*Return Period*
Llanfynydd	188 mm in 11 days	~ 200 years
Loggerheads	192 mm in 11 days	~ 400 years
Pendinas	224 mm in 11 days	~ 800 years

These analyses are based upon historic records and assume no impact from climate change.

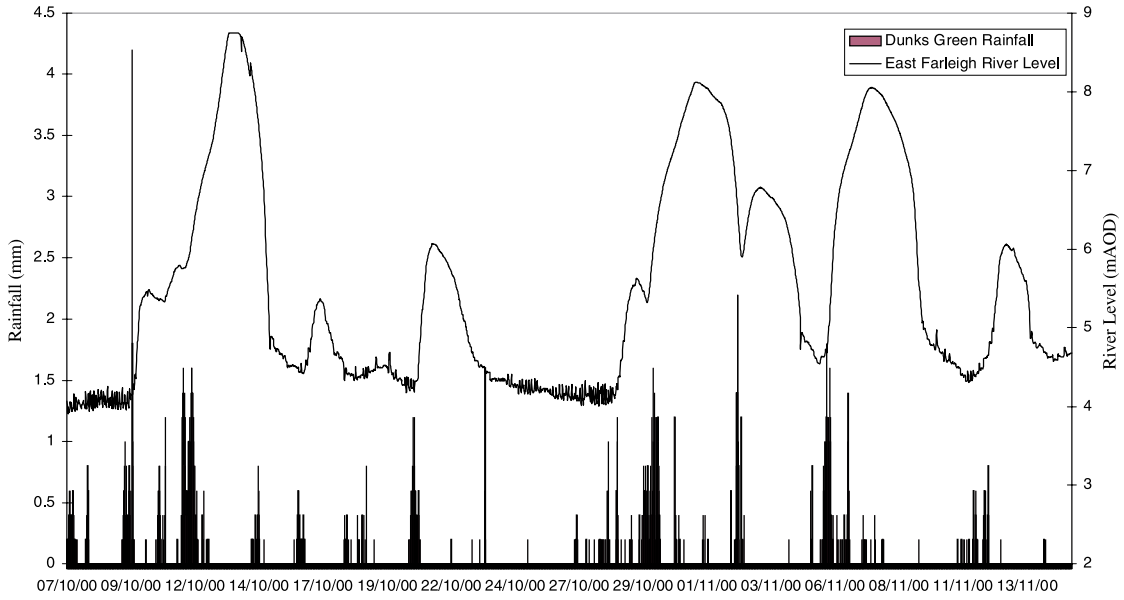
3.2 River levels

The combination of the saturated catchments and the exceptional rainfall produced record or near record river levels in many river systems.

River	*County*	*Previous Highest Level*
Ouse	Yorkshire	1625
Aire	Yorkshire	1946
Derwent	Yorkshire	1999
Nidd	Yorkshire	1942
Don	Yorkshire	1872
Weaver	Cheshire	1946
Dee	Flintshire	1946
Severn	Worcestershire	1947
Roding	London	1947
Ouse	Sussex	1960
Taw	Devon	1958

Yalding in Kent lies at the confluence of three rivers, the Medway, Teise and Beult. Figure 2 shows the peak levels on the River Medway downstream of Yalding at East Farleigh and rainfall at Dunk's Green to the west of Yalding. It demonstrates the close correlation between timing and intensity of rainfall and river level response.

Figure 2 - River level on the Medway downstream of Yalding and rainfall at Dunks Green



The response of many upland rivers in the Northeast produced four significant peak flood levels. Figure 3 shows the four flood levels in the River Nidd catchment upstream of York. These merged into a prolonged period of high river levels on the River Ouse at York, which lasted for some five weeks.

Figure 3 - River Levels on the Nidd upstream of Knaresborough

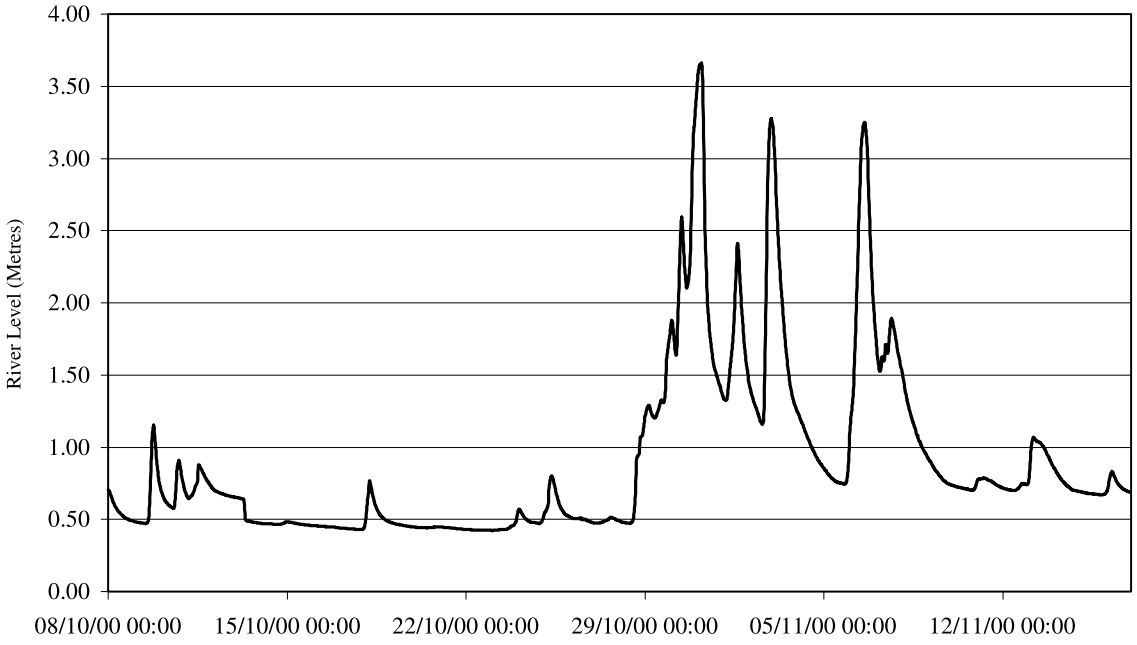


Figure 4 shows the two highest river levels on the River Ouse upstream of York. River levels exceeded three metres for the third time on 29 October and remained above this level for the following 20 days.

Figure 4 - River Levels on the Ouse upstream of York

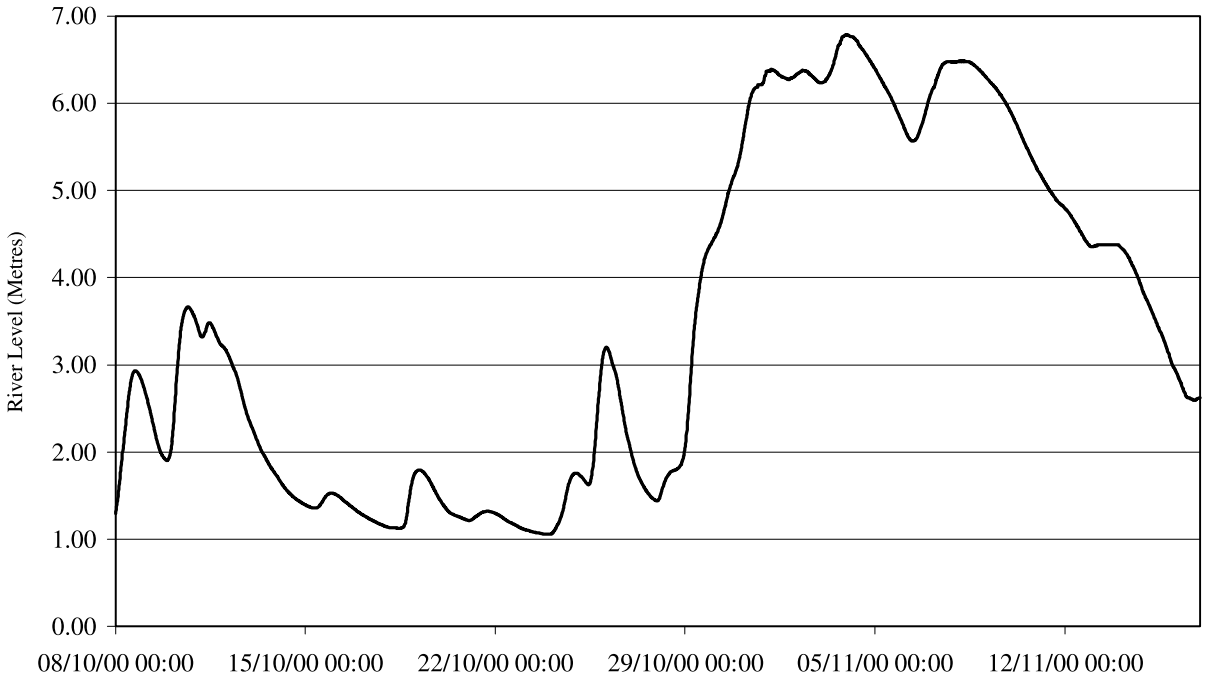
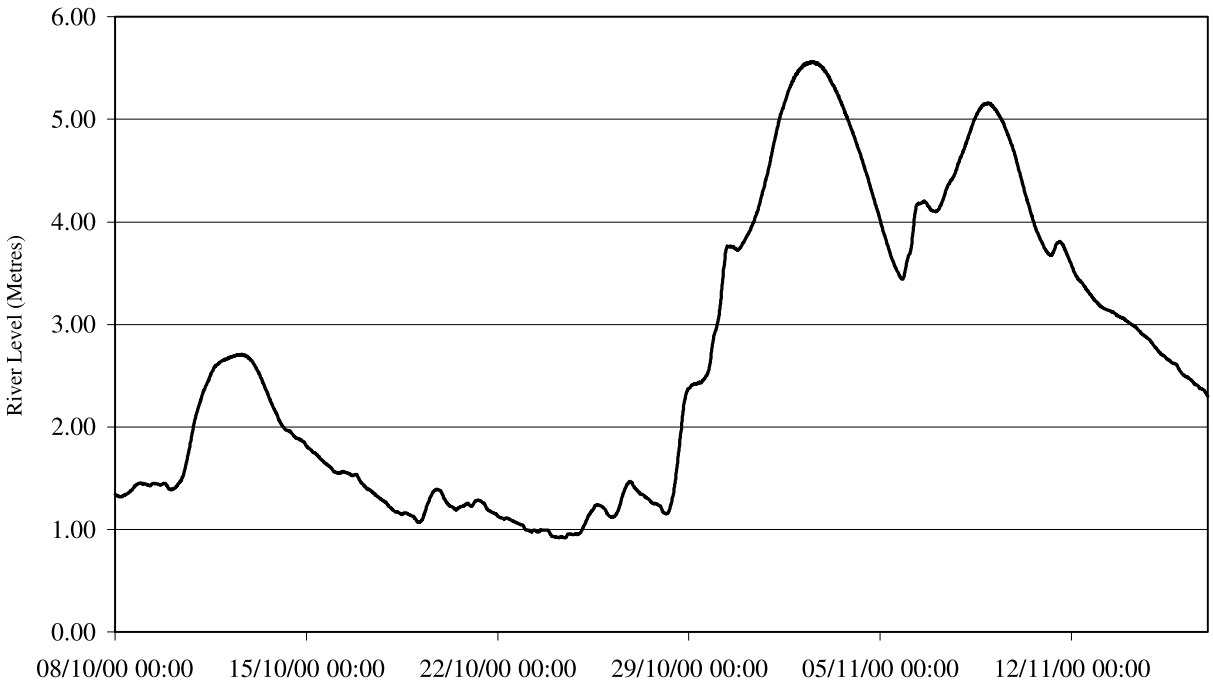


Figure 5 shows a similar pattern of river levels was experienced on the river Severn where there were three major peaks between 8 October and 12 November 2000.

Figure 5 - River Levels on the Severn at Bewdley



4. How the floods were managed

4.1 Flood forecasting

Flood forecasting requires interpretation of measured and forecast rainfall, river and tidal levels and the use of real-time hydrological and hydrodynamic models to forecast future conditions. This process requires reliable monitoring systems and accurate forecasts of rainfall.

4.1.1 Monitoring systems

Overall the Agency's network of gauges, outstations, telemetry and associated systems performed well during the autumn 2000 floods. Telephone calls to obtain river and rainfall data led to an unprecedented demand on the system. Failure rates, due to the extreme conditions, were however relatively low (for example, 3 per cent of outstations in NE Region and Midlands). Immediate action ensured that the equipment was rapidly brought back into service or contingencies introduced. Causes are being examined and solutions implemented. The performance we achieved was a direct result of the investment in hardware, systems and procedures since Easter 1998.

4.1.2 Weather forecasts for the Agency

The Bye Report highlighted the need for improved take-up and utilisation of weather forecasts. A National Weather Services Agreement was drawn up with the Met Office, effective from 1 September 2000 (1 October 2000 for Environment Agency Wales) which rationalises the weather services provided to each region. Specific rainfall accumulation forecasts which provide quantities, areal distribution and timing of rainfall for between 2 and 5 days ahead are provided by daily weather forecasts. In particular, heavy rainfall warnings issued for periods up to 24-hour ahead are relied upon to assist flood forecasters in deciding upon when to issue flood warnings.

During the autumn 2000 floods many Agency regions benefited from a close liaison between flood forecasters and Met Office forecasters. In many cases this contact was made proactively by the Met Office, which was considered helpful. Agency staff recognise that meteorological forecasting is difficult and complex and this link between weather and flood experts will continue to be developed.

Weather radar is used to estimate actual rainfall and, by extrapolating rainfall patterns to support short lead-time flood forecasting. The spatial definition and quality performance of the Met Office processing and display system (Nimrod) was, in general, found to be poor. In addition, there are gaps in the radar coverage for some regions which, undoubtedly caused difficulties in forecasting.

In general, delivery of rainfall forecasts was timely, although there were some regional variations. The accuracy (duration and quantity) of rainfall forecasts was found to be somewhat inconsistent and in some cases was noticeably in error (both under-and-over estimates). In general, limited use could be made by Agency flood forecasters of rainfall forecasts for more than 36 hours ahead, due to lack of accuracy.

4.1.3 Application to flood forecast models

Forecasting methods vary from simple extrapolation of upstream level to predict downstream level at a given point through to sophisticated predictive catchment flow forecasting modelling systems. Regions which employ the latter type of real-time modelling use them indicatively to support the majority (80-90 per cent) of their decisions to issue flood warnings, although not to directly trigger warnings.

The indicative-only use of real-time forecast models by Agency flood forecasters during the autumn 2000 floods resulted from lack of confidence in the output information.

This was due to a combination of factors:

- lack of accuracy of weather forecast information (i.e. accumulations over given area) for small, closely defined catchments;
- irregular model re-calibration and updating (reflecting lack of adequate resources).

Reported results suggested that though model runs did in some cases produce successful peak flow estimates, timing and duration of predicted flooding could be widely inaccurate.

Real-time flood forecasting techniques and capabilities vary across the Agency. This reflects different river, coastal and tidal conditions and previous investment practice by Flood Defence Committees (FDC's). The opportunities for improvement will be enhanced through new rationalised forecasting and warning responsibilities through dedicated regional forecasting centres.

The Agency and the Met office will undertake a joint review of weather forecasting performance relative to flood forecasting needs.

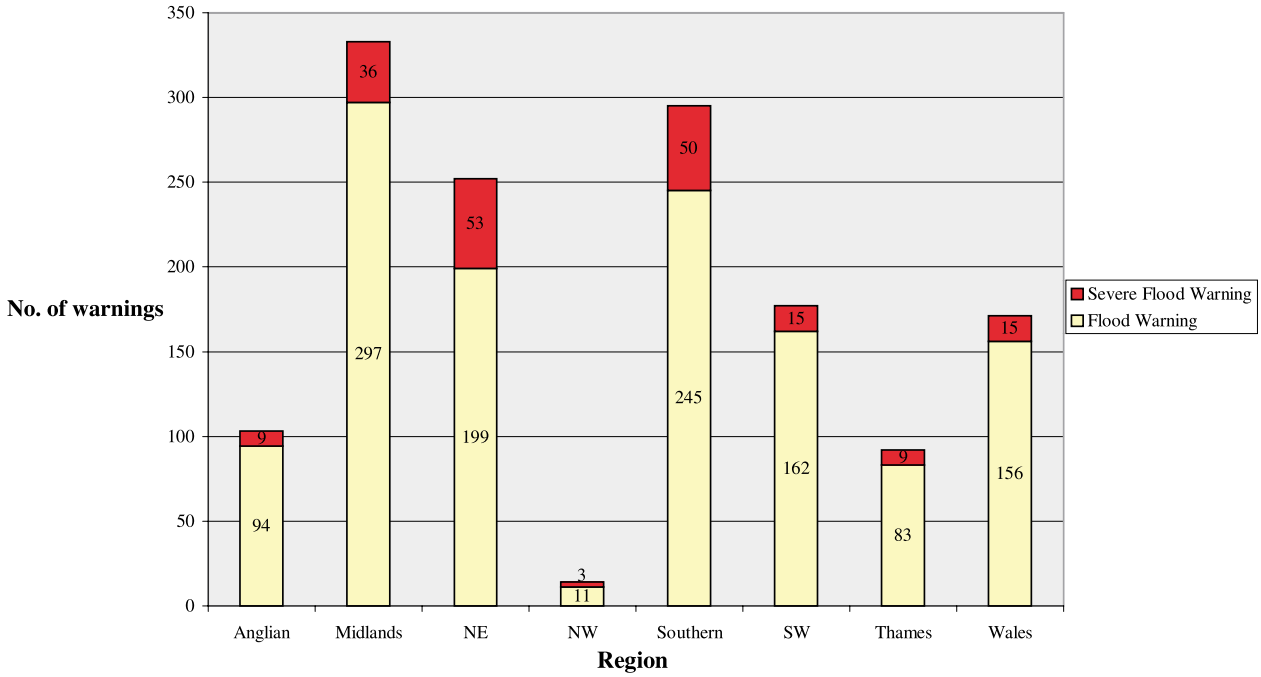
4.2 Delivering flood warnings

4.2.1 Performance

A total of 1,437 flood warnings were delivered over this period of which 190 were Severe Flood Warnings. The numbers issued by individual regions is shown in Figure 6.

The rainfall in North Wales was extraordinary because it impacted on river systems where there were no flood warning arrangements in place, primarily because previous flood experience did not identify an urgent need. Of the 1900 separate incidents, (see figure 1 on page 3) of properties that were flooded, 1500 did not receive a flood warning.

Figure 6



A key factor in effective warning, identified by previous research, is that people need "reinforcement" through a second system of any message that they receive. In order to provide this "reinforcement" the Agency policy is for all flood warnings to be targeted through at least one "direct" and one "indirect" route. Current provision means that some 40 per cent of residents in Flood Warning areas will receive "direct" and "indirect" warnings. The effectiveness of warning delivery during the October/November floods is currently being measured by independent consumer research which is due to report in June 2001.

The Agency's target for the year 2009/10 is that 80 per cent of residents will receive warnings through the following two main routes.

Direct route

The "direct route" uses systems such as:

- the Agency's Automated Voice Messaging system (AVM).
- sirens; vehicle mounted loudhailers
- local flood wardens

Indirect route

The "indirect route" is provided through:

- national and local television weather broadcasts, teletext
- national and local radio
- the Agency's Floodline information service (0845 988 1188)

All flood warning systems, but particularly the AVM and Floodline, were used at and beyond their design limits. While there were reports of individual problems due to the volume of calls being handled by the systems, there were no system-wide failures. The general perception is that the systems worked well as there have been no reports of warnings not being delivered.

In response to the recommendation in the Bye Report, the Agency has carried out local and national public awareness campaigns. The Agency also introduced new flood warning codes (Flood Watch, Flood Warning, Severe Flood Warning, All Clear), on 12 September 2000 designed, following market research, to deliver a simpler message. The new flood warning codes were exercised throughout summer 2000. These exercises played a vital role in ensuring that the emergency response with all our professional partners was more robust than at Easter 1998.

The Agency is measuring the performance of dissemination systems by public opinion surveys undertaken by independent research contractors in a sample of the flooded areas.

The annual National Awareness survey which took place in January 2001, measured the general public's awareness of the Agency, its roles and responsibilities for flood defence and flood warning plus the public's knowledge of Floodline. These results showed a marked increase in awareness of the Agency from 48 per cent in 1997 to 85 per cent in 2001. Awareness of Floodline was reported at 54 per cent.

The Agency will, in parallel with the planned review of flood forecasting and warning performance, work with all professional partners to:

- **Identify opportunities to warn properties in high risk areas not included in the current systems;**
- **Consider accelerating investment to arrive at a consistent standard of service founded on best practice.**

The results of a baseline review of good practice in flood forecasting and warning, including telemetry and monitoring will be published in June 2001. This will compare earlier experiences and those from the autumn 2000 floods and provide a valuable mechanism for sharing good practice and helping to shape future investment.

The Agency will review the existing Flood Warning Investment Strategy in the light of these floods. The results of follow-up research will be brought together over the summer for a report in October 2001. The review will include costed options for more rapid and extensive delivery of flood warnings.

4.2.2 Automatic Voice Messaging System

The Automatic Voice Messaging system delivered messages to 85,715 locations with a success rate of between 75 per cent and 85 per cent between September and mid-November 2000. This is a five-fold increase from the 15 per cent success rate at the time when the Agency became responsible for flood warnings in 1996. Methods of recruiting more members of the at risk public to the AVM system are currently being sought. Inclusion on this system requires agreement of each household or business.

The AVM service issues warnings direct to professional partners, emergency services and people at home or at work by telephone, fax or pager.

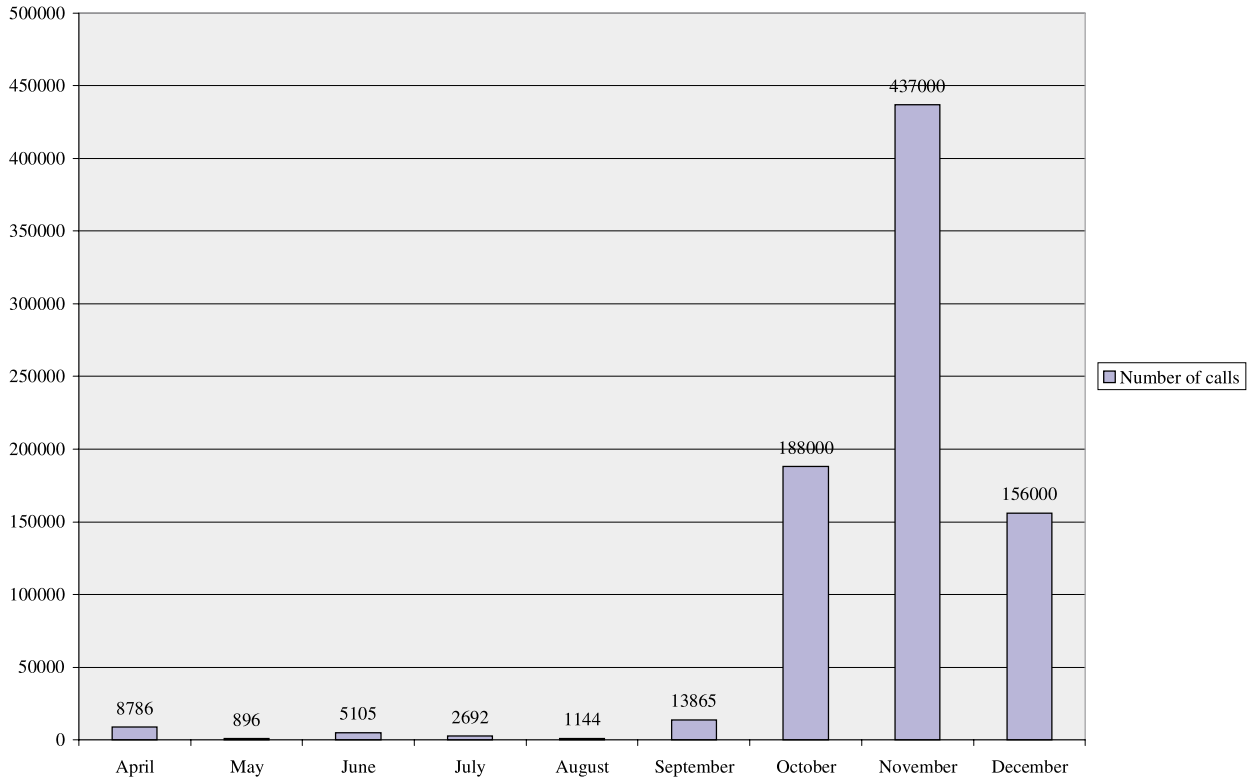
4.2.3 Floodline

Because flooding can occur at any time, the Agency's Floodline provides an information service 24 hours a day every day of the year. Call centre operators are available from 8.00am till 11.00pm weekdays and from 10.00am till 4.00p.m. on weekends and bank holidays. These hours were extended until midnight during the peak of the flooding. During October and November the Agency regularly monitored the service to ensure that information was available at all times and that a 24-hour support service was in place to rectify any problems.

Using Floodline callers can:

- listen to a recorded message about the local flood warning conditions
- report flooding to the Agency
- order printed material about flooding and how to prepare
- speak to an operator at the call centre

Figure 7 - Calls to Floodline



The Flood Warning campaign, run by the Agency in September increased flood awareness significantly. This coupled with the high media attention to the floods produced a dramatic increase in the number of public calls. Overall 781,000 calls were received in the period from 1 October to 31 December, compared with 100,000 calls during the first 11 months of operation.

The daily number of public calls to Floodline varies greatly, depending on prevailing conditions. During a dry period in the summer call levels are less than 50 per day. During the Christmas flooding of 1999 Floodline received approximately 30,000 calls, but only 70 per cent of callers were able to access a recorded flood warning message. In contrast, on 7 November 2000, 58,000 people called the recorded message service and 99.99 per cent of callers received a recorded flood warning message.

Although Floodline performed well there were times when the call centre was put under severe pressure. At peak times during October and November as few as 30 per cent of calls were being answered and handled successfully by call centre operators. A review of working practices, call handling capacity and the improved use of pre-determined

Table 2

Floodline service accessed	*Percentage of callers*
Listened to local flood warnings pre-recorded by Agency area staff	71.0
General enquiries handled by Floodline call centre operators using the pre-determined scripts provided by the Agency	14.0
Listened to pre-recorded information on the sources of road travel information (from 9 November 2000)	9.0
Specific enquiries beyond the scope of the call centre scripts and have therefore been transferred to an Agency area office for handling	3.0
Calls to report flooding transferred to the appropriate regional Agency office	2.0
Requests for a general flood information pack	1.0

scripts resulted in the call centre handling over 90 per cent of the December 2000 calls successfully. A project is currently under-way to review and develop the responsiveness of the service and to extend the number of flood warning messages available to the public.

It is clear from the public calls that there is also a demand for information on road and rail flooding and about localised flooding caused, for example, by blocked sewers. Modifications were made to the Floodline service as the autumn floods developed. The addition of road travel information significantly reduced the pressure on Agency staff to provide general but vital information. The Agency is continually monitoring and developing the efficiency of the service provided by the Call Centre. The Agency has regularly commissioned independent organisations to carry out customer satisfaction surveys. The results of these surveys are used to develop training programmes for call centre and Agency operators and to improve and clarify scripts in order to provide a better service to the public. (See R & D Summary, Annexe A)

The calls to Floodline represent a clear illustration of the public confusion over who carries the responsibility for different flooding problems and where people can turn to for help. The reviews completed by the Local Government Association and the Association of British Insurers support the Agency's view that there is a need for a one-stop-shop for all flooding enquiries.

The Floodline service is now well recognised. It should be developed, in partnership, to provide this one-stop-shop (or gateway) facility that provides a fast and efficient contact to help with all flooding problems.

Floodline should be expanded to provide a one-stop-shop information service for flooding.

The current Floodline service is restricted to England and Wales. Both the Environment Agency and the Scottish Environmental Protection Agency (SEPA) have received many public requests to extend the service into Scotland. This matter is currently being investigated.

4.3 Incident management

4.3.1 Overview

A particularly notable feature of the autumn 2000 floods was the tremendous collaborative effort of all the various agencies and organisations who have a role to play during a flood event. They included the Environment Agency, local authorities, the voluntary sector, Police, Fire and Ambulance services, RNLI, British Waterways and the Armed Services. Suppliers, contractors, consultant engineers and the utilities also provided considerable support. The floods rigorously tested the incident management and emergency procedures established by all organisations. Flood defence emergency response roles and responsibilities are shown in Annexe B.

The autumn 2000 floods provide an opportunity to establish a new baseline for scoping future emergency incident flood management plans. It is essential that robust emergency plans exist for all flood risk areas and these are regularly exercised. Plans should also consider major coastal flooding.

The Agency together with its professional partners should conduct contingency planning for prolonged, extreme nation-wide flooding and report on the implications.

4.3.2 Agency

The Agency's role was to provide timely forecasts and flood warnings, ensure the integrity of defences through the use of its own workforce, provide advice and information to emergency co-ordination centres (Silver and Gold) and provide detailed advice to members of the public through Floodline.

On 12 September 2000 the Agency introduced nationally consistent procedures for managing all flooding incidents. Incident rooms at the local Area, Region and at the National centre provided tactical, strategic and national co-ordination. The National Incident Room provided daily reports to the Prime Minister and Deputy Prime Minister. MAFF also provided daily reports to the Prime Minister representing a possible duplication of effort.

During flood events the Agency's streamlined reporting arrangements should be used within Government.

The unprecedented scale of flooding across England and Wales resulted in Agency incident rooms being open, in some cases, 24 hours a day for extremely long periods, see Table 3. Agency staff in the North East Ridings Area (River Ouse catchment) adopted an internal Silver and Gold control hierarchy which was considered to have worked well in the management of the Agency's emergency response.

All these Agency activities could only be successfully achieved by drafting in staff from many different backgrounds to support the emergency. It is estimated that approximately 3,500 Agency staff were involved in maintaining a 24-hour service in the worst affected areas. Many staff worked across regional boundaries in support of stressed locations. The benefits of this multi-functional response will be evaluated through a follow-up study. However, even at this stage its advantages are apparent.

The extended hours and the need to ensure the availability of key managers and staff over many weeks placed a tremendous strain on the organisation. The dedication and efforts of all staff and the emergency workforce were exemplary.

The Agency's 24-hour response was maintained by fully utilising the skills and experience of flood defence staff to lead, co-ordinate and direct the activities of others. Dedicated flood defence teams account for under half the total number of staff deployed over this period.

The Agency will undertake a review to establish 'best' working practice, including training needs, to gain maximum benefit from this experience.

Throughout the emergency response, the need to rigorously maintain health and safety standards was paramount. Risk assessments were made of working conditions, especially alongside fast-flowing rivers, in difficult conditions and sometimes in poor light. Although a few minor injuries were reported especially related to sandbagging work, there would appear to be no short or long-term impacts on staff health. A review of manpower levels for managing similar or more severe flood events needs to consider health and safety aspects of dealing with this type of flooding.

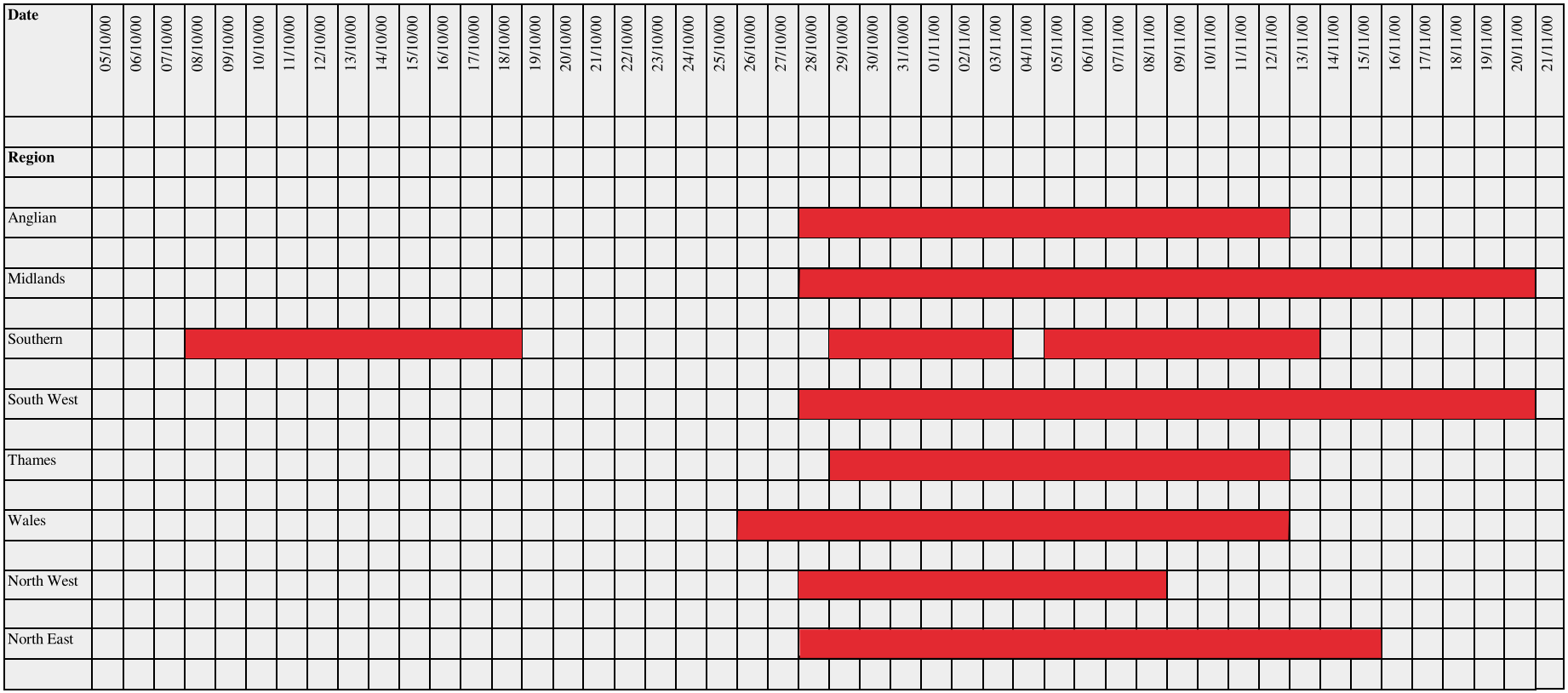
The flood also demanded a significant dedicated presence by Environment Protection teams. In the early stages they worked to ensure that industries storing or manufacturing polluting materials were taking adequate emergency measures. As the flood receded they became involved in responding to emergency requests for advice and assistance for dealing with issues ranging from the disposal of animal carcasses to responding to public concern about background pollution (usually perceived as sewage) in the floodwater.

The Agency should review the operational policy for pollution risks from industrial sites in flood risk areas and report on the generic options for managing these risks in future in October 2001.

The Agency will also review earlier research to identify further work that might be needed to improve our understanding of the level of pollution in floodwater.

Table 3

Operation of incident Rooms



4.3.3 Central Government contingency planning

The Home Office has initiated a review of central government contingency planning. The Agency would draw attention to the Flood Defence Emergency Response Project produced in co-operation with LGA, ACPO[3], CACFOA[4] and AINIA[5] following Easter 1998.

The Agency recommends that Government consider introducing a multi-organisation emergency planning structure. This would be able to co-ordinate flood warning and flood emergency plans and ensure they are robust enough to operate for extreme flood events as recommended by the Flood Defence Emergency Response[16] report.

In a major incident, multi-agency Silver (tactical) or Gold (strategic) control centres may be established. The Agency's involvement with Gold and Silver control centres, which were established during these floods, are shown in Table 4. The Agency attended many of the control centres. Where attendance was not possible, communications procedures were agreed for regular contact.

The Agency's attendance at Silver and Gold control centres considerably improved liaison compared with arrangements in earlier years. The Agency's presence also played a valuable role in that it allowed decisions to be rapidly disseminated back to area incident rooms. Information from area incident rooms informed decisions on evacuation, sandbagging and pumping operations.

In many cases demands on flood defence staff meant that the Agency liaison officer was a member of staff from outside flood defence or flood defence staff from an adjoining region. In general the arrangement worked well but there were instances where the contribution could have been more effective. The Agency will include the need for appropriate training for all staff who attend Silver and Gold control centres in its internal performance review. It also needs to provide for resourcing such control centres in its contingency planning.

However, there is concern about the number and effectiveness of some of these control centres; it has been suggested that some Gold control centres were competing with each other for support that included the armed services.

The review of central Government emergency planning initiated by the Home Office should identify and promulgate best practice for multi-agency Gold and Silver control centres.

MAFF and NAW placed a High Level Target on the Agency to develop flood emergency exercises and emergency plans with local authorities, emergency services and other partners. In some cases local authorities do not have prepared major incident plans specifically for flooding. The LGA has recognised that the emergency planning role is a critical one, both in preparing for emergencies and in marshalling and helping to manage resources to deal with them. It believes that emergency planning should be put on a statutory basis with a new Civil Protection Act with clearly established local and national responsibilities. The Agency supports this and believes that this should be included in the Home Office review.

There is an urgent need to put flood emergency planning on a sound statutory and financial footing.

MAFF and NAW High Level Target 3 calls for a national emergency exercise and an exercise in each Agency region and local area to be conducted by 31 December 2001 and at not more than three-yearly intervals thereafter.

The extent and severity of the autumn 2000 floods extensively tested Agency and central government contingency planning procedures. This report addresses many issues that would have arisen through the planned exercises for 2001.

A programme of local and regional flood emergency exercises will continue. MAFF should reconsider the timetable of a major coastal flood exercise until the lessons learned from autumn 2000 are implemented.

[3] *The Association of Chief Police Officers* [4] *Chief and Assistant Chief Fire Officers Association*
[5] *The Association of Inland Navigation Authorities represented by British Waterways* [16] *Flood Defence Emergency Response (FDER) Project Report, 1999*

Table 4

Summary of the implementation of Major Incident Plans by Local Authorities through the establishment of Silver and Gold Control Centres including Agency participation.

Agency Region	*Agency area*	*County/unitary authority*	*Major incident plan activated?*	*Control Open*		*Agency attendance*
				Silver	*Gold*	
Anglian	Northern	Northamptonshire		Yes		Yes
	Northern	Lincolnshire		Yes		
	Central	Cambridgeshire		Yes	Yes	Yes
	Central	Bedfordshire			Yes	Yes
Midlands	Upper Severn	Powys				
		Shropshire	Yes	Yes		Yes
		Worcestershire	Yes	Yes		Yes
	Lower Severn	Worcestershire	Yes	Yes		Yes
		Gloucestershire	Yes	Yes	Yes	Yes
		Warwickshire				
	Upper Trent	W Midlands		Yes		Yes
		Staffordshire	Yes		Yes	Yes
	Lower Trent	Derbyshire				
		Nottinghamshire		Yes	Yes	Yes
		Leicestershire				
		Lincolnshire	Yes	Yes		
North East		Ponteland			Yes	Yes
		Beverley	Yes	Yes	Yes	Yes
		Northallerton	Yes		Yes	Yes
		Doncaster	Yes		Yes	Yes
		York	Yes	Yes	Yes	Yes
		Leeds	Yes	Yes		Yes
		Hull	Yes	Yes		Yes
		Selby	Yes	Yes		Yes
		Sheffield		Yes		
		Wakefield	Yes	Yes		Yes
		Malton	Yes	Yes		Yes
		Rotherham	Yes			
North West	South	Cheshire (Northwich)		Yes		Yes
Southern	Sussex	Sussex	Yes	Yes	Yes	Yes
	Kent	Kent	Yes	Yes	Yes	Yes
South West	South Wessex	Dorchester	Yes	Yes		Yes
		Westbay		Yes		Yes
	North Wessex	Taunton	Yes	Yes		Yes
		Malmesbury	Yes			
		Bradford upon Avon	Yes			
		Portishead			Yes	Yes
		Chippenham		Yes		Yes
	Devon	Exeter		Yes	Yes	
Thames	North East	Redbridge			Yes	
	South East	Surrey		Yes		
Wales	North Wales	Denbigshire	Yes	Yes		
		Flintshire	Yes	Yes		Yes
		Wrexham	Yes	Yes		Yes
	Gwent	Blaenau Gwent	Gwent plan activated			

4.4 Public awareness and communications during the floods

4.4.1 Actions since Easter 1998

Communications with professional partners, the media and the public were demonstrably better in the autumn 2000 floods than in previous events - the result of sustained efforts by the Agency to take on board the lessons learned from Easter 1998 on improving public awareness of flood risk.

The Agency devised Floodline as an umbrella system for all flood-related communications. Floodline provides the focus for all activity and information about flooding, including a 24-hour telephone helpline service.

The prolonged rainfall, which culminated in the autumn 2000 floods, started barely a month after the Agency's second national public awareness campaign in September 2000. The hard-hitting campaign message - *"Flooding. You can't prevent it. You can prepare for it"* featured in the Agency's first national advertising campaign on television and radio and the new flood warning codes were launched as part of Flood Action Week (11-17 September). The Floodline service was widely promoted nationally and locally. The campaign could not have been more timely.

The Agency created a national address database of "at-risk" properties based on its Indicative Flood Plain maps for England and Wales in May 2000. The database was used for the first time in the 2000 campaign and enabled the Agency to target people living and working in flood risk areas with information about the new flood warning codes. This meant that more people knew about the flood warning system, how to prepare and what to do when they heard a warning.

4.4.2. Flood Warning Code communications

A new four-stage Flood Warning Code System was completed and launched on 12 September 2000. A major strand of this work was an integrated communications programme targeting Agency employees, professional partners, media partners and the public.

The new system received a positive response from professional partners and the media. Independent consumer research conducted by BMRB [6] with the public in risk areas in early October revealed an encouraging 27 per cent spontaneous awareness of the new warning system.

4.4.3. Collaboration with national weather providers

Key partnerships were forged with the BBC Weather Centre, Independent Weather Productions (which supplies part of the ITV network), ITV Teletext and the Met Office to ensure take-up of the new codes. This resulted in prominent broadcast of the new codes and the Floodline telephone number on national and local TV and radio weather bulletins. The high profile for the Agency, the flood codes and the Floodline number played a pivotal role in increasing awareness among the public, as evidenced by the unprecedented number of calls to Floodline during the autumn floods[7].

4.4.4 Public awareness campaign

Under the banner *"Flooding. You can't prevent it. You can prepare for it"* the autumn 2000 campaign featured a three week TV advertising and radio campaign focussed on preparing for floods. A striking red emergency warning code card was mailed to 843,000 homes and businesses covered by the Agency's flood warning system and a high profile media campaign warned about the potential for climate change to increase flood risk in the future. Some 1,400 disabled, elderly and minority groups were also mailed to ensure that the campaign was as inclusive as possible.

Post campaign and post autumn flood independent research recalled high levels of awareness among the public - 46 per cent of those interviewed spontaneously recalled seeing or hearing publicity about flooding and of those who remembered receiving the direct mail, some 85 per cent had kept it. *(Source: British Market Research Bureau Ltd.)*

The Agency believes that arrangements are needed that assure funding for a strategic 10-year campaign to promote increased flood preparedness across society and in vulnerable groups.

[6] British Market Research Bureau - Campaign 2000 Evaluation - November 2000 [7] Figure 1 - Calls to Environment Agency's Floodline service - April to December 2000

4.4.5 Internet

The Internet increased in significance during the floods with more than 87,000 hits to the Agency's website on 7 November, compared with a normal daily average of around 17,000. All the Agency's campaign material was posted on specially created Floodline pages on the web site, including information on what to do before, during and after a flood. Throughout the flooding emergency, new information was added to the site together with hotlinks to organisations such as CIRIA[8] and the Association of British Insurers (ABI).

In another major awareness raising initiative, the Agency published indicative floodplain maps on its website on 7 December 2000. This generated huge interest among the public with nearly one million map pages served on launch day and around a thousand e-mail enquiries answered by National Flood Warning Centre staff.

4.4.6 Media

National and local newspapers, radio and television sustained a high level of reporting throughout the floods, many making it a lead item. In the worst affected areas, local broadcasters adapted schedules (for example 24-hour broadcasting by BBC Radio York) to report regularly on the situation. International media interest came from Europe, the USA, Canada and Japan.

At the height of the floods four national news releases a day were being issued, timed to feed into the major news reports. A similar pattern occurred in all regions. All news releases were placed on the Agency's website, which the general public used intensively for information, including the linked flood warning and advice pages.

The main objective was to provide information on flood warnings and the flooding situation on the ground, with advice to the public on what to do. By incorporating wider messages, such as the need to avoid development in flood risk areas and the potential impact of climate change, the Agency successfully engaged the media in a productive widening of the debate about flooding, the risks, causes and solutions.

At times it proved difficult to do more than communicate the critical information such as location of warnings, likely impact and advice. A preliminary review of how information was gathered has identified some best practice, which would add substantial value. This preliminary study will support a more in depth review that will be completed by September 2001.

The communication of flood warnings and code symbols via weather bulletins, particularly on BBC national and regional networks provided major reinforcement to reports carried on news broadcasts. The Floodline telephone helpline number was extensively quoted in newspapers and broadcast throughout the floods, particularly during weather bulletins when calls to Floodline frequently peaked.

At least 3,000 radio and TV interviews were given by the Agency alone. Thousands more were given by County Emergency Officers, fire officers, local and national politicians and other emergency partners.

Independent evaluation of a sample of around 700 media reports (press and broadcast) over the period of the public awareness campaign and the flooding emergency indicated that the Agency communicated effectively, and that media comment was very largely positive[9].

The Agency National Press Office acted as the point of contact for the Cabinet Office News Co-ordination Centre, where daily updates on the flooding situation to Ministers and Government departments were compiled.

The Agency's media relations teams moved to 24-hour rostered operation, drawing also on contingency arrangements to provide professional support from elsewhere in the organisation and from external sources. At the peak, when the floods extended to most of the country, however, all teams were fully committed and additional press officers had to be hired.

One significant effect of resourcing pressures was that we were unable to collaborate in all joint emergency communication media teams at Silver and Gold control centres (such as York). Agency attendance would have helped information flows and communications.

Despite the extreme pressures, the commitment of our staff ensured a continuous and professional service to the public via media throughout the floods. We will review crisis communications resources within the Agency to ensure an improved service to the public and media during future floods.

[8] *Construction Industry Research and Information Association* [9] *Environment Agency – Key messages PR Campaign/Actual Flooding, Sept-Nov 2000, Echo Research Ltd*

4.5 Views of professional partners

The Agency sought the views of its professional partners. The view of the Local Government Association was that the Environment Agency's flood warning system was much improved from the performance at the time of the 1998 Easter floods and inter-agency co-ordination and co-operation was effective. Local protocols operated effectively in determining respective roles and responsibilities although there could be confusion as to who takes the lead in particular circumstances.

Emergency plans worked well locally. Two years planning and emergency exercises held with our partners in local authorities, emergency services and elsewhere, prior to the introduction of the Agency's new flood warning codes in September 2000 underpinned this performance.

It was felt that the Agency's Floodline was of considerable benefit. However, the public expectation was that the service provided information on all types of flooding which may have caused some confusion and callers were frustrated at being passed from one place to another. The Agency will be examining the development of Floodline and understands that local authorities are also recommending the use of Floodline or another call centre as a single point of access for all flooding enquiries.

The flexibility of Floodline meant that during the floods, the Agency added a specific option to deal with road flooding enquiries and updated its information to handle the many thousands of enquiries about sandbags. A nationally consistent policy on the provision of sandbags needs to be developed.

The Agency has a well-developed website and floodplain maps are now available through the internet. The development of websites and information and communication technology is also recognised by our professional partners as providing a valuable resource in responding to emergency situations and in providing information to the public.

The floods highlighted that there is still some confusion with the general public as to who takes responsibility for flood prevention. Although there has been a long-standing debate about the various responsibilities for main river, critical ordinary watercourses and other watercourses, this clearly has no relevance to someone who needs help and does not know where to turn for advice and support.

Liaison with professional partner organisations during the floods needs to be improved to ensure:

a) attendance by the Agency at Silver and Gold control centres is at the appropriate level,

b) consistent and up-to-date information is available for the public before, during and after a flood through all communication outlets.

Relationships with organisations such as the Association of British Insurers, Citizens Advice Bureaux, Met Office, traffic information providers and others could be strengthened. This is particularly important in the post-flood clean up phase when people need readily available advice and support.

We understand that the LGA believe that emergency planning should be put on a statutory basis with clearly established, properly funded, local and national responsibilities. The Bellwin arrangements are already subject to a separate review by DETR.

Without substantial increases in flood defence investment the backlog of flood defence schemes and maintenance works will increase with the subsequent threat of further misery to people from flooding.

Local authorities are concerned that there is a lag in their funding relating to the flood defence levy. In practice a council has to meet its obligations to fund the levy in the current financial year, and this can only be met by increasing council tax or from cuts elsewhere.

Flood defence levies and the inability of some flood defence committees to take a strategic view of area problems and the difficulties experienced by councils in funding programmes of work from existing budgets are of great concern and impact on partnership working with ourselves

5. Performance of defences

5.1 Protected properties

The Agency's flood defences are designed to reduce flood risk, by providing defences with a standard of protection appropriate to the use of the land protected. Unfortunately there will be occasions when conditions are so severe that defences are overwhelmed as happened during the October/November floods.

Although flood protection cannot be guaranteed it is estimated that almost 280,000 properties were successfully protected from flooding by flood defences during the autumn floods.

5.2 Near misses

One commendable feature of the response to the floods was the effort of many agencies and their staff in undertaking emergency repairs and strengthening of defences in difficult conditions and at times in the dark. If the wet weather had lasted slightly longer or been more severe, very many more properties would have flooded without this emergency work. In many locations the water level was very close to the top of flood defences and at others it was actually above the permanent flood defence and against temporarily raised defences. Emergency repairs also prevented at least one almost certain catastrophic breach at Barlby, Yorkshire. Table 5 shows that a significant number of communities narrowly avoided widespread flooding and the associated risk of loss of life.

Table 5 Principal locations that narrowly avoided widespread flooding

Location	*Property flooding which could have occurred*	*Notes*
Barlby/Selby	8,000	Overtopping at Barlby later stopped by sandbagging with water against the sandbags. Piping through and scour of the bank reduced by emergency actions. Thereby preventing an almost certain catastrophic breach. Emergency pumping of Selby Dam and Selby Canal prevented major flooding.
Cawood	500	Water above permanent defences and against emergency sandbags.
York	5,000	Water on average within 50mm of the top of flood defences and severe difficulties due to the overloading of Foss pumping station. Water on emergency defences at Leeman Road.
Castleford	450	Within 150mm of the top of defences.
Doncaster	9,700	Above defence level and against sandbags in at least one location. Near top of defences in others.
Ferrybridge	100	Above flood defences and against temporary sandbagging.
Leeds	1,100	100mm from inundating large areas of Central Leeds together with major arterial roads. Leeds railway station on the point of being closed.
Wakefield	1,150	Defences overtopped and against local roads. Within millimetres of affecting properties.
Wressle/Howden	500	Temporary raising of floodbanks and sandbagging reduced extent of flooding.
Blackhall Mill River	100	Water above defences and against temporary sandbagging. Emergency pumping reduced extent of flooding.
Morpeth	1,000	Water within 100mm of the top of flood defences
Burton/Derby	7,400	Water on average within 25mm of the top of recently constructed flood defences. Major pumping exercise implemented to carry flood flows away from city centre.
Chichester	1,000	5KM of emergency bypass channel excavated including culverting under the A27 and the main South Coast railway line.
Tonbridge	700	Riverside wall in danger of collapse and strengthened with sandbags.
TOTAL	36,700	

5.3 Emergency actions

The Agency and its professional partners undertook a wide variety of operations to reduce the impact of the floods. Examples of these follow below. Further detailed information is set out in regional reports and can be obtained through the relevant Agency regional office.

River Severn – Shrewsbury, Bewdley and Gloucester

Since the major flooded locations on the River Severn are undefended there was little that could be achieved by the Agency's workforce to prevent major flooding.

Emergency repairs were carried out to a breach on the River Roden at Wem and a flood bank was raised at The Haim upstream of Shrewsbury

In Shrewsbury the work force helped with disseminating information using loudhailers while the local authority carried out sandbagging of homes.

In Bewdley the work force assisted with the distribution and placing of sandbags that had been filled by the local authority.

In Worcester the Territorial Army assisted the local authority with placing sandbags and ferrying stranded residents.

River Trent - Derby and Burton

Recently constructed flood defences averted the flooding of many thousands of properties in Derby and Burton.

Asset Surveys carried out in the early to 1990's highlighted the need for major improvements to existing defences in the towns because of the structurally poor condition of flood banks and walls. Neither scheme qualified for grant aid under the scheme prioritisation system operated by MAFF at the time. Consequently, the Regional Flood Defence Committee funded the whole cost of improvements from revenue.

During the event, levels in Burton generally came to within a few millimetres of the top of the defences. Unfortunately, there was some localised over-topping and seepage, which led to 40 properties being flooded. These local problems are being addressed in our Emergency Repairs programme. Approximately 7,400 properties would have been flooded had the improvements not taken place.

Tonbridge, Kent

Intense rainfall over the upper Medway catchment produced a peak flow in the river above Tonbridge of 260m3/s 15 per cent above the previous 1968 maximum. The Leigh barrier filled in 5 hours (previous experience was 2 days) and held back river levels within Tonbridge to 900mm below that experienced in 1968. Without the barrier more than 2,000 properties would have flooded.

A potential problem for the town of Tonbridge was identified on 12 October. Lamberts Wall whilst retaining water to a depth of 1 metre started to leak. Army assistance was sought prior to the flood on 29 October to support the wall with sandbags. This work ensured that it held firm whilst again retaining 1 metre of water.

Yalding, Kent

Despite the fact that flows were being held back on the River Medway by the Leigh barrier, the swollen rivers of the Medway, Teise and Beult converged on Yalding leading to extreme flooding. The village became the centre of media attention as flooding continued after each period of intense rainfall.

Robertsbridge, Lamberhurst, Five Oak Green and East Peckham, Kent

All of these communities flooded three times during October and November. This added to the misery earlier in the year meaning that some of these communities flooded five times in 2000.

River Nail Bourne, Kent

The River Nail Bourne is a groundwater-fed river in east Kent that only flows during periods of high groundwater levels. The river caused flooding in the villages of Patrixbourne, Littlebourne and Wickhambreaux.

Direct works staff from the Canterbury depot have dedicated much of their time to ensuring that the effects of the flooding can be kept to a minimum. The Agency Emergency Works Force has installed 12-inch pumps to Littlebourne and Wickhambreaux so that the effects of flooding can be kept to an absolute minimum. Continuing high groundwater levels means that properties could be inundated by floodwater until Spring 2001.

Chichester, West Sussex

Chichester City centre suffered serious flooding in 1994. A recurrence was prevented by a major inter-agency response. Monitoring of groundwater levels early in October 2000 indicated that there was a significant risk of river flooding to the city. Procedures developed since the 1994 flood were implemented and Silver and Gold control centres established to co-ordinate a major pumping operation and the diversion of floodwaters around the city. This was still ongoing at the time of the production of this report. Prior to Christmas the pumps were unable to handle the increasing flow. Three miles of emergency bypass channel were dug including culverting a section under the main A27, two other major roads and the South Coast railway line to convey flood water out to sea at Pagham Harbour.

Lewes, East Sussex

A Severe Flood Warning was issued for Lewes on 12 October requiring residents to be evacuated through the day and into the early evening. The emergency response was seriously affected due to the very deep water and the town being cut off by floodwaters. The Coastguard and RNLI were in attendance assisting with evacuations. Inter-regional aid from Anglian Region was used to augment the local work force.

Uckfield, East Sussex

Torrential rain fell on the night of 11/12 October. Due to the speed and timing of the flooding, the emergency response, which was seriously hampered by difficult access along flooded roads, was limited to a reactive role of dealing with the aftermath and ensuring the safety of the people of Uckfield. The coastguard rescued one person swept away by the floodwaters.

Barlby and Selby, Yorkshire

Thousands of sandbags (some via Chinook helicopter) were deployed to strengthen and raise the defences along the River Ouse in Yorkshire over many miles. The Agency received invaluable assistance from British Waterways staff with this work. At one time the river level was estimated at 360 mm above the level of permanent defences at Barlby and serious further flooding was avoided.

Gowdall, Yorkshire

The potential risk to the village of Gowdall was first recognised when a major slippage on the landward side of the Gowdall barrier bank was noticed. Repair of this bank was considered too hazardous and a plan was developed to use a railway embankment to contain the floodwaters. While work was taking place to strengthen the railway embankment to make it an effective flood defence, the anticipated breach to the barrier bank occurred. Fortunately the emergency defences successfully held back 2-metres of water but then significant leakage started to fill the fields towards Gowdall. A large scale sandbagging operation was carried out in the village and a controlled breach was made in another bank to allow water to flow away from Gowdall. However, river water levels continued to rise through 5 and 6 November and properties were evacuated when it was realised major flooding could not be prevented. Some of the largest mobile pumps in the world were brought in from Holland to evacuate the washlands and return the water to the River Aire.

Wressle and Howden, Yorkshire

Large scale efforts were made to contain some serious overtopping of defences near Wressle. Large rubber blocks were brought in by Army helicopter to be used with sandbags.

York

Sandbags were deployed with Army assistance to protect properties at the Leeman Road, Marygate, North Street and Lendal Bridge locations within the city. The Foss Barrier operated well beyond its design capability.

Groundwater flooding

The flooding of homes and businesses due to rising groundwater from hidden springs brought misery to many in southern England and parts of Yorkshire. Groundwater flooding is very difficult to forecast and equally difficult to manage or control. The Agency provided technical support on request to local authorities.

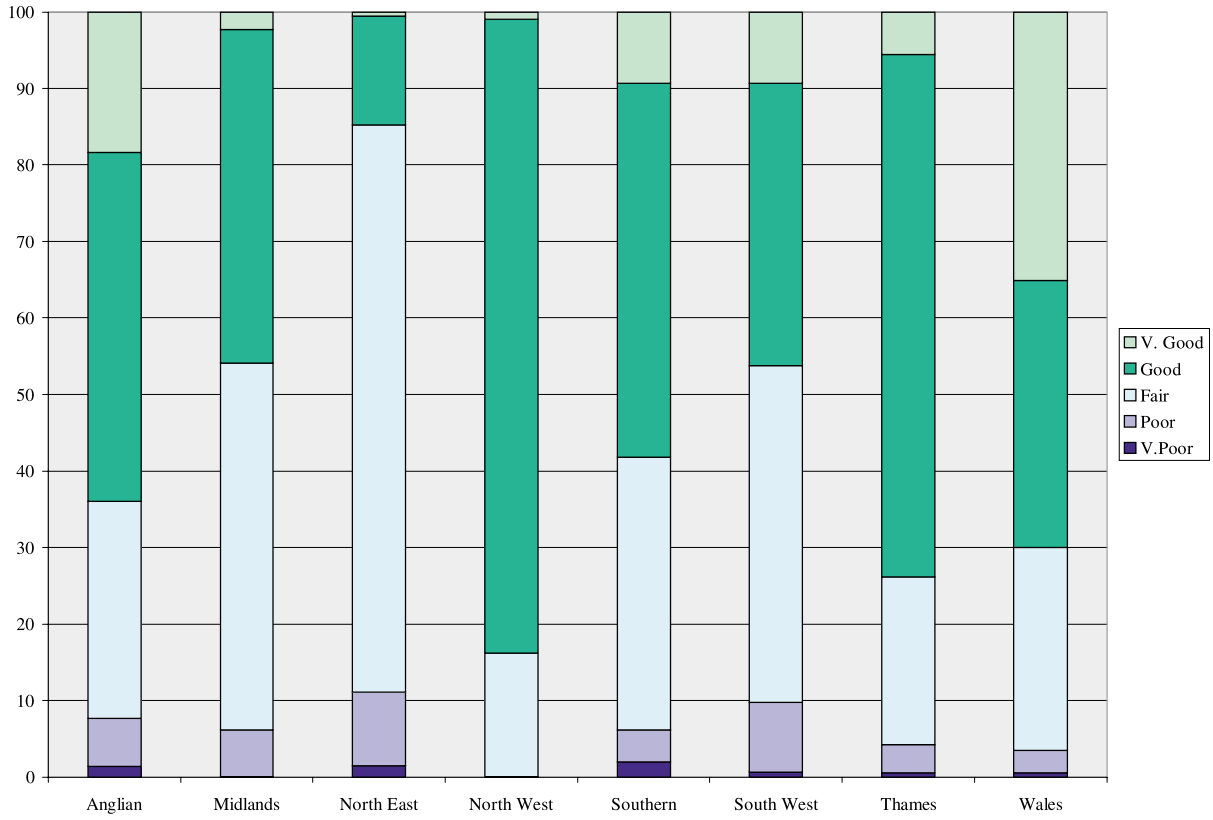
Portsmouth, Hampshire

In Portsmouth, following very heavy rainfall on 15 September, many parts of the city were flooded when the Southern Water Services Eastney Pumping Station flooded. This caused sewage and surface water flooding to c. 200 houses across parts of the city centre.

5.4 Condition of defences

As part of the Agency's Easter Floods Action Plan, visual surveys of the condition of the defences on main rivers have been carried out. The results are shown below.

Figure 8 - Defence condition ratings



The reluctance of those living in flood risk areas to accept advice to evacuate homes, followed by criticism when no flooding took place, clearly illustrated the standard of service that is expected from flood defences. The Agency's visual survey of the country's defences provides an early indication that they are not being maintained to consistent standards and hence this public confidence could be misplaced. The results of this survey will be refined over the summer and will include an understanding of defence condition at the various autumn 2000 flood locations. However, the preliminary results suggest that 85 per cent of the defences on the North East of England are in no better than fair condition, indicating that maintenance expenditure is too low.

The experiences of the autumn floods have identified weaknesses in the visual inspection regime.

The Agency will use the experience from the floods to review the accuracy of the results from the condition surveys of its own flood defences.

In February 1999 the Agency wrote to all local authorities and internal drainage boards to request that they carrying out inspection of flood defences on critical ordinary watercourses. Despite this, more than one third (110) of local authorities have not carried out this work. These include local authorities with significant lengths of flood defences. Among the reasons given for not inspecting are lack of funding and a shortage of expertise among their staff.

There is an urgent need to have an understanding of the state and adequacy of existing defences. This could be achieved by either:

a) **central funding to the Agency to enable us to carry out such a survey to common standards; or**
b) **creating a power for the Agency to require information from all owners responsible for existing flood defences; or**
c) **create a power of direction to enable Government to require all organisations, public and private, who are responsible for flood defences to undertake surveys and make them available to the Agency.**

It should be noted any of the above options would require resources to be made available. Some might significantly modify the permissive powers under which all operating authorities currently work.

The Agency is responsible for developing a national flood and coastal defence database that covers all defences on main rivers, critical ordinary watercourses and along the coast, irrespective of ownership.

We have developed a database for storing information on our defences as the first stage. The Agency and MAFF submitted a capital modernisation fund bid for further development of the database but it was unsuccessful. The failure of the bid will mean that it will take up to five years to complete the database.

The Government should fully fund the creation and maintenance of a database for storing information on the nature and state of all flood defences irrespective of ownership.

5.5 Sandbags

Some 2.5 million sandbags were used nationally to shore up defences and to protect many properties and utilities throughout the affected areas. Sandbags came from Agency stores, commercial suppliers, local authorities and army stores.

The Agency found it difficult to transport and strategically deploy the large number of sandbags needed. The situation in the north-east was made more difficult when the region's plant and sandbagging depot at Ricall was flooded from the River Ouse requiring alternative arrangements. This illustrates the necessity to locate essential activities outside floodplains.

Notwithstanding the sterling effort by local authorities and the Army, some difficulties occurred in controlling the deployment of sandbags to reinforce flood defences. We will need to review control procedures in incident plans to ensure the optimum use of sandbags in future.

One of the greatest demands facing the Agency and local authorities is the public call for sandbags. This demand is never fully satisfied. It diverts Agency resources from the vital task of securing flood defences, which in turn leads to inevitable public criticism. Local authorities also experienced problems with the deployment of sandbags to the public, many of whom reported difficulty in lifting and placing them.

The Agency and local authorities should jointly:

- **Develop a policy for the provisions of sandbags;**
- **Investigate joint call-off contracts for the supply and distribution of filled sandbags**
- **Assess the capacity to supply large numbers in an emergency.**

The Agency is undertaking a research and development project into the use of temporary defences for the flood proofing of buildings and the findings may provide suitable alternatives to sandbags in some instances. The Agency needs to carry out a proper contingency assessment of the availability of sandbags for an incident of this scale.

6. Policy and strategy

6.1 Development in the floodplain – prevention is better than cure

An estimated 1.85 million homes, 185,000 commercial properties and approximately 5 million people are now at risk from flooding. In the last 5 years there has been a year-on-year increase in the amount of development proposed in flood risk areas. Consequently, the Agency has sought to have its influence over the location and design of new development strengthened through a revision of planning guidance that was contained in DoE Circular 30/92.

The Agency believes that PPG25 will assist in delivering control over future development if it:

- ensures a more sustainable approach to development and flood risk
- consistently promotes development outside flood risk areas
- uses a sequential search approach to identify sites for development, promoting sites with the lowest flood risk first.
- prescribes minimum standards of flood defence for new development
- makes development more 'flood resistant' through innovative design
- does not add to the costs of maintaining, operating and replacing existing flood defences.
- enables properties to be re-occupied more quickly following flooding (current time to re-occupy is typically 1 year)

In doing so, it needs to be reinforced by improved Building Regulations and relevant guidance and codes, including that covering property sales, to deliver a joined-up approach.

The promotion of greater awareness of flood risk (through the use of warning notices and signs) in the consultation draft PPG25 is welcomed, but this will only apply to new development. The Agency believes that the same standards should be applied to existing development by the relevant licensing authorities within 2 years.

The Agency welcomes the fact that DETR has agreed to considerably strengthen the guidance and a second phase of consultation was launched on 6 February 2001. The Agency will be responding in detail to the new consultation draft.

The Agency is concerned that of the 1.25 million property transactions each year, only a small fraction of enlightened individuals or solicitors enquire about flood risk. The existing voluntary arrangements based around property search forms and the recently announced "Sellers Pack" initiative.

The existing voluntary arrangements based around property search forms do not include information on flooding. The Housing Minister has said that he would consider including flood risk information within the recently announced "Seller's Pack" initiative, during the passage of the Homes Bill, through the House of Commons.

The Agency recommends that government should require flood risk information to be included in future property searches and recorded in the proposed "Seller's Pack".

The Agency's floodplain mapping programme (Section 105) is an important initiative to influence the siting of new development. The Agency is currently exploring ways of assessing an extreme flood outline (1 in 1000 year historical return period) which will help identify areas of lower flood risk and contribute to the safer siting of new development.

6.1.1 Building regulations and planning guidance

The Government has recently announced that supplementary guidance on flood-resistant construction techniques for buildings within floodplains will be published in September 2001.

This best practice guidance will apply not just to new buildings but will also cover modifications to existing buildings to improve flood resistance. This will address the human and personal angle of the victims of flooding and has the support of DETR, ABI, National House Builders Federation, National House building Council, the Scottish Executive and the Agency

The Agency will continue to investigate innovative approaches for flood defences and for flood proofing properties, through field trials and its research and development programme.

6.2 Dealing with the uncertainty of climate change

The Agriculture Select Committee, in its report on flood and coastal defence (30 July 1998), state:

"In their evidence to us, the Meteorological Office noted that by 2050, winter days with heavy rainfall (25mm) will become typically four to five times more common than at present."

The UK landscape has undergone widespread and progressive change throughout the last century. For instance, the urban land area is estimated to have increased by 50 per cent between 1930 and 1990. Coupled with the greater runoff from the continued expansion in urban areas, higher precipitation rates are likely to increase the risk of inland flooding in the first century of the next millennium.

At a recent CIWEM conference[10], a representative from the Meteorological Office reported that the last 30 years show a trend to rain falling in more intense events. This is endorsed as "likely" in a statement issued in Shanghai by the Inter Governmental Panel on Climate Change from their summary for policymakers in the Third Assessment Report of Working Group I, which also concludes that, more intense precipitation events are "very likely" during the 21st century.

The climate change scenarios for the UK show an increase in the overall amount of rainfall (particularly in winter), changes in the frequency and intensity of rainfall and rises in sea level. This is particularly important for winter floods, when there could be up to 15 per cent more rain in some regions of the country by 2050, and summer floods in the north, when it is expected that there will be a higher proportion of extreme summer rain. In the south the consequence of changes in the pattern of summer rainfall could be more complex; anticipated increases in the frequency of intense rainfall could be counteracted by a reduction in summer rainfall totals. These changes suggest that the frequency and magnitude of flooding will increase with a consequent increase in regular workload for flood warning and the emergency response.

The series of recent flood events is consistent with the type of information available from both the climate change scenarios and the early modelling studies of the impacts of climate change on flood flows[11].

Some initial work [12] to evaluate the impact of climate change on flooding has been carried out for the Thames and Severn catchments. While it may not be duplicated across all catchments, this increase in the incidence of flood events would be very significant in terms of the probability and consequences of extreme events.

Research has identified a range of "no and low regrets" action on adapting to the impacts of climate change[13], including improved flood risk identification, raising awareness of practical steps to reduce flood damage, and discouraging or restricting inappropriate development in areas at high risk of flooding. Longer-term responses such as strengthening defences were also identified. The Government and the devolved administrations have already started to respond to the threat of climate change by building adaptation into many of their policies[14]. Examples include revising the approach to development in flood plains, improving flood warnings and increasing public awareness of flood risk and further research into the potential impact of extreme flood events.

The options appraisal should encourage the construction of flood defences that can be easily modified, through incremental changes, in response to growing confidence about the impacts of climate change, thereby maximising the efficiency of future investment decisions.

[10] *CIWEM, Conference Flooding Risks and Reactions 5 October 2000 London UK*
[11/12] *Institute of Hydrology / Centre for Ecology and Hydrology. Climate Change Impacts for Fluvial Flood Defence. Final Report, MAFF Project FD0424-C, March 1999.*
[13] *ERM. Potential adaptation strategies for the UK. Produced for DETR, May 2000.*
[14] *DETR. Climate Change, The UK Programme. The Stationery Office, November 2000*

Research to establish to what degree the autumn floods can be attributed to climate change is being promoted by MAFF at the Centre for Ecology and Hydrology and the Met Office Joint Centre for Hydro-Meteorological Research. These results should inform future decisions and policies on standards of defence.

Further research, monitoring and modelling will in due course give improved assessments of these very complex potential impacts. In the meantime a precautionary approach is appropriate.

The Ministry of Agriculture, Fisheries and Food has provided guidance on dealing with climate change from the point of view of uncertainty and using sensitivity analysis to assess the impact of potential changes. It recommends that the sensitivity analysis of river flood alleviation schemes should take account of a potential increase of up to 20 per cent in peak flood flows over the next 50 years. We believe this a sensible and a **minimum** precautionary response.

The Agency is leading a capital modernisation bid with the Scottish Environment Protection Agency and the Rivers Agency, Northern Ireland, to update, extend and disseminate the UK flood record, which is made generally available to those involved in flood estimation and analysis. This data will also be useful in the analysis of trends in river flow data and flooding in the context of climate change.

The indicative climatic changes that are being predicted may, in time, revise our view of the frequency and intensity of future floods. Any increase in the frequency of even more modest floods, or the severity of extreme events would stretch the resources of Agency and its partners beyond their current normal operating capabilities.

6.3 Insurance industry

The insurance industry is concerned that inland flooding is already significant and may increase due to climate change and the increased building of new property within the floodplain. The Association of British Insurers have previously commissioned research for their members on coastal and major estuary flooding.

Following the experiences of the 1998 floods and the potentially increasing threat of inland flooding ABI published a report on Inland Flooding Risk in October 2000[15]. The report examined two potential flooding scenarios – a prolonged storm over the Trent and Severn catchments and a front slowly moving from west to east causing extremely heavy rainfall over the upper Thames catchment, followed by intense rainfall over outer London. The results suggest that the losses to the insurance industry could be in the order of between £1 billion and £2 billion under a major event or series of events under climate change. The latest nation-wide floods demonstrate that such predictions are realistic.

The ABI have stated that insurers want to continue to provide affordable cover against weather related risks. This includes those in flood prone areas, unless the risk has deteriorated to the extent that the risk of flooding has become inevitable, for example, where flooding is habitual with no prospect of flood control measures. The insurance industry is also looking for the introduction of satisfactory planning policies and targeted investment in flood defences. Insurance claims for inland flooding have been small when compared to other areas of weather related claims. The current estimate of insurance claims for the autumn 2000 storms and floods is between £700 and £750 million.

6.4 Vulnerable people

The Better Regulation Task Force report "Protecting Vulnerable People"[16], recommended that policy makers should consider vulnerable people at all stages of their work. They advise that, when appraisal systems for public expenditure projects are next revised, greater consideration be given to including vulnerability impact assessments.

The flood-warning public awareness campaigns of 1999 and 2000, targeted particular socio-economic groups known to be at risk. It also addressed the special needs of those with sight and hearing impairment. Flood-warning information packs were prepared in Braille, large print and audiocassette and advertised in RNIB magazines. The RNID produced sign language videos on the dangers of flooding and provided training for call centre and Agency staff on the use of the Floodline minicom system. The Agency has

[15] *Association of British Insurers: Inland Flooding Risk – Issues Facing the Insurance Industry*
[16] *Better Regulation Task Force – Protecting Vulnerable People September 2000*

worked with the Central Office of Information to produce information packs in seven minority languages which have been promoted through the ethnic media and can be downloaded from the Agency's website.

Research by the Flood Hazard Research Centre at Middlesex University following the floods of 1998[17] and 2000[18] revealed that single heads of household, predominantly women, were a group being disproportionately disadvantaged following flooding. Recent experience from the USA and Canada in the Red River flood in North Dakota and Manitoba identified similar vulnerabilities among women.

Discussions are continuing with various national disability groups, the Central Office of Information and the Citizens Advice Bureaux (CAB) on targeting the dissemination of flood-warning information and on giving advice on what to do before, during and after flooding.

The Better Regulation Task Force also stresses the need for policy makers to be aware of the vulnerability of those without access to the skills and technology of the twenty first century. The Agency will commission research programmes, on the social performance of flood warning technologies and on flood warning for vulnerable groups. Reports are expected in November 2001 and 2002 respectively.

The Agency is currently working on a project with communities in flood risk areas in Cornwall researching public perception of the Agency and methods of establishing easy access for all groups and communities, particularly in rural areas, to information, advice and guidance. This project is sponsored by the National Flood Warning Centre and forms part of a comprehensive flood warning and flood defence research and development programme.

6.5 Project appraisal guidance

Applications for MAFF funds (in the form of grant aid for capital projects) now pass through three stages:

- compliance with absolute thresholds;
- achievement of a priority score;
- completion of MAFF project appraisal requirements.

However, there are a number of initial concerns founded on the experience of where flooding took place over autumn 2000.

6.5.1 Strategic planning

There has been a welcome shift towards the strategic consideration of flood and coastal defences. Until now this has mainly focussed on shoreline management plans and coastal strategies but the Government within the £51million of additional funding, has accelerated this thinking by establishing a priority for catchment flood risk management plans over the next two years.

There may be many affected locations where investment to reduce flood risks may not be appropriate or justifiable. Most of our river valleys comprise extensive floodplains where flooding needs to be recognised as a natural phenomenon and attempts to reduce it could only exacerbate the risks to even larger populations. In such locations risks need to be managed in less interventionist ways.

Guidelines for the development of these catchment flood management plans are currently being produced. These plans together with the detailed strategies that develop from them will take a number of years to put in place for the whole of the country.

There will be five pilot studies this summer to help define the content of future work. MAFF and the Agency have developed a two stage process consisting of initial scoping studies followed by more detailed studies where required. It ought to be possible to cover a significant part of the country with scoping studies relatively quickly and then target further studies accordingly.

[17] *Tapsell, S.M et al 1999. The Health Effects of the 1998 Easter Flooding in Banbury and Kidlington. Report the Environment Agency. Flood Hazard Research Centre, Middlesex*
[18] *Tapsell, S.M et al 2000. Follow-up Study of the Health Effects of the 1998 Easter Flooding in Banbury and Kidlington*

Interim guidelines and procedures need to be developed and followed to progress works in the capital programme that do not undermine this strategic approach.

The production of catchment flood management plans, whilst welcomed, should not lead to a delay in the completion of schemes for flooded communities. Government should agree procedures as a matter of urgency to enable the assessment and, where appropriate, the execution of urgent works in advance of catchment flood management plans.

Roles and responsibilities for flood defence are shown in Annexe C.

6.5.2 Priority score

The Priority Scoring System has supported national Government Policy by favouring flood warning and urban coastal/tidal defences and the protection of environmental assets of international importance. The Agency fully supports the importance of flood warning schemes and recognises the devastation that coastal flooding can have on these vulnerable communities. The system has, however, frustrated the promotion of non-tidal schemes.

This concern was recognised within the Government's November 2000 statement when the system was adjusted to bring non-tidal schemes into parity with those for the urban coastline. This change is welcomed by the Agency and reinforces the actions of the Regional Flood Defence Committee in the Midlands Region that promoted asset refurbishment schemes for defences in Derby and Burton-on-Trent.

It is, however, essential that the decision to bring parity for flood defence schemes does not undermine the ability to complete vital flood defence works along the coast and in tidal locations. The use of priority scores is necessary because the funding is inadequate for the risks identified.

The Ministry has published a consultation draft to review the success of the priority score system, which has been in place for three years. (The Agency will forward detailed comments within the consultation period).

6.5.3 Economic appraisals

Economic appraisals for flood and coastal defences rely on the use of benefit-cost analysis, which weighs up the benefits and costs (valued in monetary terms) to decide which is the "best" option. This methodology does, however, restrict the analysis to considering all the impacts in national resource terms. The outcome of this is that impacts such as changes in the distribution of income, changes in employment levels or the impact on the individual community cannot be considered within the appraisal system. However, the approach is consistent with current Treasury guidance given in the Green Book. Last year MAFF issued new Project Appraisal Guidance notes. Early indications are that the benefit/cost decision rule leads to a reduced standard of defence at a time of increased uncertainty such as climate change and changes in catchment characteristics. The Agency is concerned at this early unexpected outcome.

The autumn floods affected many parts of the country. The "waves" of rainfall on top of waterlogged catchments meant that some communities were flooded for several days, others suffered repeated flooding and some experienced flooding for the first time in living memory. The impact of this flooding extends well beyond damage to property and disruption to infrastructure. Many communities have been traumatised by their experience fearing the return of flooding each time that it rains (ref: Section 2.4 Impact on people). Research is currently underway that will attempt to evaluate these health concerns but earlier efforts have not been particularly successful. The experienced of these floods cannot be ignored and every attempt must be made to extend the decision-making framework, that supports investment, to fully accommodate these health issues.

Current policy is to consider individual flood cells and apply the economic tests to determine the most cost-effective solution for each cell. Flood cells are areas that flood separately for example opposite banks of a river. When the benefits vary or the costs of building higher defences vary from cell to cell because of particular local circumstances then current policy leads to different standards of protection for what are essentially the same communities. There are examples emerging that show that current policy gives different standards of protection on the same river to different parts of the same town.

There is an urgent need to introduce an approach that fully reflects the impact of flooding on people and not just simply the value of the damage to their possessions.

The Agency's experience is that the decision making framework that supports investment needs to take into account more than the benefit/cost ratio. Social impact, health, frequency and scale of flooding are all key issues. In addition it should support consistent standards of defence within each town. The Agency is producing a report on these issues for discussion with the Ministry in autumn 2001.

7. Funding

7.1 Investment needs

The Agency gave evidence to the Agriculture Select Committee in April 1998 that flood defence was under-funded and estimated that the shortfall in capital and maintenance investment was some £30-40 million. As part of the 1998 Comprehensive Spending Review, the Flood and Coastal Defence with Emergencies Division of MAFF undertook an assessment of the economic assets at risk from flooding and coast erosion. The results suggested a potential impact on the nation's economy significantly larger than had previously been estimated, so much so that a more in-depth study was commissioned.

The results from the latest in-depth study demonstrates that some 10 per cent of the population in England live within areas potentially at risk from flooding and property worth over £200 billion and land worth approximately £7 billion is also at risk.

The report concluded that the shortfall in capital works and maintenance investment is estimated at £100 million per annum. An increased investment of £100 million per annum (from the present £200 million to £300 million) would maintain residual annual damages at the existing standard of £600 million per annum. Maintaining the current investment level of £200 million per annum leads to a progressive deterioration in residual damages to £1800 million. This data was used to inform the 2000 Spending Review. The study only examined tangible losses and does not make any allowances for the impact of climate change.

The impact of the autumn 2000 floods on peoples lives, public utilities and transport has served as a timely reminder of the need for adequate investment in flood defence. Although these floods were exceptional the Ministry's own research has provided an early warning of the need for increased investment. The suggested increase will be necessary to manage flood risk and avoid the experience of last autumn becoming more frequent.

Government should recognise that there is a need for a significant increase in funding for flood defence on a planned basis as indicated by MAFF's research. This is needed to improve flood warnings, secure a reasonable condition for present assets and improve the overall standard and extent of flood defence.

The Agency will produce a report on the relevance of the medium term plans produced by the Flood Defence Committees in relation to the experience of communities flooded since April 1998.

7.2 Emergency response costs

The Agency has prepared estimates of its own costs for dealing with the flood and the Government has provided £11.6 million paid in extraordinary support. Local authorities through the county councils are preparing their estimates of their costs that will be submitted for supplementary support under the Bellwin scheme. Environment Agency Wales were originally asked by the National Assembly for Wales to follow the Bellwin philosophy through the county councils against the same criteria. Since this initial request, the appropriateness of the route through Bellwin has been questioned. Consequently the National Assembly have now advised that they will reimburse most of the emergency response and repair costs directly to Environment Agency Wales in line with the arrangements agreed between MAFF and the Environment Agency in England.

The Agency welcomes this exceptional additional support at a time of diminishing flood defence balances. Flood defence balances are intended to fund unexpected operational expenditure in times of severe weather but such balances cannot be expected to meet the exceptional activity that was experienced last autumn.

Government should confirm that the simple formula used this winter for emergency relief funding will apply to Flood Defence Committees in future.

Many groups have supported the emergency response to these floods. There appears to be no mechanism for

drawing all these activities together to understand the true cost of the emergency response for this flood. The Agency believes that it is in a unique position to bring this information together for the Government.

The Agency, with others, will prepare an assessment of the total costs incurred as a result of the autumn floods and in the emergency response to them.

7.3 Additional funding

The Government's announcements in November 2000 and January 2001 of additional funding following the October/November floods are very welcome. The November announcement comprised £51 million in the current and next three financial years to accelerate river defence works and allow new whole catchment area assessment studies to be produced. The £11.6 million package announced in January is to fund most the Agency's costs in responding to the flooding and carrying out emergency repairs. This extra funding comes on top of the additional £23 million made available in the Comprehensive Spending Review of 1998 (covering 1999-00 to 2001-02) and the further £30 million following the Spending Review 2000 (covering 2002-03 and 2003-04).

The January 2001 announcement from The National Assembly for Wales concerns £25 million of planned expenditure over the next 3 years that included the additional £3 million of funding announced in November 2000.

7.4 Levies

The Agency Board can only advise flood defence committees of the need to raise money for essential work. It is disappointing that the levy setting process for 2001/02 did not secure the recommended levy increase despite the worst flooding for over 50 years. Nearly half of the flood defence committees were unable to secure the required funding and include committees that serve the worst affected areas. The shortfall of £6 million for England will result in delays to capital schemes, reduction in maintenance programmes and delays to flood warning improvements.

A further financial consequence of the autumn floods will be a reduction in the already low level of balances, retained by flood defence committees for emergencies.

The Government has set a target for retained balances of between 5 –10 per cent. Several flood defence committees including Yorkshire have planned balances of less than 1 per cent. In doing so they are relying on the prudent budgeting of other committees. The total planned balances will have reduced by £2 million.

An examination of recent investment decisions and the levy setting process, in the aftermath of the floods raises a number of concerns. The most significant being the inability to provide nationally consistent standards of service.

It is important to register the fact that the Flood Defence Committee's determine the level of funding and the relative priorities of different types of work within their area for example, expenditure on flood warning, maintenance and capital works.

8. Recommendations and actions

The Agency recommends a number of further actions for itself, its professional partners and Government as follows:

1. Public confusion and information

1.1 The attribution of responsibility for the management of watercourses posing a significant flood risk needs to be reassessed in order to resolve the current confusion. (2.1)

1.2 Floodline should be expanded to provide a one-stop-shop information service for flooding. (4.2.3)

(These would need to be done in partnership with local authorities and others).

1.3 The Agency recommends that Government should require flood risk information to be included in future property searches and recorded in the proposed "Sellers Pack". (6.1)

1.4 The Agency will use all available information, to catalogue the flooding that took place in autumn 2000, the local causes of this flooding and how solutions or responsibility for action can be successfully attributed. (2.1)

2. Flood warning

The Agency is measuring the performance of dissemination systems by public opinion surveys undertaken by independent research contractors in a sample of the flooded areas.

2.1 The Agency believes that arrangements are needed that assure funding for a strategic 10-year campaign to promote increased flood preparedness across society and in vulnerable groups. (4.4.4)

2.2 The Agency will review the existing Flood Warning Investment Strategy in the light of these floods. The results of follow-up research will be brought together over the summer for a report in October 2001. The review will include costed options for more rapid and extensive delivery of flood warnings. (4.2.1)

2.3 The Agency will, in parallel with the planned review of flood forecasting and warning performance, work with all professional partners to: (4.2.1)

- Identify opportunities to warn properties in high risk areas not included in the current systems;
- Consider accelerating investment to arrive at a consistent standard of service founded on best practice.

2.4 The Agency and the Met Office will undertake a joint review of weather forecasting performance relative to flood forecasting need. (4.1.3)

2.5 At times it proved difficult to do more than communicate the critical information such as location of warnings, likely impact and advice. A preliminary review of how information was gathered has identified some best practice, which would add substantial value. This preliminary study will support a more in depth review that will be completed by September 2001. (4.4.6)

3. Risk assessment and contingency planning

The latest IPCC Report confirms that climate change is developing more rapidly than previously predicted. More extreme weather events will become more frequent.

3.1 **There is an urgent need to put flood emergency planning on a sound statutory and financial footing.** (4.3.3)

3.2 The review of central Government emergency planning initiated by the Home Office should identify and promulgate best practice for Gold and Silver control centres. (4.3.3)

3.3 The Agency together with its professional partners should conduct contingency planning for prolonged, extreme nation-wide flooding, and report on the implications. (4.3.1)

3.4 A programme of local and regional flood emergency exercises will continue. MAFF should reconsider the timetable of a major coastal flood exercise until the lessons learned from autumn 2000 are implemented. (4.3.3)

3.5 The Agency recommends that Government consider introducing a multi-organisation emergency planning structure. This would be able to co-ordinate flood warning and flood emergency plans and ensure they are robust enough to operate for extreme flood events as recommended by the Flood Defence Emergency Response[16] report. (4.3.3)

3.6 The Agency and local authorities should jointly: (5.5)

- Develop a policy for the provisions of sandbags;
- Investigate joint call-off contracts for the supply and distribution of filled sandbags
- Assess the capacity to supply large numbers in an emergency.

3.7 The Agency, local authorities and the National Health Service should carry out flood risk assessments and prepare contingency plans for their assets in flood risk areas. (2.3)

3.8 Water and Power Utilities, Railtrack and the Highways Agency should carry out flood risk assessments and contingency plans for their assets in flood risk areas. (2.7)

3.9 The Agency should review the operational policy for pollution risks from industrial sites in flood risk areas and report on the generic options for managing these risks in future in October 2001. (4.3.2)

3.10 During flood events the Agency's streamlined reporting arrangements should be used within Government. (4.3.2)

3.11 The Agency will undertake a review to establish 'best' working practice, including training needs, to gain maximum benefit from this experience. (4.3.2)

4. Investment needs

4.1 Condition of existing defences

4.1.1 There is an urgent need to have an understanding of the state and adequacy of existing defences. This could be achieved by either: (5.4)

a) central funding to the Agency to enable us to carry out such a survey to common standards; or

b) create a power for the Agency to require information from all owners responsible for existing flood defences; or

c) create a power of direction to enable Government to require all organisations, public and private, who are responsible for flood defences to undertake surveys and make them available to the Agency.

It should be noted any of the above options would require resources to be made available. Some might significantly modify the permissive powers under which all operating authorities currently work.

4.1.2 The Government should fully fund the creation and maintenance of a database for storing information on the nature and state of all flood defences irrespective of ownership. (5.4)

4.1.3 The Agency will use the experience from the floods to review the accuracy of the results from the condition surveys of its own flood defences. (5.4)

4.2 Investment decisions

4.2.1 The Agency's experience is that the decision making framework that supports investment needs to take into account more than the benefit/cost ratio. Social impact, health, frequency and scale of flooding are all key issues. In addition it should support consistent standards of defence within each town. The Agency is producing a report on these issues for discussion with the Ministry in autumn 2001. (6.5.3)

4.2.2 The options appraisal should encourage the construction of flood defences that can be easily modified, through incremental changes, in response to growing confidence about the impacts of climate change, thereby maximising the efficiency of future investment decisions. (6.2)

4.2.3 The production of catchment flood management plans, whilst welcomed, should not lead to a delay in the completion of schemes for flooded communities. Government should agree procedures as a matter of urgency to enable the assessment and, where appropriate, the execution of urgent works in advance of catchment flood management plans. (6.5.1)

4.2.4 Government should recognise that there is a need for a significant increase in funding for flood defence on a planned basis as indicated by MAFF's research. This is needed to improve flood warnings, secure a reasonable condition for present assets and improve the overall standard and extent of flood defence. (7.1)

4.2.5 The Agency will produce a report on the relevance of the medium term plans produced by the Flood Defence Committees in relation to the experience of communities flooded since April 1998. (7.1)

4.2.6 The Agency will continue to investigate innovative approaches for flood defences and for flood proofing properties, through field trials and its research and development programme. (6.1.1)

4.3 Funding

4.3.1 Government should confirm that the simple formula used this winter for emergency relief funding will apply to Flood Defence Committees in future. (7.2)

4.3.2 The Agency, with others, will prepare an assessment of the total costs incurred as a result of the autumn floods and in the emergency response to them. (7.2)

Annexe A

MAFF / Environment Agency R&D Projects linked to floods 2000

Concerted action on hydrological processes related to flood defences S*

- **Research objective:** to review and identify key issues related to hydrological processes involved in flood defence that will benefit from R&D. To define a related programme of practical R&D and information projects aimed at improving the quality and relevance of information on these available to users, including supporting studies to assist in the application of the Flood Estimation Handbook.

Climate change as a cause of floods 2000 U*

- **Research objective:** to assess to what degree the October/November 2000 flood events can be attributed to climate change, as distinct from normal hydrological extremes and other factors affecting run-off

Impact of agricultural soil condition on floods 2000 U

- **Research objective:** to carry out targeted surveys of agricultural soils in selected catchments which have flooded during the Floods 2000 in order to find any evidence that the condition of agricultural soils has contributed to the severity of the flooding. The work will be targeted on the Severn, York Ouse and Southern Region flood catchments

Demonstration system for modelling tools and decision support systems for flood defence-planning U

- **Research objective:** to provide a demonstration integrated catchment modelling system in order to assess improvement in accuracy and flexibility in assessing strategic flood management options.

Classification of populations vulnerable to flooding S

- **Research objective:** to improve understanding of the social and economic variance of populations inhabiting areas potentially at risk from coastal or fluvial flooding. To assist decision makers and planners take these factors into account and examine how the flood warning response to these groups can be enhanced and the impacts of flooding thereby reduced.

Improving public awareness and understanding about flood risk S

- **Research objective:** to raise the level of education and understanding by those who live and work in high-risk flood areas. To provide recommendations on improving awareness, knowledge and expectations on sensitive policy issues.

* *S just starting, U underway*

Improving dissemination of flood warnings U

- **Research objective:** to develop and implement a pilot project to assess more effective ways of disseminating flood warnings

Risk assessment of flood defence systems for strategic planning S

- **Research objective:** to improve the analysis of risk in areas protected by multiple defences and in the development of Catchment Flood Management and Coastal Management Plans.

Performance and reliability of flood and coastal defence structures S

- **Research objective:** to identify methods and provide guidance on best practice approaches for assessing the reliability of structures. This proposal supports the overall programme objective of developing improved risk-based assessment techniques for performance evaluation of engineering structures.

Reducing uncertainty in assessing flood level and flood risk in river channels / flood plains U

- **Research objective:** to develop improved tools and techniques for assessing flow conveyance (and the relation between flow, depth, and energy slope) in river channels and flood plains in order to improve the reliability of flood forecasting, design and maintenance procedures

Reducing risks of embankment breach under extreme conditions S

- **Research objective:** to improve understanding of embankment performance, including the processes of embankment breach, and to develop a better approach to managing the risks of embankment failure.

Concerted action on operation and maintenance of flood and coastal defences S

- **Research objective:** to review O&M activities carried out by the Agency and Local Authorities on Flood and Coastal Defences to identify issues that will benefit from R&D. Then to define a related programme of practical R&D and information projects to improve cost-effectiveness of O&M and performance of defences

Protection of buildings against flooding – extemporary and permanent U

- **Research objective:** to develop good practice guidance, in support of formal Planning Guidance and Building Regulations, on flood-proofing (a) new, and (b) existing, buildings in locations where there is a risk of flooding.

Restoration and repair of property U

- **Research objective:** to provide guidance to owners, occupiers and contractors on the repair and refurbishment of flooded property.

Temporary and de-mountable flood defences U

- **Research objective:** to assess, and develop a framework for use of, the range of existing and new designs and equipment currently available for temporary flood defences in order to assess its potential for use by the Environment Agency and local communities to protect property in extreme flood events.

Assessing the impacts of floods 2000 on physical structure of river channels S

- **Research objective:** to survey and assess the impacts of floods on the physical structure of river channels, with particular reference to morphology (movement of bed and banks) and habitats, using the established River Habitat Survey. (Can't be started till April 2001 for access)

Good practice baseline review U

- **Research objective:** to document current good practice within the Agency and provide recommendations to guide development of regional and area flood forecasting and warning systems and procedures to improve timeliness, accuracy and reliability of flood warnings.

Rainfall forecasting S

- **Research objective:** to review existing techniques for measurement and presentation of actual and forecast rainfall and to provide recommendations for improvements to real-time Meteorological Office systems to increase the accuracy of radar rainfall data.

Extreme event recognition U

- **Research objective:** to review conditions which have produced extreme flood events, and to identify factors which could be used for early recognition of the development of extreme events to improve response.

Real-time modelling S

- **Research objective:** to review performance information on existing hydraulic and hydrological models used in real-time, to provide guidelines on the most suitable models for use in particular catchment conditions, including confidence limits, and to identify R&D needs.

National Flood Forecasting Modelling System (FFMS) strategy

- **Research objective:** to work in close collaboration with the Agency practitioners and national and international experts to develop a clear strategy for a national flood forecasting modelling system. This will assist the Agency to plan and achieve national convergence and provide guidance to regional development initiatives on design concepts and system procurement.

The Social Performance of Flood Warning Communication Technology S

- **Research objective:** to identify the social barriers to effective performance of communication and dissemination technology currently available and likely to impact in the 2000-2010 period and make recommendations for maximising the effectiveness of current and new technology in order to assist the Agency in achieving its performance targets.

Agency flood warning quantitative and qualitative research projects supporting and monitoring flood warning dissemination and marketing programmes

Independent quantitative surveys

Carried out since 1997 by British Market Research Bureau International as follows:

- Annual Omnibus Survey (general public's awareness of Environment Agency and Agency's roles and responsibilities for flood defence and flood warning.).
- Annual Survey of public whose homes and properties have been identified by the Agency to be at risk of flooding.
- Post event surveys undertaken post flooding events to monitor the Agency's flood warning performance and public awareness of warnings and behaviour following receipt of warnings.

Commissioned by Environment Agency 1998 – 2001

Post-Autumn 2000 Floods: qualitative research programme to understand public attitudes to flooding, risk perception, barriers to action

Major scoping study to prioritise the programme of projects identified under the Flood Forecasting & Warning Research Programme, Tunstall, S.M., Flood Hazard Research Centre, Middlesex University, April 2000

Flood Warning Research Audit (National and International) Tunstall, S.M., Parker, DJ, Flood Hazard Research Centre, Middlesex University, 1999

Health impacts of flooding

Interim Report on the Health Effects of the June 2000 Flooding in Todmorden, South Church and West Aukland, Tapsell, S.M., Flood Hazard Research Centre, Middlesex University, Tapsell, S.M., Flood Hazard Research Centre, Middlesex University, December 2000

Follow-up Study of the Health Effects of the 1998 Easter Flooding in Banbury and Kidlington (2000), Tapsell, S.M., Flood Hazard Research Centre, Middlesex University

The Health Effects of the Easter 1998 Flooding in Banbury and Kidlington (1998), Tapsell et al, Flood Hazard Research Centre, Middlesex University.

Flood warning codes

Flood warning codes: qualitative research, January2000, Spencer, D., Direct Dialogue

BMRB International, Flood Warning Dissemination: National Awareness, January 1999, Werrett, M, British Market Research Bureau.

Public awareness and communication

2000 Flood Awareness Campaign Evaluation: to evaluate the effectiveness of the 2000 campaign, British Market Research Bureau, December 2000

1999 Flood Awareness Campaign Evaluation: to evaluate the effectiveness of the 1999 campaign, British Market Research Bureau, December 1999

Floodline

Surveys with BT Syncordia Solutions on Public Attitudes to RMS, Internal Staff Surveys, Effectiveness of BT Operators all in 2000 and Public Response to the Floodline Service in 1999.

Annexe B

Flood Defence Emergency Response (FDER) Project Report 1999

Flood defence emergency response roles and responsibilities

The response to a major flooding incident involves a number of organisations working together at a local level, namely the Police, Fire Service, Local Authorities, Environment Agency and other bodies such as British Waterways, the Public Utility Companies, the Communications Media, voluntary organisations and the public.

Police

a) At a major flooding event, the police service is responsible for:
b) Co-ordinating the emergency services;
c) Assisting in the saving of life and protection of property
d) Where practicable establish cordons to facilitate the work of the other emergency services in the saving of life, the protection of the public and the care of survivors;
e) Oversee any criminal investigation
f) Facilitate inquiries carried out by the responsibilities accident investigation body
g) Process casualty information and have responsibility for identifying and arranging for the removal of the dead.
h) In the event of agreed procedures for warning and informing communities at risk not being effective, then, where practicable, assistance will be given.

Local Authority

In major flood situations, local authorities provide an immediate response in order to care for people affected. The precise nature and extent of the response will depend will depend upon available resources and local arrangements. Local authorities could provide the following:

a) Co-ordination of the local authority response and liaison with other organisations, including provision, if required, of a representative to support Police arrangements for co-ordination;
b) Emergency care including feeding, accommodation and welfare for those who have been evacuated from their homes of those affected by flooding but remaining in their homes;
c) Emergency transport for personnel, equipment, materials such as sandbags and, if necessary, evacuation;
d) Information services for liaison with the media on the local authority response and for information to the public, relatives of evacuees etc
e) Flood alleviation – for flood prevention, e.g. Clearance of blocked culverts, for dealing with flooded roads and diversions and may also include other assistance to the public, such as drying-out facilities, and issuing of sandbags;
f) Emergency environmental health advice for action relating to environmental problems caused by flooding
g) Joint agency co-ordination of non-life threatening floods and the recovery phase following a flooding incident;
h) Co-ordination of the voluntary response.

Fire Service

The Fire Service role in a major flooding event is as follows:

a) The saving of the life and rescuing trapped persons from fire, wreckage or debris;
b) The containment and extinguishing of fires and undertaking protective measures to prevent them;
c) To prevent, contain and make safe spillage or release of chemicals, radioactive materials or other hazardous substances;
d) To assist the Ambulance Service with casualty handling;
e) To assist the police with recovery of bodies;
f) The provision of monitoring procedures in respect of health and safety of those persons operating within an established *inner cordon;*
g) Carrying out essential damage control operations, such as pumping out flood water and salvage works – some fire services charge for such operations;
h) To assist other relevant agencies, particularly the local authority, to minimise the effects of major flooding on the community.

Environment Agency

The Environment Agency role in a major flooding event is as follows:

a) Issue flood warning;
b) Maintenance and operation of vital flood defences.
c) Monitors water levels and flows, assessing risk and advising the emergency services and local authority
d) Checks flood defences and undertakes essential repairs and maintenance as necessary, monitors and clears blockages of culverts, and breaches of defences
e) Advises the Police on the need to declare a major civil emergency
f) Supports the joint response by providing representatives to the various emergency control points
g) By local agreement, once it has ensured that its own systems and defences are secure, the Agency supports the police and local authority by providing materials, equipment and manpower, as far as its resources and other duties permit.

British Waterways

British Waterways role in a major flooding event is as follows:

a) Protecting its own structures, some of which are flooded defences;
b) On its own navigation system and along with other bodies helps to warn the public using navigation
c) British Waterways could also provide specialist equipment, materials and other resources as appropriate by local agreement.

Roles and responsibilities of other organisations

Public utility companies

Public utility companies will:
Secure their services and equipment to ensure continuity of supply;

a) Repair services disrupted by flood events;
b) Provide alternative means of supply during service disruption if life and health risks are identified;
c) Advise local authorities and the communications media when disrupted services will be reinstated.

The communications media

The communications media organisations will:

a) Disseminate flood warnings received from the Agency to agreed standards;
b) Disseminate updated information during a flood event;
c) Disseminate stand-down messages received from the Agency to agreed standards

The Ambulance Service (To be agreed by Ambulance Service professional body).

The primary areas of Ambulance Service responsibilities are summarised as follows:

a) To provide a focal point at the incident, through and Ambulance Control Point, for all NHS/medical resources;
b) The saving of life, in conjunction with other Emergency Services;
c) The treatment and care of those injured at the scene, either directly or in conjunction with medical personnel;
d) Either directly or in conjunction with medical personnel, determination of the priority evacuation needs of those injured;
e) Determining the main "Receiving" hospitals for the receipt of those injured;
f) Arranging and ensuring the most appropriate means of transport those injured to the "Receiving" hospitals;
g) Ensuring that adequate medical manpower and support equipment resources are available at the scene;
h) The provision of communications facilities for National Health service resources at the scene;
i) The restoration to normality at the earliest opportunity.

The general public

Members of the general public are advised to:

a) Make themselves aware of the action which they should take in the event of flooding if they live or work in an area covered by a flood warning services;
b) Avoid putting themselves at risk:
c) Move property, including motor vehicles, to higher ground upon receiving a flood warning;
d) Stay aware of developing condition by listening to local radio and/or listening to Floodline
e) Riparian owners and occupiers have particular responsibilities in respect of watercourses, and these are set out in the Environment Agency's publication "Living on the Edge".

Annexe C

Roles and responsibilities for flood defence

1. Policy and strategic direction

MAFF is responsible for flood and coastal defence policy in England and administers the legislation, which enables flood and coastal defence works to be carried out. MAFF contributes to the funding of capital defence measures, undertaken by the operating authorities, which meet established criteria. It also provides strategic guidance, supported by a research and development programme. MAFF liaises on cross border issues with the Welsh Office which has similar responsibilities in respect of Wales and with the Department of the Environment, Transport and Region (DETR) on a number of issues.

2. The operating authorities

2.2. **The Environment Agency** is a Non Departmental Public Body established by the Environment Act 1995. The Agency supervises all matters relating to flood defence in England and Wales and also carries out the largest programme of flood defence capital, maintenance and operational works performed on the coast and on designated "main rivers". The Agency is required to exercise most of its flood defence powers through statutory, executive Flood Defence Committees. These committees determine the programme of works; constituent local authorities, which have a majority of representatives on the committees, provide most of the funding through revenue support grant arrangements.

2.3. **Internal Drainage Boards (IDBs)** are statutory bodies created to manage land drainage in areas of special drainage need. There are 233 in England concentrated in East Anglia, Somerset, Yorkshire and Lincolnshire. Each IDB operates within a defined area in which they are empowered to undertake flood defence works other than on "main rivers". Reflecting their funding arrangements, IDBs comprise elected members representing ratepayers (largely farming interests) and those appointed by local authorities.

2.4. **Local authorities** have permissive powers to undertake flood defence works on watercourses which are not designated as "main rivers" and which are outside IDB districts; and to reduce the risk of flooding from the sea.

2.5. **The 88 maritime local authorities** (ie those which adjoin the sea) have powers to protect the land against coastal erosion or encroachment by the sea.

In addition to the works done by the operating authorities, a number of defences are privately owned and maintained. Companies such as Railtrack and those involved in power generation, own and maintain significant flood defence assets. Defences remain the responsibility of the riparian owner unless they are adopted by operating authorities.

3. Legislative arrangements

MAFF has policy responsibility for flood defence (which includes drainage) and coast protection in England. The Ministry administers relevant provisions in the following Acts:

i) The Coast Protection Act 1949, covering schemes to protect against coastal erosion of encroachment by the sea;
ii) The Environment Act 1995, the Water Resources Act 1991 and the Land Drainage Act 1991 covering flood defence matters including schemes to reduce the risks of flooding from rivers and the sea. (Both 1991 Acts were amended by the Environment Act 1995 and the Land Drainage Act 1991 was amended by the Land Drainage Act 1994.)

These Acts empower the designated operating authorities to undertake flood defence and coast protection measures. They provide the relevant authorities with powers to carry out flood defence and coast protection measures but do not require them to be carried out, or set any benchmarks as to standards of service. They also provide for Ministers to offer financial support to operating authorities for certain of these measures.

In carrying out their functions under this legislation, operating authorities and Ministers are, among other things, required to exercise their powers to further conservation and enhancement of natural beauty, and the conservation of flora, fauna, geological and geomorphological features of special interest, consistent with the purpose of any enactment's relating to their functions, and to have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological, architectural or historic interest. The Agency also has responsibilities in relation to water related recreation and inland fisheries must have regard to the effect that proposals would have on the economic and social well-being of local communities in rural areas.

The nature of works carried out

The flood and coastal defence programme involves the following types of works:

Long term capital projects

- Constructing flood warning systems;
- Building "hard" defences such as sea and river walls, tidal barriers etc;
- Building "soft" defences such as recharging beaches with sand or shingle;
- Providing infrastructure such as pumping stations

Maintenance

- Keeping capital works in good repair;
- Removing obstructions from river channels

Operations

- the operation of certain types of defences such as pumping stations and tidal barriers

Others

- Carrying out studies of risk so that work can be prioritised and a national strategy maintained;
- Research and development;
- Supervision of flood defence programmes;
- Administration of legislation

MAFF work closely with DETR on the environmental implications of flood and coastal defence policies and on planning issues.

Source: Agriculture Select Committee, Sixth Report, Flood and Coastal Defence, MAFF Memorandum of Evidence, Minutes 8 July 1998.

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ENVIRONMENT AGENCY

Autumn 2000 floods

Intense rainfall crossed much of England and Wales over a seven-week period during October and November 2000, causing the worst flooding since 1947 and in some places the worst ever recorded.

The floods presented many challenges to the Environment Agency and partner organisations and caused misery and distress to thousands of people caught up in the deluge.

- Some 700 locations were flooded, affecting more than 10,000 properties.
- Environment Agency staff worked round the clock during the crisis and some 2.5 million sandbags were used to protect vulnerable homes, businesses and river defences
- The floods could have been much worse but thanks to effective flood defences and warning systems, a further 280,000 homes and businesses were protected.

This report tells the story of the floods and the lessons the Environment Agency and its partners have learned as a result