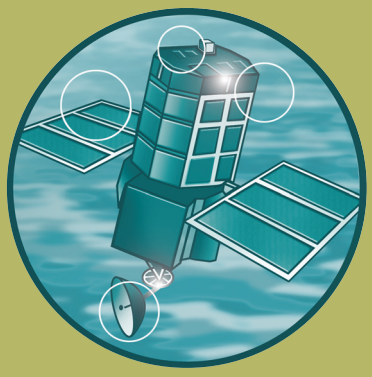
Joint Defra/EA Flood and Coastal Erosion Risk Management R&D Programme

# Post Event Appraisal – Report of Studies Monitoring, recording and analysing events

## R&D Project Record: FD2012/PR1



Environment Agency

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Department for Environment Food and Rural Affairs

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# Post Event Appraisal – Report of Studies Monitoring, recording and analysing events

R&D Project Record: FD2012/PR1

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**Statement of Use**
The project documents provide guidance to identify the need and scope for the development of a working “pilot” post event appraisal “system” to inform subsequent policy, strategy and decision-making processes, engineering design, managerial and operational procedures and performance evaluation. Primary responsibility for incorporating this into internal operations systems lies with the Environment Agency and, where appropriate, other operating authorities.

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## Abbreviations

| | |
|---|---|
| **BSI** | British Standards Institute |
| **CIRIA** | Construction Industry Research and Information Association |
| **Defra** | Department of Environment Food and Rural Affairs |
| **EA** | Environment Agency |
| **EFAG** | Easter Flood Action Group |
| **FAS** | Flood Alleviation Study |
| **FCDPAG** | Flood and Coastal Defence Project Appraisal Guidance |
| **FCDR&D** | Flood and Coastal Defence Research and Development |
| **FHRC** | Flood Hazard Research Centre |
| **GIS** | Geographical Information System |
| **GPS** | Global Positioning System |
| **HR** | Hydraulics Research |
| **ICE** | Institute of Civil Engineers |
| **IDB** | Internal Drainage Board |
| **JBA** | Jeremy Benn Associates |
| **LIDAR** | Light Intensity Detection and Ranging |
| **MAFF** | Ministry of Agriculture Fisheries and Food |
| **NCEDS** | National Centre for Environmental Data and Surveillance |
| **NFCDD** | National Flood and Coastal Defence Database |
| **NHS** | National Health Service |
| **NRA** | National Rivers Authority |
| **OS** | Ordnance Survey |
| **R&D** | Research and Development |
| **SAR** | Side Aperture Radar |
| **SEPA** | Scottish Environmental Protection Agency |

# 1. Introduction

## 1.1 Study objective

Defra commissioned this research project to examine the benefits, costs and use of post event appraisal, particularly in respect of its use to measure performance. Specifically it was required:

i. To examine the effectiveness of the monitoring and recording procedures currently employed by the Operating Authorities and the Department for Environment, Food and Rural Affairs (Defra) to collect data on events compared to best practice in other industries and the emergency services;

ii. To evaluate the usefulness of existing parameters being monitored compared to best practice in other industries and emergency services and by overseas flood management agencies;

iii. To examine how the current monitoring and recording procedures and experience in their use are used in post event appraisal to:

- Develop strategies and polices for flood and coastal defence;
- Improve managerial and operational practices and procedures;
- Review forward and emergency plans;
- Improve dissemination to and communications with the general public;
- Improve systems of monitoring and data collection in relationship to flooding and erosion events;
- Evaluate scheme (including flood warning, emergency response and maintenance regime) performances;
- Assess the achievement of national, corporate, regional and local targets;

iv. To prepare a best practice guide for recording event data in a consistent way for application throughout England and Wales.

Since Easter 1998, many areas of the UK have experienced notable flooding with some post event appraisal being undertaken. However, there is currently no fixed standard or procedure for the undertaking of these appraisals, for assessment of performance or for dealing with any findings. Furthermore, these activities are not consistent across the country. Whilst post event appraisal is not routinely carried out to a prescribed standard for lesser events, it is usual for Operating Authorities to collect information and to assess causes and effects of most flood and erosion events.

The Environment Agency's "Lessons Learned" (Environment Agency, 2001 (1)) report and the National Audit Office review report (Auditor General, 2001) both conclude that reviews should be undertaken to establish "best" working practices to gain benefit from the flooding experiences. The project brief commented that several recent reviews of the effectiveness of post event appraisal indicate that current approaches and techniques in the area of

monitoring and recording events and subsequent performance evaluation have been neglected in the past and remain rudimentary. This is, in the main, confirmed by this study.

The 1998 Report of the Advisory Committee on Flood and Coastal Research and Development (Penning-Rowsell, 1998) puts the concept of post event appraisal into context:

*"Once problems have been identified and their extent and severity gauged, the processes of appraisal and evaluation are then required to assess the impacts that floods and erosion will have on the communities and assets at risk, before seeking alternative solutions that will reduce these hazards and the economic impacts that they will bring. In addition, we need to assess, as part of that appraisal and evaluation process, the performance of measures taken in the past, so that our plans and schemes will be better in the future as a result of the lessons that we thereby learn."*

*"… the only way of measuring the effectiveness of decision making is by monitoring and evaluating outcomes (in the context of the driving forces that precipitate these outcomes) and assessing the performance of policies, plans and schemes against their original aims and objectives."*

The Defra Executive Summary of the Defra Strategy for Flood Management[1] describes monitoring as:

*"Monitoring, that is the checking on progress, condition or operation, is an essential element of any scheme of works or warning system. Monitoring during and after construction of a defence can ensure more effective management and implementation, and will be a key element of soft defence measures where continued effectiveness depends on the maintenance of certain standards."*

The project brief proposed that systematic and accurate monitoring and recording during flooding and erosion events, and the subsequent analysis of this data, would be essential if post event appraisal is, in future, to inform:

- Policy and strategic decision making
- Scheme design and engineering
- Scheme performance
- Operational procedures
- Flood forecasting and warning
- Emergency planning and response
- Flood inundation mapping

[1] http://www.defra.gov.uk/environ/fcd/pubs/stratsum.htm

# 2. Approach and methodology

## 2.1 Introduction

The project brief proposed two phases of study and development. Phase 1 (this commission) has two main components:

| | |
|---|---|
| Stage 1 | Review and assessment of present practice |
| Stage 2 | Development of a best practice guide based on current knowledge, experience and research for recording event data |

Phase 2 it was suggested would extend the project to develop detailed guidance or new methodologies in the form of:

- A working pilot post event appraisal system;
- A methodology to measure performance against national, regional and local targets for flood and coastal defence.

Phase 1 was required to examine the issues and make recommendations for a Phase 2 of further work based on current knowledge, experience and research. Recommendations are presented in Chapter 7.

## 2.2 Stage 1

This proceeded on two main concurrent fronts:

i. A questionnaire to practitioners in and users of post event monitoring and analysis, R&D Theme leaders, plus stakeholders in all other aspects of flood management or its consequences. In addition, the questionnaire was sent to eight overseas flood management agencies.

ii. A review of present practice and recent post flood reports based, in part, on the experiences of the project team. This also involved the identification and, where relevant, review of other recent and on-going projects and initiatives.

The Questionnaire (described fully in FD2012/PR2) was designed to establish:

- The extent of current monitoring, recording and appraisal;
- How any data and results are disseminated;
- Perceived and actual shortfalls in current practice;
- Requirements for additional data and analyses;
- Where ongoing research may address any shortfalls.

Where appropriate, follow up telephone interviews sought clarification and further information.

The list of consultees (FD2012/PR2) included representatives covering the full range of applications, all other R&D Theme Leaders and selected R&D project managers. This broad, but selected list of consultees, enabled canvassing of representatives of the full range of stakeholders and allowed any identified shortcomings to be matched with stakeholder group needs.

Post event appraisal embraces many activities of flood management[2], the scope of this project therefore extends from routine operational procedures, through structural and non-structural initiatives, to strategic and policy developments. The study has only been able to take a high level overview of flood management monitoring and recording procedures. Section 8 presents a bibliography of reports from which the project has drawn out issues and lessons.

The review has identified that a great deal of work, including research and development projects, has been completed, is underway or planned for developing relevant new procedures and systems. Examples include:-

- Agency Catalogue of Flood Data (properties flooded database);
- The National Flood and Coastal Defence Database to hold all data on flood and coastal defences;
- Risk, Performance and Uncertainty in Flood and Coastal Defence, including Performance Evaluation;
- Development by the Agency of a flood warning management system, incorporating a best practice baseline review, including how information was collected;
- The Flood Defence Emergency Response (FDER) project;
- Indicators of environmental change for flood and coastal defence;
- Assessing the national economic and financial losses of the Autumn 2000 floods;
- Agency NE Region Post Flood Data Collection Specification Project and Guidance Manual developed by Thames Region.

This study has made a conscious effort to draw upon the work of other Defra R&D projects and initiatives and acknowledges the contributions that these have made to the recommendations and conclusions. However, it is possible that not all relevant R&D has been identified. Although R&D Theme leaders were consulted, via the questionnaire, one declined to respond and one did not respond personally. In one case, the response did not report initiatives, already identified, which overlap with this project.

This project has also monitored Defra and Agency public web-sites, to identify those outputs that are published in the public domain.

[2] Flood management is used, throughout this project, in its broadest connotation and includes all aspects of flood and coastal defence.

## 2.3 High level indicator themes and headline topics

A review of recent post event reports revealed, as anticipated, that large amounts of data are collected to meet the needs of both the Operating Authorities, at all levels of their organisation, and to provide a high level overview to government, the public and professional partners. Reports such as that on the Autumn 2000 floods (Environment Agency, 2001 (1)) depend upon a great level of local detail in order to present a meaningful summary.

At its simplest the impacts on people of flooding or coastal erosion requires the identification of the individuals affected, of the numbers of homes and business premises, and may require following up at a later date to determine health effects. Some of this information is also needed to examine the social consequences and to investigate and develop structural solutions to alleviate the consequences of future events. This all needs to be distilled into a few key results.

This review, with the project team's experiences in appraising and recording the Easter and October 1998 and Autumn 2000 flood events, identified 5 high-level Indicator Themes:-

- Source monitoring and event magnitude
- Impacts on society and the environment
- Service delivery performance
- Performance of defences
- Strategy, policy and liaison

These Indicator Themes were expanded into sub-sets of Headline Topics (Table 2.1), which cross-cut the whole of flood and coastal defence activities, and include all the classes of information required for comprehensive and effective post event analysis of all the activities identified in the brief.

They will ensure coverage of those aspects of performance which need to be monitored to appraise performance, and provide feedback on:

- The causes, magnitude and extent of the event;
- The impact of the event on people and society;
- The performance of forecasting, warning and dissemination systems;
- The performance of flood defence assets (e.g. embankments, pumping stations etc.);
- Actions taken during the event to alleviate flooding or erosion impacts;
- Actions the Operating Authorities and others will take to alleviate problems in the future;
- Actions the public might take to alleviate problems during future events.

These data will also be capable of addressing the concerns of victims by providing answers to the following kinds of questions:

- Why have I been flooded / lost land to the sea?
- Was a warning issued, could it have been issued earlier?
- What was done to alleviate the impact of the flooding / storm?
- Whose responsibility is it to repair and protect?
- What will be done to prevent a reoccurrence?
- Will my property still be insured?

The Source - Pathway - Receptor - Consequences (S-P-R-C) model was advocated by both the ICE Presidential Commission (ICE, 2001) and in the Risk, Performance and Uncertainty in Flood and Coastal Defence report (Sayers *et al*, 2002) (see box following table 2.1). It is in the process of being adopted for flood management as a simple conceptual tool to understand the linkage between hazard and consequence and to promote consistent terminology and philosophy. Headline Topics are linked to the S-P-R-C model in Table 2.1 and classified by "output" and "outcome".

"Outputs" inform about the process of managing things and "outcomes" inform about what actually happened during an event. Information on "outputs" will lead to improved management of events and of the immediate response activities. Information on "outcomes" is required to guide the future management of flood and erosion risk and is an important input for strategic and policy decisions.

An early version of Table 2.1 was used as the basis of Questions 6 & 7 in the questionnaire (FD2012/PR2). Provision was made for respondents to propose additional data and appraisal topics. Only three items were added as a result of responses to the questionnaire; overall the responses did not identify any redundant topics.

The list of Headline Topics confirms that post event data and analyses embrace nearly all aspects of flood and coastal defence, including human, organisational and inter-agency liaison, as well as the many technical facets. The project brief also recognises the important contribution of these data and analyses to flood management.

There is a large potential interface with many other projects in the six Defra/EA R&D themes. A major challenge in drafting the Best Practice Guide has been to recognise the need to dovetail effectively with all these developments and existing reporting procedures (e.g. for Defra High Level Targets), avoid duplication and the introduction of unnecessary variations in methodologies. This will require further attention by Defra and Operating Authorities as a significant management challenge remains to co-ordinate these activities to avoid duplication of effort and data storage. It will also require further development in Phase 2 when a major proportion of the other ongoing initiatives have produced significant outputs.

Following further review of selected literature, information about on-going initiatives, and of the responses to the questionnaire, analysis, collation and reporting on the findings was used to prepare a review of current practices and initiatives and prepare the guide and recommendations.

## 2.4 Stage 2

Based on the conclusions of Stage 1, a high level draft best practice guide for recording post event data has been prepared; the draft was circulated for comment. The guide gives particular emphasis to those procedures recently developed, following the experiences in the 1998 and 2000 floods, and the need to integrate fully with ongoing R&D and other initiatives.

The Indicator Themes have been structured to give particular emphasis to the human dimensions of flooding and erosion events as these have been given considerably less attention in the past, when compared with studies of magnitude and extent and other technical aspects. However, we stress that all aspects need a more consistent and targeted approach to post event data collection and analysis.

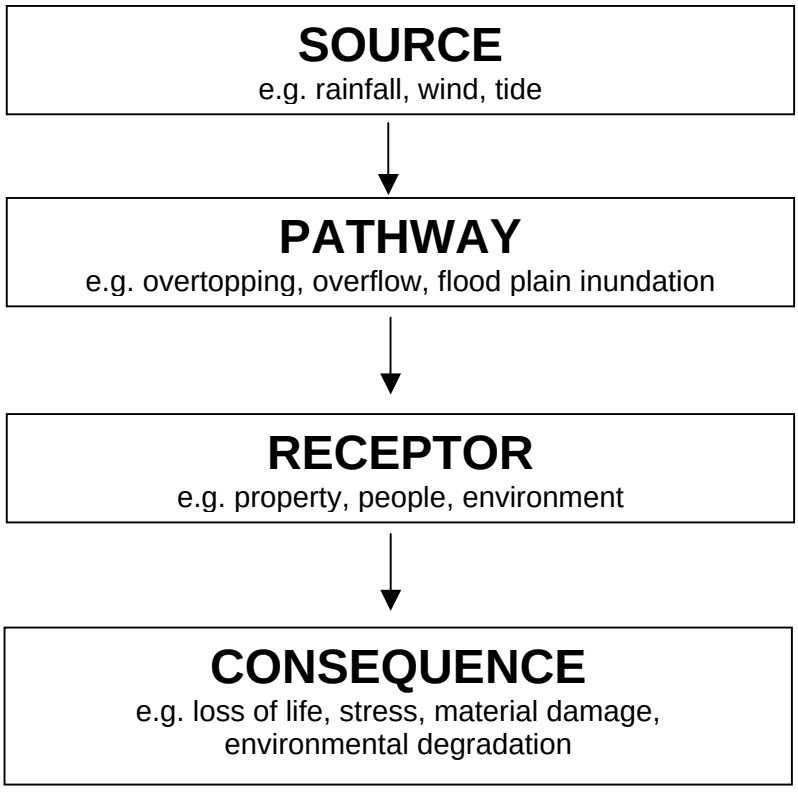
## Table 2.1 Indicator themes and headline topics (with Source-Pathway-Receptor-Consequence Outputs & Outcomes)

| Indicator themes | Headline topics | Source | Pathway | Receptor | Consequence |
|---|---|---|---|---|---|
| **1 Impacts on Society and the Environment** | 1.1 Human dimension (incl. vulnerable people / health / insurance / recovery and aftercare) | | | | Outcome |
| | 1.2 Evacuation (achieved and attempted) | | | | Outcome/output |
| | 1.3 Extent of areas inundated (including residual water) / locations eroded | | | Outcome | |
| | 1.4 Properties and businesses affected | | | | Outcome |
| | 1.5 Major infrastructure, archaeological and environmental assets affected | | | | Outcome |
| | 1.6 Financial and economic losses | | | | Outcome |
| | 1.7 Pollution threats and occurrences | | | | Outcome |
| **2 Service Delivery Performance** | 2.1 Weather forecasting performance | Output/ outcome | | | |
| | 2.2 Flood and tidal surge forecasting performance | Output/ outcome | | | |
| | 2.3 Systems (telemetry, AVM & Floodline) performance | Output/ outcome | | | |
| | 2.4 Receipt of flood warning / properties not warned | | | | Outcome |
| | 2.5 Property and assets protected | | | | Outcome |
| | 2.6 Incident & Emergency management / response | | | | Output/outcome |
| | 2.7 Resource availability / Resources used (costs) | | | | Output/outcome |
| | 2.8 Health and safety (employees) | | | | Outcome |
| **3 Performance of Defences** | 3.1 Performance of defences | | Outcome | | |
| | 3.2 Near misses (A-overtopping events; B–breach events; C-erosion events) | | Outcome (A & B) | Outcome (C) | |
| **4 Source Monitoring and Event Magnitude** | 4.1 Antecedent conditions & weather experienced | Outcome | | | |
| | 4.2 River flows & levels, groundwater levels & outflows experienced | Outcome | | | |
| | 4.3 Tidal events experienced | Outcome | | | |
| | 4.4 Sources and causes of flooding | Outcome | | Outcome | |
| | 4.5 Severity of flood / tidal event | Outcome | | | |
| | 4.6 Ground movements and erosion losses experienced | | | Outcome | |
| **5 Cross-cutting Strategy & Policy Issues** | 5.1 Media | | | | Outcome |
| | 5.2 Feedback from public, & MPs | | | | Outcome |
| | 5.3 Liaison & feedback from professional partners | Output/ outcome | Output/ outcome | Output/ outcome | Output/ outcome |
| | 5.4 Reporting mechanisms | Output | Output | Output | Output |
| | 5.5 Mitigation options and assessment | Output/ outcome | Output/ outcome | Output/ outcome | Output/ outcome |

**NOTES:**
1 OUTPUTS inform about the process of managing
2 OUTCOMES inform about what actually happened.

**SOURCE – PATHWAY-RECEPTOR-CONSEQUENCE MODEL**

To understand the linkage between hazard and consequence it is useful to consider the commonly adopted Source-Pathway-Receptor-Consequence (S-P-R-C) model (see diagram below). This is, essentially, a simple conceptual tool for representing systems and processes that lead to a particular consequence. For a risk to arise there must be hazard that consists of a 'source' or initiator event (i.e. high rainfall); a 'receptor' (e.g. cliff top or flood plain properties); and a pathway between the source and the receptor (i.e. flood routes including defences, overland flow or landslide). A hazard does not automatically lead to a harmful outcome, but identification of a hazard does mean that there is a possibility of harm occurring. Within such an analysis it must be recognised that there are likely to be multiple sources, pathways and receptors. Therefore, the methodology to determine the likelihood of a defined consequence occurring (i.e. material damage to property) must be capable of integrating several (possibly interacting) mechanisms and the linkage between the various sources, pathways and receptors. In this way risk analysis techniques can be used to compare and trade off minor, frequently occurring events, with more severe, rare occurrences, and can include beneficial impacts.




**Simple conceptual tool for representing systems – Source-Pathway-Receptor-Consequence**

Extract from: Sayers PB Gouldby BP, Simm JD, Meadowcroft I, Hall J, Risk Performance and Uncertainty in Flood and Coastal Defence. R&D Technical Report FD2302/TR1.

# 3. Results of questionnaire survey

## 3.1 Summary of findings

This chapter reproduces the main findings (Chapter 4 of FD2012/PR2) ***from the responses*** to the questionnaire survey. It should be noted that these sometimes differ from the analysis reported in Section 5. This suggests that respondents were not always fully aware of initiatives or information available on flood events. The main findings are that:

- Methods of collection or analysis are based on local practice. Where a "national" procedure has been established it is not widely used;
- Records are kept in a variety of formats and media and mostly there is poor exploitation of new technology. A number of initiatives will improve information gathering, storage and access. These include the NFCDD and the Flooded Properties Database, which is an interim short term “fix” to hold the data until it can be incorporated into NFCDD (Phase 3);
- Post event data collection and analysis is heavily weighted to technical interests. Little regard is given to the human and social dimension of flooding and erosion events;
- No information on the numerical assessment of the benefits of post event appraisal has been identified;
- Overseas practices are no further developed than in the UK.

The majority of respondents consider that there are great benefits in undertaking post event data collection exercises and appraisals. However, all of the benefits are described in quite general terms. No information on the numerical assessment of the benefits of post event appraisal has been identified. The benefits include:

- Learning from experience, greater understanding of the causes of flood events and the identification of flood risk areas;
- Processing of the data creates a historic record of the event allowing comparison with other events and the predicted performance of schemes;
- Storage of the data and appraisal mean that long-term trends can be assessed and provides information to justify future decision-making.

FD2012/PR2 provides a full analysis of the responses.

## 3.2 Effectiveness of monitoring and recording procedures

Post event monitoring and recording procedures are most effective for the following data topics:

- River flows and levels experienced
- Weather experienced

- Areas inundated

Data are also often collected for the following data topics:

- Locations and numbers of properties/ businesses affected
- Causes and sources of flooding
- Major infrastructure and utilities flooded/ disrupted
- Costs

However this information is not comprehensive and often incomplete.

The monitoring and recording procedures do not pay enough attention to the human impact of flooding, communications with the public and emergency planning issues. Improvements in the effectiveness of these procedures could be made by:

- Improved feedback mechanisms from the public (incorporating quality control);
- The identification of stakeholders who are questioned following events;
- Better provision of advice to emergency planners before, during and after an event;
- The sharing of information between Operating Authorities.

Although appraisals and data collection exercises are widely undertaken there is no consistent approach to this issue. The Environment Agency recognised that there was a need for a National Standard to improve the effectiveness of post event monitoring and recording procedures. Thames Region, as the lead for this topic in the Action Plan following the Easter 1998 floods, produced a national specification for data collection exercises but it would appear that this is not widely used. One explanation is that the guidance required development into local contexts.

Any National Standard should not be static because after each event lessons will be learnt, good practice should be shared and post flood action plans updated. The benefits of such an approach would be:

- The sharing of good practice nationally;
- A wider understanding of the issues;
- More effective targeting of resources;
- Systematic post-flood actions plans that have been agreed by all relevant agencies;
- More effective use of data collected;
- Improved forecasting and focus on flood risk areas.

The effectiveness of data collection procedures could be improved by the use of modern technology during surveys and the processing of data. The use of hand held GPS systems linked to palm top computers would improve the efficiency of

data collection during walkover surveys. Having collected the data there is a need to develop techniques to automate the processing of field data into floodplain maps and other deliverables such as databases.

## 3.3 Usefulness of existing parameters monitored

A variety of information across most topic areas, particularly those relating to hydrological and hydraulic factors, is collected although some of this may not be gathered in a formal manner. The information gained from such exercises may be disseminated among organisations within similar categories of responsibility. However the data are not generally distributed more widely. Data are also not held centrally allowing easy access to information. Consequently the usefulness of the data is devalued.

The respondents require, to a greater or lesser extent, all of the data topics identified at the outset of the project. The most needed topics varied according to the category of respondent. Overall the following topics were judged to be most important. The topics have been grouped according to the number of respondents who reported collecting such data even though they may be incomplete.

| **Frequency of data collection** | **Data collected** |
|---|---|
| Data most often collected | Weather experienced<br>Causes and sources of flooding<br>Gauged flows and levels<br>Areas inundated<br>Locations and numbers of properties & businesses flooded<br>Major infrastructure and utilities flooded / disrupted<br>Public feedback<br>Costs |
| Data sometimes collected | Flood warnings delivered[3]<br>Near misses<br>Asset inspection<br>Emergency response<br>Telemetry performance<br>Flood forecasting performance<br>Properties flooded – not warned<br>River flows and levels experienced |
| Data least often collected | Health impacts (affected population)<br>Vulnerable people<br>Aftercare provisions<br>Evacuation (success/refusals/problems)<br>Self-help actions<br>Performance of defences compared with design standard |

[3] Contrary to the responses made in the questionnaire, these data are collected as it forms the basis of the HLT 3 report to Defra

In order to gain the most from a post event data appraisal it was recognised that the data needs should be more closely defined. This would depend on the type of appraisal being undertaken and would change with location. Such issues should be planned for prior to an event. Some respondents reported having plans in place for undertaking post event exercises. However these plans may not have been applied and if so are thought to be in need of some improvement.

Particular data needs include:

- Specific water levels collected at locations so one event can be compared with another. This implies pre-event planning of what data should be collected and how appraisals should be undertaken;
- Data on extreme event sensitivity;
- More comprehensive monitoring and improved data analysis techniques;
- Effectiveness of flood warnings to confirm that current policy and strategic directions are optimum (e.g. warnings issued/ warnings received/ response to warnings/ what flooded);
- Water levels, flows, timing, locations, flow gauging, inundation limits and the rate of rise of flood water;
- Flood paths, speed of currents and depth during flooding (important for emergency planning);
- Operation and performance of flood defence structures (e.g. pumping stations, flood gates, overtopping of embankments). Specific information on relevant design parameters and monitoring of performance during more extreme loading conditions;
- The extension of data collection to ordinary watercourses.

There is little data gathered in relation to the impact of events on victims and the performance of emergency procedures. Consequently, post event appraisal does not pay enough attention to the human impact of flooding, communications with the public and emergency planning issues. These issues are of particular importance to elected representatives and the emergency services and, if addressed, would help improve dissemination to and communications with the general public.

Questions which need to be answered, include:

i. How well prepared were the public for the event?
ii. How well did the emergency services and Operating Authorities communicate with the public during the event?
iii. How could communications and emergency response be improved during future events?

Respondents perceived that more effective appraisal methods could lead to improvement in:

- “Better provision of advice to the public before, during and after an event”;
- “Provision of information the public can understand”;

- “Post event communications with flood warning recipients to assess level of the flood warning service”;
- “Feedback to the public concerning successful events”;
- “The integrated emergency management group should meet on a regional basis to discuss all aspects of contingency planning, including flood management”;
- “Local authority emergency plans give information on what people should do during an event but lack information on flood extent, flood depth, rate of rise”;
- “Detailed planning of emergency response, evacuation etc”;
- “A better understanding of risk and the impact of complacency by those at risk”.

The data storage and manipulation of information could be improved by the use of GIS and database systems. At the moment much data from post event exercises is only stored in paper format though it is apparent there are moves to address this issue. The Environment Agency is in the process of developing the NFCDD.

## 3.4 How current monitoring and recording procedures are used in post event appraisal

Almost all the respondents considered undertaking post event data collection exercises to be worthwhile. The data collected during exercises are used within post event appraisals to guide decision making across a wide scope.

In general terms, data collection exercises enable organisations to learn from experience and gain a greater understanding of the causes and impacts of events. Processing of the data allows easy access to information from the event, creates a permanent record that can be compared with previous events and with the predicted performance of schemes. Storage of the data and appraisal mean that long-term trends can be identified and provides information to justify future decision making and planning.

**Policy and strategic decision-making**

At the policy/strategic level data collection and post event appraisal is used to:

- Increase the general understanding of the natural process and catchment dynamics;
- Identify the flood risk area;
- Quantify the risk of events;
- Determine long term trends and assess the impact of climate change;
- Provide indicators for change;
- Justify expenditure and improve budget preparation;
- Allow a measured response to events.

**Improve managerial and operational practices and procedures**

For Operating Authorities, data collected during post event exercises are considered vital to improve management of flood and coastal defences. The data are used in the appraisal process to:

- Learn lessons in order to guide planning for future events;
- Allow the strengths and weaknesses of defences to be assessed;
- Identify the causes of flooding and erosion events;
- Create a permanent record of the event, preventing reliance on hearsay.

**Review forward and emergency plans**

Post event appraisals of emergency responses and long-term recovery are less common than appraisals of the weather and flooding experienced. However, where they are undertaken they allow:

- The development of action plans for future events;
- The prioritisation of competing demands during events;
- The development of best practice in response to an emergency.

**Improve dissemination to and communications with the general public**

Nearly half of the respondents collect data concerning public feedback. However, few reported the successful dissemination of information back to the general public. This is probably due to the manner in which data are processed and collated.

**Evolve systems of monitoring and data collection in relationship to flooding and erosion events**

Recent post event data collection exercises have identified several areas in which the conduct of future studies can be improved. It is anticipated that future post project reviews will evolve improved methods of data collection. Particular areas that have been identified include:

- ***Pre-event planning.*** Preparation of a clearly defined specification, (when should data be collected, who should collect data, format of data, equipment), staff training, prioritisation of data collection issues;
- ***Event organisation.*** Preserve continuity from previous events, maximising the data collection opportunities during initial site visits, liaison between the Agency and surveyors during an event, de-briefing of surveyors;
- ***Post event processing.*** Quality assurance of data, definition of deliverables and associated formats, dynamic feedback.

**Evaluate scheme performances**

Post event data collection exercises enable scheme performance to be assessed under extreme conditions. Such data are used to:

- Check the actual response of a scheme compared with that predicted and the scheme design;
- Determine the causes of flooding and erosion events;
- Drive performance review evaluation;
- Assess expenditure for maintenance of schemes;
- Determine budgets for future schemes.

**Assess the achievement of national, corporate, regional and local targets**

The questionnaire responses indicate that few targets are set for post event appraisals. Where targets are set they relate to a limited field of activities:

- Flood warning and dissemination performance;
- Frequency of inspection for defences in accordance with Defra guidance.

# 4. Recent and current initiatives

## 4.1 Introduction

The project has identified a large number of initiatives which, when fully developed and implemented, will support and improve post event data collection and analysis activities.

In the main, it would appear that post event analysis is regarded as a "one-off" activity and not a part of the continuum of providing feedback on past performance, nor is it seen as an integrated element of the FCD R&D programme. Many potential cross-links with post event analysis were often poorly appreciated. One respondent even said this project was irrelevant to his work, which was concerned with learning the lessons of managing flood emergency works! Another commented that he did not feel qualified to complete the form, but further investigation identified that his research required improved data on flows and extent of flooding.

The wide scope of this project could imply consideration of virtually all activities and current developments (except organisation and management structures) in flood management in England and Wales. This chapter focuses on those of greatest significance for improving post event analysis, including recent appraisals from which lessons can be drawn for future practice.

## 4.2 Independent review of the Easter 1998 Floods (Environment Agency, September 1998)

This was commissioned by the Agency's Board to provide an independent assessment of the performance of the Agency. The review led to a published Action Plan (Environment Agency, Nov. 1998) supported by an internal action plan of 90 individual initiatives. The changes implemented led, *inter-alia*, to a complete revision of delivery of flood warnings, to organisational changes in the Agency's flood defence activities and a clearer definition of targets and priorities.

Without the developments following Easter 1998, it is unlikely that the Agency and its professional partners would have been able to provide the improved flood warning service and to respond as effectively to the Autumn 2000 floods.

## 4.3 Lessons learned: Autumn 2000 floods (Environment Agency, 2001 (1))

The Agency produced its report in response to a request from the Minister for Fisheries and the Countryside. The report embraces all aspects of the flooding and is not restricted to the main river responsibilities of the Agency. Its coverage of the issues raised by the event, which builds on the Independent Review of Easter 1998 and subsequent developments, extends beyond technical aspects.

It provides a comprehensive overview of a major flood event in a succinct document. A similar high-level overview of earlier events, if available, would have required the examination of many separate reports. Responses to the questionnaire identified only a few topics in addition to those underpinning the report. The Lessons learned report, therefore, offers through its scope, a good model for a strategic level post event report, though presentation could vary. This in turn leads to specification for the more detailed supporting data. The report covers a wide range of topics - see box.

**Contents of Lessons learned: Autumn 2000 floods report**

***Impact of the floods:***
Impact on society, Evacuation of people, Impact on people, Disruption to business, Disruption to infrastructure
***How the floods developed:***
Rainfall, River levels
***How the floods were managed:***
Flood forecasting, Delivery of flood warnings, Incident management, Public awareness, Communications during the floods, Views of professional partners
***Performance of defences***:
Protected properties, Near misses, Emergency actions, Condition of defences, Sandbags
***Policy and strategy:***
Development in the flood plain, Dealing with uncertainty of climate change, Insurance industry, Vulnerable people, Project appraisal process
***Funding:***
Investment needs, Emergency response costs, Additional funding, Levies
***Recommendations and actions***

The main report is supported by 8 regional reports providing greater detail on the impacts, causes and on event management and response activities. The regional reports were commissioned, in part, to provide data that could be easily collated to present an overall national picture. In reality an identical request for data resulted in variations in content or format, which hindered compilation of the national overview. Nevertheless the Lessons learned report provided a comprehensive overview for England and Wales in a form which would have been extremely difficult to produce following the Easter 1998 and earlier major floods. The chapter titles for a typical regional report (Environment Agency, 2001 (2)) are:

Executive Summary
Event Management
Flood Forecasting
Flood Warning
Event Impact
Emergency Response
Public Relations
Incident Specific

Appendices tabulate (*inter alia*) emergency response and repair costs, histories of flooding, views of professional partners, public response, development in the flood plain and organisational issues.

## 4.4 Autumn 2000 floods in England and Wales: assessment of national economic and financial losses (Penning-Rowsell *et al*., 2002)

The report takes a strategic approach to high-level assessments of flood damages and losses. It was considerably helped by the catalogue of flood incidents produced by the Environment Agency, described as an invaluable database. The authors stress the growing significance to policy making of people factors, such as disruption to people's lives, loss of health status, and loss of treasured possessions.

The report examines:

- Property damages
- Emergency Services and related losses
- Effects on transport
- Agricultural Sector
- Health and other effects

It concludes with a series of conclusions and policy implications. Pertinent findings, with which we concur, that impact on post event appraisal include:

- Post event surveys are needed to establish a better understanding of mitigating action taken as a result of being warned;
- The authors were unable to find any secondary source of data on the health effects of the autumn flooding. A Public Health Laboratory Service study of Lewes was identified. It has not yet been published (CDR Weekly News 3, 2003).
- The numbers of dispersed locations experiencing flooding, which may be the result of a variety of causes from a variety of sources has policy implications.
- The high incidence of road traffic disruption affecting over 5 million people.

- There is *"no systematic effort to record the impact of floods on the people affected…. This needs to be reviewed urgently."*
- *"The Agency should design and implement a standing arrangement whereby the full impacts of floods are recorded in a systematic national database, as a basis for (a) local post-flood recovery assistance, and (b) future national and regional policy making."*

## 4.5 Overview of data management issues in flood and coastal defence (Fox and Cooper, 2001)

The reports document the systems in place to collect data and process information within the Environment Agency, other governmental bodies and the public sector to improve understanding of, and to support the development of the R&D into, data and information management.

The report provides an overview of:

- Data currently held
- Current format, usability and interoperability of data
- Data quality and documentation (metadata)
- Data capture and storage methods

Its main outputs are:

- Short report detailing study findings
- Data map showing key Agency data sources
- Key contact details
- List of external data sources

The study found that:

*"Currently, within the Agency, there are varying levels of good practice in terms of data management. Some data is poorly managed with no ownership and no accountability for data quality, whereas other data is well managed with ownership and is quality assured. Several multi-functional data management teams having been set up in some regions."*

*"There are also several current data management initiatives within the Agency being undertaken across many functions. Although these initiatives are meeting the problems of data management in a well formulated manner, there still seems to be a lack of co-ordination between all functions nationally."*

*"It is recognised that Local Authorities also hold vast amounts of data. Many different systems are in place within the different authorities for managing and coordinating their approach to data. Many authorities have designated data teams and officers whose sole responsibility is the management and control of data."*

We concur with the comment on a lack of co-ordination, which also extends to R&D activities which impinge on data collection and management where these are addressed in different R&D themes.

## 4.6 National flood and coastal defence database (NFCDD)

In our opinion the NFCDD is the single most important development, in progress, with the potential to facilitate improved post event analysis.

The aim[4] of the NFCDD project is **to provide a single easily accessible and definitive store for all data on flood and coastal defences, available to all Operating Authorities**, to allow them to make better-informed decisions on defence needs and measures. The area covered by the project is all of England and Wales.

Fundamental to its success will be good quality data, and to allow meaningful comparisons it will be important to have common standards and formats. Its design also recognises that procedures for input, analysis and reporting must be as straightforward as possible and involve minimum effort to ensure the database is appropriate for users' needs.

The NFCDD key functionality is described as follows (Linford *et al*., 2002):

- "store information on the location, composition and condition of flood and coastal defences;
- store information on asset inspections, including photographs;
- provide a standardised data set for assets from all Operating Authorities and a single repository for that data;
- allow users to create flood risk areas (although the process for defining these has yet to be determined);
- store the Indicative Floodplain Maps;
- store information on historic or modelled flood events;
- store information on Flood Warning Areas;
- allow users to import other (i.e. non-NFCDD) data, such as OS map backgrounds or land use data;
- provide a means of calculating flood risk (the exact method has yet to be confirmed);
- provide a means of supporting a risk-based approach to inspection frequencies;
- store the results of external justification and prioritisation;
- allow users to import, view and export their Medium and Long Term Plans;
- provide GIS tools to allow the analysis and manipulation of the various data sets held on the database, and to allow the results to be presented in map-based form;

[4] Defra website – http://www.defra.gov.uk/environ/fcd.hltarget/nfcdd.htm

- provide tools to allow reporting on information related to various areas, specifically Local Authority boundaries, IDB boundaries, Agency Committee and Area boundaries, and *ad hoc* as required;
- allow users in the local authorities or drainage boards to enter data for their area, and to view and query it in conjunction with other data;
- have data input configured such that it may be used on hardware in the field or provided to consultants working on behalf of the Agency and other Operating Authorities."

We see the "data warehouse" concept, inherent in NFCDD, offering a home for the vast majority, possibly all, post event data and the results of its subsequent analysis, with access for all legitimate users wherever they are based. The NFCDD has the potential, if expanded, and which we recommend should be examined, to service the needs of all users and cover potential applications. However, as it is a long-term project it will be many years before it is fully developed even as currently planned.

## 4.7 Catalogue of flood data (properties flooded database)

Following the Autumn 2000 floods, the Agency has developed an Access® database holding data on flood events. This includes:

Location
Date of event
Local cause of flooding
Source of flooding (including designation of watercourse)
Numbers of properties flooded
Severity of event (blank in all examples examined)
Lead authority
Status of investigation and summary of decisions made on solutions

The database is a development from a compilation of information on flooded properties collected as part of the Agency's review of the Autumn 2000 floods. It is an example of a worthwhile development, but one that appears to have been carried out, at least initially, for a specific purpose, without full recognition of the potential to interface with other initiatives. We are advised that this database was intended as an interim solution and will be superseded by inclusion in Phase 3 of NFCDD. Its scope should be reviewed in the light of the findings of this project and we support its incorporation within NFCDD.

## 4.8 Environment Agency management system

The system is designed to specify the way Agency staff work through a process management approach and so ensure a consistent response by staff across the broad range of the Agency activities. It comprises a series of documents that

define the way staff should do particular tasks and then make clear the actions they have to take.

To date it has concentrated on the inspection and maintenance of FCD assets and little work has been done on Emergency Response and Emergency Management; these may be examined in 2003. Consequently there is currently no guidance in relation to post event data collection and appraisals at a national level apart from that produced by Thames Region. Although the Agency's Head Office reported that this is being applied in all the regions of the Agency, we found only limited evidence of its use.

The Agency is also initiating a project on Incident Management. This is going to study how the Agency responds to major national emergencies like the November 2000 floods and Foot and Mouth Disease. The project will include a study of the resourcing of the Agency's response to major events including the role of the emergency workforce. This will study and research the Agency's operational and media responses.

## 4.9 R&D - Risk evaluation and understanding of uncertainty theme

Current research under the theme is designed to promote the uptake of risk based techniques within the FCD community. A number of projects have potential interactions with post event appraisal. Many of their objectives recognise and reinforce issues identified in this review. Others, in particular data issues, offer opportunities for collaboration if duplication is to be avoided. Key features that influence or interact with post event appraisal are identified below.

### Risk and Uncertainty Review

A review report (Sayers *et al*., 2002) provides comprehensive terminology, tools and approaches to risk assessment and decision-making. It also presents a glossary to encourage consistent use of terminology and a high-level framework for addressing performance and risk issues. The following issues are reviewed:

- Principles of risk, performance and uncertainty;
- Issues surrounding flood and erosion management from a risk and performance perspective;
- The application of risk, performance and uncertainty principles in decision making practice;
- The need to move towards a more integrated risk-based decision-making framework;
- The risk tools and techniques that may help the flood and coastal defence community achieve best value and demonstrate areas of success and failure.

**Data and Information**

Concerted Action will identify data and information needs and sources for FCD, to develop R&D in monitoring, data management and the development and application of new techniques. Specific objectives, which interact with this project are to:

- Encourage co-operative effort;
- Improve data accessibility;
- Identify data needs;
- Develop and encourage application of new technology and techniques.

**Concerted Action – Performance Evaluation**

Objectives are to develop definitions, framework and guidance for performance evaluation. The project will identify data needed for performance evaluation. The methodology embraces all aspects of FCD from policy through schemes to operations and mirrors the scope of this project.

**Environmental change indicators for flood and coastal defence**

The project will, wherever possible, draw upon historical records to allow short-term conclusions to be drawn. Flood and coastal events will potentially provide new data and the needs of the project should be recognised in post event data collection programmes.

## 4.10 Project appraisal guidance - performance evaluation

Defra will be publishing in 2004 a final volume on Performance Evaluation (FCDPAG6) in its series of Flood and Coastal Defence Project Appraisal Guidance. This will establish principles and promote best practice in performance evaluation. Simm *et al.*. (2002) present concepts and definitions upon which FCDPAG6 will be based.

The paper describes performance evaluation as a special case of ongoing risk monitoring, an essential aspect of the risk management process. It emphasises that the concept of performance is hierarchical and is applicable at all levels - from policies, plans and strategies to schemes and operations. Performance evaluation, is reported to be important for Flood and Coastal Defence, in order to:

- Audit investment efficiency and demonstrate achievement of best value;
- Provide insights for effective future monitoring and management;
- Identify lessons for future practice on similar projects elsewhere.

Performance is influenced by both the human system which organises and delivers flood and coastal defence and the natural system of loadings and responses.

The authors comment that *"….it is judged that there has been a failure to collect and analyse data in a sufficiently systematic, comprehensive and consistent way to enable all of the following to be carried out:*

- Assess the performance of policies, plans and schemes against their original aims and objectives,
- Provide insights for effective future monitoring and management of the system being evaluated.
- Identify lessons for future practice in similar situations."

The paper also identifies a number of data issues:

- Lack of long-term structured monitoring of hydraulic loading, including meteorology, tidal levels, wave data, and ecology;
- Lack of long-term monitoring of response of defences to hydraulic loading including beach levels, settlement of defences such as embankments, incidence of wall overtopping/flooding;
- Lack of guidance on monitoring loading and response during extreme events;
- Lack of data on land-use changes (e.g. farming practice changes, property development) and consequences for the benefits for flood and coastal defence;
- To avoid loss of information, it should be a requirement to submit to Defra, with the grant application, summary forms scheduling out the key data that will be needed for subsequent evaluation.

The NW region of the NRA initiated a similar requirement (Bullen Consultants, 1995) to ensure appropriate hydrometric data was collected after completion of a scheme, but the practice has not been maintained.

Specific data requirements, which are identified within the scope of this study, include:

**Asset performance data**
Loadings, e.g. water levels, flows, wave conditions, etc.
Morphological changes (global and local scour, etc.)
Asset structural response (e.g. movement, settlement, cracking, abrasion, corrosion)
Habitat (response) data
Safety incident data
Public perception (survey) data

**Flood forecasting and warning data**
Accuracy of predictions
Public response surveys

The authors comment that past projects to learn lessons and provide guidance

on improving practice have *"required considerable effort to collate the experience and data",* a comment repeated by other consultees.

The paper suggests that *"if performance evaluation were carried out in a consistent manner, it should be possible both to gain this data in a more straightforward way and to obtain more comprehensive data. The vision should be for an appropriate performance database, which could be accessible to all through the Internet."*

These comments reinforce the conclusions of this project in respect of both its findings and recommendations. Consequently, we also strongly recommend that the summary forms proposed for inclusion in submissions to Defra should clearly define the data that is required from post event monitoring.

## 4.11 Maximising the use and exchange of coastal data

The report (Millard and Sayers, 2000) comprising EA R&D Technical Report W219, sets out and elaborates on a series of five principles for data management, based on BSI (Mayon-White and Dyer, 1997) recommendations, to improve access to and the utility of coastal data for all potential users. A major conclusion, with which we concur, is that Operating Authorities, and others requiring coastal zone data, and who face difficulties in obtaining data do so not because the data does not exist, but because it is inaccessible, difficult to locate, of unknown quality or in an inappropriate format. The report states that increased data sharing leads to a greater level of data integration and hence more meaningful analysis and improved information and also results in reduced duplication of effort and cost savings. It also points out that the information needs of different users may be met from common sources of data. We consider that this is equally valid for post event analysis.

The authors identify a number of benefits from maximising data exchange and reuse; these in modified form are also applicable to post event analysis:

- Reduced duplication in the collection of data
- Cost-sharing / reduction
- Improved relationships between users and suppliers
- Improved analysis and understanding
- Better decision-making

The issues discussed by this report, together with the mechanisms and principles developed, are highly pertinent to the data management problems that need to be addressed to ensure maximum use and exchange of post event data.

In addition, the report identifies customers and suppliers of coastal data, together with data types relevant to post event appraisal.

## 4.12 Strategic monitoring survey of southern English coastline

Three coastal groups are planning a strategic monitoring survey of the coastline from the North Kent coast to Portland Bill. If funding is approved by Defra, the project would initially last for five years. Data will be collected to a standard specification and will be held in a central location. The survey has been designed on a risk assessment basis so that there is a higher density of data collected at some sites compared to others. It is anticipated that the following data will be collected:

- Aerial survey with photogrammetric profiling (annual survey);
- LIDAR survey of certain areas, low lying land and soft cliffs (3-yearly survey)
- Beach profiling surveys;
- Hydrographic surveys (5-yearly survey);
- Installation of wave rider buoys and tide gauges.

The study allows for post event surveys in the form of post storm profiles. Contractual arrangements will be in place to allow the deployment of surveyors at short notice to undertake surveys for extreme events.

These arrangements offer, in our opinion, a model protocol for routine (pre-event) monitoring and for data collection during and after erosion events.

## 4.13 Flood warning management system

The R&D project, recently started, will develop a management system to record and present real-time flood forecasting and warning information to facilitate decision-making and to provide post event performance data. The current phase of the project, the Scoping Study, is to identify the extent of the work required to carry out the full project to develop and test a prototype flood warning management system. There are 3 phases:

Phase 1 - Scoping Study and definition of business requirements
Phase 2 - Definition of a system requirement and a pilot project
Phase 3 - Final delivery stage

Initial enquiries revealed that the project team was unaware of this post event analysis project, but quickly appreciated the possibility of overlap. Their Phase 1 includes a best practice study whose results were published (Mott MacDonald, 2002) during this later stages of this project. The report notes that there is no effective national standard for post-event reporting on flood forecasting and warning. It therefore identifies the need for:

*“Data from all events to be stored to a nationally agreed format so that it may be easily retrieved, manipulated and presented.”*

Flood event data recording is reported as an identified R&D topic (Project T16) but not yet included in the R&D programme. Data format will be included in the specification for the Flood Warning Management System.

## 4.14 Field collection of flood event data

A guidance manual, prepared by Thames Region as a component of the Agency's Easter Floods Action Plan, was issued in October 2000 for *"voluntary use by Regions depending upon resources available"*. An updated version for local use in the Thames South East Area, was issued in October 2001. No evidence of its implementation in other parts of the Agency was reported. The guidance is in three parts:

i. The main text containing background information, suggested procedures, data to collect and examples of best practice;
ii. Three "compulsory" appendices containing the minimum data requirements for operating a data collection system:
    - Data collection requirements check list (reproduced in modified form in FD2012/TR)
    - Sample data collection sheet
    - Communication log sheet;
iii Eight "optional" appendices covering operational aspects such as lone worker procedures, useful telephone numbers, priority data collection locations, and external sources of resources (e.g. helicopters and light aircraft).

The manual is primarily concerned with data collection procedures and importantly recognises the health and safety requirements of collecting data in flood situations. The data collection requirements are described as comprehensive, but limited to flood events (primarily fluvial) and would not satisfy all the requirements of the headline topics in Table 2.1.

## 4.15 Flood data collection – Eire

The Office of Public Works is preparing a brochure to help government and local authority staff, who would not necessarily be familiar with flooding and related issues, optimise data collection during and after a flood. It also plans to set up a central database of this information and that for past events. Priority items are:

- Flood levels
- Flood extent
- Flood mechanism
- Time and duration of flooding

## 4.16 Floodplain management manual

The aim of the research, undertaken by HR Wallingford, is to adapt an Australian Floodplain Management Manual for the UK. A draft report produced in May 2002 provides guidance to planners on how to account for floodplains and produce Floodplain Management and Emergency Plans. In this respect the guidance has a broader scope than PPG25. Floodplain and Emergency Plans will have a similar scope to Catchment Management and Shoreline Management Plans as they will cover social, environmental and engineering issues.

## 4.17 Aerial photography and surveys

As part of the Agency's Easter Floods Action Plan consideration was given to arrangements for carrying out aerial photography and surveys. For surveys, Action M.10 required the establishment of consultancy arrangements for post-event surveys. A modified Action A1.38 established regional contacts for aerial photography of flood events. Appendix 2 of the A1.38 report (Environment Agency, 1999) lists available technologies and suppliers, which includes non-photographic remote sensing techniques.

Presentations to a Flood Event Recording Seminar[5] provide an updated overview on techniques plus a briefing on the field collection manual (5.14). The presentations identified:

i. The limitations of satellites due to the timing of over-flights, which for some locations in 2000 would have been several days after the flood peak;
ii. Flood event recording templates are held by survey companies on a national list of assessed surveyors.

A post project review (JBA Consulting, 2001) was carried out to learn lessons from the data collection exercise in Dales Area. It concluded that prior to any future flood event there were several issues that should be addressed with regard to planning a post flood data collection exercise. These included:

***Pre-event planning***
Contractual arrangements
Ready prepared paperwork
Preparation of a clearly defined specification
Prioritisation of data collection issues
Staff training
Equipment specification

***Event Organisation***
Establishment of single points of contact
Organisation of a crisis meeting at the project inception
Preserve continuity from previous events

[5] Flood Event Recording Seminar, Environment Agency, Solihull 16 October 2001

Maximise data collection opportunities during initial site visits
Liaison between the Agency and surveyors during the event
De-briefing of surveyors

***Post Event Processing***
Field data in consistent formats
Hand held GPS useful
QA standard methods required
Data deliverables must be pre-defined

This work has now been developed further as part of the Agency's North East Region Post Flood Data Collection Specification project and also offers a local North East context missing from the original guidance prepared by Thames Region. The NE project is described in Section 5.18. NE Region have also developed a specification and procedure for the procurement of aerial photography and video applied to an associated regional contract.

## 4.18 North east region post flood data collection specification

A specification for post flood data collection is currently being developed in the Environment Agency's North East Region. This is a two part approach, featuring a generic specification and a set of catchment specifications.
The generic part includes the following elements:

- Identification of required data types;
- Design of a geographical database structure for catchment specifications and collected data;
- Walkover team specification;
- Surveyor's specification;
- Management model for post flood data collection.

The specification outlines the data structure and data management approach that may then be applied to individual catchments. It also sets out a framework for management of the post-flood data collection, including an annual cycle of review and updating of individual catchment specifications.

Generic data requirements have been identified from a number of sources as follows:

- An early draft of this report;
- Defra Best Practice Guide for Monitoring, Recording and Analysing Events (Draft technical report FD2012/TR);
- Dales Area. Post event flood survey. Post project review. December 2001;
- Thames region. Flood data recording system. South East area. October 2001;

- National survey users group. Flood event recording seminar. Solihull. October 2001;
- Easter flood action plan. Action A1.38 - Aerial photography;
- Catchment specifications are being developed for two pilot basins, the Wharfe and Upper Calder. An important point to emerge from the consultation is that the differences between catchments can lead to significant differences in post-flood data priorities. Consequently, a generic specification can only be a broad outline of what should be considered for each individual catchment.

Specific data requirements and locations have been identified in consultation with Agency staff. The specifications are being designed to exploit Global Positioning System (GPS) technology. The project is making use of a GPS-enabled handheld Geographical Information System (GIS) to allow walkover survey teams to access and update the catchment databases. Interrogation of the database will allow the automatic production of survey data sheets should further information (e.g. flood levels) be required. Collected data will also be migrated, as appropriate, to NFCDD. The catchment databases will be held on Pocket PC's in the form of GIS tables. These will be updated annually from NFCDD.

The types of data that have been considered in developing catchment specifications are peak levels, properties and infrastructure affected by flooding, aerial photography/video, flood defence assets, sources and causes of flooding and flood outlines.

**Peak levels**

Peak levels are a basic requirement for the reconstruction of flood outlines, development control and monitoring of assets. Data may be obtained from peak level recorders or by surveying points identified from wrack marks or wet marks on buildings and structures. Peak level recorders have the advantage of automatically capturing and retaining the highest peak in any sequence of levels but exist at fixed locations and require installation and maintenance. Wrack marks may be found anywhere, but require interpretation of evidence on the ground and subsequent level survey.

**Properties and infrastructure affected by flooding**

There is a particular requirement from Flood Warning for information about properties affected by flooding. There is also a need for information about the effects of flooding on infrastructure, such as flooded roads and access problems. The spatial detail and depth of data required may vary from place to place. Door-knocking is required to gather the most detailed information, and consideration has to be given to the resource implications within the context of post-flood data collection and to the coordination of contacts with the public following flooding.

Infrastructure and communications affected by flooding are included as a required data type, particularly with reference to situations where properties

might not be flooded, but could be isolated by surrounding floodwater, or by flooded roads or access ways.

### Aerial photography and video

The procurement of aerial survey is covered by a separate specification for North East region. Aerial photography/video may be of particular value for extensive events of long duration.

### Flood defence assets

There may be some flood defence assets where there is an identified need for post-flood data to help in monitoring condition or performance. Additionally, there is a general requirement for field teams to note, inter alia, any specific issues or problems with defence assets, which are referred to as ‘condition exceptions’.

It is not considered a primary role of post flood data collection to gather data on crest levels of raised assets. However, it has been noted that it may be efficient for survey teams to take crest levels inter alia when carrying out surveys of peak water levels. Any locations or reaches where this information is a particular requirement can be included within the catchment data collection specification.

### Sources and causes of flooding

Information about the sources and causes of flooding is likely to be less crisp than some of the qualitative data listed elsewhere in the specification. However, notes may be made based on field observations of factors such as likely water flowpaths, blockages, failures of regulators or sluices. Photographs and plan indications of sources and pathways may be linked to a GIS table.

### Flood outlines

Reconstructed flood outlines are one of the main outputs of post flood data collection. They are derived from data collected in the field but will in general involve further data analysis, mapping and checking. There are two approaches that can be distinguished:

- Full flood outlines, i.e. closed polygons showing complete flood extents
- Partial flood outlines, i.e. polylines showing incomplete flood extents

Full flood outlines will generally be reconstructed by projecting surveyed peak levels onto a topographic surface, to be followed by reconciliation of the generated outline with other sources of information such as aerial images and eyewitness accounts. Hydraulic modelling might also potentially be used in some limited circumstances.

Partial flood outlines might be recorded where wrack marks left by peak water levels can be identified on the ground, but an accurate survey of the peak levels

is not carried out, or not carried out with a sufficient spatial coverage to permit reconstruction of a full outline as above. Partial outlines might be augmented by surveyed levels to produce a full outline, or, conversely, partial outlines might be used to help in checking a reconstructed full outline. Partial outlines are therefore treated as a separate type of data.

A partial flood extent may be recorded directly from field data (using 'Stop-and-go' handheld GPS for example) and is a linear feature, whereas a full flood outline requires post-field analysis and is a polygon feature. The two types of data are therefore regarded as separate items for specification and database management purposes.

## 4.19 Reducing uncertainty in river flood conveyance

The scoping study report (DEFRA/EA, 2001) assesses users' needs for improved understanding and information. User needs embrace, inter-alia, flood forecasting, flood risk mapping, FD works, plus operations and maintenance. Issues raised with potential links to this project are:

- River habitat surveys lack hydraulic information on survey sites; this was to be addressed in post 2000 flood surveys at selected sites;
- Overflight data (preferably at flood maximum or at several different stages) would be particularly useful.

## 4.20 Other reports

**Health effects of climate change in the UK (D.O.H., 2002)**

A major section of this report examines the implications of increased fluvial and coastal flooding on health and health services. It reports that there has been no large-scale study on the health effects of flooding in the UK. Several small-scale studies since Easter 1998 covered a total of 116 people.
Conclusions drawn are that:

1. More research is needed to understand the complex health consequences that may result following flooding;
2. The longer term psychological impacts on health and social well being along with the issue of social support require more investigation;
3. The social and community dimensions of flooding are factors often neglected in post flood studies;
4. *"….the NHS should cope well with the impacts of climate change on health in the UK. An exception….is the possibility of major coastal flooding on [the] scale [of] 1953. ….local NHS resources would be likely to be overwhelmed.";*
5. *"This preliminary work on human consequences of coastal flooding has highlighted a serious natural hazard…..even in the absence of climate change. There is a need to review the adequacy of existing disaster*

*reduction measures and bring the risk issues involved into the public domain."*

Our investigations have also identified a requirement for data to support studies of health effects of flooding.

**The health effects of floods: the Easter 1998 floods in England (Tapsell, 1998)**

This small study used 6 focus groups in Banbury and Kiddlington to examine health impacts and found significant health effects experienced by victims as a result of disruption to their households. Twenty health effects are listed along with associated stress related problems with personal relationships, employment and feelings of isolation.

**To what degree can the October/November 2000 flood events be attributed to climate change? (DEFRA, 2002)**

The report is an example of a post event review, at the strategic level, to inform policy development. It offers no direct lessons on post event data collection. The study would have been impossible without long-term databases of hydrometric and climate data. It, therefore, demonstrates the importance of high quality data collection programmes and in particular, obtaining high flow events from a national network.

The selection of flow records was limited as gauging stations cannot always contain and measure flood flows. The report also comments that the abandonment, in 1994, of the routine derivation and archiving of annual maximum flows and peaks over thresholds limits the ready availability of flood data. Additional concerns are flagged up in the Flood Estimation Handbook (Institute of Hydrology, 1999) which reports a steady decline in the number of daily rainfall gauges since 1970, as many long-term gauges had either been closed or moved.

The Easter Floods review identified difficulties in measuring flood flows and recommended that hydrometric standards should be enhanced to ensure (inter-alia) that:

"*At least one station in each sub-catchment, associated with a significant flood risk area, is capable of measuring extreme flood discharges."*

It is understood that the emphasis of the EFAG Action A1.6 was on new sites upstream of urban flood risk areas to improve flood warnings. We therefore conclude that hydrometric data collection programmes should be reviewed to ensure the that the long term requirements to provide data for flood estimation and analysis can be met.

**Papers presented to Defra 2001 conference on year 2000 floods**

These papers compliment the responses to the questionnaire and highlight some important factors to be considered in developing post event analysis protocols:

"The Autumn 2000 floods challenged the adequacy of current design standards, 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 improve standards of protection for many communities". (G Lane)

"A notable feature of the response to the floods….was the tremendous collaborative effort of all the agencies involved including the relevant Local Authority, Police, Fire, Ambulance, Military, utility companies, private sector and the Environment Agency." (D Rooke)
"Major Flood Incident Plans that are owned and well rehearsed by all the organisations involved are essential to deliver the seamless and integrated service required by the public and the Minister." (D Rooke)

"If the Agency and its professional partners are to deliver a "seamless and integrated service of flood forecasting, warning and response", management of information for the media and public is a key element." (A Pearce)

"Public confusion on how flood defences are managed and by whom reduces the effectiveness of information on flooding and the likelihood of people taking action on receiving a flood warning." (A Pearce)

"… two particular aspects which, whilst not unique to Wales, demonstrate that there remain lessons to be learnt…. They are:

- Flood warning coverage
- Public awareness and views of partners." (G Bayliss)

"In some ways, the problems of disaster recovery are just as demanding as the emergency response. ( L Frost)

"Dev7elop a database of flood affected properties as soon as possible after the event: this is a key task in assisting emergency response and recovery process. In Lewis we delayed this work too long and it became more difficult to build a reliable data base [that] is essential for ongoing communication with flood affected householders and businesses." (L Frost)

In our opinion, all of the above identify aspects of flood management which require information and would benefit from good quality post event practices.

# 5. Findings and discussions

## 5.1 Current monitoring and recording procedures

Our survey has found that there is no uniformity in the collection and analysis of post event data. The Lessons learned: Autumn 2000 floods report and the SE Region[6] initiative to collect consistent data about coastal features provide role models for the future.

Where standards had been developed for data collection (e.g. Thames Region of EA) there is no evidence of effective take-up in other regions. These standards provide a baseline for data collection protocols and have been developed in the Outline Best Practice Guide (FD2012/TR), but need further development to encourage appropriate and consistent data is collected. Further work will be required to develop detailed common standards and formats.

Records are kept in a variety of formats and media, which makes data transfer and sharing between organisations inefficient and difficult. The Agency recognises the weakness of this and has started to address the problem. A number of initiatives will improve information storage and access, but these do not fully recognise the role of post event analysis and interactions between these initiatives and data systems could be stronger. No decision has been taken on the national co-ordinating role of the NCEDS for flood defence data protocols, following the BRITE restructuring.

Other than in routine hydrometric data collection and surveys of flood levels and extents the potential of new technologies and hand held data capture devices are poorly developed. Coupled with defined information content and formats these could introduce consistency and transferability to the data collected after future events. Further development will be necessary.

Pre-planning is essential to ensure rapid deployment that will ensure the capture of essential data before it is lost or becomes degraded.

Data collected on health impacts, vulnerable people and on aftercare issues is obtained from commissioned research and is therefore limited in extent and geographical coverage. The impacts on people can be long-term, for example residents unable to return to their homes for over 12 months after flooding or not even having a house to repair after coastal erosion. Consequently, better information is needed to plan for and manage the social and health consequences of flood and erosion events.

Communications with the public and emergency planning issues were reported to receive insufficient attention in post event analysis.

[6] See FD2012/PR2 Section 3.4

## 5.2 Usefulness of existing parameters

Respondents to the questionnaire considered none of the Headline Topics identified in Table 2.1 to be unnecessary, though their relative importance reflected, as would be expected, the interests and needs of the respondents. Those ranked most highly across all respondents are:

| |
|---|
| Causes and sources of flooding |
| Weather experienced |
| Areas inundated |
| Major infrastructure affected |
| Location and numbers of properties |
| Asset inspection |
| Near misses |

This emphasis on technical issues reflects the interests of the majority of the consultees. It demonstrates an urgent need to promote more widely that:

"Flooding is about people not water and protection is about managing the risk not just building new defences" (Child, 2001)

## 5.3 Costs and benefits

Only 4 (13%) respondents reported collecting information on the costs of undertaking post event data collection and appraisal. Consequently, numerical assessment of the costs and benefits of post event appraisal has not been undertaken. However, the Agency recognised the need for this information and commissioned a study to determine the costs of the Autumn 2000 floods (Penning-Rowsell *et al*., 2002) and its regional reports contain some cost data.

Two out of three respondents considered post event data collection and analysis to be worthwhile. Responses in the Policy & Strategy and Operations categories implied, with a null response, possible reservations, but these were not elaborated. As these respondents were also economical in their answers to other questions their responses should not be interpreted as criticism of post event analysis. Only one negative response was made; this was in the Insurance category.

The comments of respondents strongly identified a clear need for post event appraisal to ensure lessons are learnt, to feedback into strategic and policy decision-making, and for developing improved processes and structural solutions to flooding and erosion problems.

No two flooding or erosion events are identical in either cause or outcome. The natural processes driving them and the responses of individuals, defences and society are complex and interrelated. Improved understanding and more effective, as well as efficient, mitigation and management of future events

depends upon good analysis which in turn requires reliable data across the full range of Indictor Themes. The benefits in the form of effective investment and reduced impacts on people will only be achieved with a more structured approach to Performance Monitoring and data gathering for post event analysis.

The qualitative benefits (see also FD2012/PR2 Table 3.22) are tabulated in the box below:

Without data we are guessing; information is vital for designing any type of scheme (including flood warning), identification of flood risk areas, modelling, calibration of design for flood mitigation schemes, refining or developing emergency response plans;

Provides direction and guidance for future developments; ensures optimum use of and better targeting of resources; vital to improve flood management;

Required for forward planning of future events, for improved understanding and for assessing coastal/climate change impacts;

Checking that the actual response observed was similar to what was previously predicted;

Performance review evaluation; strengths and weaknesses of defences, procedures, and predictions can be assessed;

Procedures (overseas) are well established but often not applied in practice. Post event appraisals that highlight the importance of doing this properly would be helpful in motivating a better attitude

Justifying (or not) action, expenditure on flood prevention, inspection maintenance etc;

Mechanics of catchment flooding can be understood through the provision of post event data. Modellers and strategists can gain an appreciation of catchments through real life scenarios;

Extreme event impact on the foreshore and structures is a critical design issue for which little data exist;

Benefits of processing the data is to give them a standard format and documenting their metadata. This process adds value to the data and enables dissemination and understanding;

Better events database that can be used in planning;

Improved access to data for future analysis particularly of trend effects.

## 5.4 Shortfalls and opportunities

Responses identified the following shortfalls and opportunities:

1. A specification for post event analysis data gathering should be designed to cover all appropriate needs. Improved planning - in advance of a flood/ erosion event of:
   - what data should be collected, and
   - how appraisals should be carried out,

   would ensure a consistent approach and allow comparison of "like with like". These would need to be reviewed and improved with experience;

2. We really don't have good information on the effectiveness of flood warning to confirm that current policy and strategic directions are optimum (overseas);

3. It can be difficult to know just which elements in the total warning system need improvement when considering investment over the whole system. Without better appreciation of the relative contribution of each element to the total system performance, investment decisions may not always be optimal;

4. Improved data to establish performance of forecasts and the delivery of warnings. Improved understanding of the response to warnings and overall effectiveness;

5. Improved monitoring of key aspects of performance, particularly during more extreme loading conditions (coastal);

6. Scheme designs should include standards of service that could be compared with actual response/impact and the success of works judged accordingly;

7. More systematic surveys not just "one offs";

8. All relevant stakeholders should be identified and questioned. Very often the Agency or Local Authority collate information from those affected by flooding;

9. Emergency plans lack information on flood extent, flood paths, flood depth, velocity and rate of rise etc; these are needed for detailed planning of emergency response evacuation etc;

10. Exact water level locations (shown on map);

11. Critical reviews of overbank ratings and peak flood flows;

12. Need a "standing team" to collect data to ensure learning from flood events that occur every winter;

13. Guidance needed to overcome the lack of good quality data;

14. Need to utilise available technologies to increase efficiencies during walkovers. Particularly need to develop techniques of automating field data process to mapping and deliverables;

15. Wider use of new technology for data collection as it becomes practical for use particularly under the physical conditions associated with extreme events;

16. Items requiring particular attention were identified and are presented in the box below:

| |
|---|
| Improved forecasting and better focus on flood risk areas. |
| Improved feedback mechanisms from the public. |
| Surveys of victims and business losses. |
| Specific information on operations (timing of gate movement/pump operation etc). |
| More effective use of data collected. |
| Extension to the mapping of ordinary watercourse flooding. |
| Improved forecasting and better focus on flood risk areas. |
| Better provision of advice to public before, during and after event. |
| Better provision of advice to Emergency Planners before during and after event. |
| Better maps of areas flooded. |
| Better understanding of scheme performance - leading to better design. |
| Better flood risk models and data from prior floods. |
| Better informed design decisions. |
| More effective targeting of resources during an event. |
| More specific information on levels, flows, timing, recorded river cross-sections during flow gauging, maps showing water level locations, inundation limits etc. |
| Information on levels with timing (level hydrographs would be ideal). Information on warnings issued/warnings received/what actually flooded. |

Two respondents (not engineers) point out that technical appraisals and data collection are much more common than those of victims, emergency response, and long term recovery. These are very important but terribly neglected.

Two other respondents, who are regular users of data supplied from post event survey and analysis remark that data are of poor quality and factually wrong (ie properties shown as flooded were not flooded). Concern was expressed that when requesting data from the Agency area/regional offices there is too heavy a reliance put on digital data (which may only extend back a decade.).

Consequently, a lot of effort is expended digging out earlier paper records, which often relies on the knowledge of experienced staff who are not always

available.

Many respondents identified areas that might benefit from modern technology:

- Properties/infrastructure affected;
- Hydrometric data;
- GIS database and better mapping;
- Collection of survey data using hand held data loggers and GPS;
- Flood extents (using SAR (Side Aperture Radar), aerial video and LIDAR).

A project to determine flood extent monitoring using airborne SAR is being undertaken by the NCEDS (Twerton) in conjunction with Thames Region of the Agency. This work is also tied in with an internal NCEDS (Twerton) project for developing airborne SAR capabilities and is now awaiting a flood within Thames Region in order to test out SAR.

One correspondent commented that:

*“One of the issues we have grappled with (fairly unsuccessfully) is that of incident logging during a flood event, i.e. how much to log, how to log it etc…*

*A prime example would be properties flooded. When these are reported to us, they tend to be in the form "6 properties in…". We seldom get details of addresses etc. There are also different definitions of "flooded" ranging from an inch deep in gardens, to feet deep in houses. So, it is difficult to assess these reports during an event.”*

## 5.5 Application in post event appraisal

A majority of the respondents (c70%) undertake post event appraisal (50% of them frequently). Whilst it is widespread, it has lacked co-ordination except for Easter 1998 and the Autumn 2000 floods. The style of the analysis of these events was very different and the differences in data and methods of presentation would hamper a comparison of their results.

## 5.6 Overseas and Scottish practice

Only three overseas responses were received; overseas practices appear to be no further developed than in the UK. It is concluded, from this and internet searches, that there are no published and well established post event appraisal procedures in regular use overseas from which UK experience might learn and benefit. Overseas activities include:

- Australia has a well developed set of handbooks (Emergency Management Australia, 1999 (1) (2) (3) (4)) on flood plain management, forecasting and warning practice and response procedures;

- Eire (Office of Public Works) has developed guidelines on data to be collected, which have been compared with the headline topics;
- Some of the flood forecasting and warning post event appraisal issues are being addressed in Scotland.

Collaboration on future developments with both the Office of Public Works and SEPA could offer mutual benefits.

## 5.7 Basic principles for best practice

Chapter 5 has identified and reviewed recent developments and current practice from which a set of principles for best practice have been established. The development of these principles and of the guide on best practice (FD2012/TR) has been shaped by the following:

1. Defra and operating authority policies and strategic aims;
2. Defra Project Appraisal Guidance (FCDPAG);
3. Operating Authorities' routine and emergency response activities;
4. Data management questions / principles ;
5. Performance evaluation and risk management principles;
6. Results of the questionnaire and analysis of recent post event appraisals;
7. Identification of priorities for attention during and immediately after a flood or erosion event.

## 5.8 Defra and operating authority policies

Defra has published its Policy Aim, Key Objectives and a series of High Level Targets.

**Policy aim**

*"Department for Environment, Food & Rural Affairs and Welsh Office policy is aimed at reducing the risks to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures."*

**Key objectives**

*"The aim of the Department and Welsh Office policy is to reduce the risks to people and the developed and natural environment from flooding and erosion:*

- by encouraging the provision of adequate and cost-effective flood warning systems;
- by encouraging the provision of adequate, technically, environmentally and

- economically sound and sustainable flood and coastal defence measures;
- by discouraging inappropriate development in areas at risk from flooding or coastal erosion."

**High level targets (MAFF, 1999)**

Fourteen targets were established to facilitate more certain delivery of the national policies and objectives. Table 5.1 lists the topics covered by these targets. Operating Authorities were required by Target No.1 to produce policy statements setting out plans for delivering the Government's policy aims and objectives. The High Level Targets provide the essential framework within which the Agency exercises its supervisory duty and against which delivery of flood defence aims and objectives can be measured (Environment Agency, 2002).

All FCD activities stem from the legislation directly or as expressed in government and Operating Authorities' policies. A high level view of data needs has been formed from consideration of these. Post event analysis is required (project brief) to inform the following flood and coastal defence activities:

- Policy and strategic decision-making
- Scheme design and engineering
- Scheme performance
- Operational procedures
- Flood forecasting and warning
- Emergency planning and response
- Flood inundation mapping

Post event analysis, must, if it is to be effective, contribute fully to the processes that contribute to meeting Targets 2 to 13 inclusive.

**Table 5.1 Defra high level targets**

| TARGET NO. | SCOPE |
|---|---|
| 1 | Policy statements |
| 2 | Provision of flood warnings |
| 3 | Emergency exercises and emergency plans |
| 4 | National Flood and Coastal Defence database (NFCDD) |
| 5 | Flood defence inspections and assessment of flood risk |
| 6 | Coast protection inspections and assessment of coastal erosion risk |
| 7 | Expenditure programmes |
| 8 | Shoreline management plans (SMPs) |
| 9 | Biodiversity |
| 10 | Water Level management Plans (WLMPs) |
| 11 | Coastal Habitat Management Plans (ChaMPs) |
| 12 | Development in areas at risk of flooding |
| 13 | Development in areas at risk of coastal erosion |
| 14 | IDB Administration and Membership |

Flood and Coastal Defence requires co-operation and joint working by many organisations for achievement of these targets. This, in turn, requires common access to reliable and relevant data in a joined up manner.

## 5.9 Defra project appraisal guidance (FCDPAG)

This series of six reports provides an integrated suite of guidance on all aspects of FCD project appraisal, including, when published, post project appraisal. Rigorous appraisal requires good quality data and feedback of experience with the performance of existing schemes for defences and warning schemes. Post event analysis should also meet the needs of the appraisal process through the comprehensive coverage of the headline topics.

## 5.10 Operating authorities' routine and emergency response activities

The analysis described in Section 3 to derive the list of Headline Topics (Table 2.1) and their grouping into Indicator Themes takes account of all routine and emergency response activities. It also extends the scope to data required to examine the wider impacts on society, people and the environment.

## 5.11 Data management principles

CIRIA Report C541 (Millard and Sayers, 2000) presents best practice guidelines for maximising the use of coastal data based on five principles of data management developed by BSI (Mayon-White and Dyer, 1997). It identifies factors that inhibit effective use of data and its exchange; these are all equally applicable to post event data:

- Data customers unable to find data;
- Data customers are unable to assess the quality of the data;
- Data suppliers are unsure what customers require.

The five principles are:

| | |
|---|---|
| **Data understanding** | recognise, understand and describe all data used, needed and available |
| **Legal framework** | understand legal issues and execute responsibilities |
| **Process and procedures** | identify and specify the processes and procedures for handling data |
| **Enabling technology** | identify and implement appropriate technologies for data management and processing |

| | |
|---|---|
| **Auditing** | audit and monitor the processes for data use and exchange |

Each of the principles is explained in more depth and the key features presented. Whilst all are relevant to post event data, the following are particularly pertinent and should be given attention when setting up post event data management procedures:

| | |
|---|---|
| **Data understanding** | *Appraise data requirements to satisfy information needs;*<br>*Recognise all organisations as potential data suppliers or data customers;*<br>*Communicate data requirements and availability with other organisations;*<br>*Ensure all data are accompanied by appropriate metadata.*<br><br>Metadata provides a description of the content and quality of the dataset. Unfortunately, there are a multitude of standards and the CIRIA report suggests that a more consistent approach would follow if the Environment Agency promoted a common standard. |
| **Legal framework** | *Ensure all staff …… operate a "duty of care" towards the management of data."*<br><br>All staff involved with data have a duty of care to preserve data and to take reasonable steps to ensure its reuse in future. |
| **Processes and procedures** | *Document and describe… procedures associated with the data processing chain….."*<br><br>For post event data this needs to extend to the pre-planning of data collection needs and procedures. |
| **Enabling technologies** | *Identify technologies that are compatible with data suppliers and customers.*<br>The questionnaire has identified the multiplicity of users (customers) and suppliers of post event data. Review and monitor. |

There are shortfalls in current practice within all of the five principles, on which the best practice guide presents remedies. Aspects of data management which require particular attention in deriving best practice are:

| | |
|---|---|
| **Data understanding** | Establishing information needs, the complexities introduced by a multiplicity of supplier and customer organisation, communication and the development and supply of metadata. |
| **Process and procedures** | Documenting procedures from pre-planning to data storage and access |
| **Legal framework** | The "duty of care" to data is often poorly recognised and valuable records have not been preserved during past reorganisations or through ignorance of the significance. |
| **Enabling technologies** | These offer the potential for greater efficiency in measurement and collection and by providing wider access to datasets. |
| **Audit** | Every new flood or erosion event creates a different challenge to those previously experienced. Application of the "learning circle" should become a routine part of post event appraisal and applied to itself. |

## 5.12 Risk management principles

Performance Evaluation forms an important component of the Risk Evaluation and Uncertainty Theme. This and other topics in the theme (see Section 5.10) have requirements for data that post event appraisal could supply. In addition the Concerted Action on data and information will have implications for post event monitoring best practice.

Data supplied by post event monitoring must meet the needs of the risk-based methods under development. As far as can be anticipated these needs have been recognised in the Headline Topics.

## 5.13 Results of the questionnaire and analysis of recent post event appraisals

The review of recent appraisals and data collection exercises and the views expressed by respondents to the questionnaire have highlighted both lessons and opportunities for improving post event monitoring and data collection. These are carried forward in the best practice developed in FD2012/TR. The key data topics needed by each category of user are shown in Table 5.2.

**Table 5.2: Key data topics required by each category of user**

| Category | Key Data Topics |
|---|---|
| Insurance | Weather experienced<br>Causes and sources of flooding<br>Areas inundated<br>Costs<br>Flood warning delivered |
| Policy and strategic organisations | Causes and sources of flooding<br>Near misses<br>Weather experienced<br>Telemetry performance<br>Flood forecasting performance<br>Properties flooded – not warned<br>Locations and numbers of properties & businesses flooded<br>Major infrastructure and utilities flooded / disrupted<br>Asset inspection |
| Emergency response organisations | Weather experienced<br>Areas inundated<br>Major infrastructure and utilities flooded / disrupted<br>Emergency response<br>Public feedback |
| Operations and design | Causes and sources of flooding<br>Asset Inspection<br>Major infrastructure and utilities flooded / disrupted<br>Weather experienced<br>River flows and levels experienced<br>Locations and numbers of properties & businesses affected<br>Design standard of defences |

# 6. Recommendations

The review of current practices for post event appraisal has identified that a hitherto largely fragmented approach needs to change to meet the full needs of a wide range of users.

These recommendations focus on the steps required to:

- raise awareness
- improve the process, and
- co-ordinate with other developments

1 The importance of post event analysis and a requirement for existing projects and initiatives to co-ordinate their data needs and collection programmes should be widely communicated:

   a) Staff in all Operating Authorities should be informed that they have a "duty of care" to data;
   b) Protocols should be established for the retention of data to ensure the preservation of valuable records;
   c) Shortfalls, in other ongoing R&D projects and policy initiatives, to meet the needs of post event analysis and to develop detailed specifications for data collection programmes and storage systems should be identified;
   d) Post event data collection must be fully integrated with the Concerted Action on a Strategic Approach to Data and Information (FD2314) within the Risks Evaluation and Understanding Uncertainty Theme. (The Concerted Action on Data and Information could provide a focal point for exchange of views and resolution of any conflicts.);
   e) The development of a common terminology with that used for Performance Evaluation requires further attention;

2 Greater efficiency will be achieved, by avoiding the duplication of measurement and collection effort, and with prompt transfer to databases accessible by all interested users (within and outside the source organisation). The "data warehouse" concept, inherent in NFCDD, offers a home for all post event data and the results of its subsequent analysis, with access for all legitimate users wherever they are based. Plans for the development of NFCDD should be reviewed to:

   a) Incorporate the data for Headline Topics
   b) Include all post event analysis applications;

3 Metadata catalogues should be developed for all FCD, including post event, data and for hydrometeorological and tidal data holdings;

4 Quality assurance procedures need to be developed for all post event monitoring and data collection, processing storage and access procedures;

5 Enabling technologies offer the potential for greater efficiency in measurement and collection and by providing wider access to datasets:

a) The potential of new technology for data collection should be regularly monitored,
b) The results of investigations by the Agency's NCEDS, the R&D project to test SAR and Project Checkmate should be used to develop new procedures as and when these and other techniques are found to be viable,
c) Their introduction for routine use should be preceded by field trials under the physical conditions associated with extreme events,
d) Techniques should be developed to automate the processing of field data into floodplain maps and other deliverables such as databases and GIS,
e) Standard data formats should be established and their use made obligatory;

6 A lead organisation should be responsible for establishing protocols for collecting data on each Headline Topic in a geographical area. (The Environment Agency will be best placed to undertake this role, in many cases, under its supervisory role.)

7 Regional teams, able to support local resources in Agency Areas and Coastal Authorities should be established. One regional team should be nominated as the national lead team, with a small core of full time staff, responsible for developing the generic plans, procedures and standards. This would also ensure continuity between events, thereby increasing the utility of the data collected at different times. Generic pre-event planning should be undertaken covering:

a) Prioritisation of data collection
b) When data should be collected
c) Who should collect data
d) Processing, quality assurance and formats of data
e) Equipment and external resource requirements
f) Staff and contractor training

This should then be developed at local level into catchment and coastal cell specific action plans ready for rapid initiation during an event[7];

8 To gain maximum benefit from post event appraisal, data needs should be more closely defined in the form of national standards and procedures.

[7] Fluvial aspects are being addressed by the NE Region project now underway (Section 5.18).

(These should build on the Best Practice Guide (FD2012/TR), the Thames region's report for fluvial data, the NE project and the SE region coastal groups' initiative for coastal data.)

a) The Agency's Flood Event Data Collection procedures (FD2012/TR Appendix A) should be reviewed and extended into protocols covering the full range of fluvial Headline Topics;
b) Defra should require Coastal Authorities, through the Coastal Groups to develop a similar protocol for erosion events and make its compliance and its application a measurable issue through a High Level Target;
c) Operating Authorities and their Professional Partners should be encouraged to collaborate in developing protocols for those items in which they have a joint interest;
d) Templates with fixed formats should be prepared for tables and spreadsheets of the data presented in the Agency's Autumn 2000 floods regional reports, to ensure consistency and compatibility of information and its rapid compilation into a composite national report;
e) The principles in (d) should be extended to coastal data;

9 Defra should include a requirement in the project appraisal procedures for the specification, at the design stage of schemes, of the data (including levels, flows, wind, tide etc) needed to assess their performance;

10 The operating authority responsible for a FCD asset should undertake data collection, on the performance of their asset;

11 Operating Authorities should establish arrangements to ensure the availability of adequate resources to gather post event data; this will require

a) Contracts with external providers;
b) The training of staff and contractors;
c) Refresher courses to be undertaken regularly.

Data collection activities may benefit from being carried out under joint contracts for all Operating Authorities in a locality;

12 The Environment Agency should have overall responsibility for gathering as part of an integrated monitoring and recording plan covering extent, properties, infrastructure, and impacts on people and society. These plans should identify the detailed information needs for Headline Topics of other organisations;

13 Procedures to examine the longer-term psychological impacts on health and social well being along with the issue of social support should be established by routinely including the human impacts of flooding, communications with the public and emergency planning issues. This will require:

a) Developing improved feedback mechanisms from the public;
b) The identification of stakeholders to be questioned following events;
c) The identification of the information needs of emergency planners;
d) Greater sharing of information between Operating Authorities;
e) Training of staff in post event data collection procedures;

14 Hydrometric data collection programmes should be reviewed to ensure that the long term requirements to provide data for flood estimation and analysis can be met;

15 Emergency exercises offer an opportunity to test the initiation of event data collection procedures and allocation or deployment of resources. Exercises should include, as a minimum, identification of actions required, if not actual mobilisation of the data collection team. Major exercises should include mobilisation;

16 Application of the "learning circle" should become a routine part of post event appraisal and used to improve the post event appraisal process at national and local level;

17 To achieve the full aims envisaged for this project, a Phase 2 study, which should draw on the current work in NE Region, is required to develop:

a) A working “pilot” of a full post event appraisal “system”;
b) Detailed guidance (including in-depth tables similar to Appendices A & B in FD2012/TR for those Headline Topics not already covered. Existing items should be reviewed);
c) A methodology to measure performance against national, regional, and local targets for flood and coastal defence.

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