



Review report of operational flood management methods and models

Date February 2007

Report Number T17-07-01

Revision Number 1_1_02

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FLOODsite is co-funded by the European Community

Sixth Framework Programme for European Research and Technological Development (2002-2006)

FLOODsite is an Integrated Project in the Global Change and Eco-systems Sub-Priority

8Start date March 2004, duration 5 Years

Document Dissemination Level

PU Public

PU

PP Restricted to other programme participants (including the Commission Services)

RE Restricted to a group specified by the consortium (including the Commission Services)

CO Confidential, only for members of the consortium (including the Commission Services)

Co-ordinator: HR Wallingford, UK
Project Contract No: GOCE-CT-2004-505420
Project website: www.floodsite.net

DOCUMENT INFORMATION

Title	Review report of operational flood management methods and models
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Distribution	Public
Document Reference	T17-07-01

DOCUMENT HISTORY

Date	Revision	Prepared by	Organisation	Approved by	Notes
18/01/2007	1_0_01	Darren Lumbroso	HR Wallingford	Marnix van der Vat	
26/02/2007	1_0_02	Marnix van der Vat	WL Delft Hydraulics	Frans Klijn	Final editing by task leader (version number, date, authors)

ACKNOWLEDGEMENT

The work described in this publication was supported by the European Community's Sixth Framework Programme through the grant to the budget of the Integrated Project FLOODsite, Contract GOCE-CT-2004-505420.

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SUMMARY

Evacuation is a response to the immediate or forecast threat of flooding that is expected to pose a risk to life, health or well-being. It involves people moving from their houses or places of business to 'safe' locations, out of the flood risk area where they are able to shelter until it is possible and appropriate for them to return. This report summarises the institutional and legal frameworks for a number of European countries.

The report details the user requirements with respect to evacuation planning for flood emergencies based on consultation with a number of stakeholders in France, Germany, The Netherlands and the UK. The following generic conclusions have been reached regarding evacuation planning and emergency management of floods:

- The timing, speed and method of communication of reports are critical to effective emergency management during a flood;
- A knowledge of the road network, location of the vulnerable elements at risk and evacuation times are key to evacuation and emergency planning;
- More robust and integrated communication links between the organisations involved in the response during a flood helps to ensure an effective response;
- A flood event management system that provides estimates of flood extents and depths for breach scenarios would assist with emergency response;
- Organised evacuation is only used as a form of emergency response in very rare circumstances. In most of Europe the authorities have no powers to forcibly evacuate people from their houses during floods;
- There is need for tools and methods to assist in the planning of evacuation/rescue operations and to estimate the optimal use of the transport network and the time required for execution of an evacuation;
- There is little experience within the European Union (EU) with methods and models to support the planning and execution of evacuation and rescue operations related to floods. .

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1. Introduction

1.1 *Structure of the report*

This report has been written as part for Task 17 of FLOODsite. The objectives of the report are as follows:

- To review operational flood management practices in the European Union with an emphasis on evacuation and rescue methods and tools;
- To assess the user requirements for evacuation and rescue planning;
- To draw lessons regarding the required tools for the support of operational flood management and especially evacuation and rescue.

The report has been structured as follows:

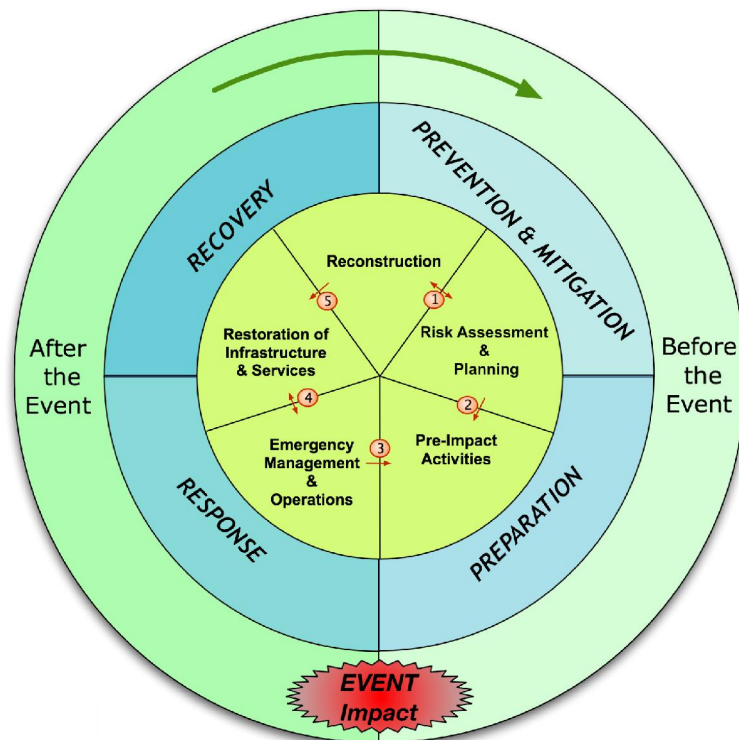
Chapter 1	This provides the background to the disaster management cycle and an introduction to the evacuation process;
Chapter 2	This reviews operational flood management including the legal and institutional frameworks, evacuation and rescue methods and models and the emergency flood management procedures in a number of European countries;
Chapter 3	This outlines the user requirements for evacuation planning for the various stages of the evacuation process;
Chapter 4	This gives the conclusions of the report;
Chapter 5	This chapter details the references used in compiling this report.

1.2 *Background to the disaster cycle*

The management of natural risks is a public task for which governments at all levels hold a certain amount of responsibility. The management of risk involves a wide range of actions and activities that fall within one of the following four activities:

- Prevention;
- Preparation;
- Response;
- Recovery.

Evacuation management is an activity that forms part of the response to a flood emergency. As such it is one of the many options decision makers have available for dealing with floods. Other possible options could be the construction of structural measures such as emergency barriers or flood storage areas and non-structural measures such as the implementation of flood forecasting schemes. Figure 1.1 shows how emergency management fits into the disaster cycle.



Note:

- ① Reconstruction (i.e. Land Use Planning) can be influenced by Risk Assessment & vice versa.
- ② Pre-Impact scenario analysis is often conducted based on previously constructed emergency planning scenarios.
- ③ Lessons Learned from Emergency Experience feeds back into pre-impact planning as well as perhaps exploiting existing communication strategies.
- ④ Emergency Management can prioritize the restoration of services during the response. Service restoration can support the management of the current emergency situation.
- ⑤ After temporary restoration of the most relevant services, reconstruction might be necessary to guarantee a better quality of the service or to recover all non functional services.

Figure 1.1 The disaster cycle

The response of authorities towards emergencies is often cyclical. This means that this year's disasters are next year's preparation. Organizations like governments and civil protection authorities expand their experience and knowledge about their activities each time a disaster occurs. In this way the organizations learn from previous experiences in disasters and strive towards improving their knowledge and skills in order to be better prepared for the next disaster. It is therefore important that the documentation of these lesson learnt plays a large role in defining user requirements.

1.3 Definition of evacuation

Evacuation is a response to the immediate or forecast threat of flooding that is expected to pose a risk to life, health or well-being. It involves people moving from their houses or places of business to 'safe' locations, out of the flood risk area where they are able to shelter until it is possible and appropriate for them to return.

1.4 Stages in evacuation planning

In evacuation planning eight main stages can be identified. These are detailed below.

1. Organizing the planning

Before the actual start of the planning takes place it is important to recognize who should be involved in the planning process. Research has demonstrated a huge added value of involving appropriate stakeholders since they bring with them an amount of experience and knowledge that might be useful for planning an organization.

2. Designing the plan

In this stage the actual emergency plan is designed. The previous stage should have provided a clear idea of the responsibilities of different actors in the process.

3. Pre-flood preparedness

This will determine the level of flood awareness and is likely to influence whether people receive official (or unofficial) warnings and how they act on them. People who have had previous experience of flooding may extend or reduce the time between warning and evacuation, depending on the level of the previous flood and their understanding of the warning codes.

4. Flood emergency stage

a) Recognition of critical situation

The physical parameters of the flood define the emergency, and the official recognition of an emergency defines the response. The depth of water and velocity of the flow are just two of the factors upon which a decision about the seriousness of a flood and evacuation may be made, whether by an official or by the individual householder.

b) Assessment of evacuation options

Given a certain flood forecast and the estimation of the likely flood extent the availability of the various escape routes can be assessed. On this basis an assessment of evacuation options will be carried out. The results of this assessment form the basis for the decision to evacuate and for any of the actions to be taken in the rest of the process.

c) Decision to act upon critical situation

The development of the source of risk (e.g. floodwater depths and velocities) needs to be monitored. After recognizing a critical situation and its potential development over time, the decision is taken to evacuate.

5. Evacuation (leaving home)

Whether or not people evacuate in a structured manner (i.e. on recommended routes, using recommended transport modes, to recommended shelter zone) will depend on whether an official evacuation recommendation is given, and how much guidance is provided to assist evacuees in their decision-making.

6. Emergency shelter

The official response at the scene will direct those affected towards the official rest centres or reception centres that have been set up by teams coordinating response. Clearly this necessitates good liaison and communication between all those involved, but in particular between the official responders and those coordinating that response across different local authority departments. For some, emergency response terminates when householders reach the rest centre, whereas for many the disaster may only just have become apparent at this stage. Communication and coordination between those involved in the response and the public is paramount at the rest centre.

7. The return

There may need to be temporary accommodation between emergency and return. A coordinated re-entry process is paramount, with appropriate social and technical support.

8. Debriefing

At the end of an evacuation is it necessary for the stakeholders to evaluate the result of the evacuation and their respective contributions to it. This is regarded as extremely important since it allows organizations to improve themselves and their actions.

2. Review of operational flood management

2.1 Introduction

This chapter provides a review of operational flood management in a number of countries in Europe including:

- The UK;
- The Netherlands;
- Germany;
- France;
- Hungary;
- General overview of Europe.

This review covers the legal framework and institutional set ups in these countries and their experience with operational flood management. This chapter focuses particularly on the management of flood emergencies, and evacuation and rescue methods and models.

2.2 The United Kingdom

2.2.1 The legal framework for flood management and emergencies

Background

The main piece of legislation covering emergency management in the UK is the Civil Contingencies Act. This legislation and accompanying non-statutory measures give a single framework for civil protection in the UK. This objective of the Civil Contingencies Act is to improve the UK's ability to deal with the consequences of major disruptive incidents by improving the planning process at a local level, building better contacts between agencies and improving the link between local areas and central government.

Civil Contingencies Act (CCA)

The Civil Contingencies Act (CCA) and accompanying non-legislative measures and Regulations deliver a single integrated framework for civil protection. The Act applies to the whole of the UK, including devolved administrations and came into force in 2004. "Emergency" is defined under the Act as *"an event or situation which threatens serious damage to human welfare in a place in the UK, the environment of a place in the UK, or war or terrorism which threatens serious damage to the security of the UK."* Part 1 of the Act establishes a new statutory framework for civil protection at the local level. Part 2 repeals existing emergency powers legislation and allows the development of special temporary legislation aimed at providing the powers required to deal with a serious emergency.

The Act provides a basic framework defining what tasks should be performed during an emergency, and how co-operation should be conducted. Working to a common framework, local responders are required to make their own decisions in the light of local circumstances and priorities about what planning arrangements are appropriate in their area. The CCA recommends an Integrated Emergency Management (IEM) procedure that comprises six related activities:

- Anticipation;
- Assessment;
- Prevention;
- Preparation;
- Response;
- Recovery.

Responders are categorised into two categories. Category 1 (core) responders are those organisations at the core of emergency response:

- Emergency Services (police, fire, ambulance, maritime and coastguard agency);
- Local authorities (all principal, port health authorities);
- Health bodies;
- Government agencies (Environment Agency, Scottish Environment Protection Agency (SEPA)).

Category 1 responders are subject to the full set of civil protection duties, as follows:

1. Risk assessment;
2. Business continuity management (BCM);
3. Emergency planning; and
4. Maintaining public awareness and arrangements to warn, inform and advise the public.

A fifth duty applies to local authorities alone:

5. Provision of advice and assistance to the commercial sector and voluntary organisations.

Category 2 responders are “co-operating” bodies who, while less likely to be involved in the heart of planning work, will be heavily involved in incidents that affect their sector. They include:

- Utilities (electricity, gas, water, sewerage, telephone);
- Transport (rail, underground, airport, harbour, highways);
- Strategic health authorities;
- Government agencies (e.g. Health and Safety Executive).

Two duties that are prescribed for all responders include:

- 1 Co-operation; and
- 2 Information sharing.

2.2.2 Role of organisations in response to a flood event

This section details the role of the various organisations in flood event management. These fall under the following headings:

- Category 1 responders;
- Category 2 responders;
- Others.

Category 1 responders

The Category 1 responders are:

- Local authorities;
- Police forces;
- Fire and rescues authorities;
- Ambulance services;
- National Health Service and Health Protection Agency;
- Environment Agency.

Environment Agency

The Environment Agency is the lead agency in England and Wales for warning those at risk and maintaining and improving flood defences. The Environment Agency's powers are mainly permissive. They maintain a flood warning system, but have not previously had a statutory duty to warn the public. The Act places a general duty on the Environment Agency to maintain arrangements to warn the public and provide advice and information about flooding. However, that duty to warn does not solely apply to the Environment Agency. When a potential flood impinges on the functions of another Category 1 responder, then it too has a duty to warn. The Environment Agency provides warnings as much to other responders, who must take decisions on, for example, evacuation, as it does to the public. Category 1 responders will generally identify and agree that the Environment Agency should be the lead responder for warning, informing and advising the public.

During a flood incident, the Environment Agency is committed to undertaking the following actions:

- Issue timely flood warnings to those at risk and to operational organisations in accordance with the Environment Agency's customer charter, by constant monitoring of weather, catchment and coastal conditions, prediction of future river and sea levels, preparation of warnings for locations at which forecast or actual levels might result in flooding and dissemination of warnings;
- Work in co-operation with professional partners to ensure a seamless and integrated response to flood incidents, including advising the police on the need to declare a major civil emergency and providing representatives to the various emergency control points;
- Manage its reputation by proactive and reactive actions to protect and enhance the Agency's reputation during a flood incident;
- Collect and record data during a flood incident in accordance with the National Flood Data Collection Manual e.g. flood levels, flows and extent; number and depth of property flooding;
- Monitor and inspect the flood defence system against design standards of defence and, at undefended flood-prone communities to report on incidents of actual or likely failure and so enable emergency action to be assessed and undertake;
- Undertake a reactive response to minimise the risk of failure of flood defence assets, remedial action upon failure of flood defence assets and mitigation measures to limit the extent and damage of flooding during an incident;
- Erect/install temporary defences to limit the extent and damage of flooding to an undefended community or individual property;
- By local agreement, once it has ensured that its own systems and defences are secure, support the police, local authorities and reservoir undertakers via the multi-agency command and control structure to the extent that their resources (materials, equipment, manpower) and other duties permit;
- Participate in flood incident contingency planning at Local Resilience Forum and lead/support the flood-related subgroups.

Local Authorities

Local Authorities play a critical role in civil protection. Local authorities maintain a small hub of planners who co-ordinate and facilitate emergency planning and response work across the authority. They have key statutory responsibilities for environmental health, housing, social services and highways and exercise a community leadership role. Local Authorities work with the police, fire and rescue services and the Environment Agency to co-ordinate the response during severe flooding.

Police forces

Police forces co-ordinate response to most land emergencies, including flooding. In particular, they will co-ordinate the activities of responders at and around scene of a land-based sudden-impact emergency.

Fire and rescue authorities

Fire and rescue authorities co-ordinate search and rescue activities. Their responsibilities include:

- Working with the police and others to plan for flood emergencies;
- The rescue of people trapped by floods;
- Pumping out of flood affected properties;
- Allocation of duties and training of staff;
- Identification and allocation of resources including boats and other rescue equipment.

Category 2 responders

The private sector is a crucial player in the response and recovery processes and must work closely with emergency services and local authorities to deliver timely restoration of essential services and to minimise the wider impact of the flood on the community. There are sector-specific emergency planning arrangements in each of the following sectors to build resilience and put in place effective response frameworks.

The key Category 2 responders are:

- Highways Agency;
- Gas and electricity distributors and transmitters;
- Water and sewerage undertakers;
- Telephone service providers, fixed and mobile;
- Railway operators;
- Airport operators;
- Port authorities
- Health and Safety Executive, Strategic Health Authorities.

Other co-operating bodies

Other significant cooperating bodies in flood response include:

- Regional Resilience Teams and the National Assembly for Wales;
- Armed forces;
- The Meteorological Office and/or regional weather centres;
- Media;
- Voluntary sector;
- Local community

2.2.3 Flood incident management

Introduction to the Environment Agency's role in incident management

The Environment Agency's role in flood incident management can be summarised as follows:

- Issue timely flood warnings to those at risk and to operational organisations by constant monitoring of the weather, catchment and coastal conditions, prediction of future river and sea levels, preparation of warnings for locations at which forecast or actual levels might result in flooding and dissemination of warnings;
- Work in co-operation with professional partners (e.g. police, fire services, local authorities) to ensure an integrated response to flood incidents. This includes advising the police on the need to declare a major civil emergency and providing representatives to various emergency control points;
- Collect data on the flood incident (e.g. flows, levels, extents, number of properties flooded);
- Operate and maintain flood defence assets during the event;

- Monitor and inspect flood defence systems against their design standard in order to report on actual or likely failure to enable emergency response action to be undertaken;
- Undertake a reactive response to minimise the risk of failure of flood defence assets;
- Erect temporary/demountable defences;
- Once the Environment Agency has ensured that its own defences are secure it should support the police, local authorities and reservoir owners via the multi-agency command as much as the resources and duties permit;
- Participate in flood event management contingency planning at Local Resilience Forums.

Classification of flood incidents

In England and Wales the Environment Agency classifies flood events into four categories as follows:

1. Category 1 flood incident

This is a flood event that results in:

- Death or serious injury caused by flooding and/or
- “High Impact flooding” i.e. more than 100 properties and/or nationally significant infrastructure, such as a motorway or mainline railway.

2 Category 2 flood incident

This is a flood event that results in:

- “Low Impact flooding” i.e. property flooding affecting less than 100 properties and/or
- Flooding of locally significant infrastructure, such as main roads and the local rail network.

3 Category 3 flood incident

This is where there is flooding of minor roads or land used for agricultural, recreational or domestic purposes (including gardens).

4 Category 4 flood incident

A Category 4 “flood incident” is one where no flooding occurred.

Flood incident response standards adopted in 2006

The incident response standards adopted by the Environment Agency for the year 2005/2006 are detailed in Tables 2.1 and 2.2. These tables help to inform the requirements of flood incident managers in England and Wales.

Table 2.1 Management activities in the UK

Adopted incident response standard	Consequences of adopting standard
Incident management activities Incident Rooms established and resourced effectively for short duration (three days or less) events. Standby rotas, shift working and welfare arrangements established for short duration events. Production of situation reports (SITREPS)	Compliant with incident management policy and service maintained at current levels. Moderate increase in flood risk due to lack of resources for prolonged events leading to danger to the public and the built environment. Low risk of lower priority incidents escalating in priority with much greater environmental impact. Failure to ensure sufficient resources to deal with prolonged flood incidents leading to moderate stress levels amongst Agency staff. Fair relations with Local Authorities and Emergency Services. Limited negative publicity in media. Sufficient information or evidence to take action.
Issue timely flood warnings Issue timely flood warnings for potential Category 1, 2 and 3 flood incidents. No flood warnings for Category 4 flood incidents.	Low risk of danger to the public and the built environment due to lack of warnings at lower priority incidents. Low risk of lower impact incidents escalating to high impact incidents. Good relations with Local Authorities and Emergency Services. High credibility with the public, media, Department for Environment Food and Rural Affairs (Defra), government Agencies etc. Little negative publicity in media due to failure to warn communities during floods.
Working in Co-operation with Professional Partners Provide information and advice from Incident Rooms to professional partners as requested during category 1 flood incidents. Attend all multi-agency Strategic groups. Attend multi-agency Tactical and Operational groups only where necessary for the avoidance of loss of life and/or for the safe and effective deployment of Environment Agency resources in undertaking their role and responsibilities.	Low risk of communication failure leading to a less effective response. Low risk of negative publicity in media. Some gaps in feedback from partners on the impact and needs of the communities affected by flooding to aid prioritisation of the Environment Agency's own activities. Fair relations with professional partners and the public.
Manage the Environment Agency's reputation Respond to media requests and interviews at the appropriate level Media trained operational staff available. Assist others in management of Very Important People (VIP) visits to affected areas. Proactive use of the Local media but no proactive promotion of national strategic issues.	Minor Increase in flood risk during the incident due to adverse and inaccurate media reporting causing the public to panic or fail to take effective action to mitigate against damage or protect themselves. Minor increase in flood risk over time after the flood incident due to lack of promotion of strategic flood risk issues during times of heightened awareness (e.g. climate change and development on the flood plain) Moderate credibility with the media, public, Defra and other Government Agencies.

Table 2.2 Response activities in the UK

Adopted incident response standard	Consequences of adopting standard
Operation of assets Operate Environment Agency Flood Defence assets in accordance with operating rules, during actual or likely category 1 or 2 flood incidents. Flood defence assets will only be operated on a best endeavours basis during actual or likely category 3 flood incidents. No manual intervention to operate flood defence assets during Category 4 incidents.	Low risk of danger to very small communities, individual properties, the public and the built environment due to non-attendance and non-operation of assets in response to low priority incidents. Risk of danger to public and the built environment due to non attendance at wrongly assessed incidents. Good credibility for the Agency. Fair relations with emergency services and Local Authorities Time taken dealing with incident follow-up. Lack of information or evidence to take action at non attended sites.
Monitoring and inspection Monitor and inspect flood defence assets with a condition rating 4 or 5 during actual or likely category 1 and 2 flood incidents. During actual or likely category 1 and 2 flood incidents, flood defence assets with a condition rating 3, with minimal risk to life, will be monitored on a best endeavours basis only related to degree of risk. No monitoring and inspection of flood defence assets with a condition rating 1 or 2 or during actual or likely Category 3 and 4 incidents.	Severe risk of danger to the public and the built environment due to non-identification of failure or likely failure of assets at low priority incidents. Severe risk of danger to the public and the built environment due to non-attendance at wrongly prioritised incidents. Risk of lower priority incidents escalating to a higher priority with much greater environmental impact. Loss of credibility of Environment Agency. Fair relations with Emergency Services and Local Authorities. Excessive time taken dealing with incident follow-up diverting resources. Significant negative publicity in media. Lack of information or evidence to take emergency action at non attended sites
Reactive response Attend flood defence assets that have failed, or where there is a significant risk of failure, that may result in Category 1 and 2 flood incidents. Take emergency action where feasible and safe to do so. On a best endeavours basis, attend and take emergency action at flood defence assets that have failed, or where there is a significant risk of failure, that may result in Category 3 flood incidents. No attendance or emergency action at: flood defence assets that have failed, or where there is a significant risk of failure, that may result in Category 4 flood incidents..	Risk of danger to the public and the built environment due to non-attendance of actual or potential failure of assets at low priority incidents. Low risk of danger to public and the built environment due to wrongly prioritising incidents. Loss credibility of Environment Agency with farmers and rural communities. Fair relations with emergency services and Local Authorities Considerable amount of time taken dealing with incident follow-up diverting resources. Lack of information or evidence to take action at non attended sites.
Erection of temporary defences Attend and provide advice to others in the erection/installation of temporary defences which may prevent Category 1 and 2 flood incidents. Provide assistance, including materials, equipment and erection/installation of temporary defences which may prevent Category 1 incidents and Category 2 flood incidents, in excess of 10 properties, on a best endeavours basis. Attendance unlikely where less than 10 properties involved No attendance at Category 3 or 4 flood incidents.	Moderate to low risk of danger to the public and the built environment due to absence of temporary defences. Low risk of lower impact incidents escalating to high impact incidents. Strained relations with some Local Authorities and Emergency Services. Credibility of the Agency in question due to inconsistent service delivery. Some negative publicity in media due to inconsistent service delivery.

2.2.4 Emergency response

‘Response’ encompasses the actions taken to deal with the immediate effects of an emergency. In many flood scenarios, it is likely to be relatively short and to last for a matter of hours or days, so rapid implementation of arrangements for collaboration, co-ordination and communication are, therefore, vital. Response encompasses the effort to deal not only with the direct effects of the flood itself (e.g. rescuing individuals, protecting property etc) but also the indirect effects (e.g. disruption, media interest etc).

Effective response procedures should be flexible and tailored but follow a common set of underpinning principles:

- Continuity (of working, but at a faster pace and in more testing circumstances);
- Preparedness (clarity of roles and responsibilities);
- Subsidiarity (decisions taken at lowest appropriate level, with co-ordination at highest necessary level);
- Direction (clarity of strategic aim and objectives, enabling prioritisation and focus of the response and recovery effort);
- Integration (effective co-ordination to produce integrated effort);
- Co-operation (positive engagement and information sharing);
- Communication;
- Anticipation (ongoing risk identification and analysis).

Flood response refers to the operations that may be initiated to reduce the hazard of an actual flood after a flood warning has been issued. These include road control, building up of defences, evacuation, rescue and providing information and advice to communities affected by flooding.

Road control may be undertaken by the police or local road authority, depending on local agreements. It involves closing roads which are liable to flood, planning and implementing detours, signposting, and be used to warn road users of flooding.

The Environment Agency and local authorities may build up defences using sand bags or other means, although sand bags have a number of disadvantages and are not used by some local authorities. Local authorities also provide labour, equipment and facilities for conducting a range of response tasks, including for example lifting or moving furniture for the elderly and disabled. Local authorities also provide temporary accommodation and food for evacuees.

Flood wardens are members of the community, who will always be available during the time of a flood. It should be noted that many floodplain residents will be preoccupied and therefore unable to undertake flood warden duties. Each flood warden is allocated a group of properties, and they are responsible for making sure everyone is aware of the flood. In addition, wardens may facilitate the evacuation of individuals, particularly families with children, the elderly and other vulnerable groups. Flood wardens must be identifiable and known to the local community.

2.2.5 Management and co-ordination of local operations

The objectives for a combined response to a flooding emergency are as follows:

- Saving and protecting life;
- Relieving suffering;
- Containing the emergency;
- Providing the public with warnings, advice and information;
- Safeguarding the environment;
- Protecting property;
- Maintaining or restoring critical services;

- Maintaining normal services at an appropriate level;
- Promoting and facilitating self-help in the community;
- Facilitating investigations;
- Facilitating the physical, social, economic and psychological recovery of the community; and
- Evaluating the response and recovery effort and identifying lessons to be learned.

There is a general national framework in use for managing emergency response and recovery that is applicable irrespective of size, nature or cause of an emergency, but remains flexible enough to be adapted to the needs of particular circumstances. Adoption of this nationally agreed management framework helps integrate plans and procedures between and within agencies and across geographical boundaries. It also ensures that all agencies understand their roles and responsibilities in the combined response. The framework identifies the various tiers of management in emergency response and recovery, and defines relationships between them. It provides a framework within which individual agencies can develop their own response and recovery plans and procedures.

Within the framework, the management of the response and recovery effort is undertaken at one or more of three ascending levels, which are defined by their differing functions rather than by specific rank, grade or status:

- **Bronze** – operational level;
- **Silver** – tactical level;
- **Gold** – strategic level.

In rapid onset emergencies within a limited geographical area, the emergency management framework will usually be constructed from the bottom up and the bronze level will be activated first. Escalation of the event or greater awareness of the situation may require the implementation of a silver or even a gold level.

Bronze

This is the level at which the management of immediate “hands-on” work is undertaken at the site of the emergency or other affected areas. Personnel first on the scene will take immediate steps to assess the nature and extent of the problem. Bronze commanders will concentrate efforts and resources on specific tasks within their areas of responsibility. The police will generally co-ordinate an operational response. Where the silver level of management is established, bronze commanders become responsible for implementing the silver commander’s tactical plan.

Silver

The purpose of the silver command is to ensure that actions taken by the bronze are co-ordinated, coherent and integrated in order to achieve maximum effectiveness and efficiency. Silver commanders will:

- Determine priorities for allocating resources;
- Plan and co-ordinate how and when tasks will be undertaken;
- Obtain additional resources if required;
- Assess significant risks and use this to inform tasking of bronze commanders;
- Ensure the health and safety of the public and personnel.

In a rapid onset emergency when there is an identifiable scene and the emergency services are in the lead, then silver will usually work from an incident control point located nearby or adjacent to the flooded area.

Where there is more than one scene or incident, it may be necessary to invoke the gold level of management to take overall command and set the strategic direction. Once this occurs, silver

commanders continue to effect multi-agency co-ordination within their area of responsibility, while simultaneously directing tactical operations within the strategic direction and parameters set by gold.

Gold

Gold command is triggered where an event or situation is likely to have:

- Especially significant impact;
- Substantial resource implications;
- Large number of organisations;
- An extended duration.

The multi-agency group, which brings together gold commanders from relevant organisations, is called the Strategic Co-ordinating Group (SCG). The SCG will:

- Determine and promulgate a clear strategic aim and objectives and review them regularly;
- Establish a policy framework for the overall management of the event or situation;
- Prioritise the demands of silver and allocate personnel and resources to meet requirements;
- Formulate and implement media-handling and public communication plans; and
- Direct planning and operations beyond the immediate response in order to facilitate the recovery process.

In most emergencies with significant recovery implications, a Recovery Working Group (RWG) will also be established. For a flood emergency, it will normally be the role of the police to co-ordinate the gold management level and therefore to chair the SCG. Depending on the nature, extent and severity of the emergency, either the regional tier or central government may become involved. The SCG will then become the primary interface with these other levels of response.

Arrangements necessary in the immediate vicinity of the flood include:

- Assessing control measures with regard to reducing risk;
- Deciding the functions to be controlled by each agency after taking account of:
 - the circumstances;
 - the professional expertise of the emergency services and other agencies;
 - statutory obligations; and
 - overall priorities;
- Reception and engagement of utility companies' staff (e.g. gas, electricity and water) on essential safety work, or to effect the restoration of essential services, where appropriate; and
- Setting up an inner cordon to secure the immediate scene and provide a measure of protection for personnel working within the area, as illustrated in the Figure 2.1 below. All those entering the inner cordon should report to a designated cordon access point. This ensures that they can be safely accounted for should there be any escalation of the incident, and affords an opportunity for briefing about the evacuation signal, hazards, control measures and other issues about which they need to be aware. People entering the inner cordon must have an appropriate level of personal protective equipment, while those leaving must register their departure.

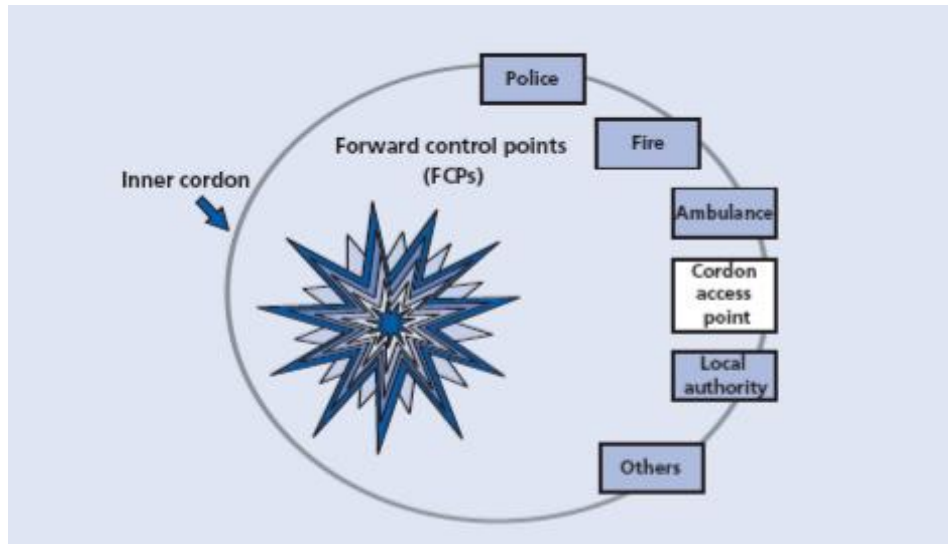


Figure 2.1 Setting up an inner cordon for incident control

If practical, an outer cordon may have to be established around the vicinity of the incident to control access to a much wider area around the site as shown in Figure 2.2. This will allow the emergency services and other agencies to work unhindered and in privacy. Access through the outer cordon for essential non-emergency service personnel should be by way of a scene access control point.

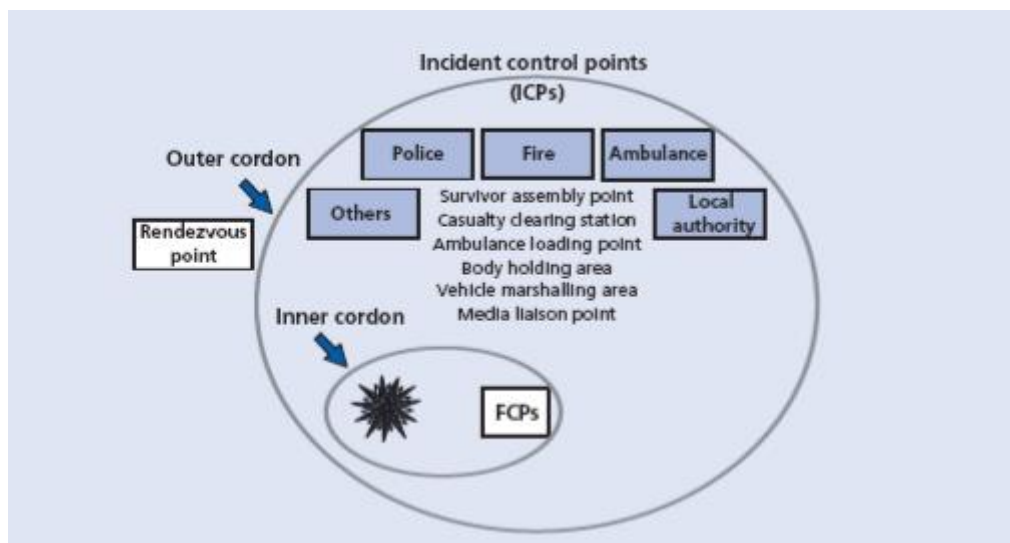


Figure 2.2 Setting up an outer cordon for incident control

Other issues that should be addressed at this level include:

- Establishing internal traffic routes for emergency and other vehicles (including a one-way system where appropriate); and
- Deciding on the location of key functions or facilities, for example:
 - Casualty clearing station(s) to which the injured can be taken;
 - An ambulance loading point for those who need to be taken to hospital;
 - A collection/assembly point for survivors before they are taken to a Survivor Reception Centre;
 - Possible helicopter landing site(s);

- A rendezvous point or points for all responding personnel, which may be some distance from the scene in the event of a bomb incident or incidents involving hazardous materials;
- A marshalling area for assembling vehicles and equipment;
- A body holding area that is under cover and protected from public view;
- A media liaison point.

2.2.6 *Evacuation planning*

It is important to note that in the UK evacuation can only be advised not ordered. The possible need for evacuation of the public from the immediate vicinity may have to be considered at a very early stage. In some circumstances it may be necessary to advise the public on whether they should evacuate a given area or remain and shelter indoors.

It is normally the police who recommend whether or not to evacuate and define the area to be evacuated. Their recommendation will take account of advice from other agencies. The Fire and Rescue Service will inform them about risks associated with fire, contamination and other hazards. Ambulance services and local authorities can advise on problems associated with moving people who are frail, disabled or at risk for any other reason. Local authorities will also be able to identify individuals or groups of individuals that may need particular support. Local authorities can also advise on the location of pre-designated rest centres and on other possible places of shelter within the area.

The police can only recommend evacuation and have no power (except within the inner cordon in response to a terrorist incident) to require responsible adults to leave their homes. Past experience has shown that people with domestic pets may be unwilling to leave their homes unless arrangements include them.

In deciding whether to evacuate or not, it is necessary to assess whether bringing people outdoors may put them at greater risk than leaving them where they are to shelter indoors. This is particularly important where flood water levels are likely to rise quickly.

When planning for contingencies, building occupiers should seek professional advice on whether there are areas in the building where people can shelter safely. Such areas must be structurally robust and should be equipped with telephones, first-aid facilities, adjacent toilet facilities and a water supply.

There are particular problems in evacuating hospitals, prisons and nursing homes, and in evacuating those individuals who are at home, but are frail or vulnerable. Large scale evacuation is a last resort owing to the length of time it takes to complete and the risks the public may be exposed to as a consequence of being evacuated. Local planning should include arrangements to support people sheltering in their own homes where this is the safest option.

However, when there is a decision to evacuate, evacuation assembly points should be set up near the affected area. If time permits, these should be signposted. People in the affected area should be advised to go to their nearest evacuation assembly point. People taking prescribed and other medications should be reminded to carry these with them, and particular attention needs to be paid to those with sensory impairment.

Bearing in mind that evacuation may be at different times of day or night and from locations as different as homes, industrial complexes, shopping malls, venues, ports or airports, various methods can be used for warning and informing the public: loudhailers, tannoy, mobile public address systems, radio or TV announcements, works sirens, display screens, scoreboards and monitors, or various combinations of these methods.

The police will, as far as is practicable, take steps to ensure the security of property left empty after evacuation. In the event of an extended evacuation, the local authority may have to consider other security arrangements.

Arrangements for warning, evacuation and securing property must take account of any safety risks to emergency service and local authority personnel that arise from exposure to hazards. At the evacuation assembly point, the dispersal of evacuees to survivor reception centres or rest centres must be co-ordinated.

2.2.7 *Evacuation and rescue models currently used in the UK*

There are currently no models used or under development to support evacuation and rescue for flood management in the UK. The response to flood risk management in the UK has mainly focused on flood defence asset management, and forecasting and warning to reduce flood risk rather than on organised evacuation.

2.2.8 *Conclusions*

The following conclusions can be reached for the UK regarding flood management

- The emergency response to incidents in the UK is governed by the Civil Contingencies Act 2004;
- It is not the Environment Agency's responsibility to organise evacuation as a part of an emergency response to flooding;
- Timing, speed and method of communication of reports are critical to effective emergency management during a flood;
- More robust and integrated communication links between the organisations involved in the response during a flood helps to ensure an effective response;
- Organised evacuation is only used as a form of emergency response in very rare circumstances. The authorities have no powers to forcibly evacuate people from their houses during floods. In terms of evacuation normally people "self-evacuate";
- The response to flood risk management in the UK has mainly focused on flood defence asset management, and forecasting and warning to reduce flood risk rather than on organised evacuation.

2.3 *The Netherlands*

2.3.1 *The legal framework for flood management and emergencies*

Background

There are three administrative levels in the Netherlands:

- National level. At this level there is the Council of Ministers and the related ministries and the Dutch parliament.
- Provincial level: There are 12 provinces, each with a Provincial Council. This is similar to a provincial parliament that nominates a provincial executive board (the 'deputies'), chaired by the Provincial Governor (the Queen's Commissioner).
- Municipal level: A Municipal Council, municipal executives (the aldermen) appointed by the council, and a Mayor as chairman of council and aldermen.

All the above levels play different roles in the management of flood emergencies. These are described below.

Relevant flood mitigation legislation

The primary law relating to flooding in the Netherlands is the Flood Protection Act, 1996 (Wet op de waterkering). The Flood Protection Act specifies the level of safety against flooding for all areas in the Netherlands that are protected by dikes. The level of service of the defences is not the same for the whole country. The level of service of the defences depends on the number of people that live behind them and on the economic value of the elements at risk. The Flood Protection Act describes a system of primary water defences that protect 53 lowland dike ring areas with different protection levels, varying from a 1 in 500 year failure probability for some 'void' areas, to a 1 in 10,000 year level of service for the densely populated western part of the Netherlands. In 2005 42 small dike rings along the Meuse were added to the system. They have a failure probability of 1 in 250 per year. The system of primary dike rings is shown in Figure 2.3.

The Flood Protection Act also refers to the high-water reference levels related to the failure probability for certain locations. Every five years the Ministry of Transport, Public Works and Water Management determines, for a number of locations along each dike ring, the high-water reference levels that the managing institutions of the primary dikes and hydraulic structures have to take into account to comply with the prescribed failure probability. Most dikes and structures are managed by a water board. The high-water reference levels and related probabilities are published in a document known as the Boundary conditions book (Randvoorwaardenboek), which reflects the latest research on for instance the effect of the climate change on flood levels.

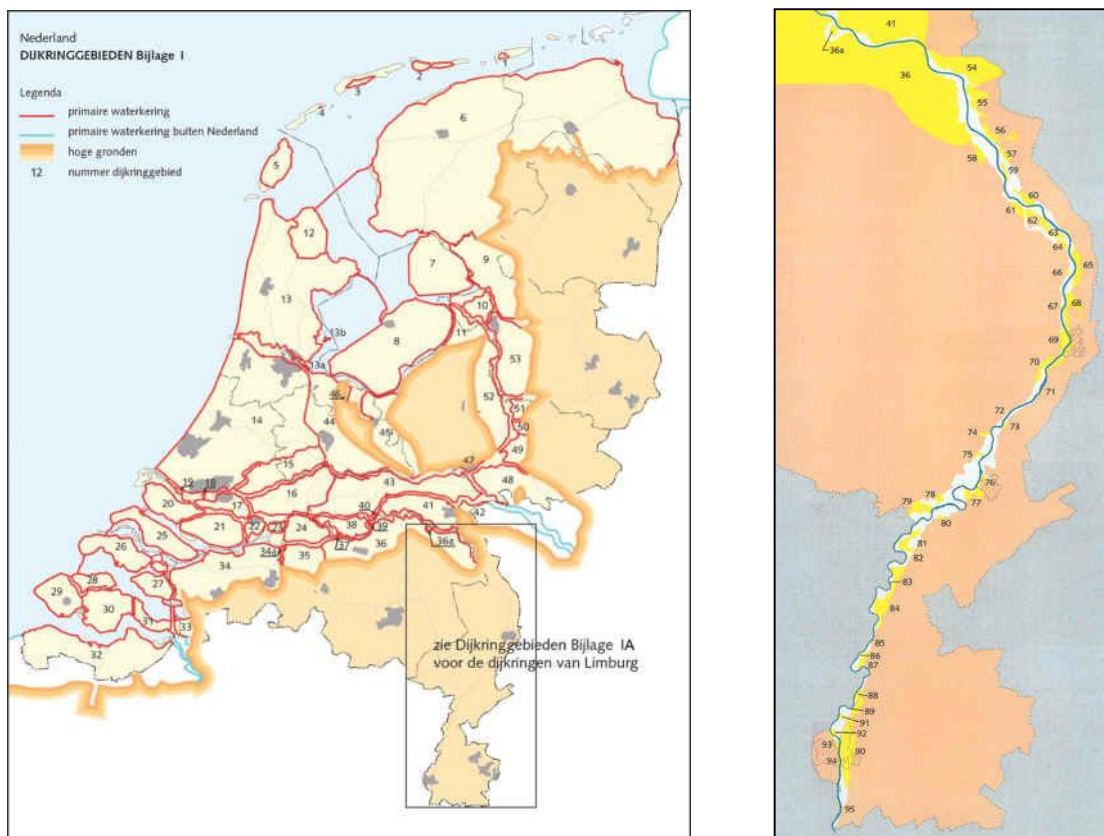


Figure 2.3 System of primary water defences and dike rings in the Netherlands

The provincial level of government has responsibility for the supervision of all primary water defences in its region. Every five years the managers of the dikes and structures, often the water boards, have to report to the province about the condition of the water defences. Based on the reference levels the water defence managers determine if their dikes and structures are still compliant with the latest boundary conditions for the required level of service. The reports are summarised and commented on

by the provinces and by the ministry, and finally discussed in parliament. The results of this discussion guide investments related to the improvement of the flood defence system.

The water boards control the majority of the primary flood defences. There is a special Water Boards Act, 1991 (Waterschapswet). The act outlines the responsibility of the water boards to keep the water defences in good condition. The provinces control the water boards. However, the act mainly deals with regulations concerning the creation of water boards by the provinces, regulations concerning the composition of the Water Board's Council and the ability to issue regulations, as well as matter related to financing and taxes.

The Water Administration Act, 1900 (Waterstaatswet) deals with the management of 'waterstaatswerken', described as the surface water and water defences, including the related structures, on a national, regional or municipal scale. With respect to flood conditions the act gives specific directives in §17: Provisions for preparation and acting in case of danger ('Voorzieningen inzake voorbereiding op en optreden bij gevaar').

This act provides guidance to 'water managers' concerning what are known as "calamity plans". Such a plan includes an inventory of the kind of emergencies that may happen and their potential risks, the measures to be taken, the required equipment and the services to be provided by different institutions. The following are also included in the plan:

- The organisation of the emergency response team;
- The warning and reporting procedures;
- The quality assurance of the plan.

Finally the act requires regular exercises to be carried out. The plans require updating at least every four years.

In 1999 the Rivers Act of 1908 was withdrawn and integrated with the Act on State Waters and Infrastructure, 1996 (Wet Beheer Rijkswaterstaatswerken). The main objective of this act is to control the construction of properties in the state waterways.

There are several general laws that have an indirect relation with flood management. The Provincial Act, 1992 (Provinciewet) defines the internal organisation of a province and its relations with the government, municipalities and water boards. Apart from the water boards, the act does not contain specific information on the issues such as water, floods or emergencies. The Local Government Act, 1992 (Gemeentewet) describes similar items for the municipality as the Provincial Act does for the province. However, Article 175 of the act¹ allows in the case of emergencies and disasters, full power to be delegated to the mayor to act as necessary. The mayor is allowed to override other regulations, except those in the Dutch constitution.

The Act on disasters and severe accidents, 1985 (Wet rampen en zware ongevallen) is also applicable for flood emergencies. The act deals mainly with the preparation of emergency management plans by municipalities and the provinces. In accordance with the Local Government Act the mayor has the primary responsibility to act in case of an emergency. The commander of the fire brigade has the operational command, under the supervision of the mayor. For emergencies that exceed the territory of the municipality the mayor can ask assistance from the provincial governor. In the case of a national disaster the Minister of Home Affairs may get involved.

¹ Artikel 175: In geval van oproerige beweging, van andere ernstige wanordelijkheden of van rampen of zware ongevallen, dan wel van ernstige vrees voor het ontstaan daarvan, is de burgemeester bevoegd alle bevelen te geven die hij ter handhaving van de openbare orde of ter beperking van gevaar nodig acht. Daarbij kan van andere dan bij de Grondwet gestelde voorschriften worden afgeweken.

2.3.2 *Institutional framework*

Emergencies are dealt with at three different administrative levels in the Netherlands as follows:

- Municipality level;
- Provincial level;
- National level.

In the case of an imminent flood posing a threat, the municipality is the primary managerial level for this type of emergency, with the mayor in command. However, it will be clear that a flood will seldom be limited to one municipality's boundaries. For example, a dike failure will result in an inundation that will gradually spread out over the protected dike ring area, as shown in Figure 2.3. During this process more and more municipalities may get affected. To cope with this 'supra-municipal' aspect the individual mayors concerned can choose one of them as the coordinating mayor. If the flooding remains regional the provincial level of government is involved at an administrative level. The national government level will of course be informed and provide assistance and directions where needed, but it will not lead the operation.

At the provincial level, the provincial governor (the queen's commissioner) is the highest administrative official. The duties and competences of the provincial governor during a regional emergency will probably change somewhat in the near future, when the recommendations of recent advice to the government are implemented. Currently under Dutch law the provincial governor can 'direct' and assist, but is not in command.

The province draws up the provincial emergency coordination plan. The governor screens the municipal emergency management plans and can enforce changes in such plans. In the case of an emergency the governor can make available the input of provincial services and can act as intermediary between the (coordinating) mayor and regional or governmental institutions for the supply of assistance. The governor also has the power to give directions to a mayor with regard to the actions to be taken during an emergency and to provide the operational management in a 'supra-municipal' disaster area. In case of a *national* disaster the Minister of Home Affairs coordinates on the governmental level with support from the National Coordination Centre.

The chain of functional responsibility with respect to flooding consists of the following organisations:

- The Water Board, which is a regional water management organisation and responsible for the primary dikes of one or more dike rings. If the water retaining function of a dike is in jeopardy the water board has the power to appropriate properties and instruct inhabitants in the dike ring to assist with and to make available vehicles and tools to combat a threatening inundation.
- The Provincial Water and Environment Service supervises the functioning of the water boards. The service can give instructions to the water boards on supply from or discharge to surface water that is not managed by government or province.
- The Ministry of Transport, Public Works and Water Management and its executing agency Rijkswaterstaat assess water levels that trigger various levels of warning in the main rivers and in the IJsselmeer every year. Rijkswaterstaat's Institute for Inland Water Management and Waste Water Treatment provides actual water levels and predictions on a regular basis. In the case of a threatening flood the frequency of the updates on water level and prediction is increased. The Ministry gives instructions to a province on the supply and discharge of water under extreme conditions.

The main professional emergency rescue and aid providers during flood conditions and evacuation, acting under the supervision of the (coordinating) mayor, are:

- The fire brigade, for rescue, technical assistance and providing emergency pump capacity.

- The medical and public health institutions, who provide urgent medical and mental health care, and preventive health care.
- The police who maintain public order, criminal inquiries, traffic regulation, closing and guarding certain areas, and identification of casualties.
- The municipality who is responsible for the registration of victims, burial, damage registration.
- The municipality usually takes responsibility for warning the public, an actual evacuation (people, livestock), provision of primary needs (shelter, food, clean water), and environmental care (during an inundation dangerous substances may start floating around).

Figure 2.4 shows the operational and administrative responsibilities in a flood emergency in the Netherlands.

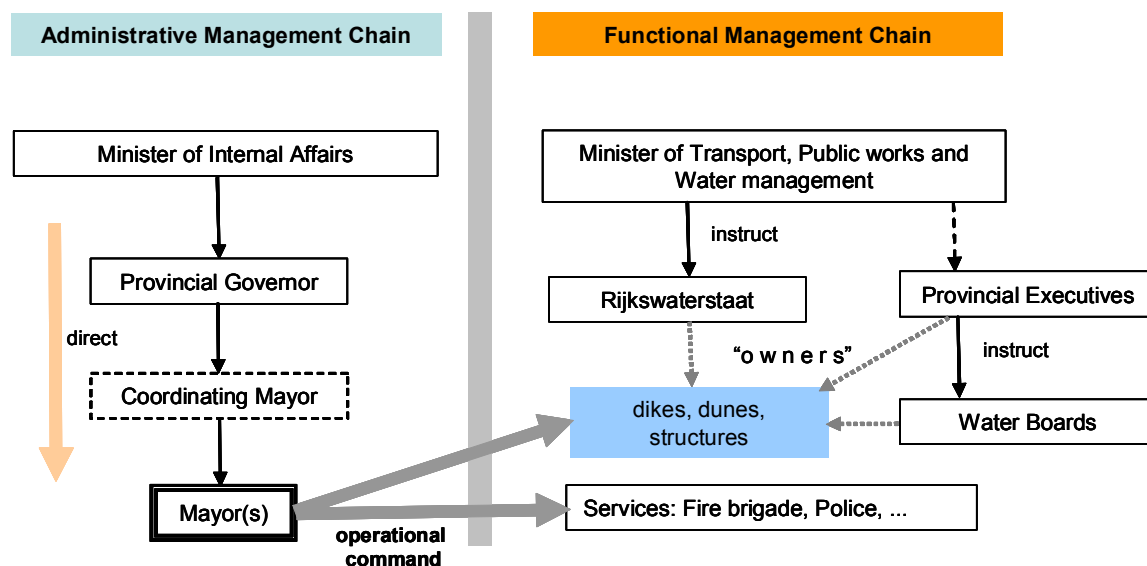


Figure 2.4 Administrative and operational responsibilities in a flood emergency in the Netherlands

2.3.3 Emergency flood management

When a flood is expected or after flooding has actually started, there is a wide variety of measures that can be implemented. With respect to infrastructure the following measures may apply.

Closure of infrastructure

There are many structures in the primary dikes that protect a dike ring area. These include ship locks, sluices, non-return sluices, pumping stations, tunnels and 'coupures'. The latter are gaps in the dike that allow traffic to move between the protected dike ring and areas outside the dike, like quays and harbour areas.

The structures in the primary dike ring have instructions as to what the managing institution of a structure should do if certain flood warning levels are predicted or have been reached. The measures to be taken usually consist of closing doors, gates or valves. The owners of these structures are obliged to perform test closures at regular intervals, usually once a year. In such a test the whole chain from the forecasting of a high water level, alert, warning and mobilisation of personnel, and the actual closing is tested. In such a test potential weak points in the procedures are detailed, for example, keys of gates that are missing, emergency power generators that did not start. For coupures the closing devices are often steel or wooden bars that have to be placed in grooves. For example, often they are not stored at the structure's location but elsewhere, in a municipal workshop or similar.

Temporary reinforcements of dikes

For certain sections of the dike a high-water alert may call for temporary measures. Some dikes may have a crest height that is not yet been constructed to the latest design flood level, or the height may be sufficient but the slope protection is still insufficient to resist design waves (the outer slope) or the effect of overtopping waves (the inner slope). In these cases a temporary additional protection with sandbags may be necessary.

There are also dikes that are sensitive to piping. This is where seepage through the dike may cause an internal erosion of the dike core material and the formation of pipes through which a water flow may develop that can affect the dike stability. The dike sections that are vulnerable to piping are usually known to the authorities. At such locations sand bags are placed on the inner dike toe to provide a counter pressure to reduce piping.

Activation of retention areas

The use of retention areas to reduce flood levels has been seriously studied by a Governmental Commission. The commission's report was submitted in 2002. It considers the use and necessity of retention areas. Areas where a controlled inundation is accepted in a critical flood situation, to prevent an uncontrolled inundation at some other place. This is known in Dutch as a 'noodoverloopgebieden' i.e. emergency inundation areas. The report considered a number of potentially suitable areas along the Rhine and Meuse. However, currently no retention area has the final status of 'noodoverloopgebied' that will be used in a future flood emergency. The reasons for this are various including the financial compensation required to pay the affected inhabitants, the critical timing to obtain an optimum effect of a retention area and because nobody wants to inhabit these areas.

Closure of storm surge barriers and gates

There are three structures in the Netherlands that have a key role when there is a severe threat of flooding. They are all located in the western part of the Netherlands, where the threat from the North Sea is dominant:

- The Hollandse IJssel barrier (1958) located just east of Rotterdam. It was constructed after the 1953 flood disaster for extra protection of the low areas along the Hollandse IJssel which is under normal conditions in open connection with North Sea. With a level of down to 6 m below sea-level this area is in fact the lowest of the country. During the 1953 disaster the stability of some dike sections there was critical, they nearly failed. One dike section was just prevented from collapsing by sinking a river-vessel on its slope.
- The Eastern Scheldt storm surge barrier (1986) protects the dikes along the Eastern Scheldt estuary. It is closed as soon as the North Sea reaches a certain level. It was constructed as an alternative for the originally planned enclosure dike, to preserve the tidal regime and its related very special ecological system, but also to maintain the high value fishery and aquaculture area (e.g. mussels, oysters).
- The Maeslant storm surge barrier (1997) provides extra protection of the urban and industrial areas along the Rotterdam Waterway.

The expression 'extra protection' as used here needs some clarification. The primary dikes along the dike ring form the primary water defence. However, the safety given by either of these barriers could compensate the need for further heightening of dike sections to comply with the safety levels in the Flood Protection Act. Dikes in this part of the country are often in densely built urban areas, and consequently dike improvement is a complicated and expensive matter.

Raising demountable flood walls and pumping

Demountable flood walls are mainly applied in the Meuse basin in the province of Limburg. As soon as a local warning level is reached the demountable flood wall units are mobilised and put in place. They usually protect only small areas such as quays or streets along the river. The height of these

structures does not usually exceed more than one metre. In fact coupures without a permanent closing device also belong to this category. Pumping is usually only applied to get rid of water that leaks through (temporary) closing devices, e.g. sand bags. It is not used as a measure on its own.

Evacuation and rescue

In the Netherlands the view is taken that preferably an evacuation should be preventive. Timing of a preventative evacuation is crucial. For example, if the evacuation takes place and eventually no flooding occurs there are numerous political and financial ramifications. However, if the evacuation starts too late and is not completed before the failure of dikes or structures, the risk of casualties as a result of flooding is high. In the 1953 flood disaster in the south-western part of the Netherlands there was little preventive evacuation.

The high-water in the Rhine in January 1995 provoked a large-scale preventive evacuation in the polder areas along the Rhine branches in the province of Gelderland. About 175,000 people were evacuated from these areas². This was the first time since 1953 that a major inundation threatened and that an evacuation had to be considered seriously, and finally realised. Although no flooding occurred in 1995 this event acted as a catalyst to streamline the organisational processes and the information flows before and during an evacuation.

2.3.4 Methods and models to support emergency evacuation

The large-scale preventive evacuation during the 1995 flood emergency led the Dutch authorities, to improve the collection and dissemination of information during a flood emergency and to streamline the cooperation between the many partners involved. Several activities were initiated. To provide the parties concerned with timely and reliable information the Rijkswaterstaat agency, part of the Ministry of Transport, Public Works and Water Management, started the development of the automated High-water Information System (HIS). This system consists of an operational part, for fast and adequate action during a flood emergency, and of a policy part that helps all parties that may get involved in a flood emergency to be well-prepared.

The policy part contains three modules:

- The inundation module, which shows what happens if a dike fails at a specific location. For example, how fast will the polder inundate, what parts are inundated first and what will be the inundation depth as a function of time. This allows the measures that will be most effective to minimise the effects of the inundation to be estimated.
- The damage and casualties module determines the consequences of a dike failure. On the basis of data on the inundation depths and current velocities in the inundated area, calculated by the inundation module or originating from another source, the damage is calculated in terms of casualties³, victims and economic losses. This information will allow an assessment of the effect of different measures to mitigate flood damage. One interesting option of the module is that it can also be used to determine the positive effects of a preventive evacuation in terms of the number of casualties and victims that can be avoided.
- The evacuation calculator provides useful information for the preparation of regional evacuation plans. The input data for the evacuation calculator consists of:
 - The network of potential evacuation routes and their capacity;
 - Data on the capacity of the exits of the area to be evacuated;
 - The 'evacuation load' to the nodes of the network: people, cattle and goods to be evacuated.

² 75,000 people in Bommelerwaard, Ooijpolder, Land van Maas en Waal, Land van Heusden en Altena; 100,000 people from Culemborgerwaard and Tielervwaard

³ The word '*casualty*' is rather ambiguous; it is used here in the sense of loss of live (so only cases of drowning, no broken legs or similar repairable injuries). *Victims* are people affected in some way by the inundation. Economic losses are damage to properties (private or public) and production losses.

On the basis of this input and a traffic model the evacuation calculator calculates the time needed to evacuate the area along the available routes to the exits of the area. The traffic model applies different options to manage the outflow of evacuees, by providing different degrees of control over departure time and exit routes to follow.

The operational part of the HIS consists of two modules:

- The monitoring module provides a detailed map of the measures and predicted water levels for the situation where there is no inundation yet. The module compares these water levels with the crest levels of the water defences and gives a red alert on the map for any alarming situation. An example of such a map is shown in Figure 2.5.
- The logbook module enables the users of the HIS to save the messages that reach the coordination centre. The messages may, for example, refer to water leaking through structures, reports on dike seepage, navigation, blocked roads.

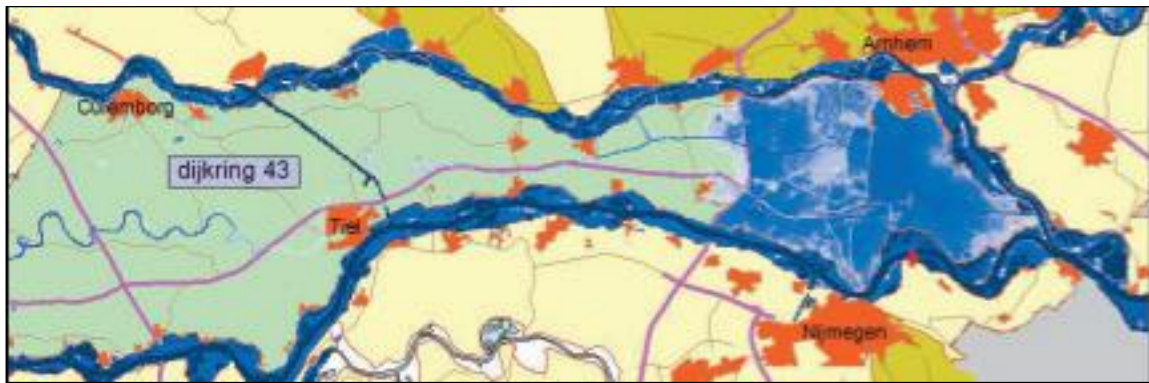


Figure 2.5 Example of a map of the Dike ring 43 in the Netherlands inundated area after 24 hours

In parallel to the development of the HIS a number of water boards have developed an Automated Script for High-water (GDH, Geautomatiseerd Draaiboek Hoogwater) to handle the complex data flows during the occurrence of a flood in the main rivers. The GDH contains all the information of the existing scripts on paper for high-water situations, with the actions to be executed if certain water levels are reached or exceeded. The GDH keeps track of all the required actions and their status.

The development of both systems stopped around 2004, when it was decided to integrate with the newly commissioned German-Dutch EU Interreg-IIIb project entitled NOAH. The NOAH partners are STOWA (a Dutch foundation for applied research in water management), four Dutch water boards, Rijkswaterstaat and the German Regierungspräsidium Karlsruhe (with six local public authorities) and the Hochwasser-schutzzentrale in Stadt Köln. Part of this project is the development and implementation of a new web-based IT flood emergency information system called FLIWAS (Flood Information and Warning System). The system will include an evacuation module for which the Evacuation Calculator of HIS will be the basis. The Fliwas project is planned to be ready in 2007.

The FLIWAS project concentrates on fluvial flooding. Another EU funded project, ESCAPE, focussed on the risks of coastal flooding, where the prediction time is often much shorter than for fluvial flooding. In the Escape project authorities from Dutch, Belgian and English regions cooperated. In 2002 to 2004 a DSS was developed and tested, again based on inundation calculations and GIS. The Escape DSS also contained a module for the calculation of potential damage and casualties as a result of inundation, and a module that permits the calculation of the time required for the evacuation of a certain area as a function of the location and number of people to evacuate, the capacity of evacuation roads and the available exits of the area.

2.3.5 Conclusions

Most of the preventative measures for floods taken in the Netherlands are related to infrastructure. There are a number of structures that need to be closed to prevent flooding. If such devices were only used during actual emergency situations, there is a fair chance that the closure may fail. Therefore most management plans of hydraulic structures contain prescribed test closures, for instance once per year.

Preventive evacuation is a quite drastic measure that often affects many people. The decision to evacuate must be based on reliable data that are available at the right time to the right people. After the 1995 flood emergency the managing authorities made great efforts in the development of decision support systems and tools (e.g. ESCAPE, Evacuation Calculator, Fliwas). However, they have not yet been applied to an actual flood emergency. To date these tools have only been used in exercises. The main lesson identified from the exercise was that effective communication between the many parties involved is difficult in flood incident management. It appeared that sometimes information was not shared or not transmitted via the prescribed channels.

2.4 Germany

2.4.1 The legal and institutional background

Legal framework

Germany is a federal republic comprising 16 federal states. Within the federal states there are different administrative districts at a regional level. At the next level there are rural counties and urban districts. All other municipalities belong to a county or are urban districts. As a result of the administrative system in Germany there are two different kinds of legislative competencies (Article 70 et seq. basic law): The competence of the federation, called “exclusive competence”, and the “competing competence” that means that the federation has only guiding competences and the federal states have the legislative competence. Examples of the exclusive competence of the federation are currency issues, air traffic and telecommunication. For example, the competing competence is used in matters of water management, disaster protection and nature protection. Emergency flood management in terms of preparation and averting danger is part of disaster protection. The following sections give an overview of the acts and responsibilities in civil defence and disaster protection in Germany.

With regards to water issues there is the Water Balance Act of 27 July 1957 on the level of the federation which has been changed and endorsed lastly in 3rd May 2005. It includes regulations for surface waters, coastal waters, groundwater, water management and the regulations for surface waters also contain rules for flood protection (§§ 31a to 32), such as principles of flood protection, floodplains and flood-prone areas, flood protection plans and co-operation in catchments. These regulations deal primarily with flood prevention. Owing to the competing competence, the federal states have their own Water Acts, e. g. Saxon Water Act. The Saxon Water Act has a similar structure to the German Water Balance Act. One part deals with flood protection, too (§§ 99 to 100b). Flood protection, flood protection action plans, flood protection concepts, floodplains and source areas are explicitly mentioned.

The regulations of the Water Balance Act are related to flood prevention, but not to emergency flood management. They have been recently enhanced by the Act for the Improvement of Preventive Flood Protection (Flood Protection Act) dated 3 May 2005. For disaster protection there are the Civil Defence Act at a federal level and the Disaster Protection Acts in the federal states. The Civil Defence Act of 25 March 1997 only regulates defence in case of attack and therefore the protection against enemy actions. The act covers self-protection, warning of the population, accomplishing measures for health protection and for the protection of cultural heritage.

The federal states are responsible for disaster protection. Hence, every federal state has its own Disaster Protection Act, e. g.:

- Bavaria: Bavarian Disaster Protection Act (BayKSG);
- Baden-Württemberg: Act for Disaster Protection (LKatSG);
- Saxony: Act for Rearrangement of the Fire Protection, Rescue and Disaster Protection (BRKG);
- North Rhine-Westphalia: Act for Fire Protection and Salvage (FSHG).

The Disaster Protection Acts of the federal states deal mostly with three issues:

- Fire control;
- Rescue issues;
- Disaster protection.

In most acts the term “disaster protection” is defined and the responsibilities are regulated and authorities including their tasks are named. For instance the Disaster Protection Act of Saxony names three disaster protection authorities and their main tasks of preparing for a disaster and mitigating its impacts (e. g. emergency flood event) (§§ 7 and 8). The Disaster Protection Act of North Rhine-Westphalia also rules preparative and operational defence measures for the case of an emergency such as a flood (§§ 21 to 24 and 25 to 31). It also names three controlling institutions and disaster protection authorities (§ 33) (for details see chapter 1.2). Furthermore, there can be additional orders and regulations at a ministry level. In every federal state the Ministry of the Interior is responsible for disaster protection. For example, in Saxony there is the Disaster Protection Order (KatSVO) which provides more detailed regulations concerning emergency planning and disaster management. There is also an administrative regulation of the Saxon Ministry of the Interior on the ambulance units and on the water officials for disaster protection. Moreover, there is an administrative regulation of the Saxon Ministry of the Interior concerning disaster protection planning in the Free State of Saxony (KatSPlanungsVwV) of 30 April 2002. This regulation rules the compilation and updating of general disaster protection plans and of special alarm and operation plans by the lower disaster protection authorities (i.e. at a county level).

In the North Rhine-Westphalia the Ministry of the Interior an Order on Crisis Management has been enacted. In this order the principles of crisis management are listed and tasks and structures are defined and explained. However, even at a ministry level the orders often do not contain much guidance on evacuation planning. This is because the responsibility for disaster protection lies with the rural counties and urban districts. Figure 2.6 shows the important acts and orders for disaster protection which include emergency flood management and the main tasks they are responsible for.

Institutional framework

As previously described flood emergency management in Germany is part of disaster protection which is the responsibility of the federal states. There are three institutional levels for disaster protection:

- The federal state level;
- The regional level;
- The municipal/rural county level.

The national level does not have “commanding functions” in this regard but has to complement the disaster protection by the formation of the federal agency Technical public social aid (THW). At a federal state level, the Ministries for the Interior are responsible for intra-regional tasks of disaster protection such as central measures and for forming of guiding devices. The Ministries of the Interior can be supported by further ministries or offices. The regional councils can be responsible for the coordination of the rural counties. However, the rural counties and urban districts are the executive authorities. At this level the fire brigades, public social-aid organisations, rescue, police and appropriate authorities work together. Sometimes there is an additional department for disaster protection and a department for the environment, in addition a flood protection centre may be formed.

This is done mainly in large cities. Owing to the specific regulations in the federal states, the following description of emergency flood management is based upon examples. The federal states of Saxony and North Rhine-Westphalia have been chosen because of their particular exposure to floods and their representation of a western and an eastern federal state.

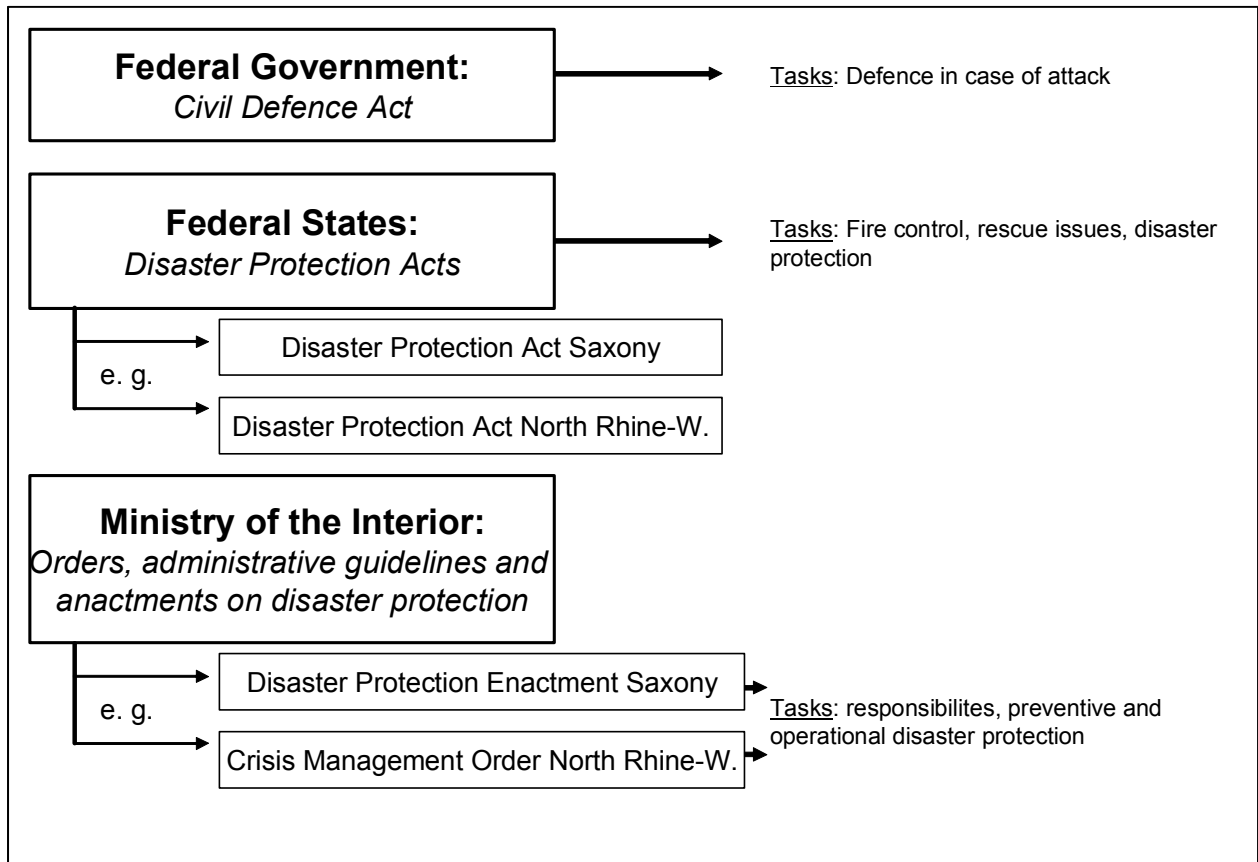


Figure 2.6 Acts and orders for disaster protection in Germany relevant to emergency flood management.

Flood emergency management in Saxony

The organisation of flood emergency management is shown in Figure 2.7. There are three disaster protection authorities on different levels: the highest, the higher and the lower Disaster Protection Authority. In Saxony the Ministry of the Interior is the highest disaster protection authority (department police head quarters, unit fire control, rescue and disaster protection). Under §8 (1) Saxon Disaster Protection Act it has to provide the legal and organisational framework for disaster protection and to support the lower authorities in their tasks. Hence, potential disasters have to be analysed and an “information programme” for the disaster management has to be provided. The highest disaster protection authority arranges the contacts with the other federal states. If necessary, the highest disaster protection authority takes over responsibility for the emergency.

The Ministry of the Interior is supported by the Saxon Ministry of Agriculture and Environment (SMUL) and the Saxon State Office of Environment and Geology (LfUG) which belongs to the SMUL. The LfUG forms the Flood Protection Centre (HWZ). The HWZ monitors water levels. This data is sent to the German Weather Service (DWD) and flood events are forecast. During a flood event the HWZ releases flood warnings and gives details of the development of the event. Flood warning information can also be sent by telephone or videotext.

The regional districts of Dresden, Chemnitz and Leipzig form the higher disaster protection authorities and have the supervision of the plant fire departments that work at a municipal level (§ 8 (2) Saxon Disaster Protection Act). In addition, the regional districts have to support the lower disaster protection authorities. If necessary, the higher disaster protection authority takes over responsibility for the emergency.

The rural districts and urban districts are the lower disaster protection authorities and therefore executive authorities. They have to develop warning and disaster protection plans and are responsible for the preventive and operational flood emergency management, and the information of the public. Furthermore, in the rural counties a co-ordinating office has to be established (§§ 7, 11, 38 Saxon Disaster Protection Act). If an emergency is foreseeable, the lower disaster protection authority has to give a disaster “pre-warning”. When the calamity is occurring, the authority has to give disaster alarm and is allowed to give instructions to the private organisations of public social aid and if necessary to the police. In the City of Dresden, for example, the Department for the Environment is responsible for the designation of floodplains and the Department for Disaster Protection deals with the emergency flood management in co-operation with the Saxon Flood Protection Centre.

Example North Rhine-Westphalia

Similar to Saxony, in North Rhine-Westphalia there are three Disaster Protection Authorities: the highest, the higher and the lower authority. The organisational set up is shown in Figure 2.8. The highest authority is the Ministry of the Interior which is responsible for central measures and has to support the salvage. Furthermore, it maintains the Institute of the Fire Brigade. At the same time it is the highest controlling institution.

With respect to flood emergency management, the Ministry of the Interior is supported by the Ministry of Environment, Nature Protection, Agriculture and Consumerism and the appropriate State Office for Environment that includes the flood message service. The message service provides information on current water levels. The regional government (higher Disaster Protection Authority) has to nominate an officer in charge for the district and to implement measures for rural counties and for urban districts. It also forms the higher controlling institution. As in Saxony, in North Rhine-Westphalia the rural counties and urban districts are executive units and the appropriate disaster protection authorities. The chief administrative of the rural county is the lower controlling institution. The rural counties have to prepare hazard defence plans and are responsible for the implementation of disaster defence and their preparation. Furthermore, a guiding device at a county has to be established. The main administrator has to nominate operation controllers with an officer in charge who has to supervise the single measures and is allowed to issue instructions (§ 30 Disaster Protection Act NRW). In addition, an information office may be set up.

In Cologne there is a flood protection centre which provides actual water levels and prognoses (including monitoring). It is also responsible for the consultancy of the citizen in case of flood event. When a certain water level is reached in the Rhine the control room is permanently staffed. The organisational chart of emergency flood management in North Rhine-Westphalia is shown in Figure 2.7.

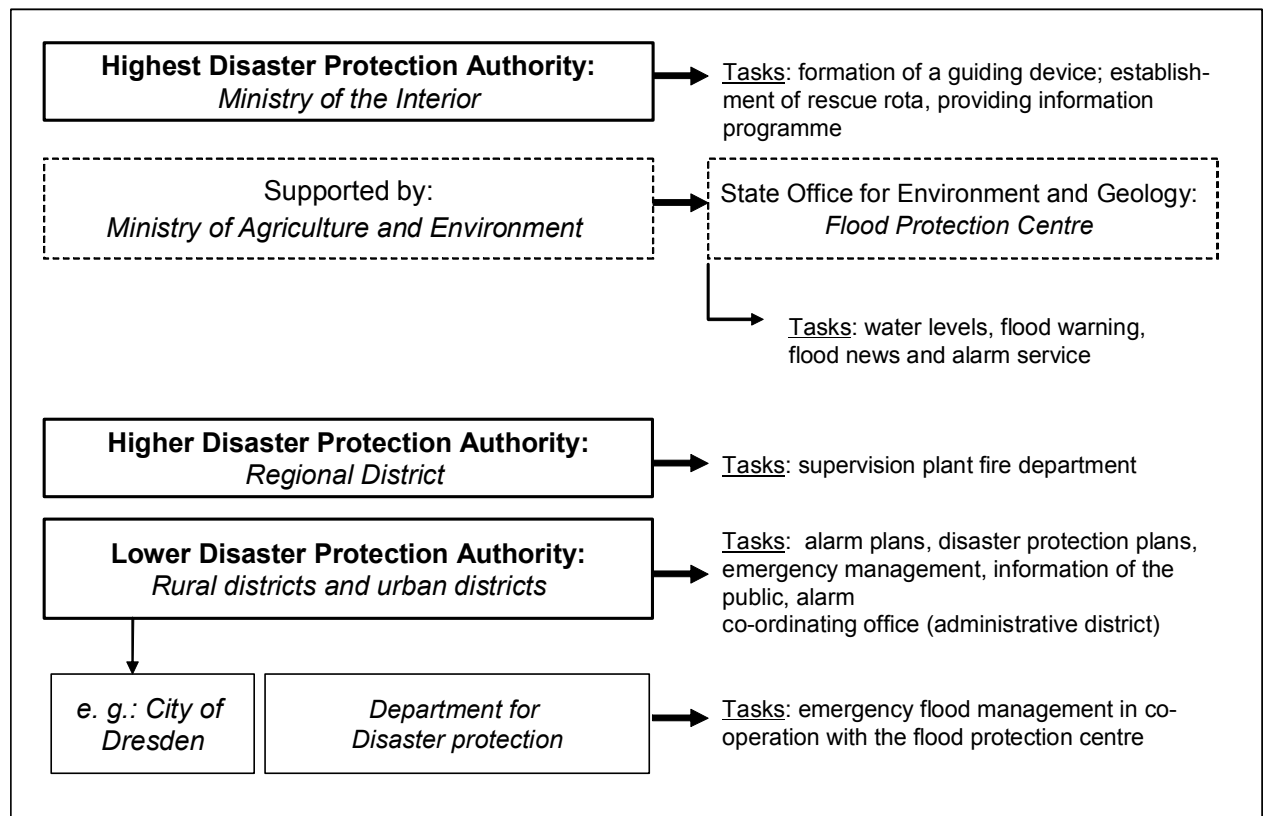


Figure 2.7 Organisational chart for emergency flood management in Saxony

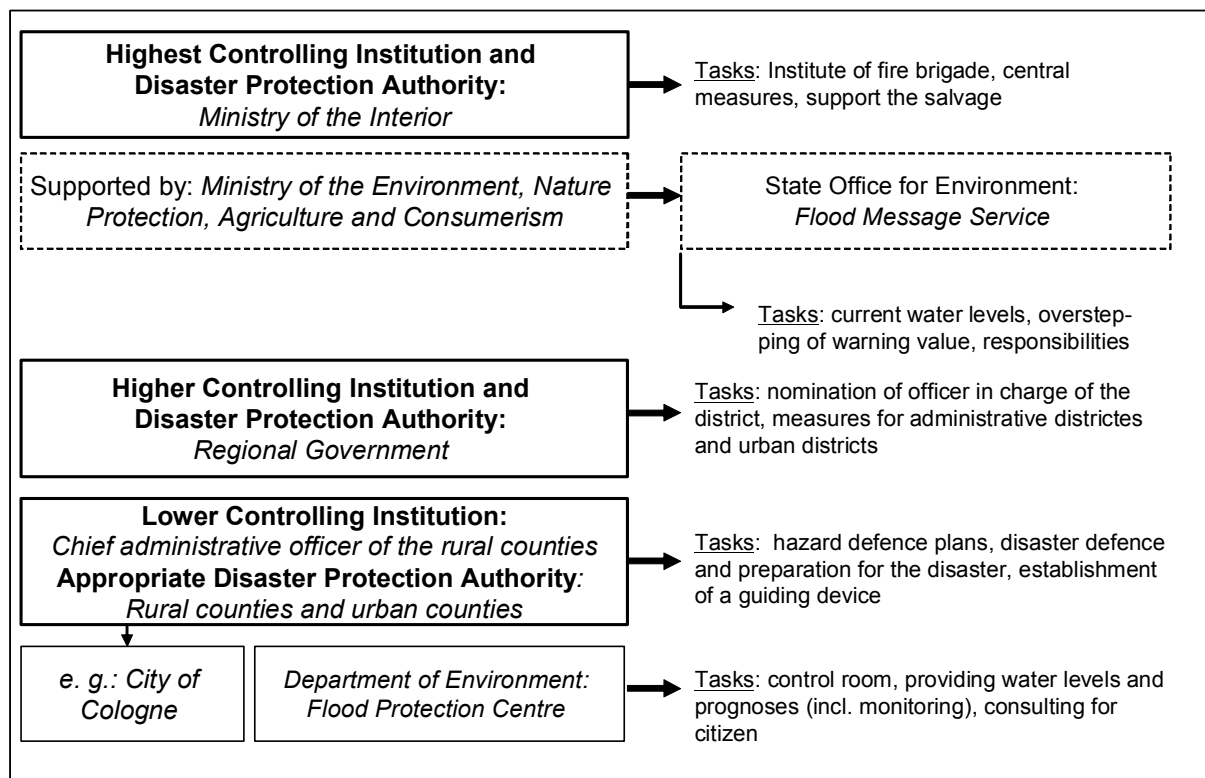


Figure 2.8 Organisational chart of emergency flood management in North Rhine-Westphalia

2.4.2 Emergency flood management

In this chapter the procedures and sequence in the case of a major flood event are illustrated. Emergency flood management is organised and accomplished by the lower disaster protection authorities that are the rural and urban districts, the measures to be implemented are described with two examples related to the City of Dresden as the capital of Saxony and the City of Cologne as the biggest city of North Rhine-Westphalia.

City of Dresden and Saxony

Flood warnings for Dresden are the responsibility of the lower water authority. There are four warning phases per water level gauge and every phase characterises a certain situation of an emergency which necessitates certain measures:

- Alert phase 1: Announcement service
- Alert phase 2: Controlling service
- Alert phase 3: Guarding service
- Alert phase 4: Flood defence.

As soon as the alert phase 3 has been activated (at a water level of 6.00 m for the Elbe River in Dresden) and alert phase 4 is expected (water level 7.00 m) the lower disaster protection authority declares “disaster pre-alarm”. If these conditions are fulfilled the disaster alarm can be activated which means that the fire brigade now has authority over the private aid organisations. Whilst the activation of disaster pre-alarm is compulsory, the activation of disaster alarm is not. However, it is possible to activate disaster alarm after the time alert phase 4 has been achieved (cf. SächsKatSVO § 9).

The basic plans for emergency flood management in Dresden are disaster protection maps, alarm, and operational maps. The disaster protection maps are used from the time disaster pre-alarm has been activated. The alarm maps are configured as registers and contain an array of information for different working groups. Well before the beginning of a flood event the operational plans are used. These plans contain general guidelines for planning and are for instance available from the fire brigades. The disaster protection plan and alarm plan maps are also available from the Management System DISMA (cf. chapter 3). In Dresden the maps neither describe processes nor do they include any ‘if-then-guidelines’, but they can be seen as databanks, including information on emergency flood management (Survey of the Department Order and Safety Dresden).

In case of an emergency flood event two special units operate. The first one is an operational and tactical guiding unit. The second one is the administrative organisational unit, the so-called administration guiding device (§ 5 KatSG Sachsen). The members of these units take up employment from the time disaster pre-alarm is activated.

Before any measures can be implemented the necessary decisions have to be made. The technical authorities (e.g. the water authorities, environmental departments) assess the situation based upon online data and onsite inspections. The appraisal is put forward to the administration unit which that assesses the available information and is responsible for decision making. Most of the measures that have to be implemented are dependent on the situation. Examples for important measures are as follows:

- Filling and distribution of sand bags for common needs (Responsibility: Department for Fire Control and Disaster Protection);
- Establishment of mobile protection walls by using maps that include water levels in half meter steps (Responsibility: Department for Fire Control and Disaster Protection)
- Closure of infrastructure and beginning of traffic diversions (Responsibility: Department for Road Engineering);
- Establishment of temporary flood defences;

- Restriction of navigation (Responsibility: Department for Shipping);
- Commencement of evacuations (Responsibility: City of Dresden).

The decision whether an area has to be evacuated is also made by the administrative units. If the operational units on location recognise that a certain area is threatened by a flood they have to inform the administrative unit which organises the evacuation. Therefore, certain steps have to be accomplished. The public needs to be informed and emergency accommodation must be prepared. Furthermore, care in emergency accommodation has to be assured and means of transport must be available. When the area is evacuated it also has to be secured. All steps of evacuation depend on the situation.

City of Cologne/North Rhine-Westphalia

In Cologne the professional fire brigade is the responsible authority for warning and leading the emergency management organisations and units. Furthermore, units are established by the operation controllers of the fire brigade. The fire brigade has to coordinate together with the Flood Protection Centre of Cologne. When high water levels are expected a crisis management group is formed in order to coordinate. In case of unexpected disastrous events the responsibilities of the crisis management group is devolved to the disaster control management.

The flood protection centre Cologne, which is established by the Department for Urban Drainage, is directly responsible to the crisis management group. The main tasks of the centre are:

- Coordination of the different offices and departments;
- Informing the urban offices about water levels and process of the flood event;
- Information and warning of the citizens and establishment of a service telephone.

Thus, there are three main working fields for the flood protection centre of Cologne:

- Providing information for the citizens and media;
- Monitoring of weather and water levels;
- Formation of the emergency management unit.

The professional fire brigade can also be supported by the Bundeswehr (German Federal Armed Forces) in erecting temporary flood protection, filling of sand bags and in controlling constructions for flood protection. With respect to warning and counselling of the citizens there are different instruments such as leaflets, posters for warning, information via radio and television, and announcements by loudspeakers. Cologne is divided into approximately 1,000 warning boroughs. There are a number of flood protection measures for Cologne that need to be implemented. Examples include the commissioning of the pumping stations, closure of infrastructure, assembling of temporary flood defences, closure and opening of dykes and flood protection walls.

The fire brigade, the Office for Fire Protection, the rescue and citizen protection are responsible for averting the danger of an emergency flood event. Operations are carried out at three levels of priority:

- The first priority is where there is a threat to people;
- The second priority is where substantial damage to properties could occur;
- The third priority covers everything else.

In Cologne the Office for Housing, the fire brigade, the Federal Armed Forces and further organisations are responsible for the evacuation in case of a major flood event. The evacuation plan is available from the professional fire brigade and it contains information about decision making for evacuations, the assessment of the time needed and the formation of working groups. There have to be several working groups for preparation of the evacuation and transport planning, warning and information, transport, assurance and control, accommodation, supervision, evacuation of animals, and

recirculation.

At water levels of 11.00 to 12.00 m in the Rhine 100,000 people have to be evacuated from Cologne. For evacuation the professional fire brigade takes over control and coordination. To undertake an early evacuation a forecast of the water levels in the Rhine is required. In parallel, numerous planning measures are undertaken and evacuation scenarios are prepared for the case of a sudden failure of flood defences.

2.4.3 Methods and models to support emergency flood management

To support emergency flood management some German cities use Disaster Management or Information Systems such as:

- Disaster Management System DISMA;
- The Flood Information and Protection System HowISS;
- Flood Information and Warning System FLIWAS.

The information system FLIWAS is still under development and will be completed in 2007. FLIWAS is based upon available information, models, data, warning and operational plans, flood hazard maps, and disaster scenarios. All the relevant data are shown via a web-based information system. The objective is to form a link between forecasting systems and operational maps of disaster protection.

The Flood Information and Protection System HowISS is used in the city of Heidelberg. HowISS is employed for the management of flood protection plans and for the preparation of an individual warning plan. The warning plan is the core element of the system. HowISS also contains a central databank. Flood forecasts and up-to-date measured data are delivered to the system. HowISS manages data concerning administrative offices, personnel, events, measures, water levels and locations. As a result HowISS generates an individual warning plan for the flood forecasts. The warning plan shows the measures that need to be implemented and the details of the implemented measures.

The Disaster Management System DISMA is applied to emergency planning and management and to the simulation of “extraordinary incidents”. It consists of the four modules data, hazard assessment, mapping, and planning and is a decision support system. The module data forms the core element of DISMA. For inquiries different filters can be used to select and show the required information (e. g. on material, equipment, means of transport). The DISMA-map provides the possibility of users managing different views and showing different maps. It is possible to connect the geographical information data with other information. It is also possible to store different maps in DISMA-catalogues, for instance flood hazard maps, flood warning maps, and evacuation maps

DISMA system used in Dresden is an important basis for the administrative emergency unit and can be understood as a databank. Decisions cannot be made by DISMA but it is important for decision-making and implementation of measures. It includes a variety of different information, e. g. on public utilities, addresses, telephone number. For certain buildings information on how many persons are living and/or working there and their age can be accessed. This may be useful information for evacuation planning. However, the DISMA system has to be maintained and used constantly. At the moment the communication in case of emergency flood events in Dresden is done via email and telephone. There is one person who records all the measures and contacts. Therefore, a log record is kept. The next version of DISMA will also include a communication-module. Figure 2.9 shows the DISMA conceptual framework. The DISMA system in Dresden is complemented by the use of systems for traffic control and information.

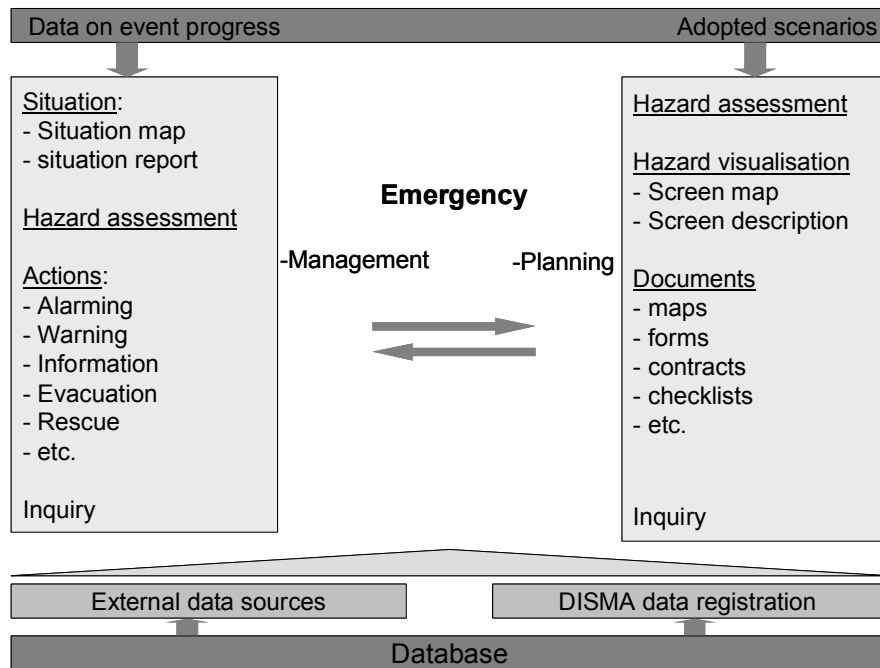


Figure 2.9 Conceptual framework of the DISMA system

The Saxon Flood Protection Centre also has a project called 'Integrated hazard map for municipal flood protection' (INGE). This incorporates software for the visualisation of flood warning documents and for giving an overview on property at risk depending on the current and expected water levels. It can be used by authorities and operational units as instrument for decision-making in planning and implementing disaster management. Within INGE database there is information concerning water levels, institutions, personnel, responsibilities, warning information, and water depth/damage curves. It is also possible to integrate digital photos, text documents, and further data. The following flood protection tasks can be supported:

- Hazard analyses and risk assessment for existing or planned objects that need to be protected
- Determination and prioritisation of measures that have to be implemented before and during a flood event
- Coordination and optimisation of operative measures of flood protection, evacuations, etc.
- Alarming of responsible persons and institutions in case of a flood event
- Information of operational units and other helpers about certain objects, possibilities of access, flooding borders, etc.
- Supporting the detailing of the implementation of measures during flood events through available information and maps
- Supporting the planning, accomplishing, and analysis of exercises and trainings for disaster protection.

INGE can be used in networks with common central databases as well as on a laptop. The core element is an interactive hazard map (INGE GIS). If the current water level is given as input to the system every object threatened by flooding could be marked and printed as map or as a list or saved and sent as an email.

All the information and data are presented in a database which is divided into clear forms. INGE can facilitate and advance the work of flood event management as well as during the phases of planning, training, and post-processing. INGE is already used in two Saxon towns (Glauchau and Meißen) and will be implemented in two more towns (Torgau and Radebeul) in the near future. Additionally, the Saxon flood protection centre also provides different maps of flood protection, such as (potential)

flood areas (the 1 in 100 year flood extent), hazard maps for certain municipalities, and areas that were flooded during the flood event 2002. In addition, there is an atlas on flood hazards in Saxony that also includes maps on damage potentials.

2.5 France

2.5.1 The legal framework for flood management and emergencies

French legislation concerning natural hazards mitigation and management has developed over the last 20 years. The key legislation is detailed in the sections below.

Law on the compensation of natural hazards victims, 1982 ⁴

The 82-600 law on the compensation of the victims of natural hazards introduced a hybrid system of compensation based on private insurance. It aimed to formalize the principle of national solidarity concerning natural hazards written down in the French Constitution. Each citizen has an obligation to be insured against natural hazards. This insurance is incorporated within their household insurance. The same proportion of the total household insurance amount is allocated to the natural hazard insurance system (15% at the moment), independently of the level of exposure of the house to natural hazards. The system is only activated if the state administrations declare an event as “an exceptional natural hazard”, typically the return period of the considered event must exceed 1 in 10 years. The damage caused by lower return period events are not insured.

A new land use regulation tool was introduced by the 1982 law to complement this insurance system, to limit new urban extensions in exposed areas: the plan d'exposition aux risques PER (risks exposition plan). According to the estimated hazards and their magnitude, these plans delimit red areas where no new constructions are permitted and blue areas where constraints concerning the constructions can be imposed. This limit on development in exposed areas is the major tool of the French natural hazard mitigation policy.

Law on the organization of rescue services⁵, 1987

This law set up the strategic organization of the rescue operations described below, and introduced a new management reference document: the ORSEC plan (organisation des secours, Rescue organisation). This document defines the rescue procedures and lists the available public and private means and the conditions for their use. This law also affirmed the need of the raising public awareness and the creation of a risk analysis and preventive information cell in each department prefecture (Cellule d'analyse du risque et d'information preventive; CARIP).

Law on the prevention of technological and natural catastrophes, 2003⁶

This law led to changes in the French flood forecasting system. It also reaffirmed the necessity to raise the population risk awareness. It placed an obligation on mayors to regularly inform the population about the existing risks, the prevention measures and the risk management procedures, and the obligation to make an inventory of existing flood level indications of previous major floods and mark these levels on a permanent support.

⁴ Law 82-600, 13/07/1982, « relative à l'indemnisation des victimes de catastrophes naturelles »

⁵ Law n° 87-565, 22 July 1987, « relative à l'organisation de la sécurité civile, à la protection de la forêt contre les incendies et à la prévention des risques majeurs ».

⁶ Law 2003-699, 30 July 2003, « relative à la prévention des risques technologiques et naturels et à la réparation des dommages ».

2.5.2 *Emergency response*

Role of local authorities and administrations

The responsibilities of the mayor

The mayor is in charge, under the supervision of the Préfet of the department, of the municipal police⁷. This responsibility includes the prevention and the management of all possible emergencies such as flooding⁸. Depending on the magnitude of the event, the mayor should also inform and ask for the intervention of the upper administrative level: the Préfet de department and the state services.

A new management tool, the municipal safeguard plan (plan communal de sauvegarde PCS) has been introduced by the article 15 of the 2004 law on the modernization of the rescue services⁹ to help the mayor and the municipal services in this task. The PCS synthesises existing procedures to save human lives, decrease material damages and protect the environment. One part of the PCS is devoted to the possible evacuation procedures.

The implementation of a PCS is the mayor's responsibility. It is not compulsory, however, it is recommended by the law. One PCS should be written for each identified risk. To our knowledge, very few PCSs have been established in France at the moment.

The responsibilities of the Préfet of the department

The Préfet is the coordinator of the state administrations in a department. In the case of the management of a crisis which exceeds the territorial limits of a municipality, the Préfet is responsible for the supervision of the rescue operations and has the authority over the state but also local authorities rescue services. In the case of a major crisis exceeding the limits of a department, the designated Préfet de zone de défense (Prefet of the defense zone) takes in charge the supervision of the rescue operations. A national disaster is directly managed by the French Interior Minister. This subsidiarity principal is described in the articles 17 to 22 of the already cited 2004 law on the modernization of the rescue services.

At each decision level, a document called ORSEC plan (organisation des secours, Rescue organisation) introduced in 1987¹⁰ is available. This document defines the rescue procedures and lists the available public and private resources and the conditions for their use. When the Préfet "activates" the ORSEC plan, he has the possibility to requisition these means according to the conditions defined in the plan. The owners of the requisitioned private resources receive a monetary compensation after the event. The costs of the rescue operations are paid by the municipality. In the case of a major catastrophe, the majority of the costs are borne by the French State.

2.5.3 *Flood preparedness and evacuation*

Raising flood awareness

A great deal of effort has been made at raising and maintaining the flood awareness of the population in France since 1987. A so called risk analysis and preventive information cell has been created in the

⁷ Art. L 2212-1, code des collectivités territoriales.

⁸ Art L 2212-2, code des collectivités territoriales « La police municipale a pour objet d'assurer le bon ordre, la sûreté, la sécurité et la salubrité publiques. Elle comprend notamment : 5° Le soin de prévenir, par des précautions convenables, et de faire cesser, par la distribution des secours nécessaires, les accidents et les fléaux calamiteux ainsi que les pollutions de toute nature, tels que les incendies, les inondations, les ruptures de digues, les éboulements de terre ou de rochers, les avalanches ou autres accidents naturels, les maladies épidémiques ou contagieuses, les épizooties, de pourvoir d'urgence à toutes les mesures d'assistance et de secours et, s'il y a lieu, de provoquer l'intervention de l'administration supérieure »

⁹ Law n° 2004-811, 13 August 2004, « de modernisation de la sécurité civile ».

¹⁰ Law n° 87-565, 22 July 1987, « relative à l'organisation de la sécurité civile, à la protection de la forêt contre les incendies et à la prévention des risques majeurs ».

Prefecture of each department (CARIP, cellule d'analyse des risques d'information preventive). It groups together elected representatives, the directors of the departmental state administrations, representatives of associations involved in risk management like the Red Cross, the local media¹¹. The CARIP is responsible for:

- The coordination of information and documents on technological and natural risks at the level of the department (Dossier Départemental sur le Risques Majeur), and the level of the communes (Dossiers communaux synthétiques). These documents provide an inventory of the risks to which the areas are exposed and of the major stakeholders at risk².
- An inventory of the camping places and tourist facilities particularly exposed to flood risks and the definition of specific risk management procedures, and possibly the decision of closing risky facilities¹² that are deemed to be at high risk.
- The preparation of the natural disaster damage compensation procedures¹³.
- The publication of information documents and recommendations on risk and crisis management. Examples are presented below.

Since the new law on technological and natural risk management was introduced in 2003¹⁴ the mayor has the following responsibilities related to the following:

- Make an inventory of existing flood level indications of previous major floods and mark these levels on a permanent support: a totem pole for instance.
- Inform the population of his municipality of the existing risks, of the prevention measures and provide details of the French damage compensation (insurance) system at least once every two years.

Evacuation

Some examples of recommendations published in the Aude departmental document on major risks (2003) are given in Figure 2.10. Aude is a region in France exposed to severe flash floods.

<i>L'évacuation</i>  La mise à l'abri dans un refuge sur place est souvent préférable à une évacuation, notamment pour toutes les habitations qui ne sont pas fortement exposées lors de la montée des eaux.  Si l'évacuation apparaît comme l'ultime solution, - évacuer rapidement, - gagner un point en hauteur ou le refuge indiqué, - suivre strictement les consignes données par les autorités.	<i>About Evacuation</i> Taking shelter on the spot is often preferable to an evacuation, particularly when the buildings are not exposed to potentially destructive flood flows. If evacuation is the only option then: • Evacuate without delay • Move to high ground or an designated refuge • Follow the orders of the authorities
<i>Prévoir</i>  - l'installation, au-dessus du niveau des plus hautes eaux (dans les étages supérieurs, les combles ou sur le toit de l'habitation), d'une zone refuge accessible de l'intérieur et de l'extérieur (pour les secours),  - sur les ouvertures, des dispositifs mécaniques destinés à ralentir l'entrée de l'eau, - les moyens de surélever le mobilier ou de le monter dans les étages, - la mise en sûreté des véhicules avant l'inondation.	<i>Before the flood</i> • Install a refuge, above the highest known flood water level which is accessible from both inside and outside the house • Slow down entrance of water through the openings • Raise the furniture above the flood water or move it upstairs • Put vehicles in a place safe before the onset of flooding

¹¹ décret d'application n° 90-918 du 11 octobre 1990 précisant le contenu et la forme des informations ainsi que les modalités de leur diffusion.

¹² Décret du 13 juillet 1994 relatif à la mise en sécurité des campings, arrêté du 6 février 1995 fixant le modèle du cahier des prescriptions de sécurité dans les terrains de camping.

¹³ Law 82-600, 13/07/1982, « relative à l'indemnisation des victimes de catastrophes naturelles »

¹⁴ Law 2003-699, 30 July 2003, « relative à la prévention des risques technologiques et naturels et à la réparation des dommages ».

<i>Ne pas...</i>  Ne pas s'engager à pied ou en voiture dans une zone inondée : une voiture n'est plus manœuvrante dans 30 à 50 cm d'eau ; ne pas forcer les interdictions. Reporter ses déplacements à plus tard,  Ne pas prendre l'ascenseur... pour éviter de rester bloqué,  Ne pas aller chercher ses enfants à l'école... l'école s'occupe d'eux,  Ne pas téléphoner... afin de libérer les lignes pour les secours,	<i>Do not...</i> • Do not walk or drive in a flooded area. It is not possible to control a car if the depth of water is between 30 and 50 cm. • Do not force pass through roadblocks. Postpone your travels. • Do not take the lift as it may get stuck • Do not go and fetch your children at school. The school will take care of them • Do not use phone as the lines need to be left free for the emergency services
<i>Agir</i>  Fermer les portes, fenêtres, soupiraux, aérations... pour ralentir l'entrée de l'eau et limiter les dégâts,  Couper l'électricité et le gaz... pour éviter l'électrocution et l'explosion,  Monter dans les étages avec : eau potable, vivres, papiers d'identité, radio à piles, lampe de poche, piles de rechange, vêtements chauds, médicaments... pour attendre les secours dans les meilleures conditions,  Écouter la radio... pour connaître les consignes à suivre,  Se tenir prêt à évacuer les lieux à la demande des autorités... prendre ses papiers d'identité et si possible, fermer le bâtiment.	<i>Act</i> • Close doors, windows and other openings to slow down the entrance of water and limit the damages. • Switch off the electricity and gas to avoid electrocution and explosions. • Go upstairs with: drinking water, supplies, identity papers, radio, torch, batteries, warm clothes, medicines and wait for the assistance under the most favourable conditions. • Listen to the radio to get the latest instructions • Be ready to evacuate when requested to by the authorities' request. Take your identity papers and if possible lock your home.

Figure 2.10 Extracts of the Aude departmental document in France on major risks

These examples illustrate the fact that, except for camping places, evacuation is generally not recommended in France and considered as a very last resort. A suggestion was made after the 2002 floods in the Gard region¹⁵ to build refuges on the roof of some houses if they are below the maximum water level so that the occupants have a place to take shelter before being the rescued.

If evacuation is considered necessary, the procedure should be described in the municipal safeguard plan (Plan communal de sauvegarde). The typical procedures are described in the regulation 2005-1156 of the 13 September 2005. These can be summarised as follow:

- Ideally, the evacuation must be prepared for by providing a pre-alert message to the affected population to give information about a possible evacuation and explain the procedure. A second message is given at the start of the evacuation. Both messages have to be clear.
- Teams are created to organize the evacuation, with one team per area to be evacuated. If necessary, specific means are prepared for the evacuation of the population and schools, for example, transport can be requisitioned. If some of the residents refuse to evacuate their houses their location should be noted. If the situation becomes dangerous they should be forcibly evacuated. People with reduced mobility have to be identified and helped. After the evacuation, every building must be checked to be sure that there is nobody remaining in the area.
- A safe place must be designated and prepared for the evacuated people to take shelter. This is typically a public building like a school or a gymnasium. This place must be located as close as possible to the evacuated areas.
- The evacuated areas must be protected. This is to avoid looting and vandalism in the evacuated area.

¹⁵ Inspection Générale de l'environnement, 2003. *Retour d'expérience des crues de septembre 2002*, rapport technique, Ministère de l'Ecologie.
http://www.environnement.gouv.fr/infoprat/Publications/syntheses-ige/2003/media/crues_gard.pdf

2.6 Hungary

2.6.1 Background to flood management in Hungary

In Europe, Hungary ranks only behind the Netherlands with respect to flood exposure with over two-thirds of its arable land at risk to fluvial, ground water and flash flood. In Hungary, like many of the former socialist countries of Central and Eastern Europe, the central government has traditionally taken the primary responsibility for protecting the public from all aspects of floods. The water authorities have invested large sums in a network of flood defences. Together with taking full responsibility for protecting the Hungarian public from flood risks, the government is held accountable for any water that comes through or over the flood defences. Although there is no statutory requirement for the Hungarian Government to compensate flood victims, the national authorities almost always take full liability for private damages in the event of a breach of flood defences, and compensate victims for other types of flood damage such as groundwater inundation.

2.6.2 The institutional framework for flood management

Under the current Water Act, the responsibility for undertaking technical activities related to flood defence for structures owned by the state is assigned to the state water agencies, the State Water Service (SWS). The SWS is also responsible for the regional planning, organization and professional guidance and supervision of flood control and emergency operations of other interested parties, including supply of all the data and information concerning hydro-meteorological and fluvial hydraulic conditions, as well the structural conditions of existing flood defence structures in order to assist the preparation of structural and non-structural preventive and emergency plans of other organisations. The SWS comes under the remit of the Ministry of Environment and Water (MEW), the National Water Centre (NWC) and the Environmental and Water Directorates (EWD).

In terms of flood management Hungary is divided up on the basis of the catchments into 12 districts, each with its own district water authority. The legislation, policy and strategy of the SWS are set by the MEW, while the operative control of the EWDs is provided by the NWC. The local functions are performed by the EWDs. The Minister of MEW controls the technical functions of flood fighting with support from the National Technical Controlling Headquarters providing the workforce and resources of the SWS can control the emergency situation.

The operation and maintenance of the flood defence in a particular area is the responsibility of the local director of the EWD involved. When a flood emergency occurs the entire personnel, machines, equipment, and materials of the EWD can be mobilized should this be required. This is in accordance with the plans prepared in advance for an emergency service. The flood defences that an EWD is responsible for usually consist of 10 to 15 sections, each of which are usually between 30 to 50 km in length.

2.6.3 Organisation of flood emergencies in Hungary

Direct technical assistance in flood emergencies is provided by the Flood and Drainage Emergency Organization (FDEO) which is located in Budapest. It has a trained workforce, machines and equipment that enables it to carry out a variety of engineering operations, such as pile and sheet pile driving, dewatering, blasting, separate country-wide communication, ice control with special ice-breakers and aerial reconnaissance with the own flying service.

During a flood emergency the FDEO is under the direct control of the National Technical Controlling Headquarters. Defence squads equipped are available at each EWD. The National Forecasting Service within the Environmental Protection and Water Management Research Institute (VITUKI) supports floods emergency activities by collecting, and analysing the hydrometeorological data and compiling these into flood forecasts.

In addition to these technical flood defence activities, a number of administrative measures are necessary, such as planning and carrying out rescue operations, evacuation and resettling, mobilization, transport, health and other care of the public workforce involved in flood fighting,

policing the inundated areas, assessment of damage etc. The implementation of the administration activities related to defence is organized and guided in the case of an emergency by the Municipal (County) Local Defence Committees established under the CX Act on Defence, 1993 legislation. These committees are presided over as follows:

- In the case of the Municipal Defence Committee by the Lord Mayor;
- In County Defence Committees by the chairman of the county assembly;
- In Local Defence Committees by the mayor. The members are the heads of the regional and local organizations who are competent in various activities: the director of (county/municipal) public administration office, the town clerk, the mayor of a town vested with county rights, the commander responsible for the deployment of armed forces and other organisations determined by the Government (e.g. police, border police, civil defence, communications inspectorate, the transportation authority, the water authority).

The liaison officers attached to the various relevant ministries support the Minister of MEW in coordinating the technical and administrative issues of emergency activities. The flood defence organization is responsible for flood defence with respect to technical issues, warnings, rescue and evacuation plans. Staff members, workforce and equipment in EWDs where there is no flood emergency may be assigned to flooded areas that require additional resources.

In emergency situations, which cover large areas, and where several EWDs are no longer capable of handling the situation, the government commissioner assumes control. The commissioner is the Minister of MEW. To perform all the required activities in such emergency situations, he is vested with powers to draw on the labour of the population, as well as on the equipment, tools, materials, machines and vehicles of private sector organizations, based on the rules laid down in the National Flood Emergency Mobilization and Cooperation Plans. In cases where the public workforce is inadequate, he can mobilize the military, civil defence and the police. In the case of national emergencies, control of the situation is assumed by a Governmental Co-ordinating Committee (GCC), the members of which are the administrative state secretaries of the sectors involved in flood fighting.

The organization of “local damage control” is the responsibility of the municipalities. Local damage control includes the mitigation of effects of intensive local rainfall that might cause inundation in low lying areas and mitigating the effects of flooding from small streams. The organization of local damage control is based on the local government structure of the various communities. The head of the defence organization is the mayor, who is free to request in cases of emergency technical assistance from the EWD competent in the area.

2.6.4 Evacuation and rescue planning

Although evacuation and rescue modelling is not carried out in Hungary evacuation and rescue plans are prepared regularly. These plans cover all types of emergency situations including flooding, chemical spills, terrorist attacks etc. This section presents the methodology and the content of the evacuation and rescue planning for flooding.

The flood management and the emergency management belong to two different ministries, namely the Ministry of Environment and Water Management and Ministry of Interior. The two organisations co-operate in the planning phase as well as during the emergency situation.

The evacuation and rescue plans for flooding are prepared in two phases. The water management prepares a so called “localisation plan” which provides all the information of the possible inundation including water depth, velocity, duration and lead time. It also includes possibilities of “localisation” (confinement) of the inundation by defining those locations where the spreading of water can be prevented or delayed. Based on this information the second phase of the evacuation/rescue plan is prepared. The emergency/rescue plans cover saving people, livestock and materials. It also deals with

environmental problems (e.g. prevention of spreading of pollutants). A typical table of content of an emergency plan includes:

- I. General description and major data of the town
- II. Glossary (explanation of terms used in the document)
- III. Legal background
- IV. Task during/prior to flooding
 - IV.1. The flood prone area
 - Number of inhabitants to be evacuated/rescued
 - Evacuation/rescue routes (roads, rail, traffic control points etc.)
 - IV.2. Shelter service
- V. Check-list of task to be performed
- VI. Shelter register
- VII. Catering facilities
- VIII. Register of Hospitals
- IX. Registry of vehicles (available for evacuation)
- X. Registry of materials needed for the evacuation

The plan considers the number of people to be evacuated at the level of houses and/or block of houses, depending on the density of population. It also takes into account the number of vehicles (e.g. buses) available for transportation, the escape routes and the shelters with their capacity. The catering facilities, hospitals with the number of beds are also included into the plan.

The annexes of the evacuation/rescue plans include:

- The organisation charts of the emergency organisation at different alert levels;
- The names, addresses and telephone numbers of emergency crew;
- A “to-do-list”;
- The transportation needs, with the meeting points;
- The available transportation means;
- The material needs (e.g. beds, blankets, tents).

The emergency/rescue plans are updated yearly.

2.7 Summary for the European Union

On a European level two legal frameworks (Bouchon, 2005) are relevant with respect to flood risk management. The first one is the framework on water and water management, the second is on the framework on civil protection. These are detailed below.

2.7.1 Framework on flood risk management

The framework on flood risk management describes the legal instruments and policy objectives. The European Commission Communication COM (2004) 472 of 12 July 2004 "Flood risk management - flood prevention, protection and mitigation" analyses the measures already taken and proposes an action programme on flood prevention, protection and mitigation. The European Commission proposes that the Member States should cooperate with it, to draw up and implement a coordinated action programme for flood prevention, protection and mitigation. This action plan would include in particular:

- Improving cooperation and coordination between Member States, through the development and implementation of flood risk management plans for each adversely affected river basin and coastal zone;
- The development and implementation of flood risk maps by the Member States;
- Improving information exchange, sharing of experiences, and the coordinated development and promotion of best practices. These measures would in fall within the responsibility of the European Commission;
- Developing stronger linkages between the research community and the authorities responsible for flood management;
- Improving coordination between the relevant community policies;
- Increasing awareness of flood risks through wider stakeholder participation and more effective communication.
- The communication also sets out guidelines concerning the essential features of the flood risk management plans and flood risk maps to be drawn up by the Member States.

Before the proposition of this action programme, the Communication COM(2002) 481 from the Commission to the European Parliament and the Council entitled "a solidarity based initiative: the European Community response to the flooding in Austria, Germany and several applicant countries"(2002) had drawn up a list of measures that can be taken directly and in the future, in particular the creation of an EU Disaster Relief Fund, to come to the aid of the Member States and applicant countries, whose citizens suffer, as a result of natural disasters in general and flooding in particular. This communication sets the need for financial resources to help the affected countries to recover. For this, the European Commission was planning mainly to:

- Reallocate existing resources using the possibilities offered by the rules governing the Structural Funds, the common agricultural policy (CAP) and aid to the applicant countries;
- Establish a Disaster Relief Fund at Community level to respond to the consequences of major disasters by rapidly mobilizing the necessary resources;
- Modify their development programmes so they can:
 - Concentrate funds on flood-related measures in affected regions under ongoing operational programmes and single programming documents;
 - Introduce new measures to rebuild infrastructure and for productive investment in companies and training and employment schemes;
 - Shift funds from other measures and priorities to the appropriate existing or newly-created measures.

2.7.2 Framework on civil protection

A second relevant legal and institutional framework is the framework on civil protection. Before the first Community Action Programme in the field of civil protection, the implementation of the Resolution 91/C198/01 of 8 July 1991 on improving mutual aid between Member States in the event of natural or technological disaster established several operational instruments. Instruments have been established by the European Commission in collaboration with the Civil Protection Authorities of Member States to ensure better preparedness in the case of requests for mutual assistance. Following this, the Council Decision 98/22/EC of 19 December 1997 established the first Community action program in the field of civil protection. This first Community action programme sets up an action program to foster cooperation among the Member States in the field of civil protection. It lays down a Community program to protect the environment, people and property in the event of natural or technological disaster. Its purpose is to step up cooperation on civil protection between Member States. In accordance with the principle of subsidiarity, Community cooperation supplements national action, in order to make the national programs more effective. Funding for specific actions is subject to certain criteria. The objectives of the specific actions are:

- To lessen risk and damage to persons, property and the environment;
- To increase the degree of preparedness of those involved in civil protection (training courses, exchanges of experts, simulation exercises);
- To improve response techniques (developing and adapting new technologies to the requirements of civil protection);
- To promote information and raise public awareness of the rules of self-protection (e.g. travelling exhibitions, distribution of information material)

The perspectives for future developments in this field refer to the conclusions of the recent Communication from the European Commission (COM (2004) 200) entitled "Reinforcing the Civil Protection Capacity of the European Union" (2004). The Communication examines the EU's capacity for civil protection intervention, both inside and outside the EU and proposes improvements where necessary. The European Commission reports that, two years after its entry into force, the Community intervention mechanism has shown that it can work to the benefit of participating countries. However, it notes that a number of issues require special attention:

- Information gaps, in respect of which the European Commission proposes defining the types of emergency most likely to trigger the Community mechanism and the available response capabilities in terms of personnel and equipment;
- A need for more training and a focus on interoperability, notably by means of further development of a programme of training and joint exercises;
- A need for better communication and improved coordination, notably between the various instruments available to the EU and by requiring Member States to inform the Monitoring and Information Centre when a major disaster occurs and/or whether they call for assistance or respond to such calls;
- Financial issues, both inside and outside the EU, in respect of which the Commission proposes to review and possibly extend the possibility of Community funding for transport costs, for operations both inside and outside the EU, and to examine the feasibility of providing immediate funding to Member States, where the costs associated with additional emergency measures overwhelm their immediate financial capacities.

In conclusion, the EC as such does not employ methods and models towards evacuation management. Given the principle of subsidiarity, this is deemed to be a national task. The White paper on European governance (COM(2001) 428) states that from the conception of a policy to its implementation the choice of the appropriate level of action is supposed to be proportional to the level of at which action is taken.

2.7.3 Institutional framework

In a European institutional framework the numbers of entities or actors that play a role depend on the scale of the event. Owing to the principle of subsidiarity events are dealt with at the lowest possible level and are only subject to European intervention if cross-border effects occur. European actions are geared towards supplementing national actions in order to make them more effective.

2.7.4 Emergency flood management

The Natural Environment and Disaster Management and Information Exchange (NEDIES) project has produced information on lessons learnt and that have been gathered with respect to floods and flood management. NEDIES is a European Commission project developed in the framework of the DG Joint Research Centre Institutional Programme "Safety and Emergency Management for Man-Made and Natural Hazards" aimed to support EU policies, mainly those of the Civil Protection and Environmental Emergencies Unit of DG Environment, in the area of prevention, mitigation and management of natural risks and technological accidents.

The lessons learnt emphasized the following:

- Strategic coordination;
- Role designation;
- Task prioritization through risk assessment and forward planning;
- Training and formation of all stakeholders;
- Inter-disciplinary collaboration;
- Inter-organisational collaboration;
- Forecasting, alert and warning systems;
- Availability of material and human resources;
- Allocation of material and human resources;
- Communication strategies;
- Dissemination of information to the public;
- International co-operation.

It is important to note that the lessons learnt mostly fall within the domain of “soft” approaches. Typically they cover the field of organizational aspects and the implementation of data and information.

3. User requirements for evacuation planning

3.1 Introduction

The objective of this chapter is to detail the user requirements for planning evacuations in response to a flood and to understand the requirements an evacuation planning tool or model should fulfil from an end user's and decision maker's point of view. For each stage of the evacuation process the information has been arranged as shown in the Table below. The information contained in this chapter is based on a number of surveys of end users carried out in France, the Netherlands and the UK.

Stage	
Activity	
Objective	
Actors	
Lessons learnt	
Role of road network	
Information needed	
User requirements	

The information has been arranged as follows:

- **Stage** - This describes the stage of the evacuation planning process;
- **Activity** - This defines one or two main activities that need to be carried in order to meet the objective of that stage;
- **Objective** - Each stage can be defined by a certain objective that needs to be met;
- **Actors** - For each different stage of the evacuation process different actors are involved. This involvement is often defined by a piece of legalisation or duty or by a clearly defined interest;
- **Lesson learnt** - This describes the best practice from the surveys that were undertaken;
- **Role of road network** - One of the key aspects of evacuation is transportation. As a consequence the road network is important. The importance of the road network varies depending on the type of flood. It is important to understand the part of the road network can still be used and how the flood inundation is likely to progress over the event. This allows end users to assess possible escape routes;
- **Information needed** - This details the information needed to meet an objective by performing a certain service.
- **User requirements** - The user requirements is a type of analysis or source of information that needs to be carried out to obtain the knowledge that supports the decision making process.

3.2 Organization of evacuation planning

Stage	Organization of planning
Activity	Plan for possible emergencies
Objective	Organize the development of planning, determine who owns what information and discuss duties and responsibilities.
Actors	Stakeholders with a responsible for evacuation planning either directly or indirectly.
Lessons learnt	Define organization structures Design communication strategies Define task and duties according to (i) capabilities, (ii) legal duties and responsibilities. Organize the available data systematically. Make an inventory of available data.
Role of road network	Involve owners of road networks.
Information needed	Roles and responsibilities of stakeholders Perception of risks Institutional context Legal framework
User requirements	

Organizing the planning

At this stage it is important to involve all the relevant stakeholders and make them aware of their responsibility during a flood emergency. The raising of this awareness serves to prepare the stakeholders so they can plan their business continuity.

Short description

The planning of an evacuation can be seen as the main activity that contains the other six activities. It is a separate stage in the process. However, evacuation planning is not an activity that stands alone, it is an option in a wide range of available options in the field of disaster management. Besides this the planning for evacuations is part of an ongoing process of local (and regional) stakeholders.

Activity

To organize the preparation for planning

Objective

Develop an understanding of the various roles stakeholders can have. Different stakeholders have indeed different responsibilities and communicate in different languages. It is therefore important to meet at an early stage and reach consensus about the process, the goals and the communication.

Actors

Depending on the legal framework, various stakeholders can be involved in the process of emergency planning. Stakeholders can be divided into two groups according to their involvement, either direct or indirect. There is a group of stakeholders with a direct stake due to their duties and responsibilities. This group typically has a certain amount of power in deciding on the strategy. A second group will have an indirect stake due to the fact that they are affected but they are lacking this certain amount of power or a say in the decision making process.

Lessons learnt

- Define organization structures

- Design communication strategies;
- Define task and duties according to (i) capabilities, (ii) legal duties and responsibilities;
- Organize the available data in a systematic way e.g. through the use of a common language.
- A strategy on how to use resources in which main priorities on use are defined.

Role of road network

At this stage it is important to understand who takes responsibility for the road network and its management.

Information needed

(i) Roles and responsibilities of stakeholders

The identification of roles and responsibilities serves as a structure and guidance in the event of an emergency. It makes roles and duties clear. This helps duplication and miscommunication and thus wasting precious resources.

(ii) Perception of risks

Stakeholder involvement is deemed to be important in this stage as it is their local knowledge and expertise that can be vital for the successful planning of emergencies and evacuations. They have their own perception of the risks.

(iii) Institutional context

The institutional context determines not only roles and responsibilities of the actors, it also defines how to act in trans-boundary events. This includes local, regional and national boundaries. This is important since it defines to what extent flood events are dealt with and at what level. It is important to understand the role of the subsidiarity principle. This is: a general principle adopted by the European Commission on governance which works as mechanism to define which level of government is responsible for what type of action. It states that events are dealt with at the lowest suitable level of governance, higher levels of governance are only taken into account in case of trans-boundary effects.

(iii) Legal framework

Each actor works within a legal framework that defines who is responsible for what action.

(iv) Strategy

In a strategy the main outline of a general approach towards disasters should be defined. Priorities are defined but a precise description is not yet the important. This is done at later stages. In such a strategy the main issues are identified.

(v) Data

An overview should be gained of what kind, how much and what quality of data is available to support the decision making process. If the amount and quality of the required data is not enough then, before any, planning can take place data needs to be gathered.

User requirements

With respect to the objective and the lessons learnt, user requirements in this stage dictate the recognition of stakes and stakeholders. In addition to statutory stakeholders other non-statutory

stakeholders should also be taken into consideration. The system of identifying two layers of stakeholders is used in both the UK and in some cases in Italy.

User requirements can be summarised as follows:

- The identification of functional involvement in the planning and evacuation process.
- Assessment of possible evacuation planning zones and identification of elements at risk and their owners/operators.
- Assessment whether the available data is sufficient and of good enough quality to be used in decision making.

3.3 *Designing of an evacuation plan*

Stage	Designing the plan
Activity	Plan for possible evacuations under divers scenarios
Objective	Design an emergency plan
Actors	The various stakeholders as identified in “organizing the planning”
Lessons learnt	Prioritize interventions, according to vulnerabilities Take into account duration of flooding to assist with: - Planning for rescue operations - Designing a strategy for the deployment of resources
Role of road network	Identification of possible evacuation routes Identification of nearest facilities
Information needed	Identify possible scenarios Identify possible elements at risk Identify possible critical elements and thresholds Identify possible shelters Combination of all previous into event-scenarios
User requirements	A service that allows for forward planning and risk assessment.

Short description Once stakeholders have been organized into working committees the planning for emergencies can start.

Activity Whereas in the previous stage the emphasis was on organizing the planning this stage concerns the planning for the events, which includes the evaluation of diverse scenarios and the distribution of tasks and activities.

Objective To develop and design a plan that describes the organization of an evacuation as well as all the necessary activities in case an evacuation needs to be started.

Actors Various stakeholders, as identified in the “organizing the planning” stage, most notably: local government stakeholders in the field of law-enforcement, transport, civil protection.

Lesson learnt

- Prioritize interventions
- Take into account the duration of a flood
- Plan for rescue services
- Design a strategy for the deployment of resources
- Assess the amount of available resources

Role of road network

Organizations involved in the planning need to understand to what degree they can still perform at the required level under different circumstances. Such an understanding also involves the forward planning of how the inundation of the road network at certain place will affect the core activities of the involved stakeholders.

Information needed

(i) Assessment of available resources

An assessment of the available resources needs to be carried out, the objective. One of the objectives of this assessment is to find out about critical thresholds in the organization that handling the response. A limited amount of available ambulances for example calls for cooperation with other districts in order to maintain a certain level, or a standard of life quality. This assessment helps to define the threshold after which additional resources and help from surrounding districts need to use.

(ii) Flooding scenarios

Flooding scenarios are important as they define the state of the system during and after an emergency. A flooding scenario is the only parameter that determines the evacuation planning zone; the areas for which an emergency response needs to be organized and for which possibly an evacuation needs to be planned.

User requirements

A service that allows for forward planning and risk assessment to be carried out. Such a service would focus on the total demand and list of actions that need to be done during an evacuation and would compare them with the amount of resources available within the area of research. The goals would be:

- To understand at what point a disaster turns into a crisis and external help is deemed to be necessary.
- To understand what tasks and activities need to be carried out and how these should be priorities under different circumstances.

The following information is deemed to be necessary in this stage.

- Data on people to evacuate and the resources available. These data should be available within a GIS and should include:
 - Spatial distribution of inhabitants
 - Location and data on objects where inhabitants cannot evacuate themselves, such as nursing houses, hospitals and schools.
 - Location, extent and capacity of safe areas
 - Lay out and capacity of the road network
- Knowledge on the potential flooding pattern, as characterised by the timing of flood, flooding depth and flow velocity for different scenarios. This information should be available in the form of animations, maps or water depth flow velocity at certain intervals. In cases where flooding is caused by failure of flood defences, an estimation has to be made of the most likely breach location. Since it is not possible to predict the exact location of the breach, enough scenarios should be assessed to provide an overall picture of potential flooding patterns.
- An estimate of the time required for evacuation. This information can be compiled for the different flooding scenarios using an evacuation model.
- Information for the different flooding scenarios of the possible number of casualties.

3.4 Pre-flood awareness

Stage	Pre-flood awareness
Activity	Prepare for possible emergencies
Objective	To reach a certain level of awareness and preparedness
Actors	Local governments
Lessons learnt	Communicate plans to public at large Make plans publicly available Raise a certain understanding of warning codes A communication plan is part of the overall planning
Role of road network	Not applicable
Information needed	Communicate plans to public at large Make plans publicly available Raise a certain understanding of warning codes
User requirements	

Stage Pre-flood awareness

Activity Prepare for possible emergencies. The number of scenarios that are prepared for will be dependent on the scale of the administrative area. Typically for local communities the number of events will be limited. This exercise allows the emergency planning zones to be defined in advance of a flood. In such a case the elements at risk are known and the population in that area can be made aware of the risk.

Objective To develop an understanding of the level of risk in certain situations.

Actors Local government and depending on the scale of the event that is being prepared for, also higher levels of government.

Lesson learnt

- Communicate plans to public at large
- Make plans publicly available
- Raise an understanding of warning codes
- Regular exercises are the only way to maintain pre-flood awareness and preparedness.

Role of road network

At this stage the network does not play a role as such. It is, however, important that the main evacuation routes are known to the public.

User requirements

To deliver an evacuation message containing the main evacuation routes, description of safe havens and a description on how to behave during an evacuation to the affected inhabitants. This message should be differentiated according to the situation of the inhabitants regarding risk, evacuation routes and safe areas and shelter place.

Awareness and preparedness of staff of the involved authorities and services can be increased and maintained by regular exercises. An important role of these services is to emphasise the coordination among different organizations with different roles. Exercises should be held at different levels, ranging from the practical implementation of traffic control to strategic consultations between the

highest representatives of the organisation. To implement higher level exercises flooding and evacuation scenarios are required as an input.

3.5 Flood emergency stage

Stage	Flood emergency stage
Activity	a) Assessment of elements at risk b) Recognition of a critical situation
Objective	Decide on starting an evacuation
Actors	Stakeholders of the first group who are involved in taking decisions
Lessons learnt	Size and extent of event Size and extent of possible damage
Role of road network	• Determination of appropriate evacuation routes • Roadblocks • Routes for emergency services. • Availability and state of road network
Information needed	Elements at risk Development of risk during possible evacuation (population) Development of risk during possible evacuation (civil protection services) Consider evacuation in the near future Costs versus the benefits of evacuation
User requirements	

Short description Given the framework on emergency management as it is defined in the stage on “organizing the planning” and the roles and duties as defined in “designing the plan” the evacuation management will take place.

Activity Assessment of elements at risk and to see whether or not the current level of risk meets a pre-defined threshold of risk that is deemed to be the threshold between acceptable and non-acceptable risk.

Objective The objective of this activity is to decide on whether to start an evacuation. An evacuation can be started if the forecast situation is deemed to be so severe that staying in place is no longer an option. If staying put is not an option as the degree of risk a population is unacceptable then an evacuation can be commenced.

Actors Local Governments (depending on scale also: regional, national, European), stakeholders

Lessons learnt

- Planning of event in advance;
- An emergency plan is necessary but in some cases not sufficient;
- Informal networks of linked communities;
- Long term inundation may require additional evacuations due to decrease in quality of life in directly affected and indirectly affected areas;
- Flood plans should be made available at large;
- Any planning should be integrated with hydrological forecasting;
- Planning should include availability of roads during an event.

Information needed

(i) Elements at risk

An assessment of the elements at risk helps in determining what areas need to be evacuated. It is also important to assist in comparing the advantages and disadvantages of evacuation. It should be noted that an assessment of the risk also helps in determining what areas are safe enough for emergency and rescue services to operate in.

(ii) Consider evacuation in the near future

The development of the event can reach a certain point at which communities can become isolated and it will be difficult to maintain a certain level of service or guarantee a certain quality of life in those areas. In those cases also these areas need to be evacuated.

(iii) Advantage and disadvantages of evacuation

An assessment needs to be made of the merits of an evacuation, such as the injuries prevented and the lives saved. These benefits need to be weighed against the risk incurred during transportation and during staying in the shelter and the costs associated with providing transport, shelter and food.

User requirements

- Information on the likelihood of the occurrence of a flooding event;
- Information on possible size and extent of event;
- Information on elements at risk;
- Information on possible number of casualties;
- Information on time required for evacuation;
- Information on the possibility to evacuate as determined by the current and future state of the road network and by the time left for evacuation.

The ultimate goal is to have an informed decision on the need for evacuation and the associated risks, to achieve this, several analyses need to be carried out. These analyses should provide the decision maker with an insight of advantages and disadvantages of evacuation.

3.6 Assessment of evacuation options

Stage	Evacuation
Activity	Assessment of evacuation options
Objective	Decide on evacuation locations and modes of transport and the evacuation routes
Actors	Local governments, police forces, highway authorities, owners of road networks.
Lessons learnt	Risk information contributes to identifying evacuation routes and shelters
Role of road network	
Information needed	Development of risk during possible evacuation (population) Development of risk during possible evacuation (civil protection) When where and how to evacuate Organization of transport Special arrangements for specific needs Recording of evacuees
User requirements	A service that supports in the choice of evacuation routes

Short description Once it has been decided that an evacuation has to be commenced it becomes important to monitor the situation and keep track of possible implications of changes.

Activity Assessment of evacuation options, modes of transport to be used and decide on the main evacuation routes.

Objective To decide on the main evacuation routes.

Actors Local governments, police forces, highway authorities, owners of road networks, every actor with a functional relationship with respect the road network.

Lessons learnt

- Risk information contributes to identifying evacuation routes and shelters
- Information on road network availability is crucial for rescue services

Role of road network See the user requirements

Information needed

- (i) Development of risk during the evacuation of the population

An important resource in an evacuation is the road network. It is limited in its use and its application needs to be managed in order to have it functioning in an optimal way. For this it is important to assess who will use the network at what time and how much of the network is still available as the flood event develops.

- (ii) Development of risk during possible evacuation in terms of civil protection

The availability of the road network is important at this stage as it determines what areas can and cannot be reached. This information is necessary for civil protection authorities since it allows them to assess the amount of risk rescue services will possibly be exposed to during their operations and who it is possible to evacuate.

User requirements

This is basically the same information that is required for stages 2 and 4 (i.e. the flood extent and the state of the road network).

3.7 Evacuation

Stage	Evacuation
Activity	Delivering a warning message and starting to move people out of the emergency planning zone
Objective	To warn within a limited amount of time the population that is scheduled to be evacuated and organize their transport
Actors	Local government and those who have been assigned the task of warning
Lessons learnt	Identification of the most vulnerable people Coordination of records of evacuees Arrange for secondary transport
Role of road network	
Information needed	Dissemination of message
User requirements	A service that schedules the delivery of the warning

Short description The plan as it is decided upon in the previous stage now needs to be communicated to the public.

Activity Warning and moving

Objective In this stage the main objective is to spread the message with evacuation instruction to the entire population that is to be evacuated. A second objective is to provide for a timely and safe clearance of people from an area.

Actors Local governments, population

Lessons learnt

- Identification of the most vulnerable people
- Coordination of records of evacuees
- Arrange for auxiliary transport

Information needed

(i) Who to warn

From the delineation of the emergency planning zones comes as a list of household addresses containing the exact households which are supposed to be evacuated.

(ii) Contents of the message

From the previous step comes a list with key information on the evacuation. A selection of this should be communicated to the public.

User requirements

- A list of addresses that need to be reached

- A message containing information on collection points, routes and shelters.
- Instructions for how to behave during an evacuation for the public
- Registration system for determining the end of evacuation.

An accurate and concise list that provides details of the number of people to be transported, their locations within the emergency planning zone and their destination. The eventual evacuation plan needs to be disseminated to the proper authorities and proper traffic management needs to be implanted on the basis of this plan.

3.8 Shelter

Stage	Shelter
Activity	Shelter people adequately for a certain period of time.
Objective	Shelter people until the evacuation planning zone has been declared safe
Actors	
Lessons learnt	
Information needed	
Role of road network	
User requirements	

Short description

Once people have been evacuated from the areas at risk they need to be sheltered and provided with food and drinks for a certain period of time. This is done at the locations of shelter. Typically these are large public buildings that provide enough space and facilities to keep people e.g. schools and sports halls.

Activity

Shelter

Objective

To temporarily shelter the inhabitants of an emergency planning zone until the clear signal has been given. In this period the evacuees need to be fed, and to have a place to sleep.

Actors

Various stakeholders; owners of larger buildings, not necessarily in the district of the disaster.

Lesson learnt

-

Role of road network

-

User requirements

-

An inventory of large buildings, that provide enough basic facilities, to shelter the people who have been evacuated for a certain period of time. An inventory also needs to be made of nearby suppliers of necessary material for sheltering people (beds, linen, sanitary equipment, food, and drinks)

3.9 Return

Stage	Evacuation
Activity	Return
Objective	Allow people to their homes once the emergency planning zone has been declared safe
Actors	Various stakeholders
Lessons learnt	-
Information needed	An assessment of the development of risk over time.
Role of road network	An assessment of the development of risk over time.
User requirements	

Short description Once the flood has receded people usually want to return to their homes. The services that were in action for monitoring the development of the risk in the beginning of the evacuation also serve to decide on whether or not an area is safe enough to return to.

Activity To allow residents to return to their evacuated homes

Objective To decide on the safety situation in order to declare the area safe enough to allow residents and property owners to return to their homes

Actors Various stakeholders

Information needed An assessment of the development of risk over time.

Lessons learnt -

Role of road network An assessment of the development of risk over time.

User requirements

The same service that delivers the assessment of risk in the first stages of a disaster could in theory also deliver the same service in this stage. This means that a continuous assessment of risk in the emergency planning zone is needed in order to know at what point in time the area is safe enough to return to.

4. Conclusions

The following general conclusions can be reached:

- The timing, speed and method of communication of reports are critical to effective emergency management during a flood;
- A knowledge of the road network, location of the vulnerable elements at risk and evacuation times are key to evacuation planning;
- More robust and integrated communication links between the organisations involved in the response during a flood helps to ensure an effective response;
- A flood event management system that provides estimates of flood extents and depths for breach scenarios would assist with emergency response;
- Organised evacuation is only used as a form of emergency response in very rare circumstances. In most of Europe the authorities have no powers to forcibly evacuate people from their houses during floods and most evacuation is initiated by individuals or households;
- There is need for tools and methods to assist in the planning of evacuation/rescue operations and to estimate the optimal use of the transport network and the time required for execution of an evacuation;
- There is little experience within the European Union of using methods and models to support the planning and execution of evacuation and rescue operations for flood events.

The following conclusions have been reached regarding concerning the various stages of the evacuation process.

(i) Planning

There is a requirement for forward planning and risk assessment when it comes to evacuation. This would focus on the actions that need to be done during an evacuation and would compare them with the amount of resources available. The goals would be:

- To understand at what point a disaster turns into a crisis and external help is deemed to be necessary.
- To understand what tasks and activities need to be carried out and how these should be priorities under different circumstances.

(ii) Pre-flood awareness

There is a need to deliver an evacuation message during a flood emergency containing the main evacuation routes, description of shelters, and a description on how to behave during an evacuation.

(iii) Flood emergency stage

During the flood there is a requirement for the following:

- Information on size and extent of the flood event;
- Information on elements at risk;
- Information and characterization of a critical level, i.e. a pre-determined threshold that, if exceeded, still allows for safe clearing of an emergency planning zone.
- Damage assessment and calculation of cost of evacuation.

The ultimate goal is to have an informed decision on the value of an evacuation. This would provide decision maker with an insight of in to the advantages and disadvantages of evacuation.

(iv) Assessment of evacuation options

An assessment of the evacuation options needs to be made including:

- The risks associated with various evacuation options;
- Identification of safe areas and shelters;
- An inventory of auxiliary transportation that can be used and called upon;
- Identification of collection points.

(v) Shelter

An inventory of large buildings that provide enough basic facilities to shelter the evacuees is required. A list of suppliers of materials such as beds, linen, showers, food, and drinks is also useful.

(vi) Return

There is a need to assess risk continuously in the emergency planning zone so that it can be established at what point in time the area is safe enough to return to.

(vii) Debriefing

There is a requirement for stakeholders to compare their actions in the context of the flood event with their pre-determined objectives. If large discrepancies exist, then these need to be explained and the explanation need to be used to up-date existing evacuation and response plans.

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