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LESSONS LEARNED FROM FLOOD DISASTERS

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1. Introduction

This document sets out the main lessons learned from selected flood disasters recently occurring in Europe. The floods taken into consideration for this purpose are:

1. The 1993 Flood in Limburg (Belgium) – NEDIES event code 012/FLO/BE
2. The 1995 High Water Emergency in the Netherlands - NEDIES event code 004/FLO/NL
3. The 1997 Summer Flooding of the Oder (in Germany)- NEDIES event code 009/FLO/DE

The above flood disasters were reported in the Information System while the pilot phase of the NEDIES project was being implemented. In this only earthquakes and floods were taken into consideration for further analysis. The floods considered in this report were selected on the basis of the quality and quantity of the reference documents available. As regards the methodology followed in the pilot phase of the NEDIES project: for each disaster reported in the system an event form was filled in and specific reference documents were provided by people at the National Contact Point. In addition an individual report was produced for each one of the above mentioned flood disasters, in which a large amount of information relating to the occurrence and management of each particular situation is documented. The information contained in the specific documents received from the respective countries, and also the individual reports, constituted the reference material for preparing this Lessons-Learned Report.

A section of the report is dedicated to each flood disaster. The information fed into each section is structured in such a way as to present:

1. An overview of each event's characteristics (e.g. information relating to the occurrence and consequences of each flood)
2. The actual situation as compared with the prediction made for the disaster and the main prevention, preparedness and response measures taken. Emphasis has also been placed on the action taken with regard to providing the public with information before, during and after the event.
3. The lessons that were learned from managing the event. Those lessons are focused on various aspects of the prediction, prevention, preparedness, response and public-information

measures and are described after the actual situation in each of the previous areas has been discussed. They are written in Italics so as to make it easier for the reader to distinguish what has been learned from the management of each crisis.

Each individual group of lessons learned as regards a particular topic is directly preceded by the set of measures taken, on which the lessons are based. These measures are mostly collected from the descriptive chapters of the individual and reference reports. The reference reports (in a country-by-country form) are listed at the end of the report.

Finally, some thought is given in the last section to identifying the common lessons learned in areas related to flood disasters.

This report is addressed to the Civil Protection Services in the EU Member States and to the organisations and people involved, and makes available validated information on past flood disasters, their main consequences and their management. Moreover, the lessons drawn would suggest potentially interesting ways of dealing with future flood disasters.

2. The Flood in Limburg (Belgium) in 1993

2.1 Date and location of the disaster

Belgium was seriously affected by rising river levels and flooding during the 1993 flood, which began on 20 December when, owing to continuing rainfall, some rivers could no longer accommodate the increasing volumes of water. The situation gradually returned to normal during the first few weeks of January 1994. The floods affected an enormous area, covering various, geographically distinct areas in seven of the nine Belgian Provinces. These included four Provinces in Wallonia (Hainaut, Namur, Liège, Luxembourg) and three in Flanders (East Flanders, West Flanders and Limburg). The River Meuse (in Flanders referred to as the Maas) and its tributaries, in particular, caused severe problems in the Provinces of Limburg, Namur and Liège. The Provinces of East Flanders and Luxembourg, and to a lesser extent the Provinces of West Flanders and Hainaut, also were affected.

2.2 Brief description of the event

In late 1993, many parts of Europe were affected by heavy rainfall. On 15 December 1993, persistent, heavy downpours over northern France, the Ardennes and Flanders led to an initial peak in water levels in many Belgian rivers. When these downpours continued over the next few days and water began to flow more rapidly off ground that was already saturated, river levels that were already high rose even further. It was this second peak, coming on top of the first, that caused the flooding. The great extent of the floods can be explained by the wide geographical spread of the river network in Belgium. In the Province of Namur, the Meuse, the Lesse, the Sambre, the Viroin and their many lesser tributaries posed the greatest threat. In Flanders, the situation was most critical in the Province of Limburg. Here, the Meuse remains a constant threat of flooding for many municipalities and their surrounding villages over a distance of 40 kilometres. A number of municipalities were flooded while others were at constant risk of their dykes leaking.

The size and speed of the floods took the relevant organisations and authorities and the various aid services completely by surprise. The rise in water levels in the Meuse and its tributaries was

sudden and unexpected. The extent of the disaster situation was also unexpected and unforeseen. No early warning was issued to the inhabitants directly at risk, while these communities were usually left to judge for themselves how seriously the situation was deteriorating. As a result, those inhabitants took almost no precautionary measures. The affected populations were also not notified in advance of the intention to evacuate people in either Limburg (some 2 000) or Namur (some 500). People ultimately had to be evacuated in an unsuspecting and unprepared state, thus causing many problems and much inconvenience for both the families affected and the emergency workers.

The flooding led to the launching of an impressive, large-scale operation. Over a period of about two weeks, thousands of volunteers, emergency personnel and all available resources and equipment were deployed to relieve the worst effects of the disaster. In addition to causing a great deal of misery and inconvenience to local inhabitants, the floods were also responsible for several billion Belgian Francs' worth of damage. The magnitude of the emergency assistance operation was unprecedented. Fire Service, Civil Defence, Red Cross, Gendarmerie and local police personnel were constantly engaged in rescue operations. In a number of places, the army was also called in.

2.3 Impact on human beings

One person and hundreds of animals were drowned, while some 2 000 people and several hundred animals had to be evacuated. The floods caused a great deal of misery and inconvenience to the local inhabitants. Victims of the flooding suffered fear and uncertainty about what would happen to them, and also upheaval and the disruption of their daily lives.

2.4 Economic losses

Cost of Material Losses. As of September 1994, the total notified damage to private property in Limburg amounted to euro 2.2 million.

In Limburg,
- Direct material damage to private and public property totalled more than euro 2.5 million. Damage to agricultural property (crops, livestock, pastures and agricultural equipment) accounted to roughly euro 0.45 million.
- The overall material damage sustained (including commercial losses, the cost of clean-up operations, longer-term damage, etc.) was estimated at around euro 7.4 million.

Throughout the Flemish region the cost of repairing the infrastructure damaged by the floods (dykes, locks and flood barriers) was set at approximately euro 37.2 million. This alone would absorb the entire budget set aside by the Flemish government for water management in 1994.

The damage to agricultural property in Belgium came to around euro 7.7 million.

Cost of Response. The cost of the relief operation on the Limburg Meuse was estimated at approximately euro 1 million. In general the assessment of the damage sustained as a result of floods is a difficult and delicate task. Certain types of damage proved difficult to measure or were not precisely quantified, since they were not relevant to a damage claim. The figures quoted above should therefore be interpreted with some caution.

2.5 Prediction made for the disaster and related lessons learned

The hydrological services of the Flemish and Walloon Regions are responsible for identifying potential problem situations on and around Belgian rivers. They use a network of limnographs or measuring stations situated at various points along the rivers in order to monitor the situation on Belgian rivers on a daily basis. These stations measure the water level via a system of plotters and floats. The measurements obtained are then usually sent to the hydrological survey's computer room twice a day, and are subsequently processed. If there is a problem situation, the frequency of these readings increases substantially, sometimes up to 30-minute intervals. The service also has access to a network of rainfall meters, which indicate how much rain has fallen in a specific area. Finally, there is a modem connection to the Royal Meteorological Institute for the latest weather forecasts. On the basis of these data, the hydrological service can identify when certain rivers are in danger of flooding. When a specific water level has been exceeded, an early warning phase is activated, and when a critical limit has been exceeded, the emergency alert phase is activated. In such situations, a monitoring unit, responsible for monitoring developments and supplying information to the various groups involved, is set up within the hydrological service.

The Royal Meteorological Institute (KMI) is another important player with responsibility for forecasting potential disaster situations. The main task of the KMI is to provide the public with the meteorological and climatological data and information they require. During extreme weather conditions, this institute plays an important part in providing up-to-date climatological data and in forecasting further meteorological developments. When forecasting exceptionally severe weather (violent thunderstorms, storms accompanied by squalls, heavy rainfall), the KMl issues 'Special Flashes' several times a day in addition to its standard bulletins. These 'Special Flashes' are faxed to news organisations as well as to the government's crisis centre, the fire service, the Gendarmerie and the Civil Defence Force. If requested, the KMI also sends direct bulletins to those in charge of directing local disaster operations.

The measurements and bulletins produced by the hydrological services were essential in enabling an accurate forecast to be made of the changes in water levels and flow rates. This was necessary before decisions (often technical) were made such as whether to strengthen weakened and saturated dykes, and where to locate additional pumps. The hydrological services were not well equipped to make accurate predictions covering periods longer than 12 hours. They had to rely primarily on the Sethy (Walloon hydrological service) and on the Dutch Department of Public Works for predictions as to how water levels on the River Meuse were likely to develop. Although the Sethy had access to a number of forecasting and simulation models, it was not fully able to forecast water levels across an extensive network of rivers.

Lesson learned

– *An improved prediction model should be developed for the water levels in the entire Meuse basin in order to improve the quality of predictions beyond the 12-hour limit.*

2.6 Preventive measures taken and lessons learned with regard to prevention

No specific information concerning preventive action against floods before 1993 is contained in the reports used to prepare this document.

Lessons learned

– *Sufficient attention should be given to the dimensioning of dykes and pumping capacity in areas exposed to the risk of flooding.*

– *Preventive measures by the inhabitants should be encouraged in good time, for instance by providing information on hazards and possible forms of action.*

2.7 Preparedness situation

Preparedness situation. The responsibility for designing regulations for disaster planning lies with the federal government and not with the provincial or municipal authorities. Throughout the various series of government reforms, responsibility for civil defence has remained a national matter (or rather a federal matter, following Belgium's metamorphosis into a federal state). The Minister of the Interior co-ordinates emergency planning and mitigation. However, the federal government can only exercise its responsibilities effectively in consultation with provincial and municipal authorities since the regions are responsible for the environment and the municipalities are responsible for public health services. Thus, both provincial and municipal authorities play an important part in emergency planning and in providing practical support during disaster situations. Emergency aid during such situations is organised at three administrative levels: municipal, provincial and federal.

Disaster planning process. A 1990 decree brings together all the legislation and regulations on disaster management planning in Belgium. The guidelines that have been formulated provide a framework for drafting a general disaster management plan. In a circular, a disaster management plan is defined as:

"A plan setting out the broad outlines for the action to be taken in the event of a disaster, catastrophe or serious accident, with a view to preparing government coordination of assistance by the various emergency services, such that all available and accessible material and staff resources can be deployed in the most efficient way possible to protect the population and the environment against the negative effects of the situation."

The Decree on disaster planning of 19 June 1990 specifies that disaster management plans must at least cover the following aspects:
- Alarm procedures and the procedure for notifying those affected by the incident;
- Coordination of the operations and division of labour among authorities and emergency services and organisations;
- Action procedures for the various emergency services and organisations;
- Preparation of individual protection measures, such as evacuations.

The general disaster plan unfolds in four phases, depending on the size of the incident, its anticipated effects and the type of emergency aid required. These phases are not necessarily implemented in chronological order.

Table: Phasing of emergency management in Belgium

Phase	Level of Administration	Authority Responsible
1	Municipal: limited action and coordination	Mayor
2	Municipal: upgraded emergency action and coordination	Mayor + municipal crisis centre
3	Provincial coordination	Provincial governor + provincial crisis centre
4	Federal coordination	Minister of the Interior + government crisis and coordination centre

A general disaster management plan must be formulated at two levels: provincial and municipal.

At the provincial level, the general disaster plan must be supplemented by specific contingency plans, since different accidents often require the application of specific operational management and safety techniques. Specific disaster plans should be drafted for each type of contingency, including road transport disasters, rail disasters, air accidents, flooding and other natural disasters, hazardous industrial accidents, accidents involving underground pipelines, serious oil spillage or interventions at sea. However, the provincial authorities are not obliged to draw up specific disaster management plans for all these risks. They must decide which risks are most significant within their own territories. They are only legally obliged to draw up contingency plans for so-called 'Seveso' or nuclear establishments in their Province.

In order to be able to respond efficiently to a disaster situation, each municipality should have its own disaster management plan. Moreover, there must be continuity between the municipal plan and the provincial plan, and between the coordination carried out by the Mayor and the subsequent coordination carried out by the provincial governor. The municipal plans should therefore be drafted according to a standard format, as defined in the provincial model municipal disaster management plan.

The model municipal disaster management plan of a province must be converted by the municipalities into a general municipal disaster-management plan. The municipal disaster-management plan is activated by the Mayor after the emergency services have notified the disaster situation. In particularly urgent cases, this decision can also be made by the chief fire officer, the local police chief or the Commander of the Gendarmerie (national police, known as the Rijkswacht in Flanders). The Mayor notifies the provincial governor, providing information on the circumstances of the disaster, the risks involved and how the situation is developing. The governor activates the provincial disaster plan after consulting the Mayor. In principle, it is activated whenever different emergency services need to work together to deal with a particular event. Indicators of the seriousness of a disaster include:

– The number of injuries or fatalities;
– The presence or release of hazardous substances and gases which constitute a threat to the inhabitants.

The General Emergency Plan of the Province of Limburg. The Province of Limburg has always taken the lead in Belgian disaster management. A new revised and extended emergency plan for Limburg was designed in 1993. It is based on the statutory guidelines issued in 1990. All of the adjustments and refinements, which had been made over the past 14 years, were included in the new plan. It consists of two parts:

The first part sets out the provincial coordination system for all types of serious accident or disaster. It contains a comprehensive description of the actual operation of the emergency plan. It covers in detail the alarm procedure, the phases of the disaster management, the coordination process, the six key disaster management functions and the communications plan. The second part covers disaster management at municipal level. It defines the powers and tasks of the municipalities and the provincial model for municipal disaster management plans. The main features of the individual emergency plans of the 44 municipalities in Limburg are also summarised. This information is arranged in accordance with the provincial "model municipal disaster-management plan".

2.8 Response action taken and lessons learned from the response

Response measures. The magnitude of the emergency response operation was unprecedented. Over a two-week period thousands of volunteers, emergency personnel and all available resources and equipment were deployed. Fire Service, Civil Defence, Red Cross, Gendarmerie and local police personnel were constantly engaged in rescue operations. In a number of places, the army was also mobilised. In Limburg, thousands of relief workers (12 610) put in full eight-hour working days. The army deployed more than 2 500 personnel. For days they worked to fortify and heighten the dykes and pump out cellars, houses and roads. In total, 190 000 sandbags were placed. Approximately 2 000 people were evacuated. The gendarmes and the police were busy with the influx of disaster spectators. The commitment of many volunteers proved an essential contribution to the successful performance of relief operations.

No early warning was issued to the inhabitants directly at risk, and these communities were usually left to determine for themselves how seriously the situation was deteriorating. This can be partially explained by the sudden way in which the flooding occurred. Yet it cannot be denied that there were also one or two factors which should have led to a greater alertness and the taking of necessary precautions. Early warning notification had been practised in Wallonia since 13 December 1993. However, the continued rainfall meant that the soil was completely saturated and could not hold any more water. Any further rainfall would have to be collected and drained off by the rivers. Consequently, forecasts of further rainfall should have been a signal that problems were to be expected. Throughout the crisis, the Flemish co-ordinators were unable to get precise information concerning water levels upstream, in Wallonia.

The flow of information between the two language regions went fairly smoothly; deficiencies were nevertheless recorded on the Flemish side. For example, the provincial coordination committee in Limburg could not always obtain precise information about the water level situation upstream in Wallonia. This flow of information was often late and did not always reach the coordination committee directly. Moreover, the contacts and the exchange of information with the relevant authority abroad in connection with the international flow of information were laborious and prone to delays. During the early phases, there was no information from France concerning water levels on the Meuse, Scheldt or Ijzer or their tributaries, even though this could have made the problem situation more predictable. Information was exchanged with the Dutch Department of Public Works only once the problem situation had actually developed. Particularly with regard to forecasts extending beyond 12 hours, the hydrological services were heavily dependent on the changes in water levels in the neighbouring countries and on the information that was available concerning non-Belgian rivers.

A delay of one-and-a-half to two hours was observed between the actual measurement of the water levels and the receipt of this information by the emergency aid workers in the disaster area. In the Province of Limburg it meant that, by this time, the emergency aid workers operating in the disaster area had usually assessed the situation for themselves, and only later had this assessment confirmed by the report from the hydrological services. The measurements and bulletins by the hydrological services were therefore important chiefly during the earliest warning and emergency alert phases.

In general cooperation between the various relief services went relatively smoothly. Nevertheless, there was friction between civil defence and fire service relief workers. The explanation for these tensions can be found in the partially overlapping tasks of the two relief services as well as in their differing working methods. The commitment of many volunteers proved an essential contribution to the successful execution of relief operations.

The various relief services were inadequately informed about the potential of the radio, the Civil Defence's new communications vector, which was under-utilised. In Namur a communications problem was created by the inadequate communications skills of many relief workers. The volunteer workers in particular were often not well trained in radio communications, and proved unable to get the essential information across in a clear and meaningful manner. As a result information transfer between the trouble-spots and the central crisis staff became rather confused.

In the Province of Limburg, engineers, whose technical expertise on the subject of dykes and watercourses made an important contribution, had a decisive impact on a number of important decisions concerning the deployment of personnel for the strengthening of dykes and the various evacuations. The emergency services did not always have a correct overview of the amount of people and equipment they employed in the field. These reporting problems were most apparent among the relief services that employed volunteers.

In both the Limburg and Namur provincial committees, key decisions were made by consensus. Unanimity was fostered by the time pressure inherent in the situation. It was also a matter of personal leadership by the provincial governors and their deputies, the district commissioners who act as the chairmen of the coordinating committees.

Lessons learned

- *At federal level there was no overall disaster response plan capable of handling such a situation (there was only one for nuclear disasters). Coordination at federal level would merely hamper and slow down the response.*
- *Drawing the members of the coordinating committees from the various relief organisations is a good way of producing a combined effort which offers an extra dimension compared with the independent deployment of each service, thus increasing overall efficiency, avoiding overlaps and misunderstandings, and improving the control over the deployment of relief workers and equipment.*
- *A good flow of information between the various parts of the emergency system, as well as between the coordination centres and the disaster areas, is one of the most crucial aspects of any emergency system: therefore, the development of an efficient communications system should be given the highest priority.*
- *Emergency planning and the structure of the emergency system should reflect the need to avoid any overlapping of the tasks of various relief services and any conflicts resulting from this. Including heads of the different services in the coordinating committees or allocating separate territories to different services is a possible way of avoiding overlaps and conflicts.*
- *In an official assessment made after the operations, the competence and expertise of the emergency services were found to be insufficient for assessing the risk of dyke breaches in the event of high water levels.*
- *Sources of high-level technical and scientific expertise should be included in the inventory of organisations and resources. During a crisis, they should be always available for the coordinating committees, or be part of the committees.*
- *Members of the emergency services should be taught to assess dyke safety by relevant experts. Highly qualified staff should be employed and abundant resources allocated.*
- *Under pressure, consensus and personal leadership (as opposed to rigid rules concerning authority) can produce effective decision-making in coordinating committees; however, this may depend on particular contexts (cultural and other).*

The emergency plan should be structured and account taken of the following aspects:

- *Early prediction and warning systems should be given a high priority. Early warning of the public concerning the possibility of evacuation, as well as explaining the reasons for evacuation, should be considered aspects of great importance and high priority. For early warning, efficient communications and an efficient flow of information within the emergency system are crucial. An improvement in the flow of information (particularly the international flow of information) is essential to improving the ability to forecast the Meuse's water levels over more than 12 hours.*
- *During an emergency the collection of reliable information on water levels should be given high priority.*
- *Immediate availability to emergency aid workers in disaster areas of measurements and forecasts concerning water levels by the hydrological services could significantly improve the efficiency of relief operations.*
- *Training, simulations and drills for relief staff, including volunteers, should include the proper and disciplined use of communications equipment, such as radios.*
- *Emergency flood plans should include the organisation, supervision, feeding, sheltering, etc. of large numbers of volunteer relief workers.*
- *The emergency services and especially those relief services which employ volunteers should be properly aware of the number of people and materials they employ in the field in the course of operations. Furthermore, inexperienced volunteers need expert supervision and assistance. The inadequate monitoring of staff and materials led to misunderstandings.*
- *The manual preparation (filling and stitching) of sandbags proved to be excessively time-consuming. Enough sandbags should be kept ready when emergency situations are possible. There should be machines available for preparing sandbags mechanically.*

Evacuation. The most serious conflicts between authorities related to the evacuation. In both Namur and Limburg, the provincial coordinating committee gave the order to evacuate several times, but Mayors delayed or blocked the execution of the order. The final say as regards evacuating inhabitants lies with the Mayors. Without their approval, the provincial coordinating committee could not proceed to evacuate.

Most of the evacuations generated a highly tense atmosphere among those involved, since there had been no advance information on the possibility of evacuation and the measures to be taken. The affected populations were not notified in advance of the intention to evacuate people in either Limburg (some 2 000) or Namur (some 500). The Red Cross had urged the authorities to distribute a leaflet with a list of instructions to the populations at risk. The provincial coordinating committee decided not to act on this advice, fearing such a leaflet might result in panic. The actual result was that people ultimately had to be evacuated in an unexpected and unprepared state, thus causing many problems and much inconvenience for both the affected families and the emergency services.

An important bottleneck was caused by the refusal of many to heed the order to evacuate. For the most part, forced evacuation was the only option remaining, but the provincial coordinating committee believed forced evacuation to be too time-consuming and risky for the relief workers. Thus nobody was obliged to be evacuated. Of all those unwilling to leave, the most reluctant were those who would have to abandon their livestock. Also, moreover the early return of evacuees to their homes constituted a major problem. The dispersal of the evacuees among various reception centres proved impossible to supervise. Moreover, night-time evacuations were difficult and risky for all of those concerned.

Nobody was evacuated by force. Those remaining behind were registered and were specifically warned that they did so at their own risk. Had the worst indeed happened, there would have been

serious problems of responsibility and liability. Belgian law does provide for enforced evacuation, but there are apparently no examples in case law, which provide clarity on this issue.

Lessons learned

- *Wherever possible, the population should be informed in advance, psychologically prepared and convinced in advance about the need for evacuation. This may be done through the media or by handing out information leaflets, which are much more likely to lead to an easier evacuation process than to cause any panic.*
- *Relief workers and operations managers should expect strong resistance to evacuation among not only the inhabitants but also among the local authorities. This is particularly true where farmers would have to abandon their livestock and where the population has been insufficiently prepared and informed in advance. Night-time evacuation makes the situation even more difficult for all concerned.*
- *Resistance of local/municipal authorities to very unpopular measures, influenced by resistance among the inhabitants: Unpopular measures such as evacuations should be controlled by organisations and authorities that have no excessive direct or personal involvement with the inhabitants concerned.*
- *Where forced evacuation is to be carried out, extra staff and equipment should be provided for this risky and time-consuming operation.*
- *The supervision of evacuees dispersed among various reception centres in a flood situation should be given careful thought in future emergency planning.*
- *Legal responsibilities and liabilities should be clearly defined where individuals prefer to take personal risks, refuse to be evacuated or otherwise refuse to be involved in emergency operations.*
- *Particular care should be taken concerning the organisation of night-time evacuation. Appropriate equipment (e.g. lighting vehicles) should be available. Specific simulations and drills should be organised for this kind of night-time operation.*
- *Action should be taken to keep disaster tourists away from disaster areas, which should swiftly be declared off-limits for anyone not directly involved in the relief operation. Any breach of the regulations should be punishable by fines. The police forces should set up roadblocks sealing off the disaster area. Particularly in flooding situations, where many roads and access routes may be already blocked by the water, the presence of disaster tourists can be extremely obstructive to relief operations*

2.9 Information to the public and related lessons learned

The procedure for notifying the public and the media in the event of a disaster is contained in the provincial disaster plan. The designation of the authority responsible for monitoring and coordinating the information flow depends on the phase of the emergency plan: In phases 1 and 2, it is the Mayor, while in phase 3 it is the provincial Governor or his deputy (the District Commissioner) and in phase 4 it is the Minister of the Interior. Each of these can also appoint a specific external spokesperson whose task it is to direct and substantiate the flow of information to the press and the public. In the event of serious disasters, the governor must also open an information centre for victims or their families where the media can also obtain information about the emergency operation. This is required when injuries and/or fatalities have occurred or when dangerous gases and products have been released which constitute a threat to public health. A special telephone number can also be provided for this purpose.

Information immediately before the event. As mentioned above, no early warning concerning the danger of flooding was issued to the inhabitants of high-risk areas. Only caravan owners were warned, and then only at a late stage. As a result, the population took almost no precautionary

measures. The most serious consequence of the lack of early information was the further difficulties encountered during the subsequent evacuations, and particularly the opposition among the unprepared inhabitants.

Lessons learned

– *Prediction, early warning, and an efficient flow of information concerning flooding hazards and the evolution of floods should be given the highest priority, and sufficient equipment and staff should be allocated for these purposes.*

Information during the event. The public was kept informed largely through the media (radio, TV). There was almost no additional means of spreading information, such as information leaflets, folders or loudspeaker cars . The process of notifying the inhabitants (in the context of Phase 3 - provincial coordination) was not always properly co-ordinated or managed. In Limburg, public information duties were too fragmented among the various members of the provincial coordinating committee, whose actual core tasks at that time clearly required them to be elsewhere. Information policy was not given enough practical and material support. No separate room was set aside for the press. Similarly, no facilities were provided for the press to set up their vehicles, broadcasting equipment and other apparatus. The press conferences were organised on a somewhat improvised basis. The press conferences themselves were held at irregular intervals and during the first few days, no written information was provided for the journalists. Owing to the overloading of telephone lines at the crisis committee headquarters, it was difficult for journalists to reach any of the officials responsible between press conferences. The local Mayors were keen to act as independent spokespersons, but the various bulletins they gave were often insufficiently co-ordinated. There was little consultation about what information would be communicated to the public. Moreover, it is quite likely that each Mayor was at the time trying to raise the profile of his or her municipality with the media, which would have the effect of minimising the problems and needs of the other municipalities. The media circulated a number of inaccurate bulletins and exaggerated accounts.

Lessons learned

– *The media can play a crucial part in keeping the public informed, fulfilling a dual role: passing on official public-service bulletins, and providing updates on the disaster situation and on the emergency operations by means of news reports.*
– *There should be checks on the circulation of inaccurate bulletins and exaggerated accounts.*
– *Additional means of spreading information should also be employed, such as information leaflets, folders or loudspeaker cars.*
– *Information policy should be given enough practical and material support, such as: separate room for the press; facilities for the press to set up their vehicles, broadcasting and other equipment; press conferences held at regular intervals by well-trained spokespersons; preparing written information for the journalists; providing some opportunity for journalists to reach the officials responsible in between press conferences.*

Information after the event. Criticism about the causes of the floods and the approach to dealing with them only began to emerge after the operations had ended. Between 1994 an 1995, there was some media criticism of the slow processing and payment of the 1993 victims' claims for compensation.

Lessons learned

– *Even where there are obvious errors in the emergency management, during the relief operations themselves, little criticism is to be anticipated from the media, which will tend to concentrate in the first place on the dramatic nature of the disaster, and to be complimentary*

about the action taken by the emergency services and the volunteers, sometimes even describing these efforts in heroic terms. However, criticism may begin to emerge after the operations have ended.

3. The 1995 High Water Emergency in the Netherlands

3.1 Date and location of the disaster

The high waters lasted from 24 January to 5 February 1995. Main locations involved the Province of Limburg (Southern, Central and North-Limburg Regions) and the Provinces of Gelderland (Nijmegen and Rivierenland Regions) Zuid Holland, Noord Brabant and Overijssel.

3.2 Brief description of the event

Over a two-year period, the rivers in the Netherlands reached extremely high levels twice: in 1993 and 1995. Such events are only expected roughly every 150-200 years. In 1995, the floods were more intense and lasted longer than in 1993. Both events correspond to the highest water levels of this century. On the other hand, historical data for the region indicate that paired occurrences of extreme water levels appears to be almost the rule: 1824 and 1825, 1844 and 1845, 1918 and 1920, 1925 and 1926, 1982 and 1983. The main rivers in the Netherlands, which caused the 1995 (and 1993) high water crises, are:

- The Meuse (Dutch name: Maas);
- The Rhine, which splits into several branches in the Netherlands, including: the Waal (southern branch), and the Ijssel (northern branch, flowing into the Ijsselmeer).

The main factors that affect the levels of these rivers are the following:

- meteorological situation / amounts of rain over the last few days
- amount of melt water from snow cover (winter only)
- the weather over the last few months: saturation or freezing of the ground in the river's catchment area increases the speed with which the rainwater flows into the rivers.
- amount of alpine glacier /snow-melt water (all year round - Rhine only)
- runoff capacity of rivers (includes effect of dams and locks, also used as regulators)
- ocean tides (Spring tides at the time of new and full moon).

In the past, major floods were expected about once every 150-200 years; this frequency appears to have increased significantly in recent years. Extremely warm winters with high rainfall (such as in 1993 and 1995) correspond to the expected consequences of the global warning caused by the antropogenic increase in atmospheric CO2 levels. However, the question whether or not the floods are related to the changing climate has no final answer yet.

3.3 Impact on human beings

The 1995 flood caused no fatalities in the Netherlands. However, about 210 000 persons living in the Central Netherlands area, where there was a risk of flooding were evacuated. In more specific terms, in the Nijmegen Region 55 000 persons were evacuated and in Rivierenland 185 000 (almost the entire population).

3.4 Economic losses

Cost of material losses. The main part of the total economic loss (which was extremely high) was not caused by the water damage, but by costs and production losses due to evacuation. In order to estimate the damage suffered as objectively as possible, positive use was made both of the experts available at the insurance companies and of experts who were specially called in, instructed and organised for damage assessment.

Cost of response. The evacuations costs were extremely high for private individuals, companies, farms, chemical establishments and distribution companies. In more specific terms, given that water damage cannot be insured against in the Netherlands, private individuals had to pay for the removal costs, extra accommodation and damage resulting from power failures.

3.5 Prediction made for the disaster and related lessons learned

River levels are monitored via measuring devices, warning systems and computer networks. Water management and in particular the alarm procedure where there are high waters is based on fixed minimum and maximum levels. Volumes of river water (flow) and sea water levels are ignored.

Meuse-Prediction system. Water levels are forecast by the Institute for Integrated Fresh Water Management and Waste Water Treatment (RIZA -- Rijksinstituut voor Integraal Zoetwaterbeheer en Afwaterbehandeling). Water levels in the Meuse are normally subject to wide and quick fluctuations, since the Meuse carries no constant flow of melt water (unlike the Rhine) and its flow depends totally on rainfall. Moreover, the soil in the Ardennes does not absorb much water, causing rainwater to each the river relatively quickly. The advantage of the Meuse in Limburg is that floods can be seen coming days ahead. However, there remains an uncertainty as regards the maximum levels expected, which are crucial for the willingness of the authorities to take drastic action. Forecasts for the Meuse levels are very dependent on the forecast rainfall; generally, predictions extending beyond 12 hours are considered too uncertain to be published. After the 1993 floods, a start was made on improving the Meuse-level measuring system; although the work had not been completed in 1995, the quality of the measurements was already much improved.

Lessons learned

– *During the 1995 flood, predictions by the RIZA (the Institute for Integrated Fresh Water Management and Waste Water Treatment) proved to be satisfactorily precise and reliable. Later corrections of the predicted levels were never necessary, as opposed to 1993. At the request of the municipalities concerned, sometimes even predictions beyond the usual 12-hour limit were issued, and proved to be correct; however, such longer-term forecasts remain uncertain because of their strong dependence on the weather forecasts.*

Rhine-Prediction system. Forecasts for water levels are made by the RIZA, together with the Regional Authority for the Eastern Netherlands (DON-Directie Oost-Nederland): the RIZA prepares forecasts of the water levels at Lobith, on the basis of the water levels of the Rhine (upstream) and its major tributaries, of the rainfall data from several stations in the Rhine area, and of the weather. Using these data, the "Lobith Model" software calculates forecasts for the Lobith level over the next four days. Only the predictions for the first two days are made available to the public, since beyond two days the predictions are considered not to be sufficiently reliable. The Lobith Model is a simple statistical model based on multiple linear regression. The

model's predictions are adjusted by the forecasters, according to a number of rules of thumb. These rules are based on the flow times in the Rhine system, the water volumes in the system, and (very important) the forecasts by the German Federal Hydrological Institution (Bundesanstalt für Gewässerkunde-BfG, Koblenz).

The DON calculates the expected water levels downstream on the basis of the RIZA's predictions for Lobith. Normally, forecasts for Lobith are prepared every workday, and in high-water situations, twice daily.

Lessons learned

– ***Rhine.*** *This high-water crisis highlighted the need for improvements in the following areas: Operational sphere: gathering of data, software models for forecasting water levels, consistency in the application of rules of thumb in adjusting forecasts, documentation.*

Communication with the Regional administration: Qualitative overviews concerning three- and four-day forecasts were sent to the Regional administrations concerned: The preparation of such overviews should have taken greater account of/focused more on the levels which are critical for the authorities, such as NAP +16m and +16.5 m. During the high water crisis, reports to the administrations several times predicted "maximum levels" three or four days ahead, with the result that the levels had to be corrected several times, reducing the credibility of the forecasts. In future, only predictions where maximum levels fall within the next two days should be communicated to the authorities.

– ***Rhine level and flow forecasts for Lobith.*** *The forecasting instruments should be improved, particularly those concerning the 3- and 4-day forecasts. The error margin of the RIZA forecasts was below 10 cm (1 day ahead), 15 cm (2 days ahead); for the 3rd day the inaccuracy exceeded 20 cm in 60% of the cases; for the 4th day the inaccuracy exceeded 40 cm in 50% of the cases.*

The importance of accurate precipitation forecasts increases with the number of days ahead covered by the water-level predictions. In particular, the following options should be investigated:

- *Improving forecasts using a specific prediction model for high flow rates.*
- *Developing a rectification software, to be applied to the results of the existing prediction model.*
- *Implementation of non-linear regression techniques.*
- *A necessary longer-term project entails the development of a new, more physically oriented prediction model for the Lobith level. Such a model should include a water movement model for the Rhine, as well as precipitation discharge models for the tributaries. Such a model should be developed in cooperation with Germany.*

– ***Rhine level and flow forecasts: downstream of Lobith.*** *The SOBEK water movement model should be operationalised for the various branches of the Rhine. The Ijssel (northern Rhine branch) levels also depend on the levels of the Ijsselmeer. The RIZA's forecasts for the Ijssel levels were systematically too high by 15-20 cm, indicating a need for improvement to the Ijssel prediction models.*

3.6 Preventive measures taken and lessons learned with regard to prevention

Several preventive structural measures mainly regarding the reinforcement and strengthening of the dykes were delayed owing to an ongoing dispute in recent years between advocates of dyke

reinforcement and environmentalist groups who oppose such construction work because valuable scenery and historical buildings would be damaged or lost.

Lessons learned

- *Land-use plans should be produced in order to prevent the storage of hazardous substances in areas with a high risk of flooding.*
- *Companies keeping hazardous chemicals in areas which could be flooded should be required to prepare plans for a quick emergency removal of those substances. For "Seveso" companies, such plans should be included in the general emergency plans required by the legislation implementing the EU "Seveso" Directives.* This lesson arises from the fact that a considerable proportion of the substances stored by the chemical companies in the evacuated area was left behind, and would have led to serious environmental contamination and actual flooding.

3.7 Preparedness situation and lessons learned with regard to preparedness

In the Netherlands, the administrative and operational responsibilities are distributed throughout the various levels of the administration, which are: The national, provincial and municipal governments and inter-municipal joint ventures (regions) and water management authorities. There is no central contingency planning organisation. Planning is organised via the cooperation of a range of services and organisations, according to the nature of a potential disaster. Up-scaling and cooperation agreements are laid down in the municipal / regional contingency plans and the provincial coordination plans.

The Minister for Home Affairs is responsible for contingency planning at national level, including coordination of the various provinces and distribution of the national relief services. At national level, the emergency response coordination and the activities of the various specialist departments in actual disaster situations and crises are organised at the National Coordination Centre (Landelijk Coördinatie Centrum -LCC), housed at the Ministry of Home Affairs.

At provincial level the senior official, who is the Queen's Commissioner, has a coordinating function in contingency planning (e.g. concerning the provision of inter-regional relief assistance) and where there are conflicts has to harmonise the decisions of disparate Mayors, whenever an incident affects several municipalities.

Given the strong Dutch tradition of local/municipal autonomy, many executive tasks are carried out at municipal level, including in emergency situations. The Mayor is responsible for coordinating the emergency response at municipal level. Where several municipalities are involved, the Mayors in a region may choose a Coordinating Mayor whose duty is to harmonise the activities in the region's municipalities; however, ultimate responsibility for the response activities remains with the Mayors. For example, during the 1995 crisis, the Mayor of Nijmegen was appointed Coordinating Mayor of the Nijmegen region (Central Netherlands), consisting of the following municipalities: Beuningen, Druten, Gennep, Groensbeek, Heumen, Millingen aan de Rijn, Mook en Middelaar, Nijmegen, Ubbergen, West Maas en Waal, and Wijchen.

The water management authorities (Waterschappen) occupy a position below provincial level, but are independent of the municipalities. They can provide hydraulic-engineering skills. In an emergency, a Mayor will have to deal with the water management authorities, e.g. to obtain advice on the soundness of dykes. They co-ordinate activities relating to water control, such as dyke strengthening, the opening of sluices and locks, etc.

Finally the emergency stand-by services constitute the core of the operational organisation. Regional and local fire services, regional police and medical emergency services etc. The most important part is played by the fire services. Preparations for contingencies and operational leadership lie within the Regional fire brigade in close cooperation with other operational services. The Regional Fire Chief is responsible for the operational management of the response. The Queen's Commissioner may give the Mayor instructions concerning the aims of the response activities. His/her intervention is particularly required if there are conflicts among Mayors. The Minister of Home Affairs can issue instructions to the Queen's Commissioner.

In the event of floods, the Coordinating Mayor is assisted by a Regional Water Emergency Committee.

This Committee is responsible for:
- coordinating requests for intervention
- providing logistical support
- preparing evacuation plans
- managing information (supra-Regional collection and distribution of information; providing a central information telephone number)
- informing and advising the Coordinating Mayor concerning the emergency situation and the operations being carried out.

The Water Emergency Committee is divided into a Coordinating Committee and an Operational Team. The Regional Coordinating Committee (in which decision-making takes place) consists of:

- The Mayors of the municipalities in the Region.
- The heads of the Regional fire service, police and health service.
- The municipal secretary of the coordinating Mayor's municipality and, possibly, other officials who are considered useful by the Coordinating Mayor.

The contingency-planning organisation in the Netherlands functioned properly. The cooperation between the various administrative levels resulted in decisions being taken in good time and being implemented efficiently.

The emergency plan. The phasing of the emergency plan is linked to particular water levels that are individually defined for each river. (The following phasing structure is taken from the emergency plan for Gelderland Province, but can be considered as representative of all Provincial plans).

Phase 0: "Measures to ensure the normal continuation of everyday life in the area".; coordination of response activities by water management authorities (waterschappen) and municipal administrations.

Phase 1: "Increased alertness":
Preparatory activities designed to facilitate the subsequent mobilisation and response); Municipal coordination centres are activated, headed by the Mayors.

Phase 2: "Serious risk of difficulties":
Regional coordination centres are activated (coordination of relief activities, logistical support, preparation of detailed response plans, based on the emergency plan).

Phase 3: "Dyke failure or immediate risk of dyke failure":
The head of the Regional fire service takes over the direction of the Regional coordination centre and the functions of the coordinating Mayor. In the event of a major

threat or actual disaster ("disaster" according to the 1985 Disaster Act) Mayors can issue special by-laws; Regional and Provincial coordinating centres are given more power.

The emergency plan includes detailed response plans for particular scenarios, such as dyke failure in various places; evacuation plans for these particular situations are included. After the 1993 floods, the Nijmegen Region had been chosen as the Pilot Region for emergency planning. Shortly before the 1995 floods a master plan had been adopted by the Mayors in the Nijmegen Region, and had been sent to the other Regions in Gelderland Province as a model.

Nowadays there is a general consensus concerning the need for operational and practical contingency plans, containing well-defined and tested agreements concerning the cooperation between the various administrative organisations and operational emergency services involved, such as fire brigades and the police. An emergency plan is necessarily just a guideline for further detailed planning, to be carried out according to the details of an actual emergency situation. Therefore, specialists in interdisciplinary planning processes should be available to the coordinating teams.

Lessons Learned
Administration

– *The presence of a generally efficient administration was a crucial factor in the smooth response operation, and particularly in the smooth large-scale evacuation in the central Netherlands. The Dutch system of leaving many responsibilities in the hands of municipal and Regional authorities and services, including coordination of the operations by local authorities and services, has proved to be a very efficient system: the small scale of the territory covered by the powers of the administrations and of the emergency services has the following advantages: a good knowledge of and strategic use of the special features of the area; shorter lines of communication within the coordinating structures; more personal relationships strengthening the administrative and coordinating structures.*

Emergency Response Teams (coordinating and operational)

– *It should be precisely defined in advance (in the emergency plans) which representatives of the emergency services and of the administrations will be called upon to join the response coordinating teams in an emergency. In this way, the organisations and administrations can prepare in advance for the absence of (often important) members of their staff during an emergency situation.*
– *The respective roles of the coordinating and operational teams were not defined clearly enough, so that often the municipal response teams had difficulties in deciding which of the two to contact in connection with particular problems. In future, the communications between the coordinating and operational teams should be strengthened, as in this instance they formally went only through the head of the operational team. The problems of the Region tended to overshadow those of the coordinating municipality (Nijmegen) itself, by absorbing all of the attention of the operational team. The work of the Nijmegen Regional operational team was on time and efficient, and there were no significant problems.*

Organisational aspects

– *The quality of the work of the coordination centres can be significantly improved by establishing and actually following efficient information-exchange procedures within the emergency response structure. In particular, a main information centre should be set up whose function is to maintain an adequate information flow. In future, the information flow between the coordinating and operational teams should be strengthened, as in this instance it formally went only through the head of the operational team.*

- *"Dual functions", e.g. officials active in both the coordinating and operational teams, proved to be a good way of ensuring the necessary synergy.*
- *Experience has shown that not all the facilities, know-how and equipment which in principle were available in the area were put to efficient use, even when they were urgently needed.*
- *The emergency plan should include agreements with the telephone companies, catering companies, security companies, etc., concerning procedures which would allow a quick up-scaling of the quality and scope of the response measures available.*

Information Flow Within the Emergency Response Structure

- *The efficiency of the coordinating centres' work (in the Rivierenland Region), suffered seriously from communication difficulties resulting from bad connections. Adequate rooms for the coordinating centres, with adequate staff, logistics and equipment (including enough emergency connections to remain connected with the outside world if the main lines failed, photocopiers, etc.), are a basic requirement for any efficient emergency system. Ensuring fast and reliable operational communications is of course a matter of the highest priority. Communications between the (Rivierenland) Regional Coordinating Centre and the polder district administrations during an emergency need to be improved.*
- *Both the reliability of dyke safety assessments by the polder districts, and the consistency of the terminology used in their reports to the coordinating centres need to be improved: crucial decisions concerning evacuations etc. depend on this information.*

Information management

- *As soon as it becomes clear that an emergency is approaching, municipal administrations should activate toll-free 24-hour telephone-contact numbers (information to the public, inter-municipal coordination, etc.). In the same way, Regional and Provincial coordinating centres should create permanently available contact points. For example, municipal response teams should always be able to reach 24-hour telephone-contact numbers in order to verify the* correctness *of information etc.*
- *A computerised automatic information management system for the operational information flows within the coordinating structure would be valuable. It should include a system for managing telephone communications, in order to optimise the accessibility of the key persons. Using such a system and sharing it throughout the emergency response system (emergency services; municipal, Regional, Provincial and national coordinating centres) reports could be quickly made available at all levels, increasing the degree of integration and synergy throughout the emergency system. Printed information material was often of poor quality (badly printed maps, incomplete diagrams, etc.).*
- *Each municipality should have Ordnance Survey maps of itself in order to be able to answer inhabitants' questions concerning the safety of their property. There should be standard maps used by all of the coordinating - and operational structures involved (coordinating centres, police, Red Cross, water-management authorities, military forces, fire services, etc. Such standard maps should be incorporated into the proposed automatic computerised information management system. For example, areas that might be flooded according to the forecasts of the water management authorities may appear on printouts of these maps, which would be immediately available to all of the organisations and administrative units concerned.*

Operational relief services

- *The cooperation between the operational services proved satisfactory, and the operations were implemented in a reasonably clear and orderly manner. As regards the activities of the relief services, a more centralised control and supervisory function at Provincial and/or national level will have to be introduced, particularly with a view to deployment over several days in situations where there is a tendency towards improvisation.*

Role of the police

– *The police's work at the roadblocks became very complex because of the many exemptions from the evacuation that were granted. The police authorities would like the exemption policy to be simplified. The police perceive a need for more clarity concerning the conditions under which they can request assistance from the army.*

Military support

– *The respective roles of the armed forces and police in guarding the evacuated areas should be defined more clearly, in particular in terms of the maximum staffing levels which can be demanded from the police before military intervention can be requested. More generally, the police perceive a need for more clarity as regards the conditions under which they can request assistance from the army. In 1993, the Limburg Provincial coordination team found that the presence of high military officials on the Provincial coordination committee would improve the overall efficiency of emergency coordination.*

Military Hospitals

– *The cooperation between the University and Military hospitals in Utrecht showed that the specific military expertise in dealing with large numbers of battle victims can also make a valuable contribution to general disaster relief. Cooperation between civil and military institutions on preparedness/disaster medicine should generally be encouraged.*

International assistance/cross-border cooperation

– *Cross-border cooperation and information exchange between Regions and municipalities situated close to national borders and the administrative districts situated on the other side of the border (for instance, between the Limburg Region and the German Kleve District) should be improved.*
– *Possible cross-border evacuation routes should be considered in the emergency plans.*
– *In areas situated next to national borders, there should be agreements concerning cross-border neighbourhood emergency relief assistance, perhaps at Regional (Netherlands)/District (Germany) level. The municipalities and relief services should be informed of the procedures for requesting international assistance.*

3.8 Response action taken and lessons learned from the response

The activation of the emergency plan and the large scale preventive evacuation carried out in the Central Netherlands constitute a unique operation from which many lessons were learned. Given the particular background of the Netherlands, the smooth and efficient large-scale evacuation was made possible by organising the operations in accordance with the following main principles:

- Informing the public in advance about the risks, and the need for timely action;
- Relying on the capacity for independent self-help among the majority of the inhabitants;
- Focusing on providing transport, help and shelter for the weaker, dependent part of the population (the sick, the old, etc.).

Lessons learned

Communications and Information Flow

– *The quality of the response operations can be improved significantly by laying down and actually following efficient procedures for the exchange of information within the emergency response structure. The activation of emergency telephone communication lines should be provided for in the emergency plans, since the lines often break down in the flooded and/or evacuated areas.*

Organisation of Relief Work

– *The organisation of voluntary relief work should be included in the municipal emergency plans. There might be some delicate aspects concerning insurance against accidents. The emergency plans should consider the possibility of employing some of the inhabitants who have particular skills which could become useful in an emergency relief operation. During an emergency, the authorities should be able to locate and contact these persons. Relief work should be organised in appropriate shifts, and excessively long working hours avoided, since worn-out staff increase the probability of errors and accidents.*

Material and Equipment Stocks

– *In Limburg, the Provincial co-ordinators have found that in order to deal with any future flooding emergency, sufficient stocks of sand bags, boats, mobile communication devices, bedding and other equipment should be kept ready.*

Flooding patterns in the event of dyke failures

– *Scenarios should be worked out concerning the scope for "sealing off" ("compartmentalising") parts of the area with temporary dykes if there are dyke failures. Clear overviews should be prepared of the advantages and disadvantages of the various options open to the municipalities. The question has been raised as to whether the areas to be evacuated could be determined via altitude contour lines, in order to avoid needless evacuation of entire municipalities when only a fraction of a municipality is threatened.*

The Assessment of Risks / Phases of the Emergency Plan

– *The main point is that the information flow concerning changes in water levels should be improved. The criteria for dyke-safety assessment should be reviewed. Communications between the (Rivierenland) Regional Coordination Centre and the polder district administrations during an emergency need to be improved. In particular, both the reliability of dyke-safety assessments by the polder districts, and the consistency of the terminology used in their reports to the coordination centres need to be improved: crucial decisions concerning evacuations etc. depend on this information.*
– *The procedure and criteria for determining the phase of the emergency plan to be activated and/or the nature of the plan's phasing structure itself should be reviewed.*

Evacuation Procedures

– *Some solution should be found for the delivery of the letters containing the evacuation order to the public, possibly at regional level. In a flooding emergency, it is not always possible to use the normal postal service. The evacuation plan is based on the estimate that in any area to be evacuated, 25% of the population will not leave by their own initiative and means, but will have to be helped (or forced) to leave by the authorities. This proportion can be altered according to the characteristics of particular areas and situations, thus enabling the staff and equipment required for the operation to be estimated more precisely.*
– *An "action centre for business evacuations" should be set up to deal with the many particular difficulties caused by the evacuation of industrial installations and other business-related structures. In areas next to national borders, possible cross-border evacuation routes should be considered.*

Evacuation - The problem constituted by those who refuse to leave

– *The policy with regard to those who refuse to leave should be thoroughly discussed: Should everybody be forced to leave? Which principles should determine the choice of a policy? What about the legality of forced evacuations: can anybody be forced to leave his/ her home?*

Evacuation - Traffic control

– *As soon as an evacuation is announced, the police should place sufficient well-instructed staff in the areas to be evacuated, in order to control the expected rush of traffic on the roads. The routes to be followed in the event of an evacuation should be mapped out in advance. Information about these routes should be available to the population concerned when needed. The scope should be examined for drawing up evacuation plans in which the areas to be evacuated are divided into smaller sections, to be evacuated one by one, in a strategic sequence. In this way, traffic jams and other problems may be avoided.*

Evacuation - Livestock

– *The evacuation of livestock did not run smoothly. The preventive voluntary evacuation of people (30 January in the Nijmegen Region) led to problems with the subsequent evacuation of animals. Better regulations and plans should be developed for the evacuation of livestock. It should also be made clearer:*
  - *how much economic damage a business can be asked to bear as a consequence of evacuation;*
  - *how different types of animal should be treated (evacuation of pigs and poultry proved more problematic than cattle evacuation).*
  - *The possibility should be considered of evacuating livestock after the human population has been evacuated, thus giving the farmers more time to organise.*

Administration of the evacuated areas

– *The administration of the evacuated areas is not dealt with in the (Rivierenland) emergency plan. In particular, the following problems need to be clarified:*
  - *the way to deal with those who have refused to leave.*
  - *the widespread lack of knowledge of the evacuated territory among the staff responsible for it.*
  - *how to keep the neighbouring municipalities and Regions informed as to what happens in the evacuated territory?*
  - *how to balance safety and order against the economic interests of companies suffering losses because of the evacuation?*
– *The access policy for the evacuated areas should be made clearer. It has been suggested that this be implemented at municipal level by adding paragraphs on access authorisations to the municipal emergency regulations.*

Evacuation - Making use of particular (especially medical) skills

– *The emergency plans should consider the possibility of employing inhabitants who have particular skills which could become useful during an emergency relief operation. During an emergency, the authorities should be able to locate and contact these persons. In particular, evacuation plans should consider the position of general medical practitioners / family doctors. Doctors should be the last persons to leave and the first to return. Where large numbers of emergency response staff are present in an evacuated area, some local doctors should remain there.*

Compensation

– *Clearer regulations concerning the compensation of economic losses caused by the evacuation of livestock farms and other industrial and business premises are needed. The Regional emergency plans only contain inadequate provisions concerning follow-up activities after the end of an emergency. The involvement of the emergency system should not end abruptly when it comes to dealing with the consequences.*

3.9 Information to the public and related lessons learned

An information strategy which was focused on specific target groups proved effective in making the population aware of the hazardous situation and of the need for timely action. Effective use has been made of messages aimed at directing the behaviour of particular target groups, persuading the population concerned:

- To make particular preparations;
- To leave the areas to be evacuated;
- Not to leave other areas;
- Not to return immediately to their evacuated homes. In doing this, the following channels have proved useful: Direct mailing, the regional, local press and broadcasting stations.

Public information before and during the evacuation in the Central Netherlands. First, a voluntary evacuation was recommended to the inhabitants involved. Then it was announced that an evacuation would become obligatory within two or three days. The pictures of seepage through leaky dykes were sufficiently clear to all, so that in general the need for the large-scale evacuation was never questioned by anyone. Immediately before and during the emergency, the local media were the most important source of information to the public. However, a variety of means was used by the authorities to reach the public: flyers distributed by the municipal authorities warned the public about the approaching flood; direct mailing; regional / local radio; regional television; police/fire service; information desks; toll-free numbers (high water line in the Nijmegen Region); word of mouth between family members, neighbours and acquaintances also played a major role. Much information was provided through the information departments of the regional coordination centres. Local information duties were performed by municipal staff.

When the high water crisis began, the water level information supplied to the public by the water emergency committee of the Nijmegen Region did not correspond to the information available through the German Teletext system, which provided more recent as well as more alarming data. This somewhat undermined the credibility of the regional toll-free information line.

Lessons learned

- *As soon as it becomes clear that an emergency is approaching, municipal administrations should activate toll-free 24-hour contact numbers (information to the public, inter-municipal coordination, etc.). It has been suggested that "communication" and "information" be considered as distinct disciplines: "communication" with particular target groups or organisation being concerned mainly with ways of obtaining a particular useful form of behaviour from these groups while "information", which includes media management, deals mainly with ways of informing the public about the events and operations.*
- *Detailed instructions concerning the provision of information to the public should be worked out and incorporated into the emergency plan. Media management should be explicitly covered by the emergency plan. The plan should include provisions to adapt media management to the up-scaling of the emergency response coordination (i.e. involving not only local media, but also national and even international media,as the emergency situation evolves). In the Rivierenland Region (Gelderland Province), the means and the professional know-how to carry out such an up scaling of media management were not yet available in 1995.*
- *The plan should include means of supplying information to the media both passively (toll-free telephone numbers providing information 24 hours a day) and actively (by authorised officials, through press conferences etc.); rules for the choice of special places for press conferences etc. could be included in the emergency plan. The main objective is to avoid as*

much as possible the uncontrolled, unauthorised spread of inappropriate or wrong information. Media management requires specialised professional know-how.

– *Local media played an important and positive part in providing information to the population involved. In future emergencies, even more attention should be given to specific local information. There should be a clearer separation between official bulletins presented through the media and independent information offered by the media themselves.*
– *Official communications regarding decisions taken by the authorities should be passed on to the media at the same time by the municipal and by the regional coordination centres.*

4. The Oder Flood (in Germany) in the Summer of 1997

4.1 Date and location of the disaster

The summer flooding by the Oder lasted from 4 to 9 July, causing extremely high water levels and catastrophic floods on the Upper Oder and from 18 to 22 July, causing a second wave of flooding on the Upper Oder, which maintained the high water levels in the middle and lower sections of the Oder over a prolonged period of time. In Germany, the main locations were in the Federal State of Brandenburg where the Brieskow-Finkenheerd dyke was breached and the Ziltendorf lowland in the Oderbruch filled up with water.

4.2 Brief description of the event

In the summer of 1997, the areas along the river Oder, in the German Federal State of Brandenburg, the Czech Republic and Poland suffered the worst flooding since records began. During the first period of heavy and persistent rainfall the maximum amount of rain fell on the Czech Station at Lysa Hora (Kahlkopf) in the western Beskides. A total of 586 mm of rain fell in that period. Three river valleys were almost completely destroyed over a total length of 70 km. The flood wave moved down the Oder valley towards the German-Polish section of the Oder, many cities and villages in the Czech Republic and in Poland were flooded, and dykes failed in many places.

The Oder is 854 km long. The sources of the Oder are located in the Oder mountain range at an altitude of 634 m above sea level. The catchment basin of the Oder can be divided into three areas:

- the upper Oder course - from the sources to Wroclaw (Breslau);
- the middle Oder course - from Wroclaw to the confluence with the Warta (Warthe):
- the lower Oder course - from the confluence with the Warta (Warthe) to the estuary in the Stettiner Haff.

The catchment basin of the Oder covers 118.861 km², the largest part of this catchment basin, corresponding to 105786 km^2 (89%) is located in Poland, whereas Germany's share is 5.600 km² (5%), and 7100 km² (6%) lie within the Czech Republic.

A third of the Czech Republic was hit by the flood, 60 people were killed and the damage was estimated at euro 1.75 billion.

In Poland, nearly 7 000 km² were flooded, 54 people died and the damage was estimated at euro 2.5 billion.

On 17 July the high water wave reached the German-Polish section of the Oder. Owing to further heavy and persistent rains a second high water peak formed on the Upper Oder. This maintained the high water levels in the middle and lower Oder section over an extended period of time. In the Oder catchment area a total rainfall of 6 billion cubic metres was estimated for the first heavy and continuous rain period and another 4 billion cubic metres for the second period. This amount of water (10 billion m^3) corresponds to roughly 61% of the Oder's annual discharge. In the German federal state of Brandenburg along the German-Polish Oder section the Brieskow-Finkenheerd dyke was breached and the Ziltendorf lowland (*Ziltendorfer Niederung*) in the Oderbruch filled up with water.

- 60 km ² of the Ziltendorf lowland (*Ziltendorfer Niederung*) were flooded,
- 2 000 people had to be evacuated from the Ziltendorf lowland,
- the damage was estimated at euro 325 million.

The many dyke failures in the Polish part of the Oder's German-Polish section – causing more than 670 000 ha to be flooded – prevented catastrophic consequences downstream in Germany.

The Ziltendorf lowland *(Ziltendorfer Niederung*) is part of the Oderbruch, which is located in the Oder/Spree District of the German Federal State of Brandenburg along the German-Polish section of the Oder and was originally marshland. The Oderbruch between Lebus in the southeast and Hohensaaten in the northwest forms a hydro-geological unit 50 km long and 12 km wide. Under normal conditions the water level of the Oder already lies above the ground level of the Polder owing to the displacement of the Oder's bed to the higher part of the Oderbruch to gain land. A channel system, that was renewed in the 70's, drains the groundwater.

Floods are relatively frequent events along the Oder. They occur at almost yearly intervals along the upper and the middle courses of the Oder, along the lower course, or along the entire course of the river. The frequency of catastrophic floods throughout its course is much lower.

A distinction is made between winter-/spring-floods and summer floods.

- Winter/spring-floods are divided into two types depending on the way in which they are formed: Ice-floods (impeded flow) caused by the formation of ice, and spring-floods (non-impeded flow) caused by melting snow and often accompanied by rain.
- Summer floods are mostly caused by strong and persistent rains that fall on already soaked ground.

The lower section of the Oder is subject to floods caused by both ice and storms in the Baltic sea which do not allow the water to flow from the estuary into the sea. The upper section of the Oder is subject to floods caused by melting snow, and to summer floods. These summer-floods are also recorded at the Frankfurt/Oder water gauge, since not all flood waves in the upper Oder's course have disastrous consequences along the middle and lower courses. Floods involving the entire course of the Oder can occur in both, in the winter and in the summer.

4.3 Impact on human beings and the environment

Impact on human beings. There was no immediate impact apart from a total of 6 500 persons being evacuated.

Impact on the environment. Water analyses during and after the flood showed that there had not been a severe pollution problem at any point. The principal problem was the low oxygen content of the water, caused by the strong concentration of organic matter, which destroyed fish

life in several cases. The high bacteriological load of the water led to limitations on the use of the water along the Oder. The re-suspending of sediments in various river-sections caused a high load of non-ferrous metals (e.g. copper). Soil analyses in the Ziltendorfer Niederung demonstrated that no significant quantities of pollutants were deposited over large areas. At some places the concentrations of pollutants were higher but did not reach hazard thresholds. This must be associated with the high dilution due to rain-water. The concentrations of pollutants measured only sometimes exceeded the EC thresholds for bathing water. The concentrations of organic substances and heavy metals in the soil did not exceed the normal values for flood-plain soils in Brandenburg. Fuel oil tanks were damaged in 19 cases, and the fuel oil polluted the ground immediately surrounding the tanks (up to 44 000 mg/kg soil).

4.4 Economic losses

Cost of material losses. The cost of material losses caused by the flooding (based on notified damage from the government departments, the rural districts and the city of Frankfurt/Oder): Total: euro 330.8 million.

A more detailed picture of the costs follows:

Damage suffered and expenses borne by the Federal government*:* The total amount is roughly euro 117.6 million.

Damage suffered and expenses borne by the Federal State of Brandenburg*:*
The total amount is roughly euro 112.9 million.

1. State Roads: euro 17.4 million, plus euro 12.8 million spent on strengthening.
2. Dykes: euro 18.9 million (not including expenditure on strengthening: euro 68.5 million estimated by the year 2005).
3. Government-department spending on protection against high water: euro 17.9 million (materials, protective dyke near Reitwein, damage to government installations, staff, etc.).

Damage suffered and expenses borne by the municipalities*:* The total sum estimated is euro 51.6 million.

1. Roads and bridges: euro 35.1 million for repairing direct damage (not counting the euro 18.9 million needed for preventive measures to reduce damage in the event of another flood, plus another euro 3.1 million needing to be spent on planning these preventive measures).
2. Damage to municipal buildings: euro 0.8 million.
3. Cost of high water containment: about euro 12.2 million .
4. Health-related activities (vaccinations, protection against mosquitoes, testing of drinking water, cleaning of wells,...): euro 0.63 million.
5. Dyke patrols: at least euro 0.31 million.
6. Municipal companies: Total damage: at least euro 1.4 million (without resultant investment costs).
7. Damage to fire-brigade installations and equipment : euro 1 million.

Damage suffered by businesses: euro 14 million, affecting about 800 companies.

Agricultural damage: The total estimated amount is euro 16 million, applying to roughly 290 cases. Of this amount, euro 2 million of damage was caused by animal transport and loss.

Damage suffered by private persons: The estimated total is euro 18.9 million

1. Damage suffered by residential premises and dwellings: damage to 302 residential premises was reported, totalling approximately euro 13.1 million.
2. Adjoining buildings: 210 cases were reported, involving roughly euro 0.82 million
3. Household effects: Damage to 230 households was reported: euro 3.8 million
4. Summer houses and gardens: Damage was reported in 900 instances: euro 1.3 million.

Cost of response

- Costs borne by the Federal State (as of 15 October 1997): euro 13.9 million
- Cost of Federal Defence Forces' activities: euro 65.7 million
- Cost of BGS (Bundesgrenzschutz - Federal Border Police) involvement: euro 20.4 million
- Cost of THW (Technisches Hilfswerk) activities: euro 7.1 million.

4.5 Prediction made for the disaster and related lessons learned

Prediction and warning system. In Germany there was no functioning prediction model for the German-Polish section of the Oder . However, predictions about water levels and water-flow in Poland (including the German-Polish section of the Oder) were accurate to 86%-96% according to the Institute for Meteorology and Water-resources in Wroclaw.

Lessons learned

– *There is a need to devise a reliable high-water prediction and information system for Brandenburg, Poland and the Czech Republic.*

4.6 Preventive measures taken and lessons learned with regard to prevention

Risk Assessment and Hazard Appraisal

Paragraph 12 of the Brandenburgisches Katastrophenschutzgesetz (BbgKatSG – Disaster Protection Law of the State of Brandenburg) states that the local corporations are responsible for producing emergency response plans and flood response plans, including risk assessment. Reliable flood-risk assessment requires extensive data. These data are not available for the whole of the Oder for various reasons such as the dispersal of powers, lack of flow data (mostly there are only data on water levels over several years from which in most cases it is not possible to extrapolate flow data), data loss due to the war etc. On the German side of the Oder's German-Polish section extensive historic flow data are only available for the water gauges at Eisenhüttenstadt and Hohensaate-Finow. At the time when the Oder flooded in summer, the information flow between the countries concerned was inadequate.

A risk assessment (hazard analysis) has been performed for the federal state of Brandenburg. In Germany a qualitative approach is adopted towards risk assessment. The following comments have been made concerning the methodology used.

- risks are identified and localised and their extension is estimated
- no quantified risk assessment based on a worst case scenario deriving from an extensive analysis of high water data has been conducted
- societal risk is not taken into consideration.

Land Use Planning - Legislation and codes of reference

- Raumordnungsgesetz (ROG - Federal Land Use Legislation)
- Baunutzungsverordnung (BauNVO- Federal Building Use Regulation)
- Landesentwicklungsplanung (LEPro, LEP - State (Land) Development Planning Codes)
- Kreisentwicklungspläne (KEP - District Development Plans)

In August 1997, the German, Polish and Czech governments agreed to co-operate in order to prevent flood disasters. They were jointed by the EU Commission. A team of experts from the three nations was assigned to draw up a «Trans-national action-programme for the catchment area of the Oder» with the aim of creating a land use planning programme for the Oder's entire catchment area, including those areas which had not been affected by the flood, using the experience gained in the international cooperation concerning the Rhine and Meuse areas.

Building-codes
- Baugesetzbuch (BauGB - Federal Building Code)
- Bauordnung (BauO- State Building regulation)
- Bauleitpläne (Building Guidelines–cities/municipalities)

Structural measures
The dykes along the Oder were built during the more recent centuries and not all were built to the same standards. The structure of a dyke is the result of historical evolution. In the more recent centuries the dykes have been raised and strengthened several times using the heterogeneous materials available at the time. Moreover, the dykes do not represent a unitary flood defence system along the Oder. The distance between the dykes, the size of their cross-section and the height of the dyke-summit were not planned and produced to a uniform hydrological standard. The geological conditions underlying the dykes are often unfavourable. Finally, in the German-Polish section of the Oder, the distance between the dykes on the Polish and the German sides is for no apparent reason too narrow, not allowing enough water to flow when the water levels are exceptionally high.

The flood plains have not always been maintained adequately. They have often been used for housing, industry and agriculture.

Lessons learned
- *In order to be able adequately to organise preparedness and response operations there is the need for a reliable hydrological prediction system, for an adequate information flow, and for a high-water information and warning service. An adequate information flow is essential, particularly for a river system such as the Oder's, whose catchment area lies mostly in Poland.*
- *In order to reduce the difficulties in quantifying the hydrological hazards along the Oder, it is essential to improve the quality of the hydrological data on the Oder in all of the countries concerned.*
- *There is a need to plan a means of regulating the flow of the Oder, particularly within the Polish section without changing the appearance of the Oder as a free-flowing river.*

4.7 Preparedness situation and lessons learned with regard to preparedness

Owing to the federal structure in Germany, organising the disaster management system is a complex matter. In Brandenburg disaster management is the responsibility of the federal state, the districts and the municipalities, which form the lower disaster protection authority, whereas the higher disaster protection authority is represented by the Ministry of the Interior, which co-ordinates any disaster response covering more than one district.

Disaster Preparedness includes disaster protection plans - also incorporating flood response plans, which are drawn up by the districts and municipalities. Maintenance plans for the flood protection

systems and high water prediction fall within the remit of the State Ministry of the Environment. Four high-water alarm levels can be declared, depending on the water level:

Alarm level I: River begins to overflow its banks
Alarm level II: Meadows or forest land flooded in areas subject to flooding.
River overflows its banks, reaching the foot of the dyke in dyked areas.
Alarm level III: Isolated land plots, roads and cellars flooded.
Polder areas soaked because of the water pressure.
Water levels up to half the height of the dykes.
Alarm level IV: Larger areas, including roads and residential complexes, flooded.
Direct threat to humans, animals, objects and buildings.
Threat to the static stability of the dykes as a result of prolonged soaking, drifting of ice, risk of overflowing or major damage.

In emergencies the Ministry of the Interior's Emergency Response Coordination Team comprises representatives of the:
- Federal Defence Forces and the Federal Border Police
- Technical Relief Organisation (THW)
- Ministry of the Environment
- Ministry of Transport

A consultant from Poland is also involved.

In this particular event, disaster intervention teams were set up at district level, each with responsibility for a Local Technical Operational Coordinating Centre. Below these Operational Coordinating Centres, intervention areas were created, either directly at the dykes or in relation to particular tasks, such as the filling of sandbags. The fire department, the Federal Border Police, the Federal Defence Forces or the Technical Relief Organisation directed these intervention areas.

These bodies have differing internal organisations, command and communication structures, which significantly complicated cooperation, particularly between military and civil organisations. The minister of the Interior personally commanded the response activities with the cooperation of the Major General and the Minister of the Environment.

Lessons learned
- *There was no information exchange between the State government and the heads of the Federal organisations in the early phase of the emergency: there should have been discussions to evaluate the scope for intervention.*
- *In order to be able adequately to organise preparedness and response operations there is a need for a reliable hydrological prediction system, for an adequate information flow, and for a high-water information and warning service. An adequate information flow is essential, particularly for a river system such as the Oder's, whose catchment area lies mostly within Poland.*
- *Disaster protection plans should emphasise the organisation of and support for self-help by the public, in order to meet the challenges of future floods.*

4.8 Response action taken and lessons learned from the response

Response measures. Almost 50 000 members of the Federal Defence Forces (Bundeswehr), the THW (Technical Relief Organisation) the BGS (Federal Border Police), the fire brigades, the police, the Civil Defence, the State Environmental Agency, the Water and Dyke Associations, relief organisations and voluntary workers from the local population took part in the operations.

The most important materials were sandbags with a standard size of 30x60 cm and a filling weight of 10 to 20 kg. The sandbags were only filled up to two thirds of their capacity so that they could adapt to uneven surfaces. 8 500 000 sandbags were used on the dykes during the emergency with a total weight of about 130 000 tonnes. Empty sandbags had to be bought from all over Europe because empty sandbags were in short supply. The following amounts of materials were used:

- 3 500 000 sandbags were provided by other federal states and 11 000 000 sandbags were filled.
- About 200 000 fascines were employed to stabilise the dykes
- 66 000 m² of geotextiles and stabilising filter matting
- 20 000 m² of film fabrics of different thickness

The materials were mainly transported over the dyke defence paths, which were no longer suitable for heavy vehicles, because of the seepage from the dykes. In the main small lorries with a total weight of 2.1 tonnes were used. At some points barges could also be used to carry materials. It was often necessary to transport materials by helicopter in particularly critical situations. Type SA 330 (Puma) helicopters with a total lifting capacity of 2 tonnes and type CH 53 military helicopters with a total lifting capacity of 8 tonnes were used.

Organisation: The creation of a centralised coordinating structure was needed in order to direct the activities of about 50 000 relief workers efficiently. On 17/7/97, the "Flood Response" Emergency Response Coordinating Team was set up inside the Ministry of the Interior. Its staff worked round the clock in 12-hour shifts. Moreover, a coordinating centre worked on the toll-free public information lines, analysing the offers of help. The Ministry of the Interior's press and information centre also prepared and organised official visits.

It was not always easy for the emergency response coordinating team at the Ministry of the Interior to get up-to-date reports on the situation. In the initial phase, the information flow between the response coordinating team and the emergency response teams did not work smoothly. Moreover, the response teams themselves often did not have a clear picture of the situation. Inaccurate and exaggerated media reports worsened that situation. The introduction of contact officials from the Ministry of the Interior into the response teams significantly improved the information flow.

Decision-making during the sessions of the emergency response coordinating team set up by the Ministry of the Interior was complicated and slowed down by the need first to assess the situation.
During the initial phase, these difficulties in the information flow and decision-making processes made it necessary for the BGS (Federal Border Police), the Federal Defence Forces and the THW to work out their own assessments of the situation. Communication problems arose from the fact that different levels of command were active at the same time, which sometimes led to conflicts. This caused uncertainties concerning the distribution of helpers. An example of this is the conflicts that occurred between district administrations and mayors.

Lessons learned

– *Where Federal forces intervene in a federal state, they should adapt to the existing emergency response structures of that federal state, particularly as regards the use of terminology, operational organisation and communications. However, where there is a massive deployment of the Federal Defence Forces, these should be allowed to maintain their*

usual, smooth-running structures and procedures. These principles were successfully applied during this emergency.
- *To ensure an efficient division of tasks between the State and the Federal organisations, there should already be contacts and exchanges of information between all parties concerned in the preliminary phases of the crisis/response process. The heads of the various organisations involved must plan the response operations together.*
- *The information exchange procedures and the actual operations should be planned in the form of a schedule. This applies not only to inter-organisational information exchange but also to supra-regional and international information exchange procedures.*
- *The structures and plans of the disaster response system are based mainly on local action by local forces. Local organisations can provide the quickest response, but the use of supra-regional forces is necessary where a massive response is required.*
- *The compatibility of communications equipment has to be guaranteed.*
- *Large-scale emergencies and supra-regional disasters create circumstances which are very different from the standard situations for which the disaster response structures are prepared, requiring massive intervention by supra-regional forces. Therefore, it is necessary for the authorities at Federal and state level to draw up standard emergency plans for such large-scale emergencies, in cooperation with the emergency services. Training for carrying out these plans is also necessary.*

4.9 Public information and related lessons learned

From the point of view of the emergency response management the public was «informed constantly and was actively involved in the reporting before, during and after the flood». Press offices and toll-free public information lines were set up in all of the emergency response headquarters. Headquarters' staff answered questions via the telephone information service and gave specific advice to the public on how to fight the flood. It is generally thought that the active information policy involving the media encouraged the active participation of the public in the emergency response. The example of the city of Eisenhüttenstadt is mentioned: Information on accommodation for evacuees was made public in an effective way. However, the brochures informing the people about the evacuation contained information on the alarm-signals but none on the muster points.

Inaccurate and exaggerated media reports worsened the problem of the unreliable information flow within the emergency system. When the flood alarm was raised an information campaign was started in the district. A certain lack of information was found among the population concerned. It appears that the situation described by the media was made to seem much more extreme than the actual situation; this may have led a certain section of the population to underestimate the actual risk and ignore the information campaign.

Lesson learned
- *Information has to meet the needs and the terms of reference of differing target groups. It has to be carefully designed and present all relevant aspects, without becoming too technical or just seem to be a set of instructions issued by experts.*

5. Some further thoughts

World-wide, flooding is the leading cause of losses due to natural hazards and is responsible for a greater number of damaging events than other type of natural event. In Europe, too, a noticeable

accumulation and an increase in extreme events resulted in serious losses. Lessons learned from flood disasters should constitute the basis for making proposals for future studies as to how lessons could be incorporated into plans, programmes and vehicles for putting knowledge into practice in order to reduce the impacts of future floods. Although a lot of lessons learned were identified and described in the previous sections, the particular characteristics of the floods examined in this lessons-learned report pointed to some common lessons to be applied to floods:

Management of cross-border rivers. *The management of cross-border rivers must be recognised as a special-status problem and should overcome administrative boundary problems by raising river basin management from a local to an international level. In order to be able to organise preparedness and response operations adequately there is a need for a reliable hydrological prediction system, for an adequate information flow, and for a high water information and warning service. In particular, trans-national flood management issues as they arose from analysing the flood disasters include:*

- *An improved prediction model for the water levels in the entire Meuse basin would improve the quality of predictions beyond the 12-hour limit.*
- *An adequate information flow is essential for a river system such as the Oder's, whose catchment area lies mostly within Poland. In order to lessen the difficulties in quantifying the hydrological hazards along the Oder, it is essential to improve the quality of the hydrological data on the Oder in all of the countries concerned.*

Prediction, early warning, and efficient sharing of the information concerning flooding hazards and the evolution of floods should be given the highest priority and sufficient equipment and staff should be allocated for these purposes.

Communication and information exchange. *The overall coordination within countries, between countries and international agencies, and between international agencies highlighted the need for better communication within the emergency system (coordination of response) as well as between the coordinating centres usually set up and the inhabitants involved. It has been shown that the effectiveness of the response could be significantly improved by establishing and actually following efficient information procedures for the exchange within each emergency response structure. A computerised automatic information management system within the coordinating structure would be valuable for the operational information flows. An electronic information exchange system, shared throughout the emergency response system could make materials available at all levels, increasing the degree of integration and synergy throughout the emergency system.*

Evacuation. *Wherever possible, the public should be informed in advance, psychologically prepared and convinced in advance about the need for evacuation. Organisations and authorities that have no excessive direct or personal involvement with the affected inhabitants should control unpopular measures such as evacuations. Where evacuation is to be forced, extra staff and equipment should be provided for this risky and time-consuming operation. Legal responsibilities and liabilities should be clearly defined where individuals prefer to take personal risks, refusing to be evacuated or otherwise refusing be involved in emergency operations. Measures should be taken to keep disaster tourists away from the disaster areas, which should swiftly be declared off-limits for anyone not directly involved in the relief operation.*

The floods considered when preparing this lessons-learned report have heightened the awareness of the devastation that flooding will inflict on society and the environment. They have also made us keenly aware that extreme events will continue to occur. Furthermore, structural changes to the

riparian environment and flood proofing of flood prone areas are not always a viable option. Therefore, as society continues to experience population growth and people choose to live by the water we have an even increasing need to educate the public on flood related hazards and to improve our predictions to support flood-mitigation activities. We can either proceed vigorously to apply the lessons learned from the flood disasters analysed or be condemned to relearn them from the next flood.

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