has been poor. Even though some 91 per cent of the population claimed to have understood the warnings, only 50 per cent reacted to them. The reasons given for not evacuating as advised included:

- No clear understanding of where to go or how to get there;
- Did not believe the warning;
- Did not want to leave possessions and their land;
- In the absence of the husband, the family could not decide what to do.

Similar reasons for failure of the population to heed warnings are observed in other societies and the design of any warning system needs to take these factors into account. Much effort needs to be spent on public awareness and in building up public confidence in the system. Evacuation routes must be designated and clearly marked. In Florida, for example, the prominent signs marking designated evacuation roads in case of hurricanes are one of the first things that a tourist is likely to see. The police and/or the army must be mobilized to protect evacuated properties from looting. Families must be encouraged to establish their own emergency procedures so that action can be taken even if key members of the family are temporarily absent. In many countries this is done by distributing posters with space for the families to complete to indicate where they are to go when an evacuation is ordered, how to get there, how to secure the house and what to take. These can then be posted prominently in the house to provide a ready reference in case of a flood.

Communities need to have their emergency plans. Evacuation centres and hospitals have to be staffed to deal with evacuees and the injured. The requirements here are the same as for other disasters.

So far this discussion has centred on evacuation of the population in time of flood, but there is much that people can do to prevent loss of life and property before an evacuation has to be ordered and advice on this has to be provided. If a property is about to be flooded furniture and other valuables can be moved to higher floors to keep them dry; doors, windows and other openings can be blocked to keep water out; emergency supplies of food and water can be prepared; and emergency equipment and warm, waterproof clothing can be readied. Many people are very reluctant to leave their homes and belongings during an emergency, not only because of the risk of looting, and there is much that they can do to protect themselves if properly advised in advance.

Special precautions for floods

A feature of the Netherlands storm surge procedure is the use of dyke patrols as the first call-out, even when the surge level would be well below the top of the dyke. As noted in chapter 4, dykes are very prone to failure and during a flood they must be carefully watched for the early signs of failure. Sandbags are the usual means of effecting emergency repairs to dykes. The bags can be filled near where they are to be used to make a strong package that can easily be handled by one man and that can be stacked with others to form a resilient structure. Manhandling is necessary because the flood may prevent construction machinery reaching the required site. In addition, sand is easy to handle, but a bank of sand will not resist water. However, when bagged, sand is very resistant. The numbers of sandbags that have to be provided can be very large. During the Christmas 1993 floods on the Rhine and the Moselle, the town of Trier, with a

CHAPTER 7

Emergency response

Floods in Koblenz, January 1995.
Studio X/Stern, Dr J. Gebhardt

population of 98,000, used 200 tonnes of sand in 24,000 bags. Cologne (population 955,000) used 60,000 bags. Most of these sandbags must be available in store before the flood starts and arrangements should be made with the manufacturers for further supplies to be made available as the flood progresses. In the same flood the town of Koblenz had to augment its emergency stocks by another 26,000 bags.

Other flood-fighting equipment that is needed and must be available includes boats and high-wheel trucks. Staff must be available to use this equipment. Untrained volunteers and personnel from the armed services can be used for unskilled work such as sandbagging, but they must be supervised by properly trained personnel.

The flood forecasting centre has to keep operating throughout the flood. This will require emergency electricity supplies and communications facilities in case the normal services are lost. The forecasts are a vital tool for the management of the flood, indicating problem areas and enabling the use of scarce resources to be planned. The operation of facilities such as flood control reservoirs needs forecasts to plan releases and the telemetry system also provides feedback on their effect.

The media provide a valuable channel of communication with the public during the emergency. The emergency is an important news story, which the media are anxious to follow so there is a predisposition on their part to broadcast news of the flood. Media relations need to be planned in advance. The media will want to interview senior personnel and this has to be included in their work plan for the emergency. During the Great Flood on the Mississippi in 1993 the United States National Weather Service, which forecasts rivers as well as the weather, found that senior officers, who saw their job as directing the forecasting teams, were so much in demand from the media for interviews that they had little time to spend with their forecasters. This problem needs to be tackled from the beginning and allowance made in these officials' schedules for media interviews. The impact on public perception of the presence of a senior official at an interview is sufficiently important to warrant this use of their time. There also need to be proper arrangements for deputies to take over the management role if senior officers are unavailable, whether this is because of media interviews, illness, or some other reason.

Floods in Vaucluse, September 1992.
Agence Vu. E. Franceshi

Post-flood recovery

After the flood the damage has to be made good. Three categories may be distinguished:

- Removal of mud, silt and debris;
- Disposal of flood-damaged objects;
- Repairs and restoration of services.

Flood waters contain large quantities of sediment that settle out wherever the flow is slow, on roads and open spaces and in buildings. The depth of sediment can range from a few centimetres up. Following a flash flood in the Swiss town of Brig, streets were blocked with up to 1.5 m of silt, gravel and larger rocks. The clean-up costs are high. Removal of silt from the public roads alone cost the city of Cologne DM 1 million, following the Christmas 1993 flood. The flood also leaves behind a mass of rotting vegetation and the carcasses of drowned animals. These constitute a severe health risk to the population and the medical author-

ities need to be on the watch for signs of cholera and other water-borne diseases. Clean-up workers in particular will need antitetanus injections.

Furniture and other bulky objects damaged by the flood have to be disposed of. Again following the Christmas 1993 flood on the Rhine, municipalities reported that the volume of bulky refuse collected was about six months' collection of such items. Houses and buildings will have been damaged by the flood. Many will have to be demolished, others will require expensive repair. Services such as water supply, sewerage, electricity and telephone will need to be reinstated. In addition to the physical casualties of the flood there will also be many people affected psychologically. The general disaster response and relief system of the country will be responsible for coping with this human and material damage.

Post-flood review

Following a major flood, a number of actions need to be taken to review how it was handled and to recommend improvements for the next time. All aspects of response to the flood emergency need to be reviewed.

Forecasting centres need to review their operations and check the accuracy and timeliness of their forecasts and how the public responded to them. Following the Great Flood on the Mississippi of 1993, the United States National Oceanic and Atmospheric Administration (NOAA) formed a Disaster Survey Team to report on how the National Weather Service (NWS) had responded. The NWS is a component of NOAA and issues both weather and river flow forecasts. The 310-page report covers all aspects of NWS operations from data collection through to forecast dissemination and public response during the several months long flood and makes some 106 recommendations for improvements.

The structures used for flood defence: dykes, reservoirs, flood walls, etc. will have suffered strain during the flood and, of course, some may have failed. All will need to be inspected and repaired. It may be decided that the dyke systems and other flood defences need to be modified and extended. The regulations controlling permitted developments on the flood plain should be reviewed and where necessary strengthened. The opportunity should be taken to remove nonconforming developments that have been damaged in the flood. The time after the flood is one for reminding people of proper flood plain and catchment management.

Many people will have views on why the flood occurred or was so damaging and will be making them known. Hydrologists, river engineers, disaster response experts and the other professionals involved need to join in this debate to take advantage of the public interest in flood prevention and disaster prevention generally and to learn more of how the public reacts to an emergency.