

Uriel Rosenthal
Paul 't Hart
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Flood Response and Crisis Management in Western Europe

A Comparative Analysis



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Editors:

Professor Dr. **Uriel Rosenthal**
Dr. Paul 't Hart
Crisis Research Centre
Leiden University
P.O. Box 9555
2300 **RB** Leiden
The **Netherlands**

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FLOOD MANAGEMENT IN GERMANY

Wolf R. Dombrowsky and Lutz Ohlendieck

1 Introduction

This chapter describes and analyses the riverine floods in Germany in both 1993 and 1995. The analysis includes a comparison of disaster management during both floods. The floods affected the majority of the German states (12 out of 16 states), six of which are situated just within the catchment area of the Rhine and its tributaries.

In Germany disaster management is the responsibility of the states. The Federal Republic of Germany consists of 16 federal states. Within these states, the Ministries of Interior, as top ranking agencies (the so-called *Oberste Katastrophenschutzbehörde*) execute this task. In practice disaster management is delegated to local administrations at the communal level within the respective federal states (the *Unterste Katastrophenschutzbehörde*).

The report concentrates on two areas which were affected the most by the riverine floods: the city of Koblenz in the state of Rhineland-Palatinate (Rheinland-Pfalz) and the city of Cologne in the state of North Rhine-Westphalia (Nordrhein-Westfalen). Both municipalities are situated along the river Rhine and thus were directly threatened by the riverine floods. During the flood events of 1993 and 1995 none of the affected states, including the two cities mentioned above, formally declared the state of disaster, although the media, the public and even officials frequently used the term "disaster" to describe the unfolding events. The reasons why both cities did not declare the state of disaster ("state of emergency") although (large) portions of the cities were flooded in 1993 and 1995, will be explained in detail in paragraph 5.

Flood response in Cologne and Koblenz is analysed for both the 1993 and 1995 floods. The analysis will focus on learning from experience within municipal Systems of disaster management (intra-system learning) and learning from other municipalities (inter-system learning). The two cities of Cologne and Koblenz differ considerably in terms of their disaster response System. Nevertheless, both cities surprised in 1993 by unusually fast rising floods and experienced similar response problems. Improvements and changes which had been made in the aftermath of the 1993 flood, allowed for a swifter response in the

1995 floods. The disaster management structure and organization were more decentralized in 1995. Accordingly more responsibility was passed to the regional or local Operation centres and more competencies were granted to them.

The systematic gathering of data on the floods is impeded by the nature of German federalism and the subsequent fragmentation of the disaster response System. This lack of systematic data is largely due to the fact that disaster management is executed on the communal level by relatively autonomous organizations on a predominantly voluntary and honorary basis. Therefore, unified, centralized data bases, aggregated Operation reports, protocols and records, and/or nationwide data on discharges and water gauges are difficult to access or not available at all. The differences with regard to countries with centralized organizational structures or specialized institutions (like the polder boards in the Netherlands) in this respect are obvious.'

2 The 1993 and 1995 riverine floods: an overview of events

The Rhine and its tributaries

The Rhine is one of the major rivers of Europe. With a total length of about 1,320 km it serves as an artery for water supply and transport, for sewer and drainage and for settlement and urbanisation. The catchment area of the Rhine, an extensive river system with its tributaries, is quite heterogeneous with respect to geologic, geographic and meteorological conditions. The area covers approximately 185,000 km² and Stretches about 700 km from the Alps to the North Sea, and covers parts of Switzerland, Liechtenstein, Austria, Germany, France and the Netherlands.

The severe floods of 1993 and 1995 foremost hit the areas of Koblenz at the confluence of the Moselle and the Rhine, and Cologne downstream the incoming Sieg. The meltwater or drain from the Alpine Rhine did not cause the 1993 or the 1995 floods. Both floods were fed by the drain of the middle range mountains along the Upper and Middle Rhine.

Outline of the floods

The 1993 floods — From Constance to the area around Mainz, a complex System of dikes with different heights Stands along the embankments of the Rhine. These dikes cover more than 500 km of the river's course. The probability of floods is estimated at one flood in every thousand years in the upper region, and every 200 years in the lower region.

To compensate for the different heights of the barrages, additional retention areas, weirs and floodable polders have been created. In many places, tall winter dikes are situated in more remote areas. Close to, or right on the embankments along the Rhine river between Lake Constance and Emmerich (near the German-Dutch border) only low summer dikes have been erected. These dikes protect against the relatively low summer floods and are not intended to withstand higher winter floods. Such winter floods are drained away to the retention areas. This is done on purpose to reduce flood peaks.

In the area downstream of Mainz to Bingen, the dikes protect against floods (probability of one flood in every hundred years). Downstream of Bingen and around Cologne there is only a very limited stretch of dikes. Cologne itself is secured by 16 km of river dikes and 11.4 km of flood protection walls, 1.4 km of which is mobile to maintain the scenic, touristic view of the Cologne waterfront. The mobile flood protection wall on the embankment of the Rhine is placed along and around the old town centre. These protective measures are only taken temporarily when water levels rise above 9 meter. This protection will be extended by the mobile flood protection wall to a height of 10m. Downstream Cologne, a complex system of summer and winter dikes and retention areas exists, offering protection against floods with a probability of one occurrence every 500 years.

In December 1993, the monthly precipitation in many areas in Germany reached levels of 200% above the mean based on a thirty year average (1951-1980). Several German weather stations recorded even above 300% to almost 400% precipitation above the mean. These weather conditions resulted in severe floodings along the Rhine river, mostly downstream. The flooding of polders enclosed by summer dikes upstream brought some relief there. However, the discharge of the Nahe and the Moselle into the Rhine further downstream caused the waterlevel to rise very fast to unusual heights. When the flood hit Cologne, it reached above the protection wall (10.63m). The river inundated the old town centre for almost three days.

A few kilometres downstream from Cologne, the comprehensive system of winter dikes prevented a wide stretch of terrain from flooding and severe damage. None of the dikes in the Rhine area collapsed or was seriously damaged. A few dikes were flooded or softened and undermined by seepage. Many of these dikes were originally built after the high flood in 1926 (10.69m in Cologne) or soon after World War II and were in need of repairment. For the tributaries of the Rhine River, no large scale flood control system exists. There are only singular dikes upstream, especially along the major adjoining towns. Most of the tributaries only have dikes where they flow into the Rhine. People living on the embankments or near the tributaries of the Rhine have developed their own strategies to cope with the almost annual floodings.

Apart from the municipality of Cologne, Koblenz was also hard hit, experiencing the worst flood since 1925/26. About 4,000 houses and almost 10,000 inhabitants of Koblenz were directly exposed to the flood, while approximately another 9,000 inhabitants suffered damage because their basements were inundated. The municipality of Koblenz is surrounded by middle range mountains which descend into both the Rhine and the Moselle. The city of Koblenz on the confluence is connected to several surrounding villages (town districts) which are incorporated in the municipality of Koblenz. The main city and the small villages are linked by roads on the embankments of the river. At certain water levels, however, the roads will be flooded, disconnecting these villages from Koblenz and each other. They became small islands surrounded by water and mountains. In Koblenz, no system of dikes or flood protection walls exists.

During the flood in 1993, most of the stricken villages were isolated. This demanded a flexible and decentralized leadership within the organization of the disaster response in Koblenz. Fortunately the social structure within the respective isolated town districts stimulated self-help and neighbourly assistance. The volunteer fire brigades proved to be up to the test, allowing for an effective and autonomous flood management in those places.

The 1995 floods — The 'Christmas Flood' of 1993 was characterized by a period of ten days with intensive rainfall saturating the ground. The 1995 floods were different. January 1995 was frosty and temperatures stayed mostly below freezing point. There was little precipitation, mostly in form of snow, down to the lower areas. The hurricane 'Ornella' then brought a low pressure zone over Germany and caused heavy rainfalls during 9 and 10 January in the low-lying areas of northern and western Germany. In the mountain areas, the snow started melting due to rising temperatures. The thaw resulted in extensive saturation of the ground. Additionally in many areas the ground was still frozen. The thaw and the rain, as well as the frozen grounds, in combination effectively sealed the ground.

On 21 January, heavy rain- and snowfalls infiltrated from the west. These showers came down on saturated ground, leading to an immediate surface drain to the rivers. The storm 'Thalia' brought a further low pressure zone over Germany and pushed the polar front further south. Masses of humid air passed along the polar front and caused heavy rains over the northern and middle part of Germany. Peaks of more than 50 mm of rain were measured on 22 and 25 January in Rhineland-Palatinate. The heavy rains lasted for days and covered a huge area, including most of the catchment area of the Rhine.

The strong precipitation combined with the thaw caused a rapid rise of the water levels in the rivers, amounting to more than 5 meters in Trier in 24 hours.

In Cologne, a "record level" of 10.69m was recorded, 6 cm above the maximum level of 1993.

Nevertheless, the floods of 1995 were not as severe as in 1993. In most places along the Rhine and its tributaries the damage was less. Earlier and better preparation served to reduce the harmful impact of the floods. Moreover, the Moselle carried much less water than in 1993, while the flood waves from Rhine and Moselle did not combine to amplify. This left more time to the authorities and the population to organize the response than in 1993. In Cologne the movable flood barrier and the inundation of the old town centre were once again flooded. Better preparation and timely evacuation kept the costs of damages caused by the flood limited to just half of the 1993 amount.

The two floods compared

Both the 1993 and 1995 floods were triggered by natural conditions. Both floods caused considerable damage, predominantly economic losses. While the people and the authorities were taken mostly by surprise during the flood events in 1993, they were better prepared when the 1995 flood struck. The public discourse on the causes of the flood differed in the 1993 and the 1995 period. In the 1995 flood period, the attention was more focused on the increasing influence of human activities on the incidence of flooding. A interpretative shift took place, away from natural and toward man-made causes. This shift has been the subject of scientific and bureaucratic controversy. The Federal Institute for Hydrology argues that meteorological and hydrological factors were primarily responsible for the floodings. The Federal Department for Environmental Affairs on the other hand Claims that man-made sealing of the ground and hydraulic engineering were major contributors to the floods. A similar argument is made in a report of a parliamentary investigation committee in the state of Rhineland-Palatinate. The media, environmental protection organizations, and a growing part of the general public also took the 1995 floods as evidence for the argument that water management and disaster prevention policies had failed.

3 Water management and disaster response in Germany

The organization of water management

The federal law of waters, the *Wasserhaushaltsgesetz* (WHG, 1976) comprises all legal matters in Germany concerning water conservation, water supply, transportation and navigation on waterways. The WHG aims for a nationwide

water management with emphasis on the purity of ground and surface-waters, regulating property rights for the use of water, water reservations (nature reserves) and the use of waterways as means of transportation. The federal WHG is implemented by the states (*Bundesländer*) which may also devise additional water laws. Specific needs for water conservation and water supply are administered through special acts and administrative provisions.

Generally, the major waterways in Germany are subjected to federal control. The federal water and navigation administration (*Wasser- und Schifffahrtsverwaltung des Bundes*, WSV) consists of several agencies subordinate to the Federal Ministry of Transportation. By law it is their task to provide for the planning, construction and maintenance of the federal waterways and the federal owned ports and dams, and to keep the waterways navigable. Regional water and shipping administrations should execute and supervise these activities. The federal authorities are solely responsible for the navigability of the federal waterways and the rivers, such as the Rhine. The states are responsible for surveillance and maintenance of the embankments, dikes and retention areas; for the dissemination of hydrological information (expected waterlevels) to the public; and the issuance of disaster warnings. Within the states, the administrative areas, the districts, municipalities and communities each take their share of these tasks.

Except for the federal waterways which are federal property, all other waters like surface, coastal and ground waters are the responsibility of the states. The surface waters are divided into waters of first, second and third categories. According to the state water laws, waters of the first category are the property of the state, whereas waters of the second and third category are the property of the owners of the real-estate on the waters' embankment.² Although the water rights of the owners (i.e. private businesses and households) are curtailed by law, it is difficult for states to regain real-estate in for instance ecologically sensitive areas to improve water and flood management.

State and federal government run the management of water affairs by means of broad skeleton plans. The design of these plans involves the Ministries for Commerce and Transportation, the Ministries for Forestry and Agriculture, the Ministries for Environmental Affairs as well as their subordinate agencies. General plans or special plans involve different authorities, institutions and organizations on the state and communal level. These concern the subordinate administrations of the aforementioned ministries and the communal Offices for water management.

The responsibilities and the supervision regarding water affairs and flood warning are delegated to the different state ministries. In general, the Ministry of Environmental Affairs is responsible for supplying the necessary hydrological information. The Ministry of Forestry and Agriculture is responsible for the

construction of dikes, measures and precautionary measures in the river basin. This covers the maintenance of reservoirs, and increasingly the reconstruction of nature reserves, which can also be used as retention areas to reduce the peaks of waves during riverine floods.

Although the state-level ministries of the Interior are formally in Charge of disaster management and the warning and public information, the defacto responsibility and execution is passed down to the communal level. Recovery and reconstruction policies are also the responsibility of the communes. Only in case of exceptional damage, both state and federal ministries of Finance and Economic Affairs may intervene by allowing remission of taxes to people who suffered damage as a result of floods (or other disasters) or by means of direct financial compensations and low-interest loans. Such state subsidiary funds are an important contribution to recovery, because no public or private insurance against natural risks exists in Germany, except for the state of Baden-Württemberg.

The Federal Institute of Hydrology (*Bundesanstalt für Gewässerkunde*, BfG) in Koblenz is responsible for scientific research in the field of water management, the development of forecast-models for waterlevels, and forecasts itself. It cooperates with other hydrological and meteorological institutes in Germany and neighbouring countries. The German Weather Service in Offenbach in Mainz (*Deutscher Wetterdienst*, DWD), which resides under the Federal Ministry of Transport provides the main meteorological information and scientific research.³

The major problems facing water management authorities and institutions in Germany are similar to those experienced by other industrial nations. Firstly, there is concern about the deterioration of the water supply and water quality. The increased use of ground in densely populated areas seals the ground, diminishing the area for Waterinfiltration and reducing the capacity of the ground to hold moisture. The result is a percolation of larger portions of the water into the so-called zone of Saturation (ground water) and the overall lowering of the watertable. This development causes a faster transport of rain, melted snow and ice into rivers and other surface waters, and is considered a major factor in the worsening of riverine floods. Secondly, the increasing amount of sewage and waste water cannot always be processed by the industrial and municipal sewer disposal and purification plants. This imposes a burden on the quality of surface waters, triggering pollution increases. Moreover, riverine flood by itself leads to considerable pollution when sewer Systems overflow and sewage spills into the surface waters. Finally, the scarcity of available space in the river valleys has resulted in increasing loss of retention areas and Vegetation, especially around the embankments along the major rivers. For the past decades, communities frequently destined former water retention areas as development

areas for business, housing estates and single homes. This has contributed to the sealing of the ground (with the aforementioned detrimental effects), and it has diminished the potential of water retention areas to reduce the effects of riverine floods.

The organization of disaster management

Under the German Basic Law, disaster response is the duty of the states. The districts, administrative areas and municipalities are obliged by state laws to make provisions in case of mass emergencies. In principle, disaster response is a state competency. However, in wartime disaster response becomes part of the civil defence System. Civil defence, contrary to peacetime disaster response, is organized at the federal level and administered by federal law. The Civil Defence Act of 1976 integrates the disaster response System into the civil defence System. To enable states to fulfil additional duties and tasks during wartime, the federal government expands the peacetime capacity of states' disaster response with so-called "supplementary and extending forces". The latter form an integral part of the peacetime System, although they are funded from federal resources. In practice, the mixture of peacetime and additional wartime forces causes some problems when it comes to estimating the identity and total size of disaster relief personnel.

All 16 German states have implemented or are in the process of implementing Disaster Response Acts. These acts are often combined with the existing Fire Defence Acts and comply with the federal law, the Extended Disaster Response Act. At the time of the riverine floods in 1993 and 1995 some states (particularly the so called "new states" in eastern Germany) were just in the process of making or passing new Disaster Response Acts. In Koblenz and Cologne, the State Disaster Response Acts of 1981 and 1977 were still in force during the flood events in 1993 and 1995. However, the context of disaster management has changed in two ways. Firstly, the obligatory federal structure for the organization of the Disaster Response exist no longer. Secondly, the post-Cold War abolition of federal supplementary and extending forces imposes financial burdens on the communities. With tighter budgets of cities and communities, the financing of the the lower Disaster Response Authorities becomes increasingly problematic.

In peacetime, disaster response is the primary responsibility of the local fire brigades, which are public Services, and private organizations on contract with the district government (such as the Red Cross).⁴ The fire brigades operate on a volunteer basis in communes with less than 100,000 inhabitants and on a Professional basis in communes above 100,000 (mainly cities). Their disaster

response task is added to their regular Services. Expenses for relief work done during disaster management are refunded afterwards.

Depending on size of the communities, one or more emergency and rescue Services are part of the Disaster Response Force. Although under normal circumstances some overlap and competition may exist between the various rescue organizations, they cooperate during mass emergencies or a disaster. The Disaster Response Force has a large potential of mostly honorary and voluntary serving people. The German Federation of Fire Services counts about 1.35 million members. Units of the Federal Institution for Technical Aid have about 65,000 members. Other medical rescue and care Services comprise: the German Red Cross with roughly 4.5 million members, and a series of additional volunteer organizations with approximately 2.8 million members in total. Following the unification of Germany, a nationwide review and reorganization of all services and relief organizations has been initiated and is still in process.

The primary disaster response units and installations are under the control of the Administrative Coordinator, who is, depending on the particular type of state administrative organization, either the director of the district (*Oberkreisdirektor*), the district president (*Landrat*), the city manager (*Oberstadtdirektor*) or the mayor (*Oberbürgermeister*). The Administrative Coordinator is responsible for disaster response planning, including the preparedness of disaster response units as well as the actual disaster operations. The local fire chief is responsible for on-site emergency management, being familiar with the local geography, infrastructure, population, dangers and resources. When a mass emergency exceeds local resources the regional fire chief takes over.

The decision to declare a disaster is made at the district level, notably the Administrative Coordinator. After a disaster declaration has been issued, the Administrative Coordinator takes command. The fire chief will establish a local Operation centre, while the Administrative Coordinator will organize the coordination of the various organizations and Services involved in a technical Operation centre. Although in all German states this model for Disaster Response is followed, the names of the actual coordination and Operation centres may differ among the states.

When the Situation is sufficiently serious, the Administrative Coordinator will establish a local disaster coordination centre with a disaster management staff. It comprises representatives of communal agencies like (public) transportation, roads and construction, health, water supplies and sewage, gas and electricity, the rescue Services, and national organizations such as telecommunication, railroad and Army. The Administrative Coordinator is also supported by experts in fields of fire protection, recovery, maintenance and repair, medical service, veterinary matters, NBC detection and decontamination, care and control, Communications, sheltering, provisioning and public assistance.

According to site proximity, a disaster area can be subdivided into operational areas and sectors with their own Operation centres to add flexibility to disaster operations. These centres are supervised by the coordinator's disaster management staff. The coordination staff generally assumes the political and administrative responsibility for emergency management, including decision making and overall coordination, whereas the technical operations centre is responsible for the tactical leadership and coordination of the actual Disaster Response Units on the scene.⁵

Once the local emergency management resources supplied by the fire brigades and rescue Services of a community have been exhausted, disaster relief is undertaken in the first instance on the district level (administrative area or municipality). The formal decision to declare the state of disaster is most likely when the scale of emergency exceeds existing local resources and outside assistance and coordination is needed. In such a case it is mandatory for neighbouring communities to give aid and assistance to their stricken counter-parts. The state will only designate the stricken region a disaster area and form a disaster management staff on the state level if several of its districts are struck by disaster and if their combined resources are not sufficient to cope with the emergency.

The System of disaster relief is basically executed by the regional authorities, which comprise the districts (*Kreise*), the municipalities (*kreisfreie Städte*), and the administrative areas (*Regierungsbezirke*). Only if several regions are simultaneously struck by a disaster, state government will intervene and establish a state-level disaster management centre.

4 Risk communication

Intergovernmental warning

In all states, the flood reporting or warning Service monitors and reports flood levels, and compares them with regard to pre-defined risk levels (so-called 'reporting-levels'). On the federal level, the Federal Water and Navigation Authority (wsv) maintains the service for flood reporting for federal waterways. All Services gather and coordinate data for the protection against flood hazards and floating ice. Public Information, including forecasts and warnings if necessary, is delivered by these Services.

Each state has its own provision for flood reporting. Although the flood reporting procedures are not standardized, all states follow similar procedures for cooperation with the WSV. The wsv is obliged by the Federal Law of Federal Waterways to maintain a flood reporting service in cooperation with the states.

The water level and accompanying hazards are distinguished in different reporting and alert stages.

In the Rhine area and its wide catchment area, the wsv and six state Services produce and deliver flood forecasts and warning procedures. The warning process in the states of Bayern, Baden-Württemberg, Hessen, Rheinland-Pfalz and Nordrhein -Westphalen is regulated by the state. In the Saarland the WSV is responsible for the flood reporting and warning. The Federal Institute for Hydrology, acting as the supervisory authority under the control of the Federal Ministry for Transport, is responsible for the preparation of models for the water level and water drain forecasts.

In the Rhine area, there are seven water level forecast centres situated in Würzburg (Bavaria), Karlsruhe (Baden-Württemberg), Saarbrücken (Saarland), Trier, Koblenz and Mainz (all Rhineland-Palatinate), and Duisburg (North Rhine-Westphalia). These forecast centres gather the information directly from the numerous water level stations by means of computerized data transfer via modern and telephone. The number of water level stations varies considerably among the states with approximately 300 stations in Baden-Württemberg and 38 in the Saarland.⁶

Almost all the wsv water level stations measure or estimate river discharges. However, not all these stations are fully equipped for the flood information Service (between 8% of the situations in Rhineland-Palatinate and 52% in Hesse). In practice the water levels have proven to be more adequate indicators for flood development. In both Cologne and Koblenz, the local water gauge is the locus of measurement in the alarm and action plan of the Disaster Response. In order to estimate the development of local water levels, upstream water gauges of the Rhine and Moselle as well as its tributaries are watched. This allows for reliable forecasts up to 24 hours. Precise forecasts can be given only for six hours.

There are different forecast models in use for the different rivers to predict the water- levels and discharges of these rivers. One hour after relevant measurements are made, the forecasts for 6, 12, 18, 24, 30 and 36 hours are available through telephone and/or data transfer by modem. The reliability of forecasting systematically decreases as the length of the forecasted period increases.

Different ways of reporting and disseminating flood related information and warnings can be found, depending upon the legal, administrative and organizational structure of the states. The states of Bayern, Baden-Württemberg and Hessen differentiate their Services into a central regional and a local Service following the administrative structure of the water authorities. The local offices of the water authorities gather the reports of the different local water levels and pass them on to the different communities, districts, municipalities, governmental authorities and whoever may be concerned. In Baden-Württemberg, the

police executes the task of the local water authorities; in Rheinland-Pfalz and partially in Hessen the police fulfils regional tasks. In general, the regional Services inform the central Services on the state level and those in the neighbouring states.

The structure of the flood information Service and the warning to the public of Rhineland-Palatinate will be used as an example. In Rhineland-Palatinate, the flood information Service was introduced in 1986 and is regulated by the Flood Reporting Provision from February 1986. This provision covers the rivers Rhine, Moselle, Saar, Lahn, Nahe, Glan, Sieg, Sauer and Our. All details for the execution of the Flood Reporting Provision are administered by the regional flood reporting plans. Rhineland-Palatinate has established three floodreporting centres to this end. Since federal waterways are involved as well (which, in the context of this study, comprise the rivers Rhein, Mosel, Saar and Lahn), state and federal authorities required by law to cooperate. The same goes for flood reporting arrangements with the neighbouring states of Hessen and Baden-Württemberg. With concern to the combined flood reporting the Service observes the precipitation, water levels and discharges of the rivers. The data is evaluated and reported to the districts, municipalities and the public affected. This Service delivers information and forecasts on the development and course of flood events to allow for timely local response and the swift taking of protective measures.

In Cologne, once the waterlevel in the rivers rises above a marked level at the water gauges, the flood reporting Service is activated and a flood Situation report is prepared. The subsequent "opening" report on the flood Situation is immediately transferred to the districts concerned via the telecommunications of the Police of Rhineland-Palatinate and to the relevant municipalities via the Flood Reporting Centres. The district authorities are obliged to inform the communities and the public about the opening report and possible hazards. The administrations of the municipalities warn the public, businesses and municipal offices.

In practice, municipalities like Cologne and Koblenz receive information about upstream watergauges via Fax and/or BTX. City authorities make their own estimates apart from the available forecasts of the hydrological institutes. The most relevant water gauges for such estimates are local ones. The water levels at these water gauges has proven to be a better indicator for the flood development than the measurement of discharges. During 1993 and 1995 Cologne and Koblenz authorities mostly relied on their own forecasts.

The warning process during the floods

Up-to-date information on the water levels of the Rhine and its tributaries are available and made public by telephone service of the Telecom, via television, radio or electronic media. All information is drawn from the same sources to avoid or at least to minimize the chance of contradictory forecasts and confusion between various reporting Services which subsequently could lead to confusion and feelings of insecurity of the general public.

1993 — The flood reporting service for the river Moselle was put into Operation on 17 December 1993, for the Nahe and Glan on 19 December 1993 and for the Rhine on 20 December 1993. The Services worked around the clock until the first flood wave subsided after Christmas. An official report and forecast on the flood Situation, was made available to administrations and the public at all times via telephone service, Videotext, BTX and the local and regional newsradio.

The 1993 flood affected all districts and municipalities along the Moselle, along the Rhine downstream the district of *Mainz-Bingen*, the district *Bad Kreuznach* at the Nahe, the district *Kusel* at the Glan, and the town of *Zweibrücken* (through minor waters: the *Hornbach* and the *Schwarzbach*). Altogether 488 communities with 102,000 inhabitants were affected.

1995 — On Monday 23 January 1995, the flood reporting service for the Rhine River was established at 07.00 in cooperation with the state and federal Services. Since the calculations based on the forecast models indicated that reporting levels at *Koblenz* (450 cm) and *Maxau* (650 cm) would be surpassed during the next 24 hours, the reporting service was established already before the reporting levels were reached. On the basis of weather forecasts and the course of floods in the tributaries, it was expected that the water level at *Koblenz* would exceed 700 cm within the next 24 hours.

The flood reporting service went into fulltime Operation, starting on 25 January 1995, in response to the fast rising water levels and hazardous flood waves, and remained so until 1 February. During the flood, an additional flood report besides the regulär daily report was prepared and disseminated every evening. Already on 25 January 1995 a warning was issued that the downstream levels of the Rhine at *Koblenz* could reach or even rise above those of the 'December Flood' of 1993. Altogether 22 flood reports were disseminated by the flood reporting Services.

Informing the public

At times of crisis or disaster, accurate and reliable information is a key to successful disaster management. However, people do not only wish to be kept informed on general aspects of floods, they also want to receive detailed and specified information, with clear and practicable instructions, to be able to cope with flood hazards. The Ministry of Environment of Rhineland-Palatinate, as well as the municipalities of Cologne and Koblenz distributed flood instruction leaflets informing the citizens in detail about information sources (phone numbers, frequencies, addresses, codes etc.), access to these sources and measures to be taken in case of floods. It also gave information on protective self-help and how to equip a household in the case of a breakdown in public supply. Furthermore, it listed the major official sources of public information which are available in the city of Cologne, including telephone information Services; regional and local FM radio stations; and water level information on TV via Videotext in three nationwide and regional programmes.

The municipalities of Koblenz and Cologne also put up posters with the above information in flood prone areas. During the 1993 flood, special issues with the latest information on the flood were put up on public notice boards in Koblenz. Compared to former floods, this did not prove to be effective due to the fast rising water levels and subsequent change of events. Often the news was already out of date prior to distribution. So this practice was not continued during the 1995 flood. Since in 1993, telephone Communications were disrupted for many households in Koblenz, special Fire Service vehicles with loudspeakers drove through town announcing the latest news and issuing instructions. Additionally, boats patrolled every half hour in those areas where access by vehicles was impossible. Again the people received instructions and were asked to put out a cloth or flash lights at night to signal the patrolling boats for help in case of such things as illness, and shortage of food or other supplies.

The principal scheme of public warning in case of river-floods remained unchanged during the 1993 and 1995 floods. One substantial difference was the improvement of the infrastructure. In Koblenz the number of radio sets was doubled, the reserved telephone lines for the connection of the different operational centres were made waterproof by installing them above the flood level, and the number of telephone lines was increased. The 430,000 telephone calls to and over 30,000 BTX-on-line-contacts directly with the authorities, clearly show that qualitative aspects of information have increased in importance.

Informing the media

The collaboration between media and authorities regarding warning and informing the public was considered to be good. By law the media has to transmit prepared messages, warnings and information according to Standard procedures.

The relationship between government and the media has been overshadowed by controversial interpretations of the causes of the floods and conflicting views of the news coverage. Tendencies to sensationalise and dramatize the flood events in the way of "action news" and "reality-TV" provoked harsh criticism. Nevertheless, the cooperation of the printed media, the local radio and local TV with the warning Services and the Disaster Response Officials was considered good. The national news took a more sensationalist "infotainment" line.

A small group of ruthless disaster tourists actually tried to Sabotage flood protection devices. A large majority of the estimated 6.000 disaster tourists in Cologne were harmless onlookers. Nevertheless, they were not allowed near the mobile flood protection wall any more, after some of them had tempered with the structure.

During the floods daily news coverage by the press was focused on local events. It acknowledged the work of the Disaster Response and the combined effort of the people, victims and helpers to cope with the Situation. Simultaneously, nationwide TV-coverage of the flood events had a more decisive influence on the collective perception of the victims' tragedy and the failure of flood control. Many onsite reports included interviews with politicians, officials, victims and relief personnel. These were frequently followed by contrasting interviews with politicians and scientists, documentaries on water management, the greenhouse effect and global warming, and critical reports on political and administrative shortcomings.

Many TV-documentaries showed that, due to the scientific data and knowledge available on meteorological, hydrological and ecological developments on a global scale and their regional effects, there is strong evidence for the anthropological coresponsibility for the increasing frequency of riverine floods and especially flashfloods. Nevertheless, Statements of politicians favour the argument that there is no clear evidence for man-made causes of riverine floods. They seem to rest with their opinion on the lack of clear Statements on the side of the scientists. Scientists find it rather difficult to come up with solid proof, since they focus on the creation of new and more complex models for the understanding of the global climate and its regional effects.

On the other hand the media discovered ecological disasters as a favourite topic, and they rather tend to follow the argumentation of the more critical scientists and the environmental protection groups, who clearly define the man-made factors to be mostly responsible for the floods. As a result of the frequent

and critical coverage of local and global events like civil wars, environmental pollution problems, acid rain, the greenhouse effect/global warming, water shortages, spoiled crops, etc. there is a growing public sensibility towards topics such as induced disasters, their man-made causes and their devastating potential in the near future.

In 1993 there was a massive breakdown of the communication of the Disaster Response in Koblenz due to insufficient radio equipment and the collapse of the telephone system. Telephone cables and distributors were installed Underground or just above the ground, and they were not waterproof. The same applied for the power lines which were damaged and left the households in the flooded areas without electricity. As a result, private radios, TV-sets and PC's could not be used any more to gain information via the news, BTX, Modem or Fax. These shortcomings made the coordination of the disaster Response in Koblenz at times impossible, but after the 1993 flood these problems were solved and during the 1995 flood none of these mishaps occurred again.

5 Disaster response

General overview

Since disaster response is initially a communal responsibility, we will focus on the response of the cities of Cologne and Koblenz. Neither the states, nor the municipalities of Koblenz and Cologne formally declared the state of disaster in 1993 and 1995. However, the two cities did activate their disaster response forces in 1993 and 1995 and both cities received assistance from disaster response forces of neighbouring districts.

Despite severe damage to town centres and districts in both cities, no formal declaration was issued in 1993 and 1995. In Cologne the water level at the Cologne water gauge remained just below the disaster alarm threshold of 10.70m. Although a disaster was not formally declared, in practice the Situation was dealt with as a disaster.

The Lower Disaster Response Authority of Koblenz did not declare the state of disaster since the State Disaster Response Act of Rhineland-Palatinate does not allow for such a declaration. This has been done to prevent organizational and communicational disruption when the leadership and disaster management structure is changed and shifts are made from the "normal" to the "disaster" administrative process. Hence, communities and districts in Rhineland-Palatinate are provided from the outset with additional legal powers for disaster management, such as the authority to issue instructions to the communal offices and Services.

The Christmas Flood of 1993, with its unexpectedly fast and high rising water levels took many people, authorities and scientists by surprise. The rapidity and the force of the flood events hit an inadequately prepared and protected population. In many places, the protective measures, the disaster response units and volunteers and the material and the infrastructure were insufficient to meet the demands of the population and to secure the continuous supply of the people in all stricken areas at all times. Although few lives were lost, severe damage to private and public property was done.

Soldiers of the German Bundeswehr remained stand-by in the affected areas from 22 January until 6 February 1995. The army fulfilled important Support functions such as preparing sandbags, constructing temporary dikes, rescuing and evacuating people, operating a ferry Service with rubber dinghies and ferries, supplying civilians in isolated spots, and securing and Clearing affected areas. The cooperation between the armed forces and the disaster response units, i.e. the coordination through the disaster and tactical coordination centres was established immediately and worked well. This not only holds true for the German Forces but also for the 600 French troops who were in action for six days and the 200 US-soldiers who were in action for two days. Their assistance was efficient and relieved the disaster response forces. Additionally, the German Air Force employed Tornado reconnaissance aircraft to take aerial photographs and map the extend of the floods of the Rhine and Moselle river. The Federal Ministry of Transport sent aircraft for aerial exploration which are normally used for the surveillance of maritime pollution and which are equipped with modern sensor technology to detect the spillage of oil. Moreover, the Federal Institute of Hydrology (BfG) measured the speed of flow and the discharges of the Rhine with ultrasound equipment.

Disaster management in Koblenz

Since the disaster law of Rhineland-Palatinate does not provide for a declaration of Disaster, the administrative coordinator is free to decide when to declare a "mass emergency" and to legally oblige the army to support the disaster response. The declaration of a mass emergency thus becomes a strictly intra-administrative and formal procedure. It is not needed to obtain extraordinary legal powers. The authorities in Koblenz nevertheless used the term 'state of disaster' unofficially, mainly to facilitate communication with the media and the public.

The 1993 response — The organization of management involves the type and division of the management levels, their coordination, as well as the distinct responsibilities of the different levels and heads of Operation. During the 1993 floods, the administrative coordinator met with the central coordination staff

twice a day. During the staff meetings, the staff consulted with the representatives of the relevant city offices, the rescue Services, liaison personnel of the police and the Army, and the heads of the technical and the area Operation centres who delivered a Situation report. In the staff decisions were taken on political and administrative matters of disaster management, whilst the technical (operational) coordination centre implemented the staff decisions. The operational centre was situated in the same building as the staff. Subordinate to the technical coordination centre, three area Operation centres managed the operations in sections of the city. In turn, these sections subdivided into local districts, each with its own local operations centres (see figure 5.1).

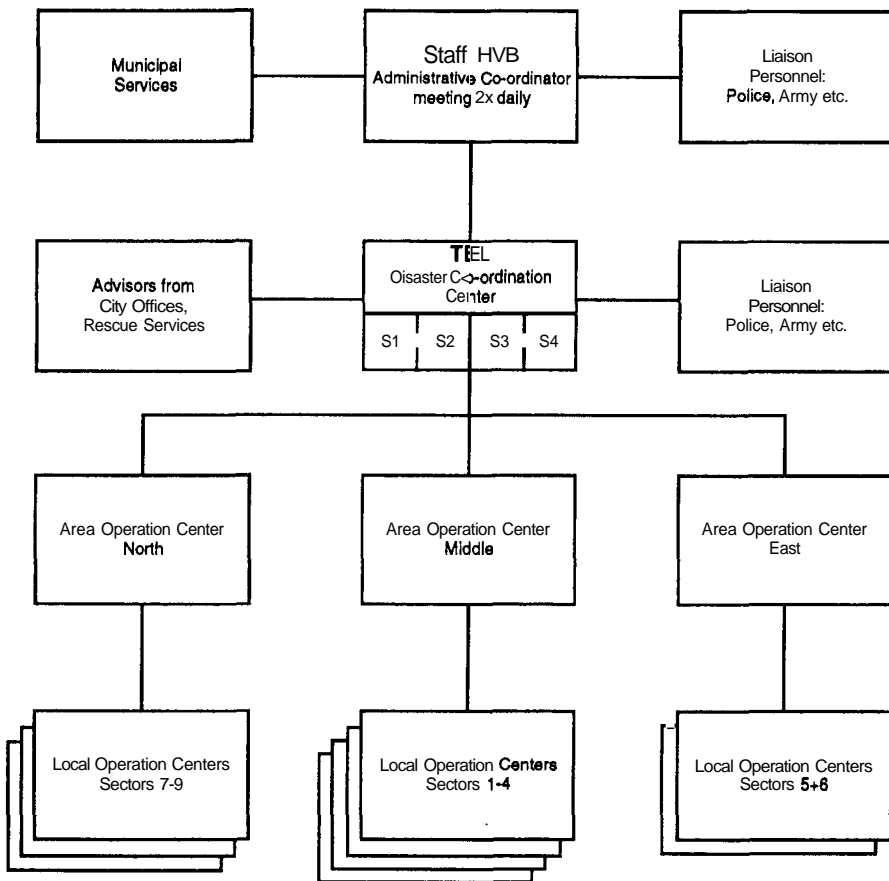


Figure 5.1 Flood response organization in the city of Koblenz

In 1993, these Operation centres and the Area Operation Centres were tied more strictly to the central leadership of the Staff HVB/TEL. This caused severe problems, since the central command structure was interrupted at times due to a complete breakdown of the communication infrastructure. The area Operation centres and field units were cut off from up-to-date information on the flood development and available resources.⁷ Underground telephone lines became unusable due to flooding and rising groundwater. Moreover, there were not enough radio sets to compensate for this loss of communication lines. Telecom supplied the Disaster Response Force with 18 handsets. However, these proved to be of little value because their frequencies were also used by administrators and private households.

The planning for disaster response in Koblenz, like in Cologne and other places, was based on the experience of the past decades. Since 1948 the Rhine area had not been struck by extraordinary high and lasting floods. The floods of 1983 and 1988 remained significantly below the 9m water level in Koblenz, the "critical" level for the planning and execution of protective measures. Up to the Christmas Flood of 1993, the floods followed similar patterns, with slow rising water levels between 6m and 8m allowing at least two to three days preparation time, in most cases even a week. This slow rise of water allowed disaster response to work according to "flood reaction plans" attuned to different water levels.

The Christmas Flood of 1993, however, turned out to be different. The fast rise of water cut back preparation time to circa 20 hours during 22 December 1993. The old flood reaction plans were not designed for such a short response time. In addition, a large number of the disaster response personnel was on Christmas holidays, many soldiers were discharged before Christmas. This lack of personnel caused problems, the available equipment (gangplanks, sandbags and pumps) could not be timely installed on the scale needed. Moreover, the Area and Local Operation Centres for the different areas and sectors of Koblenz could not fully operate on time. Only 30% of the disaster response personnel was available in the first 24 hours. Support by the army was delayed too, since with reduced personnel the army had to secure its own material first. Additionally, there was a 40% increase of regular fire fighting and technical aid missions during the 1993 flood, compared to earlier floods, which drained away considerable capacity (the Professional fire Service) from the already diminished disaster response force.

In Koblenz, at the confluence of the Rhine and Moselle river, the water level reached its highest peak since 1924 on 23 December 1993. Large portions of the city were flooded. Many people in Koblenz were cut off from the outside world: there was no electricity, telephone lines were disrupted and there was a lack of supplies. Oil-spills into the flood water caused unpleasant vapours

and polluted the ground soil and ground water, as well as public and private properties. The Situation for the people affected and the relief forces deteriorated as temperatures dropped to around 3-4°C.

More than 25,000 inhabitants were affected by the flood, 10,000 inhabitants were temporary cut off from the outside world, and about 7,000 inhabitants were without electricity. Many of the victims who left their homes due to the cold after the failure of the heating Systems were accommodated by neighbours or nearby family. In Koblenz only about 300 persons were evacuated. Overall, there was great solidarity among the people. The willingness to help was overwhelming.

The lack of sufficient capacity of the staff and response units impaired a sufficient supply of the population during the Christmas days. The local centres were located in public buildings, schools or stations of the fire brigades, and operated satisfactorily. It was therefore deemed unnecessary to operate the Disaster Coordination Centre for Koblenz continuously. Two meetings a day at 10.00 and 16.00 were deemed sufficient. At those meetings the heads of Operation of the three flood management areas and the representatives of the different Services and offices involved, presented their Situation reports and offered their judgement on the Situation and possible evacuations. Necessary measures to be taken were discussed, and requests for personnel, equipment, material and provisions were made for the forthcoming hours.

Tasks were delegated, so the tactical, the Area, and the Local Operation Centres could concentrate on the disaster management on-site, while the overall coordination centre focused on political and administrative problems and decision making. Aside from personnel shortages, the main problem besetting the operations was Communications. There was a shortage of major telephone lines, six lines for each area control centre, and as explained before, this lack of telephone lines could not be compensated by mobile phones. The number of authorized radio frequencies (channels) for the disaster response forces proved to be too low. The lack of hardware in terms of radio sets and walkie-talkies; the lack of frequencies available; and the fact that reinforcements from other organizations or areas did not operate on the same frequencies and used preset fixed channels caused severe communication failures and hindered the coordination. The breakdown of more than 7,000 telephone lines due to flooding and the rise of the groundwater, forced the rescue Services to rely strongly on radio communication, which was overburdened already. An additional problem was that the radio sets of the German Army, i.e. their available frequencies, did not match the frequencies of the other Services. This made communication impossible until the Fire Service lent several of its own radio sets to the army.

A further problem was media management. The spectacular events and the obvious response problems attracted massive interest of the media. Most rescue

agencies were unprepared for this aspect of a disaster, with reporters and camera teams invading the disaster areas and competing for interviews with on-scene commanders. The rush took officials by surprise and many of them had to spend up to 70% of their valuable and limited time to answer questions to reporters, at the detriment of their primary duties.⁸ Likewise, the work at the disaster response forces was severely impeded by disaster tourists. In this respect, the construction of elevated waterways for the inhabitants throughout the flooded parts of the town proved to be something of a mixed blessing, since it allowed an optimal access to the site for the disaster tourists. The obstruction of the disaster response units by onlookers and disaster tourists was not limited to dry land. Many of them took small boats clogging the flooded streets. Consequently, barriers had to be erected against this flotilla of onlookers.

The 1995 response — After the flood events of 1993, the flood management structure remained basically unchanged. However, personnel received better and more intensive training to prepare them for fast and high rising riverine floods. Also, the communication infrastructure was improved substantially, while elements of cooperative and decentralized leadership were strengthened. The area and local Operation centres obtained more autonomy to take tactical measures onsite. Decentralization avoids unnecessarily detailed communication with the superior levels, which inhibits a fast and adequate reaction to local problems. Another advantage is minimisation of potential misunderstandings, while decentralization also reduces potential information overload of the superior Operation centres. In conclusion: disaster management response has moved away from a command and control System to a self-reliant and decentralized System which can adapt faster and more efficiently to the local problems and needs.

The means of communication were also improved substantially, as the numbers of telephone lines, radio sets and walkie-talkies, as well as authorized frequencies (channels) increased. By 1995 the telephone lines and distributors of the German Post/Telecom were made water-proof.

In 1995, a press office was established to relieve media pressure on operational commanders and other relief personnel. All people with questions concerning the flood events and disaster response were referred to this press office. This arrangement proved very efficient.

The constant flow of information between the water reporting stations and the Operation centres was also improved. The alarm planning was adapted to the possibility of rapidly rising floods which necessitate earlier precautionary measures. This adaption carried political overtones since early precautions could turn out to be unnecessary afterwards, while having caused major costs and inconvenience. This was actually the case in 1995, when the water level remained below the level of 1993 and the city of Koblenz was not inundated.

The construction of walkways was delegated to private firms in order to reduce the workload of the disaster relief units. In 1995 the gang planks proved unnecessary due to the lower level of the flood wave. Some people complained about the discomfort caused by the construction of gang planks in the streets. However, the city authorities preferred to be on the safe side this time after the experience of the Christmas Flood of 1993.

The flood levels of 1995 rose slower and did not reach as high as in 1993, so there was enough time for preparations by the population and authorities. In January 1995 all personnel was mobilized and available, including the Army, so the disaster response units were more or less at full strength.

The problems with oil spillage were minor, since many households had switched to natural gas for heating and cooking. Moreover, existing laws for safety measures to be taken in flood prone areas, which included the securing of oil tanks, were tightened and enforced more strictly.

During the 1995 flood, organized forms of disaster tourism occurred for the first time as a major problem. Apart from the typical onlookers who impeded the mobility and work of the relief forces, especially in the often narrow streets of the old town parts, also organized forms of disaster tourism came to the fore. A private TV-station offered tours for DM 20 through the flooded parts of the town, including snorkling into the flooded homes and a T-shirt 'Ich war drinnen' ('I was in'). The authorities reacted harshly and threatened with severe fines, up to DM 10,000. Also the Rundfunk- and Fernsehrat, an official media ethics watchdog, was asked to take up the case. No further incidents of this kind took place afterwards. The TV-station claimed not to be responsible for the whole affair, since the broadcast was not produced by them but bought from a third party and was only meant to be a joke.

Volunteer organizations played an important role in Neuendorf, the most severely stricken part of Koblenz. Here an emergency action organization was founded within the neighbourhood which cooperated closely with the disaster response units. As a "convergent group" it agreed to be integrated into the command structure of the disaster response of the respective sector, thus becoming "disaster response helpers" with the Status of volunteer firemen. For the volunteers, this also had the advantage of being insured. Their assistance was of great help and was a relief for the regulär Services in that sector, but so far this type of emergent action has been exceptional.

Disaster management in Cologne

No major floods had hit Cologne in the first 35 years after the second world war. This gave its inhabitants an illusion of safety and produced a certain complacency with regard to flood protection measures. The flood of 1983, rising

to a level of 9.84m and flooding the old town centre, initiated public discussion about measures to be taken to protect the city of Cologne, especially the old town centre, without destroying the old townscape. The city government decided to raise the flood protection level to 10m. This decision was based on the 1926-estimate that only once-in-a-century floods would rise above the 10m level. To protect the old town centre, a mobile flood protection wall was built. This wall guaranteed protection up to the level of 10m, and proved successful during the 1988 flood which rose to a level of 9.95m.

In Cologne, the disaster response aims of the Flood Protection Centre and the Department of Sewage Treatment are intertwined. One of the tasks of the department of sewage treatment is to deal with water and to react as soon as possible when water levels start to rise. In addition, this department is responsible for the safe disposal of sewage during floods. During the flood of 1988, when the water level remained just below the protection level and inundation of the city was prevented, flooding of the sewer system resulted in tremendous spillage of untreated sewer into the Rhine river. The authorities remedied these problems by implementation of the plan *Abwasserkonzept 2000* (Sewer System 2000) which was already developed in 1987. The whole sewer system of Cologne was restructured and modernized at the cost of DM 650 millions to be able to cope with water levels up to 10m. Additionally a DM 200 million-draining system was installed and put into operation in 1993.

The disaster response to flood events in the city of Cologne is executed according to a basic frame for flood protection and response. This plan is attuned to the water levels measured at the Cologne Water Gauge (Kölner Pegel, KP). If water levels rise with an expected increase of more than 5 cm/h or if unusual precipitations and conditions may cause a rapid increase of water levels within a short period of time, the Department for Sewage Treatment is mobilized.

The Flood Protection Centre acts as a basic coordination unit for flood management in Cologne up to a level of 10.70m KP. The Centre is part of the Department for Sewer Treatment of the City of Cologne. Its permanent staff is made up of representatives, mostly administrators, of the municipal Services which are responsible for flood management. These Services comprise the Office for Sewer Treatment; the Transport Office (walkways, boat Service, traffic guidance, securing dikes); the Construction Office (roads, tunnels, bridges, flood gates, Underground transport); the Office for Housing (evacuation, shelter and Provision); the Police Department (traffic guidance, securing flood protection measures and private property); the Fire Department (pumps, oilspills, coordination of rescue Services, transport of the sick and for evacuation); and the liaison personnel of the German Defence Force (provision of population, transport and implementation of flood protection gear, boat and ferry service, walk-

ways and pumps). Additional Services can also be involved, depending on the development of the waterlevel, for instance the Office for Public Transportation, the Harbour Office, the Office for Gas and Electricity, the Office for Environmental Affairs, the Office for Health and Social Affairs, the Telecom (telecommunication) and the Press Office (compare figure 5.2).

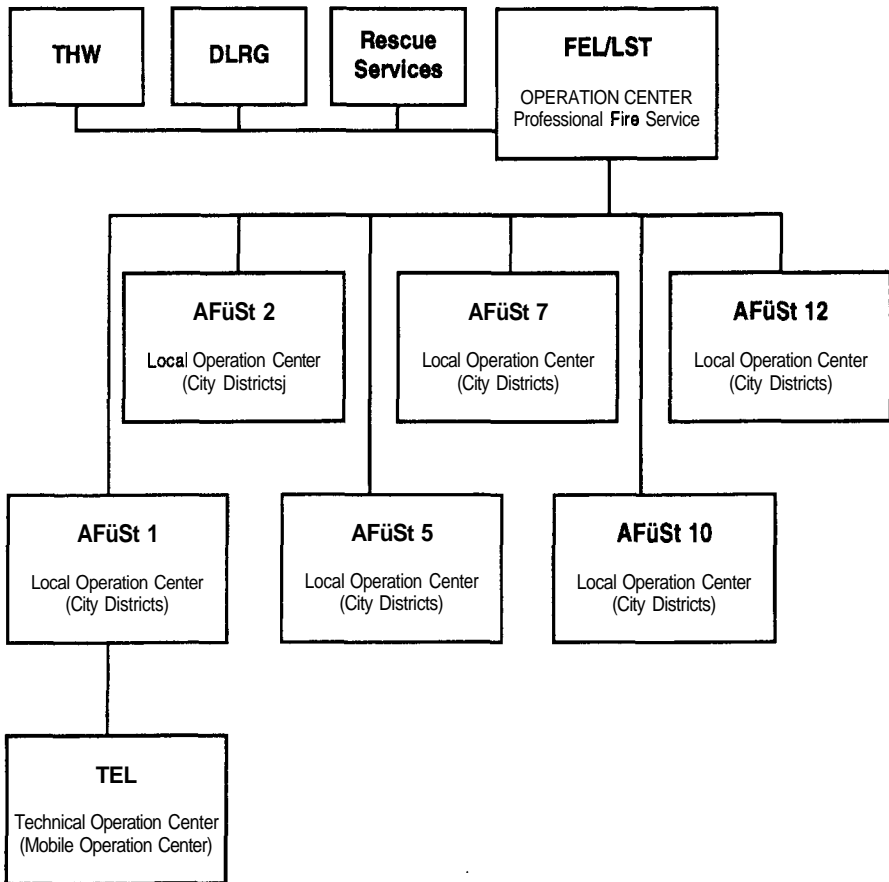


Figure 5.2 Flood response organization in the city of Cologne at moderate water levels

There exist a range of situations from "routine" flood management to disaster management, when the deployment of disaster response units is not yet necessary, but regular resources and structures for efficient management are insufficient. To cope with these mobilisation of staff and integration of other municipal Services and offices into the Flood Management Staff is needed (see figure 5.3 next page). In practice, when the old town centre is flooded, the flood coordination centre is enlarged to a 'Flood Crisis Management Staff. This is needed to handle the evacuation and provision of the population in the flooded town centre, but also to solve sewer and environmental problems caused by the flooding.

The Centre coordinates the flood management at the administrative level and is responsible for political decision making. Parallel to the Centre, the operational coordination of the response forces, i.e. the fire and rescue Services, and the police is shaped by the Operation centre of the Cologne fire Service. The staff of the operational centre is enlarged when the water level reaches 8.30m to be able to increase flood protection activities, to secure buildings and public roads, tunnels, embankments etc. The expanded operational centre is similar to the Disaster Coordination Centre in Koblenz described above. It is connected with the Overall coordination centre via reserved telephone lines and a fire Service liaison officer to secure a continuous communication flow.

Six Local Operation Centres in the different town districts along the embankment of the Rhine operate subordinate to the operational coordination centre. These so-called Technical Operations Centres are accommodated in the local fire stations. They operate mostly autonomously and are responsible for the deployment and provision of their own personnel as well as the assigned personnel from outside Cologne. They communicate frequently with the fire Service operational centre staff to update Situation reports and to give information to the logistic coordinator for the restock of personnel, provisions and resources.

The 1993 response — The Flood Protection Centre at the department for sewer treatment started to operate on the morning of 13 December 1993. The Centre coordinated the information from the police, the fire Service, and the other offices and organizations involved. It made forecasts on the development of the flood and passed this information on to the public, private firms and the media. The Centre also advised people who were threatened by the flood or who had suffered losses. Seven telephone lines were available plus one direct line to the fire Service, and at peak times, i.e. at rising water- levels, up to 5500 phone calls were received in one day. Additionally the Centre coordinated measures that were taken by the department for sewer treatment at the different water levels.

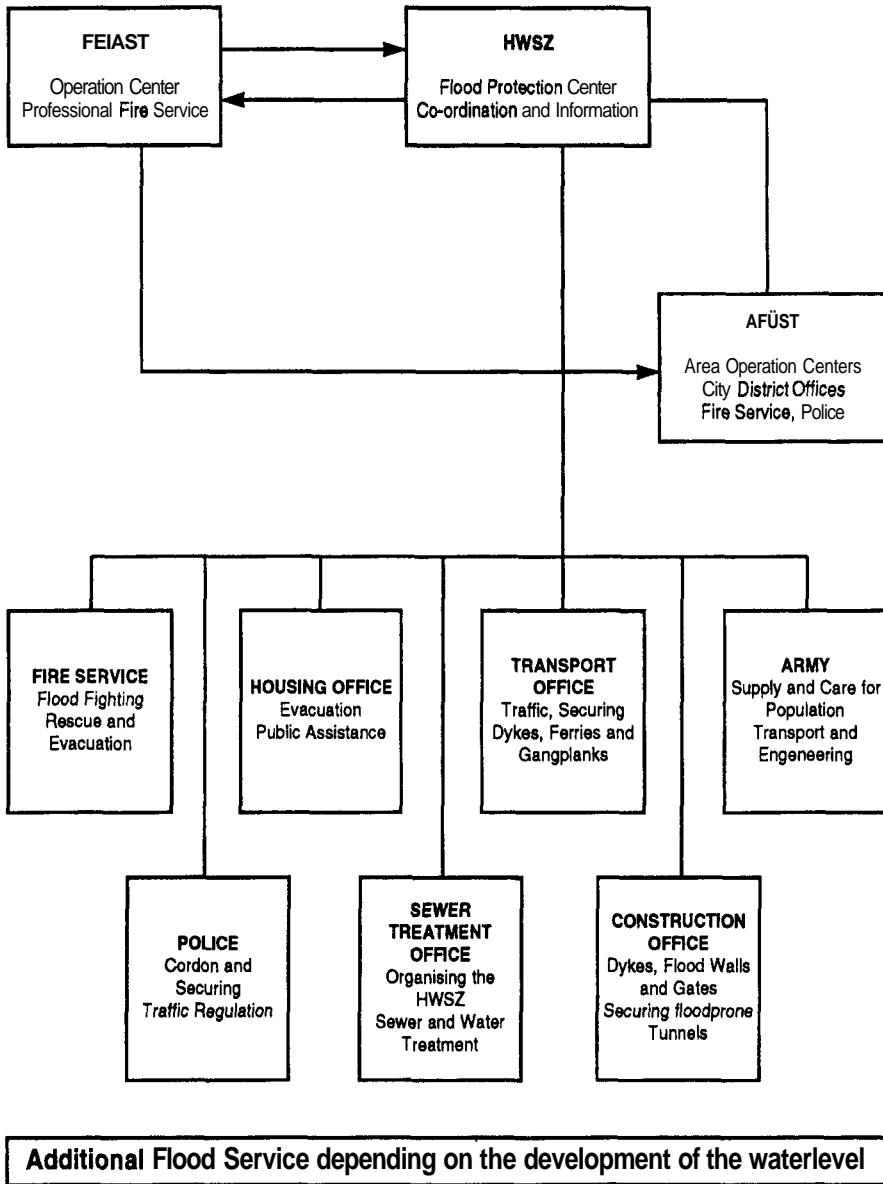


Figure 5.3 Flood response organization in the city of Cologne at high water levels

Telecommunication centres and control rooms were set up. All relevant municipal offices and Services had day and night personnel on duty for flood protection and public counselling. For example, the municipal Gas, Electricity and Water Service of Cologne which combines the power stations, gas- and water-works received circa 3,000 telephone calls per day.

The different municipal offices and departments began their assigned flood tasks in the endangered parts of Cologne independently. Formal coordination started on 19 December 1993 when the water level reached 5.70m KP. When the water rose to 8.50m KP combined with negative forecasts, representatives of all offices and departments joined for a common staff meeting, to Update the Situation report and to coordinate the next phases of the Operation. To reduce media pressure on the heads of Operation and the response forces, a central press office was set up.

During the flood a large number of disaster response units from outside Cologne assisted local fire Service. In the beginning problems occurred with the radio communication, since there was only a limited number of preset channels available for the radios and new units only used their own regional channels which did not match the channels of the Cologne fire Service. Therefore incoming reinforcements had to be directed to waiting areas and from there were guided by local personnel to the assigned sectors, causing some delays.

These inhabitants, who would be affected by the flood first, were already warned of the flood at a water level of 7.30m KP on 21 December. Early that day, posters were hung in the streets with basic information on threats attuned to water levels, precautions to be taken, plus information for counselling, telephone numbers and radio channels. At the same day at 07.00 in the morning, Radio Cologne and the West German Broadcasting Service issued flood warnings and gave information that the water could rise above 10m and inundate parts of the city. Flood information was passed on to all media and frequently updated. The radio stations broadcasted hourly flood reports. The news papers gave detailed information on threats and advise on self-help for the population from 21 December onwards. Additionally loudspeaker cars of the police and fire service dispatched warnings in the morning, in the afternoon and in the evening of 22 December. As a consequence, inhabitants were warned of the inundation of the flood protected areas and the expected consequences 12 hours ahead of time.

During the floods, over 2,000 persons, members of the police, the fire service, the disaster response and relief organizations, and volunteers worked more than 100,000 hours. One of the major tasks was the construction of sand-bag barriers to stem the flood and to make central facilities or private homes waterproof. To this end, 60,000 sandbags were used. In addition to the sandbag barriers, protective walls from steel or aluminium and 110 flood protection gates

were used to protect the old town centre, tunnels, Stores, pubs, restaurants and Underground car parks. In many places the water was constantly pumped out of basements and Underground structures to prevent major and lasting damage.

To maintain the lifelines in flooded areas and to support the pedestrian traffic in the flooded parts of the town, boats, rubber dinghies, high-wheeled trucks, and elevated walkways were utilized. The neighbouring houses in the old town centre in Cologne were linked by 3,400m of walkways. More than 40 boats were operating as "shuttle service". Like in Koblenz, the walkways were also used by disaster tourists.

In some areas, the obstruction of disaster response units by onlookers and disaster tourists on land and by small boats was disturbing. Due to the particularly narrow streets in the old town parts of Cologne, disaster tourists sometimes totally blocked traffic. As a consequence the response units could not always reach their destiny in time. In some cases barriers were erected against disaster tourists and even preventive measures against Sabotage were taken. The areas along the mobile flood barrier which protected the old town of Cologne were cleared by about 60 policemen on 22 December. This action was taken after one policeman had seen disaster tourists who manipulated the fixing of the mobile flood barrier. In other places some disaster tourists destroyed sandbags with knives or they just pulled sandbags out of the barrier 'to give the flood a chance'.

In conclusion, the disaster management and the work of the response forces was efficient. Also the new sewer system for Cologne worked well. The communication problems with the disaster response Services from outside Cologne were not severe and could be solved in the future by using common channels for events involving several regions. Only the protection level of 10m seemed to be too low to counter floods of this scale.

The 1995 response — Just thirteen months later on 25 January 1995, tremendous rainfalls, frozen grounds and thaw caused the next "once-in-a-century-flood". A flood wave went over the mobile flood protection barrier in Cologne. Almost 1,000 houses were flooded. While the flood Situation aggravated in the neighbouring countries, France, Belgium and the Netherlands, the water levels remained stable in Germany on the Rhine river and its tributaries.

In Cologne, 33,000 inhabitants were directly affected. Many households experienced damage through rising ground-water levels and flooded cellars. Sandbags once again became a major, or in some places even critical device. They were used to rise the flood protection level from 10m in some places up to 11m, thereby preventing flooding.

The people living along the rivers in general and the residents of Cologne in particular had learned from the flood in 1993. They cleared the basements

and groundfloors in advance and they set up sandbag barricades to draughtproof their doors and Windows. Also they were better equipped than in 1993 to meet power failure and shortage of supplies, or they had arranged for accommodation with the family or friends for the days of the flood.

The officials and employees of the municipal departments and offices were also well prepared. Several hundred employees were available around-the-clock. Support was received from the different relief Services and the German Army which assisted in the flood response for the first time in Cologne. Moreover several hundred police men-and-women maintained order and guarded flooded homes to prevent theft and looting.

The flood protection centre at the department for Sewage Treatment operated already during the minor floods beginning on 10 January 1995 when the water level rose above 4.50m KP, but only with limited personnel, since there was no immediate danger of a major flood. On 22 January at a water level of 3.70m, the Centre was again mobilized as rising water levels were expected. It started to operate at full strength on 24 January and coordinated the flood response measures of the fire Service, the municipal Services and offices, the relief organizations, non local disaster response forces and the Army. It was continuously informed about the execution of the assigned tasks and progress or problems. The Centre was occupied by ten representatives at all times while another ten employees took care of the telephone Service, i.e. public information Services and water level forecasts. At peak times up to 6,000 phone calls were received per day, mostly from residents of flood prone areas and journalists from all over the world. The open supply of information by authorities was appreciated by the media. The officials responsible for information Services thought this form of media management to be quite positive and necessary.

The early warning period for the population and the authorities improved in 1995. The forecasts and information on the current and imminent development of the flood were highly reliable. Also the 24-hour period forecasts were of good quality. These forecasts proved to be decisive for Cologne and its residents in their efforts to avoid or reduce damage. Although the 1995 flood rose above the Christmas Flood of 1993 by 6 cm, the damage was limited to just half the costs of 1993. This was the result of precise forecasts and early precautions taken by the residents and the authorities.

At a water level of 4.50m KP the residents of flood prone areas were warned on 23 January at an early stage by posters, as before in 1993 (then at a level of 7.30 m). Inhabitants were informed about threats caused by the flood, measures of precaution, and means of access to the information Services. This time an information leaflet was handed out to the households in the flood prone areas during December 1994. This leaflet gave detailed information on receiving

current information and aid during the flood events, but also on how to improvise and to help oneself or others.

From the morning of 23 January onwards, Radio Cologne and national radio warned of the oncoming flood and extremely high water levels. This news was passed to other media and disseminated and updated every hour. First warnings were broadcasted via radio and TV to warn owners of vehicles not to park their vehicles in flood prone areas, or to remove them from the announced locations. This information was especially relevant to many campers who had their motor homes or caravans on endangered campgrounds near the bank of the Rhine river. In highly endangered areas, where the water passed over the flood barriers, loudspeaker-cars of the police and fire service supplied immediate warnings. Everything was done to supply at any time the necessary and reliable information to the residents and the disaster response forces.

During the 1995 flood no major problems occurred in the Cologne area except for the flooding of the old town centre. The authorities have decided to raise the basic flood protection level way above 10m. New calculations expect water levels of 11.30m KP for every 100 years and of 11.90m KP for every 200 years. Taking this into account, the city of Cologne started a Flood Protection Project which aims for different flood protection levels for different areas which can vary from 10.70m KP up to 11.30m KP.

In case of water levels above 11m KP in the present state of flood protection, Cologne would suffer a major disaster. Such a flood would necessitate the evacuation of about 100,000 residents out of about 965,000 residents for the entire city. At this time Cologne is not prepared for such a mass evacuation. However, plans are being developed for such a contingency, since even with the improved and risen flood protection system, dikes may break. For this purpose the city of Cologne plans to set up a siren system along the Rhine river for an immediate areal warning.

6 Recovery and compensation

Tasks and responsibilities

The immediate recovery of the victims is the responsibility of the districts or municipalities, as long as they can handle it on their own and no declaration of disaster is issued for the whole state. With regard to rescue operations, evacuation, provisional accommodation and supply, clearance work and the reconstruction of public roads, the districts and municipalities are responsible as well.

The compensation for losses and reconstruction in the private sector exceeds the abilities and budgets of most of the districts and municipalities. No public or private insurance exists against flood damage, except for Baden-Württemberg. Up to 1 July 1994, the state of Baden-Württemberg had a compulsory and public insurance against elementary hazards, i.e. fires, storms, hails, floods (since 1960) and earthquakes (since 1971). The compulsory and monopolistic form of the insurance guaranteed compensation of risks, since it allowed a broad diversification of risks by type, while guaranteeing a sufficient pool of members. In 1994 the insurance was changed into a private and non-compulsory insurance owned for 98% by two former, in the mean time fused, monopolists who organized the public insurance before on state instructions.

Compensation is the responsibility of the State Ministry of Internal Affairs. The granting and approval of tax-deductible costs due to flood damage is the responsibility of the State Ministry of Finances. The granting of longterm credits for reconstruction in the private and business sector is the responsibility of the State Ministry of Economic Affairs. In addition, there are often special farmers recovery programmes run by the Ministry of Agriculture.

Damage inventory and compensation

An adequate and complete inventory of flood damages is difficult to make in general, but especially in Germany, since there is no single cost estimation method in the different municipalities and federal states. In several states only private damages and losses were registered, and only those above a certain value (above 3,000 DM for private and above 5,000 DM for business) covering only part of the total damage. In some places first estimates turned out to be exaggerated after investigation, while in other places the total damage did not become fully apparent until later stages.

Consequently, no exact numbers for the total damage done by the two flooding episodes can be given. Only enough estimates on the losses are available, except for North Rheinland-Westphalia, the only state which makes a complete inventory of all private and public damages. Both floods caused the same types of damages, economic losses and costs for the public and private sector (private households and business). The major types of damage, besides the tremendous ecological damages, were as follows:

Public Sector:

- damage to buildings, roads, bridges, waterways and their embankments and dikes;
- costs for disaster response units, fire brigades, police and other Services;
- costs for evacuation, Clearing and cleaning;

- financial aid for compensation of flood damages in the private and business sector.

Private Households:

- damage to buildings, furnishings, cars, etc.;
- costs for medical treatment as consequence of the floods;
- costs for repair and renovation.

Private Business (Trade, Transport and Farming):

- damage to buildings, fittings and equipment;
- loss of production, Services and sales (business and shipping);
- costs for repair and cleaning;
- crop failure, loss of seeds, deterioration of the soil.

The losses for German states affected by the floods are estimated to total DM 1.3 billion. The states who suffered the major damage are: Rhineland-Palatinate (DM 650 million), North Rhine-Westphalia (more than DM 200 million, with DM 110 million just for the city of Cologne), Baden-Württemberg (more than DM 160 million just for insured buildings), Saarland (DM 100 million in total, 36 million for registered private losses) and Bavaria (DM 35 million).

Estimating flood damages in 1995 is even more difficult, since many authorities and officials have become very reluctant to give exact figures after the experience of the 1993 floods when many early estimates proved exaggerated and false. Additionally, figures concerning the financial aid to the private sector, granted by some states, are not available or not comparable to the figures of the 1993 floods. Many administrative provisions have since been changed, mostly towards more strict criteria for claiming in damage compensation. Weather and water level forecasts proved to be good. The inhabitants had learned from the year before and took the forecasts more seriously than in 1993. They cleared their homes early. This helped to prevent substantial losses. Just for Cologne the improved anticipation and preparation of the people helped to reduce the losses in January 1995 to DM 65 million, about half the losses of 1993.

Total losses in Germany for 1995 are estimated to amount to DM 500 million, compared to DM 1.3 billion in 1993. These figures do not include losses due to reduced tax revenues, necessary costs for long term reconstruction, improvement or new construction of dikes and other measures concerning flood protection in general. In Rhineland-Palatinate and Baden-Württemberg the flood of 1995 did not reach the water levels of 1993, and there was far less damage than in 1993. For example, Baden-Württemberg flood losses in 1995 are estimated at about DM 50 million (plus DM 20 million due to storms) compared

to DM 160 million in 1993 just for insured buildings. In contrast, North Rhine-Westphalia was hit more severely by the flood of January 1995 than in 1993, but due to the better preparation, losses can also be expected to be significantly less than in 1993. Cologne presents a similar example (1993: DM 110 million; 1995: DM 65 million).

The losses due to flood damage of the waterways and structures relating to the waterways are about DM 12 million for 1993, DM 7.5 million of which concerns the Saar and Moselle river. The Rhine and the other tributaries suffered relatively minor damages. In addition during the 1993 floods the Moselle river was not navigable for 12 days, the Neckar and Saar for 9 days and the Stretch of the Rhine from below the confluence with the Moselle up to the Dutch border for 7 days. Altogether these opportunity costs totalled about DM 50 million.

Ecological damage occurred in form of Sedimentation of flooded grounds, both in agricultural and nature reservoirs. Since the Rhine and many of its tributaries are joined by industrial plants, such as chemical plants with poisonous sewers, the river may carry harmful chemicals which can cause severe damage by poisoning the ground and upsetting biotopes. Some of the spoiled agricultural grounds cannot be used any longer after flooding due to the high contents of harmful chemicals in the plants. Also sensitive biotopes may be set off balance by the chemical poisoning as well.

Sedimentation is also an expensive and time consuming effect of the floods. Especially the areas, flooded with water without or just little current were covered by several centimetres of Sediments after the flood retreated. Since the Sediments dry fast and form a solid layer, they have to be removed immediately when the water is retreating to avoid extremely expensive and labour intensive removal at a later point of time. The cleaning of the public streets and places in Cologne costed about DM 1 million. Furthermore the spilled heating oil caused considerable costs. In Cologne almost 2,000 tons of this water-oil mixture had to be removed and disposed of by specialized companies.

Flood insurance and compensation in Germany: a closer look

Except for the state of Baden-Württemberg no flood insurance in Germany for business and residential properties exists. For the Christmas Flood of 1993 the total losses are estimated to be more than DM 1 billion, with an average loss of DM 16,000 and with the largest single insured loss totalling DM 7 million. The burden of these losses falls primarily on the owners of private business and property. Compensation paid to individuals for damage and losses generally makes up for only a minor part of total losses. People mostly relied on themselves and the help from family, friends or neighbours. They accepted damage without much complaint.

The different states generally granted depreciation provisions to the victims to write off the costs of the flood damage. But there are no tax-deductible expenditures for private flood protection measures. In addition, credits for reconstruction were granted at low interest rates with repayments spread over several years. The compensations for damages were only granted if the damage surpassed e.g. DM 3,000 for private property or DM 5,000 for business. Minor damages had to be paid for by the people themselves.

The example of Koblenz shows that most of the damage and losses occurred in the private sector. Estimations of the total damage in Koblenz range from DM 150 to 200 million. The losses just for private households are estimated at about DM 57 million. At the same time, only about DM 6.7 million worth of damage compensation Claims have been put in by the people who suffered losses. The total damage for the private sector in Koblenz was split up into 16 classes. An evaluation clearly showed that people with minor damages were either not entitled to compensation claims, or when they were, most of the time abstained from claims. The smaller the losses, the less likely people claimed compensation. In all, less than 10% of the people who suffered damage and losses applied for compensation, while more than 90% did not.

Data regarding insurance and reinsurance clearly show that there is a worldwide trend towards increasing economic damage caused by natural disasters. Long term and costly measures are to be taken against riverine floods, but these measures should pay off in the long run compared to the longterm expenditures on potential flood damage. In Germany, the damage caused by riverine floods is mostly paid for by the victims. The government pays only little compensation and grants only general tax deductions. Since there is no insurance against the risk of flood damage, substantial personal and economic risks fall to the victims of floods. If "once-in-a-century-floods" occur every few years in the near future, and if government and authorities do not change their compensation policies, floods may ruin the lives of many people living and working along the rivers. One has to expect an increasing gap between the political and public perception of the causes of riverine floods and the management of flood damage by the authorities, as well as an increasing annoyance of the public due to the passiveness, negligence or even ignorance of the effects by the authorities.

Notes

- 1 The German case was included at a relatively late stage of the project (August 1995). Therefore no data concerning the people affected and the management of the riverine floods in December 1993 and January 1995 could be gained by first-hand observation. We conducted a series of telephone interviews with administrators at the different levels of administration and decision makers at the communal level and with representatives of the different disaster

relief Services, reinsurances and hydrological and meteorological research institutes. Furthermore, public evaluation and investigation reports, which were made on behalf of the communities affected, the states or the federal government (solely hydrological and meteorological reports) were analyzed. These reports all provide highly aggregated data. We held additional interviews with decision makers in Cologne and Koblenz to obtain sufficiently detailed information on the actual process of decision making and crisis management. These interviews provided additional insight into the local problems of decision making and disaster management. Finally, reports of the major reinsurances were evaluated and a content analysis of the media coverage of the flood events was made.

- 2 State water laws maintain the principle of private water property, except for the state of Baden-Württemberg.
- 3 DWD utilizes data from a nationwide network of weather stations and METEOSAT-satellite pictures for the development and improvement of weather forecasts and forecast-models.
- 4 According to communal law, the Lower Disaster Response Authority is either attached to the district (*Landkreis*), to the administrative area (*Regierungsbezirk*) or to the municipality (*kreisfreie Stadt*). For example, in the states of Rhineland-Palatinate and North Rhine-Westphalia administrative areas can consist of several districts. The municipalities (*kreisfreie Städte*) like Cologne and Koblenz are independent corporate bodies on the level of districts or administrative areas. The community (*Gemeinde*) is the basic administrative unit at the local level. It provides the fire brigade(s) and the local police.
- 5 Since the actual organization of the Disaster response in the different states is basically similar, but differs in detail and in name, the specific details for Koblenz and Cologne are given in section 5.2 and 5.3.
- 6 Not included are the water level stations of the wsv.
- 7 Additionally the Staff HVB experienced problems in gaining up to date Information on the meteorological and hydrological Situation, because they were informed via the police by means of low quality photo-copies or faxes converted to BTX-pages which were unreadable. This problem was solved after the 1993 flood by using a professionally organised fax-distributor, which in 1995 was able to supply at short notice the latest data and forecasts of the meteorological situation, and the relevant water levels of the Rhine and Moselle and its tributaries.
- 8 Based on interviews with officials affected.