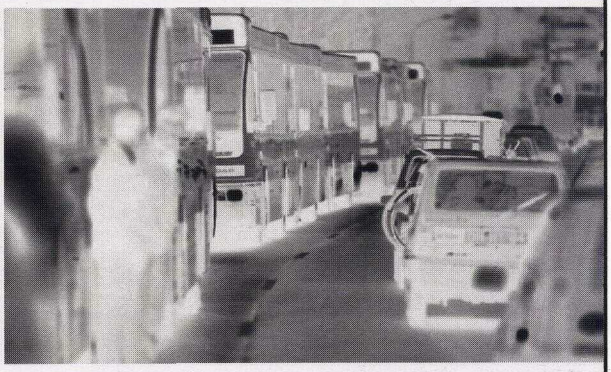
THE 1993 AND 1995 FLOODS IN WESTERN EUROPE

A comparative study of disaster response



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PART V

FLOOD MANAGEMENT IN GERMANY

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solutions.

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 areal or local Operation centres and more competencies were granted to them (compare chapter 5).

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 honourary basis. Therefore, unified, centralized data-bases; aggregated Operation reports, protocols and records; and/or nationwide data on discharges and water gauges are very rare, hardly accessible or not available at all. A complete picture of the floods could only have been achieved by assembling the data available on the communal level and from the particular organizations involved. However, even if these data would have been accessible, its worth is dubious because of potential intra-organizational purposes. 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.

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, re-insurances 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 re-insurances were evaluated and a content-analysis of the media coverage of the flood events was made.

The second chapter of the report gives a general outline of the water and disaster management in Germany. This is followed by an introduction of the significance and hazards of the Rhine river for Germany (and Europe). The third chapter gives an overview of the actual events of 1993/94 and 1995 concerning the meteorological, hydrological and flood Situation. In the fourth chapter, the report takes a closer look at risk—communication, the warning—process and Information management during the flood events. In the subsequent chapters, the actual disaster management in Koblenz (Rhineland—Palatinate) and Cologne (North Rhine—Westphalia) (chapter 5), and the organization of recovery and mitigation (chapter 6) are analyzed. Finally, chapter seven presents different views held by scientists, politicians, media and public of the actual causes of future flood hazards.

2 Water and disaster management in Germany

2.1 Water management: the formal organization

To understand the German System of water management, it is imperative to discuss the organization and structure in some detail. 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 federal 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 (Bundeswasserstraßen, Art.89 GG). The federal water and navigation administration (Wasser— und Schiffahrtsverwaltung des Bundes, WSV) consists of several agencies (Wasser— und Schiffahrtsdirektionen). These agencies are subordinate to the Federal Ministry of Transportation. By law (Bundeswassergesetz) 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 administrations (Wasser— und Schiffahrtsämter) are tasked with the execution and supervision of these activities. The federal authorities are solely responsible for the navigability of the federal waterways and the rivers, such as the Rhine. The federal 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 are entrusted with the execution of these tasks.

Except for the federal waterways which are federal property, all other waters like surface, coastal and groundwaters are the responsibility of the states. The state governed 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.[1] 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 (Rahmenpläne). 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 (Generalpläne) or special plans (Sonderpläne) 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 floodwarning are delegated to the departments of 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 Ministry of the Interior is formally in charge of disaster management and the warning and informing of the public, 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, the 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 co—operates with other hydrological and meteorological institutes in Germany and neighbouring countries. The German Weather Service in Offenbach in Maintz (Deutscher Wetterdienst, DWD), which resides under the Federal Ministry of Transport provides the main meteorological information and scientific research.[2]

The major problems concerning water management by the German authorities and institutions are similar to those experienced by other industrial nations. These problems can be listed as follows:

a) 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.

b) The increasing amount of sewage and waste water, a result of an increasing use of water supplies, cannot always be processed by the industrial and municipal sewer disposal and purification plants. This imposes a bürden on the quality of surface waters by increasing pollution. Moreover, riverine floods by itself lead to considerable pollution when sewer Systems get flooded and sewage spills into the surface waters.

c) 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 contributed to the sealing of the ground (with the aforementioned detrimental effects), and it diminished the potential of water retention areas to reduce the effects of riverine floods.

2.2 Disaster management: the formal organization

Under the German Basic Law (GG) (Art. 30, GG), the execution of federal authority and obligations is consigned to the sixteen states (Bundesländer). Disaster response (Katastrophenschutz) is the duty of the states (Art. 35, GG). The districts, administrative areas and municipalities are obliged by state laws (Katastrophen-schutzgesetze der Länder) 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" (Zivilschutzgesetz (ZSG) 1976) integrates the system of disaster response (Katastrophenschutz) into the system of civil defence. The system of civil defence has four elements:

1. Maintenance of government
2. Civil Protection
3. Supply and provision
4. Support of armed forces

The "Extended Disaster Response Act" (Gesetz über die Erweiterung des Katastrophenschutzes (EKatSG) 1968, revised 1990) specifies the specific duties and provisions of the disaster response system during wartime (Verteidigungsfall). To enable states to fulfil additional duties and tasks during wartime, the federal state 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 both types of forces (i.e. the peacetime forces and the additional wartime forces) caused some problems with concern to the determination of the actual total size of disaster relief personnel and the identification of membership.

Since the end of the "Cold War Era" and the unification of Germany, revisions of the Civil Defence Act (comp. Weißbuch 1995; "Bericht zur Zivilen Verteidigung" 1994) and the Extended Disaster Response Act have been made. Also plans have been developed to reshape the civil defence and to cut the size of the "supplementary and extending" disaster response forces.

The plans for reshaping the federal Civil Defence Act (ZSG) have been prepared by the Ministry of Defence on behalf of the Federal Government. This revision of the Civil Defence Act is relevant, in sofar

it maintains the former dual role of the disaster response forces. The Extended Disaster Response Act (Gesetz über die Erweiterung des Katastrophenschutzes (EKatSG)) upholds in its revised version the federal competencies and duties of disaster relief during war time. Since the unification of Germany, the probability of a military conflict with neighbouring countries (former Warsaw Pact), especially of NBC-warfare, has politically been estimated as very low (Weißbuch 1994, esp. §§ 202, 205 and 254). Consequently, together with the financial burdens of the unification, the Federal Government has cut spendings on the supplementary and extending disaster response forces. The expenditures on civil defence experienced major cutbacks as well. This federal retrenchment has transferred financial and organizational burdens to the states, particularly to those states which beforehand relied on these federal supplementary and extended forces.

All 16 German states have implemented or are in the process of implementing Disaster Response Aas. These acts are often combined with the existing Fire Defence Acts and comply with the federal law, the Extended Disaster Response Act (EKatSG). As a result of the partial withdrawal of the federal state of supplementary and extending components of the disaster response force, obligatory federal structures and procedures (for instance with regard to command structure) have been abandoned.

At the time of the riverine floods in 1993/94 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 abolition of supplementary and extending forces imposes financial burdens on the communities. With tighter budgets of cities and communities, the financing of the disaster response of the districts (administrative areas or municipalities resp.), i.e. 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 those organizations which are "accredited" by contract with the district government (like Red Cross and others mentioned in the following). The fire brigades, on a volunteer basis in communes with less than 100.000 inhabitants and on a Professional basis in communes above 100.000 (mainly cities), are tasked

with (actual) disaster response. This task is added to their regulär Services. Expenses for relief work done during disaster management are refunded afterwards. As a consequence of the on-going reorganization of disaster response and of the partial federal withdrawal, most of the states have not been able to maintain the former strength of the disaster response forces. In some states, budgets were cut.

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. Depending on size of the communities, one or more emergency and rescue Services are part of the disaster response force. These forces have specific functions in case of a mass emergency (see below). Although under normal circumstances some overlap and competition may exist between the various rescue organizations, they cooperate during mass emergencies or a disaster. A staff (STAFF HVB; TEL) of the lower disaster response authority (compare chapter 5) is responsible for coordination of the various emergency Services.

The disaster response force has a large potential of mostly honourary and voluntary serving people. The German Federation of Fire Services counts about 1.35 million members. Units of the Federal Institution for Technical Aid (Bundesanstalt Technisches Hilfswerk, THW) have about 65,000 members. Other medical rescue and care Services comprise: the German Red Cross (DRK) with roughly 4.5 million members; the Arbeiter—Samariter—Bund (ASB), the Johanniter—Unfall—Hilfe (JUH), the Malteser—Hilfsdienst (MHD) and the German Life Guard Organization (DLRG) 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.

In practice, 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 (resp. administrative area or municipality) (for details compare chapter 5). 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 the disaster strack community. 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 (administrative areas or municipalities resp.) within one state are struck by disaster and if their resources are not sufficient to cope with the emergency. Such action was not taken in any state affected by the floods of 1993/94 and 1995.

As mentioned above, the German disaster management System is predominantly organized to respond to disaster events. Disasters which may occur frequently and develop slowly over time, like riverine floods, however, demand anticipation and disaster prevention. The general public also expects from government a proactive rather than a reactive form of coping with flood hazards. This is particularly the case for riverine floods. Although the media has presented the river floods as extra-ordinary and unique disasters, there has also been ample discussion of the "man-made" and recurrent nature of riverine floods in conjunction with climatological changes. As a result, disaster management was afterwards criticized as inadequate and the need for solutions other than shovelling debris decreased in importance. This criticism of the German disaster response does not take into account that the disaster response was designed only to cope with actual emergencies. Disaster prevention is the duty of other institutions. A modern concept of disaster response also has to acknowledge the challenges of new hazards and risks. Flood protection (Hochwasserschutz) in Germany is a very complex issue which includes ecological and economical aspects as well as the conservation of nature, the quality of water and other interests varying from shipping, tourist industry, fishing via regulation, industrial use and energy to flood plain planning and protection (dams, dikes, levees etc.). Services of a modern disaster response should switch from supply oriented to demand oriented concepts with a strong emphasis on dialogue with the user of these Services. Especially the lack of communication between suppliers and users may be seen as an important omission in the existing disaster System. As the capacity of the relief system´s forces will decrease over the years, self-help of the people will be called for. After the "Christmas Flood" of 1993, the authorities in Cologne and Koblenz have taken this into account by reshaping the organization of the disaster response accordingly (compare chapter 5).

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

3.1 The flood history of the Rhine river

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 urbanization.

Riverine settlements and floods have a long history, reaching back to ancient times. Severe floods have been known and reported since Roman times. For Cologne, historical records document two extreme floods in 1374 and 1784. Efforts to regulate the Rhine (1817—74) considerably increased the average occurrence of riverine floods in the 19th and 20th Century. During the period from 1882 to 1980, sixteen large-scale riverine floods were reported in Cologne. These floods normally did not exceed the 10 meter mark. Flood protection measures were based on this 10 meter mark. Bigger floods were supposed to occur only once in a Century. Authorities considered the high costs for a further raising of the protection level not justified, given this small likelihood.

During the past twelve years, half a dozen high floods occurred. However, it was not until the extreme floods of 1993/94 and 1995 that the public and the authorities became seriously worried about floods. This public arousal resulted in political pressure to improve flood protection. Beforehand flood protection was not a high priority. Moreover, substantial measures were not taken. Typical for most areas (e.g. Koblenz and Cologne), floods along the river Rhine and its tributaries were considered routine. Such floods occur several times a year and normally do not cause major problems.

Nowadays, riverine floods occur, whilst in past years rivers did not flood at similar rates of rainfall (see Umweltbundesamt, 1994). For many scientists, journalists, decision makers and a large portion of the public this clearly demonstrates that Watermanagement, especially in the catchment area of the Rhine and its tributaries, is directly related to the increasing and more devastating riverine floods of the recent past. Public concern has

increased and important scientific evidence is available which suggests that large-scale floods will occur more often than once in a Century.

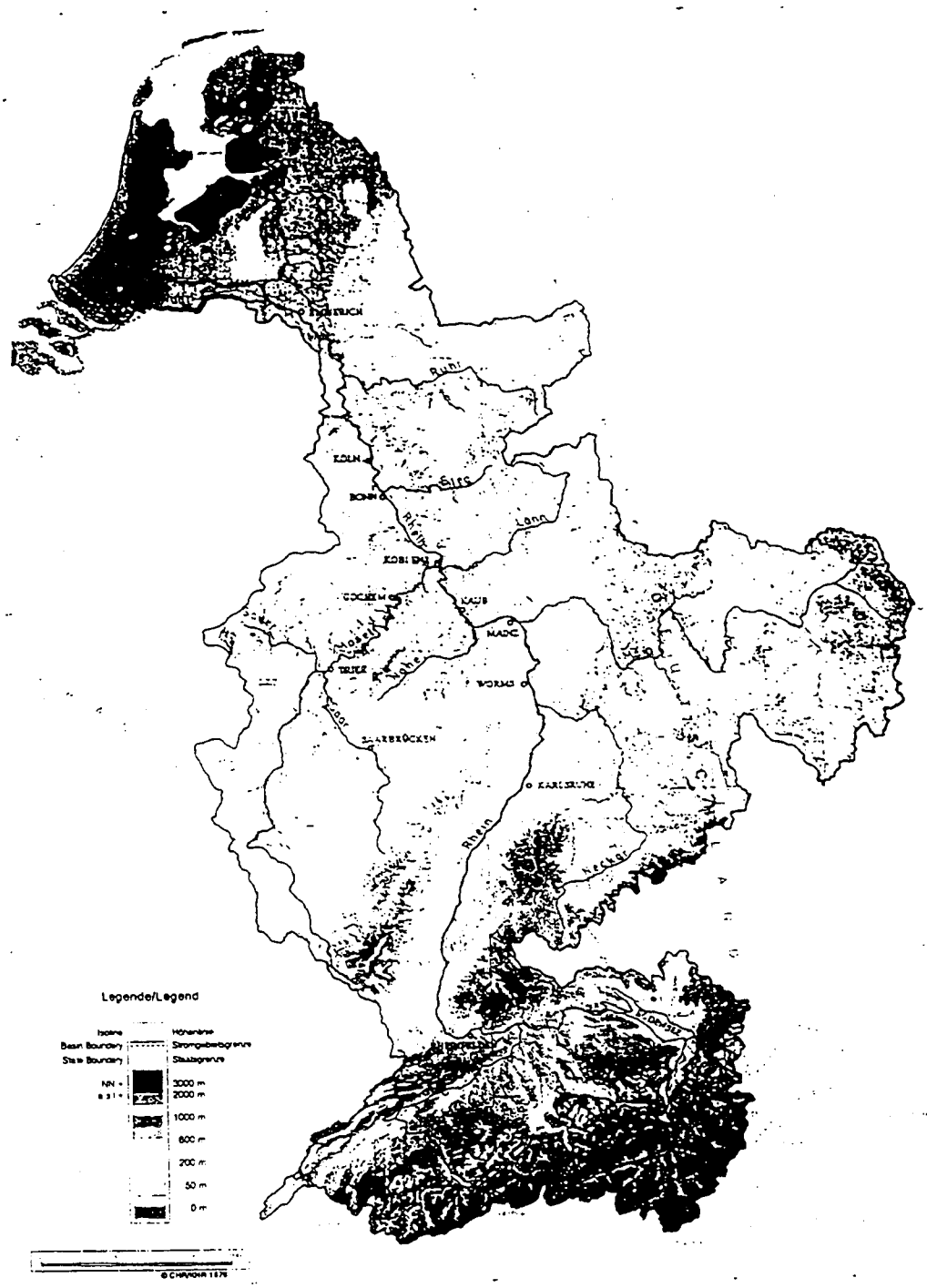
However, studies of the Federal Institute of Hydrology (BfG) indicate that there is no immediate proof for a direct link between human interventions and the course of riverine floods. These studies have pointed out that there have always been long periods (up to several decades) without unusual high floods, to be followed by short periods (few years) with high riverine floods, sometimes even two major floods within one year. Moreover, it is argued that it is difficult to detect and provide evidence for man-made contributions to floods. Meteorological and hydrological modelling so far is not precise enough to provide sufficient data and evidence in support of such a conclusion.

3.2 The Rhine river and its tributaries

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. The width of the river varies considerably, from 70 km at the end of the Rhine valley to more than 500 km at the level of the Lorainese plateau and Fichtel mountain ränge. The course of the Rhine amounts to approximately 1.320 km through Switzerland, Liechtenstein, Austria, Germany, France and the Netherlands (comp. fig. 3.1).

The Rhine river is divided into six sections: Alpine Rhine, High Rhine, Upper Rhine, Middle Rhine, Lower Rhine and the Rhine Delta. The Alpine Rhine (102 km) area Stretches 50 km up to Lake Constance. At Constance, the High Rhine (145 km) section begins and finishes in Basel. The Aare is the High Rhine's main tributary. The Upper Rhine (358 km) continues from Basel to Bingen northward with the Neckar and Main as its main tributaries. The Middle Rhine (126 km) covers the area from Bingen in northwestern direction to Bonn with the Nahe, Moselle, Ahr, Lahn and Sieg as tributaries.

Figure 3.1 The catchment area of the Rhine



The Lower Rhine (212 km) continues to the Rhine Delta below Emmerich with the Lippe and Ruhr as its main tributaries. The Rhine Delta finally is forks into the Waal and Lek, in the Netherlands, before it flows into the North Sea.

The severe floods of 1993/94 and 1995 foremost hit the areas of the Middle and Lower Rhine, where also most of the damage in Germany was done. The main areas struck by the floods were the municipalities and surrounding 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 1993/94 or the 1995 floods. Both floods were fed by the drain of the middle ränge mountains along the Upper and Middle Rhine.

3.3 Chronology and events in 1993/94

3.3.1 The meteorological Situation

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. Aside from factors discussed above (i.e. sealing of open ground and naturally impermeable ground), frost and Saturation conditions were major factors in causing the riverine floods.

In addition, the weather Situation until 7 December was bad. A polar front combined with an Atlantic warm front, lead to thaw of the prior snowfall. From 7 to 15 December, a storm front pushed the polar front further south. Several low—pressure Systems passed over Germany. This caused frequent and heavy rainfalls at a daily average of 5 to 10 mm. In some areas even higher rainfall was recorded. At higher altitude, i.e. above 600m in the middle ränge mountains, the precipitation turned into snow and formed a layer of 20 to 40 cm.

Between 19 and 21 December, the general weather Situation worsened when warm Atlantic air crossed Germany, causing heavy rains and thaw up to the tops of the middle ränge mountains. Days of extreme rainfalls followed. In the ränge of the catchment area of the Rhine and the Moselle, rainfall averaged 60—100 mm in only three days.

Following 22 December, colder air infiltrated from the north—west with another low pressure zone. The precipitation still averaged more than

20 mm in the middle mountain ranges; above the 400m height a layer of 20-80cm was formed which for the most part consisted of snow. The German Weather Service (DWD) recorded for the period from 16 to 26 December averages between 90 and 150 mm in several areas. In comparison to the Standard average for the December period, many areas experienced rainfall up to 200%, in some places almost 300% to 400% of the average precipitation.

3.3.2 The hydrological Situation

These weather conditions resulted in severe floods along the Rhine river, mostly downstream. Discharges rose in almost all of its major tributaries, i.e. the Neckar, Main, Nahe and Moselle rivers. The Sauer and Saar river, tributaries of the Moselle, had a large impact on the Moselle river, especially below the confluence with the Saar. The largest discharge of this Century was measured in this part of the river.

The flood events in December 1993 and January 1994 consisted of two hydrologically related waves. During the "Christmas Flood" of 1993, the discharges were generally higher than in January 1994. In early December, the water-levels of the Middle and Lower Rhine, the Moselle and Saar were already above the mean water-levels. On 16 December, the flood period started as the amount of water in the Rhine increased constantly. In the Upper Rhine area, it was the confluence with the waterloaden Neckar that brought about further increases in the waterlevel, although the peak was reduced by draining water away to polders along the Rhine between the Neckar and Main. The discharge of the Main did not heighten the waterlevel, but the discharge of the Nahe River with 1000 m3/s caused a decisive increase of the Rhine waterlevel.

At Koblenz, where the Rhine and Moselle meet, flood peaks followed within short time intervals. The Moselle discharge reached almost 4,200 m3/s; its highest watervolume since records were held in 1817. The Moselle added so much water to the Rhine, that the peak of the Rhine River reached its second highest water-level of this Century in Cologne (compare figures 3.2, 3.3 and 3.4).

Figure 3.2 Water-levels of the Rhineabove 9m at Cologne

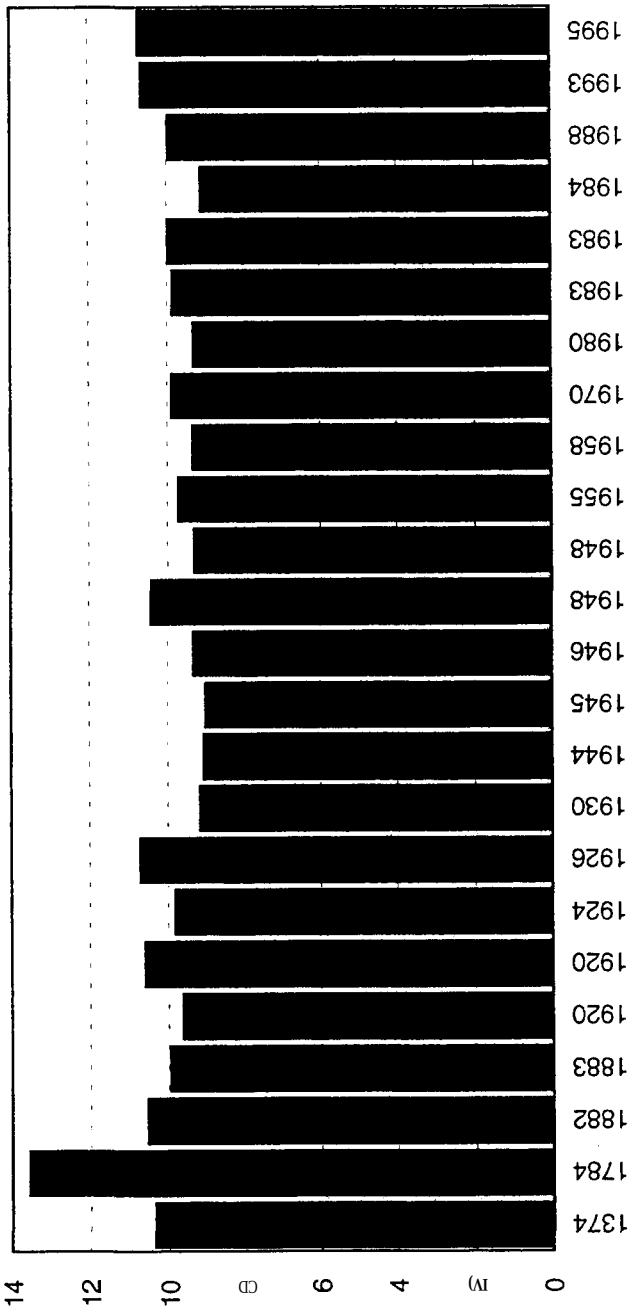
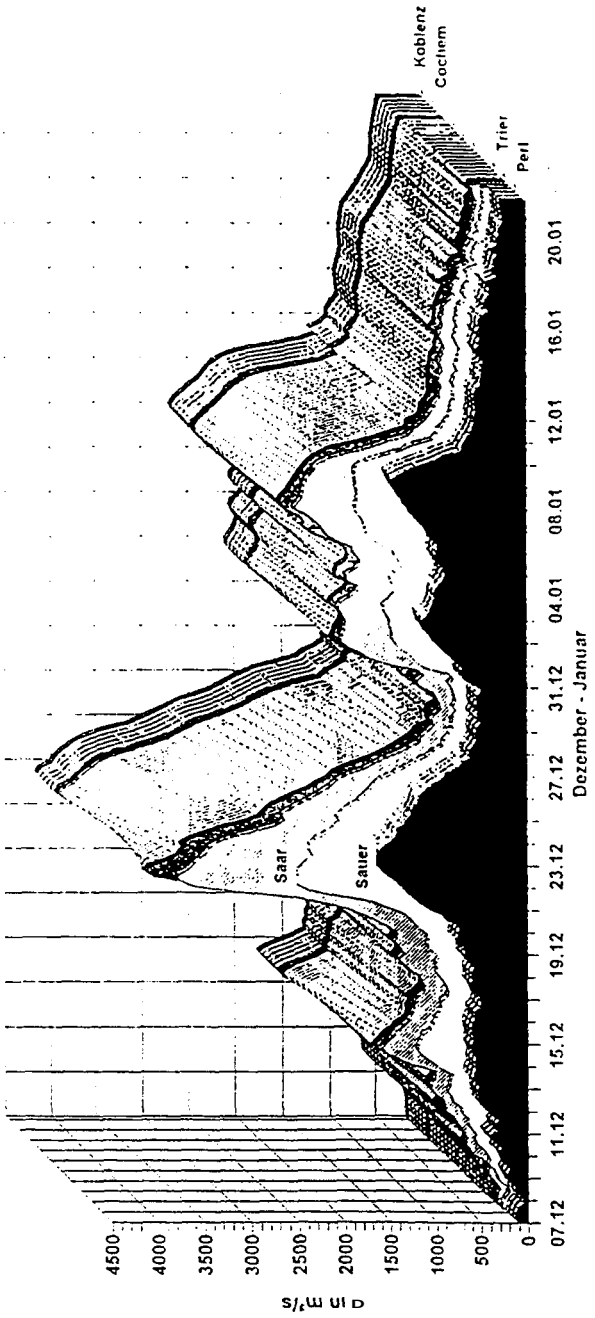


Figure 3.3 Flood wave and discharge diagram of the Moselle 1993/94



3.3.3 The flood Situation

From Constance to the area around Mainz, a complex System of dikes with different heights Stands along the embankments of the High and Upper Rhine. These dikes cover more than 500 km of the rivers' 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 (compare figure 3.5).

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. This is done out of concern with the inhabitants of this area and 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 10 meter. 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 (compare figure 3.5).

The flooding of polders enclosed by summer dikes along the Upper Rhine brought some relief. The damage in the High and Upper Rhine areas and their tributaries was relatively small. 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.

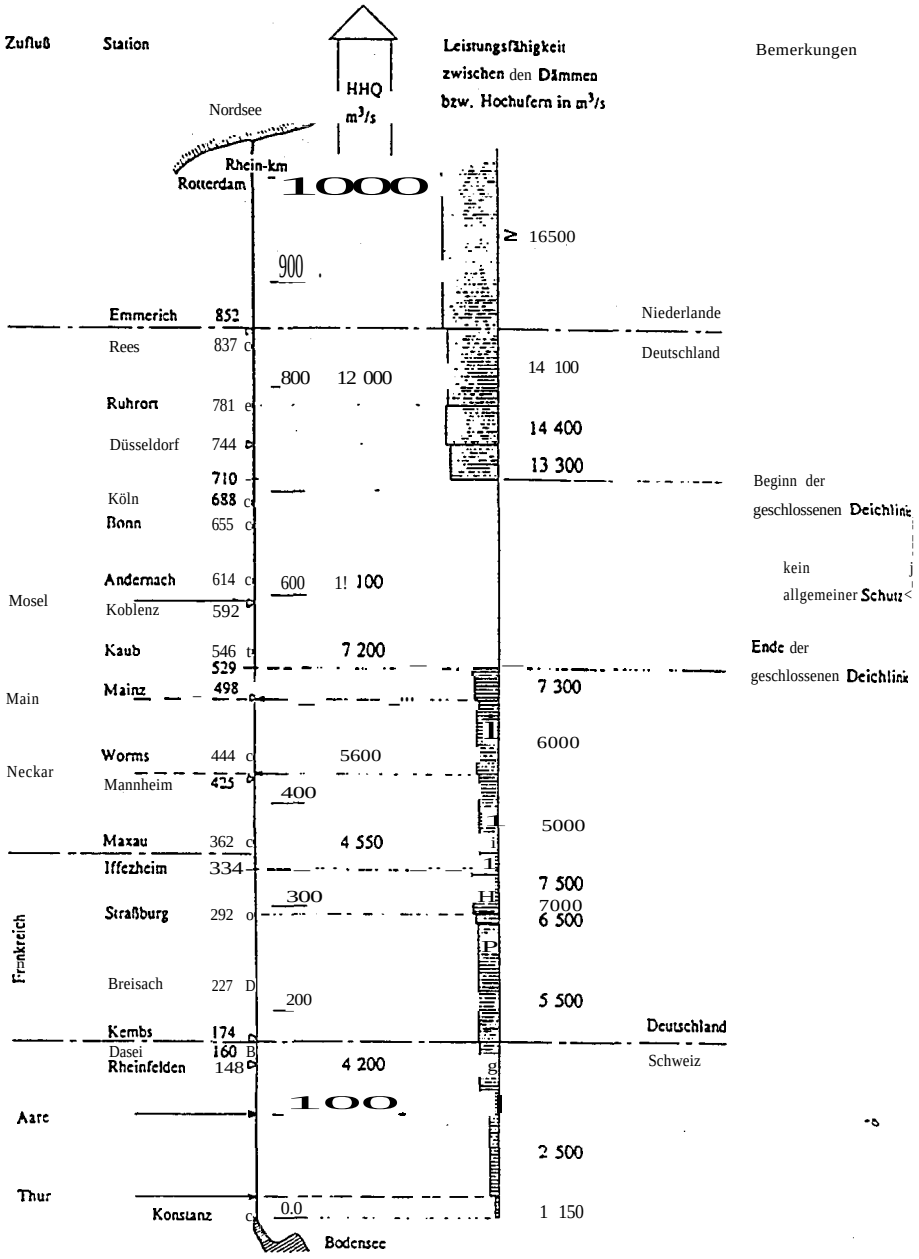
Due to the assumed global climatic changes, probabilities of average

occurrence of floods may rise and increasing flood levels may be expected in the near future. In most areas, however, flood control works sufficiently so far. In the future, especially in the Middle Rhine area, improved flood control System and additional retention areas are needed. The flood—control—report of the Enquete—Commission of Rhineland—Palatinate demands such measures and several programs are on the way now. The same applies for North Rhine—Westphalia, especially Cologne and the areas upstream of Cologne.

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. Only in some cases, dikes were flooded or softened and undermined by seepage. After the flood events of 1993/94 and 1995, many dikes were/are improved, repaired or rebuilt. 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 repair. Frequently the foundation of the dikes has proved to be insufficient according to modern Standards of safety.

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. Just for the Main area a single Stretch of 56.5 km of dikes has been erected. 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 floods.

Figure 3.5 Highest discharges and capacities of the Rhine between Lake Constance and the North Sea



Apart from the municipality of Cologne, Koblenz was also hard hit, experiencing the worst flood since 1925/26. The city authorities estimated the damage to figure between DM 150 to 200 million. 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 ränge 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. Apart from reasons which are similar to the Cologne case, the particular geography of Koblenz impairs the building of dikes and protection walls. There is no space for dikes in the narrow valleys. Water protection walls would enclose the inhabited ares like "prison walls"; obviously both inhabitants and authorities do not favour this Option. Additionally, such protection is deemed too costly by the city of Konstanz. Only one flood prone town district of Koblenz, Ehrenbreitstein on the right river bank of the Rhine, will in the future be protected at high costs by a dike or wall. But this takes tremendous efforts as the foundations have to be hammered down 14 meters into the ground to prevent the groundwater from sipping under the dikes or walls.

During the unusual high flood in 1993, most of the hit villages were isolated. This demanded a flexible and decentralized leadership within the organization of the disaster response in Koblenz. Prior to the 1993 floods, the alarm plans and the organization of disaster response had been rather rigid. These plans proved to be inadequate for fast and high rising floods. This new experience resulted in adaptions of the System (compare chapter 5). Fortunately the social structure within the respective isolated town districts stimulated self-help and neighbourly assistance. The volunteer fire brigades were highly integrated as well, allowing an effective and autonomous flood management in those places.

The facts described above indicate clearly the necessity and effectiveness of a broad System for flood protection. Such a system does not exist to a sufficient degree in parts of Rhineland—Palatinate and North Rhine—Westphalia, i.e. in the municipalities of Koblenz and

Cologne. In Cologne action is taken to reconstruct and raise the dikes and walls for flood protection as well as reshaping the organization of disaster response. In Koblenz the focus is upon improvement of flood response by improved means of communication and more flexible alarm plans. These plans have to allow for a more individual approach and timely intervention to take preventive measures and minimize damage (compare chapter 5).

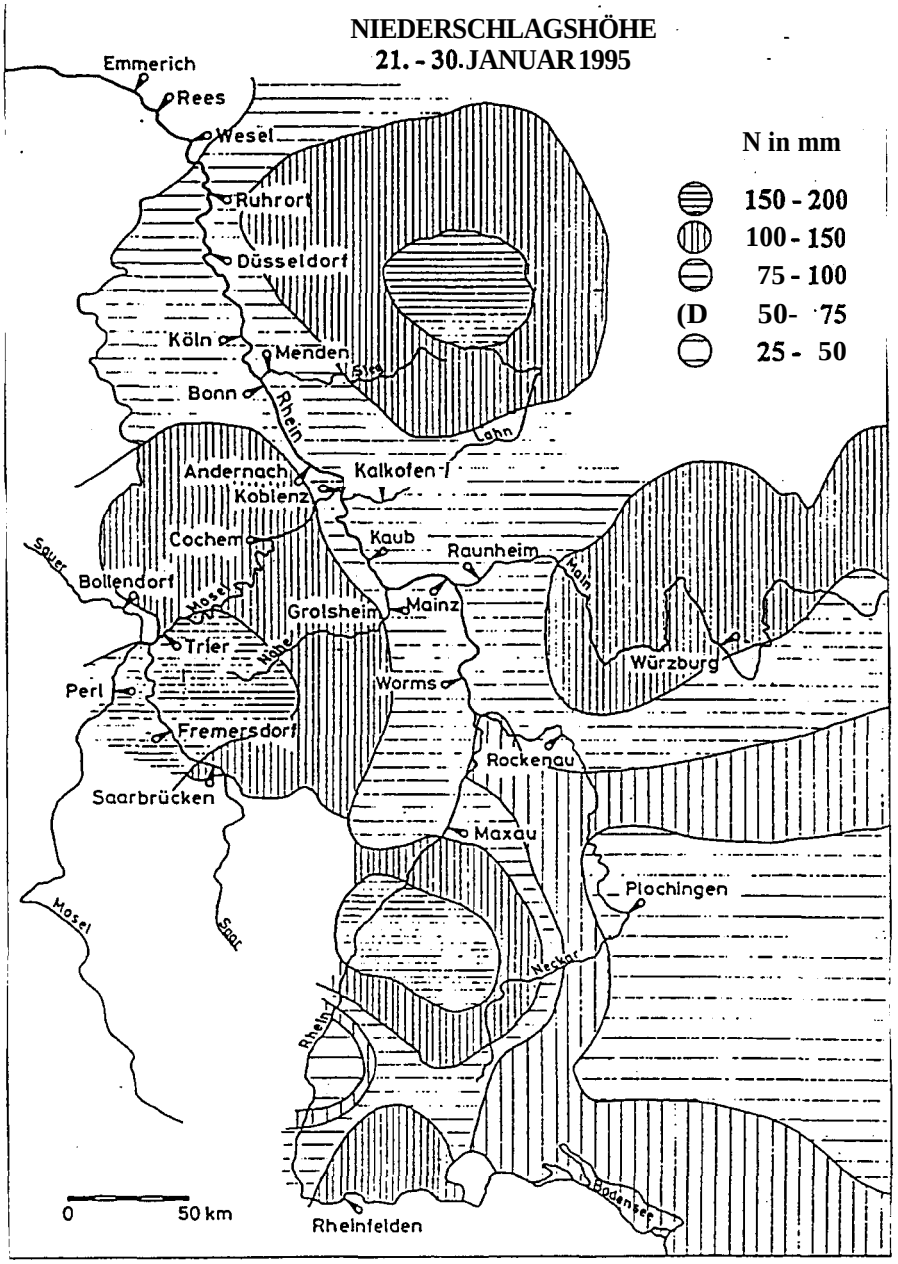
3.4 Chronology and events in 1995

3.4.1 The meteorological situation

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 rainfall lasted for 10 days and covered a huge area, including most of the catchment area of the Rhine (comp. figure 3.6). This combination of heavy rains, partially frozen grounds, or grounds already saturated by thaw and rain, and the precipitation over a wide area characterized the floods of January 1995.

Figure 3.6 Precipitations from 21 to 30 January 1995



3.4.3 The flood Situation

Since the floods of 1995 were not as severe as in 1993/94, in most places along the Rhine and its tributaries the damage figured half the costs of 1993/94. The High and Upper Rhine areas reported only minor damage. Koblenz escaped greater damage this time due to an earlier and better preparation. Moreover, the Moselle carried much less water than in 1993/94, while the flood waves from Rhine and Moselle did not combine at the same time. This left more time to the authorities and the population to organize the disaster response than in 1993. Cologne had to cope with an even 6 cm higher and a longer lasting peak of the Rhine flood wave. This caused the flooding of the movable flood barrier and the inundation of the old town centre once again. But due to a better preparation and timely evacuation, this time the damage was limited to just half the 1993/94 amount.

Damage was also reduced as a result of measures that had been taken since 1993/94 to improve flood control. North Rhine—Westphalia had allocated DM 75 million for dike reconstruction for the period from 1988 to 1997; and another DM 50 million for the improvement of dikes and the restructuring of riverbeds, biotopes and retention areas. In addition, DM 36 million are destined for dike building and improvement in the Kleeve area near the German-Dutch border.

The city of Cologne started already in 1987 with a long term waste water and flood protection concept (Abwasserkonzept 2000). Initially this plan concentrated on waste water management during riverine floods with levels up to 10m. After the floods in 1993/94 and 1995 revised estimates assume floods of 11.3m water-level for Cologne (probability of occurrence of once in a hundred years) and 11.9m once in two hundred years. The level of flood protection will be raised to 11.7m for most inhabited and floodprone areas, in some places eventually to a level of 11.9m. The step-by-step implementation of the new flood protection measures, which will take several years before being finished, is mostly due to financial restrictions.

Apart from projects concerning flood control, the municipalities of Koblenz and Cologne reacted to the threat of fast and high rising riverine floods by adopting a more flexible and autonomous management of the disaster response. This will be analyzed in further detail in chapter 5.

3.4.4 The two floods in review

In summary, the two floods were similar in some respects and differed in others. Both the 1993/94 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 1993/94, they were better prepared when the 1995 flood struck, anticipating the hazards and threats of the flood. Due to early preparations on the side of the authorities and the people, and the improved self-help and improvisation of the population, damages remained limited to approximately half the costs of 1993.

The public discourse on the causes of the flood differed in the 1993/94 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. Obviously, a shift of interpretation from natural to man-made causes took place. This shift has been subject of scientific and bureaucratic controversy. The Federal Institute for Hydrology (BfG) argues that meteorological and hydrological factors were primarily responsible for the floods. Man-made sealing of grounds is considered only a minor and not a decisive effect. The Federal Department for Environmental Affairs (UBA) 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 the "Flood—Control—Report" of the Enquete—Commission of Rhineland—Palatinate (20 September 1995). The politicians tend to follow the argumentation of the BfG. The media, the environmental protection organizations and a growing and concerned public incline towards the argumentation of the "Flood—Control—Report" and the publication of the UBA.

4 Risk communication

4.1 The organization of intergovernmental warning

In all states, the flood reporting or warning Service (Hochwassermeldedienst, sometimes Hochwasserwarndienst) 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 (Wasser— und Schiffahrtverwaltung des Bundes, 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. (In some states such information is accessible through electronic media).

Each state has its own provision for flood reporting (Hochwassermeldeordnung). 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 (Bundeswasserstraßengesetz §35 Abs.1) to maintain a water-level and flood reporting Service in cooperation with the single 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 WVS 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), Saarbruecken

(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.[3]

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).[4] In practice the water-levels have proven to be more adequate indicators for flood development. In both Cologne and Koblenz, the local water gauge (the "Kölner Pegel"; the "Koblenzer Pegel" resp.) 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. The major model in use is based on the water-levels (Sauer); the other major model is based on the summed discharges (Lahn, Mosel and Sieg). For the river Main a combination of both model is used. For the Nahe river a combination of a precipitation—run-off and a linear/non—linear flood wave models is employed. Whereas for the Neckar and the Saar different statistical filter—models are utilized introduced by the BfG in Koblenz. The Rhine forecasts are based on the filter—model, while all or a selection of the other models are utilized for the different Rhine sections. The forecasts for the Rhine and its tributaries by the BfG are based on the Multi—Channel—Filter—Model (MKF—Model) and information from sixteen selective water-level stations on the Rhine river (compare figure 4.1). The MKF-model takes into account the water-levels and discharges of all sixteen stations as measured every six hours (at 05.00, 11.00, 17.00 and 23.00), and includes information about changes in the water-level and discharges of the past three days.

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 modern. The water-levels at Speyer and Koblenz are only calculated up to 24 hours. The reliability of forecasting syste-matically 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.

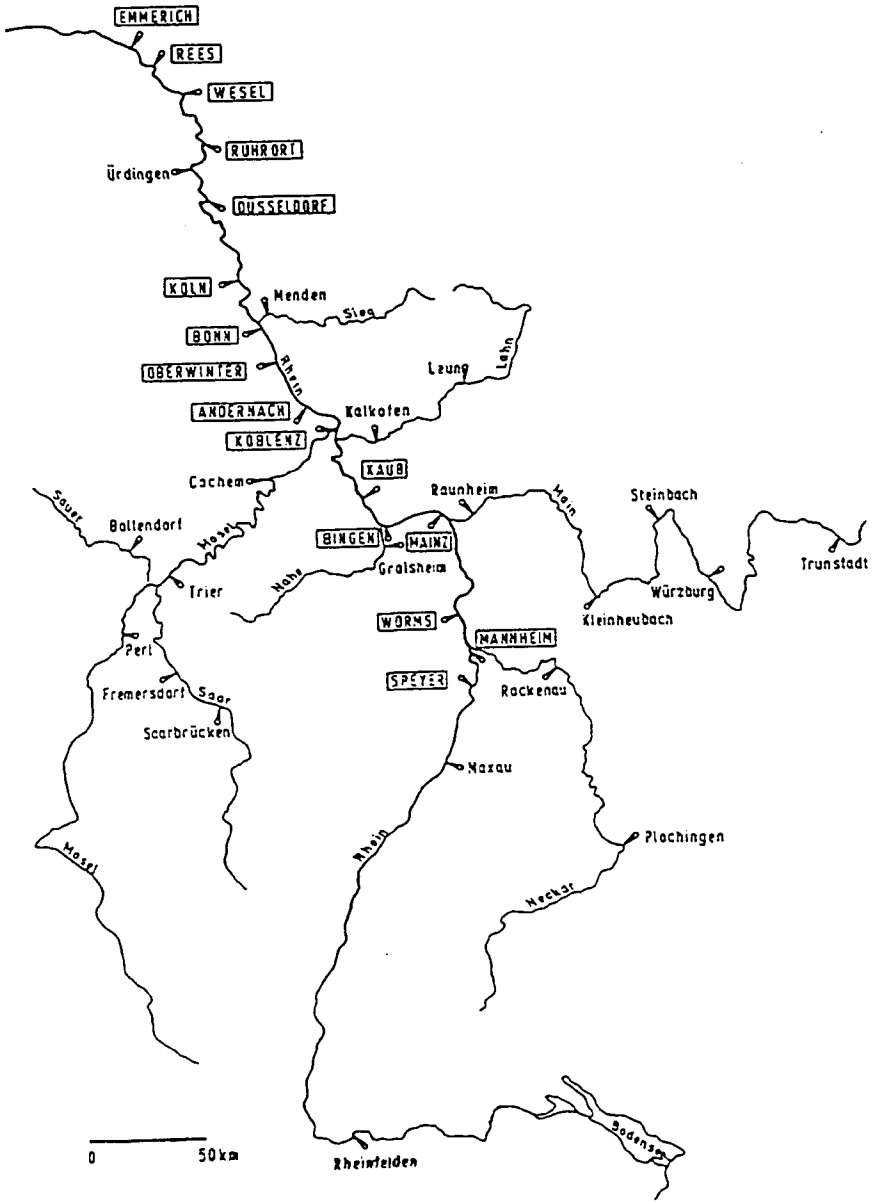
In this report, we focus on the state of Rhineland-Palatinate. The structure of the flood information Service and the warning to the public of Rhineland—Palatinate will be used as an example. In Rhineland-Palatinate, the flood information Service was introduced in 1986 and is regulated by the Flood Reporting Provision from February 1986 (GVB S.69/ Anlage 1). This provision covers the rivers Rhine, Moselle, Saar, Lahn, Nahe, Glan, Sieg, Sauer and Our. The reporting arrangement is based on §92 Abs.1 of the state's Law of Water from March 1983 and revised in December 1990. All details for the execution of the Flood Reporting Provision through the flood reporting centres are administered by the regional flood reporting plans. Rhineland—Palatinate has established the following three flood reporting centres to this end:

1. The Flood Reporting Centre Rhine at the Water and Navigation Authority Southwest in the city of Mainz which is responsible for the Rhine river;
2. The Flood Reporting Centre Moselle at the city of Trier which is responsible for the rivers Moselle, Saar, Sauer and Our;
3. The Flood Reporting Centre Nahe—Lahn—Sieg in the city of Koblenz, which is responsible for the rivers Nahe, Glan, Lahn and Sieg.

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 are 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 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.

Figure 4.1 Relevant water-level stations for the BfG forecast of the BfG (Bundesamt fuer Gewaesserkunde; MKF-model)



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; to the relevant involved municipalities via the flood reporting centres; and eventually when needed to the public by radio. The district authorities are obliged under the Fire and Disaster Act of November 1981 (GVBl S.247) 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 (see description in section 5.3 for Koblenz and in section 5.4 for Cologne).

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, i.e. the Cologne Water Gauge (Kölner Pegel) and the Koblenz Water Gauge (Koblenzer Pegel). 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 and based their decisions on the readings of local and relevant upstream water gauges.

4.2 The warning process

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 (before: German Federal Post), via television, radio or electronic media, like BTX, WWW (on PC via modem) or Videotext. All information is drawn from the same sources to avoid, or at least, to minimize the chance of contradictory forecasts and confusion on the side of the public/governmental reporting Services which subsequently could lead to confusion and feelings of insecurity of the general public.

In the state of Rheinland—Palatinate, flood information is reported or made available to the districts, municipalities and the public, as soon as local water-levels rise above a certain "reporting—level" at one or more of the water gauges. The reporting—levels are chosen in such a way that

early warning is possible, leaving sufficient time to districts and municipalities to take adequate flood protection measures. Bulletins about means of information on floods and forecasts are disseminated in the daily newspapers by the flood report centres. Up to date information is made available via:

1. Telephone Information Service (with the resp. Tel.—No.)
2. Videotext from the regional TV—stations
3. Screentext on the PC via modern (BTX—page of the Ministry of Environmental Affairs)
4. Radio news from the regional radio stations (through five different programmes)
5. The staff of the flood reporting centres through telephone-desks when sufficient manpower is available.

In Rhineland—Palatinate the reorganized flood information Service, revised after the 1993/94 floods, and the different ways of information dissemination during the 1995 floods were well received by the public. The Telephone Information Service registered about 430,000 calls during the flood events, with about 250,000 calls just for the area of Trier (Moselle). The BTX—pages were requested about 30,000 times and the Videotext was in high demand as well due to information from the regional television organization, the Suedwestfunk.

4.2.1 The warning process of 1993/94

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.

Along the minor waters no flood report Services are installed. In these areas the local authorities have to provide the population with local information gathered by local Services. In these cases the information given by flood report Services is only complementary.

The 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.

4.2.2 The warning process of 1995

On Monday 23 January 1995, the flood reporting Service for the Rhine River was established at 07.00 in co—operation 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 (first flood Situation report for the Rhine on 23 January 1995, 11.00).

The flood reporting service was active around-the-clock starting on 25 January 1995, in response to the fast rising water-levels and hazardous flood waves. Not before 1 February 1995, the flood danger abated and the staff of the reporting Services could shift to regulär working hours. During the flood, an additional flood report besides the regulär daily report was prepared and disseminated every evening. Already on 25 January 1995, a 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 during the period from 23 January until 3 February 1995 for the Rhine section in Rhineland—Palatinate. The flood Situation reports used forecasting periods of 24 hours for the Rhine, because longer forecasts would be less reliable given the present state of technology.

In the state of Rhineland—Palatinate, 23 water gauges are run by the state and 40 water gauges are operated by the federal authorities which are equipped with automatic data-read-and-transfer- technology. The data is gathered at the flood reporting centre in Mainz which uses the "Water—management Information System Kister (WISKI)". This information System has proved its worth and it is scheduled to be implemented at the flood reporting Services in Trier and Koblenz as well. The Enquete—Commission of Rhineland—Palatinate, which investigated the state flood control System, declared that the number of water gauges was sufficient, but if possible, more stations should be equipped with automatic data—read—and—transfer—technology to form part of a

statewide automatic information system.

Furthermore the flood information system of the state is to be linked to the weather—radar—system of the German Meteorological Service (DWD) which is currently being build. In addition, an automatic precipitation data system has to be established and linked to the radar System in Order to quantify the radar based weather data. This would allow the integration of more accurate precipitation forecasts into the flood forecasts.

4.3 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" ("Hochwassermerkblatt") which informed 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.

Especially the "flood instruction leaflet", which was distributed to the public of flood-prone areas by the municipalities of Cologne and Koblenz, gives detailed information on critical water-levels, measures to be taken to secure safety, especially with regard to persons in need of care (for instance sick or disabled people), and how to secure buildings, oiltanks, cars etc. It also gave information on protective self-help and how to equip a household in the case of a breakdown in public supply. Furtermore, it listed the major official sources of public information which are available in the city of Cologne:

1. Various telephone information Services:
   - the Flood Control Centre of Cologne for information on all kinds of (self-)protective measures;
   - the automatic water-level announcements;
   - information and aid by the public suppliers like the power stations, the water- and gasworks;
   - information on boat Services in flooded areas.

2. Information on regional and local FM radio stations and their frequencies (WDR II and Radio Cologne) which report hourly on water-levels and direct threats to flood prone areas.

3. Water-level information on TV via Videotext in three nationwide and regional programmes (ARD, ZDF and West 3 with special video pages).

In addition, the municipalities of Koblenz and Cologne put up posters with the above information in flood prone areas at visible places to attract the attention of a maximum number of people affected. 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 1993 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, shortage of food or other supplies.

4.3.1 The organization of the warning process

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 Operation centres were made waterproof by installing them above the flood level, and the number of telephone lines was increased.

Similar to other countries, the information Services available can be differentiated into "active" and "passive" Services. Taking the view of the authorities, "passive" Services like Videotext on TV, BTX on PC, or other electronic media are much more detailed and regionalized than "active" Services like (special) news via FM radio or TV. Moreover, passive Services are much more convenient in terms of temporal accessability and

individual feasibility. Active Services, particularly news-programs on radio and TV depend on broadcasting-schedules and -policies with the likely result that a great part of the public will not be reached in time.

The mass media constitute an important source of information. This important role is not related to the quality of the information the media provide, but to the extensive spreading of the hardware (TV-sets, radios). Analyses of the media coverage of disasters indicate that the media tend to subjugate information and prioritize commercial interests. Often information is transformed into infotainment. Some officials of the Disaster Relief Organizations reported about cases where the media cut down information which should have been broadcasted in full length.[5]

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. It seems that future information has to be "convenient information": actively retrievable, accessible at any time, and ready for Computer use opening opportunities to störe, process and print the information.

Apart from the information which was communicated to residents through electronic channels and the mass media, three other information flows were important:

1. Person-by-person information (formal and informal);
2. Informal networks (relatives, neighbourhoods);
3. Local information (information posters and leaflets; notice boards; news papers and special editions).

4.4 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 about the floods. The above mentioned transformation of facts into infotainment together with the tendency in some cases to sensationalize 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. Sometimes the regional media, but mostly the national news presented rather sensational news with a tendency toward infotainment. Purposeful animation of disaster tourism by the media was considered to be the exception and a non intended side effect.

In the city of Koblenz a private TV-Channel offered during the flood events of 1993 "disaster rides" with rubber dinghies for DM 20 per person. As "highlight" of the ride, the Channel offered to dive down into flooded homes and dwellings in diving-suits. This caused irritation and annoyance on the side of the authorities, the relief forces and the majority of the public. The problem was forwarded toward the media council (Rundfunkrat), a voluntary independent institution of the media which watches over the observance of ethic Standards. Additionally politicians and officials discussed the imposition of severe fines (up to DM 10,000) to deter disaster tourists and unscrupulous journalists. The normal fine for hindrance or obstruction of disaster response forces is DM 200 in Koblenz. Disaster tourists were summoned with the severe fines which proved to be efficient to handle most of the unfavourable situations.

No similar incidents have been reported, other than the detection of a few ruthless disaster tourists, who actually tried to Sabotage flood protection devices. A large majority of the estimated 6.000 disaster tourists in Cologne were harmless on-lookers. Nevertheless in Cologne, they were not allowed near the mobile flood protection wall any more, after it had been observed that some of them had tampered with the fixing of the structure, presumably to produce a flood (compare section 5.4.1).

The causes for this new type of "active" disaster tourism are attributed to some extend to the type of news coverage, especially by the TV stations which give sensational reports rather than solid information and warnings against possible threats. This form of infotainment promotes many distant TV spectators to come to the scene and to experience the disaster as a real life show. But for some of them their expectations were fuelled by sensational reports and not met by the actual events on scene, guiding them to initiate the "real" disaster, they came to see anyway.

The increasing public interest for such events and the increasing number of "active" disaster tourists demands new coping strategies. Normally there are not enough police or other Services to hold back large numbers of disaster tourists. During the fast rising floods of 1993, the disaster tourism crowded many of the narrow streets in Koblenz and Cologne which often prevented the prompt deployment of the disaster response units. In 1995 the floods were not rising as fast as in 1993, leaving

more time for the deployment of the personnel and preparation of needed measures. The news were also less sensational due to the slow "progress" of the floods. All this helped to reduce the immediate pressure by disaster tourists. But additionally in 1995 the approach routes for the disaster response units were closed for other traffic at an early stage and parking and blocking cars or other obstacles were removed well ahead of the time.

4.5 Conclusions

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 problems and to make the best out of a bad 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 on—site 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 co—responsibility 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/globalwarming, 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. The public is increasingly adopting a point of view which acknowledges the human factor to be primarily responsible for the occurrence of disastrous events.

As a consequence of the floods, several improvements of the public Information System have been planned. In Rhineland— Palatinate, for example, the immediate transfer of the flood reports via data link from the flood reporting centres to the radio stations will be improved to avoid time lags and the spread of false Information on behalf of the media, and to give more time to the communities and the people affected for response. Furthermore, the water-level information will be supplemented with information about development of the water-levels.

Another improvement concerns the ability of the flood reporting centres in Mainz, Koblenz and Trier to work directly on the BTX—pages and thus fasten the updating of the flood information. The Videotext System of the regional TV—organization will be increasingly utilized while direct access through the three flood reporting centres is also planned for. In case of a power failure, the local newspapers are supposed to put up bulletins with the necessary information at similar and well-known places, and in a highly visible manner.

Information on the general Situation and measures to be taken by the police, fire brigades, disaster response units and other organizations are made public either by bulletins to the local and regional press, or other media. Mayors, local officials or other responsible persons give interviews to the media, hold press Conferences and visit the disaster areas. This personal involvement of authorities was generally accepted and helped to enhance the confidence of the people affected and their sense of security.

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 distributers 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 co-ordination 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: the organization of rescue force

5.1 The German organization of disaster response

The System of disaster relief is basically executed by the regional authorities, which comprises the districts (Kreise), the municipalities (kreisfreie Städte), and the administrative areas (Regierungsbezirke). In case of a disaster, the disaster response is organized from the bottom up. Only if several districts are simultaneously struck by a disaster, state government will intervene and establish a state-level disaster management centre.

The primary disaster response units and installations are situated on the communal level, i.e. the lower disaster response authority. These units are under the control of the Administrative Coordinator (Hauptverwaltungsbeamter (HVB); or the "Leiter der Katastrophenschutzbehörde"), who is, depending on the particular type of state administrative organization, either the director of the district (Oberkreisdirektor), the district president (Landrat), the town clerk in chief (Oberstadtdirektor) or the mayor (Oberbürgermeister).

The Administrative Coordinator is responsible for disaster response planning, which comprises the organization and structure of disaster management, the warning and alarming procedures, and the organizations involved and their specific tasks during a disaster. The Coordinator is also responsible for the control of the preparedness of the disaster response units and the actual disaster management.

In case of a mass emergency the local fire chief (Orts—/ Gemeindewehrführer) is responsible for on—site emergency management, being familiär with the local geography, infrastructure, population, dangers and resources available for emergency response and management. When a mass emergency exceeds local resources the regional fire chief (Kreiswehrführer) takes over.

The decision to declare a disaster is made at the district level, represented by the Administrative Coordinator. After a disaster declaration has been issued, the Administrative Coordinator (HVB) takes command.

Usually, the HVB will leave the on—site management to the regional fire chief, who 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 (Technische Einsatzleitung, TEL). Although in all German states this model for disaster response is followed, the names of the actual co-ordination and Operation centres may differ among the different states.

Only in case of an extraordinary disaster threat, the Administrative Coordinator will establish a local disaster co-ordination centre with a disaster management staff, in which the expertise of different agencies, organizations and Services is brought together. The disaster management staff comprises representatives of communal agencies like (public) transportation, roads and construction, health, water supplies and sewage, gas and electricity etc., the rescue Services (described in section 2.2), and national organizations such as telecommunication, railroad and army. The Administrative Coordinator is also supported in the staff HVB 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 like the technical Operation centre (Technische Einsatzleitung, TEL) to add flexibility to disaster operations. These centres are supervised by the disaster management staff of the Administrative Coordinator (HVB). The staff HVB generally assumes the political and administrative responsibility for emergency management, including decision making and overall co-ordination, whereas the TEL is responsible for the tactical leadership and co-ordination of the actual disaster response units on the scene.[6]

5.2 **Disaster management: the actual response**

Since disaster response is initially a communal responsibility, we will closely look at the actual response of the cities of Cologne and Koblenz during the exceptional floods. Neither the states, i.e. Rhineland-Palatinate for the city of Koblenz and North Rhine-Westphalia for the city of Cologne, nor the municipalities of Koblenz and Cologne as lower disaster response authorities formally declared the state of disaster. In 1993 and 1995, however, the two cities did activate their disaster response forces and both cities received assistance from disaster response forces of neighbouring

districts in their states.

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 shifts are made from pre- to the disaster stage. Hence, lower disaster response authorities 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.

Large sections of the rivers Rhine, Moselle and Saar are not protected by dikes. This is the case for large cities like Saarbruecken (360,000 inhabitants), Trier (98,000 inhabitants), Koblenz (110,000 inhabitants), Bonn (295,000 inhabitants) and Cologne (955,000 inhabitants). Flood control in these areas is to a large extend left to the communities, municipalities or administrative areas. Normally floodpreparation includes alarm plans and operational plans which give clear instructions. In combination with Situation reports, the plans suffice to inform the population and the response forces how to cope with the Situation.

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.

After the flood of 1993, the authorities in Cologne prepared a long-term program to improve the flood control System. Since a flood on a similar scale was not expected so soon, i.e. 1995, it was not deemed urgent to raise the flood protection level. Due to tight budgets, only the old dikes were immediately repaired or rebuilt. Improvement of retention areas is a time consuming process which takes several years, since political bargaining and compromises between the different communities and the

state are needed. Furthermore, the various ministries involved, especially the Ministry for Agriculture and the Ministry for Environmental Affairs, as well as the private property owners (particularly farmers along the river banks) have to reach an agreement on the joint projects. With regard to the administrative and organizational aspects of flood management, several measures were taken. In addition, the personnel capacity of the coordination centre in Cologne was improved. Also, the disaster response organization was decentralized to form local and autonomous Operation centres (AFüSt) for single town districts along the river bank.

In Koblenz, the authorities improved the communication infrastructure, i.e. radio and telecommunication. The telephone lines were repositioned several meters above the water-level of the flood. Power lines and distributers were made waterproof against groundwater. As in Cologne, the disaster response organization was decentralized to allow for a more flexible handling of the different demands in the single town districts, many of which were isolated by the flood. Out of precaution, material like sandbags, gangplanks, pumps etc. were stored in the town districts instead of central storing places.

During the floods in January and February 1995 the authorities and the people were much better prepared and aware of the possibility of unusual fast rising floods. Early precautions against floods and possible damage were taken, preventing much of the damage of two years before. However, the scale of the floods required the deployment of disaster response forces. During the 1995 flood, there were ca. 30,000 firemen, 2,000 members of the THW, 800 allied soldiers, 6,350 German soldiers, and 450 members of the Federal Border Police in action. Soldiers of the German Federal Defence Forces, remained stand-by in the affected areas for twelve days, from 22 January until 6 February 1995. The army fulfilled functions such as preparing sandbags, constructing temporary dikes, rescuing and evacuating people, operating a ferry Service with rubber dinghies and ferries, supplying cut—off people, 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 (Dornier 288 LM) 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 a newly tested and introduced ultrasound equipment, at the Dutch border, and at the confluences of the major tributaries of the Rhine, like the Neckar, Main, Moselle etc..

5.3 Disaster management in Rhineland-Palatinate

In Rhineland-Palatinate, the State Fire Protection and Disaster Response Act (Brand- und Katastrophenschutzgesetz (LBKG)) regulates competencies in case of a disaster. These acts are binding for the lower disaster response authorities. During the flood of 1993/94, the fire protection, general aid and disaster response in the municipality of Koblenz were the responsibility of the mayor or his representative as Administrative Coordinator (HVB). According to a decree (dated 24 January 1983) the actual operational disaster leadership and management is in the hands of the head or the representative of the professional fire Service of Koblenz, since the disaster response is regarded as an extension of the fire service's general duty of hazard protection. The overall responsibility rests with the HVB, respectively the head of operations. When deemed necessary, the mayor can take over command at any time. During the floods of 1993 and 1995, it was the head of the professional fire Service who acted as HVB.

The above mentioned decree delegates additional legal powers for disaster management to the HVB. Under this decree the HVB is authorized to issue instructions to the communal offices and Services like those for (public) transportation, roads and construction, health, water supplies and sewage, gas and electricity etc., and the rescue Services as described in section 2.2, without needing a disaster declaration. The cooperation with the telecommunication Service (Telecom), the German railroad (DB) and the army is excluded from this provision and is not placed under direct supervision.

The State Fire Protection and Disaster Response Act also obliges the rescue Services to cooperate as an integral part of the disaster response force. These Services have to send representatives and experts as advisors to the staff of the HVB and are obliged to follow the instructions of the HVB, his representative or subordinate leaders. Under the LBKG, the

German army is obliged to give aid to the lower disaster response authority (i.e. the HVB), when the HVB declares a "mass emergency". Although the army does not have to subordinate its forces to the HVB, it has to send a representative to the staff of the HVB and has to cooperate with the disaster response force. Due to good personal relationships of the HVB and the local army commanders in Koblenz, the army in practice subordinates its forces to the staff HVB voluntarily to improve the deployment and cooperation of the disaster response forces. The possible deployment of Allied Forces is ruled by additional acts which Supplement the Disaster Response Act.

Since the LBKG of Rhineland-Palatinate does not provide for a declaration of "disaster", the HVB 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 has to be seen as an intra-administrative and formal procedure. Such declaration is not needed to set free legal powers to take measures concerning the flood or disaster response. The authorities in Koblenz unofficially used the term "State of Disaster", mainly to facilitate the communication with the media and the public.

5.3.1 **Flood response in Koblenz** 1993/94

The flood and disaster management in Koblenz (under the LBKG of Rhineland-Palatinate) and the actual "management system" are described in the Service regulation 12/1 (Feuerwehrdienstvorschrift 12/1) "operational management" of the fire Service.

The disaster coordination centre is structured according to this regulation which lists the following participants:

Representatives of the fire Service:
- The Head of Operations (head of the office for fire protection and disaster response)
- S1 Personnel and internal organization
- S2 Situation Report (analysis and assessment)
- S3 Tactical Operation Management (co-ordination)
- S4 Logistics (equipment, material, provision)

Representatives of other Services and offices involved:
- The three heads of the disaster management areas of Koblenz
- German Defence Force

- German Red Cross
- Malteser Hilfsdienst (ambulance and rescue Service)
- Technisches Hilfswerk (Federal Institution for Technical Aid)
- Police
- Telecom (telephone and communication service)

City offices and departments:
- Social Service
- Construction Office
- Transport Office
- Public Transportation
- Power Plants and Gasworks
- Garbage and Sewer Service

The Operation or management System as described by the service regulation involves three main dimensions:
- the organization of management (organizational structure)
- the Operation of management (mobilization of various Services; actual operations)
- the resources for management (infrastructure, communication)

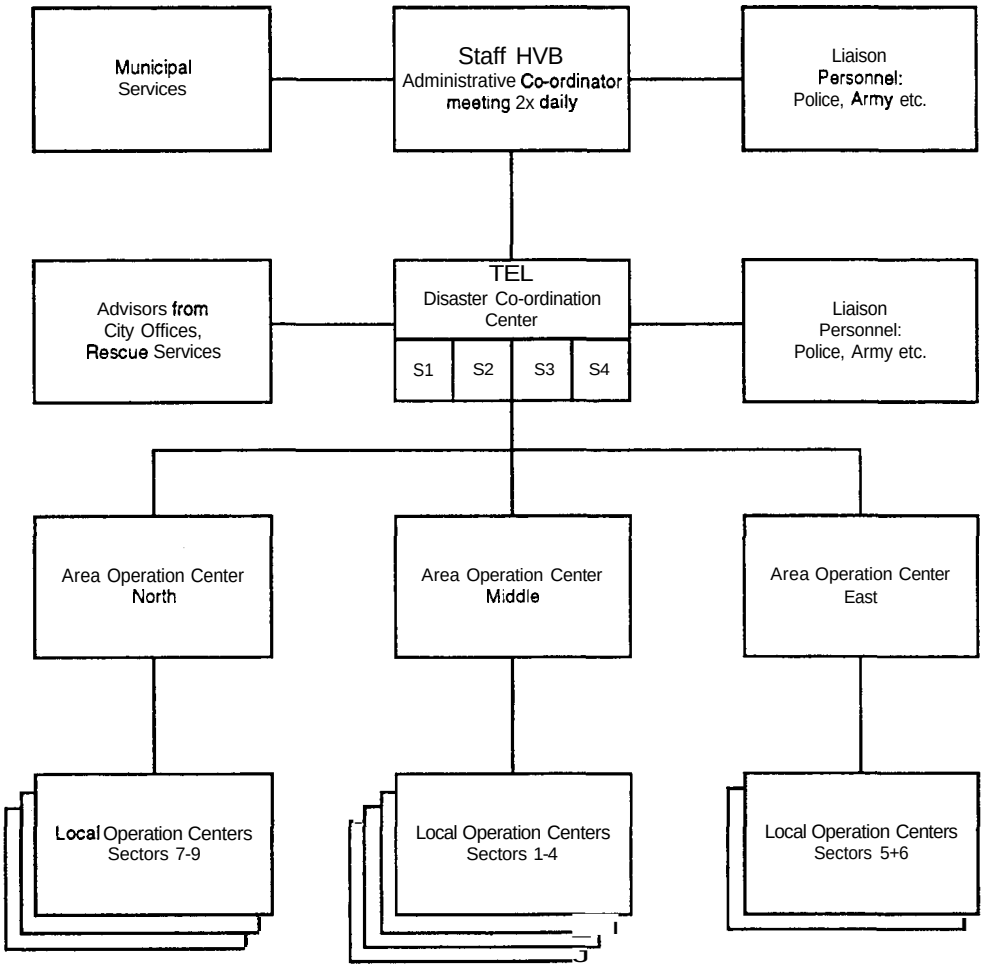
The organization of management involves the type and division of the management levels, their coordination, as well as the distinct responsibilities of the different levels and heads of Operation. During the 1993/94 floods, the administrative coordinator met with the Staff HVB twice a day. During the staff meetings, the HVB consulted with the representatives of the city offices concerned (see above) and the rescue Services, liaison personnel of the police and the army, and the heads of the TEL and the area Operation centres who delivered a Situation report. In the staff HVB the decisions were taken on political and administrative matters of disaster management.

The actual disaster coordination centre (TEL) executed and implemented the staff decisions. The TEL was situated in the same building as the Staff HVB. It is modelled according to the federal structure involving the head and the advisors from the city offices and the rescue Services, and the S1 to S4 officers. This organizational structure resembles the one of the army staff.

The S1 is in charge of personnel management and intra-organizational coordination (staff and leadership). The S2 is responsible for situational reports. This official has to analyze the Situation, assess the development

of the events and present the situational report to the HVB and his staff. The S3 coordinates the tactical inter-organizational operations, i.e. the deployment of the disaster response units, while the S4 takes care of the logistics, i.e. the supply of provision, equipment and material (compare figure 5.1).

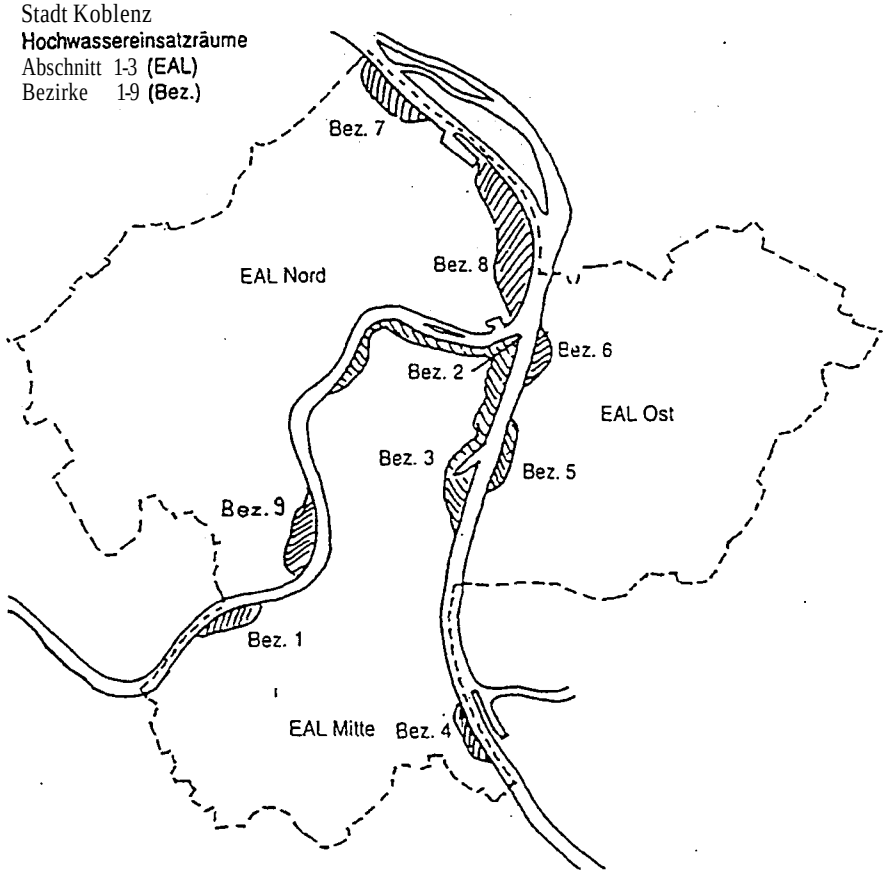
Figure 5.1 Flood response organization in the city of Koblenz



Subordinate to the TEL, three area Operation centres (North, Middle and East) function, representing the three basic parts of Koblenz, which are naturally separated by (the confluence of) the Rhine and the Moselle (see figure 5.2). The area Operation centre North covers the area north of the

Moselle and west of the Rhine, while the area Operation centre Middle covers the area south of the Moselle and west of the Rhine (the city of Koblenz, also the location of the Staff HVB/TEL), and the area Operation centre East covers the eastern side of the Rhine. These areal centres basically resemble the internal structure and functions of the TEL. Most of the time these areal centres operate autonomously, since they are not part of the Staff HVB/TEL (two centres are separated by the Rhine river and the Moselle); and the centres are closer to the site of action and thus able to react faster and more flexible.

Figure 5.2 Stadt Koblenz



The local Operation centres are subordinate to the area Operation centres and responsible for sectors (town districts) within Koblenz. The sectors 1-4 are assigned to the area Operation centre Middle, the sectors 5 and 6 to the area Operation centre East and the sectors 7-8 to the area Operation centre

North (compare figure 5.1). These nine local Operation centres organize the actual deployment of the disaster response units; they take care of the actual supply and provision of the rescuers and the population concerned.

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 areal Operation centres and field units were cut off from up to date information on the flood development and available resources. 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 organized 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. The forecasts in 1993 were sometimes of low quality due to the unusual weather Situation. In 1995 the forecasts improved and were reliable for a 24 hour period, containing very precise prognoses for up to 6 hours.

During the Operation of management, the gathering of information in the Staff HVB and the Operation centres; the analyses and the Interpretation of Information; the actual decision making and the issuing of Orders to the deployed disaster response forces are conceived of as a circular process of information, judgement, decision making and action. This process is supported by the communication infrastructure, which allows for data transfer; collecting and processing data for decision making and fast responses to current developments.

The major means of communication are "waterproof" reserved telephone lines between the Staff HVB, the TEL and the area Operation centres plus FM radio sets and walkie-talkies. During the flood events of 1993, the Underground telephone lines became unusable due to floods 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 'criticaP 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 the 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 of the drafted army personnel was discharged before Christmas and others were on holidays as well. This lack of personnel caused problems. Therefore 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 German army was delayed too, since with reduced personnel the army had to secure its own material first. Additionally, there was a 40% increase of regulär 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, increased by the flood wave of the upstream confluence of the Lahn. Large portions of Koblenz 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. The power failure was mostly due to Underground power cables and unprotected power distributors. Food supplies were spoiled because of the failure of the refrigerators and freezers. Moreover, there was no heat and light due to the failure of the flooded and/or electric heating Systems. Many tanks containing heating oil were flooded. 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.

In Koblenz 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 evacuated. Many officials and journalists expressed their surprise about the great solidarity of the people and their willingness to help whether they were affected by the flood or not.

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 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, 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 disaster coordination centre focused on political and administrative problems and decision-making. Only in cases of an emergency political or administrative decisions were made by the head of operations of a lower Operation centre. The Operation centres were located in public buildings, schools or stations of the fire brigades.

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 handies. 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. As a result of the breakdown of ca. 7,000 telephone lines due to floods and the rise of the groundwater, the disaster management had 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 disaster response force. This made communication impossible until the fire service lent several of its own radio sets to the army.

The spectacular events and the obvious response problems attracted

massive interest of the media. Most disaster response forces were unprepared for this aspect of a disaster, with reporters and camera teams "invading" the disaster areas and competing for live Interviews with the responsible heads of Operation on the scene of the action. The rush took officials by surprise and many of them had to spent up to 70% of their valuable and limited time to answer questions to reporters, at the detriment of their own duties.[7]

Likewise, the work at the disaster response forces was severely impeded by disaster tourists who in most cases were attracted by the sensationallst news coverage of the flood events. For instance, the construction of gangplanks for the inhabitants throughout the flooded parts of the town proved to be something of a Trojan Horse, 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 just went through the streets, which had become streams, with their small boats. Barriers had to be erected against disaster tourists, as these tourists blocked the narrow access roads.

5.3.2 Flood response in Koblenz 1995

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 on-site. Decentralization avoids unnecessarily detailed communication with the superior levels, which inhibits a fast and adequate reaction to local problems. Another advantage is minimization 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, so

problems no longer occurred with telephone communication and the emergency telephone line.

In 1995, a press office was established to keep all journalists away from the heads of Operation or 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 and reduced media-pressure on the responsible authorities and rescuers on site.

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. Only minor criticism of the precautions taken by the city government was ventilated by some inhabitants of Koblenz.

The construction of gang planks 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 1993/94.

The flood levels of 1995 rose slower and did not reach as high as in 1993/94, 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 in Koblenz, 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, which is a board of representatives made up from different societal groups and watches over media ethics, was appealed to. 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.

The inhabitants were busy to cope with the flood, especially the people of Neuendorf, a part of Koblenz which was struck the hardest by the flood. Here an emergency action organization was founded within the neighbourhood which cooperated in an exemplary way with the disaster response units. The ad-hoc organizations had agreed as a "convergent group" to be integrated into the command structure of the disaster response of the respective sector, and thus became "disaster response helpers" with the Status of volunteer firemen. 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.

Prior to and during the 1995 flood, the authorities, the disaster response forces and the population proved to be much better prepared and to be more aware of the threats of a riverine flood. The revised alarm-plans allowed for an earlier and swifter response at relatively low water-levels, while the disaster response shifted towards prevention. The restructuring of the disaster response, with a stronger emphasis on locally independent operating disaster response units, together with the improved communication infrastructure and the availability of abundant equipment and frequencies, allowed for better leadership on-site and coordination in the Operation centres.

5.4 Disaster management in Cologne (North Rhine-Westphalia)

No major floods had hit Cologne in the first 35 years after the second world war. This gave its inhabitants a misplaced feeling of safety and satisfaction with concern to the existing 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 of Cologne decided to raise the flood protection level to 10m. This political 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 assessments and reports made for the upstream water gauges of the Rhine and its major tributaries are used to make forecasts for the Cologne Situation. The following procedure of the flood protection and response depends of the water-levels of the Cologne Water Gauge (KP).

Rising waters and the flooding of the embankments of the Rhine are normal along the Rhine. Only when the river reaches a height of 4.50m at the Cologne Water Gauge (KP) precautionary measures are taken, mostly to protect the sewer system and to prevent spillage.

The Flood Protection Centre (HochWasserSchutzZentrale (HWSZ)) acts as a basic coordination unit for flood management in Cologne up to a level of 10.70m KP. The HWSZ is part of part of the Department for Sewage Treatment of the City of Cologne. Its permanent staff of the HWSZ is made up of representatives, mostly administrators, of the municipal Services which are responsible for flood management. These Services comprise the Office for Sewage Treatment (sewage treatment,

activating and heading the HWSZ); the Transport Office (gangplanks, 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, co-ordination 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, gangplanks and pumps). Additional Services can also be involved, depending on the development of the waterlevel (KP), 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 5.3).

There exist a ränge of situations from "routine" flood management to disaster management, when the deployment of disaster response units is not yet necessary, but regulär resources and structures for efficient management are insufficient. To cope with such situations mobilization of staff and integration of other municipal Services and offices into the Flood Management Staff is needed (see figure 5.4). In practice, when the old town centre is flooded, the HWSZ is enlarged to a "Flood Crisis Management Staff" (Stab Außergewöhnliche Ereignisse, SAE). The mobilization of the staff, i.e. the permanent staff as well as the additional Services, is mostly 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 floods.

Figure 5.3 Flood response organization in the city of Cologne at waterlevels of 7.5m KP or above

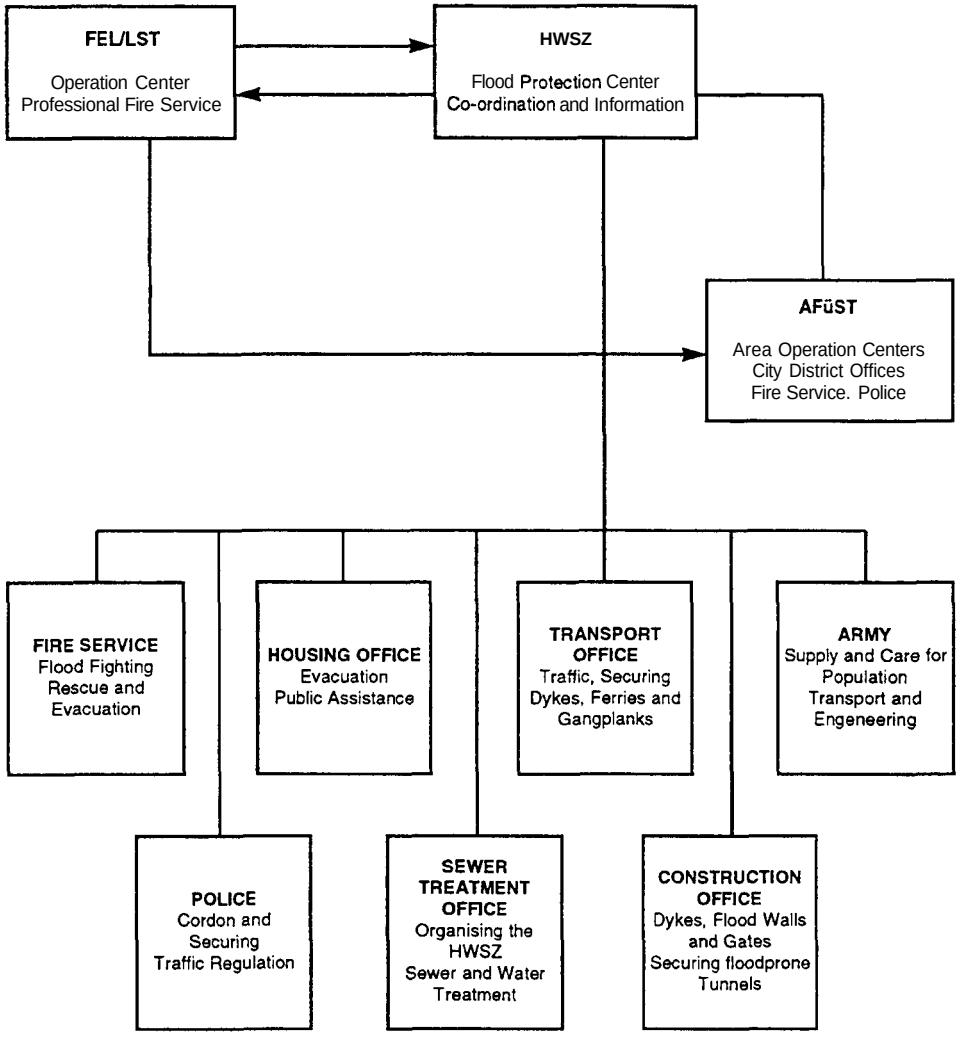
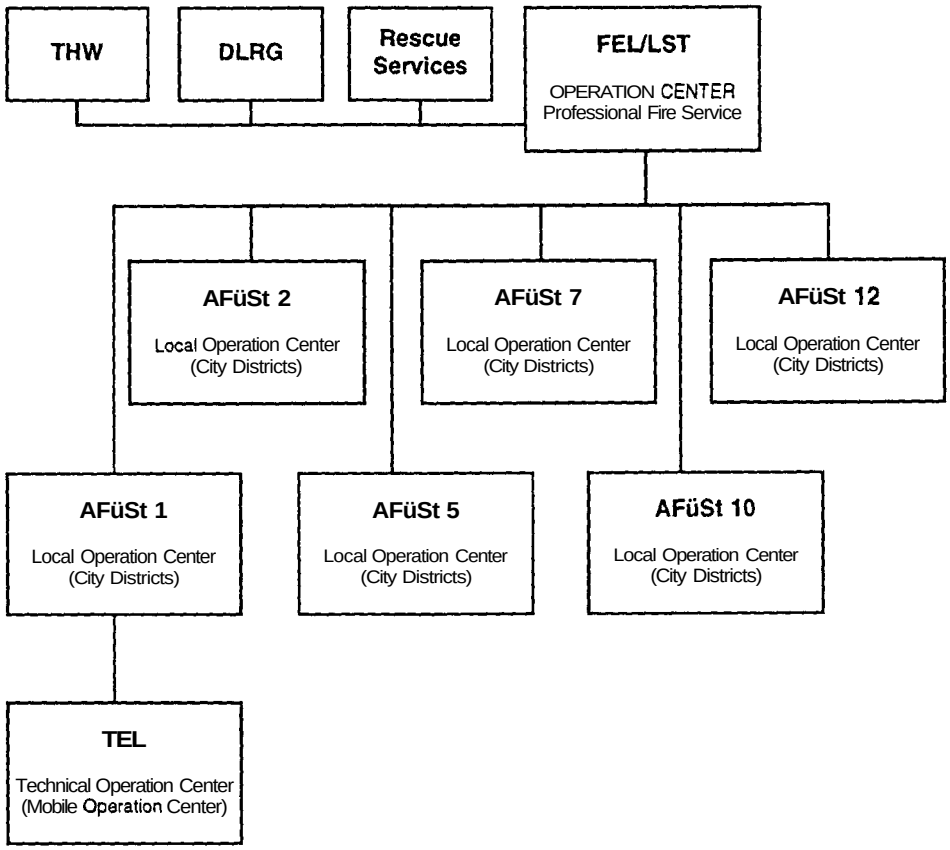


Figure 5.4 Organization of Operation Centers for Flood Response in the city of Cologne



The HWSZ coordinates the flood management at the administrative level and is responsible for political decision making. Parallel to the HWSZ, the operational coordination of the response forces, i.e. the fire and rescue Services, the THW and the police is shaped by the Operation centre of the Professional fire Service of the City of Cologne, the "Leitstelle Berufsfeuerwehr" (LST). 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 LST is renamed "Feuerwehr-EinsatzLeitung" (FEL), i.e. fire service Operation centre. The FEL staff is based on the former federal model of the HVB staff, which is similar to the disaster coordination centre in Koblenz described above. The LST resp. the FEL are connected with the HWSZ via reserved telephone lines and a liaison officer of the LST/FEL (professional fire service) to secure a continuous communication

flow.

Six local Operation centres (AbschnittFührungsStellen, AFüSt) in the different town districts along the embankment of the Rhine operate subordinate to the LST/FEL. These centres are accommodated in the local fire stations, except for the AFüSt 1 which makes use of a mobile Operation centre placed in a special command vehicle. The latter are called technical Operation centres (Technische EinsatzLeitung, TEL). These TELs operate mostly autonomous and are responsible for the deployment and Provision of their own personnel as well as the assigned personnel from outside Cologne. The TELs communicate frequently with the LST/FEL staff to update Situation reports and to give information to the logistic coordinator for the restock of personnel, provisions and resources.

The level at the Cologne Water Gauge reached 10.63m in 1993 and 10.69m in 1995. In case of higher rising water-levels, the state of disaster would have to be declared. This could have caused communication problems, because in such a case the overall co-ordination of the flood management would have been transferred from the SAE to the FEL in the renamed disaster protection centre (KatastrophenSchutzLeitung, KatSL). The head of the KatSL is the HVB, which is the director of the city administration of Cologne. From 1998 onwards, the Mayor of Cologne (the political head of Cologne) will act as head. After the state of disaster would have been declared, many of the SAE staff would have had to move from the Office for Sewage Treatment downtown Cologne to the KatSL which is accommodated in the fire Station 5 in the north of Cologne. This move would have taken about half an hour and some reorganization effort. The SAE would then have become a AFüSt under the control of the KatSL with the special administrative co-ordination tasks for the municipal offices and Services. The KatSL would have been granted the authority to issue instructions to all the involved municipal offices and Services, as well to the disaster response units of the different organizations and Services involved.

The following section shows major elements of the organization of the flood response, as described in the alarm plan which is attuned to the water-levels of the Cologne Water Gauge (KP):

- 5.50m KP: Information and assessments are passed permanently from the flood protection centre (Hochwasserschutzzentrale, HWSZ) to the Operation centre of the Professional fire Service (Leistelle Berufsfeuerwehr, LST).
- 6.20m KP: Flood Mark I, restrictions on river navigation, checks for the professional and volunteer fire Service concerning flood preparedness.
- 6.50m **KP:** Fire brigades of endangered areas prepare for action and set up their staffs for

the local Operation centres (Abschnittsführungsstellen, AFüSt).

- 7.50m KP: Liaison personnel joins the HWSZ and keeps permanent contact with the LST; the staff "Flood" joins and takes up its work; the THW is activated (just staff).
- 8.30m KP: Flood Mark II, total closing of the Rhine for river navigation; LST is at full strength or reenforced and alarms the personnel of the FEL (Feuerwehreinsatzleitung) which is the extended staff LST for flood management.
- 8.75m KP: Check of the public emergency telephones in endangered areas; where necessary additional communication hardware is set up; report on the Situation to the LST.
- 9.00m KP: The FEL is at full strength and begins to work in the rooms of the Operation centre of the disaster response of the City of Cologne in the fire Station 5 of Cologne. At this time those parts of Cologne which are endangered by the flood are subdivided into eight sections with a local Operation centre (Abschnittführungsstelle, AFüSt) each; these AFüSt are operating independently and they form the centre of action; their staff is organized in the same way as the FEL and they are directly subordinate to the FEL.
- 10.00m KP: Flooding of the flood protection System of the old town centre. The HWSZ is extended to a "Flood Crisis Management Staff" (Stab Außergewöhnliche Ereignisse, SAE).
- 10.70m KP: If there is evidence that major parts of the city will be flooded within the next 48 hours, or if whole town districts are flooded due to unusual events, e.g. broken dikes or the failure of other protective measures, it has to be decided, whether the state of disaster has to be declared.

The water-levels indicative for the disaster management activities have not been changed since 1993. No state of disaster was declared since the water-level at the Cologne Water Gauge remained below 10.70m. Only this local water gauge is relevant for the Cologne flood management and alarming. If there is evidence of very fast rising water-levels, the declaration of disaster is issued well before the level of 10.70m. If dropping water-levels are expected, the water-level may rise temporarily a few centimetres above 10.70m without a declaration of disaster is given.

5.4.1 Flood response in Cologne 1993/94

Already on 13 December 1993 the water-level of the Rhine increased rapidly. It reached a level of 6.13m KP (Kölner Pegel) on 15 December, but dropped during the following days. Due to the worsening weather the water-level started to rise again on 18 December with 2 cm per hour. Heavy rainfalls and the confluence of the Rhine with its waterloaden tributaries Moselle and Neckar upstream Cologne, increased the hourly rise to 11 cm. This fast rise of the water continued for four days.

On 22 December at 20.00, the Rhine reached the 10m level at Cologne

still rising with 5cm per hour. During the night from 23 to 24 December the Rhine reached its peak with 10,63m KP, which lasted from 22.00 till 07.00. Then the water-level started to drop at a rate of 1 cm per hour. From 25 till 31 December it dropped further at a rate of 3 cm per hour. At a level of 6m KP the water rose again. Two smaller floods of 8.17m KP on 5 January 1994 and 8.74m on 8 January 1994 followed. On 13 January the Rhine returned to its original river bed and the people of Cologne could sigh out of relief.

The Flood Protection Centre (HWSZ) at the Department for Sewage Treatment (Amt für Stadtentwässerung) started to operate on the morning of 13 December 1993. The HWSZ 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 5,500 phone calls were received in one day. Additionally the centre coordinated measures that were taken by the Department for Sewage Treatment at the different water-levels.

To optimize the cooperation and coordination between the HWSZ and the fire service at high water-levels, the professional fire service placed one liaison officer in the HWSZ staff at all times. 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 waterworks 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 the professional fire service of Cologne. In the beginning problems occurred with the radio communication, since there was only a limited number of preset channels available for the radios and

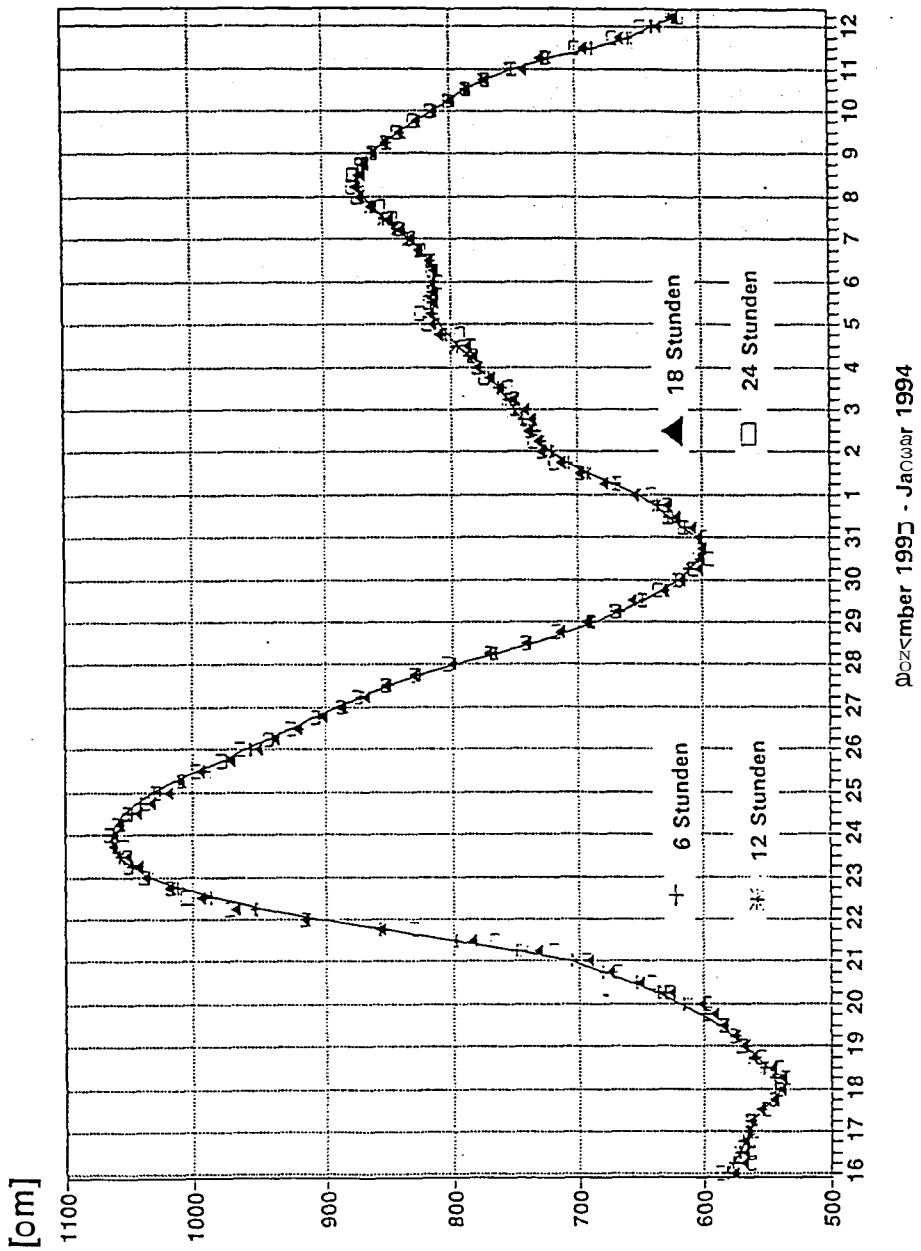
new units only used their own regional channels which did not match the channels of the Cologne fire Service. Therefore incoming reinforcements had to be directed to waiting areas and from there were guided by local personnel to the assigned sectors, causing some delays.

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 "WDR" (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 selfhelp 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. The middle ränge forecasts for the next 24 hours with concern to the Cologne water-level (KP) by the HWSZ proved reliable (compare figure 5.5). These forecasts steadied the public's expectations.

In Cologne, 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 sandbag 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.

Figure 5.5 Forecasts for6, 12, 18 and 24 hours and the actual water-levels ont the Rhine



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 gangplanks were utilized. The neighbouring houses in the old town centre in Cologne were linked by 3,400m of

gangplanks. More than 40 boats were operating as 'shuttle—service'. The gangplanks, like in Koblenz, were used by disaster tourists as well. In the future therefore, gangplanks may no longer be used. The supply and transport of the population affected will be done entirely by boat Services or high-wheeled vehicles.

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 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.

5.4.2 Flood response in Cologne 1995

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. About 4,000 gangplanks were set up in the old town centre. 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.

Permanent and mobile flood protection installations protected an area of ca. 90 km², 35 km² of which was inhabited. About 17.4 km² was flooded when the water rose to the record level of 10.69m, 33,000 inhabitants were directly affected. Many households experienced damage through rising groundwater-levels and flooded cellars. Sandbags once again

became a major, or in some places even critical device, as sandbags could be used to rise the flood protection level from 10m in some places up to 11m, thereby preventing floods.

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 HWSZ 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 HWSZ was again mobilized as rising water-levels were expected. Offices, which have to take flood protection measures below the level of 7 m, were informed about the water-level forecasts and worried residents, who lived along the river banks or other flood prone areas, were advised.

On 24 January the HWSZ started to operate at full strength 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. This continuous flow of information guaranteed adequate and current information Services to the public via the media or the telephone information Service. The HWSZ 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.

The water-level forecasts were supported by Computer based models developed in cooperation with the Federal Institute for Hydrology (BfG). These models were more efficient and exact than models used in 1993.4. With regard to future floods, the hydrological forecast model will be linked to the then completed Flood Protection and Information System (Hochwasserschutz- und Informationssystem, HOWIS). This will allow an even more efficient and coordinated co-operation of the different offices and Services at different stages of a flood.

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 the 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.

5.5 Conclusions

During and after both floods, the official bulletins and the press acknowledged the outstanding performance of the mostly honourary and/or voluntary working men and women of the different organizations participating in the disaster response and relief. The cooperation of the different organizations, authorities and units, as well as the (tele—)communication and especially the forecasts of the height and timing of water-levels were considered very good. Nevertheless there is always room for improvement. The BfG, the UBA and the Enquete—Commission of Rhineland—Palatinate each drew up a detailed list of necessary improvements after the floods of 1993 and 1995. The following section points to some of the major improvements proposed for areas exposed to flood hazards:

- stricter regulations and control concerning the processing and storage of substances which are hazardous to water;
- stricter regulations and control concerning a "flood—safe" oil storage;
- use of alternative energies for heating than oil;
- the improvements of the networks for the power supply to withstand floods and rising groundwater-levels;
- more boats should be kept available at flood prone areas and more personnel should be trained to operate the boats;
- more telephones and radio sets should be kept ready;

- pumps should be all run on gasoline, instead of electricity;
- the personal clothing and equipment of the relief forces should be better attuned to the weather conditions;
- the material for certain measures, like gangplanks, should be stored right in place;
- dikes should be inspected more frequently and more thoroughly;
- if necessary, dikes have to be repaired immediately;
- if possible, retention areas should *be* reactivated for purposes of flood control;
- the Information service for the forecasts of the weather and the water-levels is to be centralized, and the availability of this and other relevant Information to the public should be improved, e.g. through Videotext on TV;
- the forecast—models should be improved, if possible, to allow precise forecasts for even longer periods of time.

A simple solution to a complex hazard like riverine floods does not exist. It takes a coordinated effort of all the institutions, organizations and the public involved to prepare for and cope successfully with these hazards. The floods of 1993 and 1995 did not stop at state or national borders. Therefore, the disaster response to such cross-national hazards has to be organized and coordinated at a high political and administrative level as well as at the base. An efficient flood control demands long—term planning and large scale measures. Large-scale riverine floods will occur more frequently in the near future, therefore flood management takes political responsibility and measures from the international level down to the level of the communities.

The implementation of a new siren System is needed for emergencies like the breaking of dikes. Sirens are the only device for immediate warning in such cases. So far this aspect has not been taken into account sufficiently. For the first time in 1995, Cologne prepared the evacuation of 30,000 people in anticipation of breaking dikes. Today worst-case scenarios include evacuations of up to 100,000 people or more. Cologne is at the time not prepared for such large scale evacuation. However, the siren System will probably not be installed in the next few years due to tight budgets and other priorities like reconstructing old dikes and the raising of the dikes.

Currently disaster response is more and more decentralized. The flood management in Cologne proved that common training of disaster response leadership is of great value to guarantee an immediate integration of units

from different areas and an optimal co-operation during action. The federal and state level is not of major importance for actual flood management during the course of riverine floods or "normal" disasters. On the communal level, it proved to be more efficient to decentralize the command structure of the disaster response force and to transfer responsibility and decisional freedom to the local level on-site. This allows for practice-oriented bottom-up management instead of top-down central management. It stimulates responsible and independent management through teamwork as on-site disaster management is closer to the actual needs than organizations located higher in the bureaucratic command structure.

The integration of "emergent groups" like the ones in Koblenz should be promoted. The emergent groups serve as a useful intermediary with the population about threats and coping strategies. Such emergent groups integrate the innovative ability of the people in the overall rescue Operation and improves the trust and Support of the people toward disaster response units and authorities. There are already citizens action groups formed by people who are (potential) victims of floods in the Rhine area.

6 Recovery and mitigation

6.1 Introduction to federal and state management

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 etc., 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.

Long-term mitigation in form of compensations 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 farm recovery programmes run by the Ministry of Agriculture.

6.2 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 of inventorizing costs 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 DM 3,000 for private and above DM 5,000 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.

For the floods of 1993/94 and 1995, no exact numbers for the total damage can be given, due to different and incomplete inventory methods used by the federal states. Only rough 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, are as follows:

The 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.

With concern to the 1993/94 flood, 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 (ca. 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), Hesse (ca. DM 10 million for registered private losses above DM 5,000), the Saarland (ca. DM 100 million in total, 36 million for registered private losses) and Bavaria (ca. DM 35 million) (compare publication of the Federal Department for Environmental Affairs; Bavarian Re).

Estimating flood damages m 1995 is even more difficult, since many authorities and officials have become reluctant to give exact figures after the experience of the 1993/94 flood 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 1993/94 flood. 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 1993/94. 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 1993/94.

Total losses in Germany for 1995 are estimated to amount to DM 500 million, compared to DM 1.3 billion in 1993/94. These figures do not include losses due to reduced tax revenues, necessary costs for longterm 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 1993/94. So naturally, the damage was less than in 1993/94. No Overall estimates for Rhineland—Palatinate can be given. For Baden—Württemberg losses due to the flood are estimated to figure about DM 50 million (plus DM 20 million due to storms) compared to DM 160 million in 1993/94 just for insured buildings. North Rhine—Westphalia was hit more severely by the flood of January 1995 than in 1993/94. Currently, there are no official overall estimates. But due to the better preparation, losses can be expected to be significantly less than in 1993/94, similar to the experience of Cologne (1993/94: 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 1993/94, DM 7,5 million of which concerns the Saar and Moselle river. The Rhine and the other tributaries suffered relatively minor damages. During the 1993/94 flood 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 floods 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.

6.3 Flood insurance and compensation in Germany

Except for the state of Baden—Württemberg no flood insurance in Germany for business and residential properties exists. For the "Christmas Flood" of 1993/94 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 bürden 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, one of the German areas/cities which was struck the hardest by the "Christmas Flood", shows that most of the damage or losses in the private sector are paid for by the private households. Estimations of the total damage in Koblenz ränge from DM 150 to 200 million. The losses just for private households are estimated at about DM 57 million, 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, either because they were not entitled or their losses were minor ones.

Data regarding insurances and reinsurances clearly show that there is a world-wide trend towards increasing and intensifying 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.

So far the costs for 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 riverine floods and damage (none—) compensation policies, floods may ruin the lifes 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.

6.4 Conclusions

Riverine floods can become a tremendous economical factor and a cause for social disparity if the intervals of occurrence of floods exceed the mitigating potential of the affected private households and businesses. This demands a national or even European insurance fund against natural hazards. Such a fund will have to be a mandatory insurance in order to spread costs. It should follow the concept of joint sharing of burdens. Otherwise "social spreading" may occur, especially since the more wealthy people may move out of the flood endangered areas, whereas the less wealthy people have no choice but to stay in these areas.

7 Future flood hazards

In the discussion among politicians, media and public different opinions surface about the actual causes of flood hazards and preventive measures which have to be taken. Debates on flood-related issues only intensifies during and immediately after actual floods. Only the people, organizations, institutions, authorities and politicians who are directly involved in flood-mitigation and the reconstruction activities display a longer time horizon. So far many of the politicians handle the floods and the following mitigation and reconstruction phase as singular, exceptional "once-in-a-century events". The recognition that major changes in global climate could produce a continuous change (deterioration) of the regional climate in Europe, turning "once-in-a-century" into perhaps "annual-floods" has not yet become part of the political discussion.

Political passivity seriously impedes investments in long-term and extended research, and effective coordination and cooperation of flood control, in case expected deterioration in regional climate will materialize. On the other hand some of the media and critics draw a overly pessimistic picture. Most of the media and the environmental protection organizations are infusing the discussion with rather detailed reports and prejudiced arguments on potential apocalyptic consequences of climate change and resulting storms and floods.

The nature of the discussion can be illustrated by the different, but not necessarily opposing positions of the UBA (Federal Department of Environmental Affairs) and the BfG (Federal Institute of Hydrology) concerning the immediate and indirect causes of the riverine floods and their devastating effects.

The UBA argues that there is no single cause to be detected for the devastating effects of floods. Many interventions and hydraulic regulations by man, especially the straightening and canalization of riverbeds, turned most rivers, to improve control and navigability, into canals effectively blocking the entrances of the natural retention areas in times of floods. The UBA report does not claim that global climatological changes might be responsible for the unusual floods. Instead, the report takes

meteorological conditions for granted and argues that those areas in Europe which also experienced heavy rains in 1993/94, but still exist in their original "natural" condition (e.g. most part of the Loire in France) absorbed the floods in their natural retention areas and did not experience the damages and losses like other areas. So the UBA emphasizes manmade effects. These effects are the sum of different measures of hydraulic engineering along the rivers and their embankments, plus the sealing of the ground through development of these areas for real-estate, industry, business, infrastructure for traffic and transport, cultivation and drainage.

The BfG on the other hand argues scientifically on the basis of historical comparison that similar riverine floods already took place in the 19th and early 20th Century. Floods are not recent phenomena, but they occurred repeatedly in sequences of twice a year or two years in a row for a long time. Such floods reached "record—levels" which are comparable to the 1993/1995 floods. The BfG does not deny unwanted side—effects of increasing ground sealing and hydraulic engineering in general, but they try to show that the riverine floods of 1993/94 and 1995 were the result of an unusual coincidence of meteorological conditions. These comprise the rapid change of weather conditions from frost to a mild winter climate; the precipitation in form of rain up into the high mountain areas; the extreme rainfalls over an extended time and in a territory covering large areas of the catchment area of major rivers like the Rhine; and the combination of frozen grounds or grounds saturated by thaw or previous rainfall with continuous heavy rainfall. As a result of these factors, the tremendous amounts of rainwater could no longer be absorbed the ground and was drained away as surface water. This caused fast rising water-levels in the tributaries and major rivers. Additionally the almost simultaneous occurrence of the flood waves of the different tributaries, especially the Moselle and the Rhine river in 1993/94, and the Sieg and Rhine river in 1995 resulted in record—peaks of the riverine floods.

In its Flood Report on the 1993/94 floods in the Rhine area the BfG analyses the regional climatic Situation and the increased precipitation. Today there are at least 300 meteorological stations in the catchment area of the Rhine river. These stations are able to supply Information on the weather situations of the past 100 years. The BfG sampled 51 stations and compared the weather data from Switzerland, France, the Netherlands and Germany for the month of December. The evaluation of the data showed clearly that in many places the average precipitation for the month of December surpassed 200% of the 100—year—average, in some places it

almost reached 400% of the average, the highest precipitations of the past hundred years in many places. Large floods are always the result of extended precipitations, but normally precipitations differ among the various drainage areas. However, the Situation in 1993/94 (and 1995 again) was unique in the sense that most of the catchment area of the Rhine was affected at the same time. The BfG does not speculate in its Flood Report on the effects of global and regional changes of climate.

The media and the environmental protection organizations mostly argued, that besides the unwanted side—effects of the water management by man and the ground sealing due to the development of the land, the indirect effect of the change in global climate is most likely to have caused a permanent change in the winter climate in Europe. The warmer winters in connection with higher average precipitations distort the an old natural equilibrium. So far the precipitation in the wintertime mostly took the form of snow, at least in the upper regions above 400 to 1,000 meters. Together with the snow of the high mountain areas, this formed a reservoir which held back much of the precipitation during the winter month and diminished the winter floods. During spring time, as the snow of the high mountain areas did not melt before the summer, the thaw would add to the low water-levels of the dry summer period or it would cause moderate summer floods. As a consequence the major rivers remained navigable during the summer period while the dry ground easily absorbed unusual heavy rainfalls during the summer and cushioned the water-levels during the summer floods.

Nowadays, with the assumed changes in global climate, its complexity barely understood so far, evidence exists that we have to expect more extreme weather situations and precipitations during the winter and summer period in Europe. If the pessimistic expectations turn out to be right, this would prove to become an major and permanent threat for many of the people living in the river valleys, and the inland shipping as well. The frequently occurring damages and losses could turn into heavy burdens for both the national and supra-national economies (i.e. European economy).

Notes

1 State water laws maintain the principle of private water property, except for the state of Baden-Württemberg.
2 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.
3 Not included are the water-level stations of the WSV.
4 Compare also figure 4.2 with the major water gauges (Pegel) in Germany.
5 Personal interview with one of the authors.
6 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.
7 Interviews with officials affected.