THE ELBE FLOOD 2002

A CASE STUDY ON C2 SYSTEMS AND INTER-ORGANISATIONAL COORDINATION

PREPARED FOR THE NATO SAS-065 RESEARCH TASK GROUP

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OVERVIEW

In August 2002, Germany experienced with the Elbe flood the worst flooding within one century and one of the worst natural disasters in Germany. In this case we write on the course of the disaster and the disaster relief operations. We illustrate and analyse the work of the relief forces and focus herein on the Command and Control systems (C2 systems) and the inter-organisational coordination. We provide information about the topology of the federal state of Saxony and the unique weather condition insofar they are relevant to understand the course of action of the flood and the disaster relief operations. Note that we focus in this case study on the federal state of Saxony although the Elbe flood affected the whole state of Germany.

The Elbe flood is accounted for 20 fatal casualties and 110 injured people in Saxony. Nearly 100,000 people were evacuated and the damage caused by the flood was estimated by the Saxon authorities to amount to 6.2 bn €. Approximately 12.000 commercial entities were affected (WWF-Report, 2007). The capital Dresden suffered damage on the order of 340 Million Euros. 61 schools were severely damaged and 20 hospitals completely evacuated. In Dresden, 100 % of the hospital capacity was afflicted.

The Bundeswehr (German Armed Forces), the Bundesgrenzschutz (Bundespolizei, Federal Police), the Technische Hilfswerk (Governmental technical aid organisation), the Saxon Police, Fire departments, The German Red Cross, Various Non-Governmental organisations and an estimated 25.000 volunteers were involved in the disaster relief operation.

The case study is a contribution to the work of the SAS065 working group to illustrate and validate the C2 maturity model. Particular to this case study as a contribution to this working group is that an established system of relief forces acts on their own territory and domain. The so-called von Kirchbach report provides a thorough analysis of the course of actions in the relief effort and makes well-perceived recommendations to improve the efficiencies and effectiveness of the German disaster response systems.

Note that this case is intended to be used as the basis for illustrating the various kinds of inter-organisational collaboration, the advantages and disadvantages as well as the necessity to assess and to design inter-organisational collaboration in crisis response rather than to illustrate either effective or ineffective handling of crisis response and inter-organisational collaboration.

This case was compiled from published sources. The most relevant source is the 'von Kirchbach report' (Hans-Peter von Kirchbach, Stefan Franke, Hartmut Biele, Lutz Minnich, Matthias Epple, Franka Schäfer, Fred Unnasch und Margitta Schuster (2002): Bericht der Unabhängigen Kommission der Sächsischen Staatsregierung Flutkatastrophe 2002). This report was commissioned by the Saxon state government to assess the major problems of the disaster relief operation during the Elbe flood.

This case is organised as follows. First we describe the sequence of events and then we analyse the organisations and the inter-organisational coordination and collaboration. In the third main part of the case study, we assess the inter-organisational collaboration following the framework of the NATO NEC C2 Maturity Model.

SEQUENCE OF EVENTS

The topology of Saxony with its steep mountains and plenty of smaller rivers flowing into the Elbe explains some of the characteristics of the Elbe flood and the magnitude of the disaster. We provide some information and make the reader familiar with some aspects of the topology.

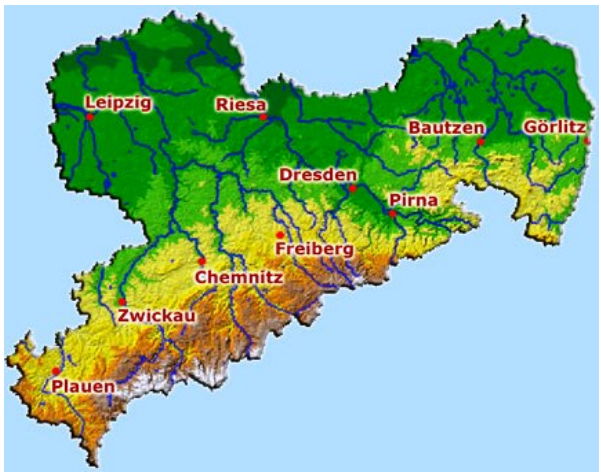

Figure 1. Saxony's Topography

Located in the South of Saxony, the Erzgebirge is a long stretch of mountains (see Figure 1). The many small rivers and creeks in the Erzgebirge are connected with larger rivers running roughly south-east to north-west. The north of Saxony is characterised as being rather flat. The transition from the mountains in the south in line with the border to the Czech Republic to a line of cities from Plauen over Zwickau, Chemnitz to Dresden which run from south-west to north-east is fairly steep. So in cases of strong rain the rivers and creeks in the mountains swell dynamically and eventually rise very quickly with nearly no warning time for citizens nor disaster response forces.

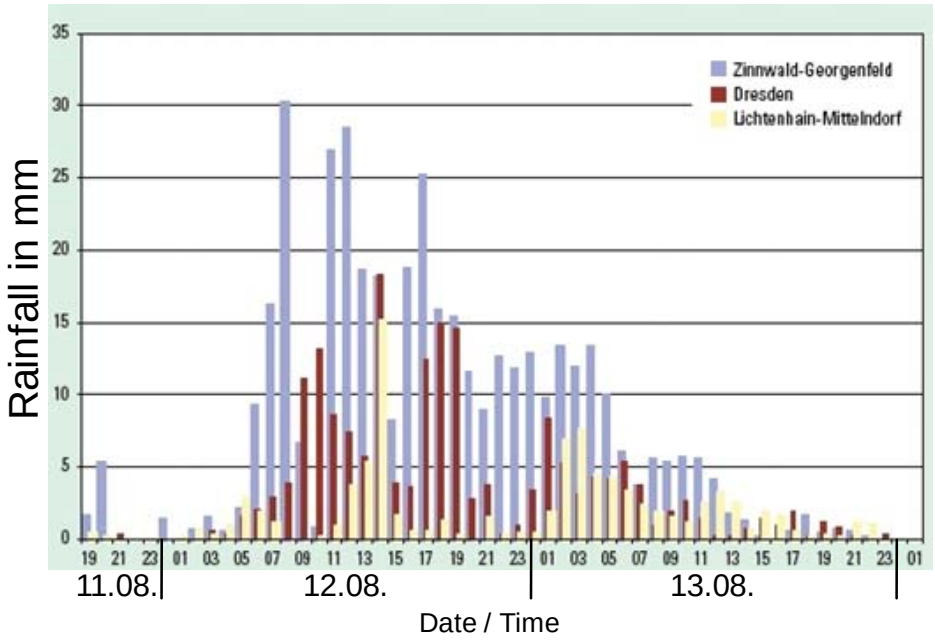

Figure 2. Rainfall per hour in 3 locations: Zinnwald-Georgenfoeld, Dresden, and Lichtenhain-Mittelndorf

According to the topography and the many small rivers and creeks especially in the south of Saxony high water levels and even small floods are common in that area. However, the weather situation in August 2002 with a rainfall volume never registered before in Germany causes unprecedented water levels of the rivers in Saxony.

In the first ten days of August long ongoing rain all over Saxony and especially in the region Erzgebirge saturated the ground and filled the levees. In most areas of the Erzgebirge the amount of rainfall in the first ten days of August is as high as the average rainfall in a “normal” August. At the 11th and 12th of August rainfall primarily in the eastern parts of the Erzgebirge increases even more. Especially the rivers Freiberger Mulde, Vereinigte Mulde, Rote Weißeritz, Wilde Weißeritz and Müglitz are being fed. In Zinnwald-Georgenfeld rainfall climaxes with 312 mm or 312 litres per m² in 24 hours. That is the highest amount of rain ever measured all over Germany (DKKV, 2003). Figure 2 above, depicts the rainfall per hour in three locations.

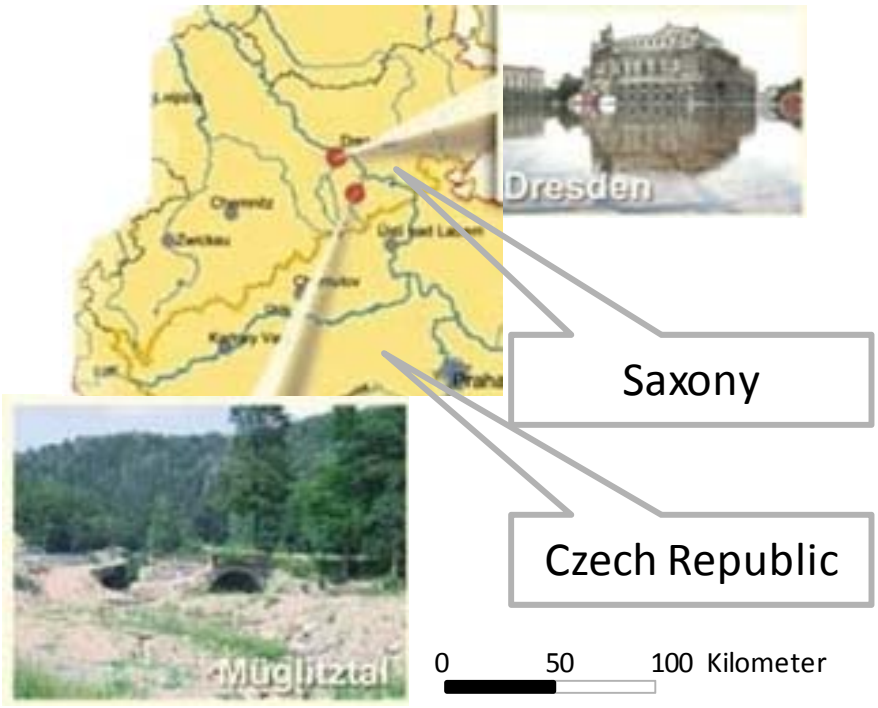

Figure 3. Two pictures during the flood in August 2002

Due to the topography and the heavy rain especially in the mountains of the Erzgebirge the Elbe flood developed in two phases. Phase one is the flood in the mountain region caused by the extreme amount of rain and the rapidly rising small rivers and creeks. Phase two – the rise and flooding of the Elbe in the northern part of Saxony – develops through the water from these rivers and the rain that goes down in the area which feeds the Elbe. Subsequently, for each phase of the disaster one example is provided. First, a case of the flood in the Erzgebirge which developed roughly in the time between August, 12th and August, 14th is described. We exemplify the Erzgebirge flood with the example Müglitztal, which is an area in the south east of Dresden. Figure 3 depicts the location of Müglitztal.

MÜGLITZTAL – AN AREA IN THE ERZGEBIRGE THAT WAS SEVERELY DAMAGED

The Müglitztal is a valley located in the Erzgebirge and its name roots back to the river Müglitz, which flows through the valley. The disaster in the Müglitztal developed through the rainfall and the masses of water not coverable by the rivers in the Erzgebirge and especially not by the river Müglitz. A sequence of events is given below. The centre of interest in this case study is Weesenstein a town in the Müglitztal.

11.08.2002	At 6:30 p.m. it begins to rain. Easily first but later in the evening it rains steadily.
12.08.2002	In the morning at circa 8:30 a.m. the Müglitz begins to rise and to transport a lot of material (trees, stones) downwards. From 12:00 a.m. there is in the area of the park at the castle of Weesenstein such an amount of stones and rubble that the river bed is barricaded. The three bridges in the town are on the verge of collapsing. The Müglitz leaves its bed and floods the park of the castle where it uproots trees which then ram houses. This causes a lot of damage. The Müglitz rises very fast (half a meter per hour). At circa 4:30 p.m. a retention basin above Glashütte (a small town in the Müglitztal) flows over. 50,000 m^3 of water flow in the Müglitz in addition to the rainfall. In the night a lot of houses were damaged. Two people die and many people climb onto the roofs of their houses or even onto last remaining walls of their houses and stay there through the night until helicopters get them in safety.
13.08.2002	It is still raining. At 7:30 p.m. the climax of the flood in Weesenstein is measured with 390 m^3/s. Infrastructure (Bridges, the Müglitztal-road, rail network, energy and water supply and the communication infrastructure) is almost fully destroyed.
The alert system	Weesenstein is located in the district Sächsische Schweiz. The Weißeritzkreis is an adjoining district to Sächsische Schweiz which officially proclaimed emergency alert at 12.08.2002 at 13:35 p.m. without informing Sächsische Schweiz. The district Sächsische Schweiz firstly is informed on the state on emergency through an information exchange with the federal border police. At 14:55 at 12.08.2002 emergency alert for Weesenstein is proclaimed. The citizens in the town are not warned. The officials have no information sourced from the flood warning system or from weather forecasts about the disaster development. Thus it was not possible to proclaim emergency alert in an early stage to gain planning time. Emergency alert was proclaimed because of the disastrous situation caused by the Müglitz.

The case of Weesenstein in the Müglitztal is representative for the situation in the Erzgebirge where the flood developed through heavy rainfall and the officials had nearly no warning time through the flooding warning and weather information system.

The second phase of the August flood developed through the rise of the main rivers in Saxony above all the Elbe. To understand the development of the Elbe flood a second case analogous to the Müglitztal is described below.

DRESDEN – THE SAXON CAPITAL SUFFERED SEVERE DAMAGE

Dresden is located at the bottom of the Erzgebirge (see Figure 3). So in fact the capital of Saxony suffered from both phases of the flood. First, the smaller rivers form the Erzgebirge as the Weißeritz flooded the city and second the Elbe heavily damaged the city. Following a sequence of events is depicted to understand the development in Dresden.

12.08.2002	Several second order rivers in Dresden and the city's outback strongly rise due to heavy rain falls in the night between August 11 and August 12. In the morning flood warning level II (where IV is the highest) is proclaimed for the Elbe in Dresden. The water level is at that time 5.27 m (2 m is normal in August). Rain goes on with 150 l/m³ per day and the Elbe water level furthermore increases. Emergency alert is being proclaimed. The river Weißeritz brakes out of the new (artificial) river bed and flows through the original one and floods parts of the city. Some of the parts were never flooded before in history.
13.08.2002	Rain goes on and the Elbe water level is at 6.66 m. The Weißeritz heavily damages the city districts Löbtau, and Friedrichstadt. Dresden main station is flooded by the Weißeritz. 1/6 of Dresden's homes are cut from electricity. The very famous picture gallery "Alte Meister" located in the Zwinger and the archive of the Saxon government are endangered by the flood. Further second order rivers as, e.g., the Lockwitzbach flood the city.
14.08.2002	The rain stops and the Weißeritz returns in its river bed. The level of the Elbe still rises.
15.08.2002	The Elbe-level is higher than 8 m. The citizens of the city districts Niedergohlis, Altkaditz, Laubegast, Kleinschachwitz, Mickten, Trachau and Pieschen are evacuated.
16.08.2002	In the morning the historical highest Elbe water level (1845 the Elbe-level was 8.77 m) is exceeded. In the evening the Elbe-level is 9.14 m. The Elbe rises slower than the Weißeritz and floods the centre of Dresden. The famous palace Zwinger and the famous opera house Semperoper are flooded by the Elbe. Some large bridges are endangered and a more than 10 m long boat has to blown up such that it not rams Dresdens' bridge once it turns loose.
17.08.2002	The Elbe is at its highest level with 9.40 m. The water level sinks slowly but the groundwater-level rises about 3 m. The ground water floods a lot of cellars and damages a lot of houses. Note that it is difficult to draw water out of cellars because the stability of the houses becomes unsafe.
18.08.2002	The Elbe-level sinks faster than expected. In the evening it is at 8.20 m.
26.08.2002	Emergency alert is abolished.

In Dresden a lot of people and more critically all hospitals had to be evacuated. The situation at the Elbe was dramatic and large parts of the city were flooded.

The given examples shall help to understand the events better. The first phase of the disaster limited the warning and planning time for the officials. This means that the dynamics of the events was at a scale which was very problematic for the responders and their C2 system. The following section describes the German disaster response system and the organisations involved in the Elbe flood.

THE GERMAN DISASTER RESPONSE SYSTEM AND ORGANISATIONS INVOLVED IN THE ELBE FLOOD

This section explains shortly the main jurisdictional rules of the German disaster response system. In the second part it clarifies the roles different organisations played in managing the Elbe flood. Some of the coordination mechanisms and the most important issues regarding the respective C2 systems of these organisations are either described.

THE GERMAN DISASTER RESPONSE SYSTEM – AN OVERVIEW

In Germany, disaster response distinguishes three phases

1. Preparations to control and reduce effects of a disaster;
2. Management of disaster response operations;
3. Repair of critical damage caused by disasters.

State laws define a disaster as an occurrence that endangers people's life and health and/or their supply with vital goods or services on a large scale, the environment or economic goods to a degree that effective protection and aid requires the engagement of governmental and non-governmental organisations under the leadership of a dedicated disaster response organisation (Sächsischer-Landtag, 2004).

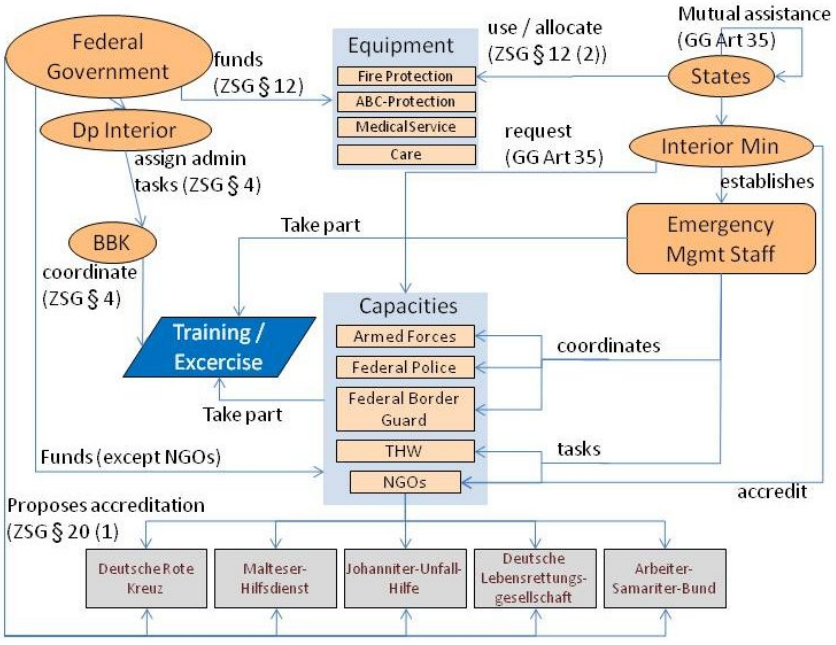

Figure 4. The German Disaster Response System

Like in many other Western Nations, subsidiarity is the basic principle for organising disaster response in Germany. Subsidiarity hereby describes that local authorities are responsible first followed by district, regional, state and federal authorities. Responsibilities are assigned through a set of laws the most important of which are the *Grundgesetz* (constitutional law) and the *Zivilschutzgesetz* (civil protection law) of the Federal Republic of Germany. Accordingly,

federal authorities are responsible only for special training and financial support of state authorities, not for coordination or control of response resources in disaster response operations. Federal authorities are not even responsible to coordinate the German Armed Forces, Federal Police, Federal Border Guard and the so-called Technical Aid Organisation THW (a disaster relief organisation of the Federal Government (Ministry of the Interior) in cases of national disasters. This fact is surprising insofar that the federal authorities finance these organisations. Coordination of resources in a disaster management operation is the responsibility of a disaster management staff established by the department of the interior of the respective state. The federal authorities also finance equipment for fire and ABC-protection, medical and care services. Its allocation is decided at state level. The Federal Department of the Interior proposes accreditation of the five most important German NGOs (German Red Cross, *Malteser Hilfsdienst, Johanniter-Unfall-Hilfe, Deutsche Lebensrettungsgemeinschaft* and *Arbeiter-Samariter-Bund*) and they are beeing accredited by state authorities which are also responsible for tasking NGOs in a disaster. Figure 4 depicts these relationships.

In case state authorities are not able to provide relief in case of a disaster with their available resources (e.g., state police, fire protection forces, and NGOs), they may request support from federal government organisations. Local authorities, who have no legal responsibility for disaster management, are responsible for operating their own fire fighting capabilities. These fire fighters are usually the first responders in nearly all cases of emergency including disasters. However, the first level responsible for disaster management is the district authority. Thus, the Elbe flood response involved a shift of command for all fire fighters from the local level to the district level. The fire fighters were about 70% of the personnel of Saxon disaster response organisations (3,800 police, 4,000 NGOs, *20,000 fire fighters*).

Table 1 summarises for the personnel deployed by the respective organisations to support the Elbe Flood response operations (von Kirchbach, Franke et al., 2002). Human resources deployed by the Federal organisations included 15,500 military, 2,200 police personnel and 1,835 technical specialists of THW. The majority of the soldiers served with a division stationed in Saxony.

Participating Organisations	**From without Saxony**	**From within Saxony**
German Armed Forces	15,500 (179 units) 15,500 soldiers	
Federal Border Police	2,200	
THW	2,835	
Police		1,600 – 4,000
Fire Fighters		20,000 – 23,000
NGOs (five accredited)	6,352	4,076
Unorganised volunteers	6,661	16,893
Total	33,548	42,569 – 47969

Table 1. Personnel deployed to support ELBE Flood Disaster Response

The organisations involved in the disaster response operation are described in the following section.

RESPONSE ORGANISATIONS INVOLVED

This section describes the most important organisations involved in the Elbe flood to respond to the disaster. The description of the organisations is structured as follows:

The following products have been produced by SAS-065:

- The main purpose of the organisation;
- The estimated number of responders;
- The most important tasks and operations conducted during the Elbe flood;
- The role of the organisation within the overall disaster response system;
- The C2 system of the organisation.

German Armed Forces

The Bundeswehr (German Armed Forces) is the military organisation of Germany. In general its forces can only be deployed in case of foreign threats. One typical exception is a disaster response operation. During disasters the responsible officials can request appropriate units of the Bundeswehr to respond to the disaster. Usually the Bundeswehr provides a huge amount of man power (for example for stabilising dikes with sand bags in cases of flood) and special heavy equipment like wrecker or mobile bridges as well as helicopters and boats.

The Bundeswehr helped with at least 15,500 soldiers during the Elbe flood most of them from a division mainly posted in Saxony. Especially with the equipment of the military engineers only the Bundeswehr was able to fulfil several tasks in particular the clearing of flooded roads and the construction of temporary bridges. In the first days of disaster primarily rescue operations were conducted. A large number of soldiers were engaged already after two days of the disaster. In Dresden Army's officer cadet school deployed its soldiers even during the first night of the flood to protect the most vulnerable areas in Dresden against the water of the Elbe. In the follow on operation a camp for up to 3,500 evacuated people was erected in close collaboration with NGOs. A very important and labour intensive task which requires a lot of personnel was the stabilisation of dikes. This was done with around 1.2 million sandbags filled and placed by soldiers.

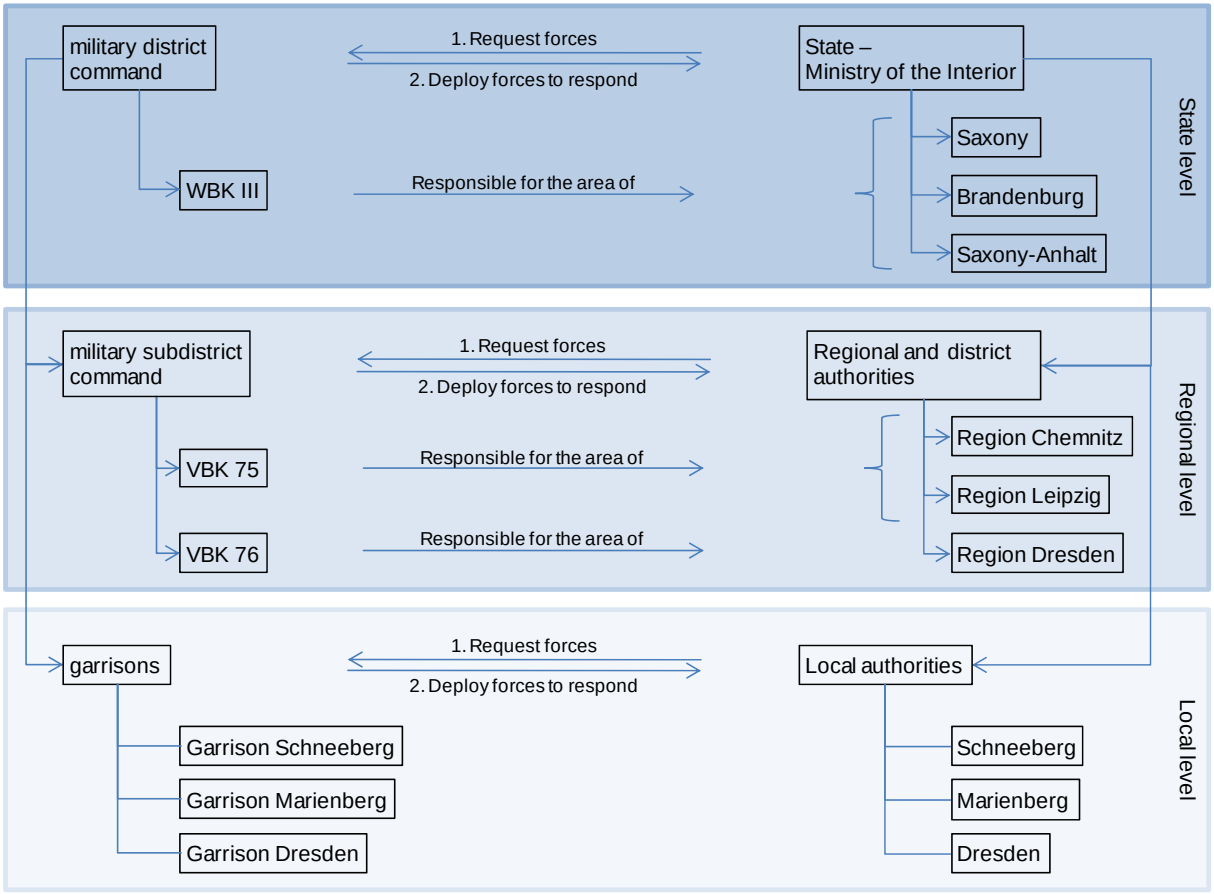

Figure 5. The interactions between the Bundeswehr and the levels of authority

The Bundeswehr is one of the major organisations within the overall German disaster response system for large scale disasters in Germany. Its potential of personnel, capabilities (especially the heavy and also special equipment) and also the experience and ability to coordinate large scale operations explains the unique role within the disaster response system. Other than for example the fire brigades, the German Armed Forces do not have the permission to proactively engage in case of disaster. All units have to be requested and coordinated by civil responsible officials. Although this procedure established for political control seems to be restrictive and time consuming, the forces necessary for disaster operations can be deployed quickly and efficient. To ensure that the capabilities of the Armed Forces can be used with only little latency every level of civil authority (district, region, state) has a corresponding level of command in the Bundeswehr (see Figure 5). Thus a staff established by a district authority can request the forces posted within the area of the district directly. This means that the garrison commander gets a phone call from the disaster operation commander and can deploy the soldiers of the garrison in time. This enables the local authorities to collaborate easily and fast with the Bundeswehr in cases of emergency. In cases when no units are posted within a respective district the disaster management staff requests forces at its superior office (regional level). Then again the civil regional commander has the ability to request Bundeswehr units posted in his area and so forth. The liaison officers within the garrisons are appointed and the responsible officials in the respective disaster management authorities know these officers from regular meetings. This helps to coordinate the requests quickly and to support the disaster management staff in coordinating the operations.

In the respective tactical relief operations of the Elbe flood, Bundeswehr units were typically controlled by the incident commander at the district level. Notwithstanding, the line of command within the Bundeswehr does not change. In a large scale disaster – like the Elbe flood – requests typically exceed the amount of forces posted in one federal state. In these cases the requests are handled within the Bundeswehr and units posted in other states are deployed and coordinated by a Bundeswehr staff that collaborates with the respective Ministry of the Interior (in the Elbe disaster with the Ministry of the Interior of Saxony).

The von Kirchbach report emphasises that due to the coordination process mentions that the lower disaster management authorities had access to Bundeswehr units fast and coordination was good (von Kirchbach, Franke et al., 2002). Also the collaboration with NGOs and fire departments is praised. However, the Saxon Ministry of the Interior reacted with some delay and contacted the respective counterpart of the Bundeswehr on August 13th with two days delay. This was actually the result of the lack of the overall situational picture within the Ministry of the Interior. In contrast the Bundeswehr established on August 12th a control centre as reaction to the weather forecast proactively. The von Kirchbach report assessed that the Bundeswehr should play a more central role in disaster response operations because its capability to coordinate large scale operations.

Bundesgrenzschutz

The Bundesgrenzschutz (BGS: Federal Border Police) was renamed in 2005 to Bundespolizei (Federal Police) and is a special police force subordinated to the Federal Ministry of the Interior. Its main tasks were to protect the German borderline and to prevent danger in border near regions. Additionally the BGS supports the German states in case of outstanding danger as natural disasters. The BGS employed in 2002 circa 31,700 police men and 8,000 civilians.

The BGS deployed circa 2,200 responders during the Elbe flood. Most of them serve for the Border Police departments Pirna and Chemnitz which are subordinated to the Border Police command east. The Border Police department Pirna is responsible for the administrative region Dresden and for the district Weißeritzkreis (see above) and the Border Police department Chemnitz is responsible for the administrative area Chemnitz. As the administrative region Leipzig has no German borderline no border police department is responsible for that region and no border police men are posted there.

Similar to the Bundeswehr the BGS anticipated the weather situation as very uncommon and dangerous and in combination with the assessment of the situation in the district Sächsische Schweiz the Border Police command East decided to set up an operational headquarter quickly – in the evening of August 12. This headquarter was tasked by the Saxon Ministry of the Interior to control the whole response operation in the regions addressed. It was able to deploy the supporting units to the regions afflicted by the flood, soon and efficiently.

The BGS has the technical and personnel expertise to handle large scale operations. This expertise was used by the officials in the affected regions because the public authorities were not able to handle such operations. As the Bundeswehr the BGS sent liaison officers in all relevant staffs especially in the staff of the Ministry of the Interior.

Additionally to the coordination of the operations in the respective areas the BGS helped to search and rescue whereby the helicopters of the BGS were very important, helped to support

the people in the affected areas for example with energy supply and water supply. A special task was to protect affected areas against depredation.

The role of the Federal Police in the overall disaster management system is comparable with the role of the Bundeswehr, a different specialisation notwithstanding. As the Bundeswehr the Federal Police is under command and control of the federal government and subordinated to the Federal Ministry of the Interior. As the Bundeswehr all levels of civil authority have an easy access in cases of disaster. All responsible levels can request forces from the Federal Police. In addition to overall police tasks the Federal Police is highly specialised in the coordination of large scale operations. This capability was used by the Saxon Ministry of the Interior primarily in the first phase of the flood disaster as the Ministry of the Interior was hardly able to set up a staff able to handle the operations.

The Federal Police is a hierarchically structured organisation comparable with the Bundeswehr but much smaller. The departments are responsible for respective areas with national borderlines. Departments are subordinated to regional commands as for example the command east. This means that the Bundesgrenzschutz is de-conflicted by region. However, in cases of disaster the organisation is flexible and can handle the tasks at hand. Police forces from one department can help in other regions as the situation requests. Thus the approach in disaster response operations is at least coordinated. Different organisations praised the collaboration with the Federal Police during the Elbe flood. The collaboration with the disaster response management was only in the beginning somewhat tenacious but it developed in a positive manner. The main criticism was that not the structure of the disaster response management organisations was problematic but that the response management departments embedded in the civil authorities suffered in training to do their job effectively. The Federal Police as the Bundeswehr usually does not share their personnel with other organisations in that way that units change their line of command. It is not possible that a unit of the Federal Police or of the Bundeswehr is commanded by a fire fighter. And it is also not possible that the disaster management staff is in the command position regarding these units. However, the civil authorities coordinate and task the units of the Federal Police and collaboration also with other organisations is usual.

Technisches Hilfswerk

The Technische Hilfswerk (THW) is a governmental technical aid organisation funded by the Federal Government (Ministry of the Interior). The order of the THW is assigned by a law and Figure 6 depicts article one which constitutes the organisation THW. According to this article THW's main task is technical aid in case of civil defence and disasters. In case of disaster or larger scale accidents the THW is requested by officials responsible for the disaster management, usually at the district level. In these cases the THW primarily helps to rescue people and animals as well as to repair facilities and plants.

During the Elbe flood first units of the THW were requested on August 12. According to the weather forecasts and the development in the districts afflicted firstly, the THW set up a coordination cell to handle the requests for forces from the disaster management authorities efficiently. All local units in Saxony were alarmed and manned to be able to deploy within 24 hours. During the Elbe flood 2,835 THW responders from all local units but also from different states were engaged in Saxony in total.

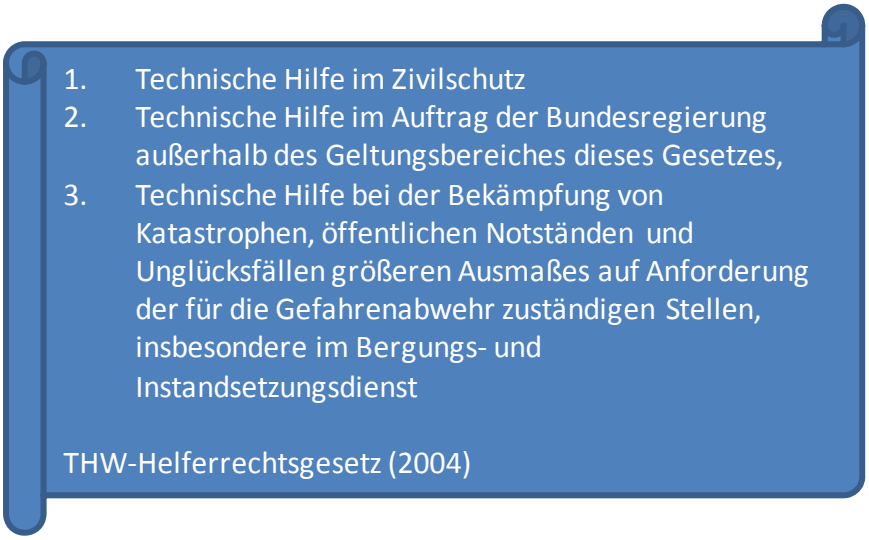

Figure 6. The Order of the THW (German law text)

The THW personnel operated very closely with the Bundeswehr, the BGS and the fire departments. The collaboration was intensive and a lot of materiel and personnel was exchanged to coordinate mutual operations. The tasks the THW fulfilled during the disaster response operations comprised of the clearing of roads, the evacuation of people in affected urban areas but also special operations like the cleaning of oil leakage and water treatment.

The THW is the only organisation responsible for technical aid in cases of disaster within the German disaster management system. The organisation is mainly funded by the Federal Ministry of the Interior. This funding helps to budget main investments in equipment and in training efforts. The costs for deployment in cases of disaster bear the requesting authority. As result this authority has the command and control power. Actually the THW does not command and control its units in a centralised manner. However, the THW is structured hierarchically and the local units are allocated all over Germany. The headquarters of the THW manage an association of eight regional quite autonomous organisations which direct 668 local organisations with about 80,000 responders all over Germany most of them voluntary. The local organisations deploy and train the operational units.

As a result of the reconstruction of the civil protection planning after the wall came down and a decline of funds the THW restructured its local units. A standard unit today has a bundle of capabilities without specialisation to help quickly in case of emergency. Specialised units for example for water treatment or protection against oil accidents are not in all local organisations and thus in all areas available. These units need longer time to deploy in case of emergency but are highly specialised.

Although the overall organisation is structured hierarchically, the THW does not command and control its local units in a centralised manner. Actually the THW usually does not establish central staff organisations in cases of large scale disasters as the Elbe flood. The cultural understanding of the THW is to be a supporter for the overall disaster management organisation. With the background of this understanding an interesting model of collaboration in case of emergency has developed. The local units requested to support the operations are directly under command of the Incident Commander mostly an officer of the fire department. This means that the fire arms usually are earlier at the place of disaster than the THW units. The THW units are

alarmed via radio on the same frequency as the fire arms or the medical rescue service. Thus the platoon commanders of the THW units can instruct their personnel which arrives one after the other from home or work at the base of the unit. The unit commander of a THW unit is alarmed in parallel by mobile and goes directly (with its own car) to the place of emergency. Thus he can consult the Incident Commander how to operate with the capabilities offered by the THW unit. When the unit arrives the plan is ready and they closely collaborate with the forces (above all with the fire department) at place. When the disaster or accident requires mainly capabilities of the THW then the leader of the THW can be assigned to be the incident commander. In this case the THW manages the forces of the fire department. This is a very collaborative nearly agile approach to handle the units in the operation flexible. However this C2 model is considered to deploy numerous units at the same time but with completely different objectives. Thus the THW is not planned to operate isolated in a disaster.

The THW criticised that the Saxon Ministry of the Interior was not able to request outer Saxon THW forces efficiently and therefore the abilities of the THW was not used in total. The Ministry of the Interior was not able to coordinate the THW units, although the federal Ministry of the Interior assured to bear all costs.

Saxon Police

The Saxon police forces have to protect the public against danger. Furthermore it is their task to control traffic ad regulate traffic. This is also the main task during disasters. However, the state police are obliged to help in cases of disaster whenever forces are available. But in contrast to all other organisations described in this section the police is not automatically under command of the disaster management staff in case of the declaration of a disaster.

In the Elbe flood disaster the state police was engaged very soon like the fire departments. The Saxon police deployed on average 3,600 – 4,000 police men per day during the disaster. Additionally police men from other states helped in Saxony and thus circa 12,500 police men coped with the disaster.

Beneath the regulation of traffic and the avoidance of plundering one of the most important jobs done in the disaster response operation was the fast establishment (12 August) of a command centre that served as basis for the disaster management staff of the Saxon ministry of the Interior. This provisional command centre was home of the staff of the highest disaster management authority until the Ministry of the Interior was able to manage a staff of that size (around 80 personnel) on their own. In this command centre the central situation room and the overall communication base was situated. Additionally the police forces were engaged in search and rescue operations. Their helicopters were important means to save people from floods in cut off areas. An important task was to inform and warn the population via loudspeakers in the villages and small towns.

The police assessed the coordination process somewhat mixed. In the beginning the uncoordinated proceeding of the disaster management departments were criticised. But also the coordination of the police forces in the beginning was not entirely successful. During the disaster the coordination became better and a good cooperation developed especially with the fire departments and the civil administration. The existence of daily life connections between police men and fire fighters but also officers in the administration strongly helped to develop efficient procedures.

Fire departments

The main task for the fire departments is fire protection and fire defence. However, the emergency control centres alarm fire brigades in a lot more cases than in the case of fire. For example in cases of severe traffic accidents or as in August 2002 in cases of flooding for example to pump water out of basements. Actually in most cases of emergency the fire departments with their personnel are the first responders.

During the Elbe flood the fire departments of Saxony played a major role in the overall disaster response operations. Their tasks were plentiful and challenging. The fire departments deployed circa 20,000 to 23,000 fire fighters during the days of flood. That was the largest contingent of personnel and crucial for the fast support of many people within the afflicted areas. All fire departments in Saxony deployed fire fighters to respond the disaster.

The fire fighters were mostly alarmed due to flooding of basements within the first hours of the flood disaster. However, due to the rapid increase of water levels almost everywhere in the Erzgebirge the disaster management authorities together with the fire brigades recognised that the ongoing threat will develop to a disaster and quickly began to establish incident commands for the counties and when necessary also for small towns and villages. This was one of the most challenging tasks for the fire brigades as it is their job to establish and command these incident commands. As described most disaster response organisations have liaison officers within the incident commands. They formed the “nerve centre” for all tactical operations conducted during the days of disaster.

The fire fighters were not only responsible for most of the incident commands they played as well an important role within all disaster response staffs as consultant for the responsible administrating officers. Additionally the fire brigades played a major role in all tactical operations. They were the specialists for evacuation and rescue operations during the flood. In addition the fire fighters tried to avoid damages in housing and infrastructure whenever possible by pumping water out of basements or houses and protecting chemical or oil and gas tanks.

The role of the fire brigades within the overall disaster management system was partly described. However, due to the knowledge of the fire fighters about the area of operation and their fast response times to every kind of threat it is a logical consequence that the fire brigades become responsible for establishing the incident commands. On the other hand the fire brigades are commanded by the local authorities. Interestingly the local authorities play a minor role within the overall disaster response system. Thus the first level of authority responsible for disaster management is the lower disaster management authority within the districts. That means with the act of declaring the case of catastrophe which is the responsibility of the disaster management authorities therefore at least for the authorities at district level all forces within the district become subordinated the disaster management authorities. Thus the fire fighters become subordinated to the district authorities in case of disaster. Due to the daily life contacts and disaster management training together with these authorities this change of command caused no documented problems. But it illustrates that mutual training is crucial for forces acting in dynamic and complex environments.

As described the fire brigades are not organised as centrally coordinated disaster response organisation but as locally organised network of organisations. Within the respective organisation the command and control system is strongly oriented on the German military regulations. Thus not only the structure in companies and platoons is comparable to the

Bundeswehr but also the staff structure with its different departments. The fire fighters are mostly coordinated via radio. The radio frequencies and systems are often incompatible with the Bundeswehr. These communication problems will be fixed by new radio systems in the future.

German Red Cross

The German Red Cross (GRC) is a charitable organisation acting as national German organisation in the association of the International Red Cross. The GRC is completely funded by donations and is one of the most important disaster response organisations in Germany. The most important services provided in disasters are rescue services, transportation of injured or sick persons and medical supply. A special task and dedicated only to the GRC is the administration of evacuated people and missed people for the purpose of reunion families. Additionally to all these tasks the GRC is responsible among other NGOs for care services for evacuated people or people who need help.

During the Elbe flood the GRC played an important role in the disaster response operations. The Saxon part of the GRC mobilised 3,143 responders. Additionally 4,231 responders came from GRC-organisations all over Germany. The Saxon GRC-responders where engaged within 29 disaster response platoons which were officially requested by the respective disaster management authorities. These specialised platoons are responsible for medical support and medical attendance and care and operated for example first-aid stations to supply emergency doctors, helped to find injured people and registered and documented all medical cases. The group responsible for care within each platoon helped all people not able to help themselves and supported with food and shelter. One platoon is able to supply about 20 injured or wounded people and circa 100 people who need care.

During the Elbe-Flood the GRC implemented liaison elements in the disaster management staffs at all levels of authority. That helped to coordinate all responders of the GRC. Although the liaison officers helped to coordinate the GRC units they were under command of the respective level of authority mostly at the district level and collaborated closely with the incident command and other disaster response organisations as the Bundeswehr, the THW or the fire brigades.

The GRC is a hierarchically structured organisation with a central National Secretariat and 19 associated sub organisations covering Germany. Although this hierarchical structure, the 19 member organisations are juridical independent. Thus, the National Secretary provides only strategic project management resources and is a committee to integrate the ideas and decisions of the association. The overall organisation has roughly 290,000 active members who are organisers within the GRC or responders organised mostly within the numerous platoons provided by the GRC for disaster response operations.

In cases of emergency the units of the GRC are requested by the local authorities mostly together with police and fire fighters via the emergency radio frequencies. Thus, the units of the GRC are connected via radio to the emergency control centres at the district level. In case of disaster when the units in the respective district are not sufficient especially in number, the disaster management requests further units at its superior office which then requests GRC-responders at different districts, or regions or states depending on the level of command. However, important to note is that the requester is responsible for the expenditures of the forces requested. Thus the requester has also the responsibility for the overall operation and the responsibility to command and control the organisational elements requested. This is an

important coordination mechanism and in some cases this process causes latency as the decision to bear the costs might come too late for the overall situation on the spot.

Different NGOs involved

The German Red Cross is only one non-governmental disaster response organisation in Germany, nevertheless the most important and recognised one. However, during the Elbe Flood disaster a lot more NGOs were involved. The most prominent were Johanniter-Unfall-Hilfe, Arbeiter-Samariter-Bund, Malteser Hilfsdienst and the Deutsche Lebensrettungsgesellschaft. These organisations are certified by the respective Ministries of the Interior of the federal states as disaster management organisations. Thus, as the GRC, these organisations organise responders and commit themselves to help in cases of emergency and verify that their units are trained. Therefore the German authorities help to fund these organisations and pay for their deployment in different operations. All NGOs described take care of comparable tasks as the GRC. Mainly the NGOs are responsible to organise the medical rescue service, the organisation of care for the people needing help as shelter and food. For example the Malteser Hiflsdienst erected a provisional tent-town for replaced people. Additionally the Deutsche Lebensrettungsgesellschaft is specialised for rescue operations in the water.

The NGOs (without GRC) organised 933 responders from Saxony plus 2121 responders from all other states in Germany. The Saxon responders were engaged with 25 disaster response platoons comparable to the platoons of the GRC.

The most important operations were named above. The NGOs operated with well trained and professional personnel, good equipment and were assessed as crucial element in disaster response operations especially to care of people in need for help.

The command and control approach of these organisations is the same as in the GRC. The units deployed by the NGOs are controlled by the incident command. Several of the named organisations had liaison elements in the staff elements at different levels of authority. However, during the Elbe-flood all NGOs complained about the organisation of their units and recommended to help to organise and control their own units in further operations. Often the responsible planners in the disaster management staff elements were not well informed about the capabilities of the NGOs. Thus their capabilities were not used effectively. The Arbeiter Samariter Bund criticised the disaster management and the coordination capability by the Saxon ministry of the interior. Following they set up their own operation control centre and organised their campaign themselves. This is unusual and caused several discussions when the whole endeavour was analysed after the disaster. Especially in the disaster management system of Saxony some major changes were organised by the officials. But also the NGOs changed some of their structures to enable better coordination with the authorities in future operations. To summarise the coordination efforts one could say that the NGOs early recognised that their capabilities were not used the way they should. Thus they organisationally restructured their units and engaged with own C2 capabilities to empower their units to operate within the whole disaster response system more efficiently.

Unorganised Volunteers

Due to the large scale of the disaster and the intensive media coverage an overwhelming willingness to help developed in Germany. Not only the extent of donations but also the number of volunteers willing to help was surprisingly high. When these volunteers began to travel in the affected areas problems to coordinate them arose. The Saxon Ministery of the Interior estimated

the number of unorganised volunteers. From Saxony circa 16,900 and from other areas in Germany 6,600 responders helped in Saxony voluntarily during the disaster.

The volunteers were engaged in a mess of operations. The problem of the officials was to bundle the remarkable potential of these responders and to route the responders to relevant tasks. Not in every case this was done sufficiently. However, a lesson learned was the procedure in the case of Grimma. In Grimma the centre of the town was cordoned off wide-ranging and assembly points for volunteers were set up. These assembly points guided the responders to an information tent in the middle of Grimma and there they were routed to the most relevant tasks. This procedure was quite successful and serves as a best practice example for future disaster response operations.

PROBLEMS ASSESSED

This chapter refers to the assessment done by the *von Kirchbach commission* (von Kirchbach, Franke et al., 2002). The report prepared by the commission lists problems in a lot of areas not all relevant to this case study. Here the concentration is on command and control issues in a broader sense. Of course relevant issues like communication and coordination are reflected but also relevant facts about the structure and jurisdictional organisation of the disaster management system in Saxony are addressed. The chapter is structured beginning with the overall preparation of the disaster management in reflecting issues as flood registration services, the organisational structure of the disaster management system and the preparedness of the respective disaster management organisations. Following, the management of the disaster itself is assessed. The focus in that description is on the disaster management authorities and their coordination efforts during the flood disaster.

DISASTER MANAGEMENT – PREPARATION

Flood preparedness covers different aspects, such as:

- technical flood protection as the construction and maintenance of levees, dikes and dams;
- the organisation of a mature flood registration service;
- a mature and efficient structure of the disaster management system;
- the preparedness of the each respective element in the disaster management organisation.

As technical flood protection is not relevant to this case study it is not discussed. The other three aspects follow.

Flood registration service

Flood registration services shall help to forecast the development of water levels and flooding in particular areas to support the response operations with an important part of the relevant situational picture. Thus a lot of technical sensors are required to measure water levels and the amount of rain feeding the rivers. Additionally a precise weather forecasting capability is required to have information about the expected rain development. The integration and intelligent interpretation of these different data sources requires mature simulation models to predict the development of an ongoing flood offering qualitatively precise results. The sooner these results are available the more time the response forces gain to plan their operations. The ability to proactively control the disaster is inherently dependent on the capabilities to predict its development. Thus the flood registration services and forecast capabilities are one central element of the overall flood response management.

Actually this highly developed flood registration service was not available in Saxony in 2002. Although a lot of sensors are installed at Saxon rivers and dams and also weather forecasting is available the system failed according to three main reasons:

1. An inefficient organisation to report data;
2. Insufficient value of information;
3. Lack of interpretation of weather forecasts.

(1) Flood registration service shall enable all organisations involved in the disaster response to get awareness of flood development. However, during the first part of the flood (Erzgebirge) disaster response organisations especially at the district level got the information about water levels mostly too late. Thus the actual water levels were usually higher than the predicted due to the time gap caused by the complicated chain of report (Figure 7). In Figure 7 the most left side depicts the sources of data and the box in the middle the organisations involved in collecting but not fusing and enriching data until the chain ends on the right side at the district or local level where the disaster management has physically to react. Four different regionally de-conflicted organisations are responsible for the analysis of data. As all rivers flow across these artificial borders, a complete and fused situational picture was not available and neither reporting speed nor reporting quality was sufficient.

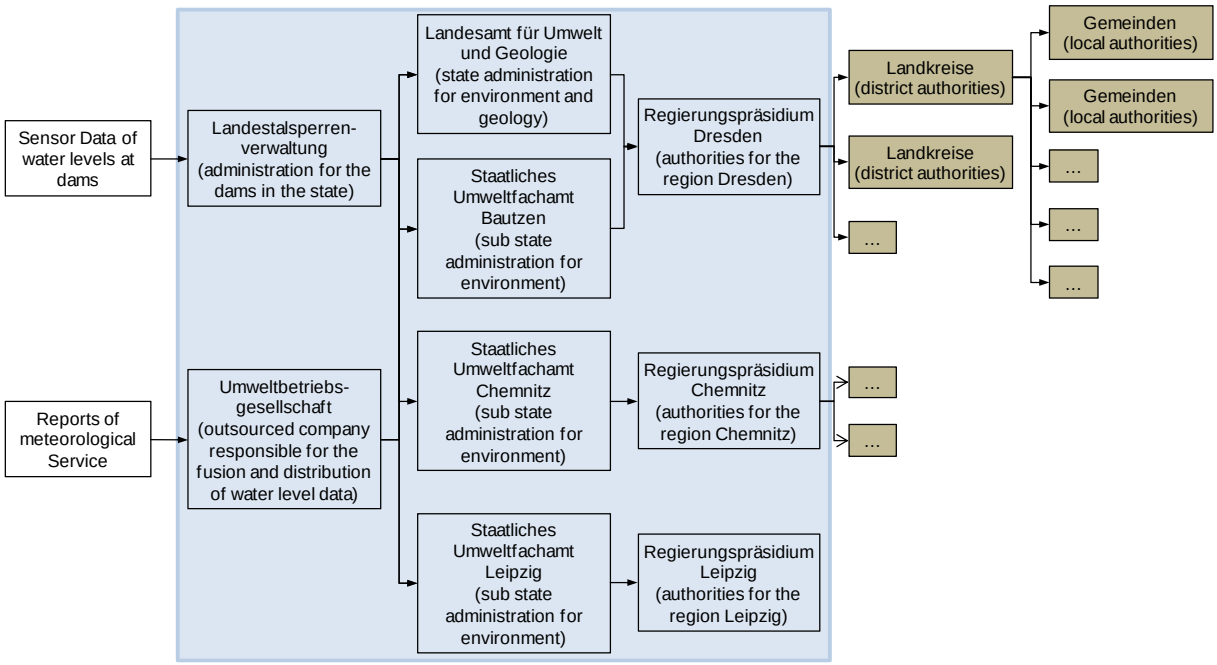

Figure 7. Flood registration service - chain of report (von Kirchbach, Franke et al., 2002)

Example: Figure 8 depicts an exemplary flood warning report in German language to explain the situation at the upper Elbe and its tributaries on August 12, 09:30 AM. The report informs:

1. About the amount of rain of the last 24 hours and the forecast of rain until the next morning (24 hours);
2. That water level warning step three or four (highest possible) is possible;

3. About water levels between 06:00 AM and 09:00 AM (half an hour old) as attached file without any analysis or any predictions.

The actual development of water levels in the described time span show contrary to the implicit messages of the forecast an explosively increase of water levels. In Liebstadt / Seidewitz the water level increased by 400%. At 02:00 PM the water level had increased by 1000%. However, due to the latency time caused by sending half-hour old data and more important a time gap between sender and receiver, responsible for action of more than 35 minutes data was more than an hour old and not fused to action relevant information.

At August 12th, 15:00 PM another report warned that in the areas around the rivers Weißeritz and Müglitz water levels of warning steps three to four are possible. More than one hour before the report left the sender the affected district Weißeritz proclaimed emergency alert because the river Weißeritz flooded the town Weißeritz.

All in all the reporting system was especially in the highly dynamic beginning of the disaster not able to cover the dynamics of the flood development due to structural problems of the reporting organisations involved as the chain of report is too complicated and too long.

(2) The value of reported information was insufficient. Weather forecasts of the meteorological institutes and the water levels were simply forwarded and lacked predictive power. Thus the operation planners had little knowledge about future situations in their own area and in neighboring areas. Important data influencing the situation and giving a comprehensive situational picture as the inflow of water into dams, the ratio of the amount of rain per time plus the increase of water level per time was neither fused nor forecasted.

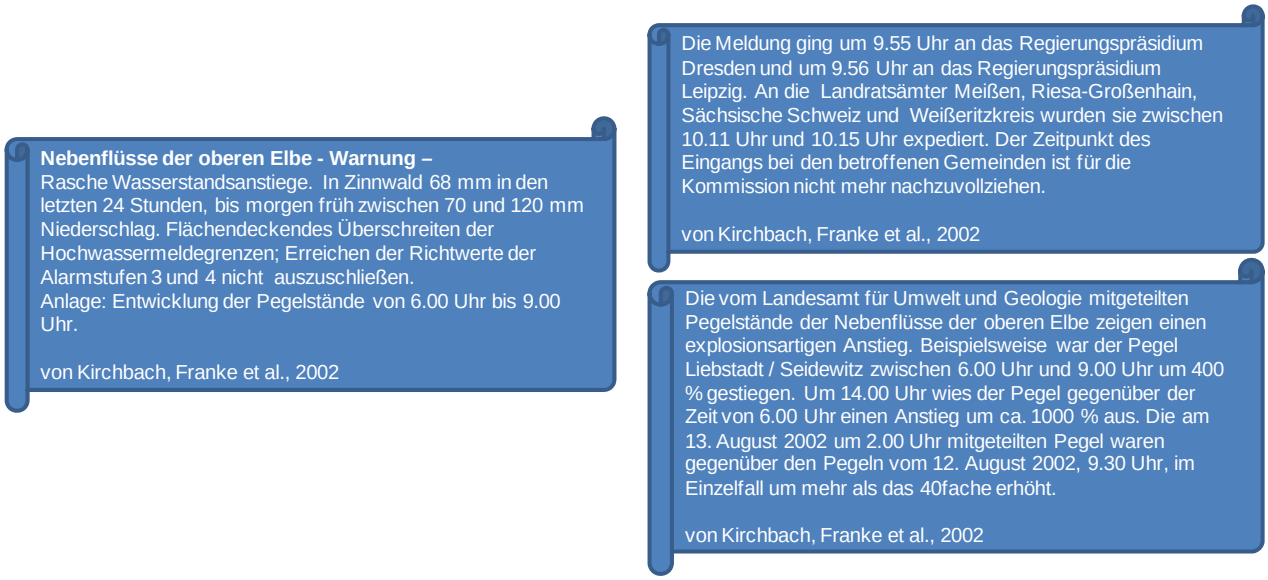

Figure 8. Exemplary flood warning reports and the assessment by the v. Kirchbach commission (von Kirchbach, Franke et al., 2002)

(3) The meaningfulness of weather forecasts was criticised. Weather forecasts were not specific enough for special areas and offered too less information. Not all possibilities and meteorological services were used during the disaster.

The structure of the disaster response system

The Elbe flood revealed several problems with regard to the organisation of the Saxon disaster response system, as blueprint for the organisation of German disaster response organisations at the state level (Figure 9).

In case of emergency – following the principle of subsidiarity – the districts are responsible first (Level 1). If the scale of disaster requires more than the district's forces, the regional level and at least the state level have to help or to overtake coordination or management of the forces required. Afflicted districts constitute incident commands. These usually mobile commands are responsible to command the tactical operations of the forces in the field. The disaster management authorities however are responsible to control and thus for requesting forces, financial help or public relations management. The disaster response organisations as described above send liaison elements: (1) into the respective disaster management authorities helping to establish a staff ready for operations and (2) into the incident commands to coordinate and to plan operations in the field. The fire departments are usually responsible to establish the incident commands as they usually are in the afflicted areas first and have the required skills to plan, coordinate and lead tactical operations in disasters.

The overall hierarchical structure depicted by Figure 9 was not criticised by the official commission. However, the leadership culture and C2 understanding of the disaster management authorities was. Most of the incident commands and lower disaster management authorities were positively highlighted by the report. These organisational elements usually convinced through acting pragmatically, anticipating the situation and helping very unbureaucratically. The higher disaster management authorities at regional levels and the highest disaster management authority at state level were criticised for being poorly organised in the beginning and for not efficiently being able to allocate available responders as the disaster required. More important, neither higher disaster management authorities nor the highest disaster management authority were able to create a situational picture in the beginning of the disaster allowing disaster planning and informing the lower disaster management authorities what the situation is and how it will develop. With this lack of situational understanding at the higher level authorities it was not possible to coordinate the disaster response forces efficiently nor to coordinate the operations in the field effectively.

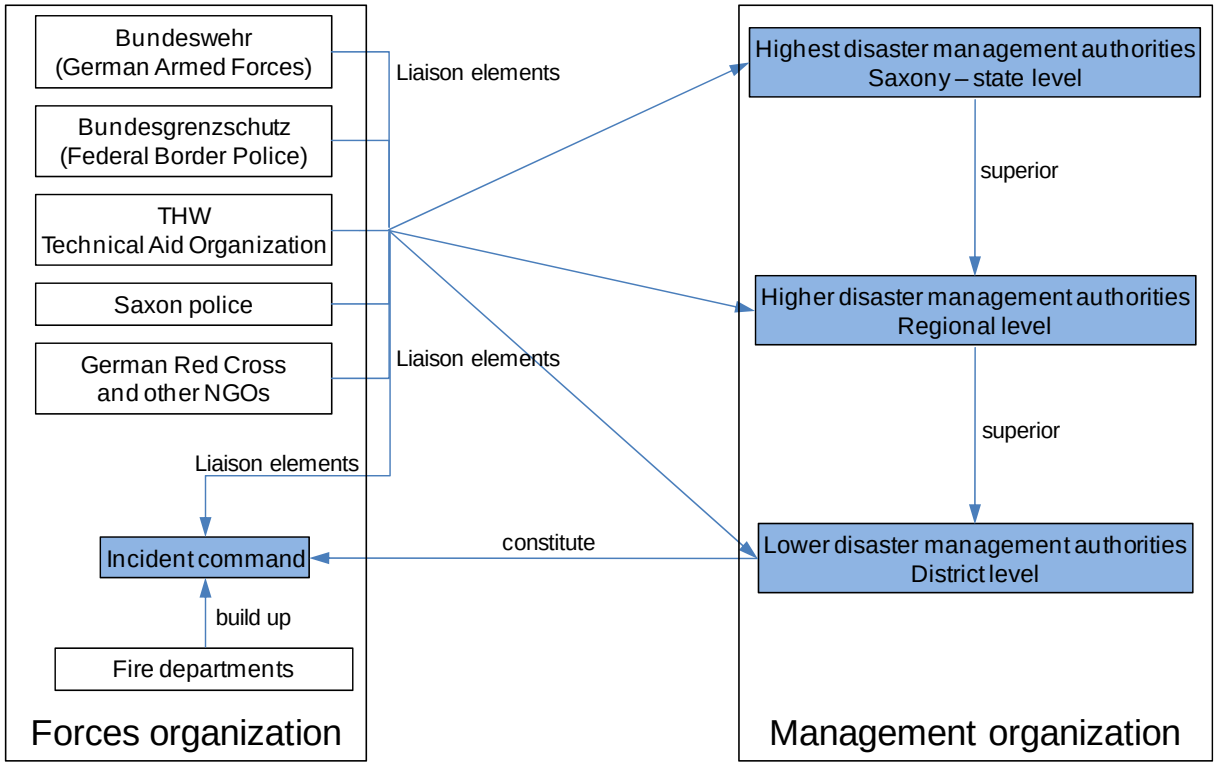

Figure 9. The organisational structure in case of disaster

Preparedness of the disaster management authorities

Disasters usually occur suddenly and unexpectedly and call for high preparedness and a high training status in all response organisations. Regarding C2 during Elbe disaster the preparedness of disaster management authorities is of predominant interest.

Lower disaster management authorities:

Most of the lower disaster management authorities were well prepared and responsible personnel was trained at the *federal academy for disaster management, emergency planning and civil protection*. Situation rooms for planning and situation assessment were prepared and management tools and communication means available. All districts had up-to-date disaster and evacuation plans. Communication to forces like Bundeswehr, Bundesgrenzschutz, THW and others was prepared. Albeit this overall positive assessment, some problems occurred:

- During disaster lower disaster management authorities have to build up a disaster management staff ad hoc. In daily business usually only two or three people per district work in the field of disaster management. Thus, in case of disaster the staff is not experienced as team.
- The personnel planned to be in the disaster management staff was to small in number and it was difficult to establish a shift operation with an efficient battle rhythm.
- The quality of disaster plans was somewhat mixed. Not all affected districts had plans for cases of flooding.
- After power blackout caused by the flood, most communication means did not work and it was usually hardly possible to find alternatives for communication between staff and field.

- The maps used in the different districts were often different. This caused coordination problems.

Despite these problems it has to be emphasised that the disaster in Saxony was completely unexpected regarding its scale and it is understandable that problems in managing a disaster of that scale cause problems. The lower disaster management authorities tried their best and organised the response organisations quickly and effectively at all.

Higher disaster management authorities

Preparedness of the higher disaster management authorities at regional level can be assessed as being acceptable. In all three regional authorities situation rooms and communication and organisation tools were prepared and after-hours service for the branch chiefs of the staff was established. Communication linkages to important forces were active or able to establish shortly. All three authorities experienced a lot of knowledge from earlier training exercises, they were responsible for.
Albeit the responsibility for conducting training for lower management authorities is helpful and opens eyes for existing problems, these exercises gave the higher disaster management authorities not the chance to be in charge and to train the processes necessary in a professional staff. Although it was from a jurisdictional viewpoint possible and from an operational viewpoint necessary to concentrate command and control at the higher disaster management authorities it did not happen and actually it seemed not possible regarding the professionalism of the staff management at the higher authorities.

Highest disaster management authorities

The highest disaster management authority at state level was not fully prepared for large scale disasters. Although an after-hours service was implemented and personnel were instructed in the tasks, the implementation of a disaster management staff was not prepared. The Ministry of the Interior was not fully able to run a staff of required size to control the disaster relief operation, neither from the personnel nor the material aspect. A situation room was not prepared. However, a conceptual idea existed that the situation room from the police could be used. As planning work and situation tracking and assessment has to take place in the disaster management staff, the idea seems not to be adequate.

The highest disaster management authority never trained together. Although this office usually initiated training for subordinated authorities, training was never conducted at state level – not even staff exercises. At the climax of operation staff had 80 personnel, a number not manageable without a plan of work and without having trained procedures.

MANAGEMENT OF THE DISASTER

As in the previous chapter describing the preparedness of the disaster response management system this chapter reflects the management of the disaster itself in the same order beginning with the lower disaster management authorities followed by the higher and the highest disaster management authority.

Lower disaster management authorities

The flood’s extent made it necessary that almost every Saxon district had to proclaim emergency alert and therefore nearly all districts were directly involved in the flood disaster. Nevertheless

the intensity differed strongly. However, this assessment tries to reflect overall problems without going into detail within several districts.

To assess a situation as ongoing disaster requires courage and willingness to take responsibility. Usually both are rare. But the earlier the situation is assessed the easier is it to plan actions and to establish disaster management staffs and incident commands and to operate properly. Additionally the proclamation of emergency alert is an important act as the disaster management staff gets the authority to command and control the whole district with all its forces available.

For the districts affected by the spring flood in the Erzgebirge the flood warning time was very short and early recognition of a developing disaster difficult. The districts affected by the Elbe flood had longer warning times. Due to the lack of situational pictures not delivered by flood registration service (as discussed above) the lower disaster management authorities at district level often recognised the disaster by their own observations or by the workload of the fire brigades at district level. Fire brigades were completely engaged in operations very soon. Thus the disaster usually was recognised when it already happened. However, lower disaster management authorities were quickly able to establish required staff elements to handle the operations and proclaimed emergency alert often in a reasonable time.

Due to the short response time in the first phase of the flood disaster it was not possible to introduce forces from outside of the respective district and the lower disaster management authorities in the Erzgebirge had to cope with the situation on their own. Incident commands were established very creatively and flexible to meet situation's requirements. In some cases lower disaster management authorities entrusted local authorities with the responsibility for operations. In other cases more than one incident command was established to cope with the spatial extent of the district's operations. All authorities coped with the situation differently as a high level of agility was required and also demonstrated.

Due to the rapid disaster development and the lack of possibilities to coordinate the processes between districts, a coordinated information exchange to clarify the situational picture did not take place. Following, requests for forces given to the higher disaster management authorities often lacked preciseness and were formulated too late. Incident commands were sometimes not able to cope with the situation including the establishment of a situational picture qualifying to request special capabilities as helicopters or heavy equipment.

The lower disaster management authorities seldom communicated with each other and additionally got too less situational information from superior authorities. Damaged communication infrastructure and the reduced technical ability to exchange information was however only one reason.

Although lower disaster management authorities usually lacked sufficient operational pictures, higher disaster management authorities were too inactive in coordinating efforts and especially in coordinating requests for forces in a proper way. During the flood disaster a lot of informal requests for forces were recognised. For example fire brigades having special partnerships with fire brigades from different states asked for help. The same did NGOs and local authorities. Often requests were too imprecise and it was often argued that the capabilities of different organisations were not well known by the requester. Additionally a lot of forces from other states wanted to help and came to Saxony without request. All these issues hampered efficient coordination of forces available especially in the beginning of the overall operation.

A problem directly linked with the C2 system was the warning of the people living in the areas affected. A general warning system helping authorities to inform and instruct people to avoid severe threads and helping to understand authorities' decisions was not installed in Saxony. Lower disaster management authorities tried their best to inform people often a tenacious process in which fire fighters went from house to house to inform and warn people. Due to the lack of forecast in the beginning of the disaster this was extra problematic. Lower disaster management authorities had no solid access to regional channels of mass communication.

Maybe the most serious challenge for lower disaster management authorities was the overwhelming amount of evacuations and the numerous rescue operations. If a coordinated evacuation operation is not timely possible, the probability, that a rescue operation has to be conducted, increases. Although the disaster management authorities and the early responders tried their best during early stage of disaster, timely evacuation of endangered people was not always possible for two reasons: (1) The unexpected and rapid increase of water levels in the Erzgebirge and (2) the unwillingness of some people in affected areas to leave houses. Both reasons were worsened due the lack of a feasible warning system. Actually several hundreds of people had to be rescued by helicopters as consequence of unwillingness to leave their houses—a considerable increase in coordination effort of lower disaster management authorities especially regarding the fact that helicopters or applicable boats often were not available in rural districts. Due to bad weather conditions and the lack of availability of helicopters and special boats, air rescue operations started lately at the morning of August 13th. Helicopters and boats were mostly provided by the Bundeswehr and the BGS. During the disaster response operation a helicopter coordination command was established in Dresden to ensure that helicopters operate efficiently. Boat rescue operations were conducted beginning in the night of August 12th, usually by fire fighters. But powerful boats able to manoeuvre in the flood were not always available. Fire departments usually had only small boats but nevertheless the fire fighters tried to rescue people and endangered themselves and sometimes had to be rescued themselves. When the Bundeswehr and the BGS were logistically able to provide larger boats the operations went more successful.

Beginning at night of August 12th numerous evacuations took place. The Ministry of the Interior estimates the overall number of evacuated people at 45 thousand. An evacuation operation of that extent requires valuable plans. Empty places useful for housing, sanitation facilities and water and electricity supply have to be appointed prior to operation and responsible authorities have to be able to communicate and to coordinate plans and actions. Capacities to accommodate people evacuated were suitable. Coordination efforts of lower disaster management authorities were effective.

However, frictions often occurred when authorities had to decide whether an area has to be evacuated or not. Flood plans available did not envision water levels of that scale and deciders had to approximate the situation to evaluate the secureness of areas. Evacuations of hospitals or homes for the aged are certainly extra challenges. Plans for these evacuations were sometimes not designed. Although hospitals had always plans to take in evacuated from other places, often no plan was available how to evacuate a respective hospital. The successful evacuation of hospitals, under these circumstances, call for a high level of improvisation and creativity. The von Kirchbach commission assessed the evacuation efforts as being effective with regard to the scale of the operation.

The Saxon disaster response system designates no responsibility in case of disaster for local authorities. This is confusing as villages and towns are strongly affected by a disaster.

Struggling for competencies cannot surprise and was actually assessed especially in strongly affected communes where the incident command was overburdened. Communes should play a major role in the disaster response system at all.

A critical success factor of an efficient and effective C2 system is the availability of information. Hierarchically structured organisations usually define information flows very strictly from bottom to top. In the Elbe flood disaster lower disaster management authorities were obliged to inform several superior authorities at certain times. The purpose of these messages was often not clear and the necessity to inform several parallel superior authorities sometimes had the flavour of broken hierarchies. For lower disaster management authorities these messages appeared only as effort causing with no affect for own command and control in any further way. Information about the overall situation or the situation at neighbour counties was usually not offered by superior authorities. Communication with neighbour counties is not intended by the respective decrees. However, sometimes information flows were established as initiative of single persons. For example the office responsible for the levees in Saxony tried to inform affected countries directly ignoring the chain of report. But this was an exception from the principle. The lack of information often caused unnecessary latency. Information about the overall situation by superior authorities is crucial in every operation especially in disasters.

Higher disaster management authorities

Saxony's three higher disaster management authorities were with their staffs at an early stage ready to deal with the disaster and established the connection and the communication link to the respective lower disaster management authorities quickly. All three offices tracked the ongoing situation and informed their superior office at the Ministry of the Interior. To create an accurate situational picture was difficult because many communication systems were physically damaged by the flood and satellite communication was not available. However, the information about emergency alert proclamations in the counties always reached the higher disaster management authorities. As reaction all three regional authorities discussed intensively to proclaim emergency alert centrally coordinated for the entire region of each distinct authority. Surprisingly all three authorities decided not to proclaim regional emergency alert as the offices felt unable to take over the lead on spot. The line of argumentation stressed always the counties' better ability to decide this question. This shows a wrong leadership culture and was sharply criticised by the official report of the von Kirchbach commission. The commission expected the regional authorities to take over the overall coordination without diminishing the ability to decide more regional questions, the counties are responsible for. The regional authorities evaded their responsibility.

In more general, the role of the higher disaster management authorities lacks in clarity. A takeover of a leadership role could not be observed. The higher disaster management authorities felt mainly responsible to inform the Ministry of the Interior, and to discuss some local decisions with lower disaster management authorities. Additionally some liaison officers were sent to districts to improve information flows upwards back to the higher disaster management authorities and to advice the decision makers. However, these officials tried not to lead the operations or to improve the overall command and control. Neither had they improved the information flow towards the affected districts to develop higher Situation Shared Awareness.

A qualitative indication that the overall reporting system between districts and regional authorities did not work properly was the circumstance that personnel from higher management authorities often tried to assess the situation directly on the spot but that their offices did not

provide the overall situation picture for the districts. The overall role of the higher disaster management authorities was too passive. They cared about single decisions for their subordinates, tried sporadically to coordinate the introduction of new disaster response forces (for example from other states) but without being able to organise and coordinate the whole operation.

Highest disaster management authority

The highest disaster management authority represents the Saxon Ministry of the Interior and is accountable for all disasters taking place in Saxony. In the beginning of the Elbe flood disaster the disaster management department of the Saxon Ministry of the Interior worked with the officers in the department, only. However, during disaster development more personnel were required. On August 14th (too late) the department decided to establish a disaster management staff according to the regulations of the Saxon law defining the structure of the staff. The department decided to involve liaison officers of the respective disaster response organisations described above and to request assistance from the fire department Hoyerswerda and the fire fighter school to organise the staff's processes. Due to this decision control of the disaster response operation was gained back. However, as described for the higher disaster management authorities in the previous chapter, also the highest disaster management authority was not willing to decide consequently about questions considering interregional issues. A lot of effort was invested to develop and maintain the overall operational picture often by sending liaison officers to subordinated offices. These liaison officers often advised the decision makers at the lower echelons. The operational picture was not sufficiently developed due to reporting routines as these were not mature enough developed.

The commander of the entire Saxon disaster response operation was the head of the disaster management division in the Saxon Ministry of the Interior. This decision created some frictions. As the Saxon Ministerpräsident (head of government of the state Saxony) and the minster of the Interior were superior to the commander it was difficult to task other governmental parts as the Ministry of Healthcare for example. The Saxon Government in total made not clear enough (also not mentally) that the operation needs an approach that is able to use all Saxon forces available. The commanding role of the Ministry of the Interior is not discussed. However, a strong involvement of other governmental departments as the Ministry for Environment and Health is important in a disaster of this extant. Here the political leaders should actively take the responsibility for leadership.

After the first phase of the disaster response operation the highest disaster management authority made two decisions of importance. First, subordinated offices were tasked to request all forces needed directly at the highest disaster management authority. Second, all German states were asked for sending forces only when agreed by the highest disaster management authority. Both decisions helped to coordinate the request for forces but came too late.

The highest disaster management authority decided to defend a central communication facility in Dresden directly, although the regional command was responsible. This decision was crucial to protect mobile communication from downfall.

An important task for the highest disaster management authority was to communicate with mass media. The TV and radio stations were overwhelmingly interested and tried to figure out all information available. The cooperation with media was well organised by the press centre established by the Ministry of the Interior. However, the officials utilised this information flow

as information base for the people in the areas affected. As they do not have full control about information this practice is to criticise. To inform and to warn as well as to direct people secure, not manipulated and trusted channels are needed. In Saxony a law about official statements broadcasted by media exists but its possibilities were not used. To inform people official statements shall be released.

IMPROVEMENTS RECOMMENDED

Following improvements with regard to disaster preparation and disaster management are recommended. The recommendations are in line with the von Kirchbach report but emphasise C2 relevant aspects.

IMPROVEMENTS FOR THE PREPARATION OF DISASTER MANAGEMENT

Flood Registration Service

The operational planners need more specific weather forecasts with regionally relevant and actionable content. The amount of rain, the saturation of ground or the inflow and outflow of water form levees are important indicators for the development of floods and necessary input-variables for flood simulation systems. When the German Weather Service is not able to deliver all information needed, officials should investigate further private service providers to gain pre-planning-time to respond more effectively during ongoing disasters.

Efficient forecast requires efficient information chains. Thus, the flood registration service is to organise in a networked information environment using modern media. This means that all responsible organisations need a central information source which is filled decentralised and organised as a combination of pull and push information system. Information necessary to warn officials that disasters will occur or significantly change has to be pushed. Information needed in an operation should be mostly pulled by officials.

The organisation providing the central information source should not only provide isolated information chunks but also make use of simulation models and should permanently analyse the overall situation on different levels of perspective. This organisation is the sink for situation reports. Especially lower disaster management authorities suffered from their fragmented reporting chains. One information sink should help to reduce the effort to inform superior organisations and to improve the possibilities for superior organisations to create an overall situational picture. Additionally, this centralised organisation should always be able to inform all organisations responsible in a 24/7 modus.

The Structure of the Disaster Response System

The jurisdictional separation of fire protection, medical response and disaster response represented by three distinct laws in Saxony is too artificial and bureaucratic. It is recommended that necessary regulations for all three separated concepts should be merged into one disaster response law, as these areas complement each other. Actually, in case of emergency always the rescue coordination services, the medical response teams and the fire brigades are the first responders involved. The main efforts in disasters handle the fire departments with plenty more tasks than only fire protection. Additionally, NGOs provide important health care services during the fight against disasters. They shall be strongly networked with the medical response teams to have the ability to help quickly.

Local authorities in the communities should be integrated into the disaster response system. The communities, villages and small towns are affected by disasters and their motivation to help should not be underestimated.

The rules and regulations for practical work in disaster operations are too detailed and too plentiful. They hinder the concept of Auftragstaktik and to act flexible and with sole responsibility.

Preparation of the Disaster Management Authorities

Compared to the different levels of authority the preparedness of the disaster management authorities was inhomogeneous. The role of the higher disaster management authorities was not clear enough. Leadership understanding and culture was to some extent diffuse. The scope of responsibility for the higher disaster management authorities should be examined. A stronger but also a weaker role would be possible. A lot of organisations involved in disaster response do not have a structural equivalent to the higher disaster management authorities. This hinders the communication and especially the first contact. However, the elimination of the higher disaster management authorities would strongly increase the span of control for the highest disaster management authority in case of a large scale disaster.

All disaster management authorities need standards for the organisational preparation of their work during disasters. Especially regulations for the fast establishment of staff organisations, preparation of control means as maps, prepared communication channels and media are crucial for fast respond. One major problem is the availability of communication channels during disasters. Most communication means are dependent on electricity and therefore the likelihood of downfalls increase with the scale of the disaster. Available and robust communication channels are antecedent for command and control. A stable communication system and plans to organise the work in case of communication downfall are required for the overall system of organisations.

In Saxony, a software based planning system for disaster response is not available. The federal government promotes the development of software named “DISMA.” During Elbe flood this system played no role. Command and control applications are valuable tools for planners and decision makers but it is absolutely crucial to train with these means.

Training is one of the most critical success factors for emergency management. The whole disaster response system should train on a regularly basis. Not only the lower disaster response authorities together with the forces available should train but the whole hierarchical system involving all disaster management authorities. In case of disasters the organisations should know each other to work together. The federal academy for disaster management in Ahrweiler is the right partner to organise these trainings and manoeuvres.

The incident commanders play key roles in disaster management. All districts should train incident commands and designated incident commanders within their respective roles.

The organisation of large staff elements like the staff of the highest disaster management authority requires professional personnel, rules and processes. Such collaboration plus the ability to work shifts has to be planned. The personnel of these staffs should be trained in staff-work and supplemented by uniformed personnel experienced in staff-work and staff organisation.

A modern leadership culture based on the Auftragstaktik is to achieve across all levels of command. To take-over control does not mean that lower echelons are not longer responsible or await orders inactively. But to shift control and responsibility to higher levels of command can help to foster coordination and to identify important requirements for different situations and locations better. Nevertheless, it is crucial to describe tasks of all organisations to enable

organisations to respond quickly. Additionally organisations shall have the flexibility to collaborate at lower levels of responsibility.

IMPROVEMENTS FOR THE MANAGEMENT OF A DISASTER

To increase the overall quality of future respond operations comparable to the Elbe flood it is necessary to increase efficiency. Although reaction times are unavoidable, it must be goal to shorten these latency times. Therefore it is crucial that all disaster management authorities have access to at least the most important disaster response organisations. One possible way is via liaison officers. Authorities and liaison officers should train to request forces for special situations.

Increasing efficiency calls for the immediate begin of operations across all hierarchical levels of disaster management. This requires mutual training to maintain coordination processes. The avoidance of double requests and an unbalanced deployment of forces with regard to respective operational tasks are the goal of well defined coordination and reporting lines. Therefore training and common understanding is crucial. This enables the overall disaster response system to use forces where they are needed and to make the build up of reserves possible.

Disaster management departments within district, regional or state governments have no experience in modern staff-work. The management of operational pictures as basis for meaningful planning, the deployment of forces and the evaluation of dynamic situations is not the daily business of its personnel. These tasks have to be trained. Collaboration with the Bundeswehr or the federal police can help to train personnel and to be able to professionally manage the staff elements needed.

Rescue and Evacuation operations

Quick access to resources necessary to conduct rescue operations is a matter of life and death. Thus, all disaster management authorities should have the ability to request for these resources (especially helicopters, motor boats or divers) fast and directly. One possible way to increase the availability of these special rare resources could be to pool them at federal level.

The planning of large scale evacuation operations is necessary and no isolated task of one state. Evacuation plans should be reviewed periodically. Hospitals should be trained for own evacuation. The evacuation of elderly people and patients has to be organised across borders.

Additionally, during large scale evacuation operations family members of evacuated people must be informed. This is task of the German Red Cross. The organisation fulfilled this task during the flood. However, a lot of people but also organisations were not aware of it.

As a lot of highly specialised tasks are dispersed over the organisations, often particular personnel lacks of the awareness of which organisation is responsible for what. This lack of task orientation knowledge hinders quick coordination.

Information and Communication

Efficient communication requires (1) valuable technology, (2) well defined processes and reporting chains and (3) a mutual information and communication culture. All three aspects have to be improved to create information flows mature enough to enable the disaster response system to act timely and to operate in a collaborative manner.

During the Elbe flood no reliable, multi-media using technical communication network existed. Radio and mobile telephony were mostly used. Digital communication was rarely available. A lot of communication channels downfall due to water damages in electricity supply. Radio used by different disaster response organisations is not compatible. Satellite based communication and digital radio as state of the art communication means should be the backbone of a reliable and secure overall communication system. Additionally, this network must be accessible for all organisations and throughout Germany.

The processes to exchange information should be renewed. As lower disaster management authorities regard the one-way reporting chain as burden, superior organisations have to inform lower echelons as well. Both groups of organisations have to assess the overall situation and to plan the operations. Thus, reporting chains have to be established from bottom to top and vice versa.

The culture of information exchange is to renew, too. Information exchange in a networked world can be created as push-pull system. Not all information should be pushed. An information hub can accumulate and store information which can be retrieved dynamically and when needed. The idea of information management and communication is not for its own but should enable fast decision making and overall planning.

Communication to warning of people in affected areas has to be improved. Conventional warning means as loud speaker and sirens are helpful but not everywhere available. These instruments were uninstalled after the wall came down and the cold war ended. Nowadays these instruments are installed again. Additionally, modern, mobile and personalised warning systems as push-texts for mobiles and messenger information can be planned. The use of modern broadcast media as TV and radio and the reorganisation of the respective laws to enable the use of these media channels could either help to inform people in a qualitative manner enabling the authorities to give official orders.

Utilisation of Forces

The Bundeswehr as well as the BGS performed best when their tasks were large and able to be handled nearly isolated. The Kirchbach commission concluded that the well organised federal organisations should always manage large tasks in a de-conflicted manner following coordinated plans. Regarding the lack of communication means during the flood, tasking in the described manner seems to be sound. Furthermore both organisations' key capability is to control a high amount of forces in large scale operations. This capability should be used more systematically. However, this means that the practiced understanding of subsidiarity has to be rethought. At least the capability of both organisations to communicate and to organise staff organisations should be better utilised in future disaster response operations.

It is recommended that availability and capabilities of disaster response forces and their reaction times should be recorded in a database system. This knowledge supports better planning processes and enables better and faster coordination of response operations.

It is not applicable that all NGOs are represented in all disaster response staffs or in all incident commands. Collective representations under the lead of respective, locally most important organisation should be aspired. This requires fundamental knowledge about the capabilities and capacities of the organisations represented. However, the planning process would be easier to organise.

Federal aspects of disaster response management

Federal authorities as the German Ministry of the Interior have no responsibility in cases of disaster. Only civil defence in cases of war is task for the federal authorities. This distinction is a cold war product and does not seem to be applicable in future. Reacting to today's threats like natural or terroristic disasters requires the whole nation's capabilities. The nation's overall disaster response capability package is to assess and to develop as a whole. Special and expensive equipment will not be available in every state all over Germany. Thus, a coordination role in cases of large scale disasters taken by the federal authorities is necessary. Therefore a national disaster response initiative should start with the goal to develop a federal disaster management law and to harmonise the disaster management laws of the states. Additionally it is necessary to standardise the command and control processes and the structure of the disaster response organisations in the respective states. The role of the Bundeswehr is to redefine. When in case of large scale disasters federal authorities coordinate operations, the Bundeswehr is best suited to develop command and control processes and to manage staffs.

An important aspect of disaster response is the capability for a nation's people to help themselves. This capability is to promote and to train. People have to be aware of their own responsibility in cases of disaster. These training processes should start in school but follow on in all organisations.

MATURITY MODEL ASSESSMENT

The following assessment describes the maturity and consequences of C2 approaches following the approach developed by the SAS-065 study group.

The assessment is based on available reference materials in form of after action reports and evaluations. Usually these reports analyse overall operation's deficiencies but address C2 problems and interactions between organisations only indirectly. To verify the conclusions derived from the reference material and to develop better understanding of interactions in disaster operations, interviews were conducted with a senior member of the THW and with a district authority official. However, further research is necessary to improve understanding of the collaboration of organisations involved.

The results of the assessments are presented in form of matrices, one each for every variable. The assessed variables defining the C2 Maturity Levels are:

- Shared Intent
    - Collective C2 Process
    - Required Information Sharing Behaviours
    - Required Resource Sharing
- Expected Patterns of Interaction
    - Cluster Attractor
    - Degree of Inter-Cluster Connectivity
    - Frequency/Continuity
- Expected Values of C2 Effectiveness
    - Entity Information Position
    - Degree of Shared Awareness
    - Degree of Shared Understanding
- Indicants of C2 Maturity
    - Degree of Interdependence
    - Nature of Collective Decisions/Planning
    - Resource Sharing
- Measures of Mission Effectiveness
    - Relative Effectiveness
    - Efficiency, Given Effectiveness
    - Agility

SHARED INTENT

Shared intent is measured by the variables:

- Collective C2 Process
- Required Information Sharing Behaviours
- Required Resource Sharing

Edge C2	Emergent Self-Synchronization	Unlimited Sharing as Required	Entities Contribute Resources to the Endeavor
Collaborative C2	Collaborative Process and Shared Plan	Significant Broad Sharing	Contributing Resources Required in Shared Plan
Coordinated C2	Coordination Process and Linked Plans	Limited Focused Sharing	Contribute Assets to Coordinated Actions
Deconflicted C2	Establish Constraints	Very Limited Sharply Focused Sharing	Sharing Environmental Resources
Conflicted C2	None	No Sharing of Information	None
	Collective C2 Process	**Required Information Sharing Behaviors**	**Required Resource Sharing**

Figure 10. Variables assessing shared intent

Collective C2 Process

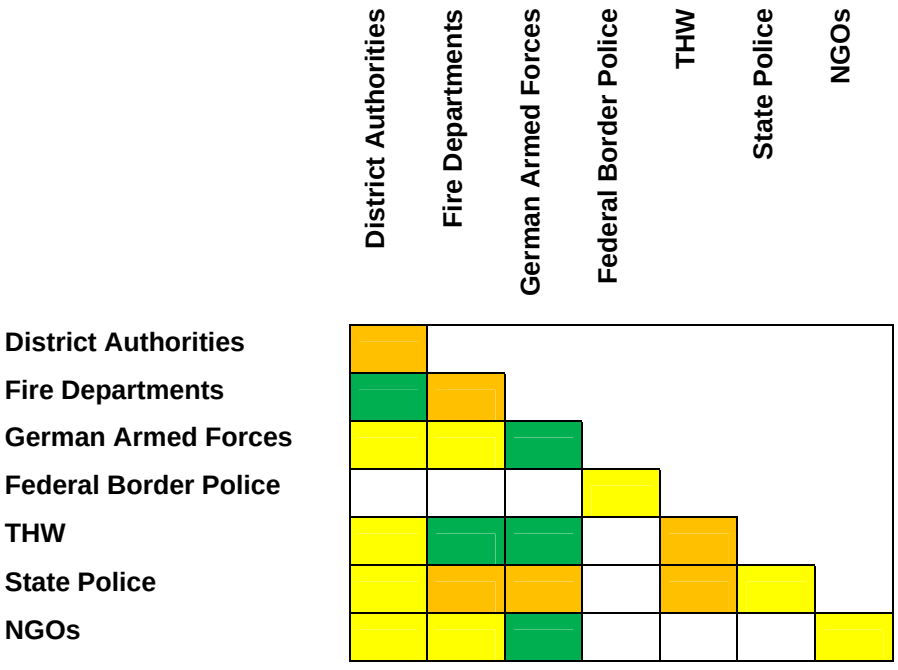

Table 2. Collective C2 Process

- *District Authorities* are responsible for disjoint territories serving as de-confliction constraints. Collaboration between district authorities is not regulated by laws and SOPs. However, in some examples direct face to face information exchanges between district officials of different districts took place on the spot and helped to develop courses of actions together.

- *Fire Departments and District Authorities* collaborate as the incident commands, usually established by the fire departments, work in close relationship with the disaster response staff, established by the district authorities. District authorities' culture is to support the tactical operations on the spot driven by the fire departments.

- *German Armed Forces and German Armed Forces, THW and Fire Departments, THW and German Armed Forces, NGOs and German Armed Forces* these organisations collaborated in the field. Especially the THW is a supporter and its responders usually work under tactical command of an incident commander. They come to a spot and always coordinate their plans with their partners very closely. NGOs and German Armed Forces built a camp for evacuated people jointly.

- *State Police and Fire Departments, State Police and German Armed Forces, State Police and THW* these organisations work together in an overall de-conflicted way. Although state police is represented in the disaster management staffs by their liaison officers, police personnel have its unique tasks to do. They ensure overall security during disaster and prevent urban terrains from looting. Additionally police is responsible for traffic regulations and take over other responsibilities given by the district authorities only when the state police personnel has capacities available.

The overall assessment for the *Collective C2 Processes* is rated as coordinated C2 insofar that all organisations are present by their liaison officers in the joint staff elements established by the disaster management authorities. All organisations fulfil specialised tasks and coordinate their plans closely. The von Kirchbach report provides numerous examples that the organisations involved in tasks directly on the spot (evacuation operations, rescue operations or levee saving operations) worked in a collaborative ad-hoc manner together and planned their actions jointly.

Required Information Sharing Behaviours

One major problem assessed by the von Kirchbach report was the insufficient flood forecast capability. The situation assessment support from the flood warning system was very limited and not sufficient to gain time for planning. The system is organised in a *de-conflicted* (hierarchical) manner with many instances involved in the overall process. Planning elements, especially in the staffs established by the district authorities, were informed too late and usually surprised by the ongoing flood event. As result, all responders lacked reliable information about the situational picture. Thus the flaw in information exchanges were not assessed as cultural but as technical and process oriented problems.

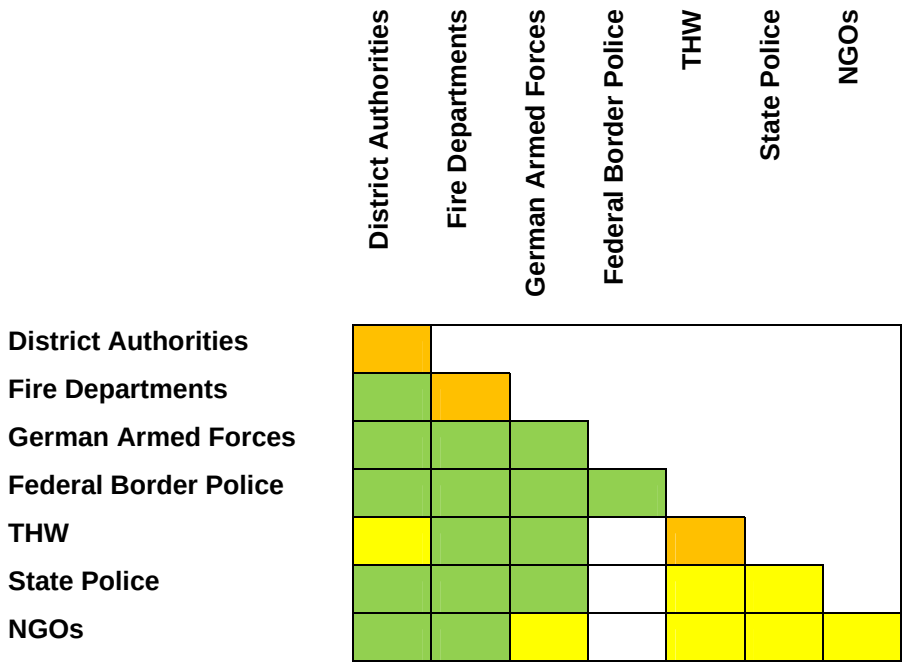

Table 3. Required Information Sharing Behaviours

- *District Authorities and District Authorities* are assessed as de-conflicted regarding the required information sharing behaviours. We assume it is required that districts pass on information about e.g. water levels not only to superior offices but also to neighbouring districts (area of interest). Due to the hierarchical administrative structure the usual information source for districts is the regional level of authority. Thus it is not intended that a broad and deep information sharing exists between districts. However, during the Elbe flood disaster districts often lacked an overall situational picture provided by the regional level. As reaction, the von Kirchbach report gives some examples that officials from the district authorities developed their own situational picture directly on the spot and exchanging information with their neighbour districts.

- *All organisational pairs assessed as collaborative with regard to required information sharing behaviours:* The flood forecasting system was insufficient and did not provide the information necessary for thorough planning. Higher disaster management authorities were seldom capable to provide rich information to clarify the overall situation. Thus, the organisations working together in tactical operations on the spot adapted their information sharing behaviours ad-hoc and did not conflict with each other but collaborated instead. The von Kirchbach report points out several opinions from responders that the collaboration between the disaster response forces was fruitful and well established and therefore we assume that required information sharing was significant broad sharing.

In cases when superior authorities are fully able to provide their subordinates with information (technically and content-wise) as needed, coordinated C2 seems to be sufficient. However, higher disaster management authorities were not always able to provide subordinated offices with the information expected. Thus, the required information sharing behaviours leveraged to collaborative especially at the tactical level of operations. Exactly this way the organisations

adapted and close relationships including personal contacts between the personnel enabled the organisations to collaborate and exchange information broadly and deeply.

Required Resource Sharing

All described organisations contribute very special capabilities all required in disaster response operations. They are De-Conflicted by function and have disposal of their own specialised resources. The incident command is responsible to plan coordinated actions with these organisations. However, some organisations accept full command over their units (THW, NGOs). Collaboration processes and collaboration culture preferred by organisations differ.

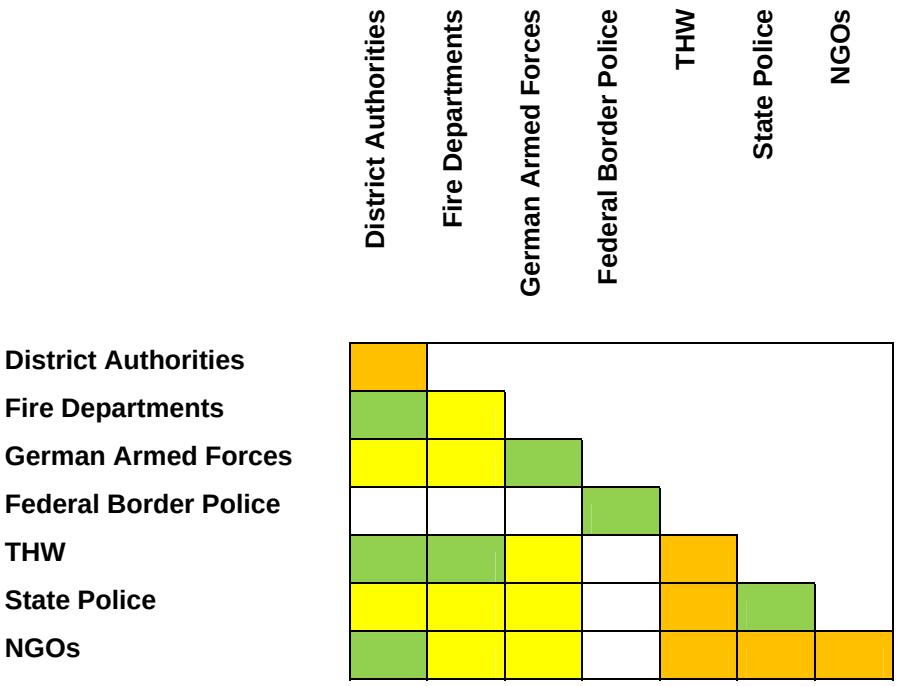

Table 4. Required Resource Sharing

- *District Authorities and all other organisations*: It is not required that district authorities broadly share resources with other districts as the overall idea of districts is to de-conflict via local borders. However when a district controls the disaster, its forces can be sent to other districts requiring them.
    - The units of THW and NGOs were usually commanded by the incident commands directly. The incident commands collaborate closely the district authorities' staffs. All resources provided to a district by fire departments, THW and NGOs are combined to a shared plan.
    - Both, German Armed Forces and state police contribute assets required to actions coordinated by the incident commands. However, both organisations are always responsible for the control of their units by their own.
- *All De-Conflicted couples without District Authorities and District Authorities*: Usually it is not required that the THW and the state police or NGOs share resources due to their degree of specialisation.

- *All Coordinated couples*: Large organisations as the German Armed Forces and the state police bring in assets in coordinative planned actions without shifting control of material or personnel. Due to their capability to command and control large scale operations their behaviour of asset contribution meets the requirements for resource sharing.

EXPECTED PATTERNS OF INTERACTION

The Expected Patterns of Interaction are evaluated by the following variables:

- Cluster Attractor
- Degree of Inter-Cluster Connectivity
- Frequency/Continuity of Interaction

Edge C2	Endeavor Objective(s) and Tasks	Complete	Tailored and Dynamic
Collaborative C2	Mixture, Largely Task and Some Home Entities	Rich	Continuous or Nearly Continuous
Coordinated C2	Mixture, Largely Home and Some Task Entities	Limited	Periodic
Deconflicted C2	Home Entity Organizations	Minimal	Episodic
Conflicted C2	Home Entity Organizations	None	None
	Cluster Attractor	**Degree of Inter-Cluster Connectivity**	**Frequency/ Continuity**

Figure 11. Variables assessing the Expected Patterns of Interaction

Cluster Attractor

Organisations established and trained to cope with national disasters are usually capable to deal with special aspects of flood events. Home entity organisations played an important role during the Elbe flood. Most of the organisational teams e.g. fire brigades or THW-units know exactly which area or location they are responsible for. However, the extent of the Elbe flood necessitates closer task-driven collaboration between organisations. Thus, the Kirchbach report exemplifies the organisation of inter-organisational teams handling tasks on the spot (e.g. camp erecting of Bundeswehr and German Red Cross units, Bundeswehr units reinforced dams and levees guided by a professional levee master or inter-organisational teams conducting complex rescue operations with Bundeswehr's helicopters, and fire fighters on the ground). Task oriented team building was effective when team members knew each other from either training or their daily work routine. Task oriented cluster building was – regarding the von Kirchbach report – not often observed within higher or highest disaster management authorities. Notwithstanding, the von Kirchbach report praises the international collaboration with e.g. Poland supporting with heavy equipment.

Numerous unorganised and unsolicited volunteer responders caused several coordination problems especially in the beginning of the operation. Whenever officials established gathering points for volunteers, it was possible to integrate them in tasks the response organisations were appointed with.

Arguing that some examples of clustering around tasks exist, the von Kirchbach report also stresses that more and more dynamic inter-organisational clustering could be possible in future endeavours. The key to enable the organisations to cluster around tasks and endeavour objectives is mutual training and mutual understanding of the capabilities brought in by the different specialised organisations.

Usually clustering was observable around home entity organisations or regions. However, formation of task entities was observed and organisations were able and willing to collaborate when necessary. Thus, we assess this variable to support coordinated C2.

Degree of Inter-Cluster Connectivity

We assume from the von Kirchbach report that entities clustered around a respective operational area (regionally) (see Figure 12 region A or B) had a rich intra-cluster connectivity with lots of interactions. As communication infrastructure was severely damaged in numerous regions inter-organisational connectivity within regional clusters was often enabled by face to face communication. The organisations worked together in the respective staff elements and in the tactical operations on the spot. An example in the von Kirchbach report illustrates that officials from different district authorities met on a critical part of a flooding river evaluating the situation and planning actions together.

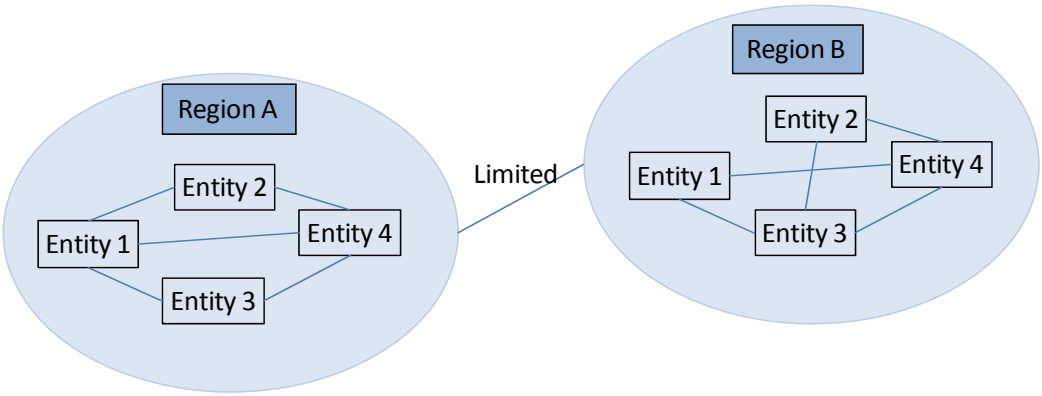

Figure 12: Relations between different clusters of organisations

The degree of inter-cluster connectivity between regions we assume as being limited with regard to communication infrastructure downfall. However, procedures hindered information and coordination exchanges between the regions either. Although higher disaster management authorities were responsible for inter-regional coordination, these offices were not able to establish rich connectivity to create a situational picture for its regions.

The previous section (link: 0) describes that connections between organisations (in that special case the German Armed Forces and the disaster management authorities) exist on different levels of command. Thus, officials can access capabilities of disaster response forces fast. A district with a garrison can request forces from the garrison commander and does not need to request these forces via its own chain of superior offices. As result the inter-cluster connectivity

is potentially high in the German disaster relief system with its interactions at all levels of authority. The system is consisted of highly connected stovepipe systems enabling on one side the training and establishment of culture and understanding within the stovepipe and on the other hand the flexibility and connectedness to react and adapt within the broader system with regard to the tasks at hand.

Frequency and Continuity of Interaction

Table 5 depicts the assessment of frequency and continuity of interactions between the different organisations during the Elbe flood. Note that we assume to consider two different levels of interactions. First, organisations interact continuously within different staff elements at district level and within incident commands. Second, organisations interact in different operations like rescue operations or evacuation operations as the situation requested.

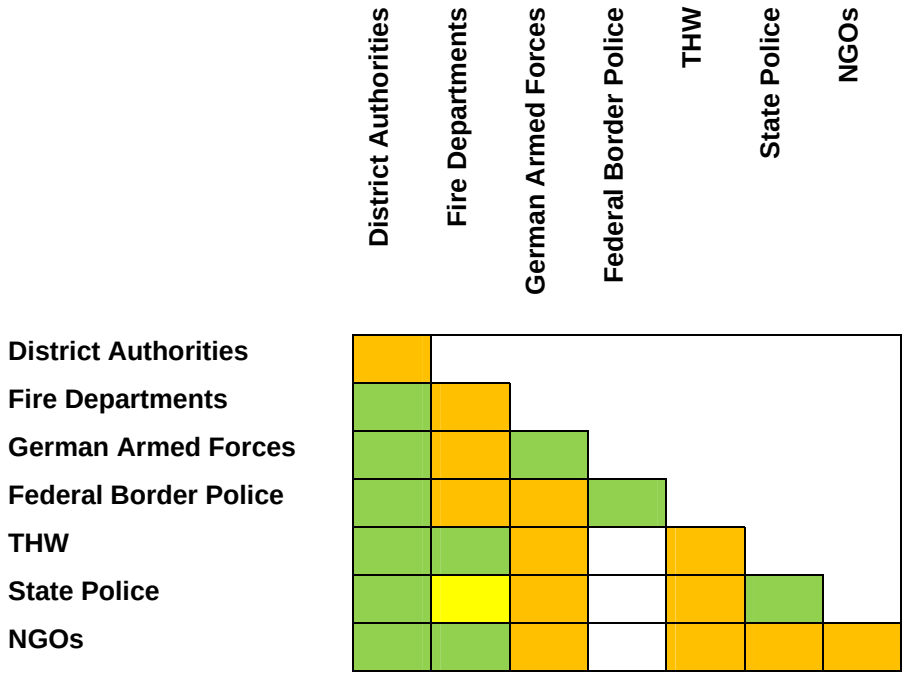

Table 5. Assessment of Frequency and Continuity of Interactions

- The interaction of district authorities with disaster response organisations is regarded as being collaborative. Numerous liaison elements from disaster response organisations gathered by the disaster response staff are enabler of collaboration.

- Interactions between disaster response organisations in the field are as the situations require and assessed as being episodic.

EXPECTED VALUES OF C2 EFFECTIVENESS

The expected Value of C2 Effectiveness is assessed by the following variables:

- Entity Information Position,
- Degree of Shared Awareness and
- Degree of Shared Understanding.

Edge C2	All Available and Relevant Information Accessible	Broad, Deep, Tailored and Dynamic	Broad, Deep, Tailored and Dynamic
Collaborative C2	Additional Information Across Collaborative Areas/Functions	Significant	Significant
Coordinated C2	Additional Information About Coordinated Areas/Functions	Limited	Limited
Deconflicted C2	Additional Information About Constraints And Seams	Focused on the Boundaries	None
Conflicted C2	Organic Information	None	None
	Entity Information Position	**Degree of Shared Awareness**	**Degree of Shared Understanding**

Figure 13. Variables assessing the Expected Values of C2 Effectiveness

Entity Information Position

The von Kirchbach report stresses that the higher disaster management authorities were not able to develop an overall situational picture. The information delivered by the flood warning system lacked quality and does not enable the officials to plan the operations properly.

The von Kirchbach report furthermore gives evidence that at the tactical level the collaboration among disaster response organisations was intensive. Information exchange can be characterised as being open and constructive, notwithstanding the limitations caused by numerous technical problems as incompatible technical radio infrastructure. The breakdown of communicational infrastructure during the disaster worsened those problems. However, the responders did their best to communicate via mobile, radio and face to face.

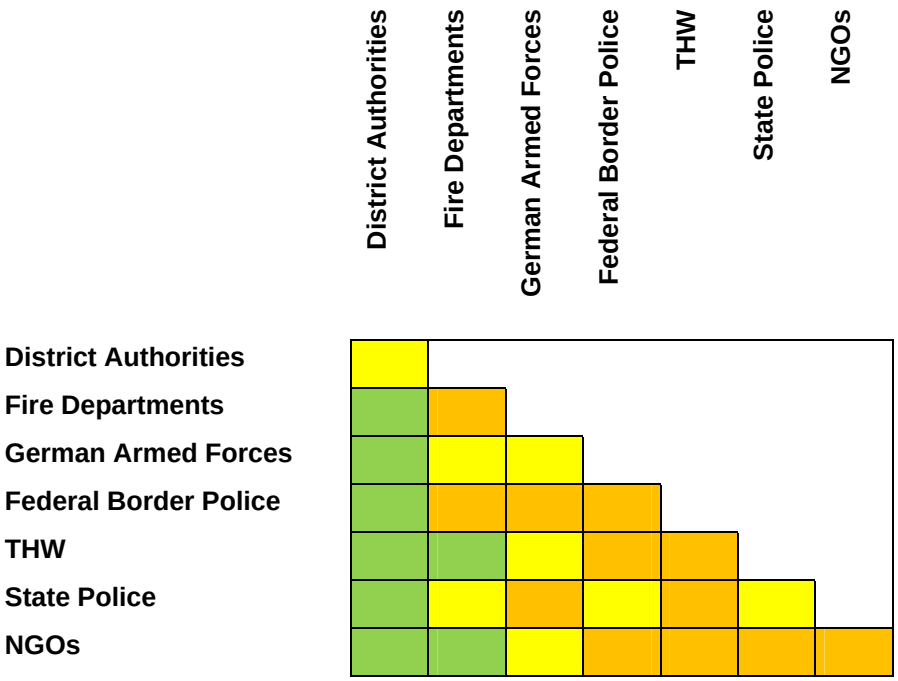

Table 6. Assessment of Entity Information Position

- *Column District Authorities*: The couples assessed as having information exchange at collaborative level were able to plan and cooperate within the disaster response staff elements and within the incident commands. The von Kirchbach report assessed this work as creative and effective. District authorities among themselves scarcely communicate as the system is designed: districts report to superior offices which coordinate.

- The couples being assessed as de-conflicted were usually de-conflicted by function or location. Their communication system was designed as de-conflicted as well. Reports give no evidence that between these organisational couples a higher maturity regarding communication processes was necessary.

Overall assessment: We refrain from providing an overall assessment for this variable for two reasons. First, the individual assessments are rather heterogeneous and second, the von Kirchbach report stresses the bandwidth of information sharing behaviours and their effectiveness for the respective organisation and the overall operation.

Degree of Shared Awareness

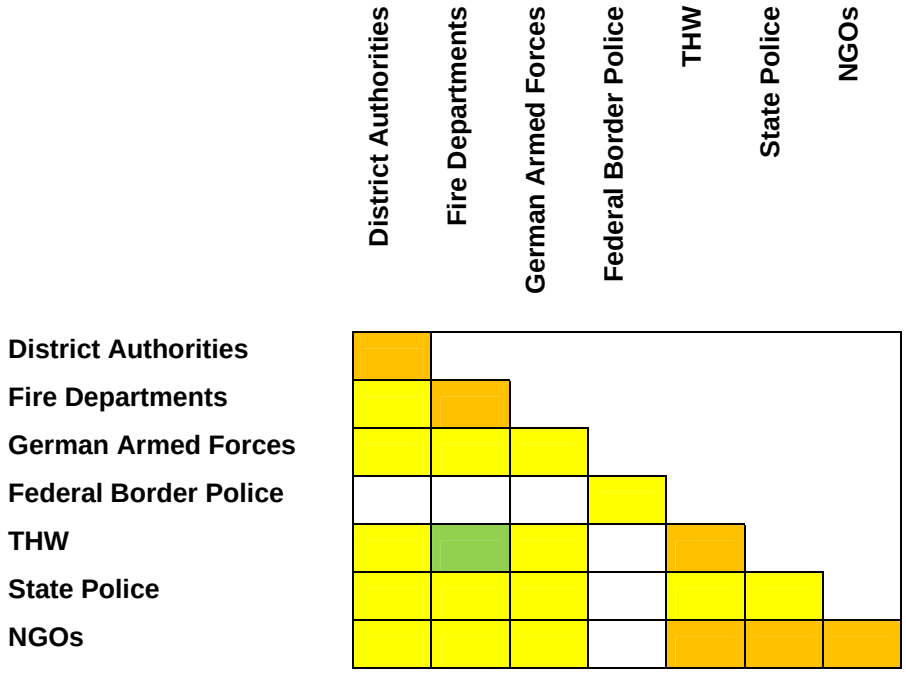

Table 7. Shared Awareness (SA)

- *District Authorities and District Authorities*: The lack of communication means and overall situational picture not delivered by superior offices hindered the development of situational awareness. Furthermore, boundaries and processes between districts were clear and well defined as the disaster response system uses local de-confliction as mechanism between districts. The development of situations was not communicated and shared awareness between districts is assessed as low.

- *All couples assessed as limited shared awareness*: Communication between disaster response forces was limited (incompatible radio, and communication system damages). However, through face to face communication in districts' staff elements and incident commands the organisations on the spot established at least a limited extent of shared awareness. Responders were able to coordinate tasks. The lack of situational picture reduced planning time and the disaster response organisations were forced ad-hoc into operations (especially rescue operations). Due to their comparable procedures in these operations, common training and a lot of personal relationships between the personnel of different organisations (fire brigades, district authorities or police for example) these organisations were able to construct shared situational awareness fast.

Overall assessment: Due to the problems with efficient communication (incompatible communication means and damages) and the insufficient role of the superior disaster management authorities in developing a situational picture which supports the districts and disaster organisations coping with the tasks in the affected areas the degree of shared awareness could not reach a high level. However, due to the cross organisational personal knowledge and the trained routines in rescue and evacuation situations at least the disaster response organisations were able to develop shared situational awareness fast.

Shared Understanding (SU)

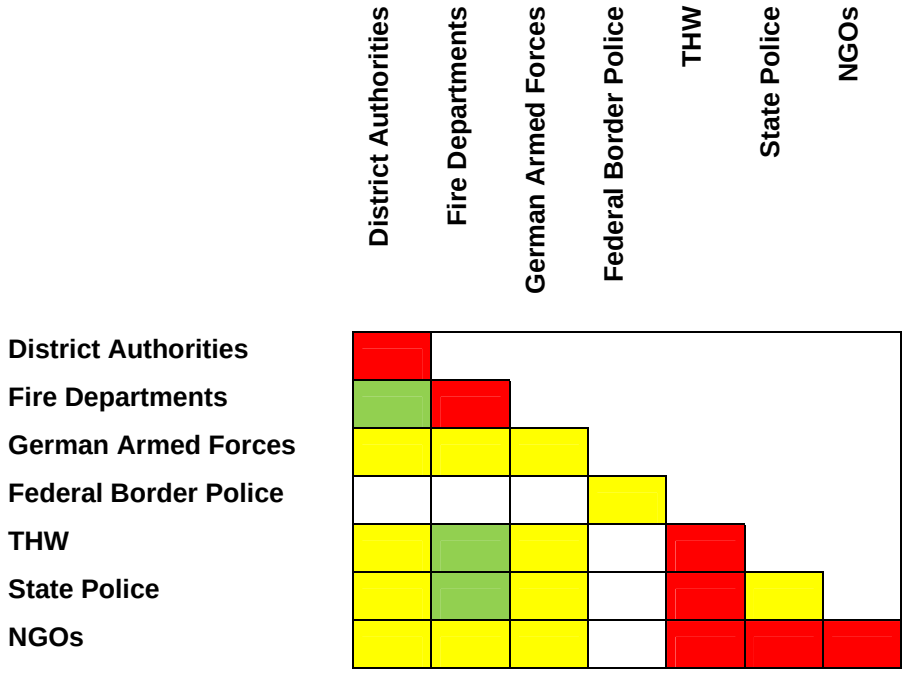

Table 8. Shared Understanding (SU)

- *The couples along the diagonal*: The couples assessed as having no shared understanding are De-Conflicted by location. Thus, they develop shared awareness only at the boundaries. The couples assessed as having limited shared understanding are, according to the von Kirchbach report, organisations able to establish large staff organisations able to cope with large scale operations. These organisations are trained to develop situational understanding mature enough to operate in complex environments fast. Note, that we assess the level of shared understanding lower than the degree of shared awareness.

- *The couples assessed as having significant degree of shared understanding*: The von Kirchbach report and our interviews with representatives of these organisations underpin the joint and intensive training of fire departments, THW, state police and district authorities. The personnel of these organisations know each other from their daily jobs. This fact was assessed as having positive impact on the degree of shared understanding, according to the von Kirchbach report.

Overall assessment: We refrain from providing an overall assessment.

INDICANTS OF C2 MATURITY

The expected Indicants of C2 Maturity are assessed by the following variables:

- Degree of Interdependence,
- Nature of Collective Decisions/Planning and
- Resource Sharing.

Edge C2	Tailored and Dynamic Interdependence	Self-Synchronization with Tailored and Dynamic Variations	Tailored and Dynamic
Collaborative C2	Broad and Deep Interdependencies Consistent with Agreed Plan	Broad and Deep across Collaborative Functions/Actions	Organic and Non-Organic Assets
Coordinated C2	Limited Interdependencies for Coordinated Functions/Actions	Limited to Coordinated Functions/Actions	Non-Organic Assets
Deconflicted C2	Mutual Willingness to Honor Constraints	Focused on Boundaries and Seams	Non-Organic Assets such as Space and Time
Conflicted C2	None	Independent	None
	Degree of Interdependence	**Nature of Collective Decisions/Planning**	**Resource Sharing**

Figure 14. Variables assessing the Indicants of C2 Maturity

Degree of Interdependence

Disaster response organisations are created as highly specialised and responsible for respective situations. Therefore they represent capability packages. Thus, their degree of interdependence is relatively low by design. However, the willingness to collaborate and the culture for interacting with each other are enabled when the situation calls for it.

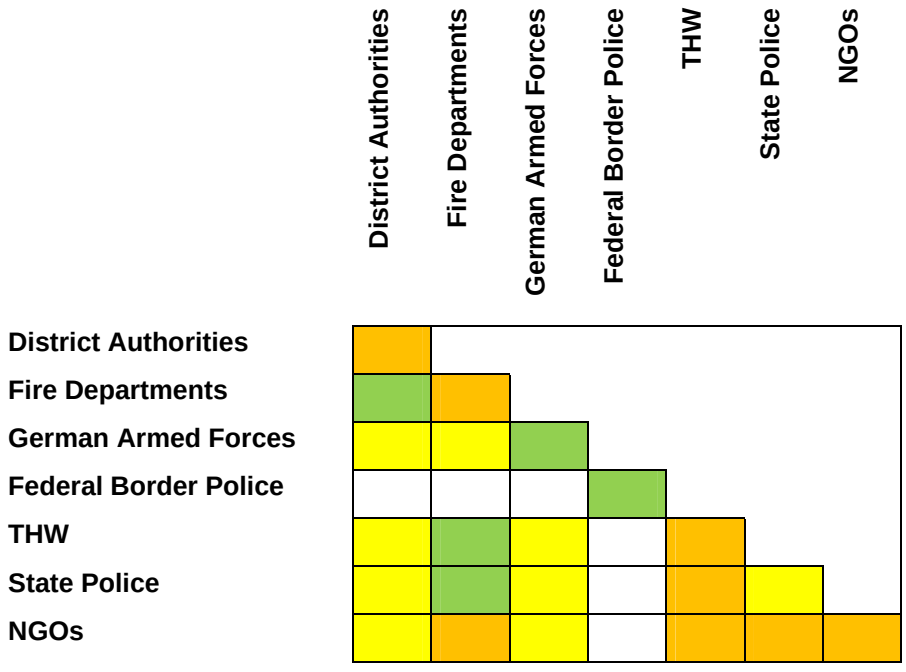

Table 9. Degree of Interdependence

- *The couples along the diagonal*: These couples' degree of interdependence is assessed as being rather low. These organisations are designed to be de-conflicted by location. However, Bundeswehr and Federal Border Police typically are dynamically grouped according to the task and commanded by an established staff. These units are then usually interdependent by function.

- *All other couples*: As described above.

Nature of Collective Decisions/Planning

Operations in affected areas were planned (1) by disaster management staffs established by district authorities, responsible for coordinating actions with superior levels of command and for requesting forces or material from superior commands and (2) by incident commands responsible for planning all actions necessary on the tactical level of operation in consent with the disaster management staff. Both organisational elements assembled all relevant organisations represented by liaison personnel.

Thus, planning and decision making is assessed as being at least coordinated. With regard to fire departments and THW units the nature of collective planning and decision making is assessed as attaining collaborative (at tactical level of operation). These organisations coordinate joint capability packages ad hoc to respond to respective situations.

Resource Sharing

All regarded organisations are highly specialised and contribute special capabilities needed in disaster response operations. The overall idea is a de-conflicting by function. Accordingly, incident commands are responsible to plan coordinated actions using the bandwidth of capabilities contributed by the disaster response organisations. However, one interesting aspect is the acceptance of direct command by the incident command over units of some organisations as THW or NGOs. Thus, collaboration processes and collaboration culture of organisations involved should be regarded for assessment as these aspects seem to differ throughout the overall system of organisations.

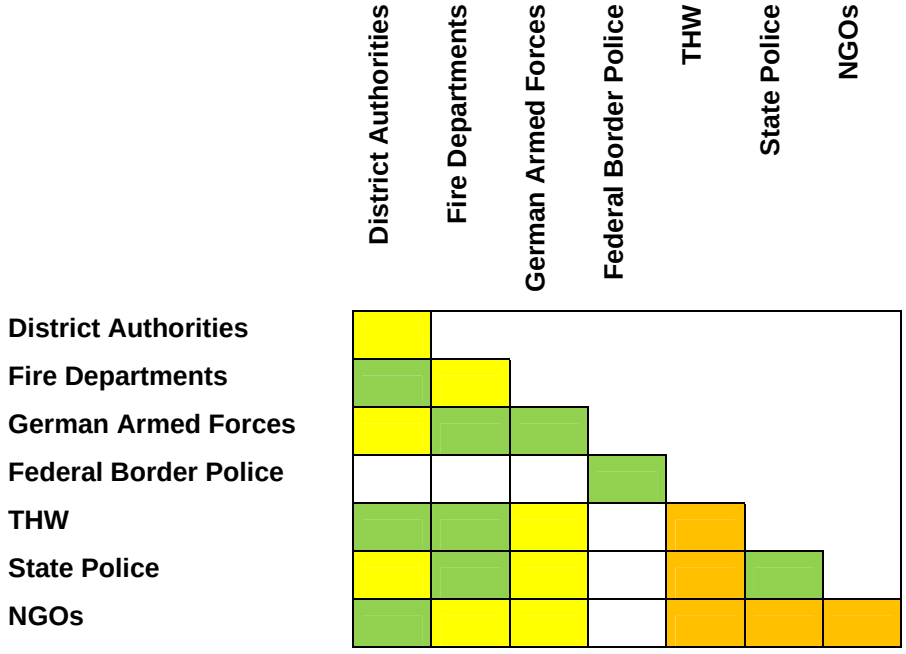

Table 10. Resource Sharing

- *District Authorities and all other organisations*: It is neither required nor designed that district authorities share resources broadly with other districts. The overall idea of districts is to de-conflict via local borders. However, in large scale disasters might one district control the situation easily when other districts lack resources to control the disaster. In these cases forces are sent across borders to help other districts. These processes should be coordinated by regional authorities.

    - The units of THW and NGOs are usually directly commanded by incident commands. Incident commands are established – whenever possible – by fire departments and collaborate closely with the district authorities' staffs. All resources provided to a district by fire departments, THW and NGOs are contributed for a shared plan.

    - Forces provided by German Armed Forces and state police are also coordinated by the incident commands but responsibility for control remains always by the organisations. However, the Bundeswehr will - whenever possible - contribute equipment for joint plans.

- The von Kirchbach report describes that Bundeswehr and NGOs built a camp for evacuated people together. Thus, they shared organic and non-organic assets. However, this was neither the rule nor required in general.

- *All coordinated couples*: Large organisations as the German Armed Forces and the state police bring in assets in coordinated planned actions without delegating control of material or personnel. As these organisations have the capability and tools to command and control large scale operations the described behaviour of force contribution largely meets the requirements for resource sharing.

MEASURES OF MISSION EFFECTIVENESS

Measures of Mission Effectiveness (MOE) are assessed by the following variables:

- Relative Effectiveness,
- Efficiency, Given Effectiveness and
- Agility (in the N2C2M2, its Agility of the Collective C2 Process).

Edge C2	Tailored and Dynamic Synergies	Highly Efficient	Proactive across a Broad Range of Conditions
Collaborative C2	Substantial Synergies across Collaborative Areas/Functions	Substantial Efficiencies across Collaborative Areas/Functions	Substantial, Timely and Continuous
Coordinated C2	Limited Synergies Due to Coordination	Limited Efficiencies Due to Coordination	Limited to Coordinated Functions/Actions; Slow; Reactive
Deconflicted C2	Avoids Costs of Negative Cross-Impacts	Sub-Optimized Use of Resources	Vulnerable at Seams; Rigid from Specialization
Conflicted C2	Negative Cross-Impacts	Inefficiency Wasted Resources	Fragile and Vulnerable at the Seams
	Relative Effectiveness	**Efficiency, Given Effectiveness**	**Agility**

Figure 15. Measures of Mission Effectiveness

Relative Effectiveness

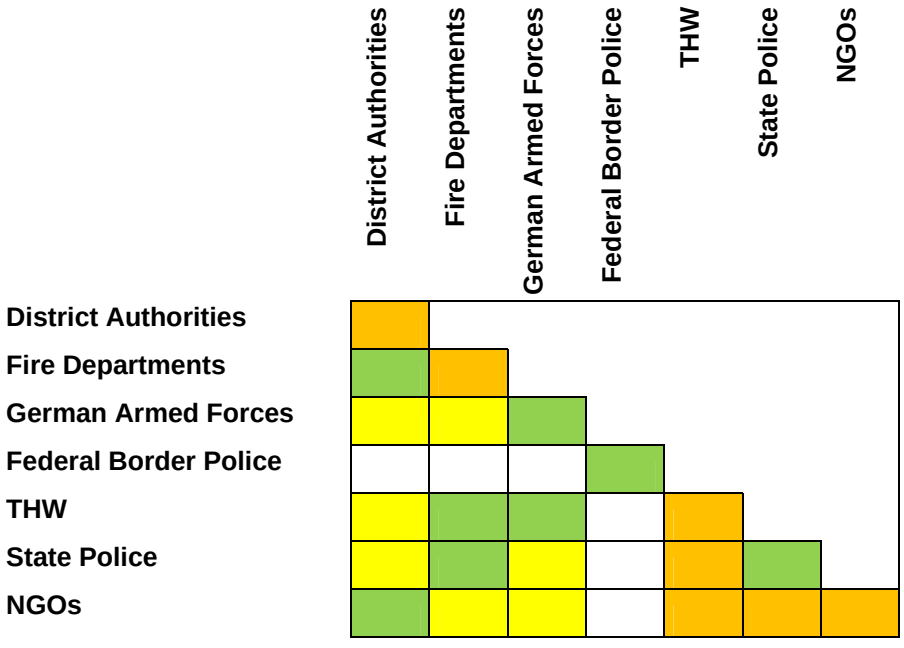

Table 11. Relative Effectiveness

- As districts neither coordinate plans nor collaborate lack of synergies was observed during disaster. However, the overall disaster response system is not designed as edge organisation. Thus, higher disaster management authorities are responsible for coordinating districts and for finding synergies. However, the von Kirchbach report offers no examples about using synergies between districts.

- The Bundeswehr, although not responsible for planning disaster response operations, established proactively and fast a staff element in Saxony and was able to deploy mission tailored units when the authorities requested them. Thus, the Bundeswehr found ways in empowering its units insofar as they collaborated with others to respond to the disaster most effectively.

- The von Kirchbach report praises the work of the incident commands planning with forces available. These forces were usually planned to fulfil tasks in a collaborative way. They expanded their trained way of collaboration ad hoc and task dependent. However, the von Kirchbach report also stresses that joint training efforts especially at higher levels of command could increase synergies in joint operations a lot.

Efficiency, Given Effectiveness

The von Kirchbach report assessed that available disaster response resources matched the overall demand of the Elbe flood disaster – a lack of specialised equipment like equipment for oil spillage clearance or helicopters able to fly by night/bad weather conditions, notwithstanding. The von Kirchbach report furthermore requests, that access to scarce resources should be simplified for example by establishing state or federal reserves. As most recommendations given by the von Kirchbach report, try to improve coordinate among disaster response forces more efficiently, we assess that the efficiency was limited due to coordination.

Agility

Saxon's overall disaster response system consists of specialised organisations coordinated by a hierarchy of staff elements established by the authorities of the respective level of governance. However, whenever the operational demands request for collaboration, the culture and willingness existed to handle tasks jointly. The overall goal to help the people in the affected areas – most of them personally known by a lot of responders – was the glue for collaboration. Due to the overall coordination and request mechanisms the overall agility is however being assessed as limited to coordinated functions/areas (coordinated C2). The disaster response forces are not fully able to cope timely with the dynamics of the events. For example the Bundeswehr is not allowed to proactively operate in disaster response operations even when the capability is available.

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