6.2 SPECIAL CHAPTER ON FLOODS

6.2.1 INTRODUCTION

In August 2002, widespread persistent rain led to catastrophic floods in many parts of Central Europe. There were extreme rainfall events in Austria on numerous rivers north of the Central Alps starting from the west. The northern Federal Provinces of Upper and Lower Austria as well as the Federal Province of Salzburg were particularly affected.

The flood events of August 2002 were caused by two episodes of heavy rainfall within a short period of time. The first episode lasted from 6 to 8 August and the second from 11 to 13 August.

The following sections provide extracts giving an overview of the course of events and the extent of damage. Primary sources are the Ereignisdokumentation des Hochwassers vom August 2002 [Event Documentation of the Flood of August 2002] (ZENAR & BMLFUW, 2003) and contributions from the Österreichischer Wasser- und Abfallwirtschaftsverband (ÖWAV) [Austrian Water and Waste Management Association] Symposium Die Hochwasserkatastrophe 2002 [The 2002 Flood Disaster] (ÖWAV-SYMPOSIUM, 2003), which each give detailed accounts. Afterwards possible causes and conclusions are discussed.

6.2.2 THE FLOOD OF 2002

The total amount of rain which fell within a very short period of time and the resulting run-off occurred with the average return period of once every 50 to 100 years. In the Federal Provinces of Lower and Upper Austria - particularly in the Mühlviertel and Waldviertel regions along the Rivers Aist, Naarn, Kamp and Krems - this flood clearly exceeded a 100-year event. In some rainfall areas even a 2 000–10 000-year frequency event was calculated (ZENAR & BMLFUW, 2003 and ÖWAV-SYMPOSIUM, 2003). The event was due to a combination of several factors that intensified precipitation.

6.2.2.1 Balance of damage

A total of 9 human lives were lost during the August 2002 flood events; including those who died while trying to control the floods and those who died due to accompanying circumstances. The loss of even more human lives was avoided only by the enormous efforts of local residents, the Armed Forces, fire fighters, the Red Cross and volunteers.
The material damage was caused in connection with the physical processes (such as transport of sediment and suspended solids, shifting of riverbeds), and was heaviest in the Waldviertel and Weinviertel regions, particularly on the River Kamp.

The resulting material damage was mainly brought on by the widespread flooding of settlement areas, infrastructure (bridges, roads) and industrial facilities.

According to information gathered by the Federal Chancellery and the corresponding analyses of flood documentation (ZENAR & BMLFUW, 2003) carried by the Zentrum für Naturgefahren [Centre for Natural Hazards (ZENAR)] at the University of Natural Resources and Applied Life Sciences Vienna, the damage incurred can be analysed as shown in Table 6.2-1.

<table>
<thead>
<tr>
<th>Type of damage</th>
<th>Proportion of total damage in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private property (incl. businesses)</td>
<td>45.6</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>18.4</td>
</tr>
<tr>
<td>Consequential costs of flood</td>
<td>22.1</td>
</tr>
<tr>
<td>Reduction of added value</td>
<td>5.8</td>
</tr>
<tr>
<td>Flood protection management (torrent control and avalanche protection, river channelisation, waterways)</td>
<td>2.5</td>
</tr>
<tr>
<td>Agriculture and forestry</td>
<td>2.3</td>
</tr>
<tr>
<td>Municipal water management</td>
<td>1.3</td>
</tr>
<tr>
<td>Costs of emergency operations, disposal and replacement</td>
<td>1.1</td>
</tr>
<tr>
<td>Federal Government property</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Total damage</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Tab. 6.2-2: Compilation of Damage from the Flood of 2002 (according to STALZER, 2003).

A final assessment of the damage associated with the flood events of August 2002 cannot be provided in the present report since long-term and consequential damage to residential property is still arising.

The unusual severity of the flood gave rise to a thorough analysis of events (Analyse des Hochwassers vom August 2002 – FloodRisk [Analysis of the August 2002 Flood - FloodRisk]), as well as to the initiation of research programmes and projects (e.g. the StartClim project, the starter project on climate protection).

The existing flood protection measures mostly stood the test in areas where the basis for assessment (100 year flood) was not exceeded. However, problems did arise with older dams, whose reconstruction or rebuilding had been proposed before the flood. By contrast, some of the areas where a 100-year event was clearly exceeded were affected by massive flooding. This holds true for the Rivers Kamp, Aist and Naarn. But also flat areas were affected by floods which were kilometres wide and/or long, causing extreme water levels in settlement areas due to the absence of possibilities for drainage.
In some floodplains, there were massive deposits of mud and debris which significantly increased the resulting damage. The Eferding basin, the northern and southern Machland areas, the Wachau region and the area around Klosterneuburg were especially affected. Along the River Kamp these deposits caused extreme shifting of the riverbed.

The sediment deposits also caused changes in the river morphology of the River Danube. The effects are now being investigated (such as changes in riverbed position, sediment deposit phenomena) (ZENAR & BMLFUW, 2003).

### 6.2.2.2 Active and passive damage control

Although the scale of the damage was extreme in many places, successful damage control made it possible to avoid even worse effects of the floods.

Only an approximate assessment can be made of the retention capacity provided by nature and preventive hydraulic engineering in areas close to rivers and of the effect of flooded riparian areas containing the flow (in the Mostviertel, Waldviertel and Weinviertel regions). Along the River Danube, the flood wave was retained through the flooding of the Tullnerfeld area and the riparian floodplains all the way to the town of Hainburg. However, retention areas were not available everywhere. Because of the enormous discharge loads on the River Kamp and the geographic characteristics of the River Kamp valley, the natural retention of the flood wave was only minor in this section of the river. The retention capacity of power plant storage facilities was equally ineffective since it was impossible to lower the water level in the reservoir areas. For a detailed description see also Chapter 5.4 (Discharge) in Ereignisdokumentation des Hochwassers 2002 [Event Documentation of the August 2002 Flood] (ZENAR & BMLFUW, 2003).

Mobile flood protection measures proved useful in many places and prevented particularly the town centres of Krems and Stein from being inundated. In Upper Austria preventive flood protection also proved successful in areas where the basis for assessment (30 year flood, 100 year flood) was not heavily exceeded. Successful examples also include Salzburg, Styria and Tyrol where, along with other engineering measures, the retention areas with their subduing effect helped to let the flood wave pass by without causing damage.

### 6.2.3 THE CONSEQUENCES OF THE FLOOD AND THE CAUSES OF THE DAMAGE

#### 6.2.3.1 Exceeding the statistical frequency

The applicable regulations for river engineering undertaken by the Bundeswasserbauverwaltung (BWV) [Federal Office of Hydraulic Engineering] are set out in the Wasserbautenförderungsgesetz [Austrian Act on the Subvention of Hydraulic Engineering] and the ensuing Guideline for the Federal Office of Hydraulic Engineering (RIWA-T, §3 Para 2), providing for protection from flood events with a probable re-
turn period of once every 100 years (100 year flood). The level of protection for torrent control and avalanche protection is set for a 150-year event pursuant to the Gefahrenzonenplan-Verordnung [Ordinance governing risk zone planning] of 1976.

As described above however, the August floods surpassed these statistical frequencies in many areas and regions and partly led to the overflowing of flood-control dams. As the event of 2002 was extreme, a large part of the damage would not have been prevented even by optimum safety measures.

### 6.2.3.2 Zoning in flood risk areas

Land use, and in particular the development of settlement areas, should be guided by the principle of keeping floodplains free from intensive building activities. The legal obligation to obtain approval for any building within the 30-year boundaries of inundation areas, as well as the implementation of risk zone planning under the Forest Act and the technical guidelines under the Austrian Act on the Subvention of Hydraulic Engineering should provide the basic fundamentals. The Gefahrenzonenpläne (GZP) [federal risk zone plans] have the status of qualified expert opinions without being legally binding. Legal enforcement of these plans must take place at the level of the Federal Provinces within the framework of the Federal Province Regional Planning Acts and the respective building ordinances. However, they usually only contain a general recommendation for consideration, which is not binding on the municipalities. The implementation of federal risk zone plans mostly has to take place within local and regional planning. Only by marking out the risk zones in regional plans, particularly in the zoning plans of the municipalities, do they become legally enforceable. To a considerable degree, the huge scale of damage in many areas can be attributed to the missing legal connection between risk zone planning and regional planning. The frequent divergence between planned settlement models and actual settlement developments shows the discrepancy between models and actual planning in practice (see Chapter 3.5.4.2).

The level of damage incurred is directly attributable to prevailing patterns of life and economic environment. Where there are measures in place to protect certain areas from a 100-year flood, the citizens often feel completely protected and accordingly make large investments. But areas protected from floods are not entirely free from flooding; there always remains a residual risk that can never be completely excluded. If the statistical design event is exceeded, the scale of damage will increase disproportionally.

An example of a risk from floods in areas with a residual risk was the fact that in several cases of water and soil contamination with heating oil, the affected installations were situated in areas that had not been flooded in many years (100 years or more). (In Upper Austria alone 1.5 million litres of heating oil leaked under the impact of the floods.) In these areas, the permits obtained for these installations had failed to consider such occurrences of damage, or, given the technical standard, there had been no need to take into account a flood risk.

This example shows how important it is to point out the risk of flooding even in residual risk areas, and to prevent against such a risk by taking suitable structural measures (for example, replace oil tanks by gas boilers or at least install tanks pressure-tested and leak-free).
6.2.3.3 Flood control systems - maintenance

According to Austrian Water Law, flood control systems are to be maintained and kept in working order. There is also a legal obligation to keep the discharge profile clear, so as to prevent premature overflowing of a flood wave. However, removing vegetation may cause conflict with the nature conservation law. Clearing river profiles and banks may also contradict the guiding principles of natural river engineering and ecological river planning. Here a consensus between nature protection, landscape conservation, regional planning and flood control maintenance needs to be sought and given a common legal basis.

6.2.3.4 Crisis management

Reduction in damage can be achieved for rivers with larger catchment areas by timely warning and correctly timed predictions. Those affected can take the necessary precautions such as finding a safe place for inventory or equipment, or for setting up mobile protection. However, the 2002 flood also highlighted in some places the need for action regarding the functioning of early warning and alarm systems and the flow of information herewith required (ZENAR & BMLFUW, 2003).

6.2.4 CLIMATE CHANGE AND FLOODING

It now seems to be generally accepted that global warming through anthropogenic greenhouse gases leads to climate change, which alters the average state of the atmosphere and therefore also influences the frequency and intensity of extreme weather events (see Chapter 6.1).

However, a single event – such as the August 2002 floods – does not confirm climate change as the cause of origin. What counts is the frequency of such events. Whether a trend towards more extreme events is taking place in Austria is still difficult to say at the present moment because of the highly variable distribution of precipitation in Austria in terms of space and time. This question is currently the focus of various research projects under the umbrella of the StartClim Project.

The Umweltbundesamt is currently establishing an information system for data on extreme meteorological events (Meteorological extreme Event Data information system for the Eastern Alpine region – MEDEA).

Overall, it is certain that due to the worldwide increase in the surface temperature of the earth, and above all of the seas and oceans (the so-called sea surface temperature SST), the water vapour saturation in the atmosphere is increasing in absolute terms. Because of the higher temperature of the air, the capacity of the air for absorbing water vapour increases, and the higher temperature of the soil as well as SST leads to an increase in evaporation from land and water surfaces. According to the laws of physics, higher vapour content in the atmosphere should lead to an overall increase of precipitation, even though regional differences in the development of precipitation must be expected.
But not only climate change is the driving force behind the increasing number of disasters such as the flood of August 2002. Climate change may be the reason for an increase of the frequency and intensity of floods, but the damage incurred and the extent of the damage are primarily dependent on direct human behaviour. While it is likely that the floods are, to some extent, man-made as a result of the anthropogenic greenhouse effect, it is certain that the flood damage is man-made. Thus, besides the emission of greenhouse gases (anthropogenic greenhouse effect and climate change) there are other reasons, such as increasing urban sprawl, sealing and settlement activities in risk zones that constitute major damage-influencing factors.

It can be concluded that more demands need to be made not only on climate protection but also spatial planning and other relevant planning departments, as well as on politics.

**6.2.5 THE ROLE OF LAND USE AND SOIL SEALING**

The change of land use in catchment areas contributes to the occurrence of floods probably to a varying extent. Different types of land use and forms of vegetation influence surface run-off, water retention and seepage in different ways. Forests have greater water storage and retention capacities than grassland in general, and grassland has more capacities than arable land. Here there are considerable differences between individual types of soil and cultivation. In some of the Austrian areas under intensive farming, the proportion of grassland has declined considerably over the last few decades, and favoured the expansion of arable land. This, together with the intensification of agriculture and the removal of natural landscape elements in the course of land consolidation, has encouraged the occurrence of floods. However, during an extreme event such as that of August 2002 when high levels of antecedent soil moisture had already exhausted the storage capacity, the type of land cover and land use only played a minor role.

Agriculture can play an active part in flood control in that certain types of cultivation in catchment areas can be changed in the medium term. Here for example maize crops and arable farming are concerned, which are likely to cause an increase in surface run-off and thus entail a higher risk of erosion in the event of heavy rain. Heavy machinery used on arable land causes soil compaction. This reduces rainwater infiltration into the soil and thus increases surface run-off and erosion. Topsoil run-off reduces soil fertility and increases sediment transport by rivers, which may *inter alia* lead to morphological alterations of rivers as well as increase the damage caused by flooding through sediment deposits. Avoiding soil compaction may therefore be one way of actively contributing to flood control.

Also, the increasing sealing of soils in areas used for settlement and transport purposes must be discussed in this context (see Chapter 3.5.2). Water cannot seep through sealed soils, which means that the run-off of large volumes of rainwater happens more quickly, resulting in a larger flood wave.
6.2.6 IDEAS AND OPEN QUESTIONS

Spreading water to reduce high water levels
To avoid the extent of damage caused by the 2002 flood in future, strategies must be developed to reduce high water levels by floodplain enlargement, and to drain large volumes of water at the same time. In this context efforts should be made to secure retention areas in time, either by buying them or through measures of regulatory planning, and especially by designating significant floodplains and retention areas in regional plans as zones that are to be kept free, following the example of the Federal Province of Salzburg (see Chapter 3.5.4.2). A key question of flood control in the years to come will be how to best achieve this while considering the interests of all parties concerned. The required measures are to be secured by sufficient financial means, so as to achieve a functional combination of ecologically designed river courses, river banks and floodplains and the necessary technical constructions.

Building capacity in the river and in areas close to it
From the perspective of flood control, examples such as the development of the River Rhine into a navigable waterway in Germany clearly show that to channelise rivers and to correct their course - by cutting through meanders or damming up previous floodplains - have the effect that capacities for extreme discharge in the event of a flood are reduced and that the flood wave is transported more quickly. In cooperation with all residents (upstream and downstream) counter-measures are now being taken. Measures for re-establishing natural conditions, restoring channelised rivers to their more natural state, reclaiming retention areas (e.g. revitalising riparian forest ecosystems) as well as river engineering measures that are closer to nature may all contribute significantly to flood control. Here efforts are made to combine active and passive flood control.

The ecological component of flood control
In many areas, provisions of nature protection and those of passive flood control are in agreement, namely that rivers should be given more space again so as to regain or retain wetlands, which, from the perspective of nature protection, represent valuable habitats for the preservation and restoration of the biological diversity of our landscapes (see Chapter 5.2).

Pure structural engineering solutions are not desirable from the perspective of both the natural balance and the appearance of the landscape. Neither is total technical control of all risk areas feasible economically. Even so, preventive hydraulic engineering does not contradict ecologically oriented flood control. It is rather that in flood protection management passive measures should be given priority over active ones. Consequently, setting back dams and dikes, keeping retention areas free as well as preserving and restoring floodplain forests are important elements of flood protection management concepts. In this context, it would be desirable to establish a legal obligation to pay compensation for losses of retention areas.
Legal aspects

The question is: How can land use in risk zones be made less intensive rather than increased and, where necessary, be reversed? Or, how can the accumulation of property be prevented in risk areas? These questions can only be considered by thoroughly examining all legal aspects involved since they are all interconnected. (E.g. regional planning laws and building laws of the Federal Provinces, Austrian Water Law, Austrian Act on the Subvention of Hydraulic Engineering etc. to name but a few. Also, the Water Framework Directive (WFD) of the EU has an indirect impact on these questions.)

By way of example, the Austrian Act on the Subvention of Hydraulic Engineering should be mentioned here, which governs the promotion and financing of flood control measures with the help of public funds. It is an important instrument for regulating activities in the field of flood control. Setting adequate priorities shall secure the implementation of a comprehensive, as well as ecologically oriented and altogether “sustainable” flood control strategy, supported by hydraulic engineering subsidies from public funds.

Spatial planning, as the regulatory discipline for development and planning, which is thus responsible for the prospective overall design of spatial requirements, plays a key role in the conflict between natural hazards, flood protection management and land use (see Chapter 3.5.2). The principle to be applied here is as follows: The management of the areas at risk from floods is simpler, more effective and less expensive than managing the floods themselves.

Research and development

Do the responsible authorities and other institutions (particularly universities) involved in the examination of the problem have sufficient data enabling them to provide suitable answers to the questions arising from the flood events? Here the need for action appears to be especially important. Not only by providing sufficient financial means to permit the generation of the necessary data, but also by combining existing “knowledge centres” designed to provide a better understanding of the flood overall, and therefore permitting better calculations. There is still a great potential in Austria and at international level.

Integrated risk management

The conclusion of studies conducted in affected countries is also that especially a widespread event such as the August 2002 flood, which produced its effects over entire catchment areas and beyond national borders, requires an interdisciplinary approach. Integrated risk management assimilates all elements needed to develop an overall economic concept for flood control that meets the needs of the population and is based on risk analysis (risk and damage potential), as well as on the analysis of measures for risk and damage minimisation and of measures for civil protection. It thus provides a comprehensive basis for the implementation of flood control measures.
After the event

As regards reconstruction after an event such as the August 2002 flood, it is important to learn from the reasons for and causes of destruction. Priority must certainly be given to the immediate protection of human lives from the effects of flooding and to securing the basic essentials of the affected population. Should this require emergency measures immediately, they must be implemented. However, once the immediate threats have been removed, intensive communication between the population and the organisations involved should take place during reconstruction, since in many areas measures will have to be taken in the longer term to improve the future protection of affected regions overall, even though they will not correspond to the "status quo ante".

Individual precautions

Are people living on floodplains aware of the existing risk and are they taking responsibility for the necessary personal precautions to protect their possessions from the potential consequences?

Individual precaution should receive greater attention through intensification of education and information. This should also ensure that citizens take personal responsibility. This can be encouraged by education and information as mentioned above, or by means of financial incentives prompting individuals to protect themselves.

6.2.7 RECOMMENDATIONS

After the flood in 2002, many experts have formed groups at different levels and given concrete recommendations (to name but a few: the Lower Austrian Platform on Floods at the Academy of the Federal Province of Lower Austria, Working Groups of the Federal Province of Upper Austria concerned with the Floods of 2002, the Report on the Findings of the Interdisciplinary Flood Control Working Group of the Federal Province of Salzburg, Event Documentation of the Flood Platform at the Centre for Natural Hazards and Risk Management (ZENAR) (University of Natural Resources and Applied Life Sciences Vienna), the Platform on Floods of the Österreichischer Wasser- und Abfallwirtschaftsverband (ÖWAV) [Austrian Water and Waste Management Association]). Lessons learned and recommendations that are relevant for Austria are also discussed in international studies (DKKV, 2003).

From the nationwide Analyse der Hochwasserereignisse vom August 2002 [Analysis of the Flood Events of August 2002 (working title FloodRisk)], a joint project between Austria and Switzerland in which experts from all levels (federal, provincial, community, universities) are united, further detailed statements (in addition to the existing recommendations) concerning future measures and strategies for flood control are expected in 2004.