Action Programme

Of the International Commission for the Protection of the Danube River for Sustainable Flood Protection

The Danube Sub-basin of the Austrian Danube

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Of the International Commission for the Protection of the Danube River for Sustainable Flood Protection

Sub-Report on the Danube Sub-basin

Austrian Danube

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1 Introduction

1.1 Reason for the study

In response to the danger of flooding and in line with its Joint Action Programme, the ICPDR decided in 2000 to establish the long-term Action Programme for Sustainable Flood Prevention in the Danube River Basin. The whole process was accelerated after disastrous floods in 2002 and resulted in adoption of the Action Programme at the ICPDR Ministerial Meeting on 13 December 2004.

The overall goal of the ICPDR Action Programme is to achieve a long term and sustainable approach for managing the risks of floods to protect human life and property, while encouraging conservation and improvement of water related ecosystems. Given the area, the complexity and the internal differences in the Danube River Basin, the Action Programme represents an overall framework, which needs to be specified in further detail for sub-basins. Therefore, the targets of the ICPDR Action Programme include preparation of flood action plans for all sub-basin in the Danube catchment area.

In September 2007 a Directive of the European parliament and of the Council on the assessment and management of flood risks (EFD) was adopted by the European Council. The aim of the Directive is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The Directive requires Member States to first carry out a preliminary flood risk assessment by 2011 to identify areas at risk of flooding. For such areas they would then need to draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015.

As the ICPDR Action Programme was designed in full coherence with EFD the flood action plans for sub-basins are an important part of implementation of the EFD and they summarize the key actions towards preparation of the flood risk management plans. Therefore, the preparation of the flood action plans for sub-basins can be considered as an interim step in implementation of EFD.

This action plan for the Austrian Danube sub-basin reviews the current situation in flood protection and sets the targets and the respective measures aiming among others to reduction of damage risks and flood levels, increasing the awareness of flooding and to improvement of flood forecasting. The targets and measures are based on the regulation of land use and spatial planning, increase of retention and detention capacities,

technical flood defenses, preventive actions, capacity building, awareness & preparedness raising and prevention and mitigation of water pollution due to floods.

It is foreseen that this planning document will be further refined as appropriate and necessary by the bilateral river commissions.

1.2 Aims and Measures of the Action Programme

The declared aim of the ICPDR is the implementation of the Danube River Protection Convention and the implementation of the European Water Framework Directive. The area under consideration by the ICPDR covers not only the Danube itself, but includes the entire catchment area, including the tributaries and groundwater reserves.

An Action Programme for sustainable flood protection in the Danube river basin, aimed at achieving a long-term, sustainable approach in dealing with flood risks and thereby protecting human life, property assets and water ecosystems, has been launched. This Action Programme incorporates the following four main aims in relation to the catchment area as a whole:

- Improvement of flood forecasting and early warning systems, as well as the networking of national or regional systems
- Support in drawing up and coordinating flood action plans for the sub-basins
- Establishment of forums for the exchange of technical knowledge
- Recommendation of a common approach for assessing areas threatened by flooding and determining the flood risk

The following six aims have been formulated for the individual sub-basins:

- Reduction of the negative effects and the probability of flooding in each sub-basin through developing and implementing a retention measure that is as natural as possible.
- Improvement and networking of flood forecasting and warning systems throughout the Danube river basin, as well as adapting them to local and regional needs.
- Promotion of active awareness-raising with regard to flood risk and anti-flood measures, as well as an expansion of the capacity of flood protection and flood control organisations.

- Development of flood risk maps in order to promote the sensible use of land, to check investments in land and to raise the awareness of the general public.
- Standardisation of dimensioning criteria and safety regulations at the national and international level.
- Avoidance and reduction of the water pollution caused by flooding.

1.3 Aim of the "Austrian Danube" Sub-Report

The "Austrian Danube" sub-report covers not only the Danube in this section of the Danube, but refers to its tributaries likewise. Thus, all the major waters are included in the scope of this report.

The aim of the present sub-report is an initial assessment of the current flood protection situation in the catchment area of the Austrian Danube. Furthermore, the report is intended to provide an overview of flood protection measures planned for the future in the sub-basin, as well as their investment volume and time frame. Measures which have already been implemented and planned for the protection of people and their environment, together with strategic aims for the future, represent a further essential component of this report. In addition, the following subject areas: public relations work, disaster control and measures for reducing water pollution resulting from floods have also been incorporated into the present report.

2 Characterisation of the Current Situation

The severe floods of 1997, 1999, 2002 and 2005, together with their effects on existing areas of settlement, have shown that technical flood protection alone can only cover a portion of the complex interconnected structure of effects relating to “flood protection”. In this context, climate change should, as far as possible, also be taken into consideration in future, together with its consequences concerning future floods, which cannot as yet be assessed.

The following map, published by the International Commission for the Protection of the Danube River, offers an overview of the 17 established Danube sub-basins. Six of these sub-basins, namely the Upper Danube, Inn, Austrian Danube, March, Pannonian Middle Danube and Drau, including the Mur sub-basins, extend at least in part over Austrian national territory.

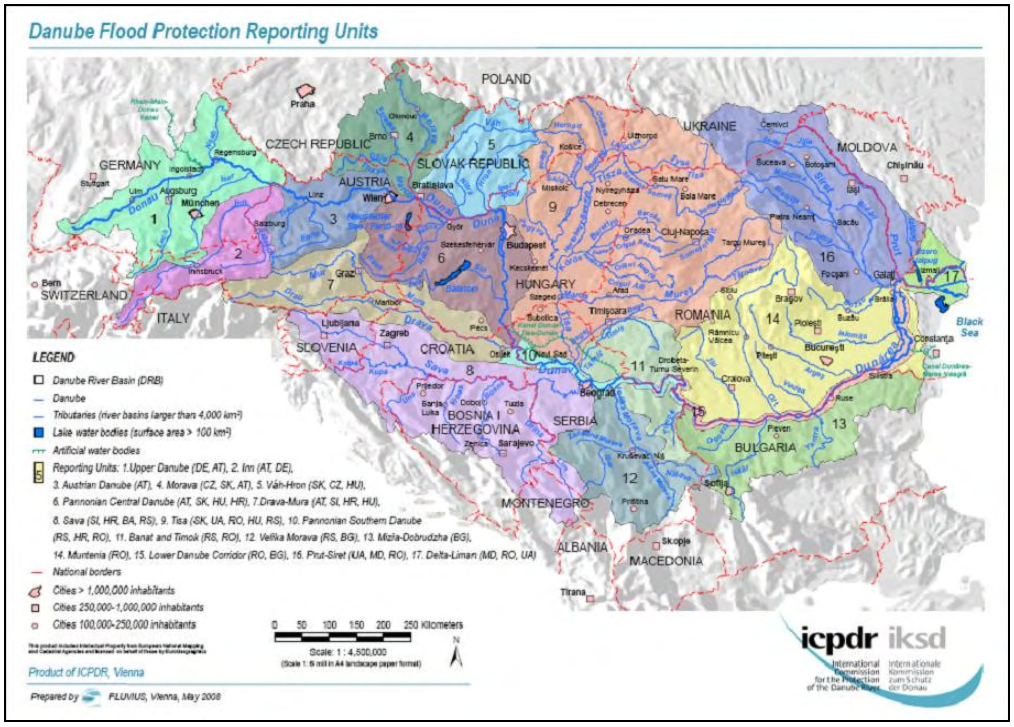


Fig. 2-1: Overview of the Danube sub-basins (Source: ICPDR)

Waters in Austria lie within the competency of the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW[1]). However, the Danube and also the March and the Thaya are exceptions to this rule. These waters lie within the sphere of competency of the Federal Ministry of Transport, Innovation and Technology (BMVIT[2]).

The Danube sub-basin of the Austrian Danube covers an area of about 24,400 km² exclusively in Austrian state territory. Besides a small portion of Salzburg, the Danube sub-basin encompasses parts of the provinces of Styria, Upper Austria and Lower Austria. The following section aims to briefly characterise the Danube sub-basin of the Austrian Danube, based on the most important waters.

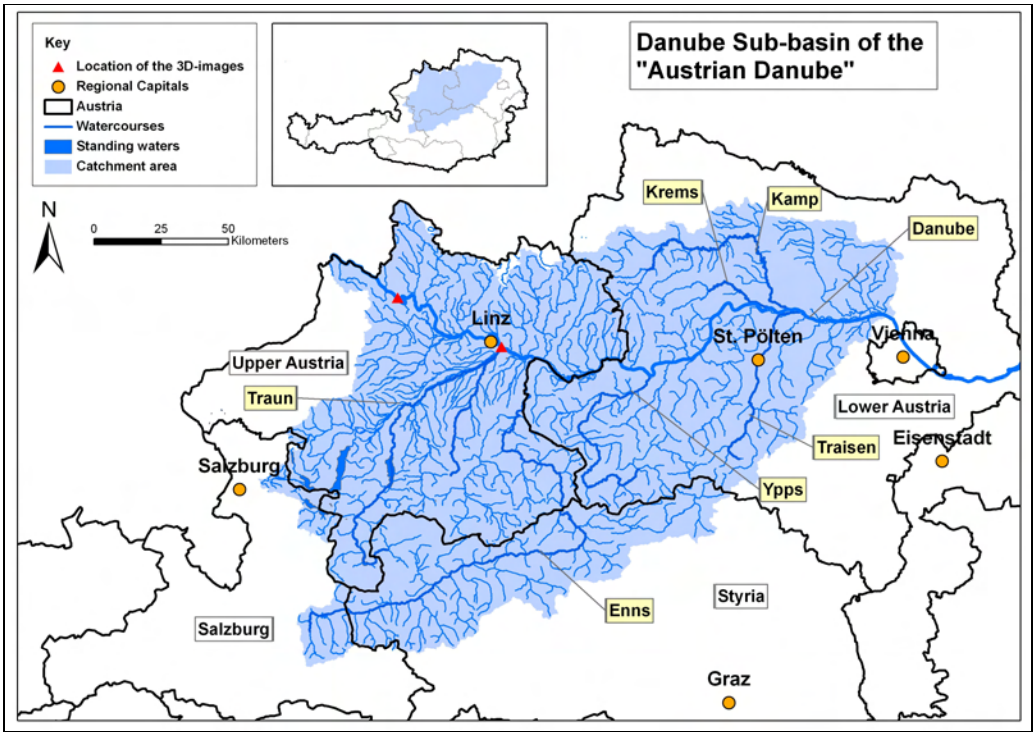


Fig. 2-2: The Danube sub-basin of the Austrian Danube (Image: Revital ZT)

[1] German acronym for Federal Ministry of Agriculture, Forestry, Environment

[2] German acronym for Federal Ministry for Transport, Innovation and Technology

On crossing the German-Austrian border near Passau, all the way to the confluence of the Donaugraben at Langenzersdorf north of Vienna, the Danube extends over the Danube sub-basin of the Austrian Danube. In this section, the river has undergone extensive construction of protective embankments and power stations (nine Danube power stations) with long backwater areas. On its approx. 380 kilometre-long course through the sub-basin, the Danube absorbs a large number of watercourses, such as the Traun and the Enns in Upper Austria as well as the Ybbs, the Traisen and the Kamp in Lower Austria.

Fig. 2-3 shows the Danube in Upper Austria in the area of the well-known Schlögener Schlinge. Here, the course of the Danube is characterised by a section of gentle gorge.

Fig. 2-3: The Danube in Upper Austria in the area of the Schlögener Schlinge (Image: Google Earth)

Fig. 2-4 shows the course of the Danube a short way after Linz in the so-called “Machland” basin. Due to the flat morphology of the Machland and the settlements which often extend as far as the Danube, these have suffered from repeated flooding over the past few years. This has given occasion for the launching of a major flood protection project. The project, which extends over 36 Danube kilometres, will be completed over the next few years.

Fig. 2-4: The Danube in the Machland basin
(Upper Austria) (Image: Google Earth)

The organisation of the responsible administrative authorities in the Danube sub-basin of the Austrian Danube

The Danube sub-basin of the Austrian Danube extends over parts of the provinces Salzburg, Styria, Upper Austria and Lower Austria and can be subdivided into the spheres of competence of the Federal Hydraulic Engineering Administration (BMLFUW), the ViaDonau (BMVIT) and the Forest Engineering Service in Torrent and Avalanche Control (BMLFUW).

3 Target Settings

3.1 Long-Term Flood Protection Strategy

3.1.1 Long-Term Strategies for Flood Protection in Austria

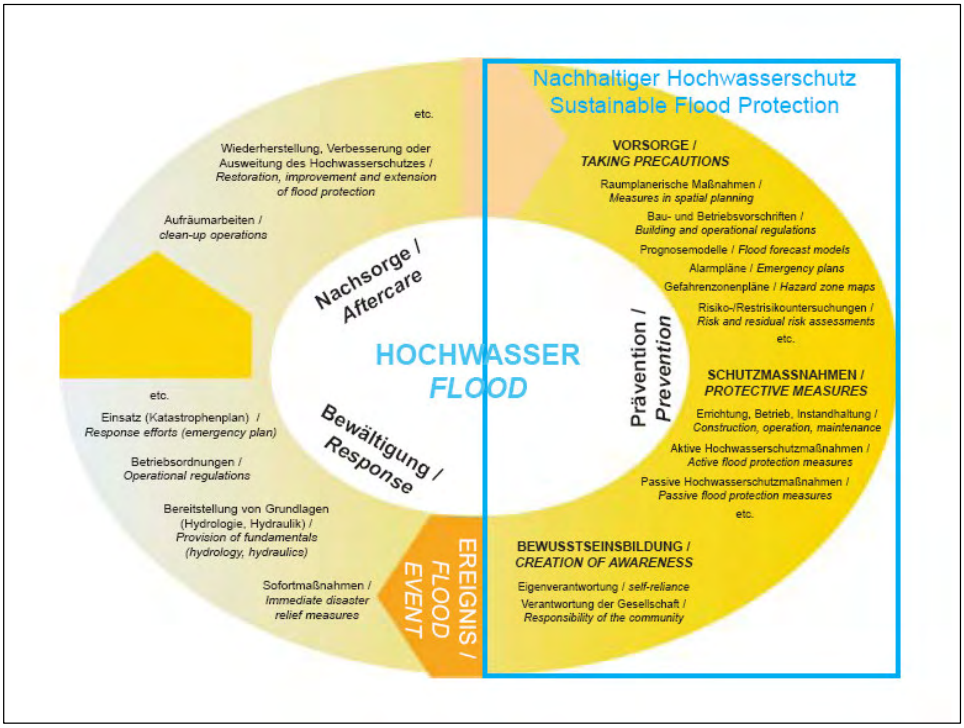
One thing is certain: the next flood is definitely coming. We must therefore be prepared (Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2006). There is thus a given need to develop a sustainable, cross-regional flood protection strategy, based on the experience already gathered, while utilising all the technical possibilities.

Since October 2007, a general legal framework for flood protection in the European Union has existed in the form of the Directive of the European Parliament and the Council concerning the assessment and management of flood risks. The implementation of this Directive, whose aim is to prevent detrimental effects on human health and human life, the environment, the cultural legacy, the economic sector and the infrastructure, is to take place in three important steps. The first step is a provisional assessment of the flood risk, based on the available information, records and studies. This is to be followed by the drawing up of flood hazard maps and flood risk maps, by December 2013. Based on the hazard and risk maps created, flood risk management plans will then be worked out.

The provisional assessment of the flood risk has already begun in Austria. Based on Flood Risk Zoning Austria, nationwide, public information is already available in Austria, showing the limits of the flooding in a total of three scenarios (HQ_{30}, HQ_{100} and HQ_{200}). Over the past few years and decades, increasing investments have been made in the creation of hazard zone maps in the Danube sub-basin of the Austrian Danube. The aim is to achieve blanket-coverage identification of all hazard zones in the relevant settlement and infrastructure areas in the Danube sub-basin by 2020 at the latest. The findings which thereby emerge can be incorporated into the up-to-date flood hazard and flood risk maps, thus enhancing their precision and incisiveness.

Protective water management in Austria is essentially based on an integrated flood management that is aimed at achieving the greatest possible safety from floods through the meaningful interaction of spatial planning, structural engineering and organisational measures. Integrated flood management basically rests on the three “pillars” of prevention, response and aftercare.

Fig. 3-1: Sustainable flood protection (Diagram: Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2006b)



Flood protection in Austria can look back on a long history and thus on rich reserves of experience. Based on this fund of knowledge and the experience gained from responding to the last flood catastrophes, the following ten strategies (cf. report on "Flood Protection in Austria", Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2006b) have been developed in the area of flood protection:

- Highlighting the limits of protection and the responsibility of those involved
- Promoting the knowledge and awareness of hazards
- Ensuring appropriate land utilisation through spatial planning
- Promoting incentives for taking individual precautions
- Recognising negative developments that are relevant to flooding
- Coordinating flood planning with public authorities
- Putting protective measures in place where necessary
- Expansion of emergency planning and disaster control measures

- Securing financial provision
- Improving the advance warning system

Sustainable flood protection that is viable for the future must include the following programmatic objectives (cf. report on "Water Future", BMLFUW 2004):

- Consistent identification of hazard zones and risk areas, as well as keeping flood discharge areas clear
- Improvement of flood retention through securing open areas of land (passive flood protection)
- More space for the dynamics of watercourses
- Maintaining existing flood protection structures (regulatory measures, embankment dams, flood retention basins)

3.1.2 Strategies for sustainable flood protection in the Danube sub-basin of the Austrian Danube

In Austria, and thus also in the Danube sub-basin of the Austrian Danube, hazard prevention is given the highest priority. The identification and taking into consideration of hazard zones on watercourses is an important aim of the next few years. The targeted retention of floods in the catchment areas is likewise one of the main focuses of strategic action. To supplement these, technical protective measures will continue to be implemented and maintained, whereby passive flood protection measures are given priority over the active protective measures. The Austrian Hydraulic Engineering Assistance Act provides a basis for financing these measures.

In addition, the individual administrative offices of the federal hydraulic engineering administrations are making efforts to achieve greater cooperation with a wide variety of specialist fields (integrated flood management), particularly spatial planning and disaster control. In future, protective water management measures will require increased coordination with spatial planning in order to support and boost the effectiveness of the implemented measures in a target-oriented way. The respectively-prevailing general legal conditions form the basis for interdisciplinary cooperation.

Lower Austria:

The planning and implementation of protective water management measures in the province of Lower Austria is carried out in accordance with both the Technical Guidelines for the Federal Hydraulic Engineering Administration (RIWA-T) 2006 and the objectives, strategies and measures for flood protection laid down by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW).

The strategic objectives set for the Danube sub-basin of the Austrian Danube aim to achieve a combined approach. With regard to future measures, increasing efforts are being made to rapidly push ahead with the preservation as well as the expansion of natural retention areas, thereby pursuing the aim of reducing the discharge peaks to fit the structural capacity of the consistently regulated waters in the Danube sub-basin. As well as the maintenance and adaptation of existing protective structures, increased co-operation with spatial planning and disaster control departments is being speeded up, in accordance with the principle of integrated flood management. Discharge analyses, hazard zone maps, as well as a wide variety of measures for the prevention of hazards are intended to improve the protection of the population against the natural force of water.

Upper Austria:

The superordinate, general objective of flood protection in Upper Austria is to protect settlement and infrastructure areas from a flood statistically occurring every 100 years. The measures build on and are based this objective, in accordance with the flood protection plan. The current flood programme in Upper Austria includes around 400 protective water management measures for the coming years.

Besides the maintenance of existing protective structures, the main focus of attention in the province is increasingly flood retention by means of general, comprehensive planning measures.

Salzburg:

In addition to the ongoing maintenance and implementation of flood protection projects in the province of Burgenland, the main focus of protective water management is hazard prevention. By the end of 2009, hazard zone maps will be commissioned, based on 2D current status flood discharge studies on the Enns and the Taurach. The project planning investment sum amounts to about 500,000 euros.

Styria:

The existing objectives and strategies of protective water management in Styria have been set up in accordance with the principle of integrated flood management. Besides the ongoing maintenance of existing protective structures and facilities, the most important aspects are the combined approach, increased retention of the water masses arising in the catchment areas, hazard prevention through land-use planning measures, as well as public relations work concerning the essential strategic objectives and key activities. The implementation of these activities takes place on an ongoing basis within the framework of the work programmes.

3.2 Regulations on Land Use and Spatial Planning

- ***Objective 1: Compilation and adaptation of flood hazard maps and flood risk maps***
- ***Objective 2: Complete identification of all flood hazard zones***
- ***Objective 3: Increased interdisciplinary cooperation between the individual specialisations***

In many cases, floods first become a threat to human beings and their constructions due to ignorance or through spatial planning mistakes of the past. Particularly in the Alpine valleys of Austria, characterised by the low proportion of usable land to be found there, the problem of land utilisation pressure is aggravated immensely due to different interests, and is fiercely competing for space with the natural area. Ever more buildings and facilities are being constructed at locations with an existing risk potential. This has given rise to the call for modern spatial planning to incorporate more into its plans the threat posed by natural disasters, and to also designate space for natural areas, in addition to the many other spatial planning aspects. One of Austria's ten flood protection strategies is to ensure that the use of specific locations is regulated by spatial planning. Flood protection departments are strategically considering pushing ahead with further, closer cooperation between the spatial planning and the water management and flood protection departments, in order to keep areas in river basins free of buildings.

Water management has various planning instruments for safeguarding flood hazard areas and keeping them free of buildings; these instruments include the flood protection schemes, river development schemes, regional studies, general and detailed projects, as well as the identification of hazard zones by the Federal Hydraulic Engineering Administration.

Regional planning programmes as well as regional development programmes represent the general legal framework for spatial planning at the supra-local level for implementing measures to secure areas of land nationwide. Local development schemes and land utilisation plans are available as instruments at the local level.

The respective spatial and land-use planning acts passed by the individual provinces of Austria contain regulations which provide for the designation of areas of land threatened by natural hazards. Likewise, the building regulations of the provinces contain suitability criteria for constructions and building plots with regard to natural hazards. Here, hazard zone mapping constitutes an important and valuable element for assessing the existing hazard situation.

Land-use planning:

Within the framework of hazard zone mapping, the Federal Hydraulic Engineering Administration identifies a wide variety of indicated and reserved areas, in order to draw attention to the threat of hazards and/or to safeguard areas for measures or for the upkeep of the flood protection system. However, as this is not legally stipulated in the land-use planning acts, no indicated and reserved spatial planning areas have been identified. The Federal Hydraulic Engineering Administration is, however, endeavouring to coordinate and cooperate more intensively with the technical discipline of land-use planning. The resulting synergic effects should make it easier to identify and to keep indicated and reserved zones free, thus increasing the effectiveness of flood protection measures.

The discharge area of a flood that statistically occurs every 100 years is definitive for both land-use planning and building law provisions. According to the Land-Use Planning Laws, areas which do not appear suitable due to the effects of potential natural hazards (floods, groundwater, landslides and the like) cannot be designated as building areas. In the province of Salzburg, this also applies to areas of land which must be preserved as important flood discharge or flood retention areas. Flood plains must be clearly shown on the land utilisation plan.

Furthermore, the building codes of the provinces stipulate construction standards for the design of buildings, for example the finished height of floors and the storage of inflammable liquids, and for buildings in flood risk areas, or they prohibit a building site if there is any threat of flooding.

In the province of Styria, the essential regulations are laid down in terms of the Land-Use Planning Law[3] within the framework of SAPRO 2005 (Programme for the floodproof development of settlement areas). This guideline is addressed to municipalities in their function as spatial planning and building authorities, as well as to planners, builder-owners and authorised experts in construction methods, in order to take into account, in conformity with the law, the findings on flood risks, and also other water-related natural hazards threatening building plots and buildings, in land-use planning and building code procedures (see the Guideline for carrying out local land-use planning and building procedures in cases of endangerment due to water-related natural hazards, 2008).

Hazard zone mapping and flood plains:

In Austria, hazard zone maps are drawn up either by the Federal Hydraulic Engineering Administration or the Forest Engineering Service in Torrent and Avalanche Control, depending on their respective spheres of authority. The hazard zone maps are technical plans which show not only those zones at risk from natural disasters, but also areas which must be kept clear for protective measures or a special kind of area management. They serve as the basis for alarm plans, and also for planning, the development of projects and experts' reports. Hazard zone maps must show the type and extent of the hazards at the onset of the design event (flood discharge occurring statistically every 100 years), while taking into account the bed load and driftwood carried in the discharge). Furthermore, they must also show the hazard zone in the event that the design event is overstepped up to $HQ_{300,}$ as well as the resulting failure of protective hydraulic engineering systems. Based on the consequences of a wide variety of potential dangers, hazard zones to which various directives and prohibitions are linked are identified by the relevant administrative office.

Salzburg:

The Danube sub-basin of the Austrian Danube extends over only a small portion of the province of Salzburg. Here, hazard zones have only been identified along the Enns. The objective is to map out the hazard zones for all major waters in the province of Salzburg lying within the field of supervision of the Federal Hydraulic Engineering Administration by the end of 2010.

[3] Raumordnungsgesetz

Table 3-1: Waters with demarcated hazard zone maps in the province of Salzburg, as they relate to the sub-basin of the Austrian Danube

Hazard zone mapping watercourse	Municipality	Approved	Designated. HQ
Enns	Radstadt, Altenmarkt, Flachau		HQ_{30}/HQ_{100}

Lower Austria:

In the province of Lower Austria, hardly any hazard zone maps are drawn up by the Federal Hydraulic Engineering Administration. Instead, discharge analyses are increasingly being carried out here (see Discharge Analyses below). The aim is to achieve blanket-coverage identification of hazard zones in the Danube sub-basin of the Austrian Danube, based on discharge analyses, by 2020.

In the future, the discharge analyses and/or hazard zone maps are to form the basis for identifying protective water management restricted and priority areas.

The following table offers an overview of the currently-existing hazard zone maps of the sub-basin.

Table 3-2: Waters with demarcated hazard zone maps in the province of Lower Austria, as they relate to the sub-basin of the Austrian Danube. (Source: BMLFUW, 2009)

Hazard zone mapping watercourse	River kilometrage, processing length	Approved	Designated. HQ
Fladnitz	Km 0,00-27,3 (27,3 km)	2004	HQ_{30}/HQ_{100}
Kamp	Km 18,10-39,55 (21,45 km)	2004	HQ_{30}/HQ_{100}
Krems	Km 13,79-20,81 (7,02 km)	2003	HQ_{30}/HQ_{100}
Perschling Michelbach, Totzenbach	Km 0,00-29,00 (29,00 km) 7,20 + 2,90 km (10,10 km)	2003	HQ_{30}/HQ_{100}
Große Tulln Inkl. Anzbach	Km 8,15-21,80 (13,65 km) Km 0,00-6,68 (6,68 km)	2002	HQ_{30}/HQ_{100}

Styria:

By 2015, the blanket-coverage hazard zone mapping of Styria within the sphere of competence of the Federal Hydraulic Engineering Administration will be complete. For further details, see the section on Discharge Analyses.

Upper Austria:

In the province of Upper Austria, a programme for drawing up hazard zone maps, primarily in the settlement and infrastructure areas, was started in 2005. At least in the settlement and infrastructure areas, all the watercourses in Upper Austria with catchment areas larger than 10 km² have up-to-date hazard zone maps. The 19 hazard zone maps drawn up within the sphere of competence of the Federal Hydraulic Engineering Administration will be supplemented by 15 more over the next few years. At present, there are hazard zone maps for over 265 river kilometres in Upper Austria, while the mapping of eight further rivers is currently in the planning phase. The hazard zone mapping in the sphere of competence of the Federal Hydraulic Engineering Administration of Upper Austria is to be completed by 2012.

Table 3-3: Waters with demarcated hazard zone maps in the province of Upper Austria

Hazard zone mapping Watercourse	River kilometrage, processing length	Approved	Designated HQ
Ager	0,00-34,81	-	$HQ_{30}/HQ_{100}/HQ_{300}$
Aist	3,00-7,50	Yes	-
Alm	0,00-48,80	-	$HQ_{30}/HQ_{100}/HQ_{300}$
Ampfelwangerbach stream		Newly compiled	$HQ_{30}/HQ_{100}/HQ_{300}$
Aschbach stream	18,10 km	2002	
Aubach stream	0,00-2,00	Yes	-
Aurach		Newly compiled	$HQ_{30}/HQ_{100}/HQ_{300}$
Dürre Ager		In the planning phase	
Enns	26,00-33,00	Yes	-
Frankenburger Redl		In the planning phase	
Freudenthaler Ache		In the planning phase	
Fuschler Ache	0,00-8,25	1999	
Grosse Gusen	7,50 km	-	-
Grosse & Steinerne Mühl incl. tributaries		In the planning phase	
Grünbach stream		In the planning phase	
Innbach stream	30,00-35,00	In process	-
Ischl (Ischler Ache)		In the planning phase	
Mondsee Ache		In the planning phase	
Naarn		In the planning phase	
Ottnager Redlbach stream incl. 7 tributaries		Newly compiled	$HQ_{30}/HQ_{100}/HQ_{300}$

Pesenbach stream	-	-	-
Radaubach stream		In the planning phase	
Sandbach stream	3,50 km	2002	-
Steinbach stream		In the planning phase	
Steyr	0,00-3,50	Yes	HQ_{100}
Sulzbach stream	4,00-10,00	Yes	-
Trambach stream		In the planning phase	
Trattnach	24,00 km	2004	-
Traun Obere Traun	84,75-131,25 Tw. Erweiterung/Revision	2003	-
Ungenacherbach stream		In process	
Vöckla incl. Dürrer Ager	0,00-40,60	Revised	HQ_{30}/HQ_{100}
Weyersbach stream	3,00 km	Yes	HQ_{30}/HQ_{100}
Wimbach stream		In the planning phase	
Zeller Ache		In process	

Discharge Analyses:

As well as hazard zone mapping, there are also discharge analyses. Discharge analyses are expert reports which describe the flood discharge area in the case of specific occurrences of flooding (mainly HQ_{30}, HQ_{100} and HQ_{300}) and which must be taken into account in official approval procedures. The flood discharge area of a flood statistically occurring every 300 years, which is presented from the year 2005, shows areas of residual risk which serve as a basis for future spatial planning in the municipalities.

The results of the discharge studies of the provinces of Styria, Lower Austria and Salzburg can be accessed online in the Digital Atlas of the province concerned, and are thus accessible for interested members of the public.

Lower Austria:

Discharge studies are currently increasingly being carried out in the province of Lower Austria and these are to be available, offering blanket-coverage of the relevant watercourse sections, by 2013. At present, the achievement rate for this target is about 80 per cent. The inundation boundary lines for floods statistically occurring every 30, 100 and 300 years are demarcated within the framework of the discharge studies.

The following table contains a list of those watercourses in the province of Lower Austria for which a discharge analysis has already been carried out or is in process. The figure after it shows an overview of the watercourses.

Table 3-4: Overview of the discharge analyses in Lower Austria

Discharge Analyses watercourses			
Anzbach stream	Danube	Erlabach stream	Erlauf
Feichsenbach stream	Fladnitz	Gaminggraben	Giessenbach stream
Gölsen	Göstlingbach stream	Grosse Tulln	Grosser Kamp
Halbach stream	Kamp	Kierlingbach stream	Kleine Erlauf
Kleine Tulln	Kleine Ybbs	Kleiner Kamp	Krems (incl. Grosser and Kleiner Krems)
Lengbach stream	Loisbach stream	Mank	Melk
Michelbach stream	Perschling	Pielach	Ramsau
Retzbach stream	Schmida	Senningbach stream	Sirnitzbach stream
Stössingbach stream	Taffa	Traisen	Trefflingbach stream
Türnitzbach stream	Unrechttraisen	Urlbach stream	Weitenbach stream
Wiesenbach stream	Ybbs	Ybbser Mühlbach stream	Zauchbach stream
Zöbernbach stream	Zwettl		

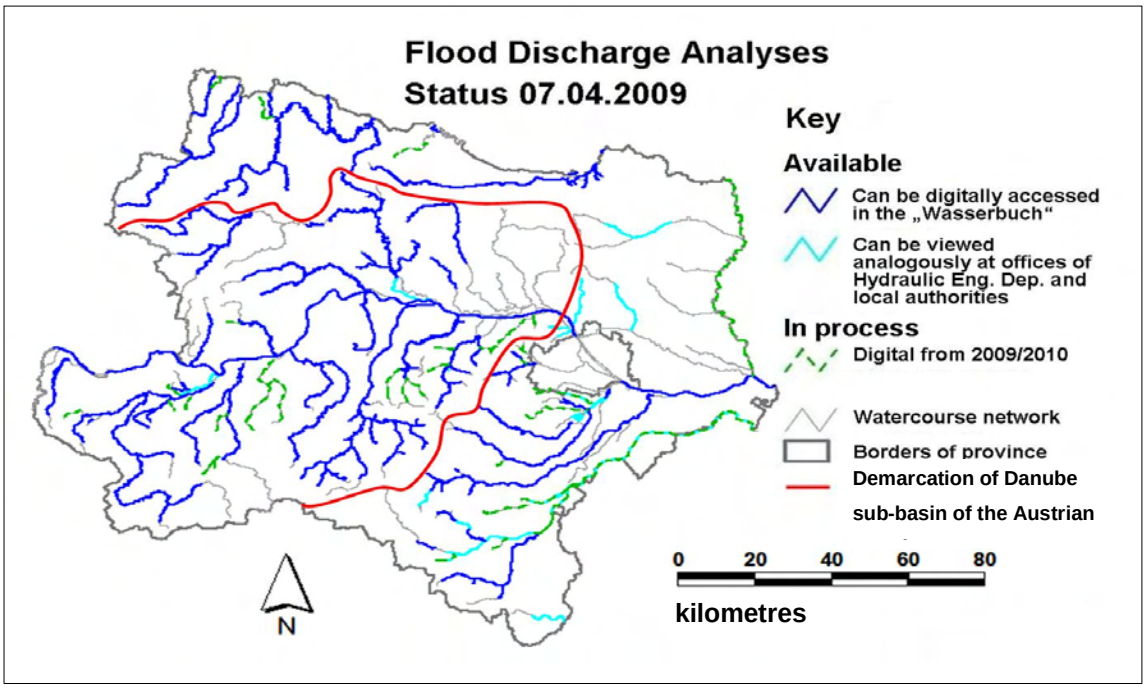


Fig. 3-2: Discharge analyses in the province of Lower Austria (Source: Regional Government of Lower Austria)

Styria:

Styria's discharge analyses are carried out in accordance with the Technical Guidelines for the Federal Hydraulic Engineering Administration (2006), and form the basis of flood

protection planning in the province. In conformity with the Guidelines, the inundation boundary lines for floods statistically occurring every 30, 100 and 300 years are shown.

Table 3-5: Overview of the discharge analyses in Styria

Discharge Analyses Watercourses			
Aschbach stream	Donnersbach stream (In process)	Enns (~20 km) $HQ_{30,\ 100}$	Erlauf (In process)
Erzbach stream (In process)	Grimming	Gröbmingbach stream (In process)	Grünaubach stream (2.7 km) $HQ_{30,\ 100}$
Paltenbach stream (In process)	Salza (7.6 km) $HQ_{30,\ 100}$	Sandbach stream	Sölkbach stream (1.85 km) HQ_{30}
Trofengbach stream (In process)	Weissenbach stream (1.85 km) $HQ_{30,\ 100}$		

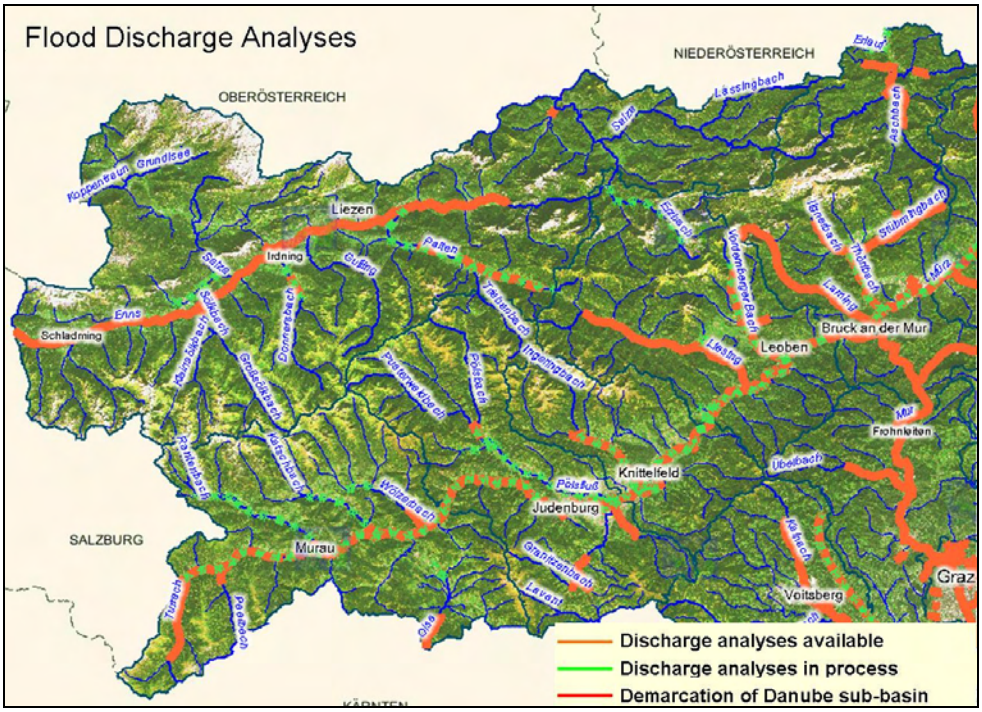


Fig. 3-3: Discharge analyses in the province of Styria (Source: Regional Government of Styria)

Salzburg:

As well as hazard zone mapping, discharge studies have been carried out on the following watercourses (see Table 3-6).

Table 3-6: Overview of the discharge analyses in Salzburg

Discharge Analyses Watercourses			
Enns ~9,9 km	Fuschler Ache ~3,4 km	Taurach	

Upper Austria:

As well as hazard zone mapping, discharge studies have been carried out on the following watercourses in the Upper Austrian sub-basin of the Austrian Danube.

Table 3-7: Overview of the discharge analyses in Upper Austria

Discharge Analyses Watercourses		
Danube (northern and southern Eferdinger Becken)	Danube (Inundation boundary lines for $HQ_{30,100}$ are being worked out from the national border to Aschach)	

3.3 Reactivation of former, and creation of new, retention and detention capacities

- ***Objective 1: Natural retention of floods in the catchment areas***
- ***Objective 2: Protective water management, morphological and ecological improvements in the river bed***

One of the ten strategies of flood protection in Austria is aimed at recognising the negative developments that are relevant to flooding, such as the loss of retention areas, and to implement suitable measures accordingly. As well as the meaningful and sustainable implementation of technical flood protection measures, and improved flood forecasting, the preservation, reactivation and creation of retention capacities may be regarded as a significant measure for improving flood safety levels in the future. In addition, these

measures improve the ecological functioning of the waters, thus satisfying the requirements of the Water Framework Directive.

Ecological river engineering is increasingly becoming an integral component of protective hydraulic engineering. In order to cover the increased demand for land and to ensure the availability of land for both ecological and flood protection purposes, the hydraulic engineering administrations are increasingly endeavouring to purchase areas of land on the rivers and streams.

Lower Austria:

Technical flood protection measures usually separate watercourses from their natural retention and flood areas (alluvial forests, extensive agricultural areas and the like). Besides the resulting negative ecological consequences for the waters and their hinterland, this also creates an increase in the flood discharge and, therefore, a risk to downstream riparians. The experiences of past floods have shown that natural retention areas are often already full before the floodwater reaches its peak, and therefore already ineffective at that point. The reactivation and enlargement of natural retention areas is therefore usually done in combination, to a greater or lesser extent, with technical construction measures, depending on the specific protective water management requirements. The flood retention measures already implemented and planned are presented in Section 3.4.2.1 Retention areas and basins.

According to the degree of construction, some watercourses in the Lower Austrian Danube sub-basin of the Austrian Danube still have natural or semi-natural areas which function as flood retention areas. In order to counteract the loss of retention areas, flood retention measures are constantly being implemented in Lower Austria. For example, restructuring measures have been carried out on the watercoursees Melk and Pielach (see www.life-huchen.at). At the beginning of 2009, it was possible to start further revitalisation projects on the Pielach, on the lower reaches of the Traisen and on the Ybbs (see www.life-Danube-ybbs.at). The “Tulln case study” project on the Grosse Tulln specifically aims to create natural flood retention areas.

Salzburg:

In the course of a flood protection project on the Enns, the accompanying renaturation of valley floor waters (area of Radstadt) also took place. Within the framework of future projects on the Enns, the renaturation of further tributaries (area of Altenmarkt, Flachau) is planned. In addition, downriver from Reitdorf all the way to the regional border,

there are important natural retention areas on the Enns in Salzburg, which contribute to the retention of flowing waters. As there is an urgent need for action regarding flood retention, the reconnection of former flood plains on the Enns and the Pleissling is currently being planned.

Upper Austria:

Over the past few years, the Hydraulic Engineering Administration of Upper Austria has already managed to successfully implement large-scale renaturation measures on some watercourses, such as the Ager, the Enns, the Naarn, the Steyr, the Traun and the Vöckler. In addition, a major renaturation project is being planned on the Krems. Besides the more major measures on the above-named watercourses, numerous smaller measures have already been applied or else are in the planning and implementation phase. One study has documented that, by means of such reconnection measures, it was possible to reintegrate an area of about 13,000 hectares into the flood circulation system in Upper Austria alone.

In Upper Austria, a sum of about 6 million euros can be estimated for renaturation and restructuring measures every year. 50 per cent of this sum is made up of federal resources, while the rest is made up of funds from the province, the environmental state aid programme (Austrian Environmental State Aid Law[4]) and stakeholders' own resources.

A few of the large lakes in Upper Austria serve as natural flood retention areas. Above all, Lake Hallstättersee and Lake Traunsee on the Traun, Lake Mondsee and Lake Attersee on the Ager (a tributary of the Traun), as well as Lake Wolfgangsee on the Ischl, play an effective part in flood retention. In addition to these lakes, mostly areas which are used for agriculture, as well as areas of alluvial forest in the hinterland, are also effective as retention areas in the case of flooding: one example is the Eferding Basin, which extends along both sides of the Danube.

Styria:

With the aim of strongly promoting natural water retention in water meadow areas and undeveloped valley areas, thus dealing with the flood risk at its root, it has already been possible to carry out restructuring, revitalisation and renaturation measures on some

[4] Umweltförderungsgesetz

watercourses in Styria. More extensive measures in the catchment area of the Austrian Danube have up to now been mainly carried out on the Enns. Further measures are also planned on the Enns over the next few years. The urgent need for action regarding flood retention is being met here partially through the reactivation of natural flood retention capacities.

The implementation of projects for lengthening watercourses is a further objective or strategy with regard to natural flood retention.

3.4 Technical Flood Protection

- ***Objective 1: To ensure adequate flood protection for the relevant settlement and infra-structure areas***
- ***Objective 2: Protection and management of natural hazards on the torrents***
- ***Objective 3: Flood protection by means of area-and-space-effective measures***

Following the marked increase in the population in the 17th and 18th centuries, and the resulting shortage of space, settlements were also increasingly established in the flood-endangered valley-bottoms. As a result, the call for flood protection grew in the Alpine regions of Austria, with its partially very limited available space. In addition, the constantly-growing need for space and the basic protective water management requirements, which are subject to continual change, demand new strategies to achieve the aims of protective hydraulic engineering.

A fundamental aim of protective water management in Austria is the nationwide protection of areas of settlement and infrastructure facilities. The aim is for these areas to be adequately protected from floods that statistically occur every 100 years, while taking into account ecological compatibility, as well as the economic requirements. In Austrian protective water management, HQ_{100} represents a flood rate that is eligible for supportive measures. If flood protection is to be increasingly safeguarded through spatially-effective measures in the future as well, the technical flood protection of residential and industrial areas must continue to be one of Austria's flood protection strategies.

Regarding flood protection, most rivers and streams in Austria are equipped with technical flood protection measures. Most of these protective measures now only require selective widening and additional measures, as well as constant maintenance. Increasingly, the main focus of attention is now the maintenance of protective structures. Based on

this, flood protection in Austria is undergoing a change. Besides the identification of hazard zones and areas of risk, the forecast and control of floods is also becoming more and more important. Technical flood protection will increasingly include systems for controlling the flood wave, as well as selective protective measures (ring dams). Furthermore, due to changed general socio-political conditions, as well as legal requirements, such as the Water Framework Directive, for about three decades Austrian protective water management has again been increasingly paying heed to the ecological aspect of measures. Through activating existing natural flood discharge and retention areas, discharge capacity can be increased and damage prevented.

3.4.1 Flood protection on the Danube sub-basin of the Austrian Danube

As a result of the agreement (in accordance with Article 15a of the Austrian Federal Constitutional Law[5]) between the Federal State of Austria and the provinces of Lower Austria, Upper Austria and Vienna concerning the scheme for flood protection in the area of the Austrian Danube, accelerated, efficient protective measures are being implemented to protect against future occurrences of flooding, in reaction to the consequences and experiences of the Danube flood in 2002.

The implementation of the agreed flood protection projects on the Danube requires special financing. In all, 420,300,000 million euros will be invested up to the year 2015, of which half will be borne by the Federal State, a further 30 per cent by the provinces and the rest by stakeholders. Of this sum, 232,400,000 million euros (Upper Austria: € 160,500,000; Lower Austria: €160,500,000) are to be invested in the catchment area of the Austrian Danube.

Lower Austria:

With regard to protective water management, the waters in the Danube sub-basin of the Austrian Danube have undergone a considerable amount of structural development. Along major sections of the watercourses, areas of settlement and infrastructure are protected against a flood statistically occurring every 100 years. Many of the major watercourses, such as the Grosse Tulln (13 km), the Kamp (19.5 km), the Krems (Kamp-

[5] Bundesverfassungsgesetz

Krems-Danube, 14 km in all), the Melk (18.5 km), the Perschling (32 km) and the Traisen (44 km), in particular, have embankments for flood protection.

As a result of the large amount of construction carried out on many watercourses, one of the main focuses of attention of flood protection is therefore the maintenance and enlargement of existing protective constructions. There is, to a greater or lesser extent, an urgent need for renovation in the case of about 98 of the total 122 embankment kilometres in the Lower Austrian sub-basin. The embankment structures are subject to a regular geotechnical inspection. The strategic objectives give preference to measures for retention rather than clear linear flood protection measures.

Upper Austria:

The majority of the watercourses in Upper Austria, such as the Ager, Aist (lower reaches), the Alm, the Aschbach stream, the Enns, the Grosse Redl, the Innbach stream, the Krems, the Naarn, the Obere Traun (partially regulated), the Trattnach and the Vöckler, have flood protection in the form of linear embankments.

As well as the maintenance of the existing protective structures, the main focus of attention regarding flood protection is above all the widening of the watercourses, as well as flood retention in the catchment areas.

Not only the lessons and consequences of the once-a-century flooding in 2002, but also the as yet unassessable consequences of climate change prompted the Regional Government of Upper Austria to create the largest semi-natural flood protection programme in the history of the province. About 500 million euros (2005-2015; funds of the Federal Hydraulic Engineering Administration and the Forest Engineering Service in Torrent and Avalanche Control) will be invested in blanket-coverage semi-natural flood protection for Upper Austria by 2015.

The flood protection of the Danube Machland has given rise to a major flood protection project in Upper Austria. The Machland basin, where agricultural areas and also extensive settlement areas have been regularly flooded, is to be given adequate flood protection for a length of about 36 kilometres. By means of different linear measures (29.2 km earthworks, 7.2 km flood protection walls), measures for interior drainage, as well as an approximately 9 kilometre long discharge basin, flood protection is to be assured here. The major project encompasses an investment sum of about 150 million euros (active and passive flood protection).

Salzburg:

In the small Salzburg portion of the Danube sub-basin, there is an urgent need for action on the Enns in particular. As well as the protective precautions already implemented on the Enns, further protective measures are urgently needed here due to the existing danger as well as the extremely high damage potential.

Styria:

Over the past few years, it has been possible to complete technical flood protection embankment measures in the Styrian portion of the Danube sub-basin on the Donnersbach stream, the Enns, and the Palten (see Fig. 3-4).

There is a further need for action regarding protective water management on the Aschbach stream, the Gröbmingbach stream, the Grünaubach stream, the Gulling, the Altausseer Traun and the Grundelseer Traun, for which reason further protective measures are to be completed here by 2020.

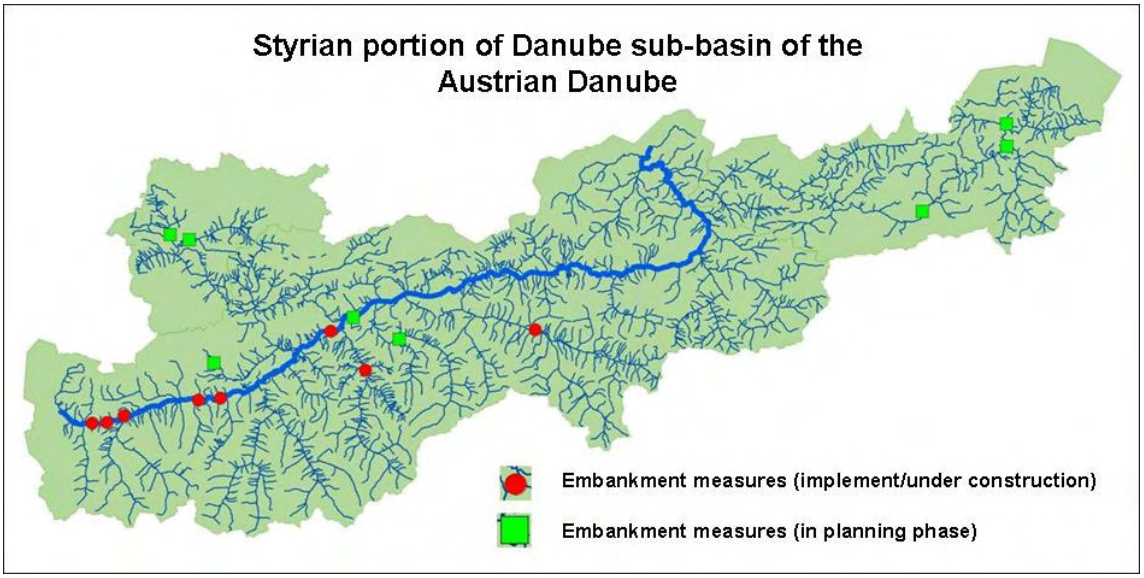


Fig. 3-4: Embankment measures in the Styrian portion of the Danube sub-basin

It is estimated that approximately 8-10 million euros will be spent annually on future flood protection measures (embankment measures), in the province of Styria. About 20 per cent of this investment sum is to be spent on measures in the Danube sub-basin of the Austrian Danube.

A further objective for the future course of action is the implementation of the Floods Directive.

3.4.2 Technical flood retention

Depending on the natural topological situation and general conditions, protective water management is endeavouring to ensure that flood protection will be increasingly safeguarded by area-effective and spatially-effective measures in the future. The occurrence of flooding can be effectively influenced by means of valley barrages, flood retention basins and natural lakes. Increased flood control potential will be developed here in the future, through the continual development of better forecasting models. Based on improved and forward-looking forecasting models, specific retention areas can be activated. In addition, technical possibilities and strategies for flood control enable the targeted mitigation of the flood peak flow.

3.4.2.1 Retention areas and basins

In contrast to the provinces of Austria with an Alpine character, such as Tyrol or Vorarlberg, the morphological formation of the land (plain) in extensive parts of the Danube sub-basin of the Austrian Danube favours the creation and enlargement of retention areas and basins. The specialist protective water management departments of the individual provinces in the Danube sub-basin are therefore making efforts to achieve secure flood protection in the settlement and infrastructure area from a flood statistically occurring every 100 years by means of the current degree of construction on the waters, by means of measures to create and reactivate retention areas.

Lower Austria:

Over the past few years and decades, numerous retention measures have therefore been implemented in the Lower Austrian portion of the Danube sub-basin of the Austrian Danube. The three regional building authorities of the Mostviertel, Zentralraum and Waldviertel[6] together have over 122 retention basins with a retention capacity of about 2.3 million cubic metres. About 26 further basins at 16 locations with a total retention volume of over 4 million cubic metres are currently in the planning or implementation phase. In the course of preliminary projects, new basin locations are constantly being surveyed.

[6] Translator's note: The Mostviertel, Zentralraum and Waldviertel are subregions of Lower Austria.

In order to be able to implement and achieve the flood retention measures and objectives, investments for implementation are being estimated on an ongoing basis for the coming years. The deployment of further retention basins represents a response to the protective water management need for flood retention in the Danube sub-basin.

Upper Austria:

The flood retention in the catchment areas represents an essential component of technical flood protection in Upper Austria. The aim is to achieve the desired protective water management objective with the aid of a large number of retention basins. For example, large retention basins have already been implemented in the catchment area of the Innbach stream (Leitnerbach stream – 500,000m³; Stillbach stream – 900,000 m³), in the catchment area of the Ager (Staiger Bach stream – 1 million m³) and in the catchment area of the Traun (Rettenbach stream– 300,000m³).

With the aim of expanding flood retention further a further 26 retention basins are to be constructed over the next few years or are already in the implementation phase. The regional study on the Aist, for example, envisages a plan for retention basins on the Aist and its tributaries, with a retention volume of approximately 5 to 7 million m³. A further study on the Naarn envisages further basins with a retention volume of about 5 million m³. Further large basins for the catchment area of the Innbach stream (in all: 1 million m³), the Grossen Rodl (40,000 m³), the Ager (in all: 1.6 million m³), the Krems (5 million m³) and the Gusen (350,000) are in the planning phase.

The implementation of the planned measures over the coming years will fulfil the urgent need for action on the individual watercourses.

Styria:

Four existing and two further retention basins planned in the catchment area of the Enns, as well as a further retention basin planned in the catchment area of the Obere Traun, are to assure flood retention in the Styrian portion of the Danube sub-basin. Comprising a retention volume of 1.65 million cubic metres and designed to cope with a flood statistically occurring every 1000 years, the retention basin of Lake Gaishornsee on the Palten represents the largest retention construction in Styria.

About 8-10 million euros will be available for the implementation of future retention plants over the coming years. About 5 per cent of this investment sum is being invested in retention measures in the Danube sub-basin of the Austrian Danube.

Salzburg:

Due to both the prevailing danger and high damage potential, two large technically-controlled retention basins in the Salzburg sub-basin are currently in the planning phase. In addition to these, supplementary measures to promote retention through re-connecting former flood plains (see Section Reactivation of former, and creation of new, retention and detention capacities).

3.4.2.2 Strategies and systems for controlling floods

Some of the existing retention basins in the Danube sub-basin area of the Austrian Danube have been designed to be controllable. Particularly in the event of major floods, the system for controlling the basins and the greater effectiveness thereby achieved ensure that the water masses can be diverted without causing damage.

Not only the retention basins, but also the lakes cited above (see Reactivation of former, and creation of new, retention and detention capacities) have fully-automatic flood control systems. With this type of technical equipment and with a joint retention potential of about 20 million cubic metres, these natural retention areas make a significant contribution towards flood protection.

3.4.2.3 Protection from natural hazards on the torrents

The foundation for effective and sustainable flood protection on the rivers is laid through carrying out appropriate measures in the catchment areas of the torrents and smaller tributaries. The following Section therefore deals with the strategies and measures for flood protection on the torrents lying within the sphere of competence of the Forest Engineering Service in Torrent and Avalanche Control (WLV) in the Danube sub-basin of the Austrian Danube.

3.4.2.3.1 Flood protection measures on torrents in Lower Austria

The Vienna, Lower Austria and Burgenland Section of the Forest Engineering Service in Torrent and Avalanche Control takes care of 2,356 torrent catchment areas. Most of the torrents pose potential hazards for areas of settlement and infrastructure. About 730 of the supervised torrents have already undergone protective measures (Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2008).

Strategies:

With regard to strategies, the Vienna, Lower Austria and Burgenland Section of the Forest Engineering Service in Torrent and Avalanche Control focuses on the professional execution of its core competences. These include the following six fields of activity: consulting services, expert services, hazard zone mapping, the planning and implementation of measures and the arrangement of subsidies. A further strategic aim is the continued ordering of priorities adapted to the specific need and the hazard situation. Another special focus is public relations work, with the aim of risk dialogue and the raising of public awareness.

Whereas construction activities used to be the main focus, nowadays preventive protection is gaining ever more importance through the creation of hazard zone maps and the involvement of flood experts within the framework of official procedures.

Within the framework of construction and maintenance activities, particular consideration is given to the requirements of the Water Framework Directive. In addition, the Torrent and Avalanche Control Section is making efforts to achieve a continuous alignment and coordination with the Federal Hydraulic Engineering Administration responsible for the downstream riparians and with the Via Donau waterway management company.

Flood protection measures:

About 90 per cent of the available financial resources of the Vienna, Lower Austria and Burgenland Section of Torrent and Avalanche Control are invested in measures to protect against torrents. The Section thereby has between 8 and 9 million euros annually at its disposal for flood protection measures. Its building activities increasingly include measures for maintaining existing constructions. In addition, flood protection measures are continually being implemented, according to need and urgency. The effectiveness and the degree of protection of these projects is placed in relation to the necessary investment volumes in order to thus be able to allocate to all implemented measures a protective effect which matches the specific need for protection.

Hazard zone mapping:

About 407 municipalities located within the sphere of competence of the Vienna, Lower Austria and Burgenland Section of Torrent and Avalanche Control need hazard zone

mapping (BMLFUW, 2008). Within the sphere of competence of the Vienna, Lower Austria and Burgenland Section, the rate of meeting hazard zone mapping targets is, on average, about 60 per cent. However, the trend is dramatically increasing. The aim is to achieve blanket hazard zone mapping of all the settlement-relevant areas lying within the sphere of competence of the Section by 2011. Hazard zone mapping has proved to be an effective instrument, as during the mapping process it has been possible to locate existing hazards before they could cause actual damage.

Within the framework of hazard zone mapping, Torrent and Avalanche Control is endeavouring to identify indicated and reserved spatial planning areas (blue, brown and violet areas). In this way, existing hazards are indicated and also important areas are kept free for further protective measures. In this endeavour, the foundation for sustainable flood protection is to be found in the catchment areas of the torrents, which are often characterised by their limited available area.

Retention:

With regard to flood retention, no major retention measures have up to now been implemented within the sphere of competence of the Vienna, Lower Austria and Burgenland Section of Torrent and Avalanche Control. The retentive effects of the existing facilities hardly extend beyond local conditions.

3.4.2.3.2 Flood protection measures on torrents in Styria

In Styria, about 3,089 torrents lie within the sphere of competence of the Forest Engineering Service in Torrent and Avalanche Control. Here too, the majority of the torrents present potential dangers for settlement and infrastructure areas. Currently, there are already protective measures on about a third of the torrents under supervision (BMLFUW, 2008).

Due to the morphological conditions, the district of Liezen, which lies in the catchment area of the Enns and therefore also in that of the Austrian Danube, is one of the main focal regions of the Styrian Section of the Forest Engineering Service.

Fig. 3-5 offers an overview of the torrent catchment areas in the province of Styria, lying within the sphere of competence of the Forest Engineering Service in Torrent and Avalanche Control.

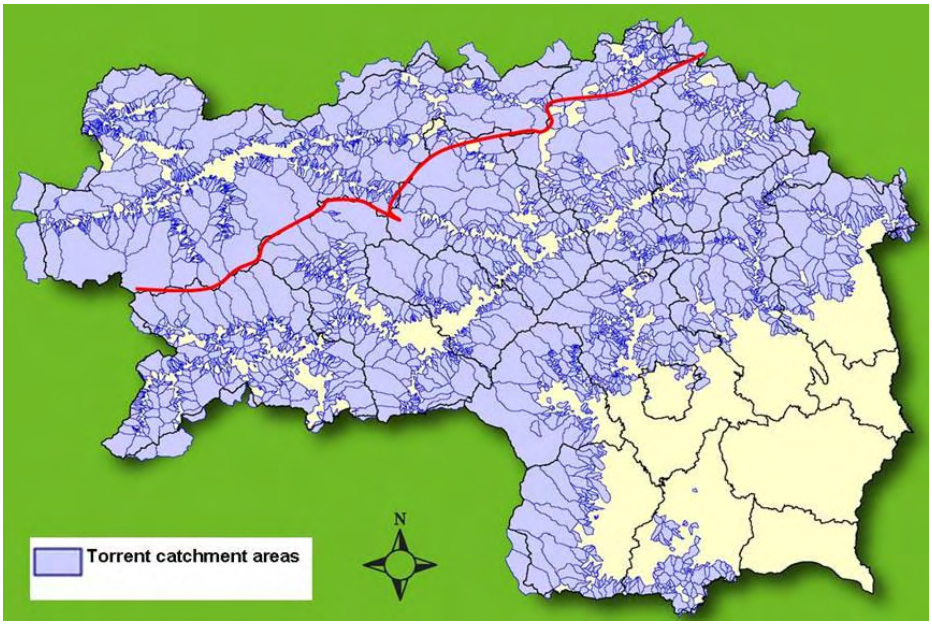


Fig. 3-5: Torrent catchment areas of the Forest Engineering Service in Torrent and Avalanche Control in Styria (Image: Styrian Section of Torrent and Avalanche Control)

Strategies:

The Styrian Section has set itself a main strategic focus regarding flood retention. The aim is that flood retention in the catchment areas should increase and improve the protection of settlement and infrastructure areas against natural hazards.

The field of activity involving bed load management includes a further strategic objective. By means of a wide variety of activities, such as area management measures, the construction of bed load retention basins and the use of debris flow barriers and debris retention basins, the potential dangers are already mitigated in the catchment area.

A further protective strategy deals with the prevailing problem of dead wood and driftwood. It is not the bed load carried by the torrents, but their load of dead wood which mainly results in log jams and the resulting potential dangers. Area management measures in the catchment area, such as afforestation measures or protection forest structuring measures, serve on the one hand to reduce the volume of dead wood and, on the other, to stabilise (bed load management) the markedly Alpine-type catchment areas. Additionally, through taking care of the waters, the discharge areas are kept free of driftwood. Furthermore, construction measures for retaining not only dead wood but also bed load (barriers for holding back dead wood) are increasingly being implemented on the torrents.

In terms of implementing the Water Framework Directive of the European Union, one objective of the Forest Engineering Service in Torrent and Avalanche Control is to dismantle impassable obstacles within the framework of current protective projects.

The Styrian Section invests about 15 to 16 million euros annually in its work programmes. The monetary value of this sum is guaranteed, and therefore an amount at least equal to this will also be available over the coming years.

Protective measures:

With regard to flood protection, the Forest Engineering Service in Torrent and Avalanche Control is pursuing the aim of designing the channel to provide adequate flood protection and/or to preserve it by means of flood retention. Above all, the Enns Valley, with its thickly-populated fan deltas at the mouths of the torrent rills, is a focal area for the Styrian Section of the Torrent and Avalanche Control. A wide variety of protective measures are being implemented here, including area management measures in the catchment area (protection forest, bed load binding measures), river regulation measures, bed load barrages, debris retention basins and flood retention measures.

As the Forest Engineering Service in Torrent and Avalanche Control has already been implementing measures to protect against natural hazards for the past 125 years, the proportion of maintenance and supervision work is increasing in relation to construction measures. The adaptation of old projects is also being carried out in the course of maintenance. Based on improved technical implementation options, these projects are complemented by means of retention areas for bed load and debris flows. The documentation of occurrences and the provision of proof regarding protective effectiveness together form a significant part of sustainable flood protection. The documentation and analysis of flood occurrences constitutes a useful instrument for learning from experiences of disasters and, where necessary, adapting structures accordingly.

Hazard zone mapping:

The settlement of hazard areas has heavily increased over the past few decades. In addition, the consequences of climate change and its influence on disastrous events to come are difficult to estimate. The Forest Engineering Service in Torrent and Avalanche Control has therefore already been pursuing a strategy of preventive protection against natural hazards, through drawing up hazard zone maps.

The Styrian Section of Torrent and Avalanche Control has already drawn up a ministerially-approved series of hazard zone maps for 290 of the total 342 relevant municipalities in Styria. In Upper Styria, the set objective of blanket-coverage hazard zone mapping of the geographically-relevant areas was already achieved years ago. Over the coming years, these hazard zone maps will undergo revision (changed bases and methods, increased degree of protection).

Since 2008, the hazard zone maps of Styria have been available to the public online, via the digital GIS Atlas of the province. In addition, in the event of disaster, operational command can rapidly and easily access the hazard zone maps via the disaster control server of the province of Styria.

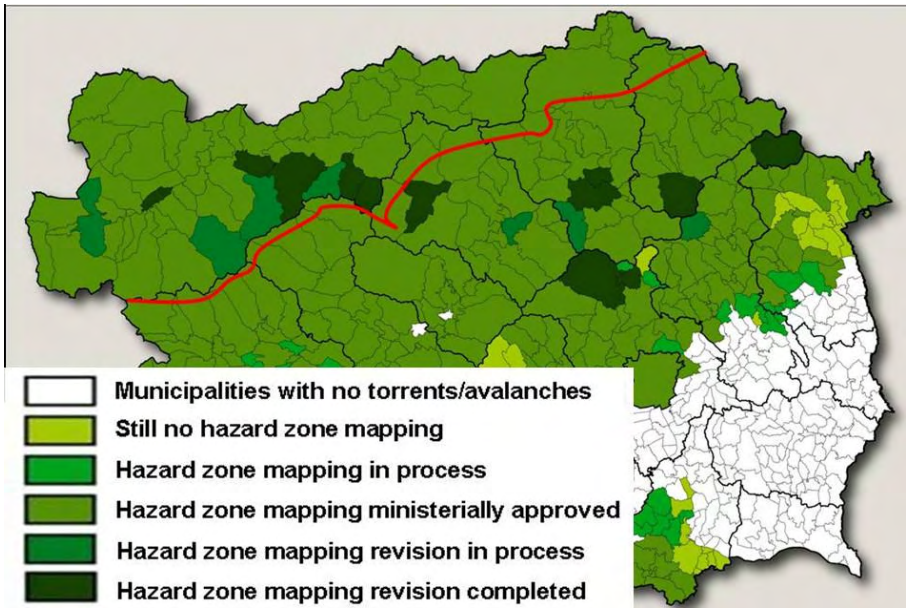


Fig 3-1: Current status of hazard zone mapping by the Forest Engineering Service in Torrent and Avalanche Control in Styria (Image: Styrian Section of Torrent and Avalanche Control)

As has already been described in the section on Vienna, Lower Austria and Burgenland, reserved and indicated areas are identified within the framework of hazard zone mapping. In terms of a long-term safe, future-oriented utilisation of the landscape and of settlement areas, there is a strategy to increase the usage of the large body of information gained through the instrument of hazard zone planning. As the interaction between water management and land-use planning represents an important key for minimising flood damage, cooperation with spatial planning has been intensified by means of the "Programme for the floodproof development of settlement areas in Styria". The focus of

this programme is to find and consistently apply land-use planning fields of action in order to minimise risk in the event of future occurrences of flooding.

In 2008, an information brochure for all municipalities and their spatial planners was produced jointly with the Association of Towns and Municipalities. The aim of the brochure is to provide information on water-related natural hazards, as well as on the need to take them into account in the building and land-use planning process.

Retention:

One of the strategic objectives of the Styrian Section is the implementation of measures for flood retention in the catchment areas of the torrents. The aim is to already hold back the water masses as they arise in the catchment area. On the one hand, this makes it possible to ensure flood protection for downstream riparians, while on the other reducing the need for cost-intensive measures and also for flood control embankment measures, which affect the state of the waters.

There are currently about 20 flood retention basins within the sphere of competence of the Styrian Section. Two more are under construction, and five basins are at present in the planning phase. Due to the morphological conditions, the Torrent and Avalanche Control basins mostly have an average volume in the region of 10,000 to 50,000 m^3. The implementation of retention basins in the Styrian portion of the Danube sub-basin is made difficult by, above all, morphological conditions (lack of available area). The primary focuses here are, in particular, bed load retention and bed load binding measures.

Within the framework of a pre-project, a series of smaller potential retention basins are currently undergoing a feasibility study. As well as the morphological conditions, land availability or land provision pose particular problems in implementing such measures. About 3 and 4 million euros are invested annually in the implementation and maintenance of retention basins in the Styrian Section.

3.4.2.3.3 Flood protection measures on torrents in Upper Austria

About 1,239 torrent catchment areas, 1,121 of which already have existing flood control measures, lie within the sphere of competence of the Upper Austrian Section. With a total area of about 5,630 km^2, the sphere of competence of the Section covers about 47 per cent of the area of the province.

Strategies:

The Upper Austrian Section of Torrent and Avalanche Control places the main focus of its protective water management directly on the catchment areas. Both area management measures (protection forest, area management and bed load binding) and the retention of solids and dead wood by means of construction measures constitute the main activities here.

However, as well as the harmless diversion of the water masses which arise during flooding, the volume regulation and capping of the flood wave on the larger torrents is a further strategic objective of Torrent and Avalanche Control.

Protective measures:

The need for protection on the torrents of Upper Austria is as diverse as the landscape there. Different geological units, ranging from the rugged Limestone Alps to the landside-prone Flysch Zone, call for suitable solutions. The flood protection projects are implemented in accordance with necessity and urgency. Besides this the maintenance and adaptation of existing constructions is gaining increasing importance in Upper Austria too. As a result of the flood of 2005, regional studies, which represent an instrument of nature hazard management for examining the type, degree and extent of existing threats within a region or spatial unit, are being increasingly compiled. They constitute the basis for the targeted implementation of activities for protection against natural hazards.

Hazard zone mapping:

It has already been possible to compile hazard zone maps for each of the 269 municipalities lying within the sphere of competence of Torrent and Avalanche Control in Upper Austria. Blanket-coverage mapping was already achieved in 2000. Changed technical standards and protective measures already implemented call for an ongoing revision of the existing hazard zone maps. In addition to revision, the digitalisation of the hazard zone maps is currently being intensively promoted.

The identification of reserved and indicated areas is carried in an analogous manner in the other provinces.

Retention:

Depending on the morphological conditions, Torrent and Avalanche Control constructs retention basins on the torrents. Most of these basins have a retention volume of between 12,000 and 70,000 cubic metres.

Despite a shift of the main strategic focuses towards flood retention, bed load and dead wood retention continues to be the main field of activity, comprising 70 per cent of the implemented retention measures.

There is currently an urgent need for action regarding retention in the Mühlviertel[7] in particular. Since the flood of 2002, there has been a call for improved flood retention here.

3.4.2.3.4 Flood protection measures on torrents in Salzburg

The Salzburg Section supervises 1,299 torrent catchment areas throughout the province, whereby many present potential dangers. Protective measures have already been implemented on about 980 of the supervised torrents.

Strategies:

Regarding protection from natural hazards, including floods, the Forest Engineering Service in Torrent and Avalanche Control has pursued and is pursuing two different strategies. Besides the implementation of protective structures and their ongoing maintenance, on the one hand, the strategic objective of flood retention is being pursued in the catchment areas, while on the other, a further protective strategy is focused on alleviating the problem of dead wood and driftwood in the torrents.

Protective measures:

The building of protective structures not only rapidly improves safety, but also represents an important contribution to the promotion of rural space. Over the past few years, protective measures costing around 21 million euros have been implemented in the province of Salzburg, of which approx. 85 % was invested in projects for protection against torrents. This investment sum corresponds to the annual need for protection of the next five years.

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[7] The Mühlviertel is a subregion of Lower Austria.

In addition to the construction of protective structures, protection against the natural hazard of water also increasingly calls for measures for the maintenance of existing structures.

Hazard zone mapping:

The hazard zone mapping within the area of operations of the Salzburg Section of the Forest Engineering Service in Torrent and Avalanche Control has already been 100 % completed for all 116 villages affected in Salzburg. Thus, all the hazard zones in the spatially-relevant areas within the sphere of authority of Torrent and Avalanche Control have been identified on maps for the sub-basin in the province of Salzburg. As the need arises, there is ongoing revision of the hazard zone maps, in order to make the latest situation regarding natural hazards available for decision-makers.

The raising of awareness in dealing with natural hazards cannot therefore remain a mere slogan, but must also be acted upon in the future. For this reason, the authorities are making efforts to closely involve the general public and those affected by flooding in the hazard zone mapping process.

Retention:

Over the past few years, the Salzburg Section has been increasingly implementing flood retention measures in morphologically-suitable areas. Particularly in the Flachgau and Tennengau, an area which is in certain places subject to the occurrence of very heavy precipitation, the retention measures have already shown a good effect. Otherwise, the aim in the course of the hazard zone mapping is to keep existing retention and discharge areas clear.

3.5 Preventive Actions – Optimising Flood Forecasting and the Flood Warning System

- ***Objective 1: Optimisation and development of flood forecasting***
- ***Objective 2: Optimisation of flood warning and the flood warning systems***

One of the aims of the Action Programme of the International Commission for the Protection of the Danube River for sustainable flood protection in the catchment area of the Danube is the improvement of flood forecasting and the early warning systems, as well as the networking of national and regional systems. The intended result is to be an international flood forecasting and flood warning system that not only covers the entire

Danube river basin, but also responds to the respective needs and requirements of the individual regions.

In Austria, the flood protection strategies envisage measures to improve flood warning and forecasting, thereby preventing or reducing potential damage. The following section offers an overview of the current status of flood forecasting and flood warning in Austria, and in the Danube sub-basin of the Austrian Danube.

3.5.1 Flood forecasting model

A forecasting model for the Danube in Austria, covering the Danube catchment area from Passau (Bavaria) all the way to the national border, has been in trial operation since 2006. As the main river in the Danube sub-basin of the "Inn", the Inn is incorporated in the model from Schärding onwards. The Bavarian State Office for Water Management calculates hourly forecasts for the mutual intersection at Passau, which are likewise incorporated into the Austrian model. The forecasts are calculated at hourly intervals by means of physics-based models, for a forecasting period of up to 48 hours.

Not only on the Danube, but also on the Enns, a supra-regional forecasting model (Salzburg, Styria and Upper Austria) is in operation, or trial operation. The model, which was already put into operation in 2007 in Styria, covers the catchment area of the Enns, all the way to its confluence with the Danube.

Upper Austria:

A meteorological-hydrological warning system on the Steyr, combined with the Enns, is currently being elaborated. The aim is to thereby achieve an early flood warning up to 48 hours in advance for the flood-endangered city of Steyr.

Lower Austria:

According to LABUT (2009), the flood which occurred in August 2002 was the immediate reason for the consistent development of a flood information system aimed at geographically representing and covering the entire province. Starting with the Danube, a flood forecasting system for all larger main rivers and affluents is being developed step by step in Lower Austria.

In the Danube sub-basin of the Austrian Danube, forecasting systems have already been in full operation on the Traisen and the Kamp since 2006. The calculation of the forecasts is carried out at hourly intervals by means of physics-based models, for a forecast

of up to 24 hours in advance. The model covers the catchment area of each watercourse all the way to its confluence with the Danube.

A flood forecasting system for the Ybbs, including its tributaries, the Ybbsitz and Url, is currently in process. By 2013, a further system is to be set up on the Erlauf in the Danube sub-basin.

In addition, forecasting models for smaller tributary catchment areas (at present 15 in the whole of Lower Austria) are in operation in Lower Austria. The forecast is carried out by means of a simplified procedure (Unit Hydrograph Procedure).

The results (analyses and forecasts of precipitation and air temperature as raster data) of the meteorological models of the Central Institute for Meteorology and Geodynamics (ZAMG[8]) are incorporated in the discharge simulation as definitive input parameters.

Styria:

In the Styrian portion of the Danube sub-basin, the above-mentioned forecasting model is currently in operation on the Enns.

Apart from the Enns model, there is no urgent need for the installation of further forecasting models in the small Styrian portion of the Danube sub-basin.

3.5.2 Installation of gauges and measuring points

The Hydrographic Service runs a basic network of observation points in Austria, to document and process the most important components in the hydrological cycle, and if necessary to be able to rapidly implement measures. This space and time-related data is displayed by means of a Geographic Information System (GIS) and can be accessed at any time.

The basic network of the Hydrographic Service consists of 950 precipitation gauges, 750 snow-depth gauges and 586 air temperature gauges. In addition, there are 800 water-level gauges, 600 discharge gauges and 210 water temperature gauges throughout Austrian territory. Of these, the Hydrological Services in Austria have 221 remote interrogation or transmitting stations at their disposal. GSM gauges (Groupe Spécial Mobile; mobile phone systems) currently represent cutting-edge technology. The collected hydro-

[8] German acronym

graphic data is managed through a standardised Hydrographic Data Management System (HyDaMS) and can be accessed via the GIS application eHYD.

Vienna and Lower Austria:

The precondition for establishing the flood forecasting system for Lower Austria is the further development of the network of telecommunicating gauges. The real-time hydrological data serves as a basis for appraising the situation. The following table presents information on the available network of gauges in Lower Austria.

Table 3-8. Network of gauges at the disposal of the Hydrographic Service of Lower Austria (Source: LABUT, 2009)

	Total number of gauges (incl. remote transmission)	Gauges with remote transmission	Display on Internet
Precipitation	259	61	61
Discharge of Danube, March and Thaya ("Via Donau" water gauge)	7	7	7
Discharge of tributaries of Danube and Elbe	146	52	50
Groundwater	527	26	25
Total	939	146	143

Within the Danube sub-basin of the Austrian Danube, the Hydrographic Service has at its disposal 80 precipitation, air temperature and evaporation gauges, which have remote transmission, as well as 43 surface water and solids gauges, which have remote transmission. Fig. 3-6 shows the position of the gauging stations.

Upper Austria:

The Hydrographic Service of Upper Austria supervises a total of 414 surface water and solids gauges, as well as 165 precipitation, air temperature and evaporation gauges. In the Danube sub-basin alone, it has 296 surface water and solids gauges and 138 precipitation, air temperature and evaporation gauges at its disposal.

Styria:

The Hydrographic Service of Styria can currently access 157 surface water and solids gauges, of which 4 are equipped with staff gauges, 30 with recording strips and 123 with data collectors. Of these gauging stations, 33 are designed to be able to telecommunicate or be remotely interrogated.

For measuring precipitation, the Hydrographic Service has 186 precipitation, air temperature and evaporation gauges at its disposal throughout Styria. Of these stations, a total of 87 are already equipped with digital data collectors, 71 of which can telecommunicate.

The further expansion as well as concentration of the existing gauge network over the next few years is one of the objectives of the Hydrographic Service of Styria.

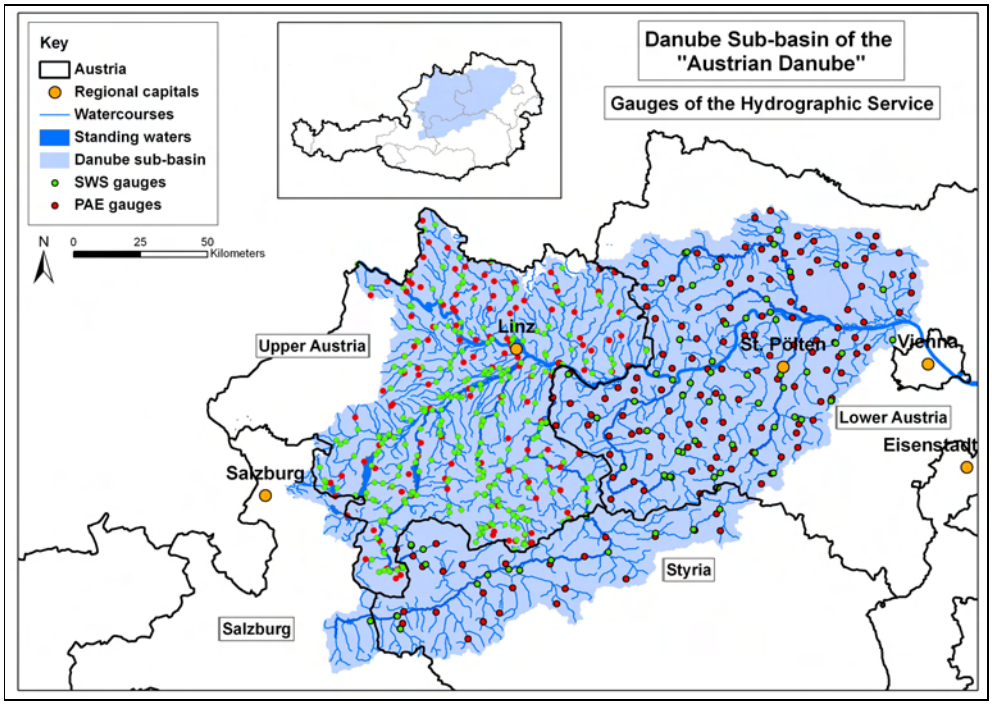


Fig. 3-6: Overview of the measuring points in the Danube sub-basin of the Austrian Danube (Graphic: Revital ZT)

Salzburg:

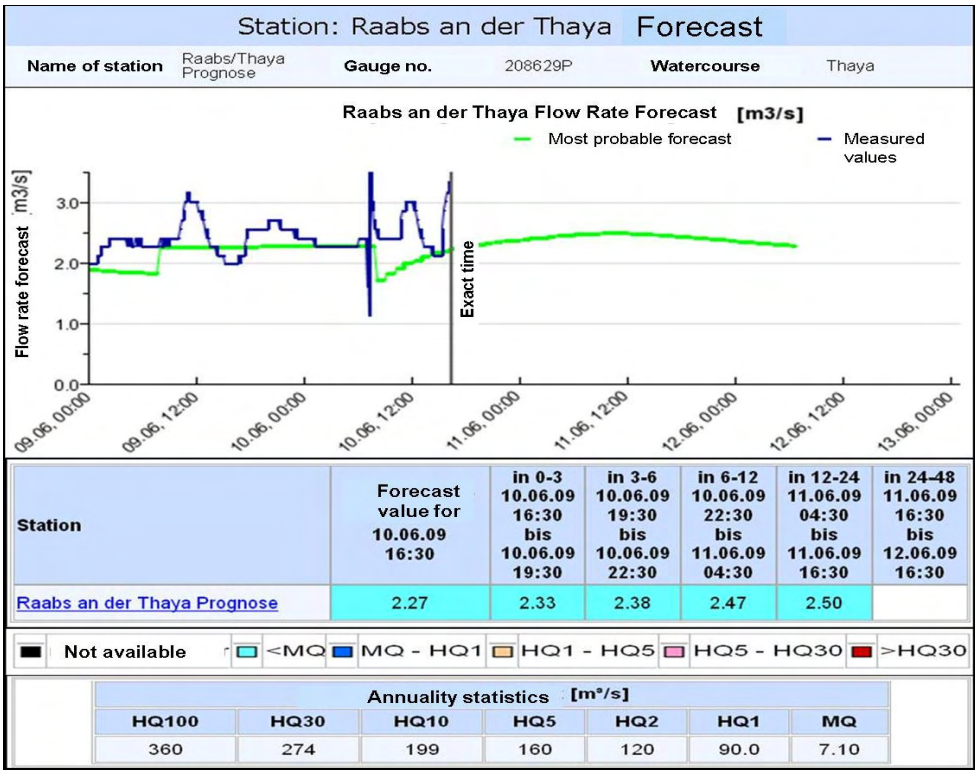
The Hydrographic Service of Salzburg currently makes use of data from 147 surface water and solids gauges. About 15 of these gauges are located on waters in the Danube sub-basin of the Austrian Danube. 14 precipitation, air temperature and evaporation gauges moreover provide meteorological data in the Danube sub-basin.

3.5.3 Flood news services, water-level information and flood warning systems

The flood news services represent the basic precondition for smoothly-functioning flood risk management. When issued at an early stage, advance warnings make it possible to carry out preventive measures in time. For this purpose, the Offices of the Regional Gov-

ernments in Austria must, commensurate with their responsibility, set up news services in the event of flooding, in accordance with the Water Rights Act. Any announcements will immediately be passed on to the regional warning centres and other emergency services.

The regional Hydrographic Services of the Federal Hydraulic Engineering Administration provide information concerning the current precipitation and discharge values at the individual gauging stations in the region to all interested citizens, free of charge, by telephone, teletext and via the homepages of the regional governments. The discharge situation on the larger rivers, subdivided into flood danger levels, can likewise be accessed at the Hydrographic Service at any time. For example, the following diagram shows the gauge data from an online-accessible discharge gauging station of the Regional Hydrographic Service of the Federal Hydraulic Engineering Administration in Lower Austria.



Station	Forecast value for 10.06.09 16:30	in 0-3 10.06.09 16:30 bis 10.06.09 19:30	in 3-6 10.06.09 19:30 bis 10.06.09 22:30	in 6-12 10.06.09 22:30 bis 11.06.09 04:30	in 12-24 11.06.09 04:30 bis 11.06.09 16:30	in 24-48 11.06.09 16:30 bis 12.06.09 16:30
Raabs an der Thaya Prognose	2.27	2.33	2.38	2.47	2.50	

Not available | <MQ | MQ - HQ1 | HQ1 - HQ5 | HQ5 - HQ30 | >HQ30

Annuality statistics [m³/s]						
HQ100	HQ30	HQ10	HQ5	HQ2	HQ1	MQ
360	274	199	160	120	90.0	7.10

Fig. 3-7: Example of an online flood forecast of the Hydrographic Service of Lower Austria (Source: Homepage of the Hydrographic Service of Lower Austria, modified: Revital ZT)

The flood warning systems of the provinces are based on close cooperation between Hydrography and the Central Institute for Meteorology and Geodynamics. The torrential rain forecasts and torrential rain warnings issued by the Central Institute for Meteorol-

ogy and Geodynamics meteorological service are analysed by the Hydrographic Service. A flood standby service is set up whenever the Central Institute for Meteorology and Geodynamics (ZAMG) warns of heavy precipitation (> 30 mm/d). If occasion demands, the Hydrographic Service also sets up a water-level news service at short notice. Activation in the event of flooding then takes place once the flood signal marker (~ HQ_{1-2}) has been reached at one of the telecommunicating water gauging stations. In addition, the Hydrographic Services in Austria function as a hub for all the information and data. Based on these, flood warnings are, if necessary, issued for the affected regions.

The flood news services in Austria have set themselves the goal of developing and improving the information system further. This is to be done by means of automatic data gathering and data transmission, and also based on forecasting models in conformity with cutting-edge technology. Improved data material will thus be available for both the experts and citizens affected by flooding in the future to be able to quickly carry out the right decisions and measures in case of emergency.

Fig. 3-8 below shows the flow chart of the flood news service of Styria in the event of flooding. As soon as the flood warning marks are exceeded or if there is any contamination of the waters, the Austrian province concerned immediately informs neighbouring countries (Hungary, Slovakia).

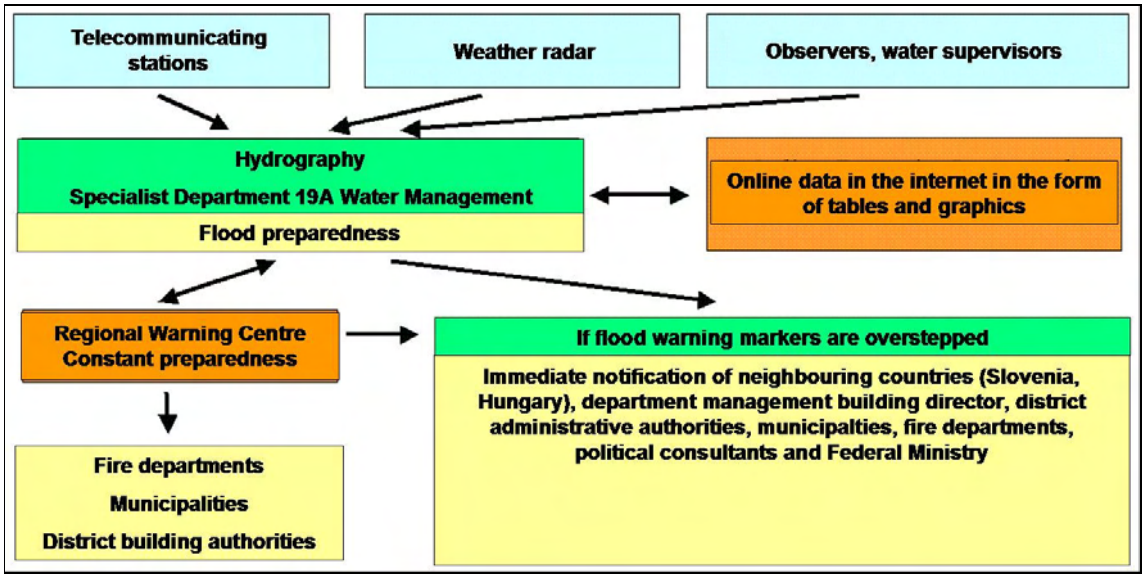


Fig. 3-8: Flow chart of the Styrian flood news service (Office of the Regional Government of Styria)

In Upper Austria, the Hydrographic Service has set up a project for alerting the municipalities if the water levels on smaller tributaries of the Danube are overstepped due to flooding. As soon as a defined gauge value or water level is overstepped, civil defence staff receive advance warning. Similar advance warning systems already exist on the Aist, the Aschach, the Ischl, the Krems and the Traun. Further advance warning systems are in the planning phase for the Rodl and the Alm.

3.6 Capacity Building of Professionals

Objective 1: Promotion of the national and international exchange of knowledge between all the specialisations of integrated flood management

Water knows no national borders. Therefore, decades ago Austria already concluded water agreements with its neighbouring states Germany, Slovakia, the Czech Republic, Hungary, Switzerland, Liechtenstein and Slovenia and has set up bilateral and multilateral water commissions (see the brochure "Flood Protection in Austria" Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2006). Sustainable flood protection that is fit for the future can only be tackled in cooperation with the riparian states in the individual river basins, including active collaboration and the exchange of knowledge and strategies. The following section describes the necessary general conditions and facilities, and offers a few examples of successful international cooperation between Austria and other riparian states on the Danube.

3.6.1 General Conditions

The Water Framework Directive of the European Union represents the framework for the common protection of waters in the member states. The precondition for achieving the aim of a good ecological state of waters is good cooperation between the member states, based on common measures, such as the installation of a gauging and monitoring programme and the setting up of national water management programmes.

The Action Programme on Flood Prevention, Protection and Mitigation of the European Union serves to facilitate the development of a flood action programme within Europe. The Action Programme basically incorporates three component aims. Firstly, to increase the mutual exchange of experiences, knowledge and information, secondly to sensitise public awareness of the problem, and thirdly, to ensure the targeted deployment of sub-

sidies by means of the Action Programme. The Floods Directive of the European Parliament and Council forms the basis for this.

Furthermore, the aim of the Action Programme for sustainable flood protection in the catchment area of the Danube of the International Commission for the Protection of the Danube River is to create forums for the exchange of expert knowledge. A long-term, sustainable approach in dealing with the issue of flood protection, through which human lives and property assets and, at the same time, water ecosystems will be protected and improved, is also an integral part of the Action Programme.

3.6.2 Commissions

The International Commission for the Protection of the Danube River, which is based in Vienna, was founded in 1994 to actively promote cooperation concerning protection and contractual utilisation in the Danube river basin. Due to the severe floods and the as yet hardly assessable consequences of climate change, in 2004 it was decided to launch a long-term Action Programme for sustainable flood protection in the Danube river basin. One of the aims of the Action Programme is its declared objective to set up forums for the exchange of expert knowledge, in order to push ahead with sustainable, efficient flood protection throughout the Danube river basin, based on these measures.

In order to speed up water management cooperation with neighbouring countries and to regulate water management relations, Austria has concluded “water agreements” with them. The work is conducted at the level of bilateral or multilateral water commissions, as well as at the level of local water management departments. Cooperation in the form of the “Austrian-Czech Boundary Waters Commission” as well as the “Austrian-Hungarian Boundary Waters Commission” is headed by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The main focuses of the work include the upkeep of the waters on the border as well as of the constructions built on them, flood protection measures and the organisation of a warning service for extraordinary water pollution incidents and for floods.

3.6.3 Transnational Projects

Over the past few years, the exchange of experiences and expert knowledge has also been increasingly coordinated on the basis of transnational projects. For example, through INTERREG pilot projects an effort has been launched to develop river manage-

ment schemes internationally in the direction of a river basin management plan. The intention is to thus boost structured cooperation and the exchange of knowledge between all the administrative departments working in the river basin, starting with hydrology, and then involving spatial planning, water rights, nature conservation, agricultural and forestry departments, etc

At the beginning of April 2006, the Standing Committee of the Alpine Conference authorised the work programme of the Platform for Natural Hazards (PLANALP), whereupon the Platform for Natural Hazards could begin concretely working on the project. The aim is to develop a common strategy for the member states who signed the Alpine Convention for the prevention of natural hazards, and to deliberate together about appropriate adaptation strategies. Within the framework of the Platform for Natural Hazards, high-ranking experts were sent out to arrange effective networking and coordination.

3.7 Raising Awareness and Preparedness of General Public

- ***Objective 1: Promotion of the knowledge and awareness of hazards***
- ***Objective 2: Optimisation and development of disaster control and emergency planning***
- ***Objective 3: Protection against disasters by means of preventive measures***

3.7.1 Informing the general public

The Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) is making strenuous efforts to adequately inform the general public on the subject of floods, as well as their dangers and possibilities of flood prevention. The Austrian flood protection strategies envisage a furtherance of public knowledge and awareness of hazards. Another aim is to point out the limits of protection and the responsibility of those involved. The Federal Ministry therefore regularly publishes brochures and folders on the subject of flood protection, and makes them available to the public. Thus for example, in 2007 it published the brochure “The Force of Water – How to protect buildings adequately from floods and high groundwater levels”, an issue that will still be dealt with in greater detail. The Hydraulic Engineering Administrations regularly organise a variety of informative events aimed at sensitising the general public to this issue. Furthermore, a wide variety of internet platforms set up by the authorities and or-

ganisations offer the opportunity to become adequately informed on the subject of flood protection. The following section presents a few more detailed examples of public relations work in Austria, which already begins with children and young people.

Youth:

Generation Blue: www.generationblue.at

In 2004, the Federal Ministry of Agriculture, Forestry, Environment and Water Management launched "Generation Blue", a youth internet platform. The aim of this internet platform is to introduce young people to the subject, to awaken their enthusiasm, and to inform and sensitise them concerning water. To achieve this aim, the website has been designed to appeal to young people, offering many possibilities of learning something on the subject through games.

Bertie Beaver: www.biberberti.lebensministerium.at

Torrent and Avalanche Control makes children aware of the problem of natural hazards through the character "Bertie Beaver". Presented in the form of school projects, the aim is for children to learn through play how to handle natural hazards correctly, as well as how to behave in case of emergency.

Free Your River: www.freeyourriver.net

In "Free Your River", the WWF offers a multilingual youth website on the subject of water. The aim is to offer young people a chance to learn many things about the protection of river ecosystems using information and work materials.

Adults:

As with children and young people, efforts are being made to interest adults in the subject of natural disasters, and in the possibilities of prevention and protection. The following section offers a few examples of this approach.

Waternet, Flood Hazard Zoning Austria: www.wassernet.at, www.hochwasserrisiko.at

The homepage of the Federal Ministry of Agriculture, Forestry, Environment and Water Management presents "Wassernet.at", a platform enabling anyone to amply inform themselves on the subject of water. The link "Force of Nature Water" takes one to the internet platform for Flood Risk Zoning Austria. Here, those interested are able to gather information on an initial hazard and risk assessment for their region.

Environmental Education Forum: www.umweltbildung.at

The Environmental Education Forum is an initiative launched jointly by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Federal Ministry for Education, Arts and Culture. This portal offers a large number of environmental education opportunities in a variety of special fields. The target group encompasses disseminators in schools, institutions offering further training for teachers, extracurricular youth educational organisations and also adult education. Valuable information, documents and publications on a wide variety of different special fields, including flood protection, can be accessed on the homepage.

Floodsite: www.floodsite.net

The largest flood research project of the European Union fulfils the requirements of the Water Framework Directive with regard to cross-border coordination between countries sharing common river basins. On the Floodsite homepage, those interested can access a variety of information, publications and newsletters, though to do this one must have a command of the English language and a certain amount of technical knowledge.

Provinces:

The staff of the Federal Hydraulic Engineering Administration is extremely eager to conduct a lively exchange of information with the resident population, in order to draw people's attention to the risks and hazards caused by floods. In order to acquire well-founded expert knowledge on the subject of disaster control and awareness-raising, training sessions, for example expert disaster control conferences, municipal training in risk analysis or integrated training sessions in staff work and crisis communication, are regularly offered. In addition, exercises are regularly conducted.

The publications, brochures and folders of the BMLFUW serve as the predominant information and illustrative material. However, within the framework of large-scale detailed planning projects, the designation of hazard zone maps and the setting-up of river development schemes, the Ministry also compiles its own, mostly river-specific brochures and folders.

In addition, a great deal of information and relevant reading materials are available for interested members of the public on the homepages of the provinces. For example, the latest water levels of watercourses can be continually accessed.

In Styria, there has for some time been the option of viewing the hazard zone plans of the Forest Engineering Service in Torrent and Avalanche Control online, via the Civil Protection Server of the province. This is aimed at supporting the disaster control authorities in implementing preventive measures and precautions, as well as ensuring the targeted planning of emergency operations.

3.7.2 Flood Risk Zoning Austria (HORA[9])

In several subzones, Flood Risk Zoning Austria is already fulfilling the requirements of the EU Directive on the assessment and management of flood risks. Flood Risk Zoning Austria is, in particular, fulfilling the requirement to provide more information to the portion of the population affected by flooding, both in general and specifically with regard to existing flood risk areas.

The aim of Flood Risk Zoning Austria:

With its "Flood Risk Zoning Austria – HORA" project, the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Association of Austrian Insurance Companies started a nationwide risk zoning system for natural disasters, particularly for floods. As well as promoting risk awareness, the aim of this measure is to highlight the limits of active protective measures and the need for the sensible utilisation of areas at risk of flooding. Valuable information on the current flood risk, based on digital hazard maps, can be accessed by every citizen via the internet. In addition, these risk maps also offer each Austrian citizen the basic possibility of assessing risk.

Methodology and display format:

At Flood Risk Zoning Austria, the entire Austrian river network is recorded, with its total length of approx. 26,000 km. Based on this, the flood plains are visualised for flood discharge HQ_T with an annuality of T = 30 (Zone 1), T = 100 (Zone 2) and T = 200 (Zone 3). The aim set for the flood risk zoning was the achievement of the greatest possible precision, taking into account the large-scale flood risk areas. However, for reasons of time and cost, it is not possible to achieve such precision in the hydraulic models.

[9] Translator's note: German acronym

The identification of the flood plains is thereby divided into a hydrological and a hydraulic part. The hydrological part serves to identify the flood discharges and is consulted as an input parameter for the hydraulic part.

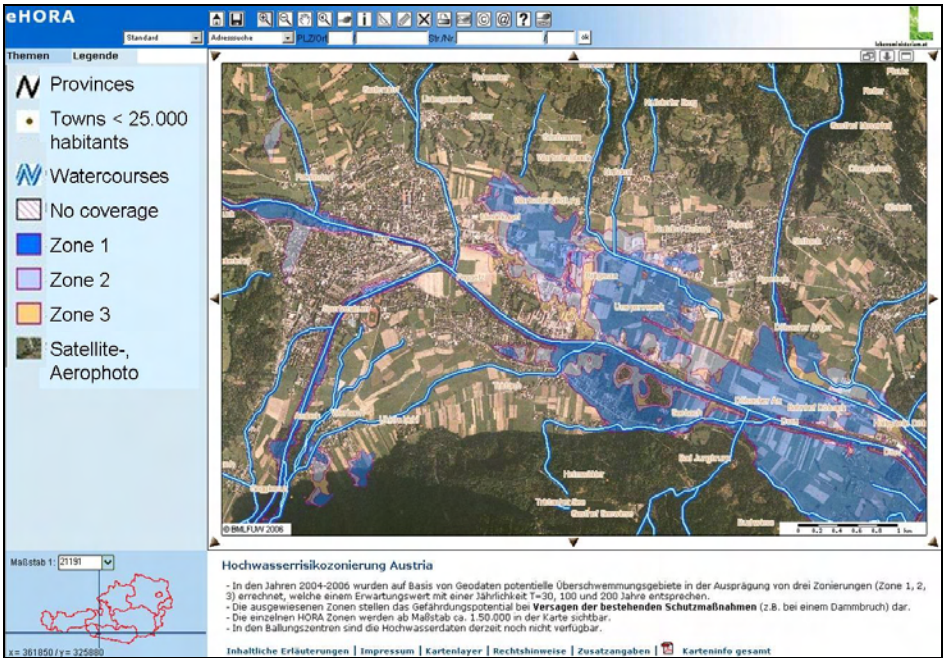


Fig. 3-9: Map section of the online Flood Risk Zoning eHORA

3.7.3 Disaster Control

The Austrian flood protection strategies envisage measures to further expand emergency planning and disaster control in Austria. Based on the allocation of authority laid down in the Austrian Constitution, disaster control in Austria is the responsibility of the federal provinces. In the event of flooding, the relevant disaster control department determines operational command on the spot and supports the authority in combating the disaster. In case of emergency, the relevant regional warning centre of each province is entrusted with coordinating the crisis management of the local emergency services. During the disaster operation, the relevant district operational commands coordinate their work with one another at the regional level, as well as with the superordinate operational command.

However, a permanently-manned Federal Warning Centre is installed in Vienna for supra-regional and international disaster control. This centre is in constant contact with the regional warning centres, as well as other bodies both in Austria and abroad. In Aus-

tria, the Federal Ministry of the Interior is responsible for the government's crisis and disaster control management.

The respective regional laws (disaster control laws and emergency help laws), which *inter alia* provide for the creation of disaster control plans, constitute the legal bases for disaster control. In terms of target-oriented disaster management, the disaster control plans provide for an area analysis, the assessment of the potential dangers, the organisation and tasks of the individual emergency services as well as the disaster alarm plan.

The development of flood forecasting models on Austria's watercourses represents a fundamental step towards improving disaster management. The institutionalisation of closer cooperation between the hydrographic services and disaster control departments over the past few years has resulted in the targeted implementation of measures in the area of flood warning and forecasting. By means of the improved flood warning systems, it is possible to considerably reduce the potential damage caused by flooding. Based on the knowledge of impending weather conditions, potential victims and disaster control organisations can be warned in time.

Protection from disasters is not only the responsibility of the public authorities, but is also the concern of every individual. In order to promote public risk awareness, and to give people information and instructions concerning flood protection and flood precautions, the Federal Ministry of Agriculture, Forestry, Environment and Water Management has issued a brochure entitled "The Force of Water – How to protect buildings adequately from floods and high groundwater levels".

3.8 Prevention and Mitigation of Water Pollution Due to Floods

Objective 1: Prevention and mitigation of water pollution produced by flooding

The destructive effect of large-scale floods is also accompanied by the pollution of waters. Floods can therefore have far-reaching consequences for the environment. Liquid fuels which escape from storage tanks, damage to supply lines, industrial enterprises, sewage treatment and chemical plants or filling stations can lead to contamination or the loss of biological diversity in waters. Increased efforts must therefore be made by planners and executing bodies to prevent the contamination of waters in the event of disaster in the future. To achieve this, it is necessary for spatial planning to be integrated to a much greater extent into the protective water management planning process and for the legislator (building regulations) to make clear stipulations in this regard. The Ministry also

offers the public valuable information with regard to flood-proof building in its brochure "The Force of Water – How to protect buildings adequately from floods and high groundwater levels". The brochure explicitly goes into the floodproof design of heating systems, with the aim of preventing pollution of waters with heating oil later on. In addition, flood protection strategies in Austria aim to encourage citizens to take individual precautions by offering them good information and, if need be, suitable incentives.

In view of the threat of water pollution in the event of flooding, the Building Technique Ordinance of Lower Austria provides for special precautions and stipulations relating to the installation of storage containers for liquid fuels (heating oil).

In Austria, constructions such as new sewage plants or industrial workshops are basically built outside the inundation zones of floods that statistically occur every 100 years, and/or suitable structural precautions are taken to design the construction to be floodproof. This represents the primary foundation for preventing the pollution of waters in the event of flooding. When carrying out construction measures on watercourses in future, the Hydraulic Engineering Administrations will endeavour not to lay any more pipelines from which polluting emissions could escape in the event of disaster.

Styria:

The majority of sewage treatment plants in the catchment area are not situated in flood-endangered locations. In the event of a threat of flooding, any measures to reduce the risk are the responsibility of the plant operator applying for official approval.

4 Measures to Achieve Targets

4.1 Regulation on Land Use and Spatial Planning

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Compilation and adaptation of flood hazard maps and flood risk maps					
Flood Risk Zoning Austria (HORA)	Prevention Raising Awareness	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)		Ongoing	To be worked out in cooperation with the Austrian Insurance Association. In certain sub-areas (informing the public, flood-endangered areas), this already corresponds to the EU Directive on the assessment and management of flood risks. Details: See Section 3.7.2 Flood Risk Zoning Austria (HORA)
Adoption of the objectives and principles of the EU Floods Directive	Administration	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)			
Objective 2: **Complete identification of all flood hazard zones**					
Full-coverage identification on hazard zone maps in the relevant settlement and infrastructure areas. Flood Discharge Analyses	Hazard zone mapping	• Administrative offices of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control (WLV) (both BMLFUW)		Ongoing until 2010 or 2020	Complete identification of all hazard zones in the sphere of competence of the Federal Hydraulic Engineering Administration will take place by 2020. Complete identification of all hazard zones in the sphere of competence of the Forest Engineering Service in Torrent and Avalanche Control will be completed by 2010. Details: See Section 3.2 Regulations on Land Use and Spatial Planning and Section 3.4.2.3 Protection from natural hazards on the torrents
Adaptation of laws, ordinances and directives to the claims and demands of protective water management.	Administration	• Federal state, provinces		Ongoing	Spatial planning and land-use planning laws, building regulations, building technique ordinances …

Identification of reserved and indicated areas	Hazard zone mapping	• Sections of the Forest Engineering Service in Torrent and Avalanche Control (WLV)		Ongoing	In this way, existing hazards are indicated and also important areas are kept free for further protective measures.
Identification of areas in need of protective water management in coordination with spatial development	Strategy Flood protection Raising awareness	• Provinces • Specialist departments			Pilot project: Protective Water Management Spatial Development Plan Currently only exists for the province of Carinthia, though its extension to cover all Austria is under discussion.
Objective 3: Increased interdisciplinary cooperation between the individual specialisations					
Promotion of closer interdisciplinary cooperation between protective water management, spatial planning, disaster control and the legislative process	Strategy	• Federal government, provinces and municipalities • Specialist departments		Ongoing	Efforts are being made not only to increasingly integrate the threat from natural disasters in the mapping process, but also to identify space for the natural area. Example: Flood Risk Study
Assure suitably-adapted area utilisation through spatial planning. Coordinate planning projects carried out by the public authorities.	Strategy Protective water management land-use planning	• Provinces (Lower Austria Land-Use Planning Law)		Ongoing	Land designation, land provision and protective water management instruments for keeping areas clear. Details: See Section 3.2 Regulations on Land Use and Spatial Planning

4.2 Reactivation of former, and creation of new, retention and detention capacities

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Natural retention of floods in the catchment areas					
Prevention of existing retentions areas	Flood retention Strategy	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Targeted flood retention in the catchment areas. Passive flood protection takes priority over active flood protection. Details: See Section 3.3 Reactivation of former, and creation of new, retention and detention capacities

Reactivation and creation of retention capacities	Flood retention Strategy	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Implementation by the Federal Hydraulic Engineering Administration and the Forest Engineering Service in Torrent and Avalanche Control. Details: See Section 3.3 Reactivation of former, and creation of new, retention and detention capacities
Recognition of negative flood-relevant developments	Strategy Research	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)		Ongoing	
Objective 2: Protective water management, morphological and ecological improvements in the river bed					
Implementation of protective water management, morphological and ecologically valuable measures in the riverbed (restructuring, revitalisation, renaturation)	Strategy Flood protection	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Details: See Section 3.3 Reactivation of former, and creation of new, retention and detention capacities

4.3 Technical Flood Defences

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: To ensure adequate flood protection for the relevant settlement and infrastructure areas (Details: See Section 3.4 Technical Flood Protection)					
Maintenance and adaptation of the protective measures and protective structures	Maintenance Flood protection Strategy	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Due to the increasing volume of protective water management construction work on the waters, maintenance is gaining increasing importance.

Implementation of measures for flood protection where necessary	Flood protection	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Basic principles: Passive flood protection takes priority over active flood protection. Measures in the catchment area take priority over measures on the main channel of a watercourse. Retention measures take priority over linear construction measures.
Upkeep and improvement of floodwater passability on watercourses	Flood protection	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Improvement of passability (outlets, channels, bridges…) in the course of the project activity
Coordination between planning projects of public authorities and the relevant special fields.	Strategy Integrated flood management	• Departments of the Federal Hydraulic Engineering Administration • Departments of the relevant special fields.		Ongoing	
Recognition of negative flood-relevant developments	Strategy Research	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)			
Objective 2: Protection and management of natural hazards on the torrents					
Measures for bed load and dead wood retention in torrent catchment areas	Protection from natural hazards	• Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Details: See Section 3.4.2.3
Implementation of area management measures in the catchment areas	Protection from natural hazards	• Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Details: See Section 3.4.2.3 **Error! Reference source not found.**

Objective 3: Flood protection by means of area-and-space-effective measures					
Creation and enlargement of retention areas and basins	Flood protection	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Main strategic focus: retention measures take priority over linear construction measures. Regarding implemented and planned measures. Details: See Section 3.4.2 Technical flood retention
Controlled retention	Flood protection	• Departments of the Federal Hydraulic Engineering Administration		Ongoing	Regarding controlled retention, greater potentials for the future lie in the continual further development of prognosis and forecasting models. The taking into account of protective water management aspects in the operating regulations of power stations, valley dams or lake reservoirs
Preservation and protection of the function of the groundwater body	Flood protection	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	

4.4 Preventive Actions – Optimising Flood Forecasting and the Flood Warning

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Optimisation and development of flood forecasting					
Development of flood forecasting and prognosis models	Prevention Research Strategy	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)		Ongoing	Gradual development of flood forecasting systems for all major main rivers and tributaries

Networking of regional and international systems	Cooperation Research Strategy	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) • Neighbouring states (Czech, Slovakia)		Ongoing	The intended result is to be an international flood forecasting and flood warning system that not only covers the entire Danube river basin, but also responds to the respective needs and requirements of the individual regions.
Adaptation and development of the gauge network	Maintenance	• Hydrographic Services of the Federal Hydraulic Engineering Administration		Ongoing	Further development of, in particular, the basic network of telecommunicating gauges (see Section 3.5.2. "Installation of gauges and measuring points". Deployment of state-of-the-art technical devices and systems.
Objective 2: Minimisation of the damaging consequences of natural disasters					
Optimisation of flood warning and the flood warning systems (improved early warning)	Prevention Strategy Disaster Control	• Provinces (Hydrographic Services, disaster control departments)		Ongoing	Well-functioning early warning systems and flood news services (improved data gathering and transmission process) represent the basic prerequisite for well-functioning flood risk management. Details: See Section 3.5 Preventive Actions – Optimising Flood Forecasting and the Flood Warning System

4.5 Capacity Building of Professionals

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Promotion of the national and international exchange of knowledge between all the specialisations of integrated flood management. (Details: See Section 3.6 Capacity Building of Professionals)					
Improvement of international cooperation in flood management	Cooperation Research	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)		Ongoing	Action Programme for sustainable flood protection in the catchment area of the Danube Action Programme on Flood Prevention, Protection and Mitigation of the European union (Floods Directive of the European Parliament and Council)
International cooperation within the framework of water agreements or bi- and multilateral water commissions	Cooperation	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) • Representatives of the participant countries		Ongoing	Sustainable flood protection that is fit for the future can only be tackled in cooperation with the riparian states in the individual river basins, including active collaboration and the exchange of knowledge and strategies.

Execution of transnational projects; partner of international platforms	Cooperation	• Federal government, provinces • Participant neighbouring countries and various organisations		Ongoing	For example, through INTERREG pilot projects an effort has been launched to develop river management schemes internationally in the direction of a river basin management plan. The intention is to thus boost structured cooperation and the exchange of knowledge between all the administrative departments working in the river basin, starting with hydrology, and then involving spatial planning, water rights, nature conservation, agricultural and forestry departments, etc

4.6 Raising Awareness and Preparedness of General Public

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Promotion of the knowledge and awareness of hazards (Details: see Section 3.7 Raising Awareness and Preparedness of General Public)					
Keeping the public continually informed	Public Relations Raising Awareness	• Federal government, provinces and municipalities • Disaster control departments, emergency organisations, insurance companies…		Ongoing	Brochures, folders, information sheets on the subject of flood protection Internet platforms Information and events designed for different age and person groups Flood news service, online services (Details: See Section 3.7.1 Informing the general public
On-the spot informative events held by the Federal Hydraulic Engineering Administration and Torrent and Avalanche Control	Public Relations Raising Awareness	• Departments of the Federal Hydraulic Engineering Administration • Sections of the Forest Engineering Service in Torrent and Avalanche Control		Ongoing	Informative events within the framework of detailed planning projects, hazard zone mapping or river development schemes
Identification and publication of potential flood hazard areas within the framework of Floor Risk Zoning Austria (HORA)	Information Raising Awareness	• Federal Ministry of Agriculture, Forestry, Environment and Water Management		Ongoing	Assessment of the flood risk. Making already complete-coverage, public information available to the general public. Basic possibility of online risk appraisal. Elaboration in cooperation with the Austrian Insurance Association.
Objective 2: Optimisation and development of disaster control and emergency planning					

The carrying out of disaster control exercises	Disaster control	• Provinces • Disaster control organisations		Ongoing	
Streamlining and optimisation of the emergency response chain	Disaster Control	• Provinces • Disaster control organisations		Ongoing	
Creation of disaster control plans and special alarm plans	Disaster Control	• Provinces • Disaster control organisations		Ongoing	
Objective 3: Protection against disasters by means of preventive measures					
Promotion of incentive systems to encourage people to take their own precautions	Prevention Disaster Control	• Federal government, provinces		Ongoing	
Securing financial provision	Prevention Disaster Control	• Federal government, provinces		Ongoing	

4.7 Prevention and Mitigation of Water Pollution Due to Floods

Measures	Type of intervention	Institution in charge	Costs	Deadline	Comment
Objective 1: Prevention and reduction of water pollution produced by flooding					
Greater integration of spatial planning in protective water management planning projects	Prevention and reduction of water pollution	• Federal government, provinces		Ongoing	See also Section 4.1
Directives and specifications given by the legislator	Prevention and reduction of water pollution	• Federal government, provinces		Ongoing	Building Code[10], Building Technique Ordinance[11] (uplift-resistant heating oil tanks; positioning of storage containers)

[10] Bauordnung

[11] Bautechnikverordnung

Information on flood-proof building	Prevention and reduction of water pollution	• Federal government, provinces			Information on constructing flood-proof heating systems