Action Programme

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

The Danube Sub-basin of the Inn

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International Commission for the Protection of the Danube River
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Sub-Report on the Danube Sub-basin

Of the Inn

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1. Introduction

1.1 The 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 Inn 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 de-

fenses, 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 The Aim of the "Inn" Sub-Report

The "Inn" sub-report encompasses the entire Danube sub-basin of the Inn. Thus, all the tributaries of the Inn, primarily the Salzach and Manfall, have also been included in the report.

The aim of the present sub-report is an initial assessment of the current flood protection situation in the catchment area of the Inn. 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. In addition, measures which have already been implemented and planned for the protection of human beings and the environment, such as those concerning the issue of public relations, or measures for the reduction of water pollution resulting from flooding, have also been incorporated in the present report.

2. Characterisation of the Current Situation

Sustainable flood protection in Austria and Germany represents an essential foundation for the settlement of many areas, particularly in the Alpine region. 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.

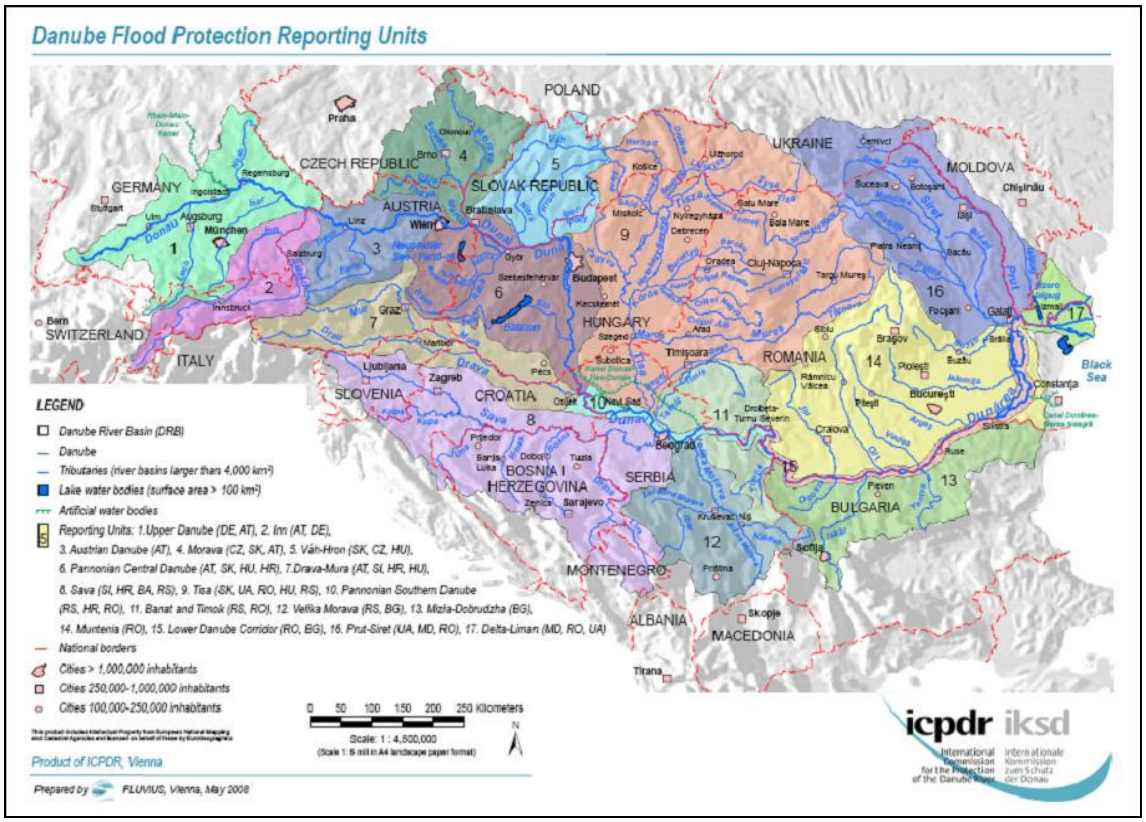

Fig. 2-1: Overview of the Danube sub-basins (Source: ICPDR)

The Inn, including its tributaries, as an important Danube sub-basin of the Upper Danube, drains a large portion of Austria's western national territory as well as a large por-

tion of Bavaria (Germany) into the Danube. As the third-largest (measured by its discharge) and seventh-longest tributary of the Danube, the Inn is also of significance importance for the Danube's flood discharge system.

The continuance of sustainable flood protection, as well as the constant further development of the flood protection strategies and preventive measures on the Inn are therefore of significant importance also for the Danube riparian states.

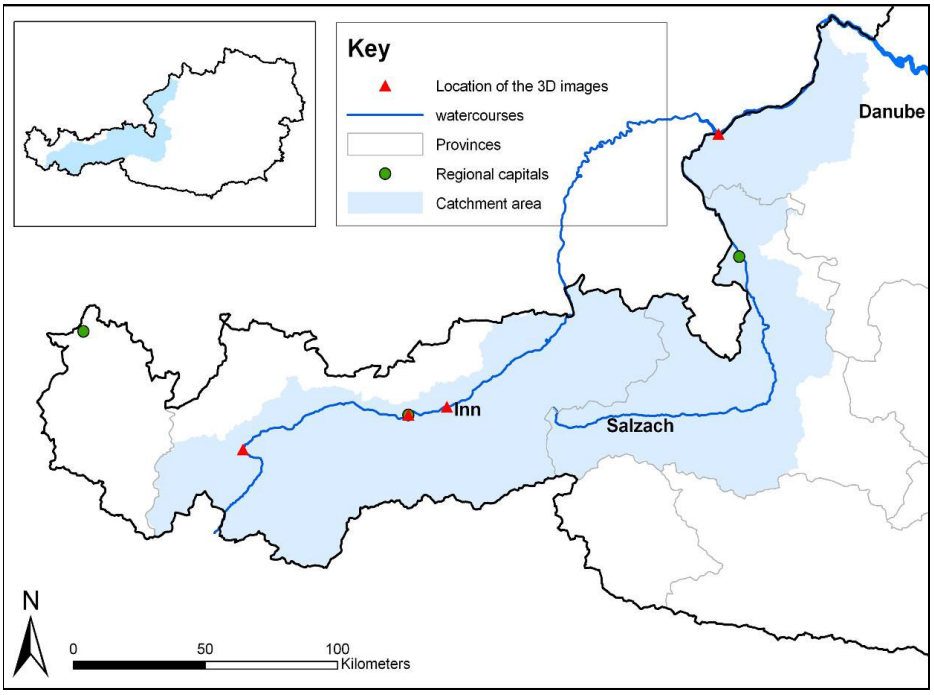

Fig. 2-2: The Inn, Salzach and their catchment areas, and also the Danube in Austria

The Inn arises at the Maloja Pass in the Swiss Engadin and extends for 517 kilometres to its confluence with the Danube at Passau. It thereby traverses not only Switzerland but also Austria and Germany, covering an altitude difference of 2193 metres. The Upper Inn Valley forms a basin, in which Landeck is situated at 816 metres above the Adriatic. The character of the landscape is still very Alpine here.

Downstream of Innsbruck (at river kilometre 300), where the Upper Inn Valley gives way to the Lower Inn Valley although the valley floor of the Inn Valley is already somewhat wider in this area, the valley is nonetheless still Alpine in character with existing

land utilisation pressure exerted by settlement, infrastructure, agriculture and natural area which decisively shapes the Inn Valley.

The German-Austrian border runs between the towns of Kufstein and Erl in the middle of the river. The Inn then crosses the south-eastern corner of Bavaria after which it again forms the German-Austrian border, downstream of the Salzach tributary. The Inn enters the Danube at Passau, “the town of three rivers”. The river Inn is about 517 km long.

Before flowing together with the Danube at Passau the Inn is the boarder between the Austrian Province of Upper Austria and Bavaria about 70 kilometres. At this point, the confluence of the Salzach into the Inn has already occurred. Here, the Alpine character of the Tyrolean Alpine valleys has given way to the plain. The is a dominant impact on the Inn by hydropower stations in the border region.

According to the Hydrographic Yearbook (2004), in Austria the Inn covers an area of 8392 km² up to the confluence of the Salzach. Below the Salzach confluence, it covers a further 1976 km² on Austrian national territory. In all, this corresponds to a portion of about 12.4 % of Austrian national territory. As the most important tributary, the Salzach covers a further 5543 km² portion of Austria. Another important tributary on the left side is the Mangfall.

At the Schärding gauge, near its confluence with the Danube, the Inn drains a catchment area of 25,663.8 km² with a mean discharge (1991-2000 series) of 742 m³/s. Of this area 8,100 km² are in Bavaria, of which some 4,600 km² are alpine and pre-alpine regions.

3. Target settings

The International Commission for the Protection of the Danube (ICPDR) is an international organisation consisting of 13 cooperating states and the European Union. 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 forecasts 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 forecasts 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.

3.1 Long-Term Flood Protection Strategy

3.1.1 Strategies for sustainable flood protection

One thing is certain: the next flood is definitely coming. We must therefore be prepared. 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. By the end of 2013, hazard zone mapping will have been completed for the Inn, the Salzach and their most important tributaries in the provinces of Tyrol, Salzburg and Upper Austria and Bavaria. In the course of hazard zone mapping, up-to-date flood hazard maps and flood risk maps can be created.

Protective water management 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.

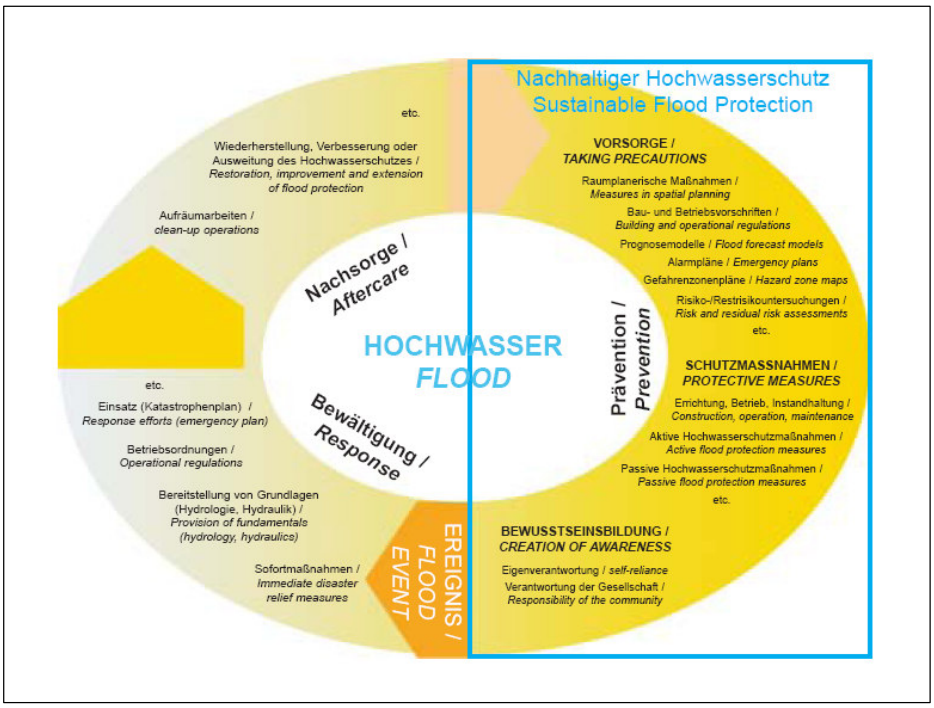

Fig. 3-1: Sustainable flood protection

Flood protection in both countries of the Inn sub-basin 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 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:

- 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 (non-structural flood protection)
- More space for the dynamics of watercourses
- Maintaining existing flood protection structures (regulatory measures, embankment dams, flood retention basins)

In Bavaria after the Whitsun floods of 1999 the Bavarian cabinet adopted the Flood-Action-Programme 2020 for sustainable flood control in Bavaria, and the implementation of this mechanism has been most successful thanks to the strong technical commitment and the allocation of substantial budgetary resources. The programme plans an investment of 2.3 billion Euro by the year 2020, of which some 0.3 billion Euro will go to the Danube catchment area. This will make it possible:

- to effectively reduce the existing damage potential,
- avoid future damage potential in a sustainable manner and
- establish adequate flood defence systems for buildings and infrastructure installations.

To this end, the Flood-Action-Programme 2020 pursues an integrated, future-proof flood control strategy comprising the three fields of action:

- natural retention,
- technical flood defence and
- preventive flood control.

3.1.1 Strategies for sustainable flood protection in the Danube - Inn sub-basin

The Danube sub-basin of the Inn, 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. However, regional funds are also constantly being pumped into the strategic planning process.

With regard to flood protection, the federal provinces in the catchment area of the Inn are endeavouring to achieve a joint approach. Concerted efforts are increasingly being made to push ahead with the preservation and expansion of natural retention areas. As mentioned above, where necessary, technical flood protection measures are being implemented on the watercourses and/or existing protective measures are being maintained. Linear expansion measures are being combined with active and passive retention measures and coordinated with one another. However, the varying topological conditions in the individual provinces do significantly influence the size and effectiveness of the planned measures. The land area available due to the topology enables, for example, greater emphasis to be placed on flood retention through retention basins in Upper Austria. By contrast, the implementation of such measures in Tyrol and in large portions of Salzburg requires considerably greater expenditure while producing, to some extent, a lesser effect.

In addition, the individual administrative offices of the Federal Hydraulic Engineering Administrations are making efforts to bring about increased cooperation with the specialist divisions of spatial planning. In the future, protective water management measures will require increased coordination with spatial planning divisions to support and increase the effectiveness of the implemented measures in a targeted way. The legal requirements prevailing in each case form the basis for interdisciplinary cooperation.

3.2 Regulations on Land Use and Spatial Planning

General introduction:

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 hazard 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 supralocal 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 Upper Austrian Spatial Planning Act (2005) states, for example, that no land in flood plains may be designated as new building land. The spatial planning laws of the other provinces contain similar stipulations, based on hazard zone mapping. Hazard zone mapping represents an essential and valuable component in creating land utilisation plans.

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. Based on the effects of potential hazards, the administrative office concerned identifies hazard zones, to which various direc-

tives and prohibitions are then linked. The hazard zone maps of the river basin subsequently serve as a basis for alarm plans, planning, and the development of projects and experts' reports.

Bavaria:

Major cities situated on the Inn are Rosenheim, Wasserburg am Inn, Mühldorf am Inn, Neuötting and Passau. Agricultural land use is therefore dominant in the undulating hill country with more grassland farming in the foothills of the Alps.

To avoid future damage potential the most effective preventive measure is to define and keep clear areas endangered by flooding.

The identification of floodplains is planned along approx. 5,100 river km of the major rivers in the Danube river basin, of which approx. 3,000 river km (approx. 60%) have already been assessed. These analyses will be completed by the end of 2010. The calculation will be carried out using digital terrain models with high resolution laserscan data as well as hydrological 2D models. For the calculations a 100-year flood event is taken as a basis. The floodplains will be defined in a legally binding manner by the competent administrative district authorities. This will restrict a more extensive use of these areas, for building purposes, for example. Moreover, other changes shall also only be permitted if these do not impair the runoff and the retention properties. Restrictions to agricultural use can also be enforced if, for example, maize planting should hinder the discharge. The same applies to farming of the alluvial forest. A corresponding ordinance was issued recently on the Danube, in the region of Deggendorf.

The new Bavarian State Development Programme came into force on April 1, 2003 and defined in binding manner priority areas for securing flood discharge and flood retention in regional plans. In the Danube river basin most of these areas have already been protected as reserve/priority areas in the regional planning. Formally, the protection of reserve areas is somewhat weaker than that of priority areas, the set goals, however, are mostly the same. In the glossary to the regional plan these terms have the same meaning.

Tyrol:

In 2001, discharge analyses for flooding occurring statistically every 30 and 100 years were conducted on the Inn in Tyrol, and the resulting areas identified. Based on changed general conditions (hydrology, improved models) fresh discharge analyses of the Inn are currently being worked out. These discharge analyses are conducted in coordination with

the Free State of Bavaria and, in the process, up-to-date hazard zone maps will also be drawn up. In accordance with the Floods Directive, up-to-date hazard zone maps will be created for the Inn and its main tributaries by the competent body, the Hydraulic Engineering Administration of Tyrol by 2013.

During the course of the planned discharge studies on the Inn, it is furthermore planned to identify restricted and priority spatial planning areas. The aim of identifying them is to keep land and retention areas with relevance for flood discharge permanently clear based on supralocal spatial planning.

Salzburg:

The following table offers a clear overview of the protective water management situation in Salzburg and on the Salzach, as well on its tributaries.

At present, flood protection schemes are in place along approx. 81 river kilometres in the province of Salzburg. According to RIWA-T (2006), these are superordinate river basin-related schemes on waterbodies which record and present the abiotic situation of waterbodies within the area of the scheme.

River development schemes have been set up for a further 108 river kilometres in Salzburg. River development schemes are, likewise, superordinate river basin-related schemes which, however, based on the watercourse situation include the specified objectives and tasks of protective water management, as well as the specified ecological objectives and tasks for watercourses.

Table 3-1: Instruments of protective water management on the Salzach and its tributaries

	Watercourses	**Length of measure (river km)**	**Processing status**
Flood protection schemes	**Lower Salzach**	22.1 (59.7)	Partly in need of revision
	Fischach	3.5	In existence
	Pladenbach	18.1	In existence
	Total in existence	81.3	
River development schemes	**Upper Salzach**	57.9	Being worked out
	Incl. Fuscher Ache	8.1	Being worked out
	Incl. Felber Ache	3	Being worked out
	Lower Salzach	26.5	Being worked out
	Gasteiner Ache	21.2	In existence
	Kleinarler Ache	6.5	In existence
	Lammer	20.9	In existence
	Saalach	59.5	In existence
	Total in existence	108.1	

Hazard zone mapping (HZP)	**Lower Salzach**	8	In existence
	Gasteiner Ache	21.2	In existence
	Grossarler Ache	13.2	At the planning stage
	Rauriser Ache	14	Being worked out
	Saalach	59.5	In existence
	Total in existence	88.7	
Identification of **flood discharge areas** and **hazard zones**	**Upper Salzach**	57	In existence
	Middle Salzach	18.5	In existence
	Lower Salzach	98	In existence
	Fuscher Ache	3.5	In existence
	Gasteiner Ache	34.5	In existence
	Grossarler Ache	8.2	In existence
	Kleinarler Ache	6.5	In existence
	Lammer	20	In existence
	Pladenbach	14	In existence
	Rauriser Ache	17	In existence
	Saalach	60	In existence
	Schöllbach	3.5	In existence
	Total in existence	340.7	

Within the framework of hazard zone mapping, areas with existing hazard zones (floods, mudslides and landslides), as well as areas with relevance for protective water management, for example areas requiring protective measures, are kept clear. About 89 river kilometres in Salzburg are currently identified in hazard zone maps. The Hydraulic Engineering Administration of Salzburg is currently endeavouring to identify the hazard zones in the relevant areas of the Salzach and its most important tributaries by 2010, in accordance with the Directive on Hazard Zone Identification of 2006. Among their other uses, the hazard zone maps also serve as a basis for alarm plans.

The identification of further flood areas has been carried out in the areas of the Upper and Lower Salzach, mainly for floods statistically occurring with a frequency of HQ_{30}, HQ_{100} and, to some extent, HQ_{300}. Flood discharge areas and hazard zones can be found along a stretch of 57 river kilometres on the Lower Salzach, 18 river kilometres on the Upper Salzach, and 98 river kilometres on the Lower Salzach.

In addition, within the framework of detailed projects, river development schemes and flood protection schemes, discharge analyses are being carried out or are at the planning stage on the Salzach, the Saalach, the Rauriser Ache, the Grossarler Ache, the Moosache, the Glan, the Söllheimerbach, the Oberalm, the Fischach, the Alterbach, the Söllbach and the Reischenbach.

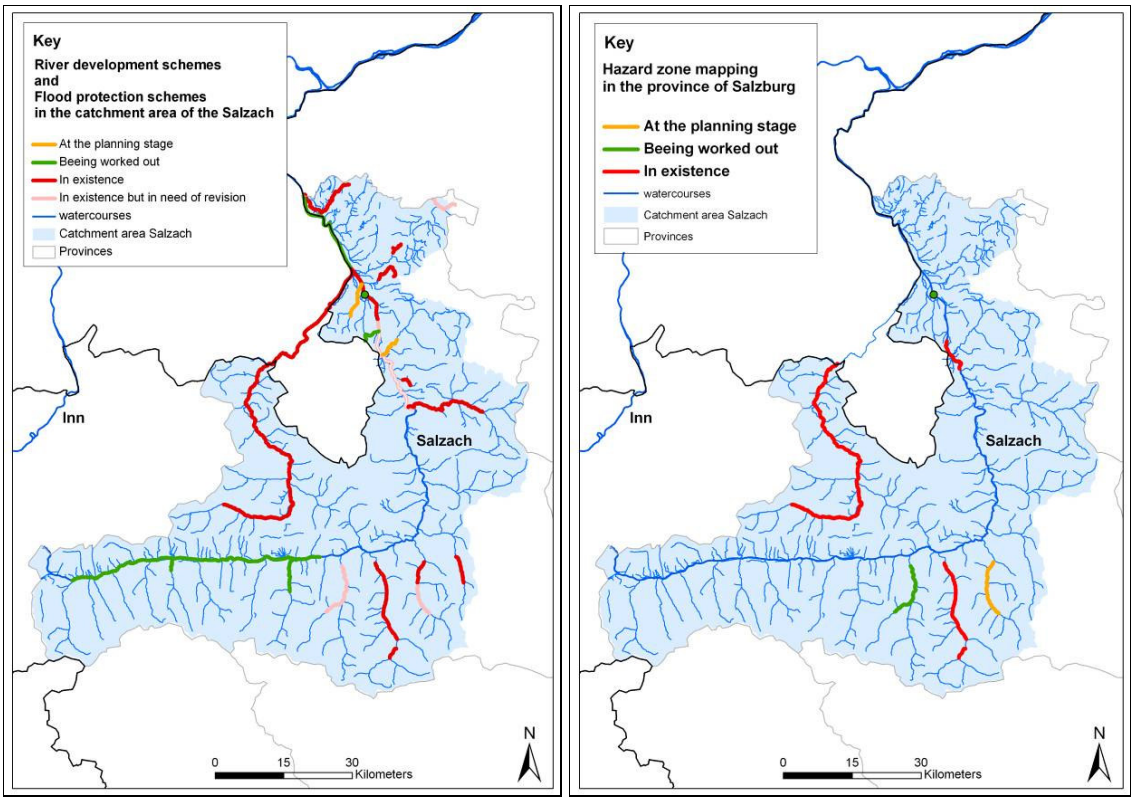

Fig. 3-2: River development schemes and flood protection schemes (left) and hazard zone map (right) in the catchment area of the Salzach; province of Salzburg

There are currently only a few restricted and priority areas identified by protective water management on the Salzach and its tributaries. However, due to the changed general conditions and the resulting closer cooperation between protective water management and spatial planning, this issue will gain increasing importance in the future.

Upper Austria:

In Upper Austria, a hazard zone map currently exists for the Inn in the area of Schärding. In addition, hazard zone maps for the larger tributaries in the catchment area of the Inn such as the Mattig, Ache and Antiesen are currently being drawn up. 50 % of the area of the major tributaries of the Inn, which drain larger catchment areas, is covered by hazard zones. However, there is still no identification of hazard zones on watercourses with smaller catchment areas and on areas that are less relevant for flood protection.

The existing hazard zone maps are mostly “out-dated” maps, which only identify a hazard area of up to HQ_{100}. The objective is, however, to create hazard zone maps of the Inn and its most important tributaries, in accordance with the requirements of the RIWA-T (2006) and the Directive on Hazard Zone Identification (2006) by 2013, in conformity

with the Floods Directive. In Upper Austria, the hazard zone map of the Antiesen is currently being revised, and a hazard zone map of Gurtenbach is in the planning stage. The Braunau Subdivision of the Federal Hydraulic Engineering Administration is currently pursuing the aim of creating the hazard zone map in coordination with the flood retention measures (retention basins) that are currently being planned.

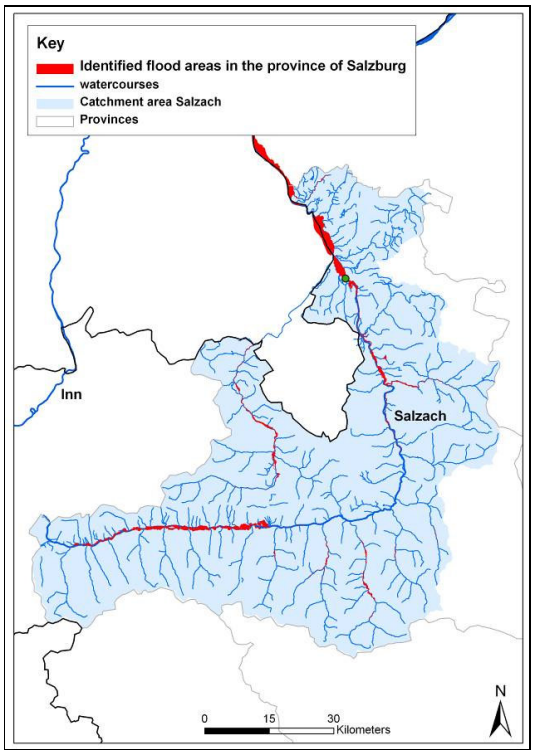

Fig. 3-3: Identified flood areas in the catchment area of the Salzach; province of Salzburg

The identification of restricted and priority spatial planning areas has not yet been carried out in the Braunau Subdivision of the Federal Hydraulic Engineering Administration. Efforts are, however, being made to integrate spatial planning in protective water management planning to a much greater extent in the future and to subsequently identify more such areas.

3.3 Reactivation and Creation of New Natural Flood Retention Capacities

General introduction:

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 forecasts, 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 waterbodies, thus satisfying the requirements of the Water Framework Directive.

Bavaria:

Besides enhancing the ecological status, renaturation of rivers is aimed to improve flood protection through measures that level out and delay discharge. Since 2001about 90 km of rivers and approximately 475 hectares of river banks have undergone renaturation. Within the scope of these measures alluvial forests have been planted on over 3 hectares of floodplains.

Precipitation that is already retained in the catchment area and not directly discharged reduces flood discharge in the river. Besides the renaturation of rivers it is therefore important to also strengthen the retention function of the riparian wetlands. This includes measures such as relocating dykes, for example, the activation of abandoned waterways, natural depressions and other retention areas as well as the new development and temporary flooding of alluvial forests. Since 2001 some 4 km of dykes have been relocated and approximately 1 million m3 of retention space activated.

Tyrol:

Due to the topographical and morphological conditions in Tyrol, the reactivation and creation of large natural areas which are, above all, suitable for flood retention, is basically only possible at great expense. Usually selective measures are implemented to improve the ecological functioning of the waterbodies, as is currently being done on the Inn. One positive side-effect of this work is, in particular, the reactivation of areas for flood discharge. In addition, severe land utilisation pressure predominates in Tyrolean valley bottoms, due to the limited amount of available land. Fig. 3-4 below offers an overview of the spatial problems which particularly predominate in the Inn Valley.

Within the framework of the “Masterplan Inn” project, a few protective water management and ecologically valuable measures are currently either being implemented or planned on the Inn. The issues of flood retention and the effect of retention areas on the Inn are now receiving much greater attention as, in August 2005, Innsbruck only just escaped a catastrophic flood. There was even massive flooding along the Inn, in the area between Wörgl and Kufstein. In order to better be able to estimate the potential effects of active retention area management on the flood discharge process, a non-stationary discharge analysis is to be carried out within the framework of the discharge analysis.

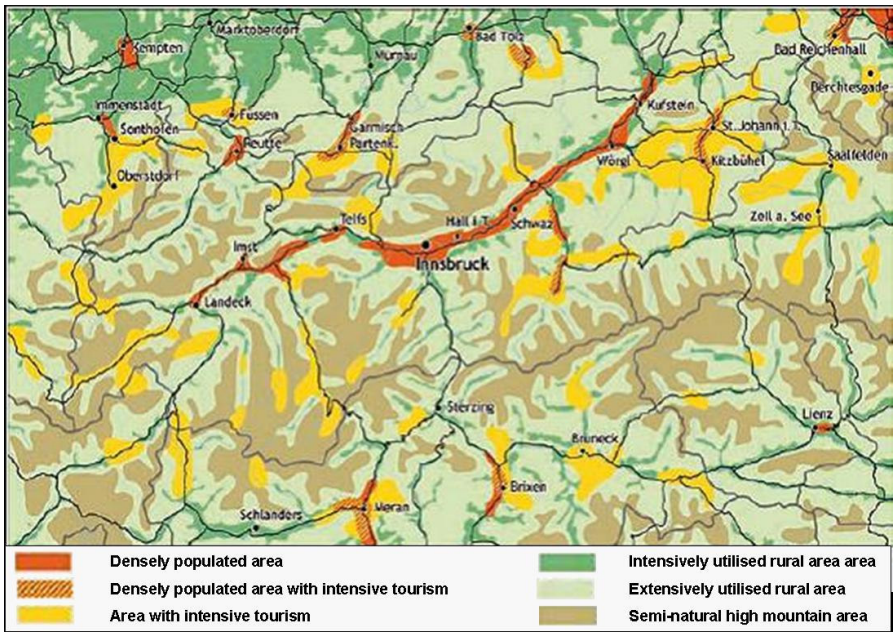

Fig. 3-4: Types of area identified according to their general function in Tyrol (Map: ZukunftsRaum Tirol)

Salzburg:

In the province of Salzburg, restructuring and revitalising measures are continually being carried out, which are furthermore showing positive effects on flood discharge. Over the past few years, the Upper Salzach has increasingly undergone widening measures along a total of approx. 15 river kilometres. Access to the Middle Salzach is heavily blocked due to the existing power stations and the sections of gorge in this area. There is hardly any possibility of implementing river engineering activities (retention measures) here. Up to now, only selective measures have been implemented on the Lower Salzach.

By 2015, a further 10 kilometre stretch is to be widened within the framework of the restructuring of the Lower Salzach. The project costs for all these measures will amount to about 50 million euros.

As in Tyrol, the creation of natural retention areas in extensive areas of Salzburg is only possible at great expense, due to both the topography and shortage of space. However, retention is increasingly being implemented wherever spatial conditions allow. The alluvial plains of Anthering and Weitwörth deserve special mention as important natural retention areas. There are retention areas with a potential capacity of about 125 million cubic metres along the whole length of the Lower Salzach (Austrian-German border section), from river kilometre 0 to 60.

Upper Austria:

Measures to create and promote natural, ecologically-valuable river basins, are being continually implemented in Upper Austria. These measures are usually carried out in the course of implementing the Water Framework Directive. The creation and reactivation of natural retention capacities for flood protection is a desired side-effect of this work. In the Braunau Subdivision of the Federal Hydraulic Engineering Administration, for example, about 250,000 euros per year have been spent on purchasing areas for ecological restructuring and the implementation of ecological measures on rivers over the past few years. By the end of 2012, it is estimated that an investment sum of about 4.4 million euros will be spent for restructuring, revitalisation and renaturation measures on the tributaries of the Inn in Upper Austria, above all the Antiesen, Mattig and Ache.

3.4 Technical Flood Defences

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 with its, to some extent, very limited available space. It would not have been possible to establish settlements in the Austrian Alpine and river valleys without efficient flood protection in many valley areas. A steadily growing need for space and the change in the general underlying conditions call for constantly renewed strategies for achieving the aims of protective hydraulic engineering.

A fundamental aim of protective water management 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 (HQ_{100}), while taking into account ecological compatibility, as well as the economic requirements. 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 the flood protection strategies.

Regarding flood protection, most rivers and streams 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 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 measures on the Inn and its tributaries

Bavaria:

Generally, technical defence measures are based on the protection against a 100-year flood event. In view of the progressing climate change, when planning new projects in Bavaria an extra 15 % has been added to the hydrological model of a 100-year discharge, as a precautionary measure. This is to account for a future increase in discharge that cannot, at present, be determined in exact terms.

Since 2001 some 37,000 inhabitants in the Inn river basin have been protected against a minimum 100-year flood event. The implemented measures protect some 15,000 hectares of developed land against flooding. The targets set in the Flood-Action-Programme 2020 have therefore already been reached.

The kilometre-long dykes along water bodies of the first and second order (larger rivers under the river management of the State of Bavaria) effectively help protect our populated areas. In order to secure their function in the long term, these rivers must be regularly monitored and professionally managed. A survey carried out rates some 100 km of dykes in the Inn river basin as being in need of restoration. Since 2001 some 30 km of these dykes have been restored. Priority must continue to be awarded to the restoration of dykes in the coming years as well.

Within the framework of technical flood defence measures some 6 km of flood walls have been newly built or completed since 2001.

Tyrol:

The prevailing topological conditions, as well as the land utilisation pressure on the available areas in Tyrol considerably impede the possibility of making larger areas available for the retention or discharge of water masses within the catchment area. For this reason, linear expansion measures are often all that is needed to ensure adequate flood protection. Thus, a flood protection project which plans to raise the height of the existing flood embankment dams and flood walls is, for example, currently being implemented in the municipality of Kufstein. No new large-scale dam construction projects are being planned on the Inn in Tyrol at present. The main focus of attention is currently the maintenance of the existing constructions, which in part need to be adapted to the changed general conditions. Within the framework of the planned discharge analyses on the Inn, the process of determining the need for further measures, to be conducted in cooperation with the Free State of Bavaria, is currently underway in Tyrol.

Salzburg:

The flood protection situation on the Salzach, the main tributary of the Inn, is as follows: the Upper Salzach can be described as being linearly built-up along its entire length. Embankment dams on both sides, in all about 100 kilometres of embankment dams, ensure flood protection in this section. The Middle Salzach is predominantly characterised by the chain of power station and the gorge sections. Within the framework of the power station chain, embankment dams have been erected here on over 40 river kilometres. On the Lower Salzach, mainly in the area of river kilometres 37 to 80, there are flood protection measures by means of embankment dams and, within the city of Salzburg, in the form of flood walls as well. There are no dams on the Salzach in the area of the Tennengau.

A large restructuring project is currently in the planning or implementation phase on the Lower Salzach. Due to the narrowing and straightening measures which the Salzach has undergone over the past centuries, and the resulting increase in shear stress, combined with bed load retention in the catchment areas, produced erosion of the river bed. The post-glacial lacustrine clays under the gravel on the bed of the Salzach produce a dynamisation of the erosion process. As soon as the gravel layer has been cleared away there is an abrupt erosion of the river bed in the area of the lacustrine clay layers, thereby resulting in the erosion of the river banks, with severe consequences for protective water management and the ecological situation. The reconstruction of the Salzach, with the aim of once more restoring river morphologic conditions which are stable in the long term, is therefore necessary. The reconstruction project has far-reaching effects on, for example, the alluvial plain system, the affluents, the groundwater level and retention.

The planning concept provides for two river bed terraces in the form of structured bed ramps, as well as a widening of the river bed through the river's own dynamics as measures to combat the erosion tendency. In addition, former affluent systems are to be actively connected up to the Salzach again. Furthermore, two extensive bed consolidations are needed in order to stabilise the river bed in the Freilassing basin.

Various measures for protecting river banks exist on long stretches of the tributaries of the Salzach, with the exception of the gorge sections. In the relevant areas, such as in areas of settlement, embanking measures have also been carried out. On the Saalach, for example, embankment dams which extend for a total of 20 kilometres in length provide protection for areas of settlement.

The existing embankment dams on the rivers in the province of Salzburg have been largely reconstructed or are in a good state, and can thus be rated as stable.

Upper Austria:

Along the Inn, in Upper Austria and the Free State of Bavaria, power station operators have erected a continuous series of barrages. The consequence is that there are largely linear barrier structures on the Inn in this area, which also become effective as protective control structures in the event of flooding.

There is an urgent need for protection against flooding on the Inn in the area of the old town of Schärding. Currently, flood protection measures in two construction phases are planned there; it is planned to begin implementing these from 2009 onwards. In a first

construction phase, the old town is to be protected from HQ_{30} flooding. The second construction phase is aimed at the HQ_{100} protection of industrial and residential buildings on the outskirts of the town. A total investment sum of about 12 million euros is estimated for both construction phases.

In Upper Austria, flood protection embankment dams have been built on the Salzach over a stretch of about 6 kilometres in the area of Ettenau. These are purely flood protection embankment dams, designed to cope with floods that statistically occur every 30 years. Up to the end of 2012, chiefly maintenance measures costing in the region of 1 million euros are planned on the Salzach in Upper Austria. Furthermore, a total investment sum of about 140 million euros is estimated for the restructuring of the Lower Salzach over the next few years, by means of (among other measures) structured bed ramps and extensive accompanying ecological measures.

There are currently few embankment dams on the tributaries of the Inn and the Salzach in Upper Austria. These are mainly low-built dams. The main focuses of attention with regard to flood protection are the tributaries, above all the maintenance and renovation of existing regulation measures. As the objective in Upper Austria is to hold back the floods, the flood protection embankment dams are mainly regarded as merely complementary to the existing retention measures. It is estimated that the cost of planning and implementing these measures, as well as of carrying out the maintenance work on the tributaries of the Inn and Salzach in Upper Austria, will amount to 19 million euros by the end of 2012.

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 Reservoirs and retention basins

Bavaria:

3 state-owned reservoirs with a flood capacity of approx. 19 million m³ decisively contribute towards reducing flood discharge in the Inn river basin. Due to the limited retention capacity their impact is, however, mostly restricted to regional flood control. They are not suitable for accomplishing a supra-regional reduction of flood peaks.

Tyrol:

Although there are a few retention basins on the Inn and its tributaries in Tyrol, due to the topological conditions it is however only possible to implement such measures at enormous additional expense in many catchment areas. The Völser Bach stream retention basin, with a retention potential of 62,000 m³ and the Wörgler Bach stream retention basin of Torrent and Avalanche Control, with a retention potential of 180,000 m³ are important with regard to protective water management. A further retention basin is currently being planned on the Pigerbach stream, although the time frame for its implementation is not yet fixed. When reservoirs are constructed in future, experts will require that the space between the normal maximum water-holding capacity gauge line and the emergency maximum water-holding capacity gauge line should be reserved for emergency flood retention capacity.

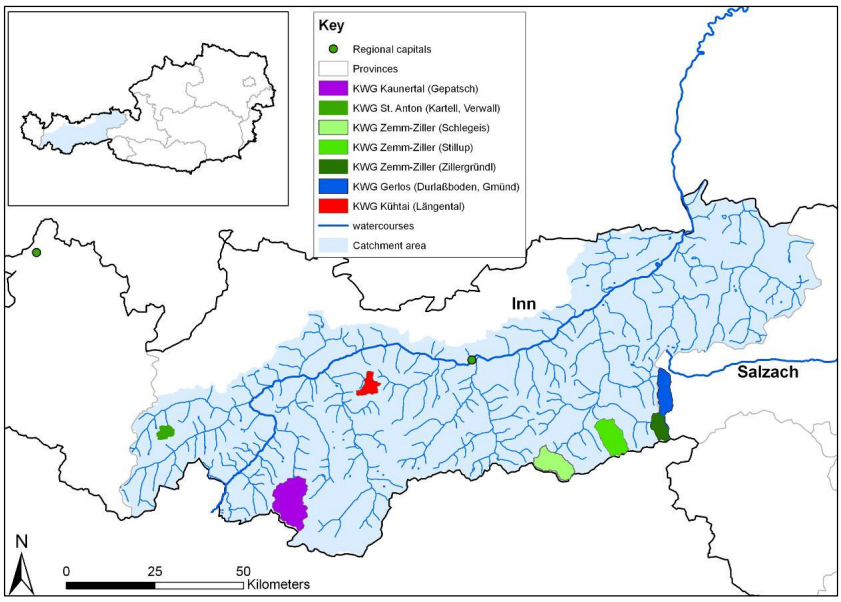

Fig. 3-5: Natural catchment areas of the storage-type plants in the Tyrolean catchment area of the Inn

Furthermore, on the Inn in the province of Tyrol, there is a series of dams (Imst power station, Kirchbichl power station, Langkampfen power station and Ebbs-Oberaudorf power station) for the production of hydroelectricity, and these dams are only able to contribute to flood retention on the Inn to a very small extent.

Table 3-2: Overview of the largest reservoirs in Tyrol

Reservoir	**Usable retention capacity**	**Barrage height**	**Natural catch-ment area**	**Attached power station**
	(millions m³)	**(m)**	**(km²)**	
Gepatsch	138.3	153	107.3	Kaunertal PS
Schlegeis	127.7	131	57.8	Rosshag PS
Zillergründl	86.7	186	29.9	Häusling PS
Finstertal	60.9	149	0	Kühtai PS
Durlassboden	51.2	79	43.9	Funsingau PS
Stillup	6.9	27	61	Mayerhofen PS
Längental	3.1	45	27.5	Silz PS
Hintersteinersee	1.2	6	?	Kaiserwang PS
Gmünd	0.85	35	89.1	Gerlos PS
Verwall	0.28	31,5	56	Rosanna PS
			∑ 472.5	

Above all, the barrages of the power station operators are of significant importance for flood protection in the province of Tyrol. Of the 14 largest reservoirs in Tyrol, 10 reservoirs are located within the catchment area of the Inn. In all, these ten power stations extend over a natural catchment area of 472 km² and are thus able to contribute, to a certain extent, to flood retention on the Inn.

Salzburg:

As in the province of Tyrol, there are a few technical retention plants in Salzburg. The largest retention basin is located near Mittersill on the Upper Salzach, with a potential retention capacity of 1.7 million cubic metres, and provides flood protection for the town of Mittersill. A further retention basin with a retention capacity of 300,000 m³ is located on the Rauriser Ache. In addition, in Salzburg the reservoirs of the power station operators contribute to flood retention in the catchment areas.

Due to the topographical position of Salzburg and the resulting limited available space, it is mostly only possible to plan large-scale technical retention plants in the province of Salzburg under very difficult implementation conditions. In the next few years, it is

planned to build a retention plant with a flood retention capacity of approx. 2 million cubic metres at Zell am See.

Upper Austria:

In the catchment area of the Inn in Upper Austria, the retention of floodwaters in each river basin has top priority. New retention measures are constantly being planned here, and mainly implemented in the form of retention basins. By the end of 2012, an estimated sum of just under 30 million euros is to be spent on the widening and new construction of flood retention basins in the Braunau am Inn Subdivision of the Federal Hydraulic Engineering Administration. Through planning and implementing the retention basins, Upper Austria is also consciously reacting to the increasing problem of the sealing-off of land in built-up areas, and the resulting surface runoff.

Large retention basins already exist in the catchment areas of the larger tributaries, such as the Mattig, Ache and Antiesen. Widening and new planning measures are also planned here in future. At present, about 4 million cubic metres can be retained by the existing retention basin on the Mattig.

In addition, retention measures with an approximate capacity of about 2 million cubic metres are planned here. There are currently two retention basins on the Ache, with a capacity of 85,000 m^3. It is planned to expand here by ten retention basins, with a holding capacity of about 2 million cubic metres, in two construction phases. On the Antiesen, in addition to the existing retention basin (750,000 m^3), a further basin is being implemented and another one is in the planning phase. The retention volume is to be increased here to reach a total of 1,200,000 million cubic metres. There are likewise two smaller retention basins on the Gurten (15,000 m^3 in all), and a further basin of 20,000 m^3 is planned.

3.4.2.2 Strategies and systems for flood control

Tyrol:

In the province of Tyrol, it is chiefly the storage-type plants of the power station operators which contribute to flood control. In this way, large volumes of water can be retained in the Ziller Valley or the Kauner Valley. These retention measures in the catchment areas provide an instrument for capping the flood wave on the Inn and its affected tributaries. Flood forecasting forms the decisive basis for the effective retention of the discharge by the storage-type plants in the catchment areas. The earlier a flood warning

is given out to the power station operators, the more effective the measures that are implemented to retain the water masses in the catchment area.

Salzburg:

In Salzburg, apart from a few isolated, mostly small retention basins, the storage-type plants of the power station operators likewise contribute to the retention of discharge waters in the catchment area, even if to a lesser extent than in Tyrol. The storage-type plants are subject to a requirement to keep a certain volume available for flood retention in case of emergency. The required retention potential is determined according to the volume which ensures the retention of three days of intensive precipitation in the natural catchment area of the plant. The targeted control of the flood retention in the catchment areas by means of an advance lowering of the water level at the storage-type plants is not practised in Salzburg. The situation at the Middle Salzach chain of power stations is very different. Here, an advance lowering of the water in the reservoir is carried out in the course of a flood management plan, in accordance with the official and operating stipulations for a discharge greater than HQ_1.

Upper Austria:

In the Upper Austrian catchment area of the Inn and its tributaries, there will in future be increased emphasis on the control of floods by means of the existing retention basins. It has already been possible to gather experience in this regard at the Teichstätt-Längau (2.4 million m^3) retention basin and the Sonnleiten (400,000 m^3) retention basin. Basins planned in future, for example on the Antiesen (250,000 m^3) in Rettenbrunn, will be increasingly equipped with a hydromechanically-controlled discharge system.

3.4.3 Protection from natural hazards on the torrents

Protection from natural hazards in general, and also from flooding, bed load and deadwood in particular, is a subject of concern at the torrents in the catchment area of the Inn, as the Inn is mainly fed by watercourses from the Alpine region. The foundation for an effective and sustainable flood protection on the rivers is therefore laid through implementing appropriate measures in the catchment area of the torrents.

As is the case with the Federal Hydraulic Engineering Administration, the strategic aims of the Forest Engineering Service in Torrent and Avalanche Control (WLV [1]) are undergoing a change. 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.

Bavaria:

In the alpine catchment area of the Inn approximately 5,000 inhabitants and 1,500 hectares of developed land have been protected against floods and mud flow since 2001. To achieve this, reinforcement work has have been carried out along torrents over a length of over 40 kilometres.

3.4.3.1 Flood protection measures on torrents in Tyrol

According to the Tyrolean Section of the Forest Engineering Service in Torrent and Avalanche Control (2007), from 1999 to 2006 306 million euros were spent on protecting living space in Tyrol. About 40 % of these funds were invested in avalanche control, a further 50 % in torrent control and about 10 % in protection from rockfall and area management measures. Thus, within the sphere of competence of the Tyrolean Section of Torrent and Avalanche Control alone, about 150 million euros were invested from 1999 to 2006 in flood control construction and, subsequently, in protection from floods and natural hazards.

Strategies:

As well as the conventional protective strategies, new strategies are also currently being considered in order to lastingly improve protection on the torrents in Tyrol. In Tyrol there is often the problem that the flood discharge, including bed load and deadwood, cannot be channelled through the abutting villages without causing damage. For this reason, there will in future be increasing emphasis on retention measures on these torrents. The volumes of water and bed load which arise will thus increasingly be already retained in the catchment area of the torrents, thus protecting downstream residents in the event of flooding.

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[1] German acronym for Torrent and Avalanche Control

Flood protection measures:

According to the 2007 Annual Report of the Forest Engineering Service in Torrent and Avalanche Control, 1878 catchment areas lying within the competency of Torrent and Avalanche Control extend over the province of Tyrol as a whole. On 859 of these torrents, a figure equivalent to about 45 per cent, flood protection measures – ranging from selective measures to systematic control structures – have already been implemented. In all, approx. 25 million euros are invested annually in protection from hazards arising through torrents in Tyrol.

Retention:

Up to the present, Torrent and Avalanche Control has not yet carried out any large-scale measures for flood retention on the torrents in the Tyrolean catchment area of the Inn. Flood retention measures at the Geroldsbach in Innsbruck are, however, being considered.

In the event of flooding, the Geroldsbach represents a major hazard, particularly for the two villages of Sieglanger and Klosteranger. According to the flood study which was carried out, a retention basin would offer the best solution for flood protection on the Geroldsbach. No definite statements can yet be made on the volume and the investment costs of the planned retention measure on the Geroldsbach, as the project is still only in the planning phase. Other than this, no concrete large-scale retention measures are currently being planned in the province of Tyrol.

According to statements issued by the Tyrolean Section of the Forest Engineering Service in Torrent and Avalanche Control, measures for bed load retention currently exist on almost every torrent.

Hazard zone mapping:

In Tyrol, hazard zone maps exist for all the regionally relevant torrents – that is, streams which pose a threat to settlements and the like. In the case of a few of the torrents (Weerbach, Wattenbach, etc.) it is, however, necessary to revise the existing hazard zone maps. The aim of finally completing hazard zone mapping for the torrents in Tyrol will be achieved by 2010.

3.4.3.2 Flood protection measures on torrents in Salzburg

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. Over the past 20 years, it has chiefly pursued the strategy of flood retention in the catchment areas. About 40 retention basins were built in the Flachgau and Tennengau, which are suitable areas for flood retention, where good protective measures predominate, with the partially very heavy precipitation in certain parts of these districts.

Any up-to-date protective strategy on the torrents must deal with the prevailing problem of deadwood or driftwood. It is not the bed-load discharge of the torrents but their volume of deadwood which often leads to log jams and the resulting potential danger. For this reason, construction measures such as a series of barriers for holding back deadwood are increasingly being built. It was already been possible to see the first positive results of these retention measures during the 2005 flood on the Salzach. At that time, there were hardly any disruptions and log jams in the flood discharge due to deadwood. Moreover, noticeably little deadwood was discharged by the Salzach. In the future, precautions such as area management measures will be increasingly implemented, in order to already keep the volume of deadwood low in the catchment area.

Flood protection 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. Therefore, about 175 million euros will be needed to meet the continuing need for protection over the next five years.

Currently, the main focus of Torrent and Avalanche Control in Salzburg concerning protection against water as a natural hazard is the construction of protective structures. However, it will also be increasingly important to pay attention to maintaining and renovating the existing constructions.

Retention:

As mentioned above, retention measures have been increasingly implemented in the geographically-suitable areas over the past few decades. Otherwise, the aim in the course of the hazard zone mapping is to keep existing retention and discharge areas clear.

Hazard zone mapping:

According to KRIMPELSTÄTTER (2008), the hazard zone maps of the Forest Engineering Service in Torrent and Avalanche Control are an indispensable instrument for safe land utilisation. Like the protective measures in Salzburg, the hazard zone maps take into account floods which statistically occur every 150 years. However, in the awareness that exceptional disasters can always occur as well, an element of risk will always remain. 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.

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 Inn 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.

3.4.3.3 Flood protection measures on torrents in Upper Austria

The regional building authority of Attergau and Innviertel of the Upper Austrian Section of the Forest Engineering Service in Torrent and Avalanche Control manages a few smaller catchment areas located on the steep slopes by the Salzach and the Inn.

Strategies:

Due to the steepness and the large number of control structures built on the torrents in the Innviertel, the main focus of flood protection is the maintenance of key constructions. An estimated investment sum of approx. 3 million euros is to be spent for this purpose over the next few years.

Flood protection measures:

In the Upper Austrian catchment area of the Inn, the main focus of attention over the past few years has been the maintenance of key constructions. Approx. 1 million euros have been invested in the maintenance and renovation of the constructions, thus restoring flood protection for about 50 people. The investment costs planned for flood protection will amount to about 3 million euros over the next few years.

Retention:

Due to the morphological conditions in the catchment areas under Torrent and Avalanche Control, in Upper Austria too it is only possible to create retention areas for the flood discharge under difficult conditions. The funds to be spent on retention measures over the next few years will amount to 250,000 euros. A 2000 m^3 retention basin is planned for the protection of one residential area.

Hazard zone mapping:

The hazard zone mapping within the sphere of authority of the Forest Engineering Service in Torrent and Avalanche Control of Upper Austria has been completed for all areas.

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

The aim of the International Commission for the Protection of the Danube River, and thus of the Action Programme 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 river basin of the Inn.

3.5.1 Gauges

General introduction:

The Hydrographic Service runs a basic network of observation points, 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.

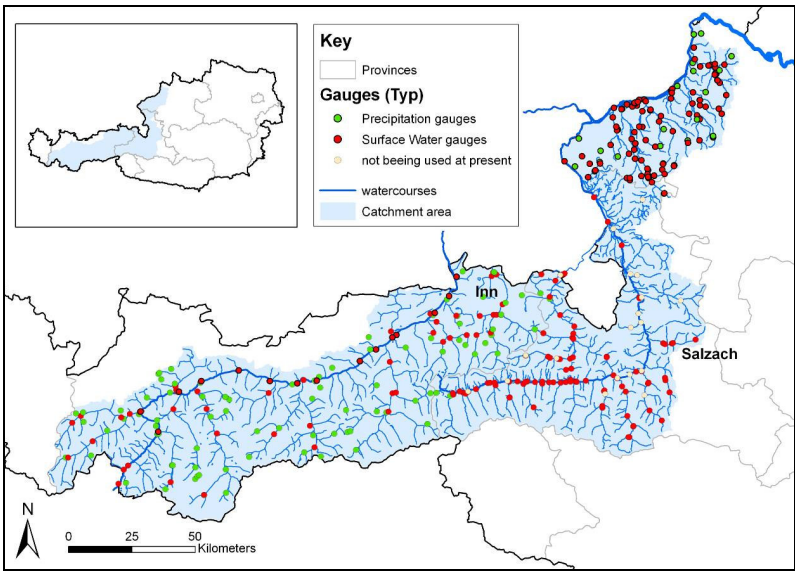

Fig. 3-5: Overview of the gauges in the catchment area of the Inn in Austria

The basic network of the Hydrographic Service in Austria 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. 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 hydrographic data is managed through a standardised Hydrographic Data Management System (HyDaMS) and can be accessed via the GIS application eHYD.

Fig. 3-5 offers an overview of the existing precipitation, air temperature and evaporation gauges, as well as the surface water and solids gauges, within the Austrian catchment area of the Inn.

Bavaria:

Gauging equipment

Within the framework of a revision of the hydrological gauging system the equipment at the some 100 hydrological gauging stations in the Inn catchment area has been substantially improved in terms of available data and fail-safe measurements. In the flood early warning system nearly all gauges have redundant data and a second remote data transfer device, i.e. the detection, storage and transmission of the water level is carried out using two independent systems.

Precipitation monitoring network

Over recent years the Bavarian Water Management Authority has, in cooperation with the German Meteorological Service (DWD), designed, built up and commissioned an automatic precipitation monitoring network. In the area of the Inn there are now 21 own and a further 32 DWD stations operating in the online system. All precipitation monitoring stations are fitted out with equipment of the same standard. They deliver high resolution data and are monitored by operators in order to obtain additional meteorological information (e.g. on snow coverage) and to ensure the quality of the measurements. Other data are acquired from different monitoring networks. The precipitation is a particularly important input variable for forecast models. In areas without radar coverage and in special hydrological cases this monitoring network is being further intensified.

Snow monitoring network

All 21 precipitation monitoring stations of the Bavarian Water Management Authority have been fitted with snow sensors. Manual measurement of the height and water content of the snow layer is carried out by operators once a day, the data are transferred online for the calibration of snow forecast models and are also published on the internet. Two automatic snow monitoring stations are also in operation.

Tyrol:

The province of Tyrol currently has at its disposal 92 precipitation, air temperature and evaporation gauges for measuring precipitation and, in part, air temperature in the catchment area of the Inn. There are also about 60 gauges available for measuring surface water and solids.

Salzburg:

The Hydrographic Service in Salzburg currently bases its calculations on a meteorological network consisting of 108 watercourse gauges in the catchment area of the Inn, of which however 20 gauges are not being used at present. 80 precipitation gauges are also available in the catchment area of the Inn.

Upper Austria:

In the province of Upper Austria, the Hydrographic Service has at its disposal 99 surface water gauges as well as 24 precipitation gauges in the catchment area of the Inn.

3.5.2 Flood forecasting models

3.5.2.1 Flood Risk Zoning Austria (HORA[2])

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

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[2] German acronym

discharge HQ_T with an annuality of T = 30 (Zone 1), T = 100 (Zone 2) and T = 300 (Zone 3).

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.

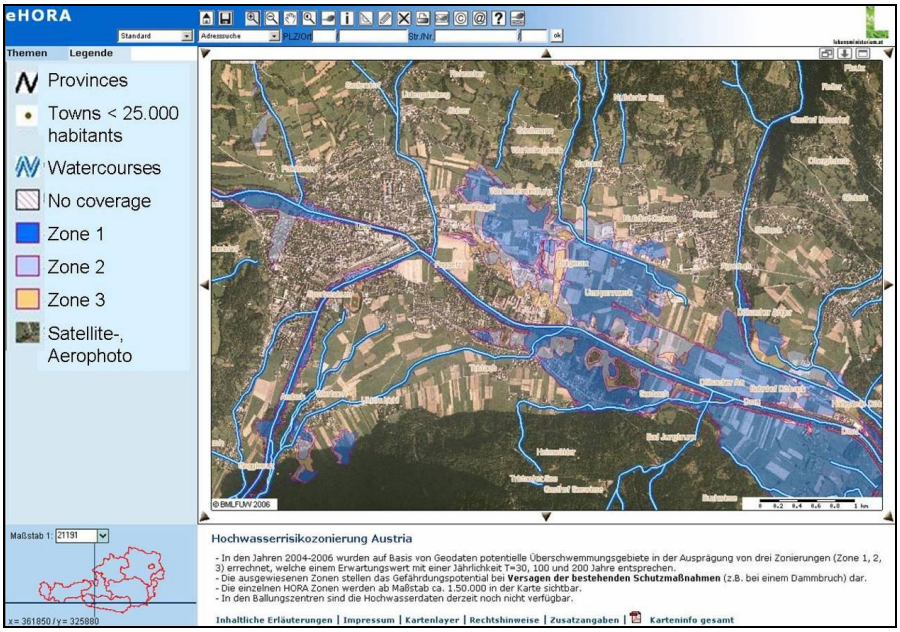

Fig. 3-6: Map section of the online Flood Risk Zoning eHORA

3.5.2.2 Flood forecasting model for the Inn in Bavaria

One Forecast model has been developed for the catchments area of the Inn (1-D precipitation runoff models, 1D wave discharge model). Using this model operational, gauge-based water level and discharge forecasts are calculated and published (several time a day in flood events). In 2007 the range of uncertainty of published flood forecasts was introduced. The bandwidth of the available precipitation forecasts available has expanded over the years (precipitation forecasts of different providers, ensemble forecasts). Improved hydrodynamic models and also hydrological models are currently being tested.

The flood warning system is a key element in risk management. Thanks to early warning systems the public and municipalities can quickly take preventive action.

The water management state offices are appropriately warned in advance, they receive gauge-based flood forecasts and a host of additional information for assessing the situation. For this purpose and in order to inform the public a comprehensive intranet and internet service has been set up for the flood early warning system (including up-to-date analyses on precipitation, water level and discharge as well as a variety of forecasts, information and warnings for specific counties). In addition, the safety and availability of the internet service has been substantially enhanced (redundant data transfer, server and database backups). In the higher, alpine catchments flood forecasting is especially difficult. On the one hand, the time for an early warning is relatively short and in the range of just a few hours. On the other hand, there is substantial uncertainty in meteorological forecasts concerning the spatial and time distribution of the precipitation.

3.5.2.3 Flood forecasting model for the Inn in Tyrol

The flow conditions of the Inn in Tyrol are determined by the high Alpine character of its catchment area and its utilisation. On the one hand, the glaciers in Tyrol significantly influence flow conditions in the partially heavily glaciated catchment area, depending on the time of year, while on the other, flow conditions are affected through water's being diverted into the storage-type plants of the power stations and retained there.

In order to protect residential and industrial areas from the danger of flooding, and also as a basis for optimising operations, an initiative was launched to create and install a flood forecasting model for the Inn in Tyrol, in cooperation with the Hydrographic Service of the Regional Government of Tyrol, the Tiroler Wasserkraft AG (TIWAG) hydroelectricity company and the company alp-S. This flood forecasting model is currently being tested in a trial operation; final completion of the forecast model is planned for the end of 2009.

As a forecasting model, a modular river basin model was selected, consisting of four main components:

- Preprocessing of the meteorological input, including meteorological forecasts
- "Snow and ice melt" glacier model (SES glacier model)
- Precipitation discharge model for unglaciated catchment areas of the tributaries of the Inn, including an HQsim routing model
- Hydrodynamic 1D model showing flood wave flow on the Inn

Based on all the data telecommunicated from the gauging stations, the model calculates an hourly forecast and, following each calculation procedure, this forecast is then made available to the Bavarian State Agency for Environmental Protection for further use.

Austria and the Free State of Bavaria jointly use the LARSIM forecasting model for the catchment area of the Großache or Tiroler Achen, which later, as the Alz, flows into the Inn between Alt-Ötting and Braunau.

In all, approx. 80 precipitation gauging stations and about 50 water gauging stations are available for flood assessment on the Inn in Tyrol. A database at the Office of the Regional Government of Tyrol, Water Management Department, Hydrography and Hydrology Section in Innsbruck functions as a data hub for the measured values. Here, the incoming data from the different gauge operators (Hydrographic Service of Tyrol, Tiroler Wasserkraft AG, Austrian Hydro Power, the Central Institute for Meteorology and GeoDynamics, etc.) is collected and managed. Data is exchanged with other users (for example Bavaria) via a data interface.

3.5.2.4 Flood forecasting model for the Salzach in Salzburg

The Hydrographic Information System for Flood Forecasting (HYDRIS) model is available on the Salzach. The forecasts provide a decision-making basis for flood management of the “Middle Salzach” chain of power stations, as well as for alerting emergency forces and citizens affected by flooding. A river basin model with an auto-adaptive parameter guiding system serves as a model concept. The most important components of this model are:

- Flood wave flow model
- Flood wave flow model with precipitation discharge
- Superimposed Overlay model
- Power station model
- whereby the whole model represents a combination of model components.

The Hydrographic Information System for Flood Forecasting for the catchment area of the Salzach consults the following input data. There are 15 water-level and/or flow rate gauges in operation. Precipitation and temperature are recorded at 24 hydrometeorological gauges. In addition, the surface water levels and flow rates from 12 power stations are also fed into the model.

The measured values are transmitted to a central computer every 15 minutes. If the preset threshold values for water level or flow rate are reached, forecasts for flood developments are calculated for the next 3 to 4 hours at several forecasting gauges, and assessed and interpreted by experienced hydrologists from the Hydrographic Service. From a discharge of HQ_1 upwards, flood management comes into force at the Middle Salzach chain of power stations, effecting a lowering of the reservoir contents in accordance with the official and operational regulations.

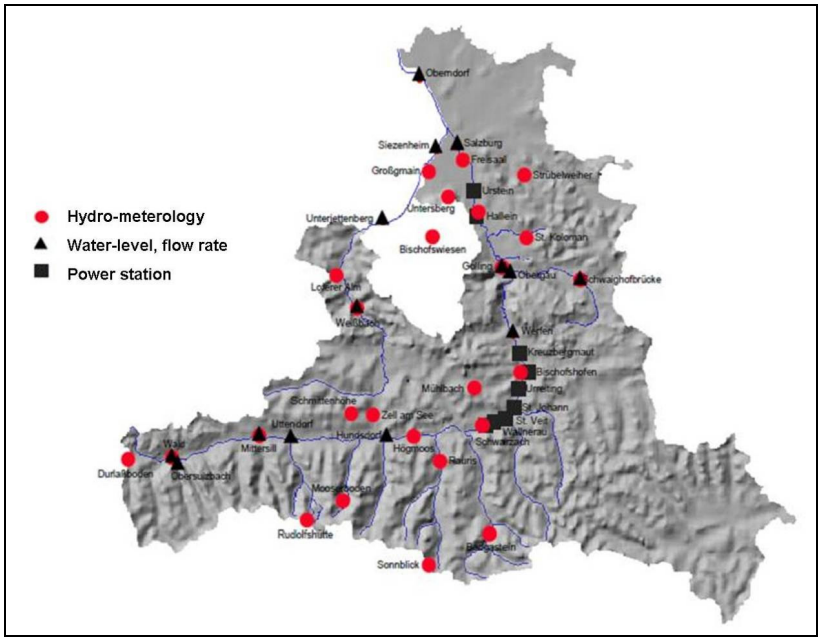

Fig. 3-7: Hydrographic Information System for Flood Forecasting (HYDRIS), gauging network in the initial expansion phase (Wiesenegger)

It is planned to expand the Hydrographic Information System for Flood Forecasting with "HYDRIS II". Precipitation discharge models are planned for sub-basins of the Upper Salzach, the Saalach and the Lammer, which will be integrated into the model and are thus intended to extend the forecasting period to 8-12 hours. In addition, a flood hazard map showing alarm levels for specific areas is to be developed.

3.5.2.5 Flood forecasting model for the Inn in Upper Austria

In the area of the Inn catchment area in Upper Austria there is close cooperation between the Free State of Bavaria and Austria, with the aim of building up a nationwide

forecasting model. The FLORIS-2000 hydrodynamic model is relied upon (see WIENER MITTEILUNGEN, a hydrological publication) on the Inn. An overview of the basic network available for the forecasting model can be found in Section 3.5.1.

For the Salzach, as the largest tributary of the Inn, the data from the Hydrographic Information System for Flood Forecasting (HYDRIS) model are transferred from Salzburg to Upper Austria, and the appropriate measures and preparations are then carried out.

3.6 Capacity Building of Professionals

Water knows no national borders. Therefore, decades ago Austria already concluded waterbody agreements with its neighbouring states Germany, Slovakia, the Czech Republic, Hungary, Switzerland, Liechtenstein and Slovenia and has set up bilateral and multilateral waterbody commissions. 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 waterbodies in the member states. The precondition for achieving the aim of a good ecological state of waterbodies 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 waterbody 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 subsidies 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.

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 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.

The project for renovating the Lower Salzach, as already discussed in Section 3.2 above, will be jointly handled by the project partners Austria and Bavaria in the form of an INTERREG project.

At the beginning of April 2006, the Standing Committee of the Alpine Conference authorised the work programme of the Platform for Natural Hazards, 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

3.7.1 Informing the general public

The Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW[3])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 organisations 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

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[3] German acronym for Federal Ministry of Agriculture, Forestry, Environment and Water Management

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.

Bavaria:

Effective hazard control activities within the scope of disaster protection can save lives and substantially reduce damage. This task is therefore of major importance.

The municipalities are the bodies responsible for hazard control in the event of floods. Operations are carried out by the fire and rescue service and the technical relief agency (Technisches Hilfswerk). In the event of major incidents the administrative district office can declare a state of emergency. Deployment is then taken over by the administrative district office. Experts of the water management state offices are on stand-by to give their advice.

The fire and rescue service carries out regular training sessions and exercises for flood operations. They are supported by water management experts. To this end, there is also a brochure on dyke defence, describing different possible action and how this is to be implemented. The brochure can be downloaded from the internet under:

www.lfu.bayern.de/wasser/fachinformationen/hinweise_deichverteidigung_deichsicherung/index.htm

Partnerships

Partnerships have been set up by state offices for water management in areas that are not affected by floods to support those state offices affected with staff and equipment in the event of prolonged floods.

Information service for flood-endangered areas

To further increase public awareness for flood hazards the Bavarian Environment Agency LfU has set up an information service for flood-endangered areas in Bavaria (IÜG) in cooperation with the Bavarian Administration for Surveying and Mapping. This service gives everyone access to information on the defined flood-endangered areas on the inter-

net under www.iug.bayern.de. The new information acquired through the project "Identification and definition of floodplains in Bavaria" will be used to update the maps every six months. For implementing the Floods Directive these maps will have to be supplemented accordingly.

Alpine natural hazard information service

The Alpine natural hazard information service (IAN) provides comprehensive information relating to these natural hazards in the Bavarian Alps region. It is an interactive geographic information system (GIS) that gives all parties involved, experts, municipalities, planners or interested citizens, a simple and fast overview of the hazard situation in a specific area. The mapping service can be called up under www.wasser.bayern.de.

Citizens must take own precautions

There was a drastic increase in damage caused by flooding during the nineties of the last century. Damage inflicted by extensive floods over the past decades cost over 11 billion euro in Germany alone.

Absolute flood protection is not possible. It is therefore essential that citizens take appropriate precautions (suitable construction measures, behaviour and risk coverage). Taking such action can limit or even avoid flood damage. There is, however, still a considerable amount of residual risk. Every individual in flood endangered areas should take precautionary action e.g. in the form of provisions or insurance coverage.

Citizens can find out more about these measures in flyers, brochures or on the internet under www.wasser.bayern.de.

Tyrol:

The staff of the Hydraulic Engineering Administration in Innsbruck are making continual efforts to inform the general public about the hazards and risks of natural disasters, as well as disaster prevention and protection. The information materials used are primarily the brochures, folders and publications issued by the Federal Ministry.

Salzburg:

As in Tyrol, the staff of the Hydraulic Engineering Administration in Salzburg are making efforts in active public relations work and the exchange of information. In terms of information media, they use their own brochures, folders and publications as well as those issued by the Federal Ministry. In addition, they refer to the rich store of informa-

tion found on the internet sites of the Regional Government of Salzburg and the Federal Ministry.

Upper Austria:

The staff of the Braunau am Inn Subdivision of the Federal Hydraulic Engineering Administration are extremely interested in closely cooperating with the resident population, in order to make people more aware of risks and hazards, as well as disaster control measures. Thus, informative events regularly take place at meetings of the water boards. Fairs and various events are, however, also regularly used to convey information to the general public.

Informative events concerning the planned projects and the accompanying flood protection for the public are currently being held in the catchment area of the Mattig, in cooperation with the Federal Ministry of Agriculture, Forestry, Environment and Water Management, under the title “River Dialogue”,.

3.7.2 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.

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”.

Tyrol:

In Tyrol, the Department for Civil Defence and Disaster Control is responsible for all tasks in the area of civil defence and disaster control. In case of emergency, it determines how the respective operations should be managed and supports the authorities in controlling the disaster. The province of Tyrol has set up its own flood alarm plan, which provides for cross-border cooperation with the Free State of Bavaria.

The flood warning system is based on close cooperation between Hydrography and the Central Institute for Meteorology and Geodynamics (ZAMG). The Hydrographic Services function as a hub for all information and data. Based on this, flood warnings will, if necessary, be issued for the regions concerned.

Salzburg:

In the event of disaster, the highest decision maker in Salzburg is the Regional Government of Salzburg. Disaster control plans for combating and coping with disasters are drawn up in the area of competence of the subdivisions of the Federal Hydraulic Engineering Authority.

Upper Austria:

In March 2007, the Upper Austrian Regional Parliament passed a new, more up-to-date Disaster Control Law, thus creating more contemporary provisions for supporting helpers in the event of disaster. With regard to flood disasters, the aim was to integrate into the new Disaster Control Law all the experience gained and weak points revealed through having coped with floods during the past few occurrences, particularly the floods of 2002. The new law moreover regulated the respective competences of the authorities in the event of disaster and established a uniform organisational structure.

In the event of disaster, flood alarm plans exist at the district level in Upper Austria; these plans are coordinated at the regional level, based on a flood framework plan. In the area of competence of the Braunau Subdivision of the Federal Hydraulic Engineering Administration and thus in the catchment area of the Inn, flood alarm plans currently exist only for the Antiesen tributary. In the course of the further expansion of retention basins in Upper Austria and the building of new ones, there will be increasing emphasis on the creation of alarm plans.

3.8 Prevention and Mitigation of Water Pollution Due to Floods

The destructive effect of severe floods is also accompanied by pollution of waterbodies. In the event of flooding, severe pollution of waterbodies very often occurs, especially due to the escape of heating oil from storage tanks, damage to pipelines or damage to industrial enterprises and filling stations. Planners and executors must therefore make increased efforts to prevent pollution of waterbodies in the event of future disasters. 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 waterbodies 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 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 flood-proof. This represents the primary foundation for preventing the pollution of waterbodies 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.

In Upper Austria, the authorities are, furthermore, rapidly pushing ahead with the purchase of areas of land bordering on the banks of rivers. In 2007, about 1.3 million euros was spent on this. The aim is, on the one hand, to ensure the availability of the land for planned measures, and, on the other, to prevent any more harmful substances (eutrophication of the waterbodies) and erosion materials from getting into waterbodies. The areas purchased represent a buffer zone between intensive agriculture and the waterbodies.

In the past, environmental damage caused by flooding was especially due to fuel spilling from heating system tanks. However, shortly after the floods had died down, there was no little pollution to be found. Through the introduction of a non-recurring compulsory test for above-ground installations in flood-prone areas the situation has improved considerably.

Sewage treatment plants are basically built in such a way that they guarantee protection against a 100-year flood event. The same applies to industrial plants. If a particular environmental risk is involved the level of protection can also be set higher in individual cases.

The insurance industry has published a guide on protection concepts and protection measures for industry and trade. The guide provides information on how to develop suit-

able provisions using a hazard analysis and the definition of protection targets. Besides reducing damage to a minimum the avoidance of water pollution also plays an important role.

3.9 Summarization of Taget Settings

The objectives for the development and implementation of long-term flood protection strategies can be found in the following sub-chapters.

3.9.1 Regulation 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 specialisation

Objective 4: Avoiding new settlement activity in areas with a medium probability of flood events

3.9.2 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 riverbed -> widening measures

Objective 3: Maintaining natural retention areas

Objective 4: Creating new retention areas

Objective 5: Improvement of Flood control

3.9.3 Technical Flood Defences

Objective 1: To ensure adequate flood protection for the relevant settlement and infrastructure areas

Objective 2: Protection and management of natural hazards on the torrents

Objective 3: Flood protection by means of area-and-space-effective measures

Objective 4: Improvement of Flood protection of towns and municipalities

Objective 5: Appropriate measures for sediment management and avoiding flash floods

Objective 6: Guaranteeing constant preparedness of the flood defence system

Objective 7: Improving the protection of objects

3.9.4 Preventive Actions – Optimising Flood Forecasting and the Flood Warning

Objective 1: Optimisation and development of flood forecasting

Objective 2: Optimisation of flood warning and the flood warning systems

Objective 3: Enhancing early-warning systems

Objective 4: Adopting the principles set out in the EU Floods Directive

3.9.5 Capacity Building of Professionals

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

Objective 2: Improving rules for action in response to emergencies

Objective 3: Preparation of flood-risk management plans

Objective 4: Improving international cooperation

3.9.6 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

Objective 4: Improving response by the population affected, operating facilities, and those responsible for national treasures, to flood events so as to avoid detrimental effects

3.9.7 Prevention and Mitigation of Water Pollution Due to Floods

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

Objective 2: Improving the storage of water-endangering substance

4. Measures to Achieve Targets

4.1 Regulation on Land Use and Spatial Planning

Measures	Type of intervention	Responsibility	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
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.
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.

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
Target 4: Avoiding new settlement activity in areas with a medium probability of flood					
Developing flood-hazard maps and flood-risk maps	Research	Environment Agency (LfU) / Water Management Agency (WWA)		by 2013	In January 2008, the Environment Agency (LfU) held a workshop entitled "Flood Hazard Maps", with the objective of initiating a co-ordinated course of action within the administration for preparing those maps..
Identifying flood plains	Act of Law	Water Management Agency / Office of County Executive (LRA)		Ongoing	Bavaria has provided for the determination of flood plains for approx. 5,100 km alongside rivers (“Flkm”), of which approx. 3,000 Flkm have already been completed. By the end of 2010, these investigations will be concluded. The flood plains thus determined will be stipulated in a binding manner bay way of statutory instrument. This will provide for types of use within such areas.
Identifying priority areas	Act of Law	Spatial Planning		Ongoing	In Bavaria, priority areas for securing flood outflow and flood retention are provided for in a binding manner in regional planning.

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

Measures	Type of intervention	Responsibility	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.
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.
Recognition of negative flood-relevant developments	Strategy Research	• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)		Ongoing	
Objective 2: Improvements in protective water management by means of natural measures					
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	

Objective 3: Maintaining natural retention areas					
Maintaining natural retention areas	Awarding Conservation Status	Water Management Agency, Conservation Agency Office of County Executive		Ongoing	
Keeping narrow passages open through a maintenance of water bodies adapted to ecological requirements	Maintenance of water bodies	State, Municipalities		Ongoing	
Objective 4: Creating new retention areas					
Design concepts for smaller rivers (third order rivers in Bavaria or Waters of the second order in Baden Württemberg)	Administrative	Municipalities, Water Management Agency,		Ongoing	Specific support provided by the municipalities for flood protection and retention measures on third order rivers in Bavaria.
Renaturation of water bodies	Planning Constructional	Municipalities, Water Management Agency,		Ongoing	In Bavaria, along 350 km of waterways and 1,300 ha of alluvial floodplains.
Flood polders / Flood retention basins – controlled retention	Planning Constructional	State, Water Management Agency			
Objective 5: Improvement of Flood control					
"Forecast of flood situation along the Danube in Bavaria taking into account the retention potential and optimised control strategies "between Donauwörth and Kelheim	Research	TU Munich		Ongoing	
Connection project between Neu-Ulm and Donauwörth	Research	TU Munich			

4.3 Technical Flood Defences

Measures	Type of intervention	Responsibility	Costs	Deadline	Comment
Objective 1: To ensure adequate flood protection for the relevant settlement and infrastructure					
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	
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	
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.
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
Objective 4 : Improvement of Flood Protection of towns and municipalities					
Construction of technical flood protection for towns and municipalities	Technical	State, Municipalities		Projects Ongoing	
Dyke upgrading	Technical	State, Water Management Agency		Ongoing	
Objective 5: Appropriate measures for sediment management and avoiding flash floods					
Flood plain programme	Administrative			Ongoing	
Objective 6: Guaranteeing constant preparedness of the flood defence system					
Maintenance	Technical	State, Municipalities		Ongoing	

Objective 7: Improving the protection of objects					
Measures towards object protection	Constructional	Private Sector, Municipalities		Projects	

4.4 Preventive Actions – Optimising Flood Forecasting and the Flood Warning

Measures	Type of intervention	Responsibility	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 in Lower Austria (Danube sub-basin of the March). Model on the March is in trial operation in cooperation with Czech Republic, and already in full operation on the Thaya.
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.

Objective 3: Enhancing early-warning system					
Improving flood forecasts	Administrative	Water Management Agency		Ongoing	
Information service, flood-endangered areas	Administrative	Environment Agency / Water Management Agency		Ongoing	
Information service, alpine natural hazards	Administrative	Environment Agency / Water Management Agency		Ongoing	
Objective 4: Adopting the principles set out in the EU Flood Directive					
M 1: Preparation of the new water law	Administrative	State Ministry of the Environment and Public Health (StMUG)			

4.5 Capacity Building of Professionals

Measures	Type of intervention	Responsibility	Costs	Deadline	Comment
Objective 1: Promotion of the national and international exchange of knowledge between all the specialisations of integrated flood management					
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
Objective 2: Improving rules for action in response to emergencies					
Implementation of FLIWAS (Flood Information and Warning System)	EDV-System	StMI , UM IM, Municipalities		Project	
Developing alert and operations plans	Planning	Municipalities		Ongoing	
Holding training sessions, meetings	Administrative	Environment Agency			
Danube action programme for flood protection					
Objective 3: Preparation of flood-risk management plans					
Flood-risk management planning	Concept	Ministries, Agencies for River Catchment Areas		Ongoing	
Objective 4: Improving international cooperation					
Intensifying international cooperation in flood management	Administrative			Ongoing	

4.6 Raising Awareness and Preparedness of General Public

Measures	Type of intervention	Responsibility	Costs	Deadline	Comment
Objective 1: Promotion of the knowledge and awareness of hazards					
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
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	
Objective 4: Improving response by the population affected, operating facilities, and those responsible for national treasures, to flood events so as to avoid detrimental effects					
PR work as part of flood-risk communication (the Internet, leaflets)	Information	HWP, Environment Agency		Ongoing	In Baden-Württemberg, provision has been made via flood cooperation schemes.
Holding training sessions, meetings	Administrative	Environment Agency		Ongoing	

4.7 Prevention and Mitigation of Water Pollution Due to Floods

Measures	Type of intervention	Responsibility	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[4], Building Technique Ordinance[5] (uplift-resistant heating oil tanks; positioning of storage containers)
Information on flood-proof building	Prevention and reduction of water pollution	• Federal government, provinces			Information on constructing flood-proof heating systems

[4] Bauordnung

[5] Bautechnikverordnung

Objective 2: Improving the storage of water-endangering substance					
Rigorous application of rules for the storage of water-endangering sub-stances	Administrative	Water Management Agency / Office of County Executive		Ongoing	