



## **Flood Protection Expert Group**

# **Sub-Basin Level Flood Action Plan - Drava-Mura -**

**November, 2009**

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## **1. INTRODUCTION**

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 Drava-Mura sub-basin reviews the current situation in flood protection in Austria, Slovenia, Croatia and Hungary 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 defences, preventive actions, capacity building, awareness & preparedness raising and prevention and mitigation of water pollution due to floods.

This Action plan is derived from Action plans prepared for Austrian, Slovenian, Hungarian and Croatian territories. It is foreseen that this planning document will be further refined as appropriate and necessary by the bilateral river commissions.

## 2. CHARACTERISATION OF CURRENT SITUATION

### 2.1. Review and assessment of current situation

#### 2.1.1. Natural conditions

##### 2.1.1.1. Topography

The **Drava** is a river in southern Central Europe and with a length of 749 km and an average discharge of 560 m<sup>3</sup>/s, the Drava River is the fourth largest (41.238 km<sup>2</sup>) and fourth longest tributary of the Danube. It begins in Toblach, Italy, (approximately 1,450 m above sea level, fig 2), and flows east through East Tirol and Carinthia in Austria, into Slovenia, and then southeast, passing through Croatia and discharges into the Danube near Osijek, Croatia (at approximately 90 m above sea level). The Drava River downstream of the Mura river mouth for the most constitutes the Croatian-Hungarian state border (total length of 136 km). Part of the Mura River in Croatia also constitutes the state border with Slovenia and Hungary (total length of the 79 km). The total length of the Mura River is 465 km.

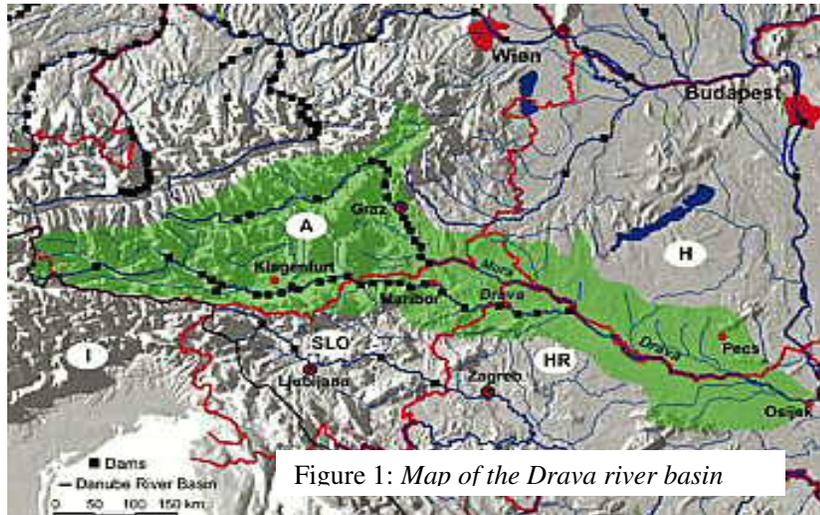


Figure 1: Map of the Drava river basin



Figure 2: The Drava spring



Figure 3: The Drava mouth

Based on geomorphological characteristics, the Drava and the Mura can be divided into three different river reaches: upper, middle and lower course. Basically the Drava and the Mura are

characterised by modified upper and middle course reaches by chains of hydropower plants and still free-flowing lower courses with partly high ecological values.

Additionally the rivers cover a broad range of different river types and bioregions from Alpine landscapes down to Pannonian lowland elements.

In its lowest stretch, from Barcs to its confluence with the Danube, the river is navigable by small ships. At its confluence with the Danube, the Drava is 322 m wide (fig 3).

Like most lowland rivers in Europe, the lower Drava has been considerably regulated, with embankments and channels to direct its flow. In spite of these changes, natural habitats along the middle and lower reaches of the river host unique assemblages of flora and fauna, and several endemic species. A large floodplain area lies at the confluence of the Drava and the Danube rivers, including territories of Hungary and Croatia and providing favourable living conditions for over 20,000 birds and 55 species of fish.

Kopacki Rit (Croatia) with some 30,000 ha between the Drava and the Danube is one of the richest and most dynamic floodplains of the Danube River Basin. It has extended floodplain forests (willow, poplar and oak), floodplain lakes, ponds, extensive reed beds and marshes and was already designated as a Ramsar Site and a Nature Park.

The Danube-Drava National Park in southwest Hungary is influenced by high natural water level fluctuations that are increased by hydropower peaking.

#### 2.1.1.2. Hydrology

The Drava basin has a mild continental and party humid climate with average rainfall of 600-750 mm/year.

The main tributaries of the Drava are: the Gail in Austria, the Mislinja and Dravinja in Slovenia, and the Bednja in Croatia from the right; and from the left the Isel, Möll, Lieser and Gurk in Austria, and the Mura in Croatia.

River Drava and it's main tributaries are significantly altered with large number of hydraulical structures.

Along the upper reaches, above Donja Dubrava in Croatia (before the Drava and the Mura confluence), in the 20<sup>th</sup> century more than 23 dams have been constructed to generate hydroelectricity (fig 4 and 5). That caused significant change of river flow and sediment regime.

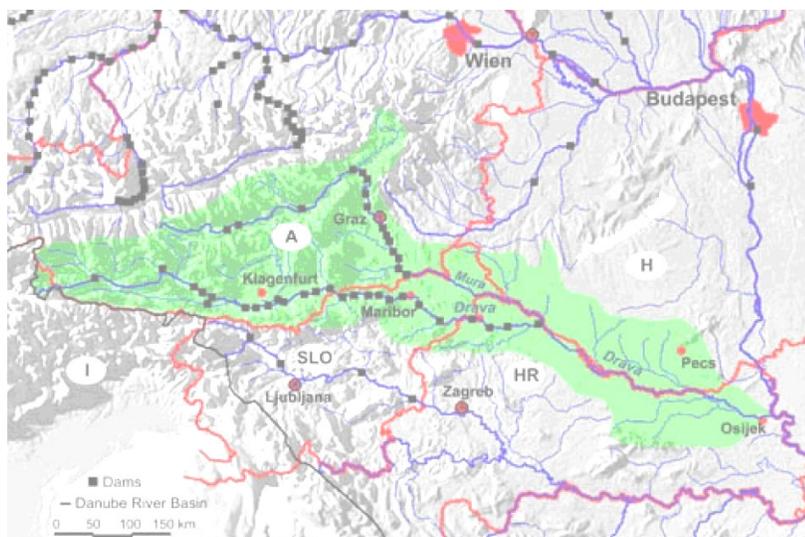


Figure 4: Locations of dams in Drava river basin

There are 14 run-off-river type hydropower plants and 8 diversion type hydropower plants.



Figure 5: *Hydro power plants Rosegg- St. Jakob (AT), Zlatolicje (SI) and Dubrava (HR)*

The total volume of all reservoirs in the Drava river basin upstream of the Mura river mouth amount to about 775 hm<sup>3</sup>; 69,1 % in Austria, 11,2 % in Slovenia and 19,7 % in Croatia.

The water regime of the Drava and Mura rivers and their upper tributaries is glacial, characterized by two distinct seasons: the high water season (wet season, highest flow) during May and June (Alpine snowmelt period) and the low water season (dry season, lowest flow) during winter months- January and February. A second flow peak occurs in late autumn due to precipitation maxima in the Southern Alps (Mediterranean influence in the middle and lower course). Their downstream tributaries are characterized with snow-rain and rain-snow regimes with peak discharges in spring and autumn and minimal discharges in summer.

Discharge (m<sup>3</sup>/s) at the gauging stations on Drava

	Lienz	HE Labot	Belisce
Catchment area (km <sup>2</sup> )	1876	11040	38 500
Average minimal (m <sup>3</sup> /s)	11	92	234
Average(m <sup>3</sup> /s)	54	252	552
Average maximal(m <sup>3</sup> /s)	265	1177	1386

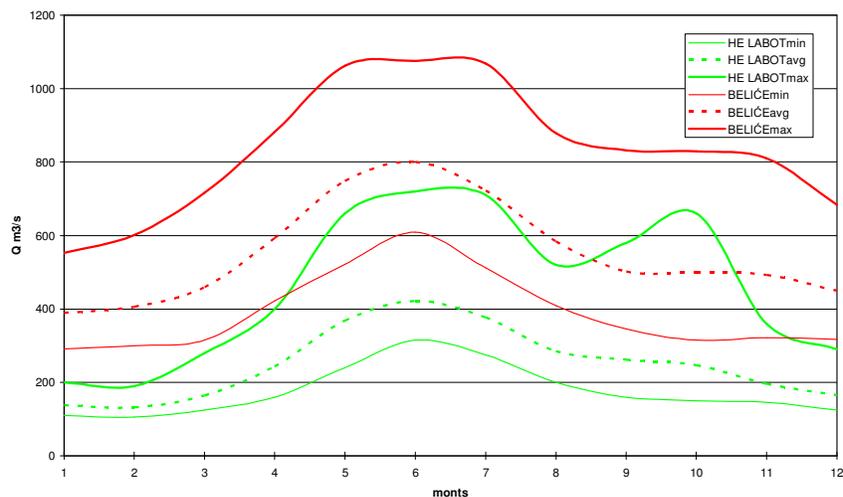


Figure 6: *Characteristic discharges*

## 2.1.2. Floodplains and flood defences

### 2.1.2.1. Levees

Floods are one of the main problems in the river Drava Basin. Due to permanent development of the region, land use changes, incomplete flood protection systems and climatic changes, flood risks are increasing dramatically. Basin is prone to two main types of floods: torrential floods on small tributaries and floods on the lower part of river Drava caused by backwaters of Danube floods. In April of 2006, during the Danube floods, backwaters of Danube caused third highest recorded level of Drava in Osijek, Croatia (fig 7). Due to high precipitation rates in upper basin, the Drava exhibits a high flood risk in upper reach, too.

Historically, the protection against floods was mainly performed through regulation of watercourses by increasing the cross-section of the channel and building bypass channels, dikes, detention and retention reservoirs.

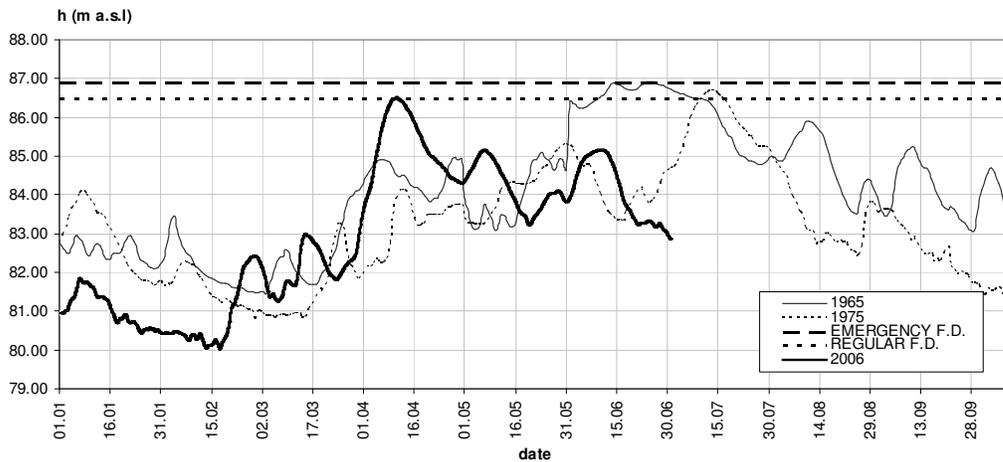


Figure 7: *Drava, Osijek – water levels in 2006.*

### Present situation in Austria

In Austria, and thus also in the Danube sub-basin of the Drava - Mura, 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.

Basically, the strategic planning and implementation of protective water management projects is carried out in accordance with the requirements of the federal government. Besides the ongoing maintenance of existing protective structures and facilities, the most important aspects are the combined approach, increased retention of the water masses arising in the catchment areas, hazard prevention through land-use planning measures, as well as public relations work concerning the essential strategic objectives and key activities.

### Present situation in Slovenia

In the Drava river basin the majority of dikes were built along river Drava, Dravinja, Pesnica and its tributaries. In the Mura river basin the majority of dikes were built along river Mura

and Ledava and its tributaries. The dikes were made through time with different project values.

Retention and detention reservoirs were designed for flood reduction, mostly on smaller rivers, with volume capacity from a few thousand to a few million cubic meters for improvement of a local flood protection. Volume reserved for flood reduction in reservoirs in Mura River Basin is about 15 mio m<sup>3</sup>, the biggest being the Radmožanci (6 mio m<sup>3</sup>) on the river Ledava and Gajševci (4 mio m<sup>3</sup>) on the river Ščavnica.

Volume reserved for flood reduction in reservoirs in Drava RB is about 12 mio m<sup>3</sup>, the biggest being the Ptujsko Jezero (4 mio. m<sup>3</sup>) on the river Drava and Pernica (1,5 mio. m<sup>3</sup>) on the river Pesnica.

### **Present situation in Hungary**

In the Mura Valley from 1965 to 1992 flood protection levees have been built locally to protect settlements. The total length of the main protection lines is 43.36 km protecting 5 flood basins. After 1972 improvement of flood protection structures have been made on several occasions. Most of the protected area is plough, meadow and pasture land. The Letenye border station, the Water Works of Molnár a large part of Murakeresztúr and the railway of Murakeresztúr-Gyékényes can be found on the protected flood plain. The flood protection of Muraszemenye is still to be made.

There are two flood retention basins on the Kerka River (built in 2005) and on the Kebele Brook (built in 2008).

The left bank of Dráva is protected by two water boards: that of Drávasztára and of Drávaszabolcs. The managed length of the flood protection dikes is 41.551 km and 31.709 km respectively. Further the lower sections of Fekete-víz (Black Water) and Pécsi víz (Pécs Water) rivers are also protected (against backwater effects from the Dráva) by 11.143 and 2.153 km long dikes.

The Drávasztára water board protects a flood basin of 145.47 km<sup>2</sup>. The number of inhabitants on this area is 4 641. The area protected by of the Drávaszabolcs water board is 149.84 km<sup>2</sup> (it includes 41.46 km<sup>2</sup> area that belongs to the Drávasztára water board). The number of inhabitants protected is 5 930.

The design level of the dikes are the level of 1:100 year flood plus 1 m freeboard. On the Drávasztára section 37.700 km dikes are in good condition and 3.851 km has to be upgraded. On the Drávaszabolcs section only 2 km long dikes (1-1 km on the Fekete-víz and the Dráva) meet the design standard. The rest needs to be upgraded: a 60 cm heightening of the dikes is required.

### **Present situation in Croatia**

The concept for flood protection on Drava-Mura area is mainly based on flood protection by dikes along the major watercourses. The dikes with a less or more sufficient altitude (superstructures from 0.5 to 1.20m) protect related areas against flood of 100 years return period (exception makes dikes next to electric power plant of Drava River – dimensioned on flood of 1,000 years return period).

The required protection level of the lowlands from floods of a 100-year return period is not in place along some sections currently, which requires their reconstruction. However, the largest problem of flood protection in the Drava river basin are numerous unregulated torrential streams in the regions of Međimurje, Podravina and Podunavlje, as confirmed by many recent local floods.

Systems for protection against torrential waters were partly completed only in two catchment areas (Međimurje and Županijski kanal), but still are insufficient. On the other catchment areas, there are only individual protective structures that can not provide adequate lowland protection. Therefore, for full completion of flood protection system is necessary to build a large number (about 70) of reservoirs and/or retentions in the future. On the Drava river basin, 11 reservoirs and 17 retention were built.

As a result of intensive flood protection works, nowadays we have totally 391 km of dikes (340 km along the Drava River and 51 km along the Mura river). In Drava and Danube river basin area around 145,000 hectares of urban, forestry and agricultural areas (approximately 16% of Drava and Danube river basin area) is protected with dikes (mostly with protection from flood of 100 years return period of occurrence).

### **2.1.3. Institutional and legal framework**

#### **Austria**

The Danube sub-basin of the Drava, together with the Mura, extends over the provinces of Carinthia, Styria, (East) Tyrol and Salzburg with a size of about 21,610 km<sup>2</sup>. The protective hydraulic engineering within the catchment area can be subdivided into the spheres of competence of the Federal Hydraulic Engineering Administration and the Forest Engineering Service in Torrent and Avalanche Control (both Federal Ministry of Agriculture, Forestry, Environment and Water Management -BMLFUW).

#### **Slovenia**

Flood risk management is defined by:

- The Water Act (adopted in 2002, amended in 2008),
- Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes (adopted in 2007),
- Decree on conditions and limitations for constructions and activities on flood risk areas (adopted in 2008),
- Decree on the detailed content and method of drawing up a water management plan (adopted in 2006),
- The Natural and Other Disasters Protection Act (adopted in 2006),
- Decree on the contents and drawing up of protection and rescue plans (adopted in 2006),
- Protection and rescue plan in case of floods (adopted in 2004).

The transposition of Flood Directive will be completed in 2009 with the adoption of Regulation on detailed content and mode of preparation of FRMP.

The institutions responsible for flood risk management/defence are:

- Ministry of the environment and spatial planning, Environment directorate, Department of waters with its Environmental Agency;
- Ministry of Defence, Administration of the Republic of Slovenia for Civil Protection and Disaster Relief and Inspectorate for Protection Against Natural and Other Disasters

National FRM work programme for 2009-2015 will contribute to more operational coordinated tasks in the process of Flood Directive implementation.

On the level of international Danube River Basin the tasks of coordination and preparation of FRMP are based on Working programme of WG Flood. Working programme is based on provisions of directive 2007/60/EC and is defining common activities and timetables, considering Convention on Cooperation for the Protection and Sustainable Use of the Danube River (1994) and bilateral agreements between the Government of the Republic of Slovenia and Governments of neighbouring countries Republic of Croatia, Republic of Austria and Republic of Hungary.

### **Hungary**

Owing to the particular physico-geographic and hydrographic situation, the Hungarian state is obliged to take a responsibility considerably higher than in the majority of the EU member states in controlling water born damages and in improving the structural measures thereof.

Under the provisions of the law LVII of 1995 on water management, in flood basins with more than two communities flood control is a function of the state and the defences are owned by the state. The locally competent KÖVIZIG is responsible for managing and maintaining these defences.

The territory of the country is divided on the basis of the catchment principle into twelve districts, which form hydrographic units, with a KÖVIZIG competent in each.

Legislation, policy and strategy of the water management are set by the KVVM, while operative control of the KÖVIZIGs is provided by the VKKI. The local functions are performed by the KÖVIZIGs.

The Minister of KVVM controls the technical functions of flood fighting with support by the National Technical Co-ordinating Body as long as the workforce and resources of the SWS can control the emergency situation.

In emergency situations, which extend to large regions where several KÖVIZIGs are no more capable of handling, national control is taken over by the government commissioner.

The commissioner is the Minister of KVVM. To perform all defence activities in such emergency situations, he is vested with powers to draw on the labour of the population, further on the equipment, tools, materials, machines and vehicles of economic organizations, following the rules laid down in the National Flood Emergency Mobilization and Cooperation Plans. In cases where the public workforce is inadequate, he is authorized to resort by the intermediary of the Minister of Defence as well as the Minister of Interior to the units and equipment of the military, the civil defence and the police as well. The state secretaries of cooperating ministries implement administrative tasks of emergency operations.

In exceptional cases of emergency, like an impending national disaster, supreme control is taken over by a Governmental Co-ordinator Committee, the members of which are the administrative state secretaries of the sectors involved in flood fighting. The GCC is a

decision preparatory organism to the government. Power it exercised through the government commissioner.

In conclusion mention must also be made of the organization of local damage control, which is a responsibility of the municipalities. Local damage control is understood as mitigation of effects of intensive local rainfall that might cause inundations in the deepest parts of a community, mitigation of effects of the flood of small torrential streams crossing villages not protected by embankments, and similar, local problems. The tasks involved being of local importance, the organization is founded on the local government structure of the various communities. The head of the defence organization is the mayor, who is free to request in cases of emergency technical assistance from the KÖVIZIG competent in the area.

### **Croatia**

Flood protection in the Republic of Croatia has been regulated under the Water Act and the Water Management Financing Act. The competent bodies for flood protection issues are: the Ministry of Regional Development, Forestry and Water Management as a state administration body and Hrvatske vode as a state agency.

Operative flood defence on state waters is conducted according to the State Flood Defence Plan adopted by the Government of the Republic of Croatia, whereas the carrying out of operative flood defence on local waters is based on flood defence plans for catchment areas, which are adopted by county assemblies on the basis of proposals put forward by Hrvatske vode.

Based on these plans, operative flood defence on state waters is established in river basin districts, and within those in counties, various sectors and on different sections of watercourses. Operative flood defence on local waters is established in catchment areas, and within those in counties, various sectors and on different sections of watercourses.

In the Danube River Basin operative flood defence is carried out by Hrvatske vode: the Department of Protection against Adverse Effects of Water (Hrvatske vode Head Office), Service for protection against adverse effects of water within the Water Management Department for the Drava and Danube River Basins (Osijek WMD), and by employees of Croatian Water branch offices in the catchment areas - 2 water management branch offices (WMBO). The Danube River Basin district flood defence center is located in the seat of river basin district in Osijek. County flood defence centers are located in county seats. Field flood defence centers for river sections and water watchmen areas have also been established. Interventions during operative flood defence are carried out by the Ministry-approved, court-registered legal entities using their own machinery, equipment and skilled workers. Materials and basic tools for operative flood defence are provided by Hrvatske vode.

### **3. TARGET SETTINGS**

#### **3.1. AUSTRIA**

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

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

##### **3.1.1. Regulations on Land Use and Spatial Planning**

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

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

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

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

mapping constitutes an important and valuable element for assessing the existing hazard situation.

### **Land-use planning:**

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

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

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

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

### **Hazard zone mapping and flood plains:**

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

***Target 1:*** Compilation and adaptation of flood hazard maps and flood risk maps

**Target 2:** Complete identification of all flood hazard zones

**Target 3:** Increased interdisciplinary cooperation between the individual specialisations

### **3.1.2.      Reactivation of former, and creation of new, retention and detention capacities**

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

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

**Target 1:** Natural retention of floods in the catchment areas

**Target 2:** Protective water management, morphological and ecological improvements in the river bed

### **3.1.3.      Technical Flood Protection**

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

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

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

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

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

*Target 2:* Protection and management of natural hazards on the torrents

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

#### **3.1.4. Preventive Measures – Optimising Flood Forecasting and the Flood Warning System**

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

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

*Target 1:* Optimisation and development of flood forecasting

*Target 2:* Optimisation of flood warning and the flood warning systems

#### **3.1.5. Capacity Building of Professionals**

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

The **Water Framework Directive** of the European Union represents the framework for the common protection of waters in the member states. The precondition for achieving the aim of a good ecological state of waters is good cooperation between the member states, based on

common measures, such as the installation of a gauging and monitoring programme and the setting up of national water management programmes.

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

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

### **3.1.6. Raising Awareness, Informing the Public and Disaster Control**

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

*Target 1:* Promotion of the knowledge and awareness of hazards

*Target 2:* Optimisation and development of disaster control and emergency planning

*Target 3:* Protection against disasters by means of preventive measures

### **3.1.7. Prevention and Mitigation of Water Pollution Due to Floods**

The destructive effect of large-scale floods is also accompanied by the pollution of waters. Floods can therefore have far-reaching consequences for the environment. Liquid fuels which

escape from storage tanks, damage to supply lines, industrial enterprises, sewage treatment and chemical plants or filling stations can lead to contamination or the loss of biological diversity in waters. Increased efforts must therefore be made by planners and executing bodies to prevent the contamination of waters in the event of disaster in the future. To achieve this, it is necessary for spatial planning to be integrated to a much greater extent into the protective water management planning process and for the legislator (building regulations) to make clear stipulations in this regard. The Ministry also offers the public valuable information with regard to flood-proof building in its brochure "The Force of Water – How to protect buildings adequately from floods and high groundwater levels". The brochure explicitly goes into the floodproof design of heating systems, with the aim of preventing pollution of waters with heating oil later on. In addition, flood protection strategies in Austria aim to encourage citizens to take individual precautions by offering them good information and, if need be, suitable incentives.

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

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

*Target 1:* Prevention and mitigation of water pollution produced by flooding

## **3.2. SLOVENIA**

With Water Act (adopted in 2002, amended in 2008) Slovenia put legal frame for overall water management within River basin districts, which includes the protection of water, water usage and water engineering as well to ensure protection against the adverse effects of water. The implementation of the Directive of the European parliament and of the council on the assessment and management of flood risks 2007/60/EC Slovenia made through the amended Water Act and Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of floods into risk classes.

Further implementation will be done through national FRM working programme for 2009-2015.

### **3.2.1. Regulation on Land Use and Spatial Planning**

The goal of FRM is to limit constructions and activities in flood hazard areas, and to reduce the existing flood risk.

The Decree on conditions and limitations for constructions and activities on flood risk areas (adopted in 2008) could be considered as a part of FRMP. The conditions and limitations for constructions and activities on flood hazard areas are based on experts studies made through the uniform methodology defined by the "Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes" (adopted in 2007). The major impact of this decree is expected in spatial planning where the planning process should follow the restrictions of the decree. In the process of producing the expert

studies through hydrology the future change of land use and possibly climate can be taken into account.

The conditions and limitations from Water act that restrict the aggravation of the high water regime due to man-made activities, stimulate the planners to reserve the areas for additional flood retention or other measures to reach the conditions from Water act and to reduce the existing flood risk.

Figure 8 illustrates the spatial planning procedure which takes into account the evaluation of current flood hazard and initial land use limitations for certain class of flood hazard. Adopted legislative allows that in the spatial planning procedures these hazard areas can be intended for certain use, but the procedure has to consider and include measures, which have to be realized or built before the predicted land use can be carried out. Protection measures must take into account the entire river basin area, using the measures to assure flood safety on the area of planning as well as the measures to prevent flood hazard increase upstream and downstream.

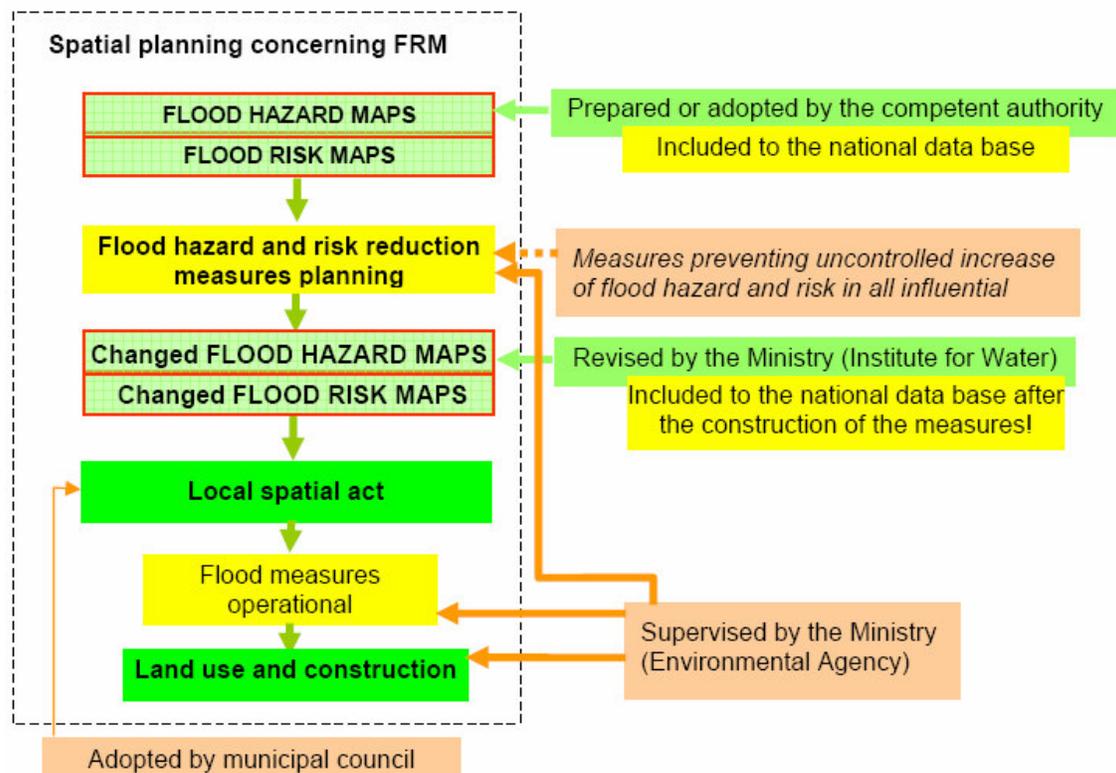


Figure 8: Scheme of spatial planning procedure concerning FRM

In addition the “Guidance on constructions methods for buildings to increase flood resistance” is in preparation.

The policy to involve the insurance company's policy in flood risk management is in progress. Also the “user pay principle” and public-private partnership should be increasingly considered in financing the flood protection infrastructure.

### **3.2.2. Reactivation of former or creation of new retention and detention capacities**

Important issue is preservation of the existing natural retentions, which can be successfully done through environmental issues too as we know that the biggest diversity of life is in wetlands, intermittent lakes, and other natural places of importance.

The “Decree on conditions and limitations for constructions and activities on flood risk areas” can be considered as a part of FRMP and its implementation can preserve the existing flood hazard areas.

"Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes" enables defining significant areas of flood and erosion risk and significant ranges of flood and erosion hazards.

The target set in water act that restrict the aggravation of the high water regime due to manmade activities, leads to solutions which include improvement of efficiency of existent or/and creation of new retention and detention capacities.

Creation of new retention and detention capacities is linked to solutions for reductions of existing flood risk.

Complementary solutions will have precedence where more national objectives can be achieved at the same time. For example, reservoirs can contribute to drought mitigation, flood retention and production of renewable hydro energy at the same time.

### **Drava and Mura River Basins**

There are several settlements at flood risk.

### **3.2.3. Preventive Actions**

For reduction of flood risk the public information on flood issues is important. The Flood indication map is available on the web; flood forecasting and warning is already working and is still improving.

Flood hazard mapping has started with "Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes", and the consequences are already reflected on land-use changes through spatial planning with the “Decree on conditions and limitations for constructions and activities on flood risk areas”.

Improvements in flood forecasting and warning (forecasting hydrological events and launching flood warnings) are going on through administrative measures (defining the procedures), scientific research (defining the hazard and risk potential) and technical improvements (flood warnings).

### **3.2.4. Capacity Building of Professionals**

The most capacity building for different professions will be done through workshops which are aimed to harmonize the elaboration of hazard and risk maps by the professionals at local level, and are also meant for the administrative professionals who are involved in spatial planning.

### **3.2.5. Raising Awareness and Preparedness of General Public**

The awareness of inhabitants in flood areas is of the crucial importance for reduction of flood risk, so the Flood indication map is already available on the web, flood forecasting and warning is working and is continuously improving.

The public participation in preparation of the flood risk management plans and in decision making process will be achieved through national FRM Working programme.

The increased awareness of risks should result in more flood insurances and improved building standards increasing flood resistance of individual building allowing every individual to make his home safer.

### **3.2.6. Prevention and Mitigation of Water Pollution Due to Floods**

The “Decree on conditions and limitations for constructions and activities on flood risk areas” defines for areas where potential pollution may occur also the strategic environmental assessment (SEA) and environmental assessment (EA) instruments in planning procedure.

## **3.3. HUNGARY**

### **3.3.1. Regulation of land use and spatial planning**

Target 1. Transposition of the EU Floods Directive into the Hungarian Water Act

Target 2. Preparation of flood risk maps

Target 3. Preparation of flood risk management plans

### **3.3.2. Reactivation of former, or creation of new, retention and detention capacities**

Target 1. Reactivation of former retention capacities

Target 2. Maintenance of existing retention capacities

### **3.3.3. Structural flood defences**

Target 1. Improvement of present flood protection structures to meet the existing safety standards

Target 2. Removing bottlenecks

### **3.3.4. Non-structural measures (preventive actions, capacity building of professionals, raising awareness and preparedness of general public)**

Target 1. Improvement of flood forecasting system

Target 2. Improvement of flood warning system

Target 3. Capacity building of professional staff

Target 4. Increase PR activity to raise awareness of general public

## **3.4. CROATIA**

The Water Management Strategy defines the legislative, organizational, financial, technical, scientific-research and IT aspects of water management activities in the present socio-economic circumstances of the accession process of the Republic of Croatia to the European Union, as well as in the future circumstances of full membership.

The conducted analyses of the current condition and developmental needs have shown that Croatia possesses sufficient quantities of water for its own needs, and that water resources, in terms of their quality and quantity, are not a limiting factor of economic development. However, due to marked temporal and spatial unevenness of the water regime, efficient and environmentally friendly water management requires systematic investment in the development and regular maintenance of the functionality of water management systems. Analyses have also shown that due to partly non-repaired war damage, as well as due to a longer period of insufficient investments in the development and regular maintenance of protective systems, the safety of the population and assets in many potentially flood-exposed areas has been reduced.

Establishment, maintenance and systematic improvements in appropriate preventive protection of the population and resources against floods are just one of the basic tasks of water management and are an essential precondition for further economic development of the country. This assumes achieving economic justifiable levels of protection for the population, material goods and other endangered assets (business premises, thoroughfares, infrastructural systems, agricultural areas, cultural-historical heritage, and so on) along with incentives for preserving and advancing the ecological state of waters and flood areas, in order to create the conditions for further sustainable economic development.

Improvements in flood protection require the application of integrated, systematic, effective and cost-efficient measures together with preventive structural and non- structural activities. The prerequisite for their application is active and coordinated participation of all actors, the water management sector, and of: protection and rescue services, meteorological and hydrological service, health service, physical planning experts, local and regional self-government units, users and managers of multi-purpose water-storage reservoirs, farmers, foresters, environmentalists, scientists and researchers, the media, higher education institutions, interested non-governmental organizations, and citizens and entrepreneurs on the areas potentially at risk.

Preventive flood protection at international river basins is planned through cooperation with competent bodies from other countries in accordance with the provisions of adopted multilateral and bilateral agreements on water management cooperation.

#### **3.4.1. Regulation on Land Use and Spatial Planning**

It is necessary to bring into balance the demands for further urbanization and economic exploitation of space and land use needs to slow down the run-off and retain water in the basins.

The problems related to water estate will be regulated through the adoption of a regulation harmonized with other regulations related to land use, which will define precise criteria for addressing all controversial issues. The water estate on unregulated inundation areas and on large lowland retarding basins of protective flood defence systems will be resolved by the zoning of the terrain and graded restrictions in land use. The priority of the water management sector is the demarcation of the water estate, its registration into land registers, and entry into physical plans, and systematic monitoring of the status of the water estate.

**Target 1:** Solve problems related to the water estate in order to prevent inappropriate exploitation of land required for proper functioning of the current water management systems, for their regular economic and technical maintenance, and for their development.

**Target 2:** Provide information of areas at risk to give input to spatial planning.

#### **3.4.2. Reactivation of former, or creation of new, retention and detention capacities**

Maximum flood wave flows, particularly in small- and medium-sized basins, can be partly reduced by preserving and improving the natural retaining capacities of land, watercourses, and floodplains. By implementing such measures, the retained water infiltrates into the ground and is available for future use, favourable water regimes are ensured for water-related ecosystems, at the same time partly reducing extreme flood risks. Natural wetlands and floodplains in the basins therefore need to be preserved, and, where possible and economically justified, reconstructed or extended.

Protection of the banks of watercourses from erosion will, wherever possible, be solved with protective vegetation. The measures based on land development must be neither underestimated nor overestimated, because they usually do not enable sufficient reduction of maximum flows of extreme flood waves, which can be ensured only through the application of various engineering measures. The implementation of renaturalization measures is usually related to high land acquisition costs and the need to provide for back-up employment options because such measures affect mostly agricultural producers. All national programs aimed at improving the status of the environment and its components will be systematically supported. On the areas of large towns urban planners must provide for improved infiltration of stormwater into the ground by developing parks and open spaces in new urban settlements. The current sources of pollution on the areas under potential flood risk will be gradually remediated.

**Target 1.** Preserving and improving natural retention capacities.

#### **3.4.3. Technical Flood Defences**

Safety from floods cannot be achieved without the implementation of structural measures that include regular economic and technical maintenance of watercourses, water estate, and water structures, as well system development works.

From the point of view of health, safety and environment, the priorities of first order in preventive flood protection are the areas of large and larger towns with more than 30,000 inhabitants, potentially at risk from the Drava River. The priorities of second order are other towns and settlements along the Drava and Mura. The current dikes at critical sections along major rivers will be gradually reconstructed and extended. Other activities will be implemented in the order defined on the basis of various criteria, including: the number of defended population, prevented material and other damage, general water management significance, estimated investment costs, etc.

Water management systems have to be planned as multi-purpose systems in order to rationalize water and land use, and account has to be taken of their economic justification and their impacts on the environment and nature. If due to uncoordinated priorities of various water and land users the development of the planned multi-purpose systems is not implemented according to the expected dynamics, preventive flood protection should, as a

matter of public interest, be addressed by simpler solutions, which would not in the future limit the development of multi-purpose systems. Water rights acts will continue to respect multi-purpose solutions envisaged under physical plans, and the water management sector will systematically encourage their development.

Small watercourses running through towns and settlements should be regulated in accordance with local needs and urban planning documents, taking into consideration the landscape and architectural demands, and the needs of municipal infrastructural systems. For the purpose of preventive protection against ice floods, regulation works at critical locations will continue to be carried out systematically.

**Target:** Achieve the 100-percent functionality of flood protection systems by the end of 2038

#### **3.4.4. Non-structural measures (Preventive Actions, Capacity Building of Professionals, Raising Awareness and Preparedness of General Public)**

The efficiency of operative flood defence will be improved through the modernization of current systems for the monitoring and forecasting of weather phenomena (on-line monitoring stations, radars, satellite images, forecasting models, etc.), and current communications systems. Flood forecasting models will be developed, officially adopted and regularly updated, and on international rivers they will be developed and coordinated in the framework of competent international bodies. Systematic monitoring and forecasting of weather phenomena and timely provision of relevant information to the competent services for operative flood defence are the responsibility of hydrological and meteorological services.

A flood defence plan will be drawn up for an integrated water system. Operative flood defence on boundary watercourses is carried out together with competent services from the neighbouring countries.

The protection and rescue services will ensure proper functioning of regional and local public alert systems; organize the work of the civil protection; prepare strategic, tactical and operative disaster management plans, and, if needed, organize appropriate exercises; organize the evacuation of inhabitants in case of need; organize emergency medical aid to affected population; and organize post-flood terrain recovery. Other agents in flood protection are: science-and-research institutions, the media and interested NGOs with active and constructive participation in the processes of development of planning documents.

**Target 1:** Reduce flood damage risk

**Target 2:** Increase the efficiency of operative flood defence measures

**Target 3:** Increase the capacity building and raise the level of preparedness  
of organizations responsible for operative flood defence

**Target 4:** Build capacity of professionals and institutions responsible for flood  
management

**Target 5:** Introduce principles of EU flood directive

**Target 6:** Raise awareness and preparedness of the general public on  
sub-basin-wide and local scale

**Target 7:** Prevent and mitigate pollution of water caused by floods

#### 4. MEASURES TO ACHIEVE TARGETS

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment	
<b>4.1. Regulation on land use and spatial planning</b>							
AT	<b>Target 1.</b> 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)			
	<b>Target 2.</b> Complete identification of all flood hazard zones	Full-coverage identification on <u>hazard zone maps</u> in the relevant settlement and infrastructure areas. <u>Flood Discharge Analyses</u>	Hazard zone mapping	<ul style="list-style-type: none"> <li>• Administrative offices of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control (WLV) (both BMLFUW)</li> </ul>		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 2015. Complete identification of all hazard zones within the sphere of competence of the Forest Engineering <i>Service</i> in Torrent and <i>Avalanche</i> Control has already been carried out.

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
		Adaptation of laws, ordinances and directives to the claims and demands of protective water management.	Administration	Federal state, provinces		Ongoing	Spatial planning and land-use planning laws, building regulations, building technique ordinances ...
		Identification of reserved and indicated areas	Hazard zone mapping	Sections of the Forest Engineering Service in Torrent and Avalanche Control (WLV)		Ongoing	In this way, existing hazards are indicated and also important areas are kept free for further protective measures
		Identification of areas in need of protective water management in coordination with spatial development	Strategy Flood protection Raising awareness	<ul style="list-style-type: none"> <li>• Provinces</li> <li>• Specialist departments</li> </ul>			Pilot project: Protective Water Management Spatial Development Plan Currently only exists for the province of Carinthia, though its extension to cover all Austria is under discussion.
	<b>Target 3. Increased interdisciplinary cooperation between the individual specialisations</b>	Promotion of closer interdisciplinary cooperation between protective water management, spatial planning, disaster control and the legislative process	Strategy	<ul style="list-style-type: none"> <li>• Federal government, provinces and municipalities</li> <li>• Specialist departments</li> </ul>		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 Carinthia: Protective water management spatial development plan pilot project
		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.
<b>SL</b>		<b>Target 1: Spatial plans must consider limitations and conditions</b>	Flood indication map - information of existing data	Administrative	MOP		continuous
	Flood hazard and hazard class map		Administrative	MOP		continuous	

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
	<i>(Decree on conditions and limitations for constructions and activities on flood risk areas)</i>	Conditions and limitations for constructions and activities on flood hazard areas	Administrative	ARSO		continuous	
		Detailed designation of boundary of waterside land	Administrative	MOP		continuous	
		Conditions and limitations for defined waterside land	Administrative	MOP/ARSO		continuous	
HU	<b>Target 1: Transposition of the EU Floods Directive into the Hungarian Water Act</b>	Modify the text of the Water Act to incorporate the aim of the EU Floods Directive	Administrative	VKKI, KvVM		2009	It is under way
	<b>Target 2: Preparation of flood risk maps</b>	Methodological development of flood hazard and risk mapping	Administrative	Consultants		2010	It is under way
		Data collection	Administrative	KÖVIZIGs <sup>1</sup>		2011	Projects under preparation
		Flood hazard mapping	Administrative	KÖVIZIGs and Consultants		2013	
		Flood risk mapping	Administrative	KÖVIZIGs and Consultants		2013	
<b>Target 3: Preparation of flood risk management plans</b>	Preparation of flood risk management plans	Administrative	KÖVIZIGs		2015		
HR	<b>Target 1: Solving problems related to the water estate</b>	Drafting and adoption of regulations (criteria for identification, zoning of the terrain, and gradation of limitations restrictions in the use of the water estate)	Administrative	MRDFWM, HV, MEPPPC			
		Delineation of the water estate, entry into land registers and physical plans	Administrative	MRDFWM, HV, MEPPPC			
		Solving property-right relations to legalise flood protection structures (repurchase of real estate, getting location and construction permit)	Administrative	MRDFWM, HV, MEPPPC			
		Systematic monitoring of the status of ownership on the water estate.	Administrative	MRDFWM, HV, MEPPPC			

<sup>1</sup> Two KÖVIZIGs are dealing with the Mura and Drava Rivers.

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
	<b>Target 2 Provide information of areas at risk to give input to spatial planning</b>	Preparation of relevant water management planning documents : - Introduction of flood risk maps and flood damage maps for the entire country, and their presentation to the interested public - Introduction of appropriate indicators and systematic monitoring of the efficiency of flood and erosion control measures	Administrative	MRDFWM, HV, MC		Uncertain	
		Preparation and systematic maintenance of: the Inventory of water bodies, water estate and water structures, the Inventory of extreme hydrologic phenomena (floods, storms and droughts), and the Inventory of the status of erosion and anti-erosion measures taken	Administrative	MRDFWM, HV DHMZ, HS		Continuous	
<b>4.2. Reactivation of former, or creation of new, retention and detention capacities</b>							
AT	<b>Target 1: Natural retention of floods in the catchment areas</b>	Prevention of existing retentions areas	Flood retention Strategy	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		Ongoing	Targeted flood retention in the catchment areas. Passive flood protection takes priority over active flood protection.

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
		Reactivation and creation of retention capacities	Flood retention Strategy	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		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	<ul style="list-style-type: none"> <li>• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> </ul>		Ongoing	
	<b>Target 2: Protective water management, morphological and ecological improvements in the river bed</b>	Implementation of protective water management, morphological and ecologically valuable measures in the riverbed (restructuring, revitalisation, renaturation)	Strategy Flood protection	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		Ongoing	
SL	<b>Target 1: Restricting the aggravation of the high water regime due to man-made activities (The compensation measures must be performed)</b>	Improvement of efficiency of existent or/and creation of new retention and detention capacities	Scientific	MOP/ARSO/IZVRS		in progress	Reducing flood risk for some smaller settlements along river Dravinja

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
HU	<b>Target 1: Reactivation of former retention capacities</b>						No further flood retention capacities planned on the Drava and the Mura
	<b>Target 2: Maintenance of existing retention capacities</b>						Very small open floodplain on the Mura will remain open
HR	<b>Target 1: Preserving and improving natural retention capacities</b>	Existing multipurpose reservoirs are used for flood attenuation	Administrative	MRDFWM, HV		Continuous	Coordinated operation of existing multipurpose reservoirs
		Existing mountain retention storages are used for flood attenuation	Administrative	MRDFWM, HV		Continuous	Coordinated operation of existing multipurpose reservoirs
		Design and construction of new reservoirs and mountain retention storages	Technical	MRDFWM, HV		Started	
		Introduction of renaturalization measures of preventive flood protection: <ul style="list-style-type: none"> <li>- Reduction of flood wave peak flows by reactivating former floodplains and restoring watercourses;</li> <li>- Implementation of the Best Practices of Flood Prevention Protection and Mitigation in land use management</li> </ul>	Administrative	MRDFWM, HV, MC, MEPPPC, LRSG, OTHER		Continuous	
<b>4.3. Technical flood defences</b>							

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
AT	<b>Target 1: To ensure adequate flood protection for the relevant settlement and infrastructure areas</b>	Maintenance and adaptation of the protective measures and protective structures	Maintenance Flood protection Strategy	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		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	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		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	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		Ongoing	Improvement of passability (outlets, channels, bridges...) in the course of the project activity

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
		Coordination between planning projects of public authorities and the relevant special fields.	Strategy Integrated management	flood	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Departments of the relevant special fields.</li> </ul>	Ongoing	
		Recognition of negative flood-relevant developments	Strategy Research		<ul style="list-style-type: none"> <li>• Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> </ul>		
<b>Target 2: Protection and management of natural hazards on the torrents</b>		Measures for bed load and dead wood retention in torrent catchment areas	Protection from natural hazards		<ul style="list-style-type: none"> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>	Ongoing	
		Implementation of area management measures in the catchment areas	Protection from natural hazards		<ul style="list-style-type: none"> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>	Ongoing	

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
<b>Target 3: Flood protection by means of area-and-space-effective measures</b>	Creation and enlargement of retention areas and basins	Flood protection	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		Ongoing	Main strategic focus: retention measures take priority over linear construction measures. Regarding implemented and planned measures.
	Controlled retention	Flood protection	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> </ul>		Ongoing	Regarding controlled retention, greater potentials for the future lie in the continual further development of prognosis and forecasting models. The taking into account of protective water management aspects in the operating regulations of power stations, valley dams or lake reservoirs
	Preservation and protection of the function of the groundwater body	Flood protection	<ul style="list-style-type: none"> <li>• Departments of the Federal Hydraulic Engineering Administration</li> <li>• Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		Ongoing	

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
HU	<b>Target 1: Improvement of present flood protection structures to meet the existing safety standards</b>	Strengthening and heightening flood protection dykes to resist the 1:100 year floods	Structural measure	DÉDU KÖVIZIG			Strengthening and heightening of 5.1 km dykes in the region of Old (Dráva)
				NYUDU KÖVIZIG			Strengthening and heightening of dykes in the region of Drávaszabolcs-Kémes (Dráva)
	<b>Target 2: Removing bottlenecks</b>	Improve flood conveyance capacity	Structural measure	NYUDU KÖVIZIG			Strengthening and heightening of 43 km dykes on the left bank of Mura
HR	<b>Target 1: Achieving the 100% functionality of flood protection systems</b>	Gradual implementation of repair and reconstruction works on about 400 km of protective systems	Technical	MRDFWM, HV, HEP, OTHER		2038	There is an idea of improving the conveyance capacity of Mura River
		Design and construction of 30 km of protective systems	Technical	MRDFWM, HV, HEP, OTHER		2038	From the point of view of health, safety and environment, the priorities of first order in preventive flood protection are the areas of large and larger towns with more than 30,000 inhabitants, potentially at risk from the Drava River.
		Regular maintenance of watercourses, water estate, and water structures; systematic technical monitoring of key water structures	Technical	MRDFWM, HV		Continuous	The priorities of second order are other towns and settlements along the Drava and Mura.
		Support to solving flood protection problems within multi-purpose systems for the regulation and use of water and land	Technical	MRDFWM, HV, HEP, OTHER		Continuous	
<b>4.4. Non-structural measures (preventive actions, capacity building of professionals, raising awareness and preparedness of general public)</b>							

Targets		Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
AT	<b>Target 1: Optimisation and development of flood forecasting</b>	Development of flood forecasting and prognosis models	Prevention Research Strategy	<ul style="list-style-type: none"> <li>Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> </ul>		Ongoing	Gradual development of flood forecasting systems for all major main rivers and tributaries
		Networking of regional and international systems	Cooperation Research Strategy	<ul style="list-style-type: none"> <li>Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> <li>Neighbouring states (Czech, Slovakia)</li> </ul>		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	<ul style="list-style-type: none"> <li>Hydrographic Services of the Federal Hydraulic Engineering Administration</li> </ul>		Ongoing	Further development of, in particular, the basic network of telecommunicating gauges  Deployment of state-of-the-art technical devices and systems.
	<b>Target 2: Minimisation of the damaging consequences of natural disasters</b>	Optimisation of flood warning and the flood warning systems (improved early warning)	Prevention Strategy Disaster Control	<ul style="list-style-type: none"> <li>Provinces (Hydrographic Services, disaster control departments)</li> </ul>		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.

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
<b>Target 3: Promotion of the national and international exchange of knowledge between all the specialisations of integrated flood management)</b>	Improvement of international cooperation in flood management	Cooperation Research	<ul style="list-style-type: none"> <li>Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> </ul>		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	<ul style="list-style-type: none"> <li>Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)</li> <li>Representatives of the participant countries</li> </ul>		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	<ul style="list-style-type: none"> <li>Federal government, provinces</li> <li>Participant neighbouring countries and various organisations</li> </ul>		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

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
<b>Target 4: Promotion of the knowledge and awareness of hazards</b>	Keeping the public continually informed	Public Relations Raising Awareness	<ul style="list-style-type: none"> <li>Federal government, provinces and municipalities</li> <li>Disaster control departments, emergency organisations, insurance companies...</li> </ul>		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	<ul style="list-style-type: none"> <li>Departments of the Federal Hydraulic Engineering Administration</li> <li>Sections of the Forest Engineering Service in Torrent and Avalanche Control</li> </ul>		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	<ul style="list-style-type: none"> <li>Federal Ministry of Agriculture, Forestry, Environment and Water Management</li> </ul>		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.
<b>Target 5: Optimisation and development of disaster control and emergency planning</b>	The carrying out of disaster control exercises	Disaster control	<ul style="list-style-type: none"> <li>Provinces</li> <li>Disaster control organisations</li> </ul>		Ongoing	
	Streamlining and optimisation of the emergency response chain	Disaster Control	<ul style="list-style-type: none"> <li>Provinces</li> <li>Disaster control organisations</li> </ul>		Ongoing	

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
	Creation of disaster control plans and special alarm plans	Disaster Control	<ul style="list-style-type: none"> <li>Provinces</li> <li>Disaster control organisations</li> </ul>		Ongoing	
<b>Target 6: Protection against disasters by means of preventive measures</b>	Promotion of incentive systems to encourage people to take their own precautions	Prevention Disaster Control	<ul style="list-style-type: none"> <li>Federal government, provinces</li> </ul>		Ongoing	
	Securing financial provision	Prevention Disaster Control	<ul style="list-style-type: none"> <li>Federal government, provinces</li> </ul>		Ongoing	
<b>Target 7: Prevention and reduction of water pollution produced by flooding</b>	Greater integration of spatial planning in protective water management planning projects	Prevention and reduction of water pollution	<ul style="list-style-type: none"> <li>Federal government, provinces</li> </ul>		Ongoing	
	Directives and specifications given by the legislator	Prevention and reduction of water pollution	<ul style="list-style-type: none"> <li>Federal government, provinces</li> </ul>		Ongoing	Building Code, Building Technique Ordinance (uplift-resistant heating oil tanks; positioning of storage containers)
	Information on flood-proof building	Prevention and reduction of water pollution	<ul style="list-style-type: none"> <li>Federal government, provinces</li> </ul>			Information on constructing flood-proof heating systems
<b>SL Target 1: Preventive actions</b>	Flood indication map - information of existing data	Administrative / Scientific	MOP		Continuous	
	Improvements in flood forecasting and warning (forecasting hydrological events and launching flood warnings)	Administrative / Technical/ Scientific	ARSO/ Notification Centre of the Republic of Slovenia		Continuous	
<b>Target 2: Capacity Building of Professionals</b>	Workshops: enforcement of prevention principle for reducing the risk instead of assuring of certain degree of safety	Administrative / Scientific	MOP/ARSO/ IZVRS		2015	probably will continue after 2015
	Workshops: on harmonization of elaboration of hazard and risk maps	Scientific	MOP/ARSO/ IZVRS		2015	probably will continue after 2015
	Workshops: for administrative professionals which are involved in spatial planning	Scientific	MOP/ARSO/ IZVRS		2015	probably will continue after 2015
<b>Target 3: Raising Awareness and Preparedness of General</b>	Flood indication map - information of existing data	Administrative / Scientific	MOP		Continuous	

	<b>Targets</b>	<b>Measures</b>	<b>Type of intervention</b>	<b>Institution in charge</b>	<b>Costs (k€)</b>	<b>Deadline</b>	<b>Comment</b>
	<b>Public</b>	Workshops on implementations of Flood directive	Administrative / Scientific	MOP/ARSO/IZVRS		Continuous	
		Flood forecasting and warning (workshops, public campaigns, demonstrations)	Administrative / Scientific	MOP/ARSO/IZVRS/ MO		Continuous	
		Adoption and execution of regulations for adaptation of construction in flood risk areas	Administrative / Scientific	MOP/ARSO/IZVRS/ MO		2010, Continuous	
	<b>Target 4: Spatial plans must include restricting measures of enlargement on flood hazard areas</b>	Flood indication map - information of existing data	Administrative	MOP		continuous	
		Flood hazard and hazard class map conditions and limitations for constructions and activities on flood hazard areas	Administrative Administrative	MOP ARSO		continuous continuous	
<b>HU</b>	<b>Target 1: Improvement of flood forecasting system</b>	Incorporate the newest monitoring data available (automatic station, ECMWWF etc.) and improve the algorithm	R&D	NYUDU KÖVIZIG, DÉDU KÖVIZIG, VITUKI		2010	NYUDU KÖVIZIG would like to apply the Austrian-Slovenian flood forecasting model DÉDU KÖVIZIG and Croatia applied for a project to improve forecasts and increase lead-time
	<b>Target 2: Improvement of flood warning system</b>	Intensive use of EFAS	R&D	VITUKI		Continuous	Incorporate, test and use the outputs of EFAS into the daily forecasting models
	<b>Target 3: Capacity building of professional staff</b>	Regular, yearly training of professional staff; improve vocational and post-graduate education to bring up new generation of staff	Training	KvVM, VKKI, KÖVIZIGs, Universities, High schools		Continuous	Regular training of disaster mitigation groups along the Drava
	<b>Target 4: Increase PR activity to raise awareness of general public</b>	Production and distribution of leaflets and other PR materials; paid programmes on broadcasting stations	PR	KÖVIZIGs		Continuous	Part of ongoing and planned projects (There is also an Italian initiative)
<b>HR</b>	<b>Target 1: Reduce flood damage risk</b>	Implementation of operative flood defence measures	Technical / Organizational	MRDFWM, HV		Continuous	
		Managing and coordinating the operation of water distribution structures during high water periods	Technical / Organizational	MRDFWM, HV, HEP, OTHER		Continuous	

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
<b>Target 2: Increase the efficiency of operative flood defence measures</b>	Improving the system of automated weather stations and gauging stations, and making the measured data available to relevant services in real time	Technical / Organizational	MRDFWM, HV, DHMZ		Continuous	
	Improving the system of hydrological and weather forecasting, and making the created forecasts available to relevant services; establishment of local forecasting centers and application of the latest technologies in forecasting - monitoring and water information system	Technical / Organizational	MRDFWM, HV, DHMZ		Continuous	
	Improvement of alarm systems and systems for issuing timely warning to population at risk; organizing improved operations of the police and fire fighting forces during floods; organizing evacuation of population, if needed; organizing life on damaged areas by providing humanitarian aid, organizing medical services, and emergency recovery of essential infrastructure	Technical / Organizational	NPRD		Continuous	
	Improvement and formalizing of international basin wide on line flood related meteorological and hydrological data exchange	Administrative	HV, DHMZ		Continuous	
	Improvement and formalizing of international basin wide on line operative flood defense information exchange	Administrative	HV, NPRD		Continuous	
	<b>Target 3: Increase the capacity building and raise the level of preparedness</b>	Preparation, adoption, and regular updating of the National Flood Defence Plan	Administrative	MRDFWM, HV		Continuous
<b>Target 4: Build capacity of</b>	Support of scientific and educational projects related to all aspects of floods.	Administrative	HV, MSES, MRDFWM		Continuous	

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
<b>professionals and institutions</b>	Professional education of scientific personnel to perform the tasks of integrated water resources management. It is necessary to create new interdisciplinary plans and programs of education	Scientific	HV, MSES, MRDFWM		Continuous	
	Continue action in the framework of international multilateral and bilateral agreements	Administrative	MRDFWM, HV MFAEI, MEPPPC, MC		Continuous	
<b>Target 5: Introduce principles of EU Floods directive</b>	Continue action in the framework of international multilateral and bilateral agreements	Administrative	MRDFWM, HV MFAEI, MEPPPC, MC		Continuous	
	Bring into force the laws, regulations and administrative provisions complied with Flood Directive	Legal/ Administrative	MRDFWM, HV		26 November 2009	
	Decision on units of management	Legal/ Administrative	MRDFWM, HV		26 May 2010	
	The Preliminary flood risk assessment	Scientific/ Technical	MRDFWM, HV		22 December 2011	
	Preparation of flood hazard and flood risk maps	Scientific/ Technical	MRDFWM, HV		22 December 2013	
	Preparation of Flood risk management plan	Scientific/ Technical	MRDFWM, HV		22 December 2015	
<b>Target 6: Raise awareness and preparedness of the general public</b>	Presentation of flood risk and flood damage maps to the interested public	Administrative	MRDFWM, HV, MC		Continuous	
	Introducing the principle of covering uncovered flood damage risks through insurance policies	Administrative	MRDFWM, HV, MF		Continuous	

Targets	Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment	
	<b>Target 7: Prevent and mitigate pollution of water caused by floods</b>	Recovery of the current sources of pollution on the areas potentially at risk	Administrative	MRDFWM, HV, MEPPPC, MHSW, LRSG		Continuous	

## Annex 1

### List of competent authorities responsible for preparation and implementation of the Action Plans

Country	Name of institution	Abbreviation	Address
SL	Republic of Slovenia, Ministry of environment and spatial planning, Directorate for water	MOP	
	Institute for water of the Republic of Slovenia	IZVRS (IWRS)	
	Environmental Agency of the Republic of Slovenia	ARSO (EARS)	
	Ministry of Defence, Administration of the Republic of Slovenia for Civil Protection and Disaster Relief	MO	
HU	Ministry of Environment and Water	KvVM	Fő utca 44-50 Budapest, 1011
	Central Directorate for Water and Environment	VKKI	Márvány u. 1/d Budapest, 1012
	Environmental and Water Management Directorates	KÖVIZIGs	
	West Trans-Danubian Environmental and Water Management Directorate	NYUDU KÖVIZIG	Vörösmarty út 2. Szombathely, 9700
	South Trans-Danubian Environmental and Water Management Directorate	DÉDU KÖVIZIG	Köztársaság tér 7. Pécs, 7623
	VITUKI Environmental and Water management Research Institute Non.profit Ltd.	VITUKI	Kvassay J. út 1. Budapest, 1095
HR	Meteorological and Hydrological Service	DHMZ	Grič 3 10000 Zagreb
	Hrvatska elektroprivreda (Croatian power company)	HEP	Ulica grada Vukovara 37 10000 Zagreb
	Hrvatske šume	HS	Ljudevita Farkaša Vukotinovića 2 10000 Zagreb
	Hrvatske vode	HV	Ulica grada Vukovara 220 10000 Zagreb
	Ministry of Culture	MC	Runjaninova 2, 10000 Zagreb
	Ministry of Environmental Protection, Physical Planning and Construction	MEPPPC	Ulica Republike Austrije 20 10000 Zagreb
	Ministry of Finance	MF	Katančićeva 5 10000 Zagreb
	Ministry of Health and Social Welfare	MHSW	Ksaver 200a 10000 Zagreb
	Ministry of Regional Development, Forestry and Water Management	MRDFWM	Babonićeva 121 10000 Zagreb
	Ministry of Science, Education and Sport,	MSES	Donje Svetice 38 10000 Zagreb
	National Protection and Rescue Directorate, Ministry of the Interior	NPRD	Ulica grada Vukovara 33 10000 Zagreb
	Ministry of Foreign Affairs and European Integration	MFAEI	Trg N. Š. Zrinskog 7 -8 10000 Zagreb