Flood Action Plan for the Vah, Hron and Ipel Rivers Basin

icpdr International Commission for the Protection of the Danube River
iksd Internationale Kommission zum Schutz der Donau

Action Programme for Sustainable Flood Protection in the Danube River Basin



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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 **Vah, Hron and Ipel Rivers** sub-basin reviews the current situation in flood protection and sets the targets and the respective measures aiming among others to reduction of damage risks and flood levels, increasing the awareness of flooding and to improvement of flood forecasting. The targets and measures are based on the regulation of land use and spatial planning, increase of retention and detention capacities, technical flood defences, preventive actions, capacity building, awareness & preparedness raising and prevention and mitigation of water pollution due to floods.

In general, the causes and impacts of floods are very variable and thus the action flood protection planning requires different specific solutions. This diversity should be taken into account in the definition of the objectives, in the planning of the whole cycle of flood risk management:

1. Prevention;
2. Protection;
3. Preparedness;
4. Emergency response;
5. Recovery;
6. Lessons learned;
7. Execution of measures to ensure reduction of floods adverse impacts.

Even though it is possible to find out basic common approaches, which should be considered in the action flood protection planning in every sub-basin of the Danube River basin:

1. River basin approach: Flood protection measures should be effective in the whole river basin and thence it is necessary to take into account interdependence and interaction of the effects of individual measures implemented along all of the water courses in every single river sub-basin.
2. Interdisciplinary integrated approach: The complex flood protection action planning requires the interdisciplinary approach which includes:
   a) Meteorology and hydrology (flood forecasting and early warning systems);
   b) Water management and hydraulics engineering (design and assessment of structural measures);
   c) Protection of environment;
   d) Spatial planning and urban development (design of both structural and non-structural measures);
   e) Land use, agriculture and forest management (design of non-structural measures);
   f) Public information and participation (public participation in decision-making concerning flood protection, flood risk management actions and learning to live with floods);
   g) Other measures, according to the conditions in individual cases.
3. International harmonisation and cooperation: It is known, that local flood protection measures can have negative effects both downstream and upstream. Therefore, it is important to harmonise databases and safety criterions for the flood protection. Very important is close cooperation between neighbouring states, as well as coordination of measures in large-scale hydrological units in the whole river basin.
4. Financing of measures:
   a) The national sources (state funds or state budget, regional and municipal budgets, support by business corporations, projects of non-governmental organizations, etc.);
   b) The financial instruments of the European Union;
   c) Immediate financial assistance in the event of large-scale disasters.

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

The ICPDR sub-basin of the Vah, Hron and Ipel rivers consists from the following parts:

- The Vah River basin, with the sub-basins of the Nitra River, the Orava River, the Kysuca River and some smaller rivers. The small parts of the Vah River basin are situated at the territory of the Czech Republic and marginally the Poland.
- The Hron River basin, situated completely at the territory of Slovakia.
- The northern and north-western parts of the international Ipel River basin are situated in the Slovak Republic. The south-eastern and southern parts of the Ipel River basin are situated in the Hungary.

The **Vah** River is the major tributary of the Danube River in Slovakia (length 402 km, average discharge 161 $m^3.s^{-1}$). The area of Vah River basin is 19 696 km^2 what is the biggest one in Slovakia. The part of the Vah River basin found in the Czech Republic is about 451 km^2. This region is one of the most economically developed regions in the Slovak Republic. There are a lot of branches of industry, for example car producing, leather processing, machinery, electrical, woodworking, textile, paper, pharmaceutical, metalworking, and many other sorts of the industry. The agricultural sector is developed on the high level in this river basin either. The settlements, industrial centres and the transport corridors are the most developed in the alluvia along the riverbanks of watercourses in the whole Vah River basin. Many parts of villages in the upper parts of the river basin are situated in the floodplains and the flood protection is secured only partially there.

The flood protection in the Vah River valley is secured by the Vah water management system, the construction of which started in 1932 (hydraulic structure Dolné Kočkovce – Ladce). There are in operation 10 water management reservoirs in the Vah River itself at present. Another 12 water management reservoirs are in operation in the sub-basins of the Vah River. The largest in the Vah River basin are reservoirs of the hydraulic structures Liptovská Mara (the Vah River) and Orava (the Orava River), which have the multipurpose exploitation (the hydropower production, flood protection, water management and the flow regime control, affection of the water discharges during the dry seasons, recreation, fish breeding, etc.). Their roles in the flood protection system were strengthened in the new operating rules recently so that the retention volumes in the reservoirs were enlarged. The dykes are constructed along the middle and lower stretches of rivers, above all in the towns and villages. The flood protection against the floods with the peak discharge Q_{100} is ensured in all important towns in the Vah River basin. Generally, the less safe flood protection is along the smaller watercourses in the upper parts of the river basin especially, which are not trained. The list of important reservoirs in the Vah river basin is given in the Table 2.1.

Table 2.1. **Important water reservoirs in the Vah River basin**

Name	River	Catchment area	Volume	
			Total	Retention
		[km^2]	[$10^6 \cdot m^3$]	[$10^6 \cdot m^3$]
Bešeňová	Vah	1493.2	9.78	1.65
Boleráz	Trnávka	94.4	2.465	0.380
Čerenec	Holeška	61.0	1.680	0.920
Čierny Vah	Čierny Vah	256.1	4.70	-
Drahovce	Vah	10 093.0	12.2	-
Dubník I	Kostolník	26.8	0.657	0.201
Dubník II	Kostolník	26.1	1.110	0.283
Hričov	Vah	7 145.8	8.46	-
Kráľová	Vah	10 400.4	51.9	-
Krpeľany	Vah	4 320.0	8.30	-
Liptovská Mara	Vah	1 266.5	360.0	20.5
Nitrianske Rudno	Nitrica	135.0	3.730	0.450
Nosice	Vah	7 896.0	36.0	-
Nová Bystrica	Bystrica	59.3	35.0	-
Orava	Orava	1 181.7	345.9	14.5
Selice	Vah	10 620.1	12.7	-
Trenčianske Teplice	Teplička	38.0	0.355	0.085
Turček	Turček	29.9	10.4	0.5
Tvrdošín	Orava	1 198.0	4.7	0.3
Veľké Uherce	Drahožica	26.5	1.100	0.185
Žilina	Vah	5 724.6	18.9	-

Economic activities in the Orava River and the Kysuca River basins are concentrated close to the riverbanks. The river training was realized discontinuously for the purpose to provide the flood protection of the towns and villages, industrial complexes, railways and roads. The towns and villages along the main river channels are protected sufficiently, but the settlements on the banks of their tributaries have not satisfactory protection. Scattered residential settlement complicates the flood protection in the Kysuca River basin, because there is not enough space for the construction of the effective flood protection structures. The creation of effective retention volumes including polders is almost impossible. The similar level of the flood protection and also conditions for its improvement are in the river basins of the Turiec, Rajčianka and Varínka Rivers either.

The river trainings have not been optimal from the viewpoint of the present concepts of the flood protection in the Nitra River basin, because of dyke constructions placed out the widespread natural floodplains. Alignment of the lower stretches of the Nitra River and Žitava River had been important for the flood protection. Flood peaks are redirected into the Vah River or the Nitra River respectively. The main Nitra River channel is trained from its mouth upstream to the town Topoľčany and the dykes are constructed along the river channel in the towns and villages. The other rivers (rivers Žitava, Dlhý kanál, Bebrava, Nitrica, etc.) are trained as well and the protection dykes are partially constructed there. The flood protection in the lowland in the canal Dlhý kanál watershed ensured the reconstruction of the adjacent drainage system. But the flood protection is not satisfactory in the villages in the upper parts of the river basin, where the natural channels have not adequate discharge capacity for the maximum floods.

The biggest tributary of the Vah River in the Czech Republic is the Vlára River, which originates in the Vizovické hills at the altitude of 650 m above sea level and through the Vlárský mountain pass flows to Slovakia, where it joins the Vah River. The Vlára River basin area is 342.87 km^2, the average discharge at the Czech-Slovak border is 3,06 $m^3.s^{-1}$, the length 30,7 km, the annual sum of precipitation is 829 mm.

The various branches of the industry are located in the **Hron River basin**. There are industrial branches like the metallurgy, woodworking industry, machinery, pharmaceutical industry, textile industry and some others. The agriculture is more developed in the southern regions of the watershed, because there are more favourable natural conditions comparing with the upper and northern regions.

The total length of the water management important watercourses in the Hron River basin is 2 744.76 km, from which 247.18 km are trained. It follows, that the natural character of the watercourses predominates in the river basin. The local river trainings have been realised in the period from 1922 to 1938 and then after the end of the 2nd World War till 1951. Their objective was the local flood protection of the towns, villages and the agricultural land as well. The majority of those river training works have been devastated by the floods. The watercourses obtained the natural character and the river training is not practically recognizable in the terrain at present. The subsequent river trainings have been realised in the most important water stretches after the large floods in the middle of the 70ties during the next decade, in the 80ties. The systematic water training was realized in stretches from mouth of the river to the Danube River to the village Biňa (Biňa is situated approximately in the middle of the river stretch from the mouth to the town Želiezovce), in the towns Žiar nad Hronom and Brezno and in the stretch between the towns Zvolen – Banská Bystrica. In spite of that a lot of family houses are located in the floodplains that are permanently endangered, along the smaller rivers and creeks especially. Another reason for the flood risk is the

sedimentation in the channels of the smaller rivers and the decrease of their flow capacity in the lowland stretches above all.

The hydro-morphological evolution of the lower stretch of the Hron River is negatively affected by the realized river training works. The degradation of the river channel bottom caused the significant change of the longitudinal profile. This process resulted in the depression of the ground water level in the alluvium along the riverbanks. The list of important reservoirs in the Hron river basin is given in the Table 2.2.

Table 2.2. **Important water reservoirs in the Hron River basin**

Name	River	Catchment area	Volume	
			Total	Retention
		[km^2]	[$10^6 \cdot m^3$]	[$10^6 \cdot m^3$]
Hriňová	Slatina	71	8.2	-
Môťová	Slatina	431	3.58	0.73
Veľké Kozmálovce	Hron	4 021.7	24.5	1.24

The flooding can be also caused with the backwater effect from rivers through the sewage systems in some towns and villages during the flood events. The deforested areas negatively influenced runoff conditions in the upper parts of the Hron River basin and also in the lower part of the Slatina River basin.

The watershed of the **Ipeľ/Ipoly River** (hereinafter Ipel River) is surrounded from west and north by the Štiavnické Vrchy Mountains and the Slovenské Rudohorie Mountains while from east and south by the Karancs, Cserhát and Börzsöny Mountains. About 100 km long stretch of Ipel River forms the boundary between Slovakia and Hungary. From the point of view of water quantity the major tributaries arrive from Slovakia.

The clime of the region is cool. The summers are moderate (the mean July temperature is 20-21 °C), the winter is grim (below -2 – -3 °C). The yearly maximum temperature is 32-33 °C and the minimum is -17 – 18 °C. The precipitation due to the strong orographic effects is varied the mountains get more precipitation than the plains.

The industrial production in the Slovakian part of the Ipel River basin is oriented on the agricultural production, building material industry, textile industry and mining. The important springs of mineral water in the villages Santovka and Dudince are widely well-known. The agricultural production in the southern parts of the river basin has suitable conditions. It is oriented on cultivation of barley, wheat, sugar beet, maize and vegetables. Important is fruits cultivation and also the winegrowing on the southern slopes of the hollow Ipelská kotlina and in the tableland Krupinská planina.

The Ipel River is the largest left bank tributary of the Hungarian Danube stretch. Out ot the 5 108 km^2 area of the watershed 1 430 km^2 (about 1/3 of the watershed) belongs to Hungary. The Hungarian tributaries are the Dobroda, Ménes, Szentlélek, Lókos, Csitári and Derék Creeks and the Fekete (Black) Stream. The watershed of these tributaries is in the hills and their flow regime is very flashy. The travel time of the flood waves range from a couple of hours to 1-2 days. The floodplain of these tributaries is not protected except the vicinity of their mouth.

The necessity of river training and the construction of a flood protection system has already been considered in the mid XIX^{th} century. Many feasibility studies have been prepared but only minor interventions were made at the end of the XIXth century. Between the First and the Second World War again minor projects were carried out (and not all of them were actually finalized).

The river trainings were limited to the upper and middle stretch of the Ipel River and to the some stretches of its tributaries before 1966. These regulations had the local importance only and they included also the construction of the dykes in some cases. The complex river trainings aimed at the flood protection of the settled and agricultural areas begun after 1966. Relatively large part of the Ipel River basin was satisfactorily protected in the end of the 70ties. The systematic river channel regulation continued in the upper and also in the lower stretch of the Ipel River, following the former agreement between Slovakia and Hungary.

The updating of the design hydrological data showed that the most of the river trainings have not adequate flow capacity in the majority of the towns and villages in Slovakia at present. According to the hydrological data that are valid at present, along the main Ipel River the stretch from the village Balog nad Ipľom to the mouth of river in the Danube River is sufficiently protected. The discharge capacity in the other stretches of the Ipel River is lower than the values of the updated design flood peaks, in the stretches situated in the intravilans of the towns and villages especially. The deforestation and also unsuitable agricultural technologies have negative influence on the runoff conditions in several mountainous parts of the river basin.

The left bank of the Ipel River in Hungary is managed by the Central Danube Valley Environmental and Water Management Directorate. The river training of the Ipoly is based on a feasibility study prepared in 1962 and supported by a survey of 1970's. The river training plans for the Ipoly between Szob and Ipolytarnóc was prepared in 1975 as a result of a joint efforts of the two countries. The basic principles of the river training were approved in 1978. The actual river training works were carried out from the '70s until the turn of the century. As a first step the regulation of the main bed (shortening by cutting through bends) was done. The design discharge for the main bed was set to the discharge of one year return period, while for the protection of settlements and the valuable agricultural lands the 1:100 year flood was agreed. The freeboard within the settlements was set to 1 m and outside of them 0,5 m. As a second step 8 barrages were built to maintain the ground water levels during the dry periods and to provide irrigation water for the agriculture.

The "02.09 flood protection section" between Ipolydamásd-Letkés-Ipolytölgyes provides protection for three separate flood basins. It includes levees along the Ipoly River and levees along the lower stretches of the Letkés, Nyerges and Ganád Creeks. Further it also provides protection for the inner part of Ipolydamásd

With these interventions the river training (flood protection) works of the Ipel River is considered finished by both countries.

The map of the Vah, Hron and Ipel rivers basins topography is included as Appendix 1.

2.1.2 Conditions of flood forecasting and warning

The Slovak Hydrometeorological Institute is responsible for providing operational information on the hydrological situation on the territory of Slovakia. The network consists of 80 hydrological forecasting stations. The hydrological information contains the following parameters: water stages, discharges, water temperatures, the appearance of ice effects and the relation of current water stages / discharges to their long-term means. Apart from these instantaneous values, the Department provides set of various types of forecasts – numerical forecasts for selected stations, trends in water stages, information on snow conditions (snow depth, water equivalent of snow cover, information on the water supply in the snow for selected profiles utilized for reservoirs operation).

***Table 2.3*. Numbers of water gauging stations in the Vah, Hron and Ipel river basins in Slovakia**

Sub-basin	Number of stations	among them: number of telemetric stations
Vah	141	90
Hron	50	30
Ipel	26	20

The following input data for hydrological forecasting in Slovakia are used:

- Hydrological information (*water stages, forecasts*)
- Total precipitation in a basin or set of basins
- Meteorological information – air temperature, vertical gradient of air temperature for next 24 hours and next 2 or 3 days
- Output from NWP (Numerical Weather Programme) model ALADIN
- Radar measurements of rainfall intensity, accumulated rainfall for 1, 3, 6 and 24 hours, rainfall amounts for some predefined basins within the range of a radar
- Satellite images for visual usage (state and development of the meteorological situation)

Czech Hydrometeorological Institute (CHMI) is responsible for both meteorological and hydrological forecasting and warning in the Czech Republic. Central Forecasting Office (CFO) and six Regional Forecasting Offices (RFO) have meteorological and hydrological offices cooperating closely together.

The hydrological service of the CHMI monitors the actual situation on the rivers in the Vlára river basin by 2 gauging stations which are providing regular information, but the data are without transmission. The gauging station Horné Srnie on the Slovak part of the Vlára River provides on line data.

2.1.3 Recent awareness of flooding

The catastrophic historical flood, which heavily affected whole basin of the Vah River occurred in 1813. It resulted in many casualties, as well as huge damages in the Vah River valley. Return period of this flood is estimated to 500-1000 years. Other significant large floods, which affected whole Vah River basin in the second half of the XXth century, occurred in 1958, 1960, 1970 and 1997. The largest and registered flood on the Vlára River (CZ) occurred in 1919 (Q > 100 y ARI). Floods historically comparable with the 1919 flood on the Vlára River did not occur from that time.

Large historical floods in the Hron River basin occurred in 1813, 1853 and 1899. Catastrophic flood in October 1974 caused extensive damages in the whole river basin. Its return period in the upper and middle parts of the river basin was estimated to 500-1000 years. The same flood affected also the Ipel River basin. Other significant flood (peak discharges around Q_{100} in some stretches) occurred in both river basins in 1976. Experiences from these two floods were utilized in the design of flood protection measures.

Table 2.4.: Summary of significant floods in the basins of the Vah, Hron and Ipel rivers (period 1997-2008) in the Slovak Republic

Period	Affected territory	Flood characteristics and consequences
July 1997	Vah River basin	flood caused with regional heavy rainfall which affected large territory, evacuation of the inhabitants from the town of Piestany, breach

		of flood protection dyke prevented
June 1999	Vah sub-basins (Rajcianka, Ciernanka, Varinka)	flash floods
June 1999	Ipel River basins	repeated floods caused with intensive long-lasting rainfalls, heavilly affected town of Sahy
July 1999	Hron River basin – upper and middle parts	local flash floods caused with intensive rainfalls
July 1999	Ipel River basin, Krupinica tributary	extreme flash flood, town of Krupina affected with flood above the value of Q_{1000}
February and April 2000	Ipel River basin, Ipel tributaries (Krupinica, Stiavnica, Olvar, Litava)	floods caused with intensive rainfalls, town of Sahy partially flooded
July 2001	Kysuca River in the Vah River basin	flood caused with intensive rainfalls
January 2002	Vah and Hron River basins	floods caused with ice jams
July and August 2002	Vah and Hron River basins, several small tributaries	flash floods
January 2003	Vah and Hron River basins	floods caused with snowmelt after sudden raise of temperature in combination with rainfall and ice jams
May 2003	Vah River basin, Dubrava sub-basin	flash floods
February 2004	Hron and Ipel River basins	floods caused with ice jams
March 2004	Vah River basin, Nitra sub-basin	floods caused with the combination of snowmelt and rainfall
June 2004	middle part of the Vah River basin	flash floods
March 2005	Vah, Hron and Ipel River basins	floods caused with melting of enormous supply of snow in combination with rainfall, positive effect of water retention in the reservoirs
April 2005	Hron and Ipel River basins	floods caused with intensive rainfalls
May 2005	Vah River basin, north-western part	flash floods
August 2005	Vah River basin, Biela Voda tributary	flash flood
December 2005	Vah and Ipel River basins, Nitra nad Bebrava tributaries	floods caused with intensive rainfalls
January 2006	Vah, Hron and Ipel River basins	floods caused with snowmelt after sudden raise of temperature in combination with rainfall and ice jams
March 2006	Vah and Hron River basins	floods caused with the combination of snowmelt and rainfall
June 2006	Vah River basin, Nitra sub-basin	flash floods

2.1.4 Institutional and legal framework

The framework for coordination of the land use and spatial planning with flood protection generates from the Water Act in **the Slovak Republic** (Act Nr. 364/2004). This Act defines the notion of the floodplains and principles of their determination and approval. The area of floodplain is suggested by the administrator of watercourse and proposal is submitted to the competent water law state authority. The state authority makes the decision about the proposal of the floodplain area and afterwards the map of floodplain to the territorially relevant building bureau. The Flood Protection Act (Act Nr. 666/2004) contains the rules for permitted activities in the floodplains. The Flood Protection Act and connected bylaws will be amended (2009) in order to achieve accordance with the Direction 2007/60/EC. Regulations for activities in the floodplains are stricter in the ongoing proposal of the amended law.

The Water Act and the Flood Protection Act create a legal framework for regulation of activities in the territories that are endangered by floods only. Neither from them has power to order the modification of the land use or change of spatial plans.

Basic legislation for the flood protection in **the Czech Republic** is water act No. 254/2001 Coll. which for example specified in more details the characteristics and delimitation of the flooding areas, appointed responsibility of the both legal entities and natural persons and government in the field of flood prevention and defined organization for flood protection. Amendment of the Act No. 20/2004 Coll. brought the change of the structure of the flood protection authorities – changed the flood committees of the river basins into the regional flood protection committees.

Assuring rescue or prevention works is still based on the Act No. 238/2000 Coll. concerning Fire Rescue Crops and on the Act No. 239/2000 Coll. concerning Integrated Rescue System. In case of crisis situation, when suggested parameters of flood protection measures are significantly exceeded and flood committees are not able to take necessary measures, management passes on the crisis bodies according to the Act No. 240/2000 Coll., on crisis management. Impacts of the floods are resolved in the Act No. 12/2002 Coll., concerning governmental support during restoration of the areas afflicted by natural or other disaster.

The legal framework **in Hungary** is provided by the LVII. Water Act of 1995 and the 347/2006 (XII. 23.) Decree of the Hungarian Government. The water and flood management of the Ipel watershed is done by the Central Danube Valley Environmental and Water Management Directorate (Budapest). The Directorate reports to the Central Water and Environment Directorate (Budapest) while the overall control is in the hand of the Ministry of Environment and Water (Budapest).

The law enforcement is done by the Central Danube Valley Environmental, Nature Protection and Water management Inspectorate (Budapest) and the second order authority is the National Inspectorate for Environment, Nature and Water (Budapest).

The Ipel watershed largely overlaps with the Duna-Ipoly National Park. The national Park is managed by the Duna-Ipoly National Park Directorate (Budapest).

In general, as the new directive **No 2007/60/EEC** on the assessment and management of flood risks was adopted, all the activities in the area of the flood protection in the whole territory of Vah, Hron and Ipel River Basins are focused on its implementation.

2.2 Review and assessment of the predictable long term developments

Long term developments in flood protection follow European Directives (Water Framework Directive and Floods Directive) that are currently implemented, as well as the

National Strategies or Plans of flood protection. Important part of implementation will be River Basin Management Plans and Flood Risk Management Plans that will set the targets and give the frame for all prevention activities and measures in water management and especially in flood protection. In planning of long term developments we have to consider also climate change.

The United Nations Framework Convention Climate Change (UNFCCC) was adopted and opened for signature at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The Czech Republic ratified the treaty in 1993. The principal update is the Kyoto Protocol, which was signed by the Czech Republic 23.11.1998 and ratified 15.11.2001.The Slovak Republic ratified UNFCCC in 1994.

The first preliminary scenarios of the climate change were elaborated in **Slovakia** in 1993. Totally nine General circulation models from four world climate centres have been utilized in Slovakia up to 2005. The most important are models CCCM 2000 and GISS 1998. The method of statistical downscaling is used in regional modification of the GCMs outputs. Climate scenarios are provided with regard to annual development of individual climate elements for certain time horizons. Climate change scenarios are developed for several elements, such as air temperature, atmospheric precipitation, global solar radiation, and air humidity. While temperature scenarios might be used for whole Slovakia, precipitation scenarios vary at individual stations by more than 10 %. Higher increase in precipitation is expected in the northern part in winter, while higher decrease in summer in the southern part of the territory of Slovakia. The assessment of climate change impacts on the hydrological cycle is carried out based upon mathematical modelling of potential changes of the hydrological regime. The changes of the hydrological regime were assessed based upon hydrological balance models. A spatial model using GIS methods was developed to construct anticipated changes of long time average runoff. The relationship between average annual runoff, average annual precipitation and air temperature was assessed and the maps of changes in a long-time average precipitation were developed.

Results of studies of climate change impacts on water resources in basins of the **Czech Republic** support water management planning at different levels, which include central planning carried out by Ministry of Agriculture, planning at regional level and water management activities of individual water users. Climate change impact on water resources was studied in monthly time step also for Czech parts of Danube River basins. The study was performed for four alternative climate change scenarios that were derived from two types of climate models and two types of emission scenarios.

The results of the study showed that the climate change would be mainly reflected in a decrease in mean annual runoff, which applies to all of the basins except for several basins in southern Moravia and simulations of there hydrological conditions.

For most of the months the runoff also decreases, except for winter period from December to February when outflows increase or only moderately decrease. This is caused by higher winter temperature (monthly temperature below zero is predicted only for December), which is reflected in an increase in runoff and a decrease in snow storage. Consequently, spring and summer outflows decrease significantly in some basins, even to their current minimum values.

The results of the Model simulation also indicate that groundwater storage and base flow could be also highly reduced by the impacts of climate change.

The results of these studies show that mean annual runoff and monthly runoff in spring, summer and autumn can significantly decrease consequently to climate change. These impacts can be reflected in a risk of insufficiency of the existing retention capacities in water resources for meeting the water supply requirements in future.

In addition to that, the regions on both sides of the **Ipel** River have decided to reconstruct 8 bridges. The presidents of Slovakia and Hungary have already agreed on the reconstruction in the regions of Szécsény-Puszta and Ráróspuszta. Further design of the other bridges has already been launched.

3. TARGET SETTINGS

Floods are one of the most serious natural disasters exposing to threat both the lives of the inhabitants and their property. The anticipated climate change may result in an increased occurrence of flood discharges. Basic approach to deal with flood protection must be based on respect to the natural character of these extreme phenomena and on the need to mitigate their impact. It is appropriate to prefer such targets and measures that are of multipurpose features and help to increase the retention capacity of landscape and to stabilize landscape water regime. The appropriate flood protection should respect the following knowledge:

- floods are a natural phenomenon which cannot be prevented
- irregular occurrence of floods results in underestimation of flood hazard
- areas with flood occurrence do not depend on administration borders
- floods are a part of natural processes and for river ecosystems are important factor of their natural development
- changes in land use in the river basin and in floodplain areas affect the rainfall – runoff conditions and bring the risk of runoff acceleration and increase
- expected climate changes may increase the frequency of occurrence as well as the intensity of extreme floods

The measures for mitigation of adverse impacts of floods for human life and health, the environment, economic activities, cultural and historical heritage result from the sources of menace and conditions in the given endangered localities. It is impossible to find universal solutions and measures valid everywhere, because they have to respect at least:

- Sources and courses of floods;
- Nature of runoff conditions in the individual watersheds;
- Natural conditions in endangered territories;
- Charges of the flood protection measures and their comparison to the value of protected properties.

3.1 Regulation of land use and spatial planning

Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants, animals and also on the rainfall-runoff conditions in the river basin. There are many theoretical recommendations for coordination of the land use with the flood protection. Their practical realization is always difficult task.

The forests are not only important components of nature and environment, but they are also valuable in the protection against floods. Generally, the water capacity of forests is always higher than that of deforested soil in the same natural conditions and in the same time. The deforested soil water capacity represents only 50 – 60 % of the forest water capacity. The detention water capacity of forests ranges from 22 mm to 68 mm of precipitation, and 45 mm in average. It is evident, that the forest can not retain runoff in the case of the extreme rainfall occurrence. Suitable forest management can reduce surface runoff and also to prolong time of the concentration. The training of mountain creeks can partially contribute to the flood waves routing.

The experience shows that floods are milder in the ecologically stable lands. Conservation of ecologically stable land, their biological diversity and environmental protection represent indirect measures of the flood protection, too. The erosion causes damages in agriculture, forest management and in water management as well. The soil conservation is topic of many measures, but results are still insufficient. Sediments as a product of erosion reduce discharge capacity of channels and increase flood risks.

The growth of urban areas into rural or natural land is bringing a lot of problems in the flood protection. Impervious surface causes intensive concentrated surface runoff during every precipitation event. The flood waves influenced by urban areas are faster with higher peak discharges, comparing with the past. The protection measures should be realized in sewage systems as well, where detention reservoirs represent important elements in the urban flood protection.

Targets in this area were specified as follows:

The Slovak Republic (SK)

- Target 1: Landscape development plans and spatial plans contain and respect flood hazard maps and flood risk maps.
- Target 2: Limitations related to land use in flood prone areas are defined.

The Czech Republic (CZ)

- to complete the designation of inundation areas along major watercourses with regard to built-up areas, in areas suitable for building on according to the general land use planning documentation or also in other areas for the purpose of determining the size of potential flood hazard areas
- to delimit in land use plans areas exposed to flood hazard risk, including the regulatory provisions, using the prepared flood hazard and flood risk maps as mandatory basis which is planned to be implemented into legislation at least for defined areas with significant flood risk (follows Flood Directive)
- to reduce the existing housing and production functions of areas in the active zones of inundation areas and to explore rehabilitation of buildings and structures destroyed by flood with the exception of the necessary transport and technical infrastructure which is already amended by Water Act but applied with difficulty
- to allow to convert the use of farmland in inundation areas important for retention of flood runoff to permanent grassland at least. The restoration of river flood plains furthered by complex landuse changes would be the best but the most difficult solution due to land laws.

Hungary (HU)

- 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

3.2 Reactivation of former, or creation of new, retention and detention capacities

The violation of the nature ability to detain water storage in the watershed is always clearly manifested by the increase of water discharge fluctuations in watercourses in comparison to previous long-lasting seasons. Reasons for the change of water discharge fluctuations can be very different in every watershed and they are in the nature influenced by many various elements. In spite this; it is possible to define general targets for flood action programme:

SK

- Target 1: Water in every sub-basin is detained as long as possible - realization of non-structural measures within whole sub-basins in the forested and agricultural lands either.
- Target 2: Provision of suitable tools for the retention of the water - water management reservoirs and polders.
- Target 3: Provision of adequate space for flood waves routing in settled areas especially.

CZ

- to prepare measures in the landscape implemented in a nature friendly manner, like natural overflows, polders, watercourse channel improvements in built-up areas of municipalities
- to optimize landscape hydrological regime by improving the retention capacity of landscape and by reducing the occurrence and the impacts of flood situation through implementation of measures favourable to nature conservation and landscape protection by rehabilitating the natural hydrological regime of landscape and by water erosion protection (especially revitalizing inappropriately regulated watercourse channels, inappropriate drainage and other interventions having adverse impacts on landscape water regime, reducing the occurrence of adverse water erosion impact and decreasing the adverse impacts of surface runoff using infiltration zones and seeping depressed areas, renewal of flood storage)
- to prepare detention along rivers and their tributaries, creation of new polders, dry flood reservoirs or multipurpose reservoirs with flood retention capacity
- relocation of flood embankments to make more space to rivers

HU

- Target 1: Reactivation of former retention capacities
- Target 2: Maintenance of existing retention capacities

3.3 Structural Flood Defences

Structural (technical) flood defence measures belong to most important measures in flood protection. Technical measures can be prepared according to actual needs in flood protection and usually are used in built-up settlement areas. New technical flood defence measures should be conceptually planned in catchment areas and must not deteriorate hydrological situation downstream.

Proposed targets are following:

SK

- Target 1: Maintenance of existing retention volumes (removal of sediments) in reservoirs and polders.
- Target 2: Design and construction of reservoirs with flood retention volume and polders.
- Target 3: River training works in urban areas and rural municipalities.
- Target 4: Reconstruction of the trained stretches in the towns and villages in order to achieve sufficient discharge capacity.
- Target 5: Removal of obstacles in the channels, like bridges of insufficient flow capacity, improperly designed culverts and other barriers.
- Target 6: Realization of ordinary maintenance in trained river stretches.
- Target 7: Design and construction of measures to decrease erosion and to increase water retention in the river basins (trenches, ditches, canals, etc.)
- Target 8: Torrents regulation in the mountainous areas.

CZ

- to prepare technical flood protection measures with retention (creating new flood storage capacity on watercourses, refurbishment and improvements of water reservoir structures with retention effect to increase the level of area protection, construction and refurbishment of building and structures in inundation areas)
- to prepare technical flood protection measures along watercourses to increase watercourse discharge capacity (the channel and the surroundings in its close proximity) in urban areas including its stabilization, to build and refurbish flood banks designed for local protection of the relevant area, to construct relieving channels and tunnels and to increase flow capacity of weirs
- to improve the safety of hydraulic structures (refurbishment of outlet structures and emergency spillways and increase of their capacity, refurbishment of weirs)
- torrent control in forests

HU

- Target 1: Improvement of present flood protection structures to meet the existing safety standards
- Target 2: Removing bottlenecks

3.4 Non-structural measures (preventive actions, capacity building of professionals, raising awareness and preparedness of general public)

Non-structural measures (preventive actions …) are very important in the whole flood protection system and the most effective form of protection. Effective preventive measures must be implemented in a systemic manner in hydrological catchment areas and with regard to interconnection of the impacts of individual measures along watercourses. Targets in this field can be specified as follows:

SK

- Target 1: Reduce flood risk
- Target 2: Introduce principles of EU flood directive
- Target 3: Build capacity of professionals and institutions responsible for flood management
- Target 4: Upgrade flood monitoring, forecasting and warning services
- Target 5: Introduce regulations for emergency situations response
- Target 6: Prepare flood risk management plans
- Target 7: Improve awareness of stakeholders on floods
- Target 8. Update/build scientific base for flood management
- Target 9: Improve international cooperation in flood management
- Target 10: Improve information system on floods and flood risk management accessible to public

CZ

- to evaluate and to submit for approval to the competent water authority rules of operation for hydraulic structures significantly affecting flood flow and allowing the respective operation
- to elaborate the studies of rainfall-runoff conditions in watercourses constituting documents to be used for obtaining information for proposals designating new inundation areas, flood hazard maps and flood risks maps as the basis of implementation of regulatory provisions in the land use planning documentation regarding the areas exposed to flood hazard and also for building permit procedure regarding construction in these areas.

- to permanently improve hydrological forecast systems, their reliability and informative capacity and to extend the forecast period. To use to this end area information on precipitation to detail the rainfall-runoff modelling and to improve the quality of operating forecast.
- to create conditions for accelerated allocation of funds for rehabilitation of state owned property fit by floods, for provision of state aid to other entities after floods during the crisis periods declared in compliance with the effective legal regulations and as appropriate also for provision of state aid in the course of rehabilitation of the respective area
- to initiate a process leading to a generally higher standard of elaborated flood plans of municipalities and companies and to ensure operational flexibility allowing to update information in the respective flood plan and its availability for the responsible entities and concerning certain information also for the public
- to lay down the obligations in the process of estimating the value and keeping records of flood damages and their analysis in relation to flood extremity
- in the transboundary level to harmonize warning and forecasting systems, support information exchange, harmonize measures in the river flood plains and flood risk management plans with relevant transboundary effects
- to provide for regular training of flood protection bodies including suitable simulators of potential flood situations
- to support a long-term research and development programme dealing with extreme hydrological floods
- to support an overall involvement of professional institutions in relevant branches in international cooperation aimed at the research and development of the fields affecting improvement of flood protection
- to produce, in connection with operating measures components (flood forecasting and warning service, the integrated rescue system activity etc.) an outline of practical operating rules for flood protection systems – information transfer and management directives transfer
- to ensure the obligation of crisis bodies to proceed in accordance with flood plans and to consult with the competent river basin administrator and riverboard administrator decision making on all measures in the course of floods that may affect rainfall-runoff condition in the river basin in a broader scale
- to add the process of receiving and submitting reports of flood forecasting and warning service also by integrated rescue system operation and information centres.
- to pay systematic attention to the process of informing and educating the public by preparing focused programmes and notifications in writing for mass media as well as by arranging conferences and workshops, focused primarily on popularization of the purpose and the function of management system for flood protection, presentation at fairs
- to inform the public about the causes of floods, the principles of minimizing the damages, the importance and the possibilities of water retention in landscape as well as other flood prevention measures
- to make the map of inundation areas available for the public to obtain information on flood hazard
- to pay attention to installing information boards near major hydraulic structures, revitalization measures and structures designed to increase water retention in landscape with the aim to inform the public on the importance and the purposes of these structures and measures

- to introduce a single system for education and training of the population exposed to flood threat.
- to identify in the flood plain facilities designed for treatment or neutralization of wastewaters and sewerage systems or industrial sites or contaminated sites that pose risks in the case of extreme floods and to prepare the suitable measures to reduce the risks, which are following target of EU Flood Directive.

HU

- 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

4. MEASURES TO ACHIEVE TARGETS

Measures	Type of intervention	Institution in charge	Costs (k€)	Deadline	Comment
4.1 Regulation of land use and spatial planning					
SK					
Target 1: Landscape development plans and spatial plans contain and respect flood hazard maps and flood risk maps.					
Target 2: Limitations related to land use in flood prone areas are defined.					
Transposition of EU Directive 2007/60/EC on the assessment and management of flood risks to the Slovak national Flood Protection Act	Legal	MoE SR		2009	
Implementation of the Slovak national Flood Protection Act (i.e. also EU Directive 2007/60/EC on the assess-ment and management of flood risks)	Admin/Technical	MoE SR, SWME, SHMI, municipalities		continuous	
Introduction of flood maps into spatial plans of regions, districts, municipalities	Administrative	MoE SR, SWME, SHMI,EPDO, municipalities			
Application of Land use limitations introduced in spatial plans	Technical	EPDO, municipalities		continuous	
CZ					
Implementation of EU Flood Directive 2007/60/EC	administrative	Ministry of the Environment		ongoing	Building database and GIS layers with endangering areas sites due to floods
Comprehensive Land Improvement in the Vah river basin in the Czech Republic	Legal	Land Registry Authority	n.a.	2015	
Embankment vegetation improvement in the Vah river basin in the Czech Republic	natural	Forests of CR, Agricultural WaterManagement Authority, Povodi Moravy	n.a.	2015	
Strategy of protection against	administrative	Ministry of the	10 000	in preparation	analyse hydromorphology, hydropedology,

negative impacts of floods and water erosion by natural friendly measures in the Czech Republic		Environment			climate forecast in case of flood, erosion and drought risks in the scale of small catchments, define priority areas prepare conceptual measures
HU					
Target 1: Transposition of the EU Floods Directive into the Hungarian Water Act					
Modify the text of the Water Act to incorporate the aim of the EU Floods Directive	Administrative	VKKI, KvVM		2009	It is under way
Target 2: Preparation of flood risk maps					
Methodological development of flood hazard and risk mapping	Administrative	Consultants		2010	It is under way
Data collection	Administrative	KÖVIZIGs		2011	Projects under preparation
Flood hazard mapping	Administrative	KÖVIZIGs and Consultants		2013	
Flood risk mapping	Administrative	KÖVIZIGs and Consultants		2013	
Target 3: Preparation of flood risk management plans					
Preparation of flood risk management plans	Administrative	KÖVIZIGs		2015	Projects under preparation
4.2 Reactivation of former, or creation of new, retention and detention capacities					
SK					
Target 1: Water in every sub-basin is detained as long as possible - realization of non-structural measures within whole sub-basins in the forested and agricultural lands either.					
Target 2: Provision of suitable tools for the retention of the water - water management reservoirs and polders.					
Target 3: Provision of adequate space for flood waves routing in settled areas especially.					
Tighten the rules applied during giving permission for activities within whole sub-basin	Administrative/legal	MoE SR, SWME, EPDO, municipalities		continuous	
Paríž swamps, national natural reserve revitalization project (water regime modification, sustainable development rules, cooperation, education …)	Admin/Technical	SNPA			Project programme “LIFE +”
Design and building of new polders, retention reservoirs	Technical	SWME, SHMI, municipalities			
Reassessment of rivers retention and	Technical	MoE SR,		continuous	

detention capacities		SWME			
Updating and implementation of results of the study "The survey of water courses in towns and villages (SWME)".	Admin/Technical	SWME		continuous	
CZ					
Identifying flood plain - Inundation areas definition in Vah river basin in the Czech Republic	administrative	Forests of CR, Agricultural Water Management Authority, Povodi Moravy	30	2015	
HU					
Target 1: Reactivation of former retention capacities					
NA					No flood retention capacities exist or planned on the Ipel
Target 2: Maintenance of existing retention capacities					
Maintenance of the existing floodplains	Non-structural	KDV KÖVIZIG Municipalities			Maintaining the agricultural production on the floodplains
4.3 Structural flood defences					
SK					
Target 1: Maintenance of existing retention volumes (removal of sediments) in reservoirs and polders.					
Target 2: Design and construction of reservoirs with flood retention volume and polders.					
Target 3: River training works in urban areas and rural municipalities.					
Target 4: Reconstruction of the trained stretches in the towns and villages in order to achieve sufficient discharge capacity.					
Target 5: Removal of obstacles in the channels, like bridges of insufficient flow capacity, improperly designed culverts and other barriers.					
Target 6: Realization of ordinary maintenance in trained river stretches.					
Target 7: Design and construction of measures to decrease erosion and to increase water retention in the river basins (trenches, ditches, canals, etc.)					
Target 8: Torrents regulation in the mountainous areas.					
Regular maintenance of dams, water courses and water structures, e.g.: - recovery of water courses vegetation protection - technical-farming activities at dikes and in river beds - maintenance of natural river beds - removal of obstacles from river beds	Technical	SWME, owners		continuous	

- removal of sediments etc.					
Systematic technical monitoring of key water structures	Technical	SWME, owners		continuous	
Nitra River, Nové Zámky km 7,800 – 11,895 right-side flood protection dike and 6,466-7,795 left-side flood protection dike raising	Technical	SWME, SHMI		2009	the Slovak National Flood Protection Plan
Žitava River, Dolný Oháj - left-side flood protection dike raising	Technical	SWME, SHMI		2010	
Water reservoir Orava – Tvrdošín - reconstruction	Technical	SWME		2009	the Slovak National Flood Protection Plan
Studený creek, Oravský Biely Potok – river bed stabilisation	Technical	SWME		2010	the Slovak National Flood Protection Plan
Nitra River, left-side and right-side flood protection dike, 1st phase	Technical	SWME, SHMI		2010	the Slovak National Flood Protection Plan
Vah River, Šaľa, Water reservoir Kráľová - left-side flood protection dike stabilization	Technical	SWME		2012	the Slovak National Flood Protection Plan
Vah River, Kolárovo – Selice, left-side flood protection dike reconstruction	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Hradský creek, Klátová Nová Ves – polder construction	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Nové Zámky, Čechy - polder construction	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Trnovka creek, Žilina – Trnové - polder construction	Technical	SWME, SHMI		2012	the Slovak National Flood Protection Plan
Hron River, Water structure Veľké Kozmálovce, flood discharges regulation, sedimentation elimination	Technical	SWME		2011	
Dobronivský creek, Dobrá Niva – outflow conditions modification, polder construction	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Jelšovka creek, Ipelský Sokolec – flood protection measures	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Slatina River, Slatina - outflow conditions modification, polder construction	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan

Podlužianka creek, Levice - flood protection measures, II. Phase, km 2,050 - 6,405	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
Ipel River, Kalinovo – river training km 174,854 – 175,325	Technical	SWME, SHMI		2009	the Slovak National Flood Protection Plan
Vyhniansky creek, Bzenica - river training km 1,000 – 3,700	Technical	SWME, SHMI		2012	the Slovak National Flood Protection Plan
Hron River, Banská Bystrica – right-side flood protection dike raising r. km 172,0 – 173,55 Radvaň - Iliaš	Technical	SWME, SHMI		2011	the Slovak National Flood Protection Plan
CZ					
Hrusovka river, Nedasov – river regulation	technical	Forests of CR	123	2010	proposal, depends on funds available
Klanecnice river, Strani – river regulation	technical	Forests of CR	173	2011	proposal, depends on funds available
HU					
Target 1: Improvement of present flood protection structures to meet the existing safety standards					
Strengthening and heightening flood protection dykes to resist the 1:100 year floods	Structural measure	KDV KÖVIZIG		Continuous	Maintenance of existing flood protection dykes and strengthening them in view of the new design discharge
Construction of flood protection dyke at Ipolytarnóc and Ludányhalászi	Structural measure	Municipality		No deadline as yet	Local initiative without too strong support
Target 2: Removing bottlenecks					
NA					
4.4 Non-structural measures (Preventive actions, Capacity building of professionals, Raising awareness and preparedness of general public)					
SK					
Target 1: Reduce flood risk					
Target 2: Introduce principles of EU flood directive					
Target 3: Build capacity of professionals and institutions responsible for flood management					
Target 4: Upgrade flood monitoring, forecasting and warning services					
Target 5: Introduce regulations for emergency situations response					
Target 6: Prepare flood risk management plans					
Target 7: Improve awareness of stakeholders on floods					
Target 8. Update/build scientific base for flood management					
Target 9: Improve international cooperation in flood management					

Target 10: Improve information system on floods and flood risk management accessible to public					
Implementation of the Slovak national Flood Protection Act (i.e. also EU Directive 2007/60/EC on the assess-ment and management of flood risks)	Admin/Technical	MoE SR, SWME, SHMI, EPDO, municipalities		continuous	
Regular updating and implementation of the Slovak National Flood Protection Plan	Administrative	MoE SR, SWME, SHMI		continuous	
Implementation of flood forecasting and early warning system POVAPSYS	Admin/Technical	MoE SR, SHMI		ongoing	
Introduce directive for emergency situations response	Legal	MoI SR + MoE SR,			
Bring into force bilateral agreements	Administrative	MoE SR		continuous	
Improvement and formalizing of international basin wide online flood related meteorological and hydrological data and operative flood defense information exchange	Admin/Technical	MoE SR, SHMI, SWME			
Introduce and carry on the web sites focused on floods and flood risk management	Technical	MoE SR, SHMI, SWME		ongoing	
Support scientific base for flood management	Technical	MoE SR, WRI			
Organize vocational retraining for water professionals of SWME, SHMI, WRI, EPDO and municipalities that participate in flood protection	Technical	MoE SR, WRI			
CZ					
Preventive Actions					
Operative measures in Vah river ba-sin in the Czech Republic (gauging station improvement)	technical	Povodi Moravy	120	2015	
Developing flood hazard and flood	research	Ministry of		2013	according to EU Flood Directive

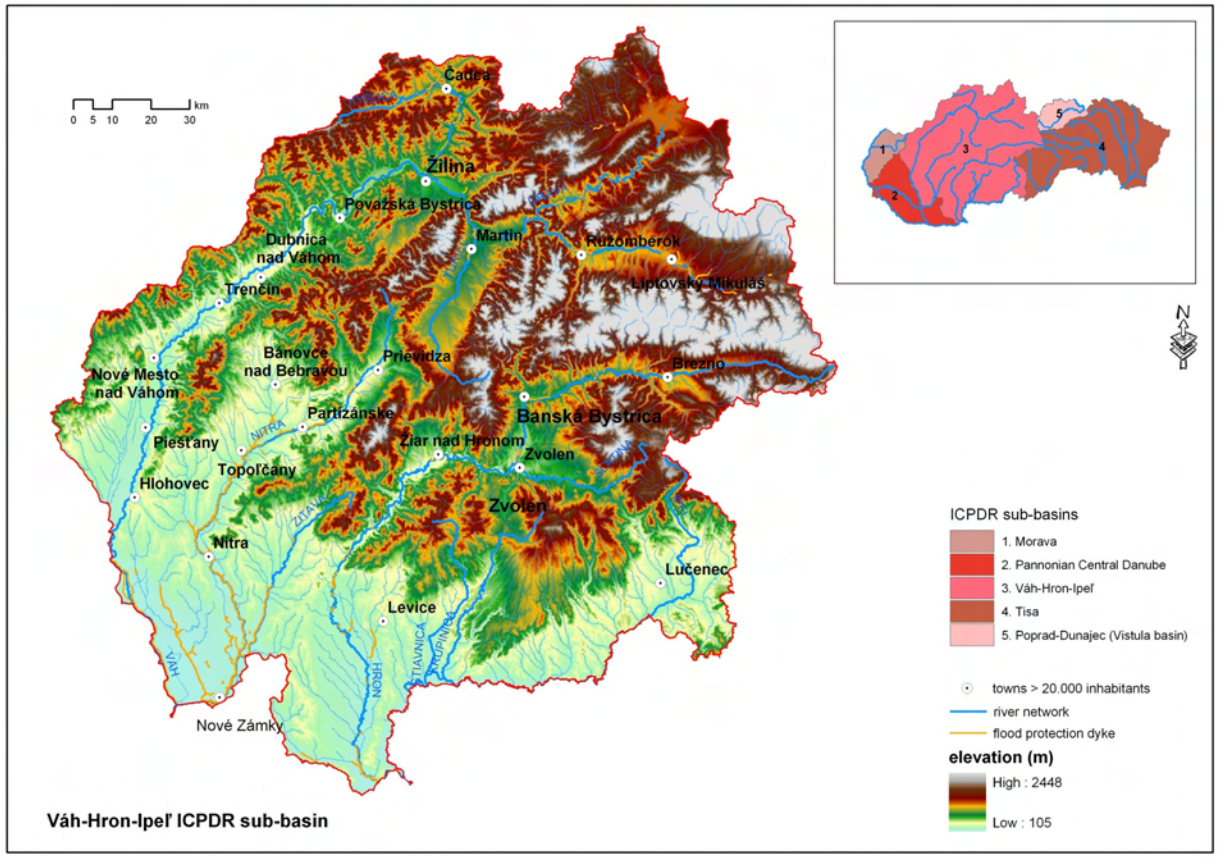
risk maps		Environment, Water Research Institute T.G.M.			
Enhancing of early warning systems, building of new forecast at warning profile, precipitation check stations and technical support of flood committees in Vah river basin in the Czech Republic	technical	Municipalities and regional authorities, river basin authorities		2013	Operational programme Environment cofinanced from EU Structural Funds
Digital flood management plans in Vah river basin in the Czech Republic	administrative	Ministry of Environment, regional Authorities and Municipalities		Ongoing	Czech Republic has digital flood management plan since (www.dppcr.cz)
Flood information system POVIS	administrative	Ministry of Environment		Ongoing since 2006	www.povis.cz includes database of: • flood committies • information of flood events • legislation, methodologies and best practice documents • digital flood management plans
updating of water law in the Czech Republic	administrative	Ministry of Environment and Ministry of Agriculture		2010	Includes transposition of EU directives
Capacity Building of Professionals					
Training of flood committees and state administration in Vah river basin	Information exchange	Ministry of the Environment		ongoing	Workshops on digital flood management plans
Prevention and Mitigation of Water Pollution Due to Floods					
Implementation of EU Water Framework Directive and Priority Substances Directive	administrative	Ministry of the Environment		ongoing	Building database and GIS layers with endangering areas sites due to floods
Building and modernization of waste water systems and plants		municipalities		2013	Separation waste waters of rain waters
HU					
Target 1: Improvement of flood forecasting system					
Incorporate the newest monitoring data available (automatic station,	R&D	KDV KÖVIZIG, VITUKI		Continuous	Deployment of automatic hydrometeorological stations

ECMWWF etc.) and improve the algorithm					
Target 2: Improvement of flood warning system					
Intensive use of EFAS	R&D	VITUKI		Continuous	Incorporate, test and use the outputs of EFAS into the daily forecasting models
Target 3: Capacity building of professional staff					
Regular, yearly training of professional staff; improve vocational and post-graduate education to bring up new generation of staff	Training	KvVM, VKKI, KDV KÖVIZIG, Universities, High schools		Continuous	
Target 4: Increase PR activity to raise awareness of general public					
Production and distribution of leaflets and other PR materials; paid programmes on broadcasting stations	PR	KvVM, VKKI, KDV KÖVIZIG		Continuous	

Remark: The measures defined in the section "4.3 Structural flood defences" in the case of the Slovak Republic can be completed or replaced in respect to flood protection priorities change in country (e.g. after big floods) and can be realized within economic limits of SWME.

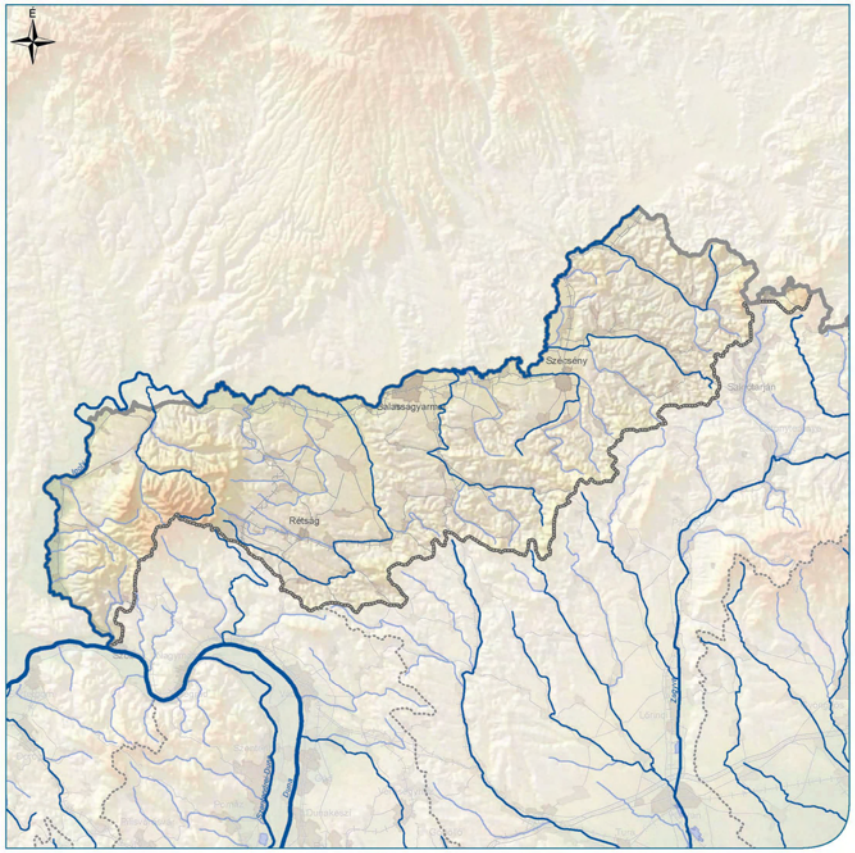
Acronyms:	
SK	
MoE SR	The Ministry of Environment of the Slovak Republic
MoI SR	The Ministry of Interior of the Slovak Republic
SWME	The Slovak Water Management Enterprise, state owned enterprise Žilina
SHMI	The Slovak Hydro Meteorological Institute
EPDO	The Environment Protection District Offices
municipalities	Municipalities
owners	Owners of water structures, water courses
WRI	The Water Research Institute
SNPA	State nature protection agency Banská Bystrica
CZ	
CHMI	The Czech Hydrometeorological Institute
HU	
KvVM	Ministry of Environment and Water
VKKI	Central Directorate for Water and Environment
KDV KÖVIZIG	Central Danube Valley Environmental and Water Management Directorate
VITUKI	VITUKI Environmental and Water management Research Institute Non.profit Ltd.

5. APPENDICES



Appendix 1a: Topography of the Slovak part of the international basin of Vah, Hron and Ipel Rivers

Appendix 1b: Topography of the part of Vah River basin in the Czech Republic



Appendix 1c: Topography of the part of Ipel River basin in Hungary