Preliminary Flood Risk Assessment in the Danube River Basin

Summary Report on implementation of Articles 4, 5 and 13(1) of the European Floods Directive in the Danube River Basin District

Document number: IC 166
Version: Final
Date: 20.03.2012

Imprint

Published by:
ICPDR – International Commission for the Protection of the Danube River

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1 Introduction

Directive 2007/60/EC on the assessment and management of flood risks (European Floods Directive, EFD) entered into force on 26 November 2007. This Directive now requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent, assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. This Directive also reinforces the rights of the public to access the information on flood risks and on related measures and to influence the planning process.

Member States shall coordinate their flood risk management practices with all countries sharing an international river basin, including non-Member States, and shall in solidarity not undertake measures that would increase the flood risk in neighboring countries. In addressing the Directive 2007/60/EC the Member States shall take into consideration long term developments, including climate change and sustainable land use practices.

According to EFD the Member States shall, for each river basin district, or unit of management referred to in EFD Article 3(2)(b), or the portion of an international river basin district lying within their territory, undertake a preliminary flood risk assessment (PFRA) in accordance with paragraph 2 of EFD Article 4.

Based on available or readily derivable information, such as records and studies on long term developments, in particular impacts of climate change on the occurrence of floods, a preliminary flood risk assessment shall be undertaken to provide an assessment of potential risks. The assessment shall include at least the following:

a) maps of the river basin district at the appropriate scale including the borders of the river basins, sub-basins and, where existing, coastal areas, showing topography and land use;

b) a description of the floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed;

c) a description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged;

and, depending on the specific needs of Member States, it shall include:

d) an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing manmade flood defense infrastructures, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of floods.

In the case of international river basin districts, or units of management referred to in EFD Article 3(2)(b) which are shared with other Member States, Member States shall ensure that exchange of relevant information takes place between the competent authorities concerned.

On the basis of a preliminary flood risk assessment as referred to in EFD Article 4, Member States shall, for each river basin district, or unit of management referred to in EFD Article 3(2)(b), or portion of an international river basin district lying within their territory, identify those areas for which they conclude that potential significant flood risks exist or might be considered likely to occur (so called Areas of Potential Significant Flood Risk (APSFR)). The identification of areas belonging to an international river basin district, or to a unit of management referred to in EFD Article 3(2)(b) shared with another Member State, shall be coordinated between the Member States concerned.

The PFRA must be completed by 22 December 2011 and made available to the Commission by 22 March 2012. The PFRA will be used by Member States as the basis for identifying areas where potential significant flood risks might exist, or might be considered likely to occur.

According to EFD Article 13 the Member States may decide not to undertake the preliminary flood risk assessment referred to in Article 4 for those river basins, sub-basins or coastal areas where they have either: (a) already undertaken a risk assessment to conclude, before 22 December 2010, that a potential significant flood risk exists or might be considered likely to occur leading to the identification of the area among those referred to in Article 5(1) or (b) decided, before 22 December 2010, to prepare flood hazard maps and flood risk maps and to establish flood risk management plans in accordance with the relevant provisions of EFD.

To address the issue of flood risk management on a basin-wide level the International Commission for the Protection of the Danube River (ICPDR) adopted the Action Programme for Sustainable Flood Prevention in the Danube River Basin at the ICPDR Ministerial Meeting on 13 December 2004.

The key milestone in the implementation of the ICPDR Action Programme was publication of 17 sub-basin flood action plans in 2009. These plans are based on 45 national planning documents and provide the first ever comprehensive overview of actions to reduce flood risk in the Danube Basin. They review the current situation and set targets and respective measures for reducing adverse impacts and the likelihood of floods, increasing awareness and level of preparedness and improving flood forecasting. The targets and measures are based on the regulation of land use and spatial planning; increase of retention and detention capacities; technical flood defenses; preventive actions (e.g. flood forecasting and flood warning systems); capacity building; awareness and preparedness raising and prevention and mitigation of water pollution due to floods.

At the ICPDR Ministerial Meeting in 2010 the Danube Declaration was adopted in which the Danube Ministers reaffirmed conviction that flood prevention and protection are not short term tasks but permanent tasks of highest priority and committed themselves to make all efforts to implement the EU Floods Directive throughout the whole Danube River Basin and to develop one single international Flood Risk Management Plan or a set of flood risk management plans, based upon the ICPDR Action Programme for Sustainable Flood Protection and the sub-basin plans, coordinated at the level of the international river basin district by 2015 making full use of the existing synergies with the DRBM Plan.

This report informs the European Commission, the stakeholders and public on the achievements made in the international Danube River Basin District in response to the provisions of the Articles 4, 5 and 13(1) of EFD.

2 Overall approach and methodology of PFRA

This chapter summarizes the methodologies and criteria used to identify and assess floods that occurred in the past and their past adverse consequences (including whether such consequences would be ‘significant’) and whether the likelihood of such floods remains relevant.

It also addresses the methodologies and criteria used to identify and assess significant floods that occurred in the past that would have significant adverse consequences were they to reoccur in the future and methodologies and criteria used to identify and assess potential future significant floods and their potential adverse consequences.

2.1 Germany

The standard basis for conducting the preliminary assessment in Germany is the recommendation for the “Approach to be used in the preliminary assessment of flood risk under the European Floods Directive” [Vorgehensweise bei der vorläufigen Bewertung des Hochwasserrisikos nach HWRM RL] developed by LAWA (German Working Group of the Federal States on Water Issues – Bund/Länder Arbeitsgemeinschaft Wasser). Following these recommendations, all available information, or relevant information that was easy to obtain, was used to formulate conclusions about potential significant flood risks.

The basis for this consideration was the water body network, which also forms the basis of Directive 2006/60/EC (water bodies with a catchment larger than 10 km^2) and waters which are known to have flooded in the past and which experts consider may also be the source of flood events with significant adverse consequences in future. The Danube and all important tributaries have thus been included.

The preliminary risk assessment based on Art. 2 (2) of the Floods Directive covers the following different types of floods: fluvial floods, pluvial floods, groundwater; artificial infrastructure failure of impoundments and excessive demands imposed on artificial infrastructure sewerage systems.

The existing analyses of the adverse consequences of floods that have occurred in the past show clearly that significant flood risks arise only from regional or supraregional floods with probability of occurrence higher than average (HQ100) in average-to-densely populated areas. These floods are caused by surface waters.

To assess the adverse consequences of future potentially significant floods, an analysis was made of the danger of flooding and the possible adverse impacts in the river basins, and the risk was then deduced by means of GIS methods.

The entire process was managed by water management experts and the results subsequently checked for plausibility. More information is available at:

http://www.lfu.bayern.de/wasser/hw_vorlaeufige_risikobewertung/index.htm

http://www.hochwasser.baden-wuerttemberg.de

2.2 Austria

In Austria the preliminary assessment of flood risk was conducted on the basis of an expanded nationwide river network (catchments larger than 10 km^2 plus additional river catchments smaller than 10 km^2). All available geo-data on flood hazards and risk receptors (population, infrastructure, potential pollutants, WFD protected areas, cultural heritage) were put together in a geo-database. In this geo-database flood risk data from various sources was integrated and attributed to river-stretches of about 0.5 km. The results were classified into five flood risk classes (very high, high, moderate, low or no risk) separately for each risk receptor.

The most important thresholds for "high flood risk" were:

- 100 persons (inhabitants + employees) in flooded areas per 0.5 km river stretch
- destruction or blockage of important infrastructure facilities for several days
- destruction of cultural assets of national importance and
- heavy pollution of protected areas.

In a first step, data on the adverse consequences of past floods were collected, assigned to the river stretches in the geo-database and classified according to the five risk classes. Flood zones (data sources: HORA and more detailed hazard studies) provided the basis to assess the adverse consequences of potential future floods in the geo-database. They were overlaid with data of the risk receptors.

All risk assessments for past and future floods were finally combined to assess the "total risk per river stretch" considering only the highest risk class for each river stretch. Future development of land use was taken into account, in case that reliable data was available.

As a result a total of about 1,840 km - relating to 5.2 % of the total river length that has been assessed - are classified as having high or very high flood risk in the Austrian part of the Danube River Basin. The predominant causes for the assessment of high and very high risks are the residential population and economic activities (employees) in flood prone areas, followed by traffic infrastructure. Due to Austria's alpine topography, land use is particularly located in lowlands and valleys including flood prone areas.

2.3 Czech Republic

In the Czech Republic the EFD was fully transposed in February 2011 by the Act No 150/2010 Coll., the amendment of the Act No. 254/2001 Coll. on Waters and by the Public Notice on RBMPs and FRMPs. Article 13 of the EFD was not applied. The three units of management (the national parts of the Danube, Elbe and Oder river basins) are the same as used for the Water Framework Directive. The competent implementation authorities are the Ministry of Environment and the Ministry of Agriculture. Public communication and information is partly provided by Flood Information System POVIS, www.povis.cz, where public can find all relevant information and documents about implementation of the directive.

The preliminary flood risk assessment has been prepared since 2008 for the whole country area using the same methods based on spatial analyses and available information:

- Reports on the assessments of significant floods;
- Designed floods (5, 20, 100 year return period and 10 000 years for dams);
- Fundamental Base of Geographic Data (map scale 1:10 000);
- Data of the Czech Statistical Institute;
- National Culture Heritage Database;
- IRZ Integrated Register of Pollution, SEVESO (both under IPPC);
- Extent of past floods in 1997, 2002, 2006, 2009.

Due to country location in the upper parts of the international river basins, as well as due to hydrological and geomorphological characteristics, people suffered in the past mainly from fluvial and flash floods caused by long and/or intense precipitation. Other type and sources of floods such as debris flows, snow melt, and landslips were very rare, mostly of a local importance or accompanying fluvial floods.

National criteria for the significant past flood used in the database developed for the purpose of the preliminary flood risk assessment are as follows:

Flood Type	Criteria
Fluvial flood	• flood with a medium probability (Q_{100}) at least; • observed at more than three gauge station profiles; • affected an area of river basin larger than 2,000 km^2 .
Flash flood	• caused three and more casualties or economic loss higher than 250 million CZK.
Dam brake or failure of hydraulic structure	• if primary cause/source is independent of natural flood, the criteria is: three and more casualties; • if occurring due to natural flood, the criteria are: flood with a low probability (Q_{500}) downstream a construction site or failure which caused three or more casualties.
Other type of flooding	• caused economic loss higher than 250 million CZK

It was assessed that potential adverse consequences of future floods will not differ from past experiences. Important developments affecting future floods are not expected in the Morava river basin.

2.4 Slovakia

Act 7/2010 on flood protection is the basic legislative document transposing the Directive 2007/60/ES into the Slovak legislation. Practical implementation of this act is based (along with other decrees) on the Decree of the Ministry of the Environment No. 313/2010 on the preliminary flood risk assessment, its reassessment and updating. PFRA is performed in the whole territory of Slovakia in the respective river basins.

Ministry of Environment of the Slovak Republic (MoE SR) is in charge of PFRA preparation, reassessment and updating via river basin authorities. The task group „Floods“ was formed in order to support implementation of the Directive 2007/60/ES. This task group led by the MoE SR consists of the representatives of river basin authorities, other relevant organizations in the frame of the MoE SR, Slovak Academy of Science and selected universities, self-governing regions, municipalities, other administrators of watercourses and the representatives of private sector.

Determination of the geographic areas with an existing significant flood risk was based on the analysis of the occurrence of floods in the Slovak territory in the period 1997-2010. Only fluvial floods were considered in this analysis. The following criteria were taken into account in the selection of areas and their ranking:

- repeated occurrence of floods in the period 1997-2010;
- vulnerability of a territory expressed by means of a „flood index“ (GIS analysis of hydrological data);
- flood consequences expressed in terms of damages.

In the final determination and ranking of areas with an existing significant flood risk a number of other factors were taken into account such as: sites of cultural heritage, sources of potential water pollution, economic activities or expected number of affected inhabitants. The final assessment was based on the weighting system and risk matrix.

2.5 Hungary

In Hungary the preliminary flood risk assessment has been done based on the readily available information within the Hungarian water management. In Hungary, three flood groups are created for an examination of inundation hazards:

- Floods of river sections protected by dykes (riverine floods);
- Floods of river and stream sections not protected by dykes (flash floods);
- Inland inundations (excess water).

These three cases require a completely different management technology during hazard mapping, and the risk calculation is also different.

Along the rivers in Hungary about 4,200 km of flood protection dykes have been built. Their establishment and protective ability are on different levels, so the hazard of flooding in the areas they protect varies as well. The hazard of inundation in these areas is fundamentally affected (apart from the hydrological load) by the protective ability of the dykes, and the by the defence potential (the human and material resources of the defence organization). In case of river sections, which are not protected by dams, an inundation hazard can be derived virtually directly from the hydrological load. This applies mainly to the flash floods on the small streams in mountainous and hilly areas. Here, due to the typically narrow valleys, 1D hydraulic simulations are usually sufficient. The risk calculation, next to the inundation depth is defined by the water velocity.

Inland inundation can be interpreted as the opposite situation than that of the previous cases, as in this case the inundation of the area does not originate from the river, but directly from rainfall and high groundwater level. Consequently, the simulation of the process is based on the modeling of the soil water balance. The risk calculation is determined mainly by the duration of the inundation. The depth is typically few decimeters, but supersaturation of the soil can cause problems.

2.6 Slovenia

The aim of PFRA in Slovenia was determination of APSFR. The work was done for whole territory of the country. All available / relevant information that was easy to obtain, was used to enable conclusions to be drawn about potential significant flood risks.

The basis for definition of hazard potential was hazard indication map containing data from flood events and flood models: (http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso), upgraded with attributes such as maximum water levels, return period of flood, type of flood, date of commencement and duration (days) of flood, type/degree of adverse consequences, etc.

Identifying the highest registered elevations/discharges from the national data base and using an information on morphology of the river network (based on 1:25,000 scale) and the expert judgment, the additional area of flood hazard was defined. The data were available for fluvial and sea water floods. There were no data with indication of possible significant pluvial and groundwater floods as well as floods from artificial infrastructure sewerage systems. In the assessments the flood defense infrastructure was not considered.

The existing analyses of the adverse consequences of floods that have occurred in the past show, that the sources of adverse consequences are not only the areas near larger rivers.

The future development is not considered as relevant in PFRA, because of the applied prevention measure in “Governmental decree on conditions and limitations for constructions and activities on flood hazard areas”(http://www.uradni-list.si/1/content?id=88381). This decree requires that the future development should take place outside the flood hazard areas. In case of an extension of an existing infrastructure, the measure for reducing the existing flood risk should be applied before the extension works should start.

There is no evidence of an influence of the climate change on the frequency of fluvial floods and the trends of discharge peaks are slightly declining. The trends of average sea level and the frequency of floods increase.
(http://www.arso.gov.si/o%20agenciji/knji%c5%benica/publikacije/Okolje_se%20spreminja.pdf, Okolje se spreminja. Podnebna spremenljivost Slovenije in njen vpliv na vodno okolje, MOP ARSO, 2010).

An analysis of damage potential (human health, environment, cultural heritage, economic activities) was made, and the potential flood risk index was then deduced by means of GIS methods. This resulted in potential flood risk areas classified by the damage risk index.

2.7 Croatia

The obligation of undertaking PFRA in accordance with the EFD is regulated under Article 110 of the Water Act, which includes the following: maps of the river basin districts including the borders of sub-basins and, if needed, coastal areas, showing topography and land use; a description of floods which have occurred in the past; and an assessment of the potential adverse consequences of future floods. When undertaking the PFRA, the methodological approach is adjusted to the available stock of data, and the basis for the assessment of recipient, i.e. assessment of damage, was (i) the data from the CORINE Land Cover of 2006, (ii) the statistics about the population and settlements from the 2001 Census (the data from the 2011 Census still hasn't been processed; upon its publication, the revision of PFRA can be expected), (iii) the sites of major industrial plants and smaller settlements not visible on the Corine Land Cover, (iv) the data base managed by Hrvatske vode, and (v) the available data on the locations of waste disposal sites.

According to EFD Article 2(2), the PFRA in the Danube River Basin District includes four different types of floods: fluvial floods, pluvial floods - erosion and flash floods-torrents and artificial infrastructure failure. Account was also taken of the data on the floods recorded in the past. Data on groundwater floods was not available at the time. The assessment analyzed all the watercourses within the national network of watercourses with a catchment area larger than 10 km^2, and, exceptionally, the watercourses with smaller catchment area, particularly in the part concerning torrents.

For an administrative scope of each individual settlement, preliminary assessment of flood risks was undertaken and they were classified into four main categories of risk:

- High flood risk, for which detailed flood risk maps and flood hazard maps will be prepared, as well as a special system of emergency measures in case of a flood event under the Operative Flood Defence Plan;
- Moderate flood risk, for which detailed flood risk maps and flood hazard maps will be prepared;
- Low risk, for which additional analyses will be made, if needed;
- Insignificant flood risk, for which additional analyses will be made, if needed.

The basic criterion for the classification into the above-mentioned categories was adjusted to the need for the preparation of flood risk management plans under the European Floods Directive, operative flood defence, and different approaches to efficient, environmentally sensitive and financially affordable flood protection.

2.8 Serbia

The provisions of EFD were included in Water Law enacted in May 2010. Art. 47 of the Water Law set the obligation for preparation of PFRA for Serbian territory. PFRA in Serbia was conducted based on a draft methodology, which will be issued as a bylaw till the end of 2011.

PFRA was prepared for the whole territory of Serbia by the responsible Ministry, but with an active participation of all responsible institutions such as public water management companies, hydro-meteorological service and scientific institutes. The PFRA process started in 2009 with the preparation of a questionnaire on floods that occurred after 1965.

PFRA included risk caused by fluvial (river) floods, as well by internal floods resulting from excess atmospheric water and groundwater. Data on past floods were collected from Civil Protection units at the level of municipalities and from water management companies and institutes. Only those floods which caused large scale damage (damage which exceeds 10% of the total income of the municipality) or floods that endangered more than 100 households or 300 inhabitants and/or covered 50 km^2 and/or had important social consequences were identified as being significant. It is assumed that all significant past floods could occur again.

Potentially flooded areas are unprotected areas and areas that may be flooded in case of failure of the existing protection structures or high dams, with adverse consequences on human health, environment, cultural heritage and economic activity. They were assessed by taking into account the topography of the terrain, hydrology, the effectiveness of flood protection system, the position of populated areas and areas of economic activity, forecasts of long-term developments, and impact of climate change.

For the PFRA the following digital data was used:

- GIS map 1:300,000 containing: administrative borders, relief, hydrography, cultural heritage, communications, settlements, hydropower plants, industrial facilities, digital terrain model;
- Corine Land Cover 2000 (EEA);
- GIS map of indicative flood zones, containing the potential flood zones, which are the result of different hydraulic studies and the extent of past floods from post-flood analyses;
- Map of levees and dams;
- Data on the population.

The main problem in PFRA was the lack of digital data on economic activities, potential sources of pollution, and protected areas.

2.9 Bosnia and Herzegovina

At present, both entities in B&H work on PFRA preparation. As the Republic of Srpska is still in the process of data collection, this report covers only the Sava river basin in the Bosnian Federation.

The first step for the preparation of PFRA was the development of the “Methodology of preliminary flood risk assessment for Sava River Basin for watercourses of I category” in 2010. The following information was used for defining potential significant flood risk:

1. Historical flood data were collected from municipalities through a questionnaire in the first phase of the “Methodology of preliminary flood risk assessment for Sava River Basin for watercourses of category I”. Years: 2010, some data for 2009, 2006, 2004, 2002 and 2001 and occasional data for older floods.

2. GIS databases on different land uses (CORINE), maps, flood areas (historical and statistical T = 1/20, 1/100 and 1/500), risk assessment and vulnerability data and all other available relevant information.

3. Strategy for managing flood protection issues in the Sava River Basin and a proposal for activities during high water conditions.
4. Evaluation of the current level of flood protection in the Federation of Bosnia and Herzegovina and designing improvement programs.
5. Main preventive plan for flood defence, 2010.
6. Water management Strategy of the Federation of Bosnia and Herzegovina, 2002.
7. Federal operational flood defence plan, 2010.
8. Preliminary design of flood risk assessment in the Sava River Basin in the Federation of Bosnia and Herzegovina for category I watercourses.

Significant historical floods are those floods that have historically had significant adverse impacts on human health, environment, cultural heritage and / or economic activity, and those which could have significant adverse effects to the same, if repeated.

According to Methodology (see Chapter 5.1.9) an "index" of 100 or higher was obtained by combining (adding up) all adverse impacts in four categories (Human health, Environment, Cultural heritage and Economy). Each category was assigned with a weighing factor.

2.10 Romania

In Romania the EFD was transposed into national legislation in February 2010 by a new Water Law, in its 5th section (Management of flood risk). The authorities responsible for the implementation of the EFD are the Ministry of Environment and Forests (MEF), the Romanian National Water Administration (RNWA) and the National Institute of Hydrology and Water Management. There is a management unit responsible for the EFD implementation in each RNWA branch corresponding to the national river basins.

PFRA started in 2009 preparing new plans for flood defence for municipalities, towns, hydrographic basins and counties, containing GIS maps at 1:25,000 scale showing historic flood extent and potential damages based on past events (2000, 2001, 2004, 2005, 2006, 2008 and 2010). These plans used information from synthesis reports after each significant flood event, geographic data (1:25.000 and 1:100,000 scale), CORINE Landcover, data from National Institute for Statistics, IPPC database etc. In March 2010 the new plans has been approved by the MEF.

Selection of the significant floods has been done by the National Institute of Hydrology and Water Management as follows:

1. Floods in large hydrographic basins using a combination of the following criteria:
    - maximum recorded flow>Q10%;
    - maximum recorded flow > flow corresponding to the inundation level;
    - high-floods recorded at hydrometric stations with a basin area > 500 km^2;
    - high-floods observed especially on main river course and on important tributaries in a large number of hydrometric stations;
    - high-floods produced on main river course tributaries.
2. Flash floods with 1% frequency in small areas where sufficient data exist.
3. High floods caused by natural blocking: thaw, ice etc.
4. High floods produced by artificial blocking at bridges, dams or dikes failure.

More information is provided at www.rowater.ro , www.hidro.ro and www.mmediu.ro .

2.11 Bulgaria

The EFD was fully transposed in the national legislation by the amendment of the Water act in August 2010. The units of management under EFD are the same as used for the WFD implementation – the River Basin Districts. In Bulgaria there are four units of water management – Danube RBD; Black Sea Basin District, East Aegean RBD and West Aegean RBD. The PFRA is to be performed for each of the Basin Districts separately. Responsible organizations are the Basin Directorates. Art. 146a of the Water Act states that PFRA is to be performed in accordance with the common national methodology, issued by the Minister of Environment and Waters. This Methodology was adopted in July 2011. It determines the working steps, sources of information, methods and the criteria for the assessment of the significant past floods and their adverse consequences as well as the negative consequences of potential future floods. According to the provisions of the national law the consequences of floods are to be assessed with respect to the main risk receptors as required by the EFD: human health, economic activities, environment and cultural heritage.

The assessment of the past floods, their significance and the likelihood of their future re-occurrence is based on the information collected from different national sources: the information from local authorities (an inquiry of the municipalities was conducted); historical records; reports of the "Fire Safety and Rescue" Directorate General; reports and analysis's of the National Institute of Meteorology and Hydrology; GIS data and maps of past floods. Analysis and assessment were performed by means of GIS, using the available national GIS data in a scale 1:100,000 covering river network; dams, settlements; infrastructure objects; land use and IPPC facilities. Additionally topographic maps in a scale 1:25,000 and 1:5,000 are used.

The criteria used for the assessment of the significance of floods are: the number of people affected; affected important industrial and infrastructure objects; affected IPPC plants; polluted Natura2000 protected areas and drinking water protected areas. For the assessment of the potential future adverse consequences, additional data from the National Statistical Institute on the alteration of the population and its density and data on the infrastructure development obtained from the Ministry of Agriculture and Food and the Ministry of Economy, Energy and Tourism were used.

2.12 Ukraine

For the preliminary flood risk assessment in Ukraine the data on historical floods, design maximum flood level and design flooded zones were used for floods of 1, 5 and 10% probability. Particularly for the identification of the design flooded zones hydrological characteristics applying the long-term data from the network of stations of the Ukrainian State Hydrometeorological Service and also the digital elevation model and programs MIKE 11 and MIKE 11 GIS were used.

National Complex Flood Protection program in the Tisza River Basin till 2015 foresees creation of an additional retention capacity by construction of 42 dry flood protection reservoirs in the mountainous part of the river basin with the total volume of 289 mil. m^3. The main purpose of this activity is flattening of flood peaks. Also reactivation of former floodplains by construction of 24 polders in the plain part of Tisza river basin with total volume of 257 mil. m^3 and the average depth of polders 1,5 m. The other planned measures are the following: reconstruction and construction of new dikes, river bank enforcement, riverbed training, construction of dams.

2.13 Moldova

The Hydrological Forecasting Division had developed forecasting methods that are periodically updated. The data on historical floods that occurred in the past, on the maximal flood discharge and flooded areas are used for the preliminary assessment of the flood risk in Moldova for of 1, 5 and 10% probability. For the forecasting of the flooded areas the data on the floods that occurred in the past are used.

According to the Resolution of the Republic of Moldova, the “Waters of Moldova” Agency had developed an action plan for mitigation of the flood consequences, improvement of the water management system and flood protection. The action plan has three sections: short term, medium term and long term (for the next decades) actions. The plan also foresees the reconstruction and building of new dams and barrages.

3 Historical floods in the Danube River Basin

This chapter provides information on major flood events that occurred at the scale of the Danube River Basin District focusing primarily on the last decade. It refers to both floods that occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant (EFD art 4.2.(b)) as well as to significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged (EFD art. 4.2(c)).

Through many centuries records of the occurrences of floods have been kept in the Danube countries. The most famous among these is the 1501 flood on the upper Danube, considered to be the largest summer flood of the last millennium, causing extensive devastation down to Vienna, and presumably, its impact was extreme downstream to the Danube Bend at Visegrád. Among the ice jam-induced floods, the one of 1838 has historical significance. It devastated a number of settlements from Esztergom to Vukovar, including the towns Pest, Óbuda and the lower parts of Buda on the territory of today’s Hungarian capital.

During the last century the major flood events occurred in 1902, 1924, 1926, 1940, 1941, 1942, 1944, 1954, 1965, 1970, 1974 and 1991. Last decade brought a series of massive flood events the most significant being those of 2002, 2006 and 2010.

3.1 Floods in 2002

In August 2002 a 100-year flood caused by over a week of continuous heavy rains devastated large parts of the Danube River Basin, killing dozens, dispossessing thousands, and causing damage of billions of Euros. The floods started with heavy rainfall in the Eastern Alps, which resulted in floods in Bavaria and Austria, and then the floods gradually moved eastwards along the Danube.

In Bavaria floods affected the Danube from Regensburg to Passau, and many tributaries including the Inn, Traun, Salzach and Regen. Thanks to flow regulation structures, the negative impacts of the flooding were substantially reduced. The utilization of reservoirs at Dillingen and at Ingolstadt helped to reduce flood peaks considerably. The extent of damage to infrastructure and private properties amounted to 230 million Euro. The Austrian states of Lower and Upper Austria and Salzburg suffered heavily from the floods. More than 10,000 homes were damaged, infrastructure was destroyed, and the total damage exceeded three billion Euros. In the Morava River Basin about 20 communities were affected by floods. Major damage was caused to urban settlements, infrastructure and agriculture. Damages amounted to approx. EUR 11.7 million (7 million for state and municipal property and 4.7 million for private property). In Slovakia the areas mostly affected by flooding included parts of central Slovakia inundated by flash floods and the area around Bratislava impacted by the Danube flood. 144 settlements and 8,678 hectares of land were flooded. Damages amounted to EUR 36.2 million and emergency measures cost some EUR 2.2 million. Several municipalities in Hungary were affected by the flooding of the Danube near Visegrád. About 2,000 people had to be evacuated, and 4,370 homes were damaged. Flash floods in the Suceava region of northern Romania caused 11 casualties, while 1,624 houses were flooded, and more than 1,000 km of roads and 567 bridges were destroyed. Gas, electricity and communication networks were also badly damaged.

3.2 Floods in 2006

In 2006, a serious spring flood occurred in the Danube River Basin, the result of specific meteorological weather conditions. Heavy floods inundated Central and Eastern Europe due to melting snow and heavy rainfall. Swollen rivers and rising groundwater levels caused widespread damage and forced thousands to leave their homes. For the first time in history, high water was recorded on the Danube, Sava, and Tisza at the same time – this rare coincidence caused an extreme flood event in the main Danube (primarily in the Central and Lower Danube reaching a 100-year return period).

3.2.1 The Upper Danube

A sudden temperature rise and heavy rainfall activity at the end of March resulted in a fast snowmelt. While only minor floods of a 2-5 year return period occurred on the main Upper Danube, floods up to a 100-year return period developed on many smaller tributaries in Germany, Austria, Czech Republic and Slovakia which led to an increased Danube flooding downstream. Such runoff events represent a typical spring flood, however, this flood event was significant with regard to its discharge hydrograph and volume. While in the German and Austrian stretches of the Danube River the flood hydrograph had two well-marked peaks, this was not so evident on the Slovak stretch. This was the result of the influence of the Danube's left side tributary, the Morava River, in the Devín profile at the Austrian-Slovak border (river kilometer 1879). The critical flood flow proceeded slowly downstream the Danube with specific time delays from Passau (km 2225) to Sturovo/Esztergom (km 1719) on a stretch of approximately 500 km. Simultaneously, flood waves passed along the Morava, Váh and Hron rivers. On 3 April, a 1,500 m^3/s peak discharge on the Morava flood coincided with a 5-6,000 m^3/s flood peak on the Danube at Devín. A 1,200-1,400 m^3/s flood peak on the Váh entered the Danube one day before the peak of the recipient arrived.

3.2.2 The Central Danube

Meteorological conditions in the Upper Danube area had an important impact on the development of the extreme flood event on the Central Danube, especially in the Budapest region. The meteorological conditions in the Carpathian region were of prime importance for the Tisza River Basin upstream of Szeged. By mid February, water reserves accumulated in snow cover in the Tisza region reached approximately 150% of the multi-annual average for the given period. A significant amount of snow accumulated also in the Maros/Mures valley (where the water reserves recorded exceeded the multi-annual average by 70 %) and in the Körös/Crisul river system (where levels were exceeded by 30 %). The combination if heavy precipitation and the snow melt resulted in an exceptional runoff in the Tisza basin. Moreover, flooding on the Sava River took a long time, beginning in mid March and lasting until mid May. During this time the river flow was always between 3,000 m^3/s and 4,000 m^3/s (a return period of 1-5 years). This way, the rare coincidence of relatively large and prolonged floods on all the main tributaries of the Central Danube Basin resulted in one of the largest floods recorded in the lower Danube stretch.

3.2.3 The Lower Danube

A relatively long period of precipitation was recorded between mid March and the end of April in the Carpathian mountain area. As a result, a high discharge from all the major tributaries in the region (such as the Timis, Jiu, Arges, Ialomitsa, Siret and Prut) was recorded over several weeks. The extremely rare coincidence of relatively large floods occurring simultaneously in the Upper Danube, Tisza, Sava and Velika Morava rivers resulted in a very serious 100-year flood event downstream of Serbia. Throughout the entire Lower Danube, historically significant flows and water levels were registered, being the largest recorded during the last hundred years. The registered flows had maximum values of 15,600 -15,800 m^3/s, similar to those in 1895. Unusually, there was also a long period of high flood alert on the Danube downstream of the Iron Gate, lasting more than 6 weeks. Several dyke breaches occurred, especially on the Romanian side.

3.3 Floods in 2010

According to climatic data, the 2009-2010 hydrological year (measured from November to November) produced the largest amount of precipitation ever observed in many parts of the Danube region. The layer of snow and rain along the central Danube exceeded the multiannual average by 1.5 to 2.0 times, a maximum never observed since systematic instrumental weather observations have been available. Contrary to the massive single flood events on the Danube as occurred in 2002 or 2006 due to high precipitation volume in a short time, in 2010 the scattered character of the rainfall throughout the whole year and throughout the most of the Danube River Basin led to a high number of damaging flood events at the local level. Except of German and Austrian part of the Danube River Basin, where only minor floods occurred, all other countries suffered from considerable flooding causing casualties and massive damages.

In Czech Republic the largest floods in May were on the Morava tributaries with return periods between 10 – 50 years. After this first precipitation wave the elevated soil saturation caused the second flood event in the beginning of June despite the rainfall in that time was not so strong. These floods had return periods between 10 – 100 years and were evaluated as the second most significant summer flood event in the Morava basin during the last 100 years.

The extreme floods were recorded in Slovakia mostly in May and June. Altogether there were 206 days of flood alerts until the end of August (85 % of the time) and the floods affected the whole territory of the Slovak Republic. High saturation of the Nitra river basin in June 2010 caused flood with the estimated peak discharges Q_{20}-Q_{50} in Nitrianska Streda and Nove Zamky. Extreme flood events, which resulted from long-lasting rainfalls in the beginning of June, occurred in several river basins of the Central Slovakia. The return period of floods in the Slana and Rimava river basins was estimated to 50 years. In the Litava at Plastovce (the Ipel River tributary) the flood peak discharge was estimated to Q_{100}. Eastern Slovakia has been continuously affected by floods since the mid May. Extreme rainfalls in the beginning of June, combined with high saturation of river basins in this region, caused floods with return periods 50–100 years in several river reaches.

Hungarian river reaches experienced several significant flood waves resulting from intensive rainfall events either directly or as a superposition of a number of floods following subsequently. Multiple floods on the tributaries resulted in a significant Danube flood wave upstream of Budapest, equal to the third largest one of the last century causing serious transport limitations within the city of Budapest. The Vienna-Budapest railway line was also endangered while the motorway M1 was cut by a flash flood induced damage for a couple of days. Extreme character of the events was manifested on streams of the Slana/Sajó river network together with Hornád/Hernád and Bodva/Bódva where two or three subsequent flood peaks in May-June exceeded historical flood crest (water level) or peak discharge maxima of the year 1974. Lower Hernád Valley was mostly saved by intensive flood protection works by constructing a temporary dike of 40-km length. Water levels reaching historical maximum levels occurred on the River Tisza at Tiszaujváros and the recently completed emergency reservoir (detention basin or polder) of Tiszaroff was opened reducing the flood peak by 15-20 cm easing the load on the flood protection of the city of Szolnok. The year 2010 was denoted in Hungary with the highest number of the flash flood events (510) since such statistics are available (1980).

In Slovenia fluvial foods, flash floods and karst phenomena floods occurred accompanied by landslides. Floods reached their peak between 18 to 22 September. The discharge return period varied from less than 5 years to more than 50 years.

Flood events on the Croatian rivers were caused not only by an extreme precipitation in the territory of Croatia but also due to a large inflow from the upstream parts of the river basin in the neighboring countries. At many hydrological stations, the maximum water levels which occurred during 2010 exceeded or were only slightly below those recorded during the previous 35 years. This period was chosen because in 1975 the flood relief structures for the Sava and Kupa rivers were either constructed or put into operation. In the Sava upstream of Sisak and in the western left-bank Sava tributaries, extremes occurred during the large water wave in September 2010. The eastern left-bank tributaries achieved their maximums in June, and the largest right-bank tributaries, the Kupa and the Una, during December 2010. Preliminary statistical analyses showed that the large water wave in the upper section of the Sava river basin in September was the occurrence of a 100-year return period. The flood maximums which occurred in June had occurrences between 25- and 100-year return periods, and those in December between 10- and 50-year return periods.

In Bosnia and Herzegovina the key flood events were registered at the beginning of January 2010 on Una, Sana, Vrbas and Bosna River with the recurrence period ranging from 5 to 100 years. Main floods in the Drina basin were caused by the extreme precipitation in Montenegro's and Serbian's part of river basins. Flow rate of the Drina river, at the confluence to the Sava river, was over 4,000 m3/s what is the highest flow recorded in the last 50 years. The recurrence period of the Sava river flow downstream the confluence with Drina, almost reached 100 years (6,000 m^3/s).

The hydrological situation in Serbia was highly unfavourable throughout the whole year with repeated floods on nearly all national and international rivers. A prime example is the Sava River, where floods occurred at the very beginning of the year, in the summer, and in December 2010. Flood defence activities lasted in Serbia for 185 days, during the most of these days emergency flood defence was in force. Rapid snowmelt and rainfalls generated flood waves on many rivers in Serbia already in December 2009 and this situation continued in January and February 2010. The most serious events exceeding emergency flood defence stages occurred on the Sava River, the Timok River, and the rivers in Banat. The most adversely affected was the Timok River Basin, where the soil was already saturated by snowmelts and rainfalls in the previous year and an exceptional runoff occurred in the second half of February and in the second half of April with absolute maximum levels recorded at many gauge stations, with return periods estimated at 20-100 years. Frequent and abundant rainfalls induced flood waves in the Velika Morava River Basin in April 2010. The most dangerous situation was recorded along the most downstream section of the Juzna Morava River, where the historical maxima were exceeded (at Aleksinac and Mojsinje gauge stations on 21 April).

At the end of June a flood event occurred in the Kolubara River Basin (a right tributary of the Sava, near Belgrade) caused by abundant rainfall, reaching soil already saturated by previous rains. New extremes were recorded on many tributaries and the Kolubara River itself, where the return period of peaks was estimated at 50-100 years.

In the Drina River Basin the most extreme flood event occurred in the end of November and the beginning of December. Flood waves on the Drina and its tributaries were induced by extreme rainfalls in Montenegro and East Herzegovina, where 100-200 mm of rain fell in 3 days. Flood waves on the Drina tributaries (Piva, Tara, Cehotina, Lim and Jadar) and the main course were exceptional, such that hydropower reservoirs could not retain them. A new maximum was recorded on 3 December at Radalj, the most downstream gauge station on the Drina River. As a result, a flood wave also occurred on the Sava River in Serbia, where emergency flood defence was declared at the beginning of December.

In Romania the major flood events have been registered between June and August. In June danger and inundation water levels were exceeded on Crasna and Tur (both in Somes-Tisa basin) and on Timis, Barzava and Moravita River (Banat region). On 1-3 July danger water levels have been recorded on the Upper Olt at Tomesti, on the middle Siret (Lespezi-Dragesti sector) and on the Prut River (Oroftiana-downstream Stanca sector) while the inundation level was observed on Olt and several Siret tributaries. In the second half of June and beginning of July the whole North-Eastern Romania has been affected by continuous significant precipitation which induced successive massive floods especially on the Siret and Prut rivers, reaching historical values recorded in 2005 and 2008.

The hydrological situation in February/March in Bulgaria (high water in the Timok combined with groundwater floods) caused floods in Bregovo. In June high water levels were observed on the Orshova River.

In Ukraine in May the high flood levels were recorded at the lower Tisza and Latorytsa. On 20 May Latorytsa at Chop reached 701 cm (the historical maximum being 750 cm) while in December at the same station the historical maximum was reached.

The major pluvial floods on the Prut in Moldova occurred in June-July. In the first decade of June, upstream the Costeşti-Stînca reservoir the pluvial flood led to the rise of water level by approx. 2.0 m and to inundation of the floodplain of Briceni district. In the beginning of July, the inundation of floodplains from Briceni and Edineț districts and of the railway embankment of the Bălți – Cernăuți districts occurred. Few days later a flood wave on the Prut increased the water level near Şirăuți village by 5.10 m and the maximal discharge reached 2,020 m^3/s. This led to inundation of floodplains and of some localities of Briceni district. In the sector Costeşti - river mouth, floodplains and farm lands were inundated and the water supply for the Ungheni district was jeopardized.

4 Potential adverse consequences of future floods

In reference to the EFD art. 4.2(d) a description is provided here on the assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing manmade flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of floods.

4.1 Germany

To assess the adverse consequences of future potentially significant floods, an analysis was made of the danger of flooding and the possible adverse impacts in the areas, and the risk was deduced from this.

The flood risk was assessed by evaluating the available data on topography, hydrology and land use. In addition to the factors mentioned in EFD Article 4.2 (d), the existing flood plains and flood-control installations were taken into account. The development of the land use on a medium and long-term time-scale using available water-management reference frameworks and the information provided by spatial and regional planning institutions were also taken into consideration.

The ascertainment of possible risks took particular account of the location of populated areas and the location of areas of economic activity. Taking this as a basis, the adverse effects were then assessed either directly, using potential damage and the number of persons affected, or indirectly, using regional criteria. Consideration was also given to major long-term developments like climate change, demographic change and foreseeable economic development.

4.2 Austria

For the assessment of the potential adverse consequences of future floods in Austria, the modeled flood areas of the "Flood Zoning System Austria" (link: http://www.hora.gv.at/) and, where available, more detailed hazard studies were applied. The hydrodynamic models are adapted to the geomorphological characteristics and topography of watercourses and floodplains. The actual effects of floodplains as natural retention areas and the effectiveness of existing manmade flood defence infrastructures are integrated in the models.

Populated areas and areas of economic activity are accurately represented by gridded data of inhabitants and employees. Information about long-term residential and economic developments was taken into account in a final review of the assessment by expert evidence. Estimations on the impacts of climate change show a very high level of uncertainty in Austria. In recent studies, future changes in flood discharge due to climate change ranging from –4% to +10% were computed for several river catchments. These values are far below natural variations in present flood discharge.

4.3 Czech Republic

The past changes during 1940s – 1960s such as different agriculture practices, building large dams and regulation of the rivers, have affected character of floods. In future only small local changes in land-use, land-cover, urbanization, and population density around the rivers are expected.

Hydrological and geomorphological conditions and land-cover were analyzed to define "critical points", locations of potential flooding after very intense showers at borders of urban areas.

Potential adverse consequences of future floods were assessed by spatial analyses of medium probability floods (Q100) along the rivers. Approximately 5 % of inhabitants live in a potential flood risk with medium probability and 5 % of value of major types of properties is at risk.

Climate change study did not affirm any trend or important changes in conditions which could cause neither different character of floods in future, nor their different seasonal distribution.

4.4 Hungary

Excess water endangers about half of Hungary's territory (mainly the plain areas), and nearly a quarter of the territory is endangered by floods of river sections protected by dams. The small streams of mountainous and hilly (flash flood prone) areas potentially endanger about 10% of the territory. As a consequence any part of the country and the whole population can be affected by some type of floods.

The existing flood protection measures provide a fairly good land use development. Some also claim that these development possibilities encouraged people to move to places that could be better used for flood management and nature development. This creates problems when floodplain restoration, dyke relocation, flood retention reservoirs and wetland development comes into picture. The New Vásárhelyi Plan uses these measures to counterbalance the ever increasing flood threats and the effects of climate change.

The territories determined on the base of past research represent the upper limit of the potential flood hazards in Hungary. Flooding of larger areas is practically impossible. During the preparatory phase, the climate change research could not give quantifiable results for the coming 50 years, which could be used as a basis to alter the probability distribution of the hydrological load. In the present phase of the work, it is planned to consider the future trends, and to develop test scenarios and options for the national strategy.

4.5 Slovenia

The potential flood risk areas were assessed by evaluating available data on flood hazard potential and damage potential. The results are potential flood risk areas classified by the risk potential index.

The future development is not considered as relevant in PFRA, because of applied prevention measure in "Governmental decree on conditions and limitations for constructions and activities on flood hazard areas"(http://www.uradni-list.si/1/content?id=88381). According to this decree the future development should be outside of a flood hazard area. If it is an extension of an existing infrastructure, the measure for reducing the existing flood risk should be applied before the extension can begin.

There is no evidence of an impact of the climate change on frequency of fluvial floods while the trends of discharge peaks are slightly declining. The trends of average sea level and the frequency of floods increase. See:
(http://www.arso.gov.si/o%20agenciji/knji%c5%benica/publikacije/Okolje_se%20spreminja.pdf, Okolje se spreminja. Podnebna spremenljivost Slovenije in njen vpliv na vodno okolje, MOP ARSO, 2010,).

4.6 Croatia

Due to hilly and mountainous areas with high rainfall intensities, alluvial lowlands of the Danube, Drava, Mura, Sava, Kupa and Una rivers and their tributaries, towns and settlements located in potentially endangered surfaces and unfinished protection systems, the Danube River Basin District in Croatia is at considerable flood risk. High and moderate risks were identified in many areas of the country.

Protection systems along large rivers are partly unfinished and consist of defensive dikes, wide flood zones and large lowland retention areas which enable a significant reduction of peak discharges. Such approach also contributes to the reduction of flood risks in the downstream countries and at the same time preserves natural values (Lonjsko polje, Kopački rit and other areas). Protection systems for torrential floods in smaller river basins, which consist of mountain retention areas, reservoirs and lateral canals, are mostly unfinished.

Further investments in the development of protection systems for reduction of identified flood risks and mitigation of consequences of climate changes will be implemented according to the Multiyear construction programme for regulation and protection water works and amelioration water works, which is in preparation.

4.7 Serbia

The largest potentially flooded areas are along the Danube, Tisza, Sava, Drina, Velika Morava, Južna Morava, and Zapadna Morava rivers. As summarized in the national GIS (based on a 1:300,000 scale map), potentially flooded areas along the largest rivers in Serbia cover almost 12,000 km^2. These lowlands host the largest cities and economic activities.

Approximately 1,500,000 people in Serbia are directly or indirectly endangered by potential future fluvial floods. All large populated areas are protected, mostly from 100-year flood, and effectiveness of structural defences is satisfactory. Nevertheless, new developments in flood prone areas can lead to an increase of risk. The impact of climate change is still under consideration and will be taken into account in the next PFRA.

4.8 Bosnia and Herzegovina

Most of the man made structural defences (river trainings, levees and dykes) in the country are effective. Some of them were damaged or neglected during the war and are being reconstructed now.

According to analyses of spatial plans the trend of urbanization development is obvious. As a result, the value of the land will increase and so will the possible flood damages.

Terrain topology in Bosnia does not allow for development of natural retention areas, so the urbanization has a significant impact on development plans.

As regards the impacts of climate change according to the research conducted by the Intergovernmental Panel on Climate Change (IPCC) on the Sava River catchment area in Bosnia for the period of 2000-2050, no significant changes in climate are to be expected.

4.9 Romania

According to the National Strategy for Flood Defence based on the results of previous studies the potentially flooded areas along the rivers with catchment areas over 4,000km^2 cover more than 1,100,000 hectares at the level of 1% frequency. Total potentially flooded area was estimated to be about 2,120,000 Ha.

2,050 localities and 310,000 households are vulnerable to flooding. About 1,300 localities benefit from flood protection measures such as 9,000 km dikes and 300 dams with flood mitigation capacities. Along the Danube about 1,200 km of dikes protect agricultural and urban areas

The assessment of potential adverse consequences of future floods took into account the current share of the estimated damage as given by flood defence plans and compared to trends in development provided by landscaping plans and river basin development plans (in accordance to WFD).

The impacts of climate change could not be estimated at this stage due to uncertainty of the data available.

4.10 Bulgaria

To assess the future danger of flooding and future potentially significant floods an additional analysis by GIS methods is being performed considering the topography and the hydrologic conditions. The potentially flooded areas are calculated for medium probability (Q100) of flooding. This analysis is conducted for the river sections which are preliminarily specified as potentially vulnerable in view of close proximity of critical objects such as: populated areas, significant industrial plants; main infrastructure facilities, sources of pollution, protected areas and cultural objects.

For the assessment of the potential future consequences the long term development is taken into account, considering the trends in the alteration of population, the industrial and infrastructure projects.

There is not enough available information on climate changes in Bulgaria and especially regarding their influence on the future floods. For the PFRA the impact of climate changes will be assessed in specific cases depending on data availability.

4.11 Moldova

Assessment of flooding of the settlements resulting from dyke breaches is ongoing.

5 APSFR

5.1 APSFR methodology

This chapter provides a brief description of the methodology used at the national level for the identification of potential significant flood risk areas.

5.1.1 Germany

In Germany, any person who may be affected by floods is obliged, as far as this is possible and reasonable, to take suitable preventive measures as a protection against adverse consequences of floods and to reduce possible damage (Section 5 (2) Federal Water Act). There is a public interest in protecting the community at large, if floods are a threat to the life of the population or if economically relevant material damage frequently occurs to such an unusual extent that it affects a larger number of people.

Areas with a potentially significant risk can thus be found along sections of water in which there is a particularly high flood risk of supra-local importance compared to the entire river basin.

Adverse consequences for human health depend on a variety of factors. As there is no sufficiently accurate information for the examined region available, or only available for a small part of it, regional criteria were applied to identify areas that are distinguished by a high settlement density or a large number of affected inhabitants.

The potentially significant risk for economic activity was assessed for all areas based on their regional importance. This means that higher-order and middle-order centres are especially marked out as being significant risk areas in terms of economic activities and, depending on their location in conurbations or rural regions, also lower-order centres.

There are potentially significant risks to the environment as a protected natural resource that are caused by industrial enterprises in the flood plain that handle or store environmentally hazardous substances. If the relevant locations of these industrial enterprises are situated in a 100-metre corridor along the waters under consideration, these have been taken into account when defining sections of water with a potentially significant flood risk.

In addition to municipalities that can be expected to have cultural assets on account of their central functions (see above), World Cultural Heritage Sites and, where relevant, outstanding objects included in lists of registered monuments, were identified as objects with a particularly high flood risk potential.

The definition of potentially significant risk areas is checked for plausibility on the basis of expert knowledge.

5.1.2 Austria

In Austria, APSFR were identified on the basis of the results obtained in the preliminary flood risk assessment. The aim was to identify areas where flood risk is of supra-local importance and has already actively been managed or should be managed in future.

The two highest risk classes (very high and high assessment of "total risk" in the PFRA) correspond approximately to the significant flood risk under Article 5. The minimum criteria for identifying APSFR are stretches of at least 1.5 km at "high flood risk" or any stretch of "very high flood risk", respectively. For practical reasons these stretches can be combined to larger APSFR.

As a result, Austria identified about 400 APSFR with an average length of 7 km. More than half of the APSFR are already protected by structural defences against floods up to a 30 years return period or higher.

5.1.3 Czech Republic

Methodology of identification of the areas with potentially significant flood risk addresses potential adverse consequences of future floods (Art. 4 d). The key factors taken into account were the number of permanent residents and the value of properties affected by designed floods of 5, 20 and 100 year return period. A year loss functions of different return periods helped to include the existing flood defences (hydraulic structures) and then the matrix of APSFR variants helped to set up the thresholds: 25 inhabitants affected /year, 3 million EUR affected properties /year. Localities with potential sources of heavy pollution and national cultural heritage affected by designed flood of 100 yrs return period were taken into consideration as well. Comparing the extent of past significant floods (1997, 2002, 2006, and 2009) with the lists of priorities of Regions, a list of river sections defining the final APSFR was prepared. In the Czech part of the Morava river basin 583 kilometers of river sections were identified as APSFR. In the Czech part of the Vah river basin (Vlara catchment) 34 kilometers of river sections were identified as APSFR.

5.1.4 Slovakia

In Slovakia, the areas where floods did not occur in the period 1997-2010 were determined as areas of potential significant flood risk, if the annual maximum cumulative 5-day precipitation total (return period 100 years) exceeded value of 120 mm (GIS analysis based at meteorological data). Further ranking was based at the terrain configuration analysis.

5.1.5 Hungary

The aim of the preliminary flood risk assessment is the delineation of the areas designated for detailed examination. During the development of the methodology, it was concluded that in case of inland waters, and the river sections protected by dykes, these delineations have already been completed in Hungary.

Along the river sections that are protected by dams, the endangered areas were defined in 1977 using then available methodologies. The areas were allocated for the 1% and the 0.1% exceedance probability. According to this, the possibly flooded basins of Hungary were determined. In case of river sections protected by dykes, these are the areas exposed to a significant risk according to the preliminary flood risk assessment. The actual hazard and risk values can only be determined after proper data generation, and after the time- and labor-intensive data processing has been accomplished.

In case of excess waters, the basis is the hazard map developed by Pálfai (Final excess water map of Hungary, ATIVIZIG 2001). The detailed examinations need to be performed in separate territory units. The endangered area is divided into such units, in which the diversion of the inundation is coherent, and the separate units compose independent systems (protection is also arranged according to these units). These units are called excess water protection sections, and are considered to have significant risk.

The flash flood prone areas were delineated based on a study made by the University of Pécs. In the previous cases, usually the data with an adequate accuracy is available for the hazard map examinations, but in this case, the cost-intensive measurements are still necessary. Therefore the delineation of the whole endangered area is not possible, but the following method has to be applied.

In case of minor watercourses, an assessment is only necessary on those sections where inundation of valuable assets is more likely (so the upper part of the river basin is not affected). The available financial budget was divided among the concerned territorial directorates, according to the length of the streams under their responsibility. The unit price of the measurements was set and the directorates were asked to allocate the concerned sections, using the available funds. When choosing the concerned stream sections, they should take into consideration the following points:

- Inundations have already occurred on the section;
- Settlement is involved;
- Cultural heritage is present in the area;
- Significant industry is present in the area;
- Other important objects are present and under a risk of damage (according to the local judgment).

5.1.6 Slovenia

The potential flood risk areas classified by the risk potential index were the basis for selecting the areas of potential significant flood risk (APSFR). The criteria were based on classes for different damage potential as human health, environment, cultural heritage, economic activities. Classes were defined by a quantile method.

The definition of APSFR is checked on the basis of expert knowledge and will be finalized in cooperation with the decision makers.

5.1.7 Croatia

For an administrative scope of each settlement, preliminary assessment of flood risks was undertaken and they were classified into four main categories of risk:

- High flood risk, which includes frequently flooded areas of settlements, large industrial complexes (outside of settlements), large infrastructural facilities, and waste disposal sites;
- Moderate flood risk, which includes defended areas of settlements, large industrial complexes (outside of settlements), large infrastructural facilities, waste disposal sites, and frequently flooded agricultural areas;
- Low flood risk, which concerns defended agricultural areas and other frequently flooded areas (pastures, forests, and the like);
- Insignificant flood risk, which concerns all other remaining areas.

The assessment of flood risk complexity was obtained based on the results of the priority weighting approach. In spatial terms, it was defined by overlapping the assessed areas under the impact of different types of floods, taking also into account the size of a settlement according to the following categories:

- Settlements with up to 100 inhabitants;
- Settlements with 100 – 1,000 inhabitants;
- Settlements with 1,000 – 10,000 inhabitants; and
- Settlements with more than 10,000 inhabitants.

Based on the assessed complexity of flood risks, a high flood risk was divided into two subcategories:

- Very complex high flood risk - when it concerns areas under the impact of several types of floods;
- High flood risk - other areas under high flood risk.

The above classification with sub-categorization is based on the provision of Article 115 of the Water Act, according to which the tasks of flood defence, ice defence, and protection from erosion and torrents are an emergency service. For that reason, it was already in the PFRA phase necessary to assess those areas where an increased risk might be expected due to the superimposition of adverse effects of different types of floods.

5.1.8 Serbia

Areas of potential significant flood risk are the areas along river sections which were exposed to a significant flood in the past and/or are endangered by a potential future flood. River sections where flood is not likely to occur or to cause significant damage (unpopulated areas, areas with no economic activity, cultural heritage or protected areas, gorges) were not taken into account.

APSFR in the river basins with a catchment area above 4,000 km^2 (Danube, Sava, Tisza, Begej, Tamiš, Drina, Lim, Velika Morava, Zapadna Morava, Ibar, Južna Morava, Nišava and Timok) are considered as being the most significant. The total length of these rivers is about 2,500 km (measured in GIS, 1:300,000) and there are flood protection structures along these rivers with the length of about 1,650 km (Annual Plan for Flood Defence, 2011). Since the most of the riparian land along these rivers is protected from 100-year flood, floods had occurred in the past only locally or along the non-protected sections. However, the largest cities and many settlements are located in the flood-prone areas and may be flooded in case of structures failure or overtopping. Therefore, most of the APSFRs at the largest rivers in Serbia were identified based on the criterion that floods may potentially occur in the future. Total length of APSFRs along these rivers is almost 2,000 km (measured in GIS, 1:300,000).

Also, APSFR at smaller rivers are identified, mainly based on past floods. The national database contains more detailed information and APSFRs. Public information will be provided by Water Management Information System, where APSFR map will be displayed.

5.1.9 Bosnia and Herzegovina

"Significant historical floods are those floods that have historically had significant adverse impacts on human health, environment, cultural heritage and/or economic activity, and those which could have significant adverse effects to the same, if repeated. If data on the assessment of damages are not available, significant historical (or potential future) floods include flooding, which according to the methodology has caused (or could cause) a damage rated by a combined "index" as 100 or more."

This index is obtained by combining (adding up) all adverse impacts in four categories (Human health, Environment, Cultural heritage and Economy) and their subcategories that are assessed using the number, area or length of the affected people, dwellings, historical buildings, industrial facilities, agricultural land, potential pollutants etc. according to the adopted weighing factors. The development plans were used as a basis for this assessment. An Excel-based software was developed for processing of all relevant parameters and data.

Single (sub) category can amount up to 100 if certain criteria are met (e. g., 100 dwellings flooded or 300 people displaced). If a single impact is lower, the index is then adjusted linearly (e.g., for 50 dwellings the index is 50) Finally all indexes from all other categories are summed up and in case the sum reaches 100 – the flood is considered as significant.

Depth (h), flow velocity (v) and duration of flood (t) are important parameters that affect the significance of each flood but for the time being not all these data are available. The initial scoring (indexing) was made for an assumed flood depth of h=1 m, flow velocity of v=1 m/s and flood duration of 5 days (available for historical floods and the value is about the average duration of a typical flood in the region). As soon as the actual data are available a correction factor, for each parameter, should be derived by a ratio of actual parameter value and those "reference" values assumed in the table. Ratio is linear for the depth and the velocity while it is logarithmic for the duration.

Reference indices are given for 20-year flood or lower. The correction factor for 100-year flood is 0.8 and for 500-year flood 0.5.

Based on the considerations described above the following classification has been adopted:

Index	Significance
0-50	Insignificant
50-100	Moderately significant
100-500	Significant
Over 500	Extremely significant

5.1.10 Romania

Preliminary flood risk assessment is the basis for determining areas with significant potential adverse consequences of future floods (Art.4d). In this respect, the information in flood protection plans has been transformed into a digital format and processed as envelope flood events selected according to the methodology of the National Institute of Hydrology and Water Management. This has been statistically correlated with information on population distribution, land use data (CORINE 2006), and information on communications infrastructure damaged in the past. The future trends and the influence of hydraulic works (reservoirs and dikes) were taken into account as well. The Romanian standards for the design of dikes are based on social cost-vulnerability analysis. This way, using the level of importance, most of the dikes were designed to a flood with the return period of once to 100 years in urban areas (about 25% of the total length of dikes) and to once to 10 years for agricultural areas (about 20% of the total length of the dikes). The analysis of potential effects of climate change and of development trends of urban areas was included in the identification of APSFR. For areas without flood defense works, "> EUR 1,000,000" was the damage criterion adopted. The locations with potential significant pollution in case of floods were also included in the analysis. There were altogether 114 flood zones and 600 river sectors with potential damages over one million EUR identified.

5.1.11 Bulgaria

Preparation of APSFR is still ongoing. Only preliminary results are shown in the chapter 5.2.

5.1.12 Ukraine

Areas of potential significant flood risk were identified on the base of past floods with significant adverse impact and inundation zones for Tisza River and its main tributaries. For the assessment of historical floods the description data, digital layers (GIS 1:200,000), expert knowledge and satellite images were used mainly for floods in 1998, 2001, 2010. Inundation zones were identified by the Ukrainian key design and research institute Ukrvodproject in 2008 and they include Flood inundation zones of 1%, 5% and 10% probability along the Tisza as well as in the basins of its main tributaries (Tisza River from Rakhiv to state border with Hungary, Kisva, Shopurka, Teresva, Tereblya, and Borzhava).

5.1.13 Moldova

For the determination of the flooded areas, the risk marking scheme is used. The risk marks are set according to the previous floods. Finalization of APSFR is foreseen in 2013.

5.2 APSFR in the Danube River Basin District

The areas of potential significant flood risk (APSFR) in the Danube River Basin District are shown on the map below. The design and background data of the map follows the approach of the ICPDR for WFD reporting on level A (international river basin district). As for the Danube River Basin Management Plan 2009, the river network is displayed using 4,000 km^2 catchment size as a threshold. This approach has been followed with the view of ensuring a joint flood risk management – river basin management reporting by 2015. The web-version of the map shows also the types of floods (sources of flooding). Transboundary areas of potential significant flood risk are indicated by a specific color.

The data on APSFR were agreed to be provided in the following geometry types:

Polygon: Recommended for areas >= 100km²

Line: Recommended for river stretches >= 50km. If the APSFR is located on a reported river (>4000km² catchment), the same geometry should be used as reported with the river segment dataset. However, the segmentation does not need to match.

Point: Recommended for areas <100km² and river stretches <50km.

The FP EG agreed upon the definition of the transboundary APSFR:

Transboundary APSFR is any area (in the transboundary reach of a river) which has been assigned as transboundary APSFR by at least one country and this assignment was discussed at the bilateral level. If the transboundary character of an APSFR is regarded as not yet agreed by one country, this will be shown on the map. For a river crossing a border, the area of common interest will be assigned as transboundary APSFR. The extent of this area of common interest has to be agreed by the neighboring countries.

Three types of APSFR to be shown on the map were agreed:

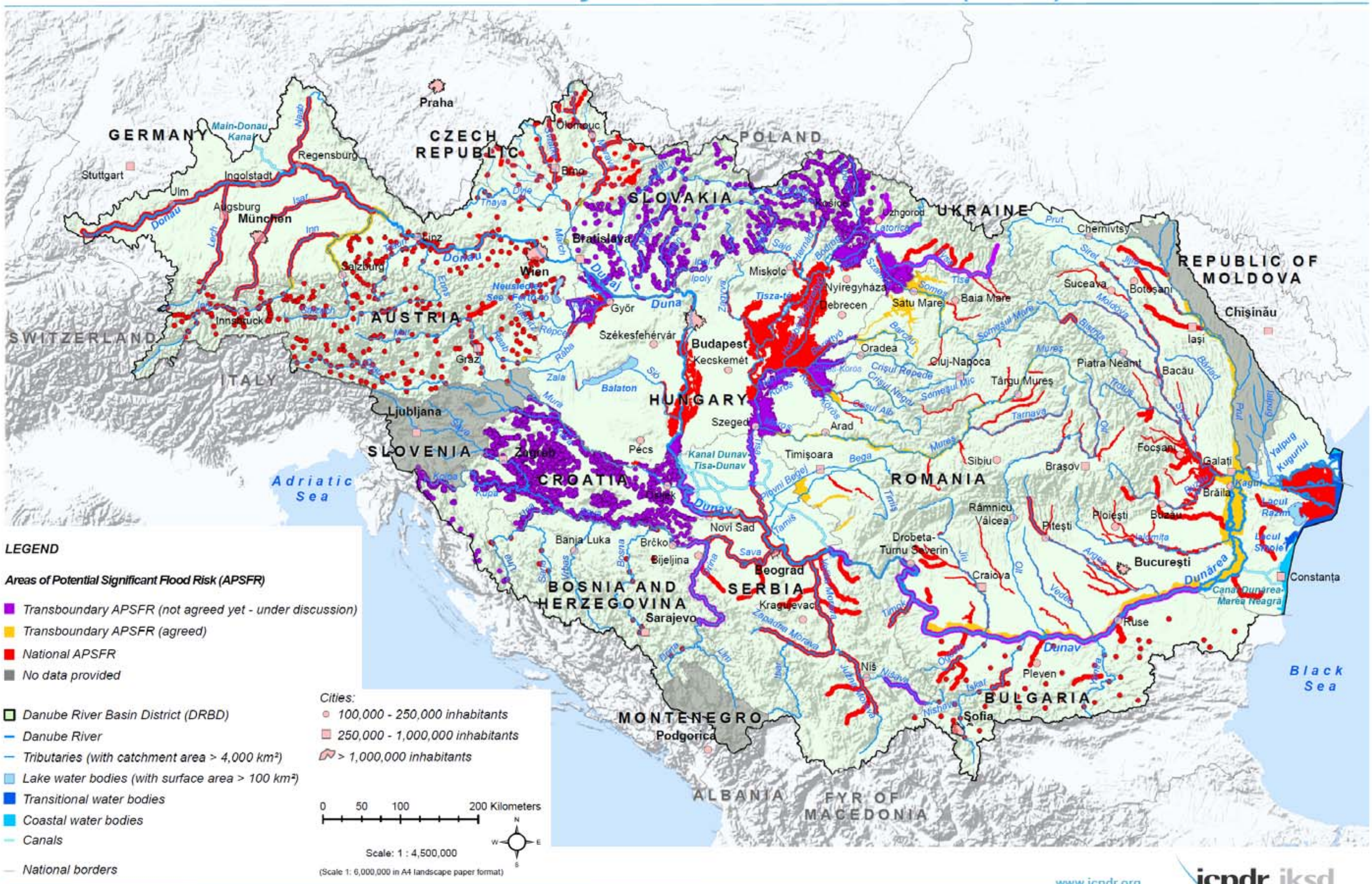
Description in legend	**Color on map**	**Value of attribute TRANSBOUNDARY**
National APSFR	red	N (“No”)
Transboundary APSFR (agreed)	orange	Y (“Yes”)
Transboundary APSFR (not agreed yet - under discussion)	purple	U or 0 (“unknown” or “yet to be determined”)

The order of layers (top→bottom): purple→ orange→ red

The map shows the status as of 31 January 2012. Due to the fact that this report had to be finalized several months before the official reporting deadline of 22 March 2012, the map of APSFR in the Danube River Basin District shows only preliminary data for some countries. Slovenia will submit the APSFR data later in 2012. The final data will be available in the national reports of the EU Member States, which are due by 22 March 2012. These data will be used for an update of this report which will be submitted to the European Commission by 22 September 2012.

The APSFR have not yet been indentified in Moldova, it is foreseen that this task will be accomplished there by the end of 2013. No information was received yet from Montenegro.

Danube River Basin District: Preliminary Flood Risk Assessment (PFRA)



This ICPDR product is based on national information provided by Contracting Parties to the ICPDR (AT, BA, BG, CZ, DE, HR, HU, RO, RS, SK, UA). More details on the methodologies used for identification of APSFR at the national level and the definition of significance criteria are provided in the report "Preliminary Flood Risk Assessment in the Danube River Basin", chapter 5.1. National borders data provided by the Contracting Parties to the ICPDR (AT, BA, BG, CZ, DE, HR, HU, MD, RO, RS, SI, SK, UA) and CH was used; ESRI data was used for national borders of AL, ME, MK; Shuttle Radar Topography Mission (SRTM) from USGS Seamless Data Distribution System was used as topographic layer; data from the European Commission (Joint Research Center) was used for the outer border of the DRBD of AL, IT, ME and PL.

Vienna, December 2011

6 Addressing the impacts of climate change

The EFD established that the potential impacts of climate change must be considered within the preliminary flood risk assessment from the first planning cycle, based on the available information. There are likely to be challenges and limitations on the degree of consideration of climate change in undertaking the preliminary flood risk assessment (PFRA), particularly in the first cycle, given the qualitative rather than quantitative information that may be available or readily derivable. This knowledge is foreseen to be improved in the second cycle (after the first flood hazard/risk maps and flood risk management plans).

To ensure climate change is properly considered in the reviews of the preliminary flood risk assessment, including the subsequent identification of areas of potential significant flood risk, WFD CIS Guidance Document 24 recommends to:

- always use latest available (yet robust) information;
- identify "climate change hot spots" which should be subject to more detailed checks and which can serve as trend detection areas and indicators of the vulnerability of certain regions. The need for reassessments shall be considered in each review period;
- exchange information between MS on climate change impacts, not just between MS sharing water courses but also at a wider scale, so as to raise awareness on changes noted.

To utilize the synergy between preliminary flood risk assessment activities and the investigation of impacts of the climate change WFD CIS Guidance Document 24 suggests following actions:

- Understand and anticipate as far as possible climate change impact on floods;
  - Monitor changes to flood patterns by gathering comprehensive information on past floods - consider development of a "past floods database at European level";
  - Develop a structure for gathering information on past and new floods;
  - Improve trends detection, using the information gathered over the implementation cycles detecting trends of changing flood patterns;
- Use best available information;
  - Anticipate and improve readily available information;
  - Use monitoring under WFD on flows, physical modifications, pressures and impacts, etc.;
  - Consider what is "available and readily derivable information" today and what is foreseen to be "available and readily derivable information" in future;
  - Exchange information with the insurance industry, as well as land use and spatial planners;
  - Make the best use of review cycles of PFRA;
  - Continue further best practice exchange on how to incorporate climate change information in the PFRA at European level;
- Homogenize time series, and remove bias as far as possible;

  - Remove bias from time series and use time series that are as long as possible;
- Understand and anticipate as far as possible increased vulnerability and flood risk due to climate change;
  - Take climate change into account when assessing the effectiveness of existing man-made flood defense structures;
  - Be transparent in the use of "worst case" scenarios – take latest available climate change information into consideration;

7 Transboundary coordination & information exchange

EFD Article 4(3) stipulates that in the case of international river basin districts, or units of management referred to in Article 3(2)(b) which are shared with other Member States, Member States shall ensure that exchange of relevant information on the preliminary flood risk assessment takes place between the competent authorities concerned.

In accordance with the Article 5(2) the identification of areas of potential significant flood risk belonging to an international river basin district, or to a unit of management referred to in Article 3(2)(b) shared with another Member State, shall be coordinated between the Member States concerned.

Summary on the steps taken by the ICPDR Contracting Parties to ensure the exchange of relevant information on PFRA between competent authorities in the DRBD and the description of international coordination of APSFR that has taken place between the ICPDR Contracting Parties is provided below.

7.1 Germany

The coordination of the regions with a potentially significant flood risk was carried out bilaterally between the Republic of Austria and the Free State of Bavaria at the level of the Bavarian State Ministry of the Environment and Public Health and the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management by the Working Group of Experts under the title "Protection and Management of Waters" [Schutz und Bewirtschaftung der Gewässer] of the Standing Committee on Management of Water Resources based on the Regensburg Treaty.

Coordination with the Czech Republic was carried out within the framework of the meetings of the Standing Bavarian Committee for the Bavarian Border Section of the German-Czech Transboundary Water Commission [Ständiger Ausschuss Bayern für den bayerischen Grenzabschnitt der deutsch-tschechischen Grenzgewässerkommission], and specifically during two meetings of experts in September 2010 and February 2011.

7.2 Austria

The exchange of relevant information and the coordination of the APSFR were mainly conducted at the level of the bilateral river commissions that already existed between the Republic of Austria and the neighboring countries: Slovenia, Hungary, Slovakia, Czech Republic and Germany. Mutual information was exchanged in the relevant Working Groups of Experts and/or in the Water Management Committees according to the relevant bilateral treaty.

7.3 Czech Republic

The Czech Republic shares its waters in the Danube River Basin with Austria, Germany and Slovakia. Bilateral border commissions were established to manage transboundary coordination and have discussed the implementation of EFD including PFRA and APSFR and exchanged information during last two years. Besides those meetings a trilateral conference was organized addressing the international cooperation in the water management and flood protection within the border area of Morava sub basin.

Details of PFRA and identification of the APSFR have been discussed also by the CEframe project community, where all relevant countries are participating as project partners (see also chapter 8.2).

7.4 Hungary

The international cooperation is organized through pilot projects as well as by bilateral activities via transboundary river commissions.

In 2010 Romania was informed about the PFRA methodology & developments that took place in Hungary. An international conference was held in 2010 with participation of Austrian and Croatian experts. In 2011 an expert-level consultation was held with Austria on the preliminary flood risk assessment.

The initiatives are ongoing that the transboundary river commissions should make in bilateral agreements a record of the areas of common concern, for which the strategic flood management plans have to be jointly elaborated.

7.5 Slovenia

Information exchange of methods for PFRA and definition of APSFR took place at the level of:

- AT/SI and HR/SI commission for river Mura;
- Permanent SI/AT and SI/HR commission for Drava ;
- HU/SI bilateral commission;
- ICPDR and ISRBC meetings.

7.6 Croatia

Transboundary APSFRs in Croatia should be jointly identified for the Danube (Croatia, Hungary, and Serbia), Drava (Croatia, Slovenia, and Hungary), Mura (Croatia, Slovenia, and Hungary), Sava (Croatia, Slovenia, Bosnia and Herzegovina, and Serbia), Kupa (Croatia, Slovenia) and Una (Croatia, Bosnia and Herzegovina) rivers through the existing bilateral or multilateral commissions (ISRBC).

In this context, joint projects were initiated in the framework of bilateral commissions with Hungary and Slovenia on the Drava and Mura rivers, whereas joint projects in the Sava river basin are prepared and implemented in the framework of the ISRBC. Cooperation on the Danube is achieved through an implementation of the FLOODRISK project.

7.7 Serbia

Transboundary APSFRs are identified at the Danube (being common with HU, HR and RO), Tisza (HU), Sava (HR and BA), Tamiš (RO), Drina and Lim (BA, ME), Timok and Nišava (BG).

No steps regarding the PFRA information exchange or coordination of the APSFR identification with the countries in the international river basin districts were done so far. It is expected that it will be done through the existing bilateral commissions with HU and RO and the river basin commission (ISRBC).

7.8 Bosnia and Herzegovina

Bosnia and Herzegovina has signed a bilateral agreement on cooperation in the area of water management with the Republic of Croatia. The activities on bilateral agreements with the Republic of Serbia and Montenegro are under preparation. In addition, the transboundary coordination is ensured through the activities of the international river basin commissions (ICPDR, ISRBC)

Among few examples implemented recently, development of hydrological-hydraulic model of Sava river basin and the adoption of the Decision on Approval of Ratification of the Protocol on Flood Protection on Framework Agreement of the Sava River Basin can be mentioned.

7.9 Romania

The information exchange and transboundary coordination in water management sector is achieved through the work of bilateral commissions established with the neighboring countries as well as in the frame of the ICPDR through its Flood Expert Group.

Romania has adopted intergovernmental agreements on cooperation and sustainable use of transboundary waters with Hungary, Ukraine, Serbia, Bulgaria and Moldova.

7.10 Bulgaria

The areas with potentially significant flood risk in Bulgaria are in a process of being delineated. Steps regarding the information exchange with the neighboring countries are undertaken. For the Danube River Basin the transboundary coordination is conducted mainly in the frame of the ICPDR activities and of the Joint Commission on Water Management between Republic of Bulgaria and Romania. Issues requiring a transboundary coordination will be dealt with in the Expert Groups in the frame of the Joint Commission.

7.11 Ukraine

At present the identification of transboundary APSFR is not discussed. Information exchange on coordination of the APSFR identification with the neighboring countries is expected to be carried out by the Working Groups within the existing bilateral agreements with Slovakia, Hungary and Romania.

7.12 Moldova

Due to the fact that the Prut River flows through the territory of Ukraine, Romania and Moldova, there is a cooperation agreement on information exchange between these countries. At present, the identification of transboundary APSFR is not discussed. Information exchange on coordination of the APSFR identification with the neighboring countries is expected to be done by the Working Groups within the existing bilateral agreements with Ukraine and Romania.

8 Supporting transboundary activities

This chapter provides not only examples of pilot projects addressing the transboundary issues of preliminary flood risk assessment but it informs on the international activities addressing wider aspects of flood risk management at the regional and basin-wide level. Information on bilateral activities is provided in the national reports.

8.1 Danube FLOODRISK

The Danube FLOODRISK is a three-year project focusing on the most cost-effective measures for flood risk reduction: risk assessment, risk mapping, involvement of stakeholders, and risk reduction by adequate spatial planning. The project brings together scientists, public servants, NGOs and stakeholders who develop jointly a scalable system of flood risk maps for the Danube River floodplains. Transnational methodology and models will be defined and implemented for flood risk assessment and mapping. This results in proposals for flood mitigation measures, adjustments of spatial development plans, assessment tools for economic development in flood plains and raised awareness of flood risk of stakeholders, politicians, planners and the public. Infrastructures at risk like industry, power stations and supply infrastructure will be considered in the project.

The overall objective of the FLOODRISK project is to develop and produce high quality, stakeholder oriented flood risk maps for the transnational Danube river floodplains to provide adequate risk information for spatial planning and economic requests. Risk information is the basis for sustainable development along the Danube River. The key objective will only be reached by intensive transnational cooperation and stakeholder integration. The goal is to link scientific progress in harmonization of approaches and data with practically oriented stakeholder and end user involvement. Vertical and horizontal cooperation are the two pillars of the project. The project’s single objectives are:

- Development of a joint mapping method for flood risk and harmonization of data sources.
- Production and provision of risk maps and risk information.
- Integration of relevant stakeholders and users on different levels into the definition and realization processes.
- Involvement of different economic aspects of land use in the river basin like spatial planning, recreation and agriculture as well as energy supply or health service.
- Linkage of flood risk mapping and provision of maps as basis for planning, e.g. within the EU Floods Directive.
- Development and distribution of exemplary procedures within the Danube countries and beyond.
- Reflection of the EU Directives, e.g. WFD, Floods Directive, providing feedback based on the experiences of the project cooperation by using the platform of the ICPDR Flood Protection Expert Group.

The project contributes with these objectives to the improvement of the institutional cooperation of the ICPDR and further towards the realization of measures within the existing international cooperation structure. It supports decisions for investments on political and administrative levels by allowing the assessment of investments and land use decisions taking into account the Joint Program of Measures, based on the risk reduction aspects.

http://www.danube-floodrisk.eu/

8.2 CEframe

The four neighboring countries Austria, Czech Republic, Hungary and Slovakia participate in the transnational project CEframe. The project partners are the ministries and regional authorities responsible for flood protection, the project lead is conducted by the Water Management Administration of the Regional Government of Lower Austria.

For a successful flood management in the region with many transboundary rivers a well coordinated approach is essential. The aim of the project is the harmonization of the existing and future flood protection strategies in the CENTROPE-Region, focusing on the cross-border rivers March (Morava), Thaya (Dyje), Leitha (Lajta) and Danube.

For the first time the relevant institutions of the four countries are jointly working on a multilateral plan for prospective flood management in the project region comprising:

- the documentation of current flood protection including an Inventory of hydrologic and hydraulic conditions and harmonized flood maps;
- documentation of existing land uses and potential flood damage, flood risk assessment and calculation of residual risk;
- flood management strategies including recommendations for transregional cooperation;
- proposals for future joint action including a catalogue of risk management strategies and a charta of flood protection.

The results provided by the CEframe project will be compliant with the EU Floods Directive. They will support decision makers in the regional administrations and in the transboundary commissions. The project duration is May 2010 - March 2013. It is funded by the European Regional Development Fund. More information on: http://www.ceframe.eu/

8.3 Other projects

Within the frame of the European Territorial Cooperation 2007–2013 a project on “Flood forecasting in the confluence area of the rivers Morava and Dyje” was launched. As a result of this project an extended upgrade of the forecasting model HYDROG for the Morava river basin was prepared and since February 2010 the forecasts for the profile Hohenau (A) / Moravský Sv. Ján (SK) on the river Morava have been daily disseminated under the test operation. More information: http://www.pmo.cz/projekty/projekty-preshranicni-spoluprace-eu/

The FLOOD-WISE project stimulates a joint approach in sustainable flood management in six international river basins (Meuse, Ruhr, Elbe, Sava, Western Bug and Tisza-Somes) represented by 15 selected partners. The overall objective of the project is the identification, sharing and transfer of good practices on sustainable cross border flood management in European river basins, using the instruments of the Flood Risk Management Directive. The project is divided into three phases addressing the three different flood risk management tools:

- flood risk assessment;
- flood risk mapping;
- flood risk management plans.

This overall objective is reinforced by the integration of other EU directives and national policies, taking into account the hydrological, ecological and socio-economic functions of the river. The project will result in the collection of good practices and recommendations for the European Commission, Member States and other relevant stakeholders. For the future implementation of the project’s results, it will also create actions plans per river basin (http://flood-wise.eu/elgg/).

DRA-MUR-CI: The DRAVA-MURA Cross-border Initiative aims toward the integration of the water management activities in the area of the largest rivers (Drava and Mura), that are shared by two EU states (Austria and Slovenia), according to two EU Directives: Water Framework Directive (WFD Water Framework Directive) and Flood Directive (Directive Flood FD)

http://www.dramurci.eu/page/default.asp?id_language=3

Hydrological Study of the Mur River (Project partners: Austria, Slovenia, Croatia and Hungary):

According to the agreement among the hydrological services of the countries bordering on the Mura river (Austria, Slovenia, Croatia and Hungary), the goal of the study is an integrated processing of the entire Mura flow and harmonization of hydrological data. Hydrological processes are analyzed along the entire course of the Mura river for the uniform period from 1961-2005 for a series of hydrological stations on the Mura and some of its tributaries. At selected meteorological stations, precipitation and temperature regimes are analyzed. The study results should show the (lack of) data harmonization along the Mura flow, define characteristic discharges, analyze probabilities of discharge occurrences and propose further activities.

Joint flood mapping study for the Sava River (Project partners: Slovenia, Croatia, Bosnia and Herzegovina, Serbia, ISRBC, The U.S. Army Corps of Engineers):

The goal of the project is to establish a single hydraulic model of the Sava River that can be a tool to help meet the goals of fostering multilateral cooperation and flood-hazard protection in the member Sava countries through the development of a regional floodplain delineation and flood-risk mapping effort. More information available on web sites: www.lrn.usace.army.mil, www.savacommission.org.

9 Conclusions

The Danube Declaration adopted at the ICPDR Ministerial Meeting in 2010 shows a clear commitment of the Danube Ministers to make all efforts to implement the EU Floods Directive throughout the whole Danube River Basin. This report is the first tangible evidence of this commitment presenting the preliminary flood risk assessment in the Danube River Basin District and displaying the areas where potential significant flood risk exists.

The report provides information on major flood events that occurred in the Danube River Basin District focusing primarily on the last decade. It summarizes the methodologies and criteria used at the national level to identify and assess floods that occurred in the past and their past adverse consequences (including whether such consequences would be ‘significant’) and whether the likelihood of such floods remains relevant. It also addresses the methodologies and criteria used to identify and assess significant floods that occurred in the past that would have significant adverse consequences were they to reoccur in the future and methodologies and criteria used to identify and assess potential future significant floods and their potential adverse consequences. In reference to the EFD Article 4(2)(d) a description is provided in this report on the assessment at the national level of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity.

This document also provides a brief description of the methodology used at the national level for the identification of areas of potential significant flood risk as required by EFD Article 5 as well as the methodology agreed by the ICPDR to identify the areas of potential significant flood risk in the Danube River Basin District including those having a transboundary character. A map displaying APSFR of the basin-wide importance (level A) is included.

The impacts of the climate change are addressed in a specific chapter. To respond to the provisions of EFD Article 4(3) and Article 5(2) a summary on the steps taken by the ICPDR Contracting Parties to ensure the exchange of relevant information on PFRA between competent authorities in the DRBD and the description of international coordination of APSFR that has taken place between the ICPDR Contracting Parties is provided as well.

This report sets the necessary basis for the development of flood hazard and flood risk maps and for the preparation of flood risk management plans by 2015. It provides the first ever overview of the areas of potential significant flood risk in the Danube River Basin District being thus an important message to the public and stakeholders on a potential vulnerability to flood hazards.