PART B

METHODOLOGICAL INSTRUCTIONS

for

Preliminary flood risk assessment

SHORTENED ALGORITHM

21st June 2011

WORKING STEPS
for
Preliminary assessment based on past floods

Part B Methodological instructions for preliminary flood risk assessment

Working steps for Preliminary assessment based on past floods - shortened algorithm

Working Step	*Activity*

1	**Collecting available information on past floods (Chapter B.4.1)**	
	Prior to the actual data processing, all available flood information for one river basin or one project unit is initially collected. An overview of all available sources of information on past floods in Bulgaria can be found in an appendix B.4.1. A detailed description of the sources of information is provided in Chapter B.4.1.5 and Annex B.4.4 of the Methodology. The collection of available information is done as follows:	
	1	**Sending questionnaires to all municipalities**
	2	**Collection (obtain) of all available maps of flood**
	3	**Collection (obtain) of all reports of flooding from standing committees of disasters, accidents and catastrophes to municipalities**
	4	**Collection of all available literature sources on the topic of floods**

2	**Standardized processing of available information (Chapter B.4.1.5)**	
	With available flood information, a distinction is made between verbal (textual, descriptive) and spatial information about floods containing floodplain boundaries.	
	1	**Processing verbal (descriptive) information:**
		- Transfer the information from the questionnaires to Excel (it is recommended to do this in an automated way)

Working Step		*Activity*
		- All other available descriptive informations and flood data are processed in the same way as the questionnaires are handled. For this purpose it is necessary any additional information on floods to be processed in accordance with the structure of the questionnaires (Annex B.4.3) and in accordance with the instructions in chapter B.4.1.4; a description of the characteristics of the different types of floods is given in Chapter A.7.
		- Under available verbal descriptions of the flooding boundaries, this information is transferred to the GIS environment, if there is no information / description of the territorial extent of the flood, the location where the flood occurred occurred is applied as a "point" topic in the GIS.
		- If data for several past floods is available for a river section, account shall be taken of the flood with a maximum territorial coverage, respectively the flood with the maximum damage
	2	**Processing of spatial information**
		- If there are ready-drawn boundaries of flooded plots (from maps, from questionnaires, from other sources), they are transferred directly to the GIS
		- In case of indirect information about the spatial extent of a flood, it is attempted, based on the available data, to restore the territorial extent of the flood. If necessary, Google Earth can be used for this purpose, after which the restored spatial information is transferred to the GIS format.
		In the standardized processing of available data, information about floods from different sources is collected and summarized.

Working Step	*Activity*
3	**Determination of potential damages (Chapter B.5)**
	In order to determine the flood risk based on the floodplain boundaries, the potential damage must be known. Determining potential damage is also needed to identify potentially endangered areas. In either case (data processing of a past or potential flood threat), the potential damage is determined in the same way. The following potential damages must be taken into account and reflected in the GIS (similar to potential floods):

	1	**Settlements (Protected categories "Human health" and "Economic activity")**
		Information on settlements can be obtained directly from CORINE - land use data.
	2	**Important Industrial and Infrastructure Facilities (Protected category "Business Activity")**
		Information on industrial areas and infrastructure is contained in the CORINE data on land use. The designation of significant industrial areas and infrastructure facilities (see Table C.8) should be done mainly on the basis of existing knowledge of local authorities and General Directorate "Fire Safety and Protection of the Population"services. GIS coverage of important industrial areas and infrastructure facilities can be done with “Point” or “Polygon”.
	3	**Water Pollutants / Facilities from the European Pollutant Release and Transfer Register - EPRTR (protected category "Environment")**
		The coverage of water contamination substances, respectively of EPRTR facilities in GIS can be done with "Point" or "Polygon".
	4	**Protected Natural Areas and Water Protection Areas (protected category "Environment")**

Working Step	Activity

		Under the Biological Diversity Act, protected natural areas include habitats and species conservation areas, and under the Water Act, water protection areas include water bodies for drinking water and water bodies containing mineral waters, sanitary protection areas around water abstraction facilities and bathing water areas (B.5.3). The coverage of protected natural areas in GIS can be done with a "Point" or "Poligon".
	5	**Cultural Monuments (protected category "Cultural Heritage")**
		The coverage of cultural monuments in GIS is usually done with "Point"

4	**Determination of flood damage impact (Chapter C.6.2)**	
	When defining the flood impact, a verbal (textual, descriptive) information on floods and spatial (territorial and flood boundary) flood information is distinguished.	
	1	**Spatial information processing (at known flooding boundaries)**
		In this work step, based on known flood limits for historical floods, the impact of individual protected categories is determined. This is done in the following way (similar to potential floods):
		1) Verification of source data in Google Earth Before the actual processing, the available data must be checked. For this purpose, all GIS-relevant data (flood boundaries, population boundaries, other potential damages) are converted into KLM / KLZ format and depicted on Google Earth. Then, based on the information on Google Earth (orthophoto), available information, such as population boundaries, can be checked and, if necessary, corrected.

Working Step	*Activity*

2) Anticipating future development of settlements (if necessary)

If there is evidence of foreseeable future development of settlements, this development can be taken into account when processing through an appropriate adjustment (in GIS), for example, at the actual population boundaries or industrial zones. If floods have been built after the flood, they can have a significant impact on the flood situation and should therefore be taken into account in accordance with the instructions in Chapter B.4.3.3. Depending on the type of protective equipment (dams, riverbed correction, protective dikes, respectively firewalls), different directions are given that can be summarized as follows:

- Floods can be excluded only in cases where the safety of flood protection can be demonstrated unequivocally / clearly in case of sufficient retention volume.
- In most cases, the effect of flood protection measures is not taken into account.
- If the type of protective device itself indicates indirectly that there is a significant flood risk (for example due to large investments in flood protection), it is considered that the significance of the flood risk is thus proven and the additional treatment can be abolished.

3) Determination of population density

Minimum population density should be calculated for flood-affected settlements. It can be obtained by dividing the total population of a given settlement with the area of the settlement, which is defined in the GIS.

Working Step	Activity

		4) Determining the number of affected residents In order to determine the impact of the protected categories "Human health" and "Economic activity" in the GIS, the known boundaries of the floodplains are compared with the updated boundaries of the settlements or of the industrial zones respectively. Through the so-called affected area of the settlement and the calculated density of the population of the respective settlement, the number of affected inhabitants for one settlement, which is reflected in the GIS, is obtained.
		5) Affect of important industrial zones and infrastructure facilities In order to determine the impact of a protected economic activity category, important industrial areas and infrastructure facilities are located within the boundaries of floodplains and the consequences of flooding of these areas and facilities are determined. The affected industrial areas and facilities are submitted to the GIS with appropriate comments on their impact.
		6) Impact of facilities from the European Pollutant Release and Transfer Register - E-PRTR (water pollutants) In order to determine the impact of a protected environment category within the floodplains, facilities from the European Emissions and Transfer of Pollutants (EIPPP) pollutants are located and the effects of leakage of water pollutants are assessed. The affected facilities are classified and noted in the GIS with appropriate comments on their impact.

Working Step		Activity
		7) Affect of protected natural areas under the under the Biodiversity Act and the areas of water protection, according to the Water Act In order to determine the impact of a protected environment category within the floodplains, the protected areas for the protection of the habitats and species of Natura 2000 and the water protection areas, which include the groundwater bodies for drinking water supply and the water bodies containing mineral waters, the sanitary protection areas around the abstraction facilities and the bathing water areas and assessing the environmental consequences of flooding with contaminated waters. The affected protected areas are classified and noted in the GIS with appropriate comments on their impact.
		8) Affect of cultural monuments In order to determine the impact of a protected cultural heritage category within the floodplains, cultural monuments are localized and the consequences of flooding of these cultural monuments are estimated. Affected cultural monuments are classified and noted in the GIS with appropriate comments on their impact
	2	**Processing of verbal (text) flood information**
		Based on available data and past flood information, the severity of individual endangered categories is determined. For this purpose, the following steps are required:
		1) Verification of significance Before the actual processing of the information available, it must be checked whether, in the event of a future flood event (described in the past), the negative consequences of the floods described above can be expected both in today's and future situations. To this end, the available information on past floods is first transferred to today's, or future, situation.

Working Step	*Activity*

2) Predicting future development of settlements (if necessary)

Then, an analysis of the interdependent development (from the flood of the past to the present) is made. If there is information on planned future development, it may be taken into account, through appropriate adjustments, for example at industrial or residential boundaries. If floods have been built after the flood, they can have a significant impact on the flood situation and should therefore be taken into account in accordance with the instructions in Chapter B.4.3.3. Depending on the type of protective equipment (dams, riverbed correction, protective dikes, or protective walls), there are various indications that can be summarized as follows:

- Floods can be excluded only in cases where the safety of flood protection can be demonstrated unequivocally / clearly in case of sufficient retention volume.
- In most cases, the effect of the measures for flood protection is not taken into account.
- If the type of protective device itself indicates indirectly that there is a significant flood risk (for example through large investments in flood protection), it is considered that the significance of the flood risk is thus proven and the additional treatment can be eliminated.

3) Determination of the population density

Minimum the population density should be calculated for the flood-affected settlements. It can be obtained by dividing the total population of a given settlement with the area of the settlement, which is defined in the GIS.

Then the determination of the impact on individual protected categories proceeds in a similar way as for the processing of spatial data for past flooding with points 4) to 7) of step 4 of this guideline.

Working Step	Activity

		It can be expected that in most cases of verbal (descriptive) processing of past floods, eventually it probably does not contain the relevant information (criteria). In this case, it is not possible to process this information as described here. In such cases, the assessment of significance shall be done by the method for identifying areas with a potential flood threat

5	**Verification of significance criteria (Chapter B.4.4)**
	The determination of the significance criteria is carried out in an iterative manner described in Chapter B.6.4.1 (similar to potential floods). The initial threshold values of the criteria set out in the methodological guidelines are initially used to check the significance. In this way, all flooded areas with significant flood risk are obtained from the processing of the flood data, for which further in-depth studies should be carried out. The chosen approach allows at this stage to estimate the necessary means and time for subsequent studies. Thus, where necessary, the thresholds for the criteria can be optimized according to the available resource. Initially, for the protected categories, the criteria of importance listed in Chapter C.6.4.2 and Chapter C.6.4.3 and listed here apply: A river stretch is defined as meaningful if the following result is obtained when determining potential damage:
	• **More than 15 residents are affected within a settlement (Protected Categories of "Human Health" and "Economic activity") or**
	• **Important industrial areas or important infrastructure facilities are affected and floods on these plots can also be expected to cause significant damage (the "Business activity" category) or**

Working Step	Activity
	• **Facilities are covered by the European Pollutant Release and Transfer Register (EPRTR) and in the event of flooding, significant damage to the environment is expected. (Protected category "Environment") or**
	• **Affected protected natural areas and / or areas to protect water from contaminated water in case of flooding expected significant damage to the environment (protected category "Environment")**
	• **Flood-affected areas are important cultural monuments where significant irreparable damage is expected in the event of flooding (protected category "Cultural Heritage")**

6	**Determining areas with a significant potential risk of flooding**
	If a river stretch is defined on the basis of criteria of significance as an area with a significant flood risk, it is marked in GIS by Line or Polygon as such (similar to potential floods). Typically, when defining river areas with significant potential risk, areas longer than the length of the real threat area are marked. For example, settlements are always taken into account with all their current territory and a certain buffer zone added to it (anticipation of future expansion of the settlement).

7	**Description of significant floods (Chapter B.8)**
	The description of significant floods is done in accordance with the structure and guidelines described in Chapter B.8.

WORKING STEPS
for
Preliminary assessment
based on a potential flood threat

Working Step	Activity
	(This analysis is limited to surface waters with catchments of> 10 km² and the Black Sea coast.) The designation of areas with a potential flood threat for the Danube River may be dropped because here the flood situation with a repeat period of 100 years or a 1% documented very well during the 2006 flood, corresponding to a high wave with a repetition period of 100 years, respectively with a 1% guarantee.)

1	**Pre-processing of height SRTM data**	
	Prior to the actual determination of the flooded plots for the entire catchment and for the whole project unit, the SRTM altitude data must be processed and appropriate terrain altitude models must be created in the UTM Zone 35 N reference reference system (reference projection). Creating the altitude models is as follows:	
	1	**Internet Download of SRTM Heights - data for the whole of Bulgaria**
		- raw data can be downloaded from the Internet at: "http://dds.cr.usgs.gov/srtm/version2_1/SRTM3/Eurasia/"
		- selecting the desired altitude network is done by geographic latitude and latitude
		- SRTM - Data can also be downloaded from ArcGIS - the free (gratuitous) access extension "XT Download SRTM File" (download: http://arcscripts.esri.com/).
		- it is also possible and providing altitude SRTM - net (SRTM - raster) by the company Wald + Corbe!
	2	**Conversion of raw data into the designed UTM Zone 35N coordinate system**
		- transformation of the height SRTM - net (cell size 3 arc seconds) at height

Working Step	*Activity*

		- transforming elevation point coordinates using ArcGIS from the geographic coordinate system (WGS84) in the design coordinate system (UTM Zone 35 N)
	3	**Creating altitude grid (raster) for the area of a water catchment area, respectively a project unit**
		- triangulation of elevation points and creation of TINs (Triangular Irregular Networks based on a network of uncovered triangles or heightless models without loss of information) for the subsequent generation of cross profiles
		- transformation of TINs into a 40 m cell height grid (raster) for subsequent hydrological calculations
		- conversion of TINs into a 20 m cell height grid (raster) for subsequent float plot calculations
		On the basis of the 40 m cell height network, the necessary hydrological calculations can be made:
	4	**Creation / Generation of the so-called "Flow Accumulation Grids" to determine the size of the catchment with the free (gratuitous) extension of ArcGIS - Hec-GeoHMS**
		- download Hec-GeoHMS (software + documentation) from the Internet site: "http://www.hec.usace.army.mil/software/hec-geohms/"
		- to create "flow accumulation grids", the following HEC GeoHMS functions are used sequentially

Working Step		Activity
		a) if necessary "Terrain Preprocessing / DEM Manipulation / DEM Reconditioning" for further insertion of a river network in elevation model
		b) "Terrain Preprocessing / DEM Manipulation / Fill Sinks" to fill the river valleys; c) "Terrain Preprocessing / Flow Direction" to determine the direction of flow d) "Terrain Preprocessing / Flow Accumulation" zur Ermittlung des "Flow Accumulation Grids"
	5	**Establishment of the relevant river network (catchment area> 10 km²) using the free (gratuitous) extension of ArcGIS - Hec-GeoHMS**
		the following additional functions of HEC GeoHMS are used to create the relevant river network, based on the work steps taken so far:
		a) "Terrain Preprocessing / Stream Definition" to define a threshold for the size of the catchment (10 km²) and identify all cells that fulfill this condition; б) "Terrain Preprocessing / Stream Segmentation" to distinguish interconnected river sections; в) "Terrain Preprocessing / Drainage Line Processing" for generating the rival river network in the form of polylines.

Working Step	*Activity*
2	**Determination of potential damages (Chapter B.5)**
	In determining the flood risk, the potential damage is crucial. For this reason, the potential damage must be determined before the actual study so that the calculations of the actual study can only focus where the damage is expected to occur. Determination of potential damage is also necessary in the context of the flood risk assessment based on past floods. The following potential damages must be taken into account and reflected in the GIS:

1	**Settlements (Protected categories "Human health" and "Economic activity")**
	Information on settlements can be obtained directly from CORINE - land use data
2	**Important industrial and infrastructure facilities ("Economic Activity" category)**
	Information on industrial areas and infrastructure is contained in the CORINE data on land use. The identification of significant industrial zones and infrastructure facilities (see Table B.8, Chapter B.5.4.2) should be done mainly on the basis of existing knowledge of the local authorities and the departments of the General Directorate "Fire Safety and Protection of the Population". GIS coverage of important industrial areas and infrastructure facilities can be done with Point or Polygon.
3	**Polluting substances / facilities from the European Pollutant Release and Transfer Register - E-PRTR (Environmental Protection Category)**
	The coverage of water polluting substances, respectively of E-PRTR facilities in GIS can be done with a "Point" or "Poligon".

Working Step	Activity

	4	**Protected Natural Areas and Water Protection Areas (Protected category "Environment")**
		Under the Biological Diversity Act, protected natural areas include habitats and species conservation areas, and under the Water Act, water protection areas include water bodies for drinking water and water bodies containing mineral waters, sanitary protection areas around water abstraction facilities and bathing water areas (B.5.3). The coverage of protected natural areas in GIS can be done with a "Point" or "Poligon".
	5	**Cultural Monuments (Cultural Heritage Category)**
		The coverage of cultural monuments in GIS is usually done with "Point"

Working Step	Activity

3	**Limiting the scope of the study**
	The determination of potentially flood-prone areas should only be carried out where potential damage is expected. In addition, the study concentrates only on surface water bodies with catchments> 10 km² and on the Black Sea coast. Settlements, large industrial enterprises, important infrastructure facilities, the European Pollutant Release and Transfer Register (E-PRTR), nature protection areas (Biological Diversity Act), water protection zones (Water law) and cultural monuments are not in close proximity to the current river network or to the Black Sea coast respectively, which due to their location (height) are certainly not threatened by floods, can be excluded in advance from studies to limit their scope. The identification of relevant plots for which the territorial coverage of a flood can be determined can be done in two ways:

	1	**Option A (recommended): Manually (separately) identifying the adequate sections**
		The GIS depicts / visualizes the relevant river network ("Line" theme), all potential damages (settlements, cultural monuments, etc. in the form of the "Polyline" or "Point") and the topographical / terrain of Izolinias). Then potentially endangered settlements, industrial zones and others are defined manually in the GIS on the basis of their distance to the appropriate river network or coast and on the basis of their heights, defining areas larger than those identified as endangered (buffers to ensure greater security). Generally, on the basis of the available data, it is possible to immediately identify which settlements or other potentially endangered sites can be immediately excluded from the flood threat from the county river network or from the Black Sea coast.

Working Step	*Activity*

	2	**Option B: Automated identification of adequate sections**
		In the case of automated identification, these potentially endangered sites (settlements, industrial areas, etc.) that do not exceed a certain distance criterion (eg 500 m for smaller rivers and 1000 m for larger rivers and for coast). The ArcGIS Buffer function is used to verify the distance criterion. The buffer zones thus determined are then matched with the potential damage. Because the topography / relief are not taken into account in this approach (option), a sufficiently large distance criterion must be selected to prevent, especially in plains, erroneous exclusion of potentially endangered settlements and other sites.

4	**Approximate determination of floodplains (Chapter B.4.2.5)**	
	The approximate determination of the floodplains shall be performed for all pre-defined plots along the relevant river network in accordance with the standardized approach described in Chapter B.4.2.5. The use of a relatively easy-to-use GIS tool that automates the workflows described here allows very efficient and fast processing for large water catchments / design units as well. Given the remaining minimum implementation time for the Floods Directive, the use of such an automated processing tool is strongly recommended. Using a GIS tool the following work steps are performed:	
	1	**digitization of the lines defining the position of the transverse profiles**
		manual digitization of lines defining the position of transverse profiles in GIS

Working Step		Activity
	2	**generating cross profiles**
		generation of terrain cross sections from terrain altitude of SRTM-TIN - model
	3	**processing the cross profiles**
		determining the lowest point of the river valley and calculating cross-sections and wetted perimeter for different depths of the flow, for example from 1 to 10 m.
	4	**Determination of the dimensional water quantity**
		The simplified regionalization method described in Chapter B.4.2.3 (regression approach) can very easily be automated in GIS. The water catchment area required for the method can be derived directly from the generated “flow accumulation grid”.
		Then determine the water quantity corresponding to a high wave with a guarantee of 1%, respectively with a period of repetition of 100 years. This water quantity can be determined directly by the calculation formula described in Chapter B.4.2.3.2 (QmaxT = a A_E • b) with the parameters **a** and **b** described in Chapter B.4.2.3.3 and, if possible, using an improved database with the revised parameters **a** and **b** in accordance with the new database.
		In principle, the water quantity could be determined by other methods, but these methods are considerably more labor-intensive in their application and can not be fully automated, which means that their application would be associated with much more necessary for their application and with significantly higher cost of funds.

Working Step	Activity

	5	**Reporting additional threat from small dams (if necessary)**
		- If a section of a dam is located above the studied area, it must be checked whether this dam belongs to Group 3: **Group 1: Significant dams with complex use** **Group 2: dams that are part of the irrigation systems** **Group 3: All other dams** (for the most part small dams (so called "micro-dams"), which are managed by the municipalities or are given for lease by the municipalities).
		- If the dam is in Group 3, it is necessary to check with the District Fire Safety and Population Protection Directorate whether this dam is on the list of potentially hazardous hydro-technical facilities. For those on this list, the services and agencies responsible for their operation should be consulted. **If, after inspection and consultation, there is an additional threat of dam wall destruction, this threat must be taken into account!**
		- - If there is a danger of destroying a dam above the area under investigation, the resulting additional threat can be taken into account by increasing the Q_{100} water quantity accordingly: $$Q_{sum} = Q_{100} + Q_{max}$$ - - The value of the additional Q_{max} water quantity resulting from damage to the dam can be calculated based on the water state H in the dam at the beginning of the spillage by the formula described in Chapter B.4.2.6:

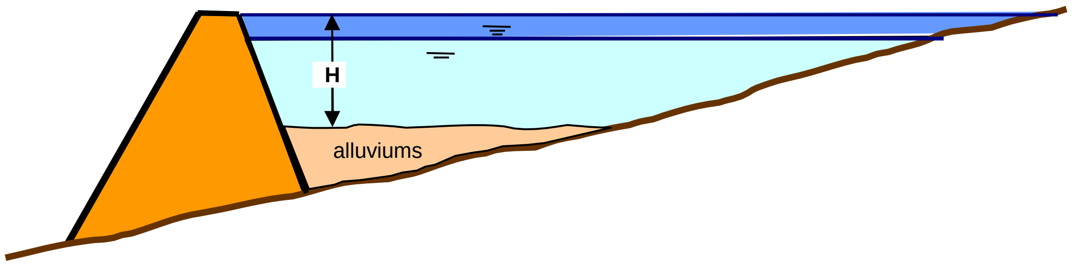
Working Step	*Activity*

$$Q_{max} = \frac{8}{27}\sqrt{g} \cdot B \cdot H^{\frac{3}{2}}$$

where H = water standing in the dam at the beginning of the breakage / spill [m]

= height of the dam wall from the water side (overflow of the dam)

B = Maximum destruction / breakthrough width [m]



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for H <= 5 m B = 30% of the width of the dam wall (from experience in Bulgaria)

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for H> 5 m B = 2 H (in case of destruction / breakdown of the dam wall)

$$Q_{max} = \frac{8}{27} \cdot \sqrt{g} \cdot 2 \cdot H \cdot H^{\frac{3}{2}} = 1{,}856 \cdot H^{\frac{5}{2}}$$

- In order to limit the hydraulic impact of the destruction of the dam in the downstream, below the installation, it is taken simplified that the additional water quantity calculated in the formula decreases in the order of 1% - 2% per kilometer distance from the destruction site.

Working Step		Activity
		- If a cascade of dams is located under a critical dam wall, and the other dams would take up the high wave generated by the destruction, the additional threat in the area under the cascade dams can be removed.
	6	**Determination of the roughness factor**
		The roughness factor, usually or in most cases, can be determined generally (e.g., n = 0.04) for the study area
	7	**Determination of representative bottom slope**
		It is advisable to determine the slope of the bottom based on a longitudinal profile depicting the shape of the river bed. From this longitudinal profile the average slope is displayed. With a varying slope of the bottom in the longitudinal profile, in individual cases, it would be appropriate to separate the river stretch of the survey on separate plots for which the calculations to determine the mean slope separately be made.
	8	**Conducting calculations for uniformity stream conditions**
		By calculation of the conditions of uniform movement is possible estimating the volume of water in high waves for different depths specify and thereby - determining the key trajectory for each cross section. Then, using the key curve, the depth (normal depth) corresponding to a set Q_{100} water quantity (with a 1% coverage and a repetition period of 100 years) can be determined, respectively the Q_{sum} corrected for an additional threat. The averaging of the specified depth of flooding by plots gives a representative depth that is generally used to determine the water levels corresponding to a high wave with a 1% security, respectively a repetition period of 100 years.

Working Step		*Activity*
	9	**Verification of the reliability of the results**
		In principle, the results of the water level calculations must, finaly, be verified for reliability. The depiction of the calculated water levels in longitudinal profile allows the identification and in case of need – manual correction of unrealistic values. If in some cases this calculation method or the height model SRTM used is in principle not suitable for calculating realistic pouring depths, a more accurate method (digital modeling, card processing, etc.) should be applied in such cases.
	10	**Generate a continuous water surface (water mirror) for the Q_{100}**
		The water levels calculated for each cross section are triangulated to form a continuous water surface.
	11	**Calculation of the flooded areas for high wave with a guarantee of 1%, respectively with a period of repetition 100 years**
		The calculation of the flooded areas for a high wave with collateral of 1%, respectively with a repetition period of 100 years, is done by comparing the continuous water surface with the digital model of the terrain (calculation of differences).
	The standardized approach to identifying potentially endangered stretches along the river is also applicable to lakes (see the supplementary description for a "Lakes" particular case in Chapter B.4.2.8). The determination of the water levels for the Black Sea coast is done not on the basis of hydraulic calculations but by statistical processing of the available data from the coastal network. After this treatment, the floodplains along the Black Sea coast are determined, similarly to the rivers, by matching the water surface and the terrain model.	

Working Step	Activity
5	**Special cases "Lakes" and "Black Sea coast"**
	The standard method for determining floodplains along river basins can also be used in general for lakes (see additional guidelines for a special "Lakes" case in Chapter 4.2.8.1). For the Black Sea coast, water levels are not determined by hydraulic calculations but based on a statistical analysis of all existing data from sea level measurements. Then and here, as in river stretches, the floodplains are obtained by comparing the designated water surface and the digital model of the coastal terrain.
6	**Subsequent adaptation of flood threat results by taking local features into account (if necessary) (Chapter B.4.3)**
	It is possible that in a given area of study there are local features that are not reflected in the results of the calculation of the flooded areas (eg the decisive influence of small terrain structures on the flood situation such as bridges, railways and road embankments, etc.) or there are built facilities for flood protection, which had a significant impact on the situation in the case of flood. In these cases, the results of calculations of the flooded areas can be manually adapted to the existing conditions. For this aim must be used the experience and knowledge of responsible and local offices. The impact assessment of the protective devices shall be assessed in accordance with the instructions given in Chapter C.4.3.3. Depending on the type of protective facilities (dams, riverbed correction, protective dikes, respectively firewalls), various instructions are made which can be summarized as follows (similar to past floods):
	• Floods can be excluded only in cases where the safety of flood protection can be demonstrated unequivocally / clearly, provided that sufficient retention volume is available.

Working Step	Activity
	• In most cases, the effect of the measures for flood protection is not taken into account.
	• If the type of protective facilities itself indicates indirectly that there is a significant flood risk (for example, due to large investments in flood protection), it is considered that the significance of the flood risk is thus proven and the additional treatment can be abolished.

7	**Determination of flood damage (Chapter B.6.2)**	
	In this work step, the impact of the individual protected categories is determined on the basis of calculated or corrected flooding limits. This is done in the following way (similar to past floods):	
	1	**Verify output data on Google Earth**
		Before actual processing, the available data must be verified. For this purpose, all GIS-relevant data (flood boundaries, population boundaries, other potential damages) are converted into KLM / KLZ format and depicted on Google Earth. Then, based on the information on Google Earth (orthophoto), available information, such as population boundaries, can be checked and, if necessary, corrected.
	2	**Anticipating future development of settlements (if necessary)**
		If there is evidence of foreseeable future development of settlements, this development can be taken into account in the treatment, by means of an appropriate adjustment (in GIS), for example, of the actual boundaries of settlements or industrial zones.

Working Step		Activity
	3	**Determining the population density**
		Minimum population density should be calculated for flood-affected settlements. It can be obtained by dividing the total population of a given settlement by the area of the settlement defined in the GIS.
	4	**Determining the number of affected residents**
		In order to determine the impact of the protected categories "Human health" and "Economic activity" in the GIS, the known boundaries of the floodplains are compared with the updated boundaries of the settlements or of the industrial zones respectively. The resulting affected area of the settlement and the calculated population density of the respective settlement give rise to the number of affected inhabitants per settlement, which is reflected in the GIS.
	5	**Impact on important industrial zones and infrastructure facilities**
		In order to determine the impact of a protected business category, additional important industrial areas and infrastructure facilities are located within the boundaries of the floodplains, and the consequences of flooding of these areas and facilities are determined. The affected industrial areas and facilities are submitted to the GIS with appropriate comments on their impact
	6	**Impact on facilities from the European Pollutant Release and Transmission Register - E-PRTR (water pollutants)**
		In order to determine the impact of a protected environment category within the floodplains, facilities from the European Emissions and Transfer of Pollutants (EIPPP) are located and the effects of leakage of water pollutants are assessed. The affected facilities are classified and noted in the GIS with appropriate comments on their impact.

Working Step	Activity

	7	**Impact on protected natural areas pursuant to the Law on Biological Diversity and Water Protection Areas in accordance with the Law on the Carriages**
		In order to determine the impact of the protected environment category within the floodplains, the protected areas for the protection of the habitats and the Natura 2000 species and the water protection areas, which include the groundwater bodies for drinking water supply and the water bodies, containing mineral waters, sanitary protection zones around water abstraction facilities and bathing water areas and assessing the environmental consequences of flooding with contaminated waters. The affected protected areas are classified and noted in the GIS with appropriate comments on their impact.
	8	**Impact on cultural monuments**
		In order to determine the impact of a protected cultural heritage category within the floodplains, cultural monuments are localized and the consequences of the flooding of these cultural monuments are estimated. Affected cultural monuments are classified and noted in the GIS with appropriate comments about their impact.

8	**Verification of significance criteria (iterative) (Chapter B.6.4)**
	The determination of the significance criteria is carried out in the iterative manner described in Chapter B.6.4.1 (similar to past floods). The initial threshold values of the criteria set out in the methodological guidelines are initially used to check the significance. Thus, in combination with the processing of past flood data, all flooded areas with significant flood risk are obtained, for which further in-depth studies should be carried out. The chosen approach for determining the significance criteria allows at this stage to approximate the resulting volume of funds and time for subsequent studies. In case of need, the threshold values of the significance criteria can be optimized according to the available resource. Initially for the protected categories "Human Health", " Economic Activity ", "Environment" and "Cultural heritage" applies described in

Working Step	*Activity*
	Chapter B.6.4.2 and Chapter B.6.4.3 and listed here criteria for significance of flood risk sections with potential threat: A river section is defined as meaningful if the following result is obtained in the determination of potential damage:
	• More than **100** people (Protected Categories of Human Health and Economic Activity) are affected within one settlement, or
	• important industrial areas or important infrastructure facilities are affected and in addition floods on these plots can be expected to cause significant damage (the Economic Activity category) or
	• the facilities of the European Pollutant Release and Transfer Register - E-PRTR (water polluting substances) are affected and, in the event of flooding, significant environmental damage is expected. ("Environment" protected category) or
	• protected areas (Biodiversity Act) and water protection zones (the Waters Act) with polluted waters are affected, and in case of flood, significant environmental damage is expected ("Environment" protected category)
	• flood-hit areas are important cultural monuments, where significant irreparable damage is expected in the event of flooding ("Protected cultural heritage" category)

Working Step	*Activity*
9	**Determining areas with a significant potential risk of flooding**
	If a river stretch is defined on the basis of the criteria of significance as an area with a significant potential flood risk, it is labeled in GIS by Line or Polygon as such. Typically, when defining river areas with significant potential flood risks, areas longer than the length of the real danger area are marked. For example, settlements are always taken into account with their entire territory, adding a certain buffer zone to the actual boundaries of the settlement (foreseeing future expansion of the settlement).

10	**Summarizing the results (Chapter B.8)**
	Summarizing and transmitting the results is done in accordance with the guidelines described in Chapter B.8.